# ChibiOS/HAL

6.0.1

# Reference Manual

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# Contents

# Chapter 1

# ChibiOS/HAL

## 1.1 Copyright

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## 1.2 Introduction

This document is the Reference Manual for the ChibiOS/HAL hardware abstraction layer.

## 1.3 Related Documents

- ChibiOS/HAL General Architecture

# Chapter 2

# Deprecated List

**Global canReceive (canp, mailbox, crfp, timeout)**

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**Global sdGetWouldBlock (SerialDriver ∗sdp)**

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# Chapter 3

# Module Index

## 3.1 Modules

Here is a list of all modules:

# Chapter 4

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# Chapter 5

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## 5.1 Data Structures

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# Chapter 6

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## 6.1 File List

Here is a list of all documented files with brief descriptions:

# Chapter 7

# Module Documentation

## 7.1 Generic Accelerometer Interface

HAL Generic Accelerometer Interface.

### 7.1.1 Detailed Description

HAL Generic Accelerometer Interface.

#### Macros

- #define _base_accelerometer_methods_alone

  *BaseAccelerometer specific methods.*
- #define _base_accelerometer_methods

  *BaseAccelerometer specific methods with inherited ones.*
- #define _base_accelerometer_data _base_sensor_data

  *`BaseAccelerometer` specific data.*

#### Macro Functions (BaseAccelerometer)

- #define accelerometerGetAxesNumber(ip) (ip)->vmt->get_channels_number(ip)

  *Accelerometer get axes number.*
- #define accelerometerReadRaw(ip, dp) (ip)->vmt->read_raw(ip, dp)

  *Accelerometer read raw data.*
- #define accelerometerReadCooked(ip, dp) (ip)->vmt->read_cooked(ip, dp)

  *Accelerometer read cooked data.*
- #define accelerometerSetBias(ip, bp) (ip)->vmt->set_bias(ip, bp)

  *Updates accelerometer bias data from received buffer.*
- #define accelerometerResetBias(ip) (ip)->vmt->reset_bias(ip)

  *Reset accelerometer bias data restoring it to zero.*
- #define accelerometerSetSensitivity(ip, sp) (ip)->vmt->set_sensitivity(ip, sp)

  *Updates accelerometer sensitivity data from received buffer.*
- #define accelerometerResetSensitivity(ip) (ip)->vmt->reset_sensitivity(ip)

  *Reset accelerometer sensitivity data restoring it to its typical value.*

## Data Structures

- struct BaseAccelerometerVMT

  *BaseAccelerometer virtual methods table.*
- struct BaseAccelerometer

  *Base accelerometer class.*

## 7.1.2 Macro Definition Documentation

### 7.1.2.1 #define _base_accelerometer_methods_alone

**Value:**

```
/* Invoke the set bias procedure.*/                                        \
  msg_t (*set_bias)(void *instance, float biases[]);                         \
  /* Remove bias stored data.*/                                              \
  msg_t (*reset_bias)(void *instance);                                       \
  /* Invoke the set sensitivity procedure.*/                                 \
  msg_t (*set_sensitivity)(void *instance, float sensitivities[]);           \
  /* Restore sensitivity stored data to default.*/                           \
  msg_t (*reset_sensitivity)(void *instance);
```

BaseAccelerometer specific methods.

### 7.1.2.2 #define _base_accelerometer_methods

**Value:**

```
_base_sensor_methods                                                       \
  _base_accelerometer_methods_alone
```

BaseAccelerometer specific methods with inherited ones.

### 7.1.2.3 #define _base_accelerometer_data _base_sensor_data

BaseAccelerometer specific data.

### 7.1.2.4 #define accelerometerGetAxesNumber( *ip* ) (ip)->vmt->get_channels_number(ip)

Accelerometer get axes number.

**Parameters**

| | | |
|---|---|---|
| in | *ip* | pointer to a BaseAccelerometer class. |

**Returns**

The number of axes of the BaseAccelerometer

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

### 7.1.2.5 #define accelerometerReadRaw( *ip, dp* ) (ip)->vmt->read_raw(ip, dp)

Accelerometer read raw data.

**Parameters**

| | | |
|---|---|---|
| in | *ip* | pointer to a BaseAccelerometer class. |
| in | *dp* | pointer to a data array. |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *MSG_OK* | if the function succeeded. |
| *MSG_RESET* | if one or more errors occurred. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.1.2.6 #define accelerometerReadCooked( *ip, dp* ) (ip)->vmt->read_cooked(ip, dp)

Accelerometer read cooked data.

**Parameters**

| | | |
|---|---|---|
| in | *ip* | pointer to a BaseAccelerometer class. |
| in | *dp* | pointer to a data array. |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *MSG_OK* | if the function succeeded. |
| *MSG_RESET* | if one or more errors occurred. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.1.2.7 #define accelerometerSetBias( *ip, bp* ) (ip)->vmt->set_bias(ip, bp)

Updates accelerometer bias data from received buffer.

**Note**

The bias buffer must have the same length of the the accelerometer axes number.

**Parameters**

| | | |
|---|---|---|
| in | *ip* | pointer to a BaseAccelerometer class. |
| in | *bp* | pointer to a buffer of bias values. |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *MSG_OK* | if the function succeeded. |
| *MSG_RESET* | if one or more errors occurred. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.1.2.8 #define accelerometerResetBias( *ip* ) (ip)->vmt->reset_bias(ip)

Reset accelerometer bias data restoring it to zero.

**Parameters**

| | | |
|---|---|---|
| in | *ip* | pointer to a BaseAccelerometer class. |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *MSG_OK* | if the function succeeded. |
| *MSG_RESET* | if one or more errors occurred. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.1.2.9 #define accelerometerSetSensitivity( *ip, sp* ) (ip)->vmt->set_sensitivity(ip, sp)

Updates accelerometer sensitivity data from received buffer.

**Note**

The sensitivity buffer must have the same length of the the accelerometer axes number.

**Parameters**

| | | |
|---|---|---|
| in | *ip* | pointer to a BaseAccelerometer class. |
| in | *sp* | pointer to a buffer of sensitivity values. |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *MSG_OK* | if the function succeeded. |
| *MSG_RESET* | if one or more errors occurred. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.1.2.10 #define accelerometerResetSensitivity( *ip* ) (ip)->vmt->reset_sensitivity(ip)

Reset accelerometer sensitivity data restoring it to its typical value.

**Parameters**

| | | |
|---|---|---|
| `in` | *ip* | pointer to a `BaseAccelerometer` class. |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *MSG_OK* | if the function succeeded. |
| *MSG_RESET* | if one or more errors occurred. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

## 7.2 ADC Driver

Generic ADC Driver.

### 7.2.1 Detailed Description

Generic ADC Driver.

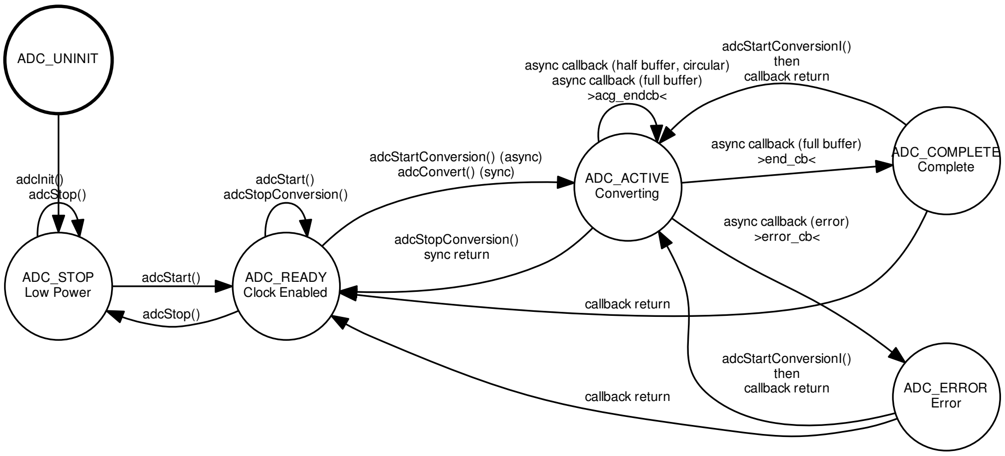
This module implements a generic ADC (Analog to Digital Converter) driver supporting a variety of buffer and conversion modes.

**Precondition**

In order to use the ADC driver the `HAL_USE_ADC` option must be enabled in `halconf.h`.

### 7.2.2 Driver State Machine

The driver implements a state machine internally, not all the driver functionalities can be used in any moment, any transition not explicitly shown in the following diagram has to be considered an error and shall be captured by an assertion (if enabled).



### 7.2.3 ADC Operations

The ADC driver is quite complex, an explanation of the terminology and of the operational details follows.

#### 7.2.3.1 ADC Conversion Groups

The `ADCConversionGroup` is the objects that specifies a physical conversion operation. This structure contains some standard fields and several implementation-dependent fields.
The standard fields define the CG mode, the number of channels belonging to the CG and the optional callbacks.
The implementation-dependent fields specify the physical ADC operation mode, the analog channels belonging to the group and any other implementation-specific setting. Usually the extra fields just mirror the physical ADC

registers, please refer to the vendor's MCU Reference Manual for details about the available settings. Details are also available into the documentation of the ADC low level drivers and in the various sample applications.

#### 7.2.3.2 ADC Conversion Modes

The driver supports several conversion modes:

- **One Shot**, the driver performs a single group conversion then stops.
- **Linear Buffer**, the driver performs a series of group conversions then stops. This mode is like a one shot conversion repeated N times, the buffer pointer increases after each conversion. The buffer is organized as an S(CG)∗N samples matrix, when S(CG) is the conversion group size (number of channels) and N is the buffer depth (number of repeated conversions).
- **Circular Buffer**, much like the linear mode but the operation does not stop when the buffer is filled, it is automatically restarted with the buffer pointer wrapping back to the buffer base.

#### 7.2.3.3 ADC Callbacks

The driver is able to invoke callbacks during the conversion process. A callback is invoked when the operation has been completed or, in circular mode, when the buffer has been filled and the operation is restarted. In circular mode a callback is also invoked when the buffer is half filled.
The "half filled" and "filled" callbacks in circular mode allow to implement "streaming processing" of the sampled data, while the driver is busy filling one half of the buffer the application can process the other half, this allows for continuous interleaved operations.

The driver is not thread safe for performance reasons, if you need to access the ADC bus from multiple threads then use the `adcAcquireBus()` and `adcReleaseBus()` APIs in order to gain exclusive access.

### ADC configuration options

- #define ADC_USE_WAIT TRUE

  *Enables synchronous APIs.*
- #define ADC_USE_MUTUAL_EXCLUSION TRUE

  *Enables the `adcAcquireBus()` and `adcReleaseBus()` APIs.*

### Low level driver helper macros

- #define _adc_reset_i(adcp) osalThreadResumeI(&(adcp)->thread, MSG_RESET)

  *Resumes a thread waiting for a conversion completion.*
- #define _adc_reset_s(adcp) osalThreadResumeS(&(adcp)->thread, MSG_RESET)

  *Resumes a thread waiting for a conversion completion.*
- #define _adc_wakeup_isr(adcp)

  *Wakes up the waiting thread.*
- #define _adc_timeout_isr(adcp)

  *Wakes up the waiting thread with a timeout message.*
- #define _adc_isr_half_code(adcp)

  *Common ISR code, half buffer event.*
- #define _adc_isr_full_code(adcp)

  *Common ISR code, full buffer event.*
- #define _adc_isr_error_code(adcp, err)

  *Common ISR code, error event.*

## PLATFORM configuration options

- #define PLATFORM_ADC_USE_ADC1 FALSE

  *ADC1 driver enable switch.*

## Typedefs

- typedef uint16_t adcsample_t

  *ADC sample data type.*
- typedef uint16_t adc_channels_num_t

  *Channels number in a conversion group.*
- typedef struct ADCDriver ADCDriver

  *Type of a structure representing an ADC driver.*
- typedef void(∗ adccallback_t) (ADCDriver ∗adcp, adcsample_t ∗buffer, size_t n)

  *ADC notification callback type.*
- typedef void(∗ adcerrorcallback_t) (ADCDriver ∗adcp, adcerror_t err)

  *ADC error callback type.*

## Data Structures

- struct ADCConversionGroup

  *Conversion group configuration structure.*
- struct ADCConfig

  *Driver configuration structure.*
- struct ADCDriver

  *Structure representing an ADC driver.*

## Functions

- void adcInit (void)

  *ADC Driver initialization.*
- void adcObjectInit (ADCDriver ∗adcp)

  *Initializes the standard part of a `ADCDriver` structure.*
- void adcStart (ADCDriver ∗adcp, const ADCConfig ∗config)

  *Configures and activates the ADC peripheral.*
- void adcStop (ADCDriver ∗adcp)

  *Deactivates the ADC peripheral.*
- void adcStartConversion (ADCDriver ∗adcp, const ADCConversionGroup ∗grpp, adcsample_t ∗samples, size_t depth)

  *Starts an ADC conversion.*
- void adcStartConversionI (ADCDriver ∗adcp, const ADCConversionGroup ∗grpp, adcsample_t ∗samples, size_t depth)

  *Starts an ADC conversion.*
- void adcStopConversion (ADCDriver ∗adcp)

  *Stops an ongoing conversion.*
- void adcStopConversionI (ADCDriver ∗adcp)

  *Stops an ongoing conversion.*
- msg_t adcConvert (ADCDriver ∗adcp, const ADCConversionGroup ∗grpp, adcsample_t ∗samples, size_t depth)

  *Performs an ADC conversion.*
- void adcAcquireBus (ADCDriver ∗adcp)

*Gains exclusive access to the ADC peripheral.*
- void adcReleaseBus (ADCDriver ∗adcp)

  *Releases exclusive access to the ADC peripheral.*
- void adc_lld_init (void)

  *Low level ADC driver initialization.*
- void adc_lld_start (ADCDriver ∗adcp)

  *Configures and activates the ADC peripheral.*
- void adc_lld_stop (ADCDriver ∗adcp)

  *Deactivates the ADC peripheral.*
- void adc_lld_start_conversion (ADCDriver ∗adcp)

  *Starts an ADC conversion.*
- void adc_lld_stop_conversion (ADCDriver ∗adcp)

  *Stops an ongoing conversion.*

## Enumerations

## Variables

- ADCDriver ADCD1

  *ADC1 driver identifier.*

## 7.2.4 Macro Definition Documentation

### 7.2.4.1 #define ADC_USE_WAIT TRUE

Enables synchronous APIs.

**Note**

Disabling this option saves both code and data space.

### 7.2.4.2 #define ADC_USE_MUTUAL_EXCLUSION TRUE

Enables the `adcAcquireBus()` and `adcReleaseBus()` APIs.

**Note**

Disabling this option saves both code and data space.

### 7.2.4.3 #define _adc_reset_i( *adcp* ) osalThreadResumeI(&(adcp)->thread, MSG_RESET)

Resumes a thread waiting for a conversion completion.

**Parameters**

| | | |
|---|---|---|
| `in` | *adcp* | pointer to the `ADCDriver` object |

**Function Class:**

Not an API, this function is for internal use only.

### 7.2.4.4 #define _adc_reset_s( *adcp* ) osalThreadResumeS(&(adcp)->thread, MSG_RESET)

Resumes a thread waiting for a conversion completion.

**Parameters**

|  |  |  |
|---|---|---|
| in | *adcp* | pointer to the ADCDriver object |

**Function Class:**

Not an API, this function is for internal use only.

### 7.2.4.5 #define _adc_wakeup_isr( *adcp* )

**Value:**

```
{                                              \
  osalSysLockFromISR();
      \
  osalThreadResumeI(&(adcp)->thread, MSG_OK);
      \
  osalSysUnlockFromISR();                                              \
}
```

Wakes up the waiting thread.

**Parameters**

|  |  |  |
|---|---|---|
| in | *adcp* | pointer to the ADCDriver object |

**Function Class:**

Not an API, this function is for internal use only.

### 7.2.4.6 #define _adc_timeout_isr( *adcp* )

**Value:**

```
{                                             \
  osalSysLockFromISR();
      \
  osalThreadResumeI(&(adcp)->thread, MSG_TIMEOUT);
      \
  osalSysUnlockFromISR();                                              \
}
```

Wakes up the waiting thread with a timeout message.

**Parameters**

|  |  |  |
|---|---|---|
| in | *adcp* | pointer to the ADCDriver object |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.2.4.7 #define _adc_isr_half_code( *adcp* )

**Value:**

```
{                                                   \
  if ((adcp)->grpp->end_cb != NULL) {                                    \
    (adcp)->grpp->end_cb(adcp, (adcp)->samples, (adcp)->depth / 2);      \
  }                                                                      \
}
```

Common ISR code, half buffer event.

This code handles the portable part of the ISR code:

- Callback invocation.

**Note**

This macro is meant to be used in the low level drivers implementation only.

**Parameters**

| | | |
|---|---|---|
| in | *adcp* | pointer to the ADCDriver object |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.2.4.8 #define _adc_isr_full_code( *adcp* )

Common ISR code, full buffer event.

This code handles the portable part of the ISR code:

- Callback invocation.
- Waiting thread wakeup, if any.
- Driver state transitions.

**Note**

This macro is meant to be used in the low level drivers implementation only.

**Parameters**

| | | |
|---|---|---|
| in | *adcp* | pointer to the ADCDriver object |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.2.4.9 #define _adc_isr_error_code( *adcp, err* )

**Value:**

```
{                                     \
  adc_lld_stop_conversion(adcp);                                       \
  if ((adcp)->grpp->error_cb != NULL) {                                \
    (adcp)->state = ADC_ERROR;                                         \
    (adcp)->grpp->error_cb(adcp, err);                                 \
    if ((adcp)->state == ADC_ERROR)                                    \
      (adcp)->state = ADC_READY;                                       \
      (adcp)->grpp = NULL;                                             \
  }                                                                    \
  else {                                                               \
    (adcp)->state = ADC_READY;                                         \
    (adcp)->grpp = NULL;                                               \
  }                                                                    \
  _adc_timeout_isr(adcp);                                              \
}
```

Common ISR code, error event.

This code handles the portable part of the ISR code:

- Callback invocation.
- Waiting thread timeout signaling, if any.
- Driver state transitions.

**Note**

This macro is meant to be used in the low level drivers implementation only.

**Parameters**

| | | |
|---|---|---|
| in | *adcp* | pointer to the ADCDriver object |
| in | *err* | platform dependent error code |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.2.4.10 #define PLATFORM_ADC_USE_ADC1 FALSE

ADC1 driver enable switch.

If set to TRUE the support for ADC1 is included.

**Note**

The default is FALSE.

### 7.2.5 Typedef Documentation

#### 7.2.5.1 typedef uint16_t adcsample_t

ADC sample data type.

#### 7.2.5.2 typedef uint16_t adc_channels_num_t

Channels number in a conversion group.

#### 7.2.5.3 typedef struct ADCDriver ADCDriver

Type of a structure representing an ADC driver.

#### 7.2.5.4 typedef void(∗ adccallback_t) (ADCDriver ∗adcp, adcsample_t ∗buffer, size_t n)

ADC notification callback type.

**Parameters**

| | | |
|---|---|---|
| in | *adcp* | pointer to the ADCDriver object triggering the callback |
| in | *buffer* | pointer to the most recent samples data |
| in | *n* | number of buffer rows available starting from `buffer` |

#### 7.2.5.5 typedef void(∗ adcerrorcallback_t) (ADCDriver ∗adcp, adcerror_t err)

ADC error callback type.

**Parameters**

| | | |
|---|---|---|
| in | *adcp* | pointer to the ADCDriver object triggering the callback |
| in | *err* | ADC error code |

### 7.2.6 Enumeration Type Documentation

#### 7.2.6.1 enum adcstate_t

Driver state machine possible states.

**Enumerator**

***ADC_UNINIT*** Not initialized.

***ADC_STOP*** Stopped.

***ADC_READY*** Ready.

***ADC_ACTIVE*** Converting.

***ADC_COMPLETE*** Conversion complete.

***ADC_ERROR*** Conversion error.

#### 7.2.6.2 enum adcerror_t

Possible ADC failure causes.

**Note**

Error codes are architecture dependent and should not relied upon.

**Enumerator**

***ADC_ERR_DMAFAILURE*** DMA operations failure.

***ADC_ERR_OVERFLOW*** ADC overflow condition.

***ADC_ERR_AWD*** Analog watchdog triggered.

## 7.2.7 Function Documentation

### 7.2.7.1 void adcInit ( void )

ADC Driver initialization.

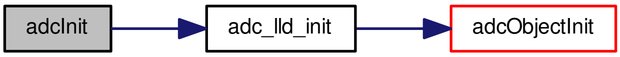
**Note**

This function is implicitly invoked by `halInit()`, there is no need to explicitly initialize the driver.

**Function Class:**

Initializer, this function just initializes an object and can be invoked before the kernel is initialized.

Here is the call graph for this function:



### 7.2.7.2 void adcObjectInit ( ADCDriver ∗ *adcp* )

Initializes the standard part of a `ADCDriver` structure.

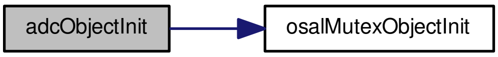
**Parameters**

|  |  |  |
|---|---|---|
| out | *adcp* | pointer to the `ADCDriver` object |

**Function Class:**

Initializer, this function just initializes an object and can be invoked before the kernel is initialized.

Here is the call graph for this function:



### 7.2.7.3 void adcStart ( ADCDriver ∗ *adcp*, const ADCConfig ∗ *config* )

Configures and activates the ADC peripheral.

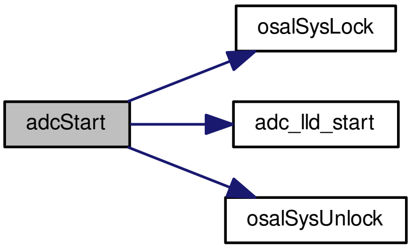
**Parameters**

| | | |
|---|---|---|
| in | *adcp* | pointer to the ADCDriver object |
| in | *config* | pointer to the ADCConfig object. Depending on the implementation the value can be NULL. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.2.7.4 void adcStop ( ADCDriver ∗ *adcp* )

Deactivates the ADC peripheral.

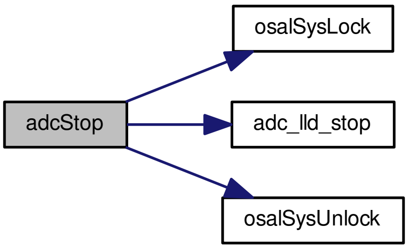
**Parameters**

| | | |
|---|---|---|
| in | *adcp* | pointer to the ADCDriver object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.2.7.5 void adcStartConversion ( ADCDriver ∗ *adcp*, const ADCConversionGroup ∗ *grpp*, adcsample_t ∗ *samples*, size_t *depth* )

Starts an ADC conversion.

Starts an asynchronous conversion operation.

**Note**

The buffer is organized as a matrix of M∗N elements where M is the channels number configured into the conversion group and N is the buffer depth. The samples are sequentially written into the buffer with no gaps.

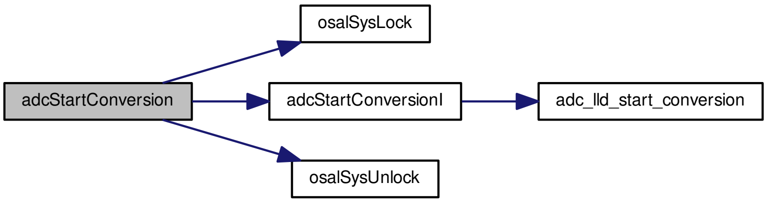
**Parameters**

| | | |
|---|---|---|
| `in` | *adcp* | pointer to the `ADCDriver` object |
| `in` | *grpp* | pointer to a `ADCConversionGroup` object |
| `out` | *samples* | pointer to the samples buffer |
| `in` | *depth* | buffer depth (matrix rows number). The buffer depth must be one or an even number. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.2.7.6 void adcStartConversionI ( **ADCDriver** ∗ *adcp*, const **ADCConversionGroup** ∗ *grpp*, **adcsample_t** ∗ *samples*, size_t *depth* )

Starts an ADC conversion.

Starts an asynchronous conversion operation.

**Postcondition**

The callbacks associated to the conversion group will be invoked on buffer fill and error events.

**Note**

The buffer is organized as a matrix of M∗N elements where M is the channels number configured into the conversion group and N is the buffer depth. The samples are sequentially written into the buffer with no gaps.

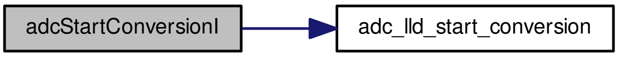
**Parameters**

| | | |
|---|---|---|
| in | *adcp* | pointer to the ADCDriver object |
| in | *grpp* | pointer to a ADCConversionGroup object |
| out | *samples* | pointer to the samples buffer |
| in | *depth* | buffer depth (matrix rows number). The buffer depth must be one or an even number. |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

Here is the call graph for this function:



#### 7.2.7.7 void adcStopConversion ( **ADCDriver** ∗ *adcp* )

Stops an ongoing conversion.

This function stops the currently ongoing conversion and returns the driver in the `ADC_READY` state. If there was no conversion being processed then the function does nothing.

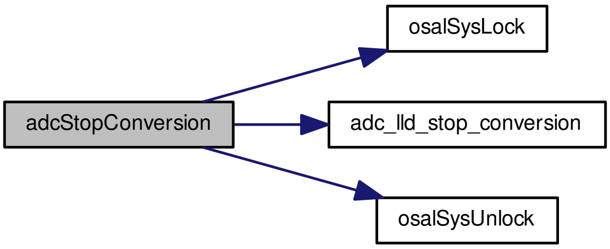
**Parameters**

| | | |
|---|---|---|
| in | *adcp* | pointer to the ADCDriver object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.2.7.8 void adcStopConversionI ( ADCDriver ∗ *adcp* )

Stops an ongoing conversion.

This function stops the currently ongoing conversion and returns the driver in the `ADC_READY` state. If there was no conversion being processed then the function does nothing.

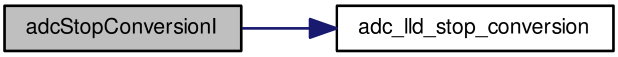
**Parameters**

| | | |
|---|---|---|
| in | *adcp* | pointer to the `ADCDriver` object |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

Here is the call graph for this function:



#### 7.2.7.9 msg_t adcConvert ( ADCDriver ∗ *adcp,* const ADCConversionGroup ∗ *grpp,* adcsample_t ∗ *samples,* size_t *depth* )

Performs an ADC conversion.

Performs a synchronous conversion operation.

Note

The buffer is organized as a matrix of M∗N elements where M is the channels number configured into the conversion group and N is the buffer depth. The samples are sequentially written into the buffer with no gaps.

Parameters

| | | |
|---|---|---|
| in | *adcp* | pointer to the ADCDriver object |
| in | *grpp* | pointer to a ADCConversionGroup object |
| out | *samples* | pointer to the samples buffer |
| in | *depth* | buffer depth (matrix rows number). The buffer depth must be one or an even number. |

Returns

The operation result.

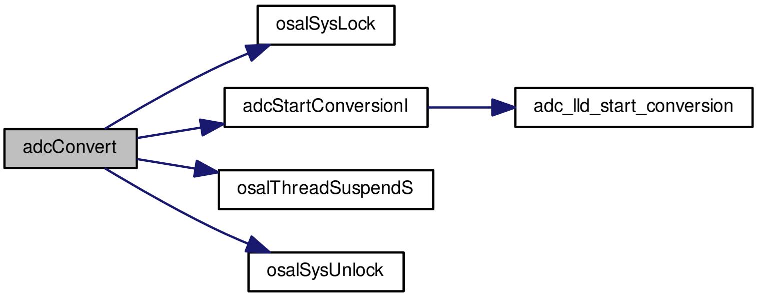
Return values

| | |
|---|---|
| *MSG_OK* | Conversion finished. |
| *MSG_RESET* | The conversion has been stopped using `acdStopConversion()` or `acdStopConversionI()`, the result buffer may contain incorrect data. |
| *MSG_TIMEOUT* | The conversion has been stopped because an hardware error. |

Function Class:

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



### 7.2.7.10 void adcAcquireBus ( ADCDriver ∗ *adcp* )

Gains exclusive access to the ADC peripheral.

This function tries to gain ownership to the ADC bus, if the bus is already being used then the invoking thread is queued.

**Precondition**

In order to use this function the option ADC_USE_MUTUAL_EXCLUSION must be enabled.

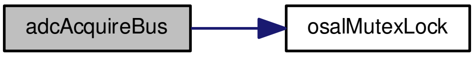
**Parameters**

|  |  |  |
|---|---|---|
| in | *adcp* | pointer to the ADCDriver object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.2.7.11 void adcReleaseBus ( ADCDriver ∗ *adcp* )

Releases exclusive access to the ADC peripheral.

**Precondition**

In order to use this function the option ADC_USE_MUTUAL_EXCLUSION must be enabled.

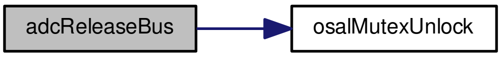
**Parameters**

|  |  |  |
|---|---|---|
| in | *adcp* | pointer to the ADCDriver object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



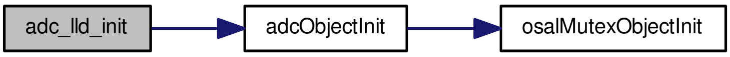
#### 7.2.7.12 void adc_lld_init ( void )

Low level ADC driver initialization.

**Function Class:**

Not an API, this function is for internal use only.

Here is the call graph for this function:



#### 7.2.7.13 void adc_lld_start ( ADCDriver * *adcp* )

Configures and activates the ADC peripheral.

**Parameters**

| | | |
|---|---|---|
| in | *adcp* | pointer to the ADCDriver object |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.2.7.14 void adc_lld_stop ( ADCDriver * *adcp* )

Deactivates the ADC peripheral.

**Parameters**

| | | |
|---|---|---|
| in | *adcp* | pointer to the ADCDriver object |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.2.7.15 void adc_lld_start_conversion ( ADCDriver * *adcp* )

Starts an ADC conversion.

**Parameters**

| | | |
|---|---|---|
| in | *adcp* | pointer to the ADCDriver object |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.2.7.16 void adc_lld_stop_conversion ( ADCDriver * *adcp* )

Stops an ongoing conversion.

**Parameters**

| | | |
|---|---|---|
| in | *adcp* | pointer to the ADCDriver object |

**Function Class:**

Not an API, this function is for internal use only.

### 7.2.8 Variable Documentation

#### 7.2.8.1 ADCDriver ADCD1

ADC1 driver identifier.

## 7.3 Generic Barometer Interface

HAL Generic Barometer Interface.

### 7.3.1 Detailed Description

HAL Generic Barometer Interface.

### Macros

- #define _base_barometer_methods_alone

  *BaseBarometer specific methods.*
- #define _base_barometer_methods

  *BaseBarometer specific methods with inherited ones.*
- #define _base_barometer_data _base_sensor_data

  *`BaseBarometer` specific data.*

### Macro Functions (BaseBarometer)

- #define barometerGetChannelsNumber(ip) (ip)->vmt->get_channels_number(ip)

  *Barometer get channels number.*
- #define barometerReadRaw(ip, dp) (ip)->vmt->read_raw(ip, dp)

  *Barometer read raw data.*
- #define barometerReadCooked(ip, dp) (ip)->vmt->read_cooked(ip, dp)

  *Barometer read cooked data.*
- #define barometerSetBias(ip, bp) (ip)->vmt->set_bias(ip, bp)

  *Updates barometer bias data from received buffer.*
- #define barometerResetBias(ip) (ip)->vmt->reset_bias(ip)

  *Reset barometer bias data restoring it to zero.*
- #define barometerSetSensitivity(ip, sp) (ip)->vmt->set_sensitivity(ip, sp)

  *Updates barometer sensitivity data from received buffer.*
- #define barometerResetSensitivity(ip) (ip)->vmt->reset_sensitivity(ip)

  *Reset barometer sensitivity data restoring it to its typical value.*

### Data Structures

- struct BaseBarometerVMT

  *`BaseBarometer` virtual methods table.*
- struct BaseBarometer

  *Base barometer class.*

### 7.3.2 Macro Definition Documentation

#### 7.3.2.1 #define _base_barometer_methods_alone

**Value:**

```
/* Invoke the set bias procedure.*/                                        \
  msg_t (*set_bias)(void *instance, float biases[]);                         \
  /* Remove bias stored data.*/                                              \
  msg_t (*reset_bias)(void *instance);                                       \
  /* Invoke the set sensitivity procedure.*/                                 \
  msg_t (*set_sensitivity)(void *instance, float sensitivities[]);           \
  /* Restore sensitivity stored data to default.*/                           \
  msg_t (*reset_sensitivity)(void *instance);
```

BaseBarometer specific methods.

### 7.3.2.2 #define _base_barometer_methods

**Value:**

```
_base_sensor_methods                                                       \
  _base_barometer_methods_alone
```

BaseBarometer specific methods with inherited ones.

### 7.3.2.3 #define _base_barometer_data _base_sensor_data

BaseBarometer specific data.

### 7.3.2.4 #define barometerGetChannelsNumber( *ip* ) (ip)->vmt->get_channels_number(ip)

Barometer get channels number.

**Parameters**

| | | |
|---|---|---|
| in | *ip* | pointer to a BaseBarometer class. |

**Returns**

The number of channels of the BaseBarometer

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

### 7.3.2.5 #define barometerReadRaw( *ip*, *dp* ) (ip)->vmt->read_raw(ip, dp)

Barometer read raw data.

**Parameters**

| | | |
|---|---|---|
| in | *ip* | pointer to a BaseBarometer class. |
| in | *dp* | pointer to a data array. |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *MSG_OK* | if the function succeeded. |
| *MSG_RESET* | if one or more errors occurred. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.3.2.6 #define barometerReadCooked( *ip,* *dp* ) (ip)->vmt->read_cooked(ip, dp)

Barometer read cooked data.

**Parameters**

| | | |
|---|---|---|
| `in` | *ip* | pointer to a `BaseBarometer` class. |
| `in` | *dp* | pointer to a data array. |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *MSG_OK* | if the function succeeded. |
| *MSG_RESET* | if one or more errors occurred. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.3.2.7 #define barometerSetBias( *ip,* *bp* ) (ip)->vmt->set_bias(ip, bp)

Updates barometer bias data from received buffer.

**Note**

The bias buffer must have the same length of the the barometer channels number.

**Parameters**

| | | |
|---|---|---|
| `in` | *ip* | pointer to a `BaseBarometer` class. |
| `in` | *bp* | pointer to a buffer of bias values. |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *MSG_OK* | if the function succeeded. |
| *MSG_RESET* | if one or more errors occurred. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

### 7.3.2.8 #define barometerResetBias( *ip* ) (ip)->vmt->reset_bias(ip)

Reset barometer bias data restoring it to zero.

**Parameters**

| | | |
|---|---|---|
| `in` | *ip* | pointer to a `BaseBarometer` class. |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *MSG_OK* | if the function succeeded. |
| *MSG_RESET* | if one or more errors occurred. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

### 7.3.2.9 #define barometerSetSensitivity( *ip*, *sp* ) (ip)->vmt->set_sensitivity(ip, sp)

Updates barometer sensitivity data from received buffer.

**Note**

The sensitivity buffer must have the same length of the the barometer channels number.

**Parameters**

| | | |
|---|---|---|
| `in` | *ip* | pointer to a `BaseBarometer` class. |
| `in` | *sp* | pointer to a buffer of sensitivity values. |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *MSG_OK* | if the function succeeded. |
| *MSG_RESET* | if one or more errors occurred. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.3.2.10 #define barometerResetSensitivity( *ip* ) (ip)->vmt->reset_sensitivity(ip)

Reset barometer sensitivity data restoring it to its typical value.

**Parameters**

| | | |
|---|---|---|
| in | *ip* | pointer to a BaseBarometer class. |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *MSG_OK* | if the function succeeded. |
| *MSG_RESET* | if one or more errors occurred. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

## 7.4 CAN Driver

Generic CAN Driver.

### 7.4.1 Detailed Description

Generic CAN Driver.

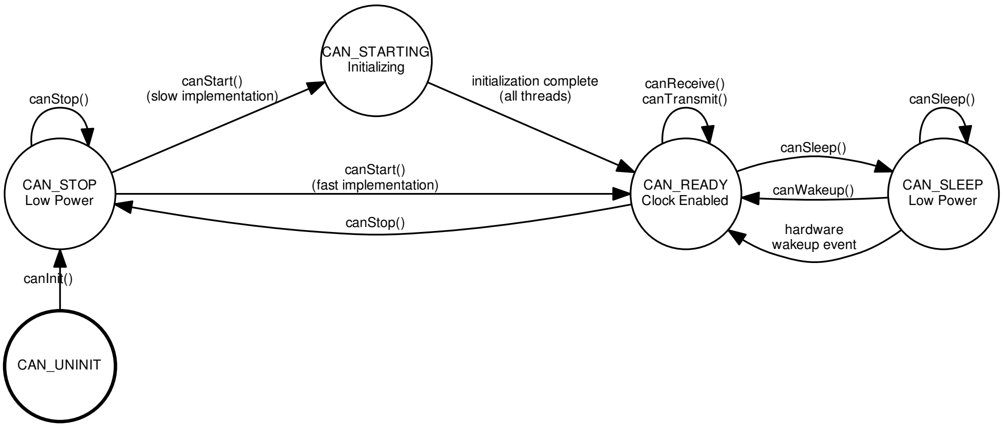
This module implements a generic CAN (Controller Area Network) driver allowing the exchange of information at frame level.

**Precondition**

In order to use the CAN driver the `HAL_USE_CAN` option must be enabled in `halconf.h`.

### 7.4.2 Driver State Machine

The driver implements a state machine internally, not all the driver functionalities can be used in any moment, any transition not explicitly shown in the following diagram has to be considered an error and shall be captured by an assertion (if enabled).



#### Macros

- #define CAN_ANY_MAILBOX 0U

  *Special mailbox identifier.*
- #define CAN_TX_MAILBOXES 1

  *Number of transmit mailboxes.*
- #define CAN_RX_MAILBOXES 1

  *Number of receive mailboxes.*

#### CAN status flags

- #define CAN_LIMIT_WARNING 1U

*Errors rate warning.*
- #define CAN_LIMIT_ERROR 2U

  *Errors rate error.*
- #define CAN_BUS_OFF_ERROR 4U

  *Bus off condition reached.*
- #define CAN_FRAMING_ERROR 8U

  *Framing error of some kind on the CAN bus.*
- #define CAN_OVERFLOW_ERROR 16U

  *Overflow in receive queue.*

## CAN configuration options

- #define CAN_USE_SLEEP_MODE TRUE

  *Sleep mode related APIs inclusion switch.*
- #define CAN_ENFORCE_USE_CALLBACKS FALSE

  *Enforces the driver to use direct callbacks rather than OSAL events.*

## Macro Functions

- #define CAN_MAILBOX_TO_MASK(mbx) (1U << ((mbx) - 1U))

  *Converts a mailbox index to a bit mask.*
- #define canTransmit(canp, mailbox, ctfp, timeout) canTransmitTimeout(canp, mailbox, ctfp, timeout)

  *Legacy name for `canTransmitTimeout()`.*
- #define canReceive(canp, mailbox, crfp, timeout) canReceiveTimeout(canp, mailbox, crfp, timeout)

  *Legacy name for `canReceiveTimeout()`.*

## Low level driver helper macros

- #define _can_tx_empty_isr(canp, flags)

  *TX mailbox empty event.*
- #define _can_rx_full_isr(canp, flags)

  *RX mailbox empty full event.*
- #define _can_wakeup_isr(canp)

  *Error event.*
- #define _can_error_isr(canp, flags)

  *Error event.*

## PLATFORM configuration options

- #define PLATFORM_CAN_USE_CAN1 FALSE

  *CAN1 driver enable switch.*

## Typedefs

- typedef struct CANDriver CANDriver

  *Type of a structure representing an CAN driver.*
- typedef uint32_t canmbx_t

  *Type of a transmission mailbox index.*
- typedef void(∗ can_callback_t) (CANDriver ∗canp, uint32_t flags)

  *Type of a CAN notification callback.*

## Data Structures

- struct CANTxFrame

  *CAN transmission frame.*
- struct CANRxFrame

  *CAN received frame.*
- struct CANConfig

  *Driver configuration structure.*
- struct CANDriver

  *Structure representing an CAN driver.*

## Functions

- void canInit (void)

  *CAN Driver initialization.*
- void canObjectInit (CANDriver ∗canp)

  *Initializes the standard part of a `CANDriver` structure.*
- void canStart (CANDriver ∗canp, const CANConfig ∗config)

  *Configures and activates the CAN peripheral.*
- void canStop (CANDriver ∗canp)

  *Deactivates the CAN peripheral.*
- bool canTryTransmitI (CANDriver ∗canp, canmbx_t mailbox, const CANTxFrame ∗ctfp)

  *Can frame transmission attempt.*
- bool canTryReceiveI (CANDriver ∗canp, canmbx_t mailbox, CANRxFrame ∗crfp)

  *Can frame receive attempt.*
- msg_t canTransmitTimeout (CANDriver ∗canp, canmbx_t mailbox, const CANTxFrame ∗ctfp, sysinterval_t timeout)

  *Can frame transmission.*
- msg_t canReceiveTimeout (CANDriver ∗canp, canmbx_t mailbox, CANRxFrame ∗crfp, sysinterval_t timeout)

  *Can frame receive.*
- void canSleep (CANDriver ∗canp)

  *Enters the sleep mode.*
- void canWakeup (CANDriver ∗canp)

  *Enforces leaving the sleep mode.*
- void can_lld_init (void)

  *Low level CAN driver initialization.*
- void can_lld_start (CANDriver ∗canp)

  *Configures and activates the CAN peripheral.*
- void can_lld_stop (CANDriver ∗canp)

  *Deactivates the CAN peripheral.*
- bool can_lld_is_tx_empty (CANDriver ∗canp, canmbx_t mailbox)

  *Determines whether a frame can be transmitted.*
- void can_lld_transmit (CANDriver ∗canp, canmbx_t mailbox, const CANTxFrame ∗ctfp)

  *Inserts a frame into the transmit queue.*
- bool can_lld_is_rx_nonempty (CANDriver ∗canp, canmbx_t mailbox)

  *Determines whether a frame has been received.*
- void can_lld_receive (CANDriver ∗canp, canmbx_t mailbox, CANRxFrame ∗crfp)

  *Receives a frame from the input queue.*
- void can_lld_sleep (CANDriver ∗canp)

  *Enters the sleep mode.*
- void can_lld_wakeup (CANDriver ∗canp)

  *Enforces leaving the sleep mode.*

## Enumerations

## Variables

- CANDriver CAND1

  *CAN1 driver identifier.*

### 7.4.3 Macro Definition Documentation

#### 7.4.3.1 #define CAN_LIMIT_WARNING 1U

Errors rate warning.

#### 7.4.3.2 #define CAN_LIMIT_ERROR 2U

Errors rate error.

#### 7.4.3.3 #define CAN_BUS_OFF_ERROR 4U

Bus off condition reached.

#### 7.4.3.4 #define CAN_FRAMING_ERROR 8U

Framing error of some kind on the CAN bus.

#### 7.4.3.5 #define CAN_OVERFLOW_ERROR 16U

Overflow in receive queue.

#### 7.4.3.6 #define CAN_ANY_MAILBOX 0U

Special mailbox identifier.

#### 7.4.3.7 #define CAN_USE_SLEEP_MODE TRUE

Sleep mode related APIs inclusion switch.

This option can only be enabled if the CAN implementation supports the sleep mode, see the macro `CAN_SUPPORTS_SLEEP` exported by the underlying implementation.

#### 7.4.3.8 #define CAN_ENFORCE_USE_CALLBACKS FALSE

Enforces the driver to use direct callbacks rather than OSAL events.

#### 7.4.3.9 #define CAN_MAILBOX_TO_MASK( *mbx* ) (1U << ((mbx) - 1U))

Converts a mailbox index to a bit mask.

### 7.4.3.10 #define canTransmit( *canp,* *mailbox,* *ctfp,* *timeout* ) canTransmitTimeout(canp, mailbox, ctfp, timeout)

Legacy name for `canTransmitTimeout()`.

**Deprecated**

### 7.4.3.11 #define canReceive( *canp,* *mailbox,* *crfp,* *timeout* ) canReceiveTimeout(canp, mailbox, crfp, timeout)

Legacy name for `canReceiveTimeout()`.

**Deprecated**

### 7.4.3.12 #define _can_tx_empty_isr( *canp,* *flags* )

**Value:**

```
{                                     \
  osalSysLockFromISR();
      \
  osalThreadDequeueAllI(&(canp)->txqueue, MSG_OK);
      \
  osalEventBroadcastFlagsI(&(canp)->txempty_event, flags);
      \
  osalSysUnlockFromISR();                                                    \
}
```

TX mailbox empty event.

### 7.4.3.13 #define _can_rx_full_isr( *canp,* *flags* )

**Value:**

```
{                                      \
  osalSysLockFromISR();
      \
  osalThreadDequeueAllI(&(canp)->rxqueue, MSG_OK);
      \
  osalEventBroadcastFlagsI(&(canp)->rxfull_event, flags);
      \
  osalSysUnlockFromISR();                                                    \
}
```

RX mailbox empty full event.

### 7.4.3.14 #define _can_wakeup_isr( *canp* )

**Value:**

```
{                                              \
  osalSysLockFromISR();
      \
  osalEventBroadcastFlagsI(&(canp)->wakeup_event, 0U);
      \
  osalSysUnlockFromISR();                                                    \
}
```

Error event.

#### 7.4.3.15 #define _can_error_isr( *canp, flags* )

**Value:**

```
{                                        \
  osalSysLockFromISR();
      \
  osalEventBroadcastFlagsI(&(canp)->error_event, flags);
      \
  osalSysUnlockFromISR();                                                     \
}
```

Error event.

#### 7.4.3.16 #define CAN_TX_MAILBOXES 1

Number of transmit mailboxes.

#### 7.4.3.17 #define CAN_RX_MAILBOXES 1

Number of receive mailboxes.

#### 7.4.3.18 #define PLATFORM_CAN_USE_CAN1 FALSE

CAN1 driver enable switch.

If set to `TRUE` the support for CAN1 is included.

**Note**

The default is `FALSE`.

### 7.4.4 Typedef Documentation

#### 7.4.4.1 typedef struct CANDriver CANDriver

Type of a structure representing an CAN driver.

#### 7.4.4.2 typedef uint32_t canmbx_t

Type of a transmission mailbox index.

#### 7.4.4.3 typedef void(∗ can_callback_t) (CANDriver ∗canp, uint32_t flags)

Type of a CAN notification callback.

**Parameters**

| | | |
|---|---|---|
| `in` | *canp* | pointer to the `CANDriver` object triggering the callback |
| `in` | *flags* | flags associated to the mailbox callback |

### 7.4.5 Enumeration Type Documentation

#### 7.4.5.1 enum canstate_t

Driver state machine possible states.

**Enumerator**

***CAN_UNINIT*** Not initialized.

***CAN_STOP*** Stopped.

***CAN_STARTING*** Starting.

***CAN_READY*** Ready.

***CAN_SLEEP*** Sleep state.

### 7.4.6 Function Documentation

#### 7.4.6.1 void canInit ( void )

CAN Driver initialization.

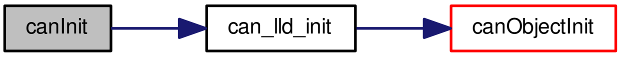
**Note**

This function is implicitly invoked by `halInit()`, there is no need to explicitly initialize the driver.

**Function Class:**

Initializer, this function just initializes an object and can be invoked before the kernel is initialized.

Here is the call graph for this function:



#### 7.4.6.2 void canObjectInit ( CANDriver * *canp* )

Initializes the standard part of a `CANDriver` structure.

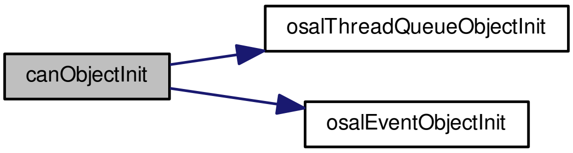
**Parameters**

| | | |
|---|---|---|
| `out` | *canp* | pointer to the `CANDriver` object |

**Function Class:**

Initializer, this function just initializes an object and can be invoked before the kernel is initialized.

Here is the call graph for this function:



#### 7.4.6.3 void canStart ( **CANDriver** ∗ *canp*, const **CANConfig** ∗ *config* )

Configures and activates the CAN peripheral.

**Note**

Activating the CAN bus can be a slow operation.
Unlike other drivers it is not possible to restart the CAN driver without first stopping it using canStop().

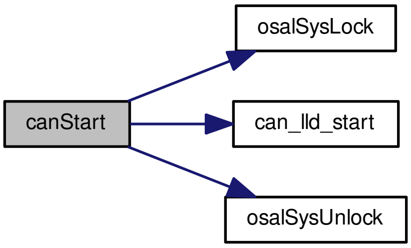
**Parameters**

| | | |
|---|---|---|
| `in` | *canp* | pointer to the `CANDriver` object |
| `in` | *config* | pointer to the `CANConfig` object. Depending on the implementation the value can be `NULL`. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.4.6.4 void canStop ( **CANDriver** ∗ *canp* )

Deactivates the CAN peripheral.

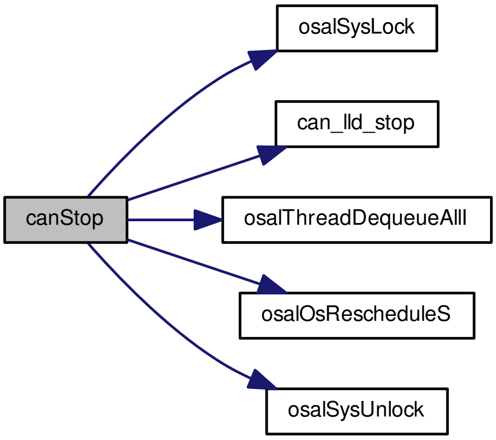
**Parameters**

| | | |
|---|---|---|
| in | *canp* | pointer to the CANDriver object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



### 7.4.6.5 bool canTryTransmitI ( CANDriver * *canp*, canmbx_t *mailbox*, const CANTxFrame * *ctfp* )

Can frame transmission attempt.

The specified frame is queued for transmission, if the hardware queue is full then the function fails.

**Parameters**

| | | |
|---|---|---|
| in | *canp* | pointer to the CANDriver object |
| in | *mailbox* | mailbox number, CAN_ANY_MAILBOX for any mailbox |
| in | *ctfp* | pointer to the CAN frame to be transmitted |

**Returns**

The operation result.

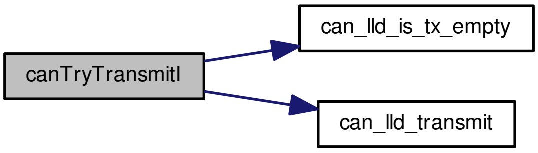
**Return values**

| | |
|---|---|
| *false* | Frame transmitted. |
| *true* | Mailbox full. |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

Here is the call graph for this function:



#### 7.4.6.6 bool canTryReceiveI ( **CANDriver** * *canp,* **canmbx_t** *mailbox,* **CANRxFrame** * *crfp* )

Can frame receive attempt.

The function tries to fetch a frame from a mailbox.

**Parameters**

| | | |
|---|---|---|
| in | *canp* | pointer to the CANDriver object |
| in | *mailbox* | mailbox number, CAN_ANY_MAILBOX for any mailbox |
| out | *crfp* | pointer to the buffer where the CAN frame is copied |

**Returns**

The operation result.

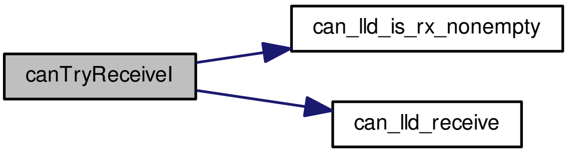
**Return values**

| | |
|---|---|
| *false* | Frame fetched. |
| *true* | Mailbox empty. |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

Here is the call graph for this function:



### 7.4.6.7 msg_t canTransmitTimeout ( CANDriver ∗ *canp,* canmbx_t *mailbox,* const CANTxFrame ∗ *ctfp,* sysinterval_t *timeout* )

Can frame transmission.

The specified frame is queued for transmission, if the hardware queue is full then the invoking thread is queued.

**Note**

Trying to transmit while in sleep mode simply enqueues the thread.

**Parameters**

| | | |
|---|---|---|
| in | *canp* | pointer to the CANDriver object |
| in | *mailbox* | mailbox number, CAN_ANY_MAILBOX for any mailbox |
| in | *ctfp* | pointer to the CAN frame to be transmitted |
| in | *timeout* | the number of ticks before the operation timeouts, the following special values are allowed:<br>• *TIME_IMMEDIATE* immediate timeout.<br>• *TIME_INFINITE* no timeout. |

**Returns**

The operation result.

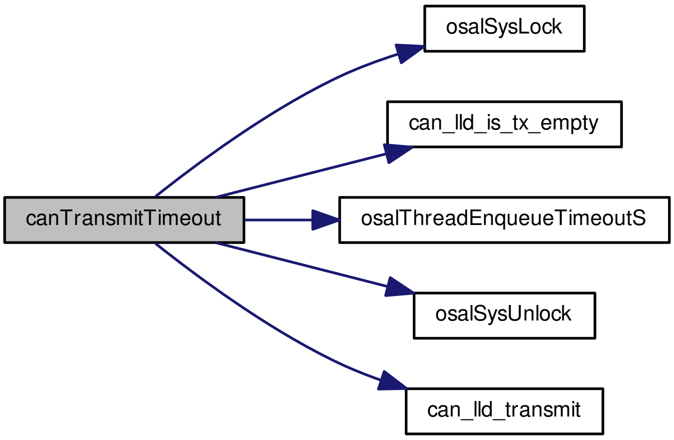
**Return values**

| | |
|---|---|
| *MSG_OK* | the frame has been queued for transmission. |
| *MSG_TIMEOUT* | The operation has timed out. |
| *MSG_RESET* | The driver has been stopped while waiting. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.4.6.8 msg_t canReceiveTimeout ( CANDriver * *canp*, canmbx_t *mailbox*, CANRxFrame * *crfp*, sysinterval_t *timeout* )

Can frame receive.

The function waits until a frame is received.

**Note**

Trying to receive while in sleep mode simply enqueues the thread.

**Parameters**

| | | |
|---|---|---|
| in | *canp* | pointer to the `CANDriver` object |
| in | *mailbox* | mailbox number, `CAN_ANY_MAILBOX` for any mailbox |
| out | *crfp* | pointer to the buffer where the CAN frame is copied |
| in | *timeout* | the number of ticks before the operation timeouts, the following special values are allowed:<br>• *TIME_IMMEDIATE* immediate timeout (useful in an event driven scenario where a thread never blocks for I/O).<br>• *TIME_INFINITE* no timeout. |

**Returns**

The operation result.

**Return values**

| | |
|---|---|
| *MSG_OK* | a frame has been received and placed in the buffer. |
| *MSG_TIMEOUT* | The operation has timed out. |

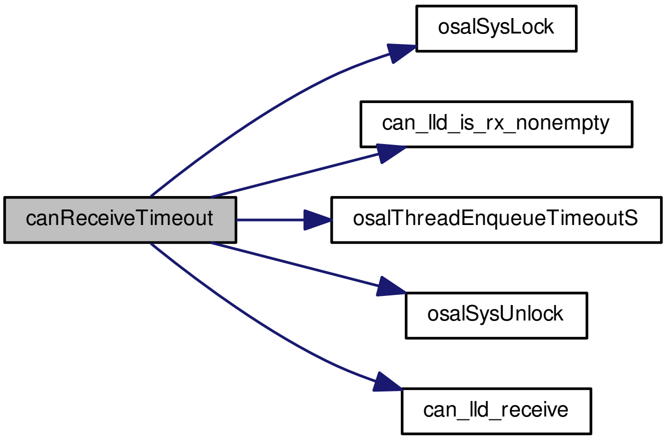
**Return values**

| | |
|---|---|
| *MSG_RESET* | The driver has been stopped while waiting. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



### 7.4.6.9 void canSleep ( CANDriver ∗ *canp* )

Enters the sleep mode.

This function puts the CAN driver in sleep mode and broadcasts the `sleep_event` event source.

**Precondition**

In order to use this function the option `CAN_USE_SLEEP_MODE` must be enabled and the `CAN_SUPPORTS_SLEEP` mode must be supported by the low level driver.

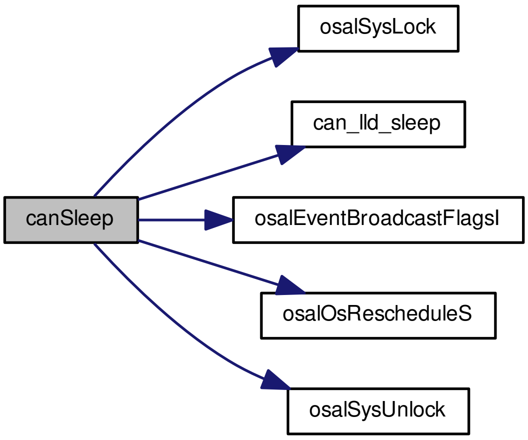
**Parameters**

| | | |
|---|---|---|
| in | *canp* | pointer to the `CANDriver` object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



### 7.4.6.10 void canWakeup ( CANDriver * *canp* )

Enforces leaving the sleep mode.

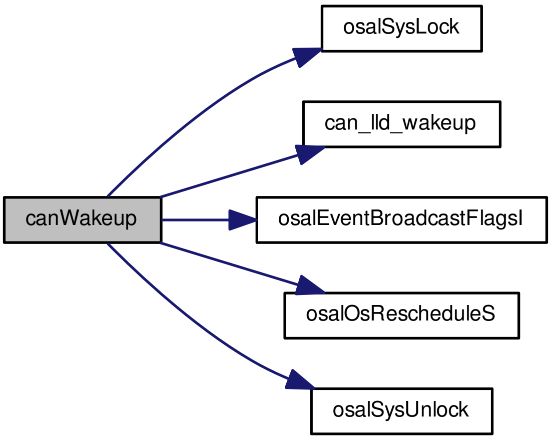
**Note**

The sleep mode is supposed to be usually exited automatically by an hardware event.

**Parameters**

| | | |
|---|---|---|
| in | *canp* | pointer to the `CANDriver` object |

Here is the call graph for this function:



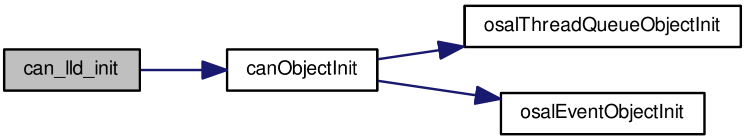
#### 7.4.6.11 void can_lld_init ( void )

Low level CAN driver initialization.

**Function Class:**

Not an API, this function is for internal use only.

Here is the call graph for this function:



#### 7.4.6.12 void can_lld_start ( CANDriver ∗ *canp* )

Configures and activates the CAN peripheral.

**Parameters**

| | | |
|---|---|---|
| `in` | *canp* | pointer to the `CANDriver` object |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.4.6.13 void can_lld_stop ( CANDriver * *canp* )

Deactivates the CAN peripheral.

**Parameters**

| | | |
|---|---|---|
| in | *canp* | pointer to the CANDriver object |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.4.6.14 bool can_lld_is_tx_empty ( CANDriver * *canp,* canmbx_t *mailbox* )

Determines whether a frame can be transmitted.

**Parameters**

| | | |
|---|---|---|
| in | *canp* | pointer to the CANDriver object |
| in | *mailbox* | mailbox number, CAN_ANY_MAILBOX for any mailbox |

**Returns**

The queue space availability.

**Return values**

| | |
|---|---|
| *false* | no space in the transmit queue. |
| *true* | transmit slot available. |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.4.6.15 void can_lld_transmit ( CANDriver * *canp,* canmbx_t *mailbox,* const CANTxFrame * *ctfp* )

Inserts a frame into the transmit queue.

**Parameters**

| | | |
|---|---|---|
| in | *canp* | pointer to the CANDriver object |
| in | *ctfp* | pointer to the CAN frame to be transmitted |
| in | *mailbox* | mailbox number, CAN_ANY_MAILBOX for any mailbox |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.4.6.16 bool can_lld_is_rx_nonempty ( CANDriver * *canp,* canmbx_t *mailbox* )

Determines whether a frame has been received.

**Parameters**

| | | |
|---|---|---|
| in | *canp* | pointer to the CANDriver object |
| in | *mailbox* | mailbox number, CAN_ANY_MAILBOX for any mailbox |

**Returns**

The queue space availability.

**Return values**

| | |
|---|---|
| *false* | no space in the transmit queue. |
| *true* | transmit slot available. |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.4.6.17 void can_lld_receive ( CANDriver * *canp,* canmbx_t *mailbox,* CANRxFrame * *crfp* )

Receives a frame from the input queue.

**Parameters**

| | | |
|---|---|---|
| in | *canp* | pointer to the CANDriver object |
| in | *mailbox* | mailbox number, CAN_ANY_MAILBOX for any mailbox |
| out | *crfp* | pointer to the buffer where the CAN frame is copied |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.4.6.18 void can_lld_sleep ( CANDriver * *canp* )

Enters the sleep mode.

**Parameters**

| | | |
|---|---|---|
| in | *canp* | pointer to the CANDriver object |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.4.6.19 void can_lld_wakeup ( CANDriver * *canp* )

Enforces leaving the sleep mode.

**Parameters**

| | | |
|---|---|---|
| in | *canp* | pointer to the `CANDriver` object |

**Function Class:**

Not an API, this function is for internal use only.

### 7.4.7 Variable Documentation

#### 7.4.7.1 CANDriver CAND1

CAN1 driver identifier.

## 7.5 Generic Compass Interface

HAL Generic Compass Interface.

### 7.5.1 Detailed Description

HAL Generic Compass Interface.

#### Macros

- #define _base_compass_methods_alone

  *BaseCompass specific methods.*
- #define _base_compass_methods

  *BaseCompass specific methods with inherited ones.*
- #define _base_compass_data _base_sensor_data

  `BaseCompass` *specific data.*

#### Macro Functions (BaseCompass)

- #define compassGetAxesNumber(ip) (ip)->vmt->get_channels_number(ip)

  *Compass get axes number.*
- #define compassReadRaw(ip, dp) (ip)->vmt->read_raw(ip, dp)

  *Compass read raw data.*
- #define compassReadCooked(ip, dp) (ip)->vmt->read_cooked(ip, dp)

  *Compass read cooked data.*
- #define compassSetBias(ip, bp) (ip)->vmt->set_bias(ip, bp)

  *Updates compass bias data from received buffer.*
- #define compassResetBias(ip) (ip)->vmt->reset_bias(ip)

  *Reset compass bias data restoring it to zero.*
- #define compassSetSensitivity(ip, sp) (ip)->vmt->set_sensitivity(ip, sp)

  *Updates compass sensitivity data from received buffer.*
- #define compassResetSensitivity(ip) (ip)->vmt->reset_sensitivity(ip)

  *Reset compass sensitivity data restoring it to its typical value.*

#### Data Structures

- struct BaseCompassVMT

  `BaseCompass` *virtual methods table.*
- struct BaseCompass

  *Base compass class.*

### 7.5.2 Macro Definition Documentation

#### 7.5.2.1 #define _base_compass_methods_alone

**Value:**

```
/* Invoke the set bias procedure.*/                                    \
  msg_t (*set_bias)(void *instance, float biases[]);                    \
  /* Remove bias stored data.*/                                         \
  msg_t (*reset_bias)(void *instance);                                  \
  /* Invoke the set sensitivity procedure.*/                            \
  msg_t (*set_sensitivity)(void *instance, float sensitivities[]);      \
  /* Restore sensitivity stored data to default.*/                      \
  msg_t (*reset_sensitivity)(void *instance);
```

BaseCompass specific methods.

#### 7.5.2.2 #define _base_compass_methods

**Value:**

```
_base_sensor_methods                                                   \
  _base_compass_methods_alone
```

BaseCompass specific methods with inherited ones.

#### 7.5.2.3 #define _base_compass_data _base_sensor_data

BaseCompass specific data.

#### 7.5.2.4 #define compassGetAxesNumber( *ip* ) (ip)->vmt->get_channels_number(ip)

Compass get axes number.

**Parameters**

| | | |
|---|---|---|
| in | *ip* | pointer to a BaseCompass class. |

**Returns**

The number of axes of the BaseCompass

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.5.2.5 #define compassReadRaw( *ip, dp* ) (ip)->vmt->read_raw(ip, dp)

Compass read raw data.

**Parameters**

| | | |
|---|---|---|
| in | *ip* | pointer to a BaseCompass class. |
| in | *dp* | pointer to a data array. |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *MSG_OK* | if the function succeeded. |
| *MSG_RESET* | if one or more errors occurred. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.5.2.6 #define compassReadCooked( *ip*, *dp* ) (ip)->vmt->read_cooked(ip, dp)

Compass read cooked data.

**Parameters**

| | | |
|---|---|---|
| in | *ip* | pointer to a `BaseCompass` class. |
| in | *dp* | pointer to a data array. |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *MSG_OK* | if the function succeeded. |
| *MSG_RESET* | if one or more errors occurred. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.5.2.7 #define compassSetBias( *ip*, *bp* ) (ip)->vmt->set_bias(ip, bp)

Updates compass bias data from received buffer.

**Note**

The bias buffer must have the same length of the the compass axes number.

**Parameters**

| | | |
|---|---|---|
| in | *ip* | pointer to a `BaseCompass` class. |
| in | *bp* | pointer to a buffer of bias values. |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *MSG_OK* | if the function succeeded. |
| *MSG_RESET* | if one or more errors occurred. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.5.2.8 #define compassResetBias( *ip* ) (ip)->vmt->reset_bias(ip)

Reset compass bias data restoring it to zero.

**Parameters**

| | | |
|---|---|---|
| `in` | *ip* | pointer to a `BaseCompass` class. |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *MSG_OK* | if the function succeeded. |
| *MSG_RESET* | if one or more errors occurred. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.5.2.9 #define compassSetSensitivity( *ip, sp* ) (ip)->vmt->set_sensitivity(ip, sp)

Updates compass sensitivity data from received buffer.

**Note**

The sensitivity buffer must have the same length of the the compass axes number.

**Parameters**

| | | |
|---|---|---|
| `in` | *ip* | pointer to a `BaseCompass` class. |
| `in` | *sp* | pointer to a buffer of sensitivity values. |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *MSG_OK* | if the function succeeded. |
| *MSG_RESET* | if one or more errors occurred. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

### 7.5.2.10 #define compassResetSensitivity( *ip* ) (ip)->vmt->reset_sensitivity(ip)

Reset compass sensitivity data restoring it to its typical value.

**Parameters**

| | | |
|---|---|---|
| in | *ip* | pointer to a BaseCompass class. |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *MSG_OK* | if the function succeeded. |
| *MSG_RESET* | if one or more errors occurred. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

## 7.6 Crypto Driver

Generic Crypto Driver.

### 7.6.1 Detailed Description

Generic Crypto Driver.

This module implements a generic Cryptography driver.

**Precondition**

In order to use the I2C driver the `HAL_USE_CRY` option must be enabled in `halconf.h`.

#### Macros

- #define HAL_CRY_MAX_KEY_SIZE 32

  *Maximum size of a key for all supported algorithms.*
- #define HAL_CRY_USE_FALLBACK FALSE

  *Enables the SW fall-back of the cryptographic driver.*
- #define HAL_CRY_USE_FALLBACK TRUE

  *Enables the SW fall-back of the cryptographic driver.*
- #define HAL_CRY_ENFORCE_FALLBACK FALSE

  *Makes the driver forcibly use the fall-back implementations.*

#### Driver capability switches

- #define **CRY_LLD_SUPPORTS_AES** TRUE
- #define **CRY_LLD_SUPPORTS_AES_ECB** TRUE
- #define **CRY_LLD_SUPPORTS_AES_CBC** TRUE
- #define **CRY_LLD_SUPPORTS_AES_CFB** TRUE
- #define **CRY_LLD_SUPPORTS_AES_CTR** TRUE
- #define **CRY_LLD_SUPPORTS_AES_GCM** TRUE
- #define **CRY_LLD_SUPPORTS_DES** TRUE
- #define **CRY_LLD_SUPPORTS_DES_ECB** TRUE
- #define **CRY_LLD_SUPPORTS_DES_CBC** TRUE
- #define **CRY_LLD_SUPPORTS_SHA1** TRUE
- #define **CRY_LLD_SUPPORTS_SHA256** TRUE
- #define **CRY_LLD_SUPPORTS_SHA512** TRUE
- #define **CRY_LLD_SUPPORTS_TRNG** TRUE

#### PLATFORM configuration options

- #define PLATFORM_CRY_USE_CRY1 FALSE

  *CRY1 driver enable switch.*

#### Typedefs

- typedef size_t bitsize_t

  *Size, in bits, of a crypto field or message.*
- typedef uint32_t crykey_t

  *CRY key identifier type.*
- typedef struct CRYDriver CRYDriver

  *Type of a structure representing an CRY driver.*

## Data Structures

- struct SHA1Context

  *Type of a SHA1 context.*
- struct SHA256Context

  *Type of a SHA256 context.*
- struct SHA512Context

  *Type of a SHA512 context.*
- struct CRYConfig

  *Driver configuration structure.*
- struct CRYDriver

  *Structure representing an CRY driver.*

## Functions

- void cryInit (void)

  *Cryptographic Driver initialization.*
- void cryObjectInit (CRYDriver ∗cryp)

  *Initializes the standard part of a `CRYDriver` structure.*
- void cryStart (CRYDriver ∗cryp, const CRYConfig ∗config)

  *Configures and activates the cryptographic peripheral.*
- void cryStop (CRYDriver ∗cryp)

  *Deactivates the cryptographic peripheral.*
- cryerror_t cryLoadTransientKey (CRYDriver ∗cryp, cryalgorithm_t algorithm, size_t size, const uint8_t ∗keyp)

  *Initializes the transient key for a specific algorithm.*
- cryerror_t cryEncryptAES (CRYDriver ∗cryp, crykey_t key_id, const uint8_t ∗in, uint8_t ∗out)

  *Encryption of a single block using AES.*
- cryerror_t cryDecryptAES (CRYDriver ∗cryp, crykey_t key_id, const uint8_t ∗in, uint8_t ∗out)

  *Decryption of a single block using AES.*
- cryerror_t cryEncryptAES_ECB (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out)

  *Encryption operation using AES-ECB.*
- cryerror_t cryDecryptAES_ECB (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out)

  *Decryption operation using AES-ECB.*
- cryerror_t cryEncryptAES_CBC (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out, const uint8_t ∗iv)

  *Encryption operation using AES-CBC.*
- cryerror_t cryDecryptAES_CBC (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out, const uint8_t ∗iv)

  *Decryption operation using AES-CBC.*
- cryerror_t cryEncryptAES_CFB (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out, const uint8_t ∗iv)

  *Encryption operation using AES-CFB.*
- cryerror_t cryDecryptAES_CFB (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out, const uint8_t ∗iv)

  *Decryption operation using AES-CFB.*
- cryerror_t cryEncryptAES_CTR (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out, const uint8_t ∗iv)

  *Encryption operation using AES-CTR.*
- cryerror_t cryDecryptAES_CTR (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out, const uint8_t ∗iv)

*Decryption operation using AES-CTR.*

- cryerror_t cryEncryptAES_GCM (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out, const uint8_t ∗iv, size_t aadsize, const uint8_t ∗aad, uint8_t ∗authtag)

  *Encryption operation using AES-GCM.*
- cryerror_t cryDecryptAES_GCM (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out, const uint8_t ∗iv, size_t aadsize, const uint8_t ∗aad, uint8_t ∗authtag)

  *Decryption operation using AES-GCM.*
- cryerror_t cryEncryptDES (CRYDriver ∗cryp, crykey_t key_id, const uint8_t ∗in, uint8_t ∗out)

  *Encryption of a single block using (T)DES.*
- cryerror_t cryDecryptDES (CRYDriver ∗cryp, crykey_t key_id, const uint8_t ∗in, uint8_t ∗out)

  *Decryption of a single block using (T)DES.*
- cryerror_t cryEncryptDES_ECB (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out)

  *Encryption operation using (T)DES-ECB.*
- cryerror_t cryDecryptDES_ECB (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out)

  *Decryption operation using (T)DES-ECB.*
- cryerror_t cryEncryptDES_CBC (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out, const uint8_t ∗iv)

  *Encryption operation using (T)DES-CBC.*
- cryerror_t cryDecryptDES_CBC (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out, const uint8_t ∗iv)

  *Decryption operation using (T)DES-CBC.*
- cryerror_t crySHA1Init (CRYDriver ∗cryp, SHA1Context ∗sha1ctxp)

  *Hash initialization using SHA1.*
- cryerror_t crySHA1Update (CRYDriver ∗cryp, SHA1Context ∗sha1ctxp, size_t size, const uint8_t ∗in)

  *Hash update using SHA1.*
- cryerror_t crySHA1Final (CRYDriver ∗cryp, SHA1Context ∗sha1ctxp, uint8_t ∗out)

  *Hash finalization using SHA1.*
- cryerror_t crySHA256Init (CRYDriver ∗cryp, SHA256Context ∗sha256ctxp)

  *Hash initialization using SHA256.*
- cryerror_t crySHA256Update (CRYDriver ∗cryp, SHA256Context ∗sha256ctxp, size_t size, const uint8_t ∗in)

  *Hash update using SHA256.*
- cryerror_t crySHA256Final (CRYDriver ∗cryp, SHA256Context ∗sha256ctxp, uint8_t ∗out)

  *Hash finalization using SHA256.*
- cryerror_t crySHA512Init (CRYDriver ∗cryp, SHA512Context ∗sha512ctxp)

  *Hash initialization using SHA512.*
- cryerror_t crySHA512Update (CRYDriver ∗cryp, SHA512Context ∗sha512ctxp, size_t size, const uint8_t ∗in)

  *Hash update using SHA512.*
- cryerror_t crySHA512Final (CRYDriver ∗cryp, SHA512Context ∗sha512ctxp, uint8_t ∗out)

  *Hash finalization using SHA512.*
- cryerror_t cryTRNG (CRYDriver ∗cryp, uint8_t ∗out)

  *True random numbers generator.*
- void cry_lld_init (void)

  *Low level crypto driver initialization.*
- void cry_lld_start (CRYDriver ∗cryp)

  *Configures and activates the crypto peripheral.*
- void cry_lld_stop (CRYDriver ∗cryp)

  *Deactivates the crypto peripheral.*
- cryerror_t cry_lld_loadkey (CRYDriver ∗cryp, cryalgorithm_t algorithm, size_t size, const uint8_t ∗keyp)

  *Initializes the transient key for a specific algorithm.*

- cryerror_t cry_lld_encrypt_AES (CRYDriver ∗cryp, crykey_t key_id, const uint8_t ∗in, uint8_t ∗out)

  *Encryption of a single block using AES.*
- cryerror_t cry_lld_decrypt_AES (CRYDriver ∗cryp, crykey_t key_id, const uint8_t ∗in, uint8_t ∗out)

  *Decryption of a single block using AES.*
- cryerror_t cry_lld_encrypt_AES_ECB (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out)

  *Encryption operation using AES-ECB.*
- cryerror_t cry_lld_decrypt_AES_ECB (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out)

  *Decryption operation using AES-ECB.*
- cryerror_t cry_lld_encrypt_AES_CBC (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out, const uint8_t ∗iv)

  *Encryption operation using AES-CBC.*
- cryerror_t cry_lld_decrypt_AES_CBC (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out, const uint8_t ∗iv)

  *Decryption operation using AES-CBC.*
- cryerror_t cry_lld_encrypt_AES_CFB (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out, const uint8_t ∗iv)

  *Encryption operation using AES-CFB.*
- cryerror_t cry_lld_decrypt_AES_CFB (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out, const uint8_t ∗iv)

  *Decryption operation using AES-CFB.*
- cryerror_t cry_lld_encrypt_AES_CTR (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out, const uint8_t ∗iv)

  *Encryption operation using AES-CTR.*
- cryerror_t cry_lld_decrypt_AES_CTR (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out, const uint8_t ∗iv)

  *Decryption operation using AES-CTR.*
- cryerror_t cry_lld_encrypt_AES_GCM (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out, const uint8_t ∗iv, size_t aadsize, const uint8_t ∗aad, uint8_t ∗authtag)

  *Encryption operation using AES-GCM.*
- cryerror_t cry_lld_decrypt_AES_GCM (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out, const uint8_t ∗iv, size_t aadsize, const uint8_t ∗aad, uint8_t ∗authtag)

  *Decryption operation using AES-GCM.*
- cryerror_t cry_lld_encrypt_DES (CRYDriver ∗cryp, crykey_t key_id, const uint8_t ∗in, uint8_t ∗out)

  *Encryption of a single block using (T)DES.*
- cryerror_t cry_lld_decrypt_DES (CRYDriver ∗cryp, crykey_t key_id, const uint8_t ∗in, uint8_t ∗out)

  *Decryption of a single block using (T)DES.*
- cryerror_t cry_lld_encrypt_DES_ECB (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out)

  *Encryption operation using (T)DES-ECB.*
- cryerror_t cry_lld_decrypt_DES_ECB (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out)

  *Decryption operation using (T)DES-ECB.*
- cryerror_t cry_lld_encrypt_DES_CBC (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out, const uint8_t ∗iv)

  *Encryption operation using (T)DES-CBC.*
- cryerror_t cry_lld_decrypt_DES_CBC (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out, const uint8_t ∗iv)

  *Decryption operation using (T)DES-CBC.*
- cryerror_t cry_lld_SHA1_init (CRYDriver ∗cryp, SHA1Context ∗sha1ctxp)

  *Hash initialization using SHA1.*

- cryerror_t cry_lld_SHA1_update (CRYDriver ∗cryp, SHA1Context ∗sha1ctxp, size_t size, const uint8_t ∗in)

    *Hash update using SHA1.*
- cryerror_t cry_lld_SHA1_final (CRYDriver ∗cryp, SHA1Context ∗sha1ctxp, uint8_t ∗out)

    *Hash finalization using SHA1.*
- cryerror_t cry_lld_SHA256_init (CRYDriver ∗cryp, SHA256Context ∗sha256ctxp)

    *Hash initialization using SHA256.*
- cryerror_t cry_lld_SHA256_update (CRYDriver ∗cryp, SHA256Context ∗sha256ctxp, size_t size, const uint8_t ∗in)

    *Hash update using SHA256.*
- cryerror_t cry_lld_SHA256_final (CRYDriver ∗cryp, SHA256Context ∗sha256ctxp, uint8_t ∗out)

    *Hash finalization using SHA256.*
- cryerror_t cry_lld_SHA512_init (CRYDriver ∗cryp, SHA512Context ∗sha512ctxp)

    *Hash initialization using SHA512.*
- cryerror_t cry_lld_SHA512_update (CRYDriver ∗cryp, SHA512Context ∗sha512ctxp, size_t size, const uint8_t ∗in)

    *Hash update using SHA512.*
- cryerror_t cry_lld_SHA512_final (CRYDriver ∗cryp, SHA512Context ∗sha512ctxp, uint8_t ∗out)

    *Hash finalization using SHA512.*
- cryerror_t cry_lld_TRNG (CRYDriver ∗cryp, uint8_t ∗out)

    *True random numbers generator.*

### Enumerations

### Variables

- CRYDriver CRYD1

    *CRY1 driver identifier.*

## 7.6.2 Macro Definition Documentation

### 7.6.2.1 #define HAL_CRY_MAX_KEY_SIZE 32

Maximum size of a key for all supported algorithms.

### 7.6.2.2 #define HAL_CRY_USE_FALLBACK FALSE

Enables the SW fall-back of the cryptographic driver.

When enabled, this option, activates a fall-back software implementation for algorithms not supported by the underlying hardware.

**Note**

> Fall-back implementations may not be present for all algorithms.

### 7.6.2.3 #define HAL_CRY_USE_FALLBACK TRUE

Enables the SW fall-back of the cryptographic driver.

When enabled, this option, activates a fall-back software implementation for algorithms not supported by the underlying hardware.

**Note**

> Fall-back implementations may not be present for all algorithms.

#### 7.6.2.4 #define HAL_CRY_ENFORCE_FALLBACK FALSE

Makes the driver forcibly use the fall-back implementations.

**Note**

If enabled then the LLD driver is not included at all.

#### 7.6.2.5 #define PLATFORM_CRY_USE_CRY1 FALSE

CRY1 driver enable switch.

If set to `TRUE` the support for CRY1 is included.

**Note**

The default is `FALSE`.

### 7.6.3 Typedef Documentation

#### 7.6.3.1 typedef size_t bitsize_t

Size, in bits, of a crypto field or message.

**Note**

It is assumed, for simplicity, that this type is equivalent to a `size_t`.

#### 7.6.3.2 typedef uint32_t crykey_t

CRY key identifier type.

#### 7.6.3.3 typedef struct CRYDriver CRYDriver

Type of a structure representing an CRY driver.

### 7.6.4 Enumeration Type Documentation

#### 7.6.4.1 enum crystate_t

Driver state machine possible states.

**Enumerator**

***CRY_UNINIT*** Not initialized.

***CRY_STOP*** Stopped.

***CRY_READY*** Ready.

#### 7.6.4.2 enum cryerror_t

Driver error codes.

**Enumerator**

***CRY_NOERROR*** No error.

***CRY_ERR_INV_ALGO*** Invalid cypher/mode.

***CRY_ERR_INV_KEY_SIZE*** Invalid key size.

***CRY_ERR_INV_KEY_TYPE*** Invalid key type.

***CRY_ERR_INV_KEY_ID*** Invalid key type.

#### 7.6.4.3 enum cryalgorithm_t

Type of an algorithm identifier.

**Note**

It is only used to determine the key required for operations.

**Enumerator**

***cry_algo_aes*** AES 128, 192, 256 bits.

***cry_algo_des*** DES 56, TDES 112, 168 bits.

### 7.6.5 Function Documentation

#### 7.6.5.1 void cryInit ( void )

Cryptographic Driver initialization.

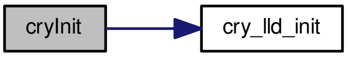
**Note**

This function is implicitly invoked by `halInit()`, there is no need to explicitly initialize the driver.

**Function Class:**

Initializer, this function just initializes an object and can be invoked before the kernel is initialized.

Here is the call graph for this function:



#### 7.6.5.2 void cryObjectInit ( CRYDriver * *cryp* )

Initializes the standard part of a `CRYDriver` structure.

**Parameters**

| | | |
|---|---|---|
| out | *cryp* | pointer to the `CRYDriver` object |

**Function Class:**

Initializer, this function just initializes an object and can be invoked before the kernel is initialized.

### 7.6.5.3 void cryStart ( **CRYDriver** ∗ *cryp*, const **CRYConfig** ∗ *config* )

Configures and activates the cryptographic peripheral.

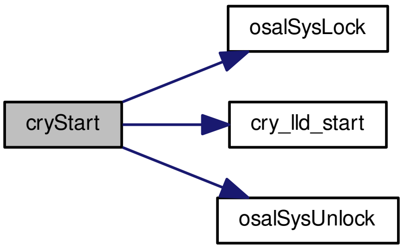
**Parameters**

| | | |
|---|---|---|
| in | *cryp* | pointer to the `CRYDriver` object |
| in | *config* | pointer to the `CRYConfig` object. Depending on the implementation the value can be `NULL`. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



### 7.6.5.4 void cryStop ( **CRYDriver** ∗ *cryp* )

Deactivates the cryptographic peripheral.

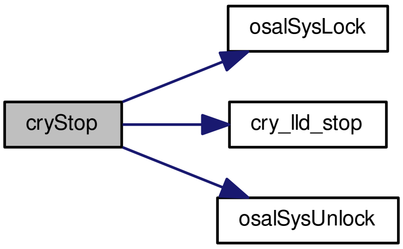
**Parameters**

| | | |
|---|---|---|
| in | *cryp* | pointer to the `CRYDriver` object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.6.5.5 cryerror_t cryLoadTransientKey ( CRYDriver ∗ *cryp,* cryalgorithm_t *algorithm,* size_t *size,* const uint8_t ∗ *keyp* )

Initializes the transient key for a specific algorithm.

**Note**

It is the underlying implementation to decide which combinations of algorithm and key size are allowable.

**Parameters**

| | | |
|---|---|---|
| in | *cryp* | pointer to the CRYDriver object |
| in | *algorithm* | the algorithm identifier |
| in | *size* | key size in bytes |
| in | *keyp* | pointer to the key data |

**Returns**

The operation status.

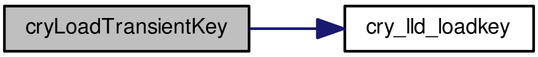
**Return values**

| | |
|---|---|
| *CRY_NOERROR* | if the operation succeeded. |
| *CRY_ERR_INV_ALGO* | if the specified algorithm is unknown or unsupported. |
| *CRY_ERR_INV_KEY_SIZE* | if the specified key size is invalid for the specified algorithm. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.6.5.6 cryerror_t cryEncryptAES ( CRYDriver ∗ *cryp,* crykey_t *key_id,* const uint8_t ∗ *in,* uint8_t ∗ *out* )

Encryption of a single block using AES.

**Note**

The implementation of this function must guarantee that it can be called from any context.

**Parameters**

| | | |
|---|---|---|
| in | *cryp* | pointer to the CRYDriver object |
| in | *key↵ _id* | the key to be used for the operation, zero is the transient key, other values are keys stored in an unspecified way |
| in | *in* | buffer containing the input plaintext |
| out | *out* | buffer for the output cyphertext |

**Returns**

The operation status.

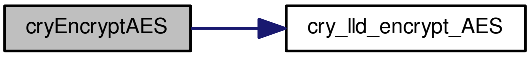
**Return values**

| | |
|---|---|
| *CRY_NOERROR* | if the operation succeeded. |
| *CRY_ERR_INV_ALGO* | if the operation is unsupported on this device instance. |
| *CRY_ERR_INV_KEY_TYPE* | the selected key is invalid for this operation. |
| *CRY_ERR_INV_KEY_ID* | if the specified key identifier is invalid or refers to an empty key slot. |

**Function Class:**

Special function, this function has special requirements see the notes.

Here is the call graph for this function:



#### 7.6.5.7 cryerror_t cryDecryptAES ( CRYDriver ∗ *cryp*, crykey_t *key_id*, const uint8_t ∗ *in*, uint8_t ∗ *out* )

Decryption of a single block using AES.

**Note**

The implementation of this function must guarantee that it can be called from any context.

**Parameters**

| | | |
|---|---|---|
| `in` | *cryp* | pointer to the `CRYDriver` object |
| `in` | *key←_id* | the key to be used for the operation, zero is the transient key, other values are keys stored in an unspecified way |
| `in` | *in* | buffer containing the input cyphertext |
| `out` | *out* | buffer for the output plaintext |

**Returns**

The operation status.

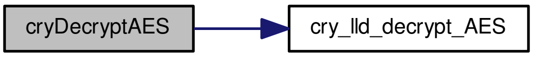
**Return values**

| | |
|---|---|
| *CRY_NOERROR* | if the operation succeeded. |
| *CRY_ERR_INV_ALGO* | if the operation is unsupported on this device instance. |
| *CRY_ERR_INV_KEY_TYPE* | the selected key is invalid for this operation. |
| *CRY_ERR_INV_KEY_ID* | if the specified key identifier is invalid or refers to an empty key slot. |

**Function Class:**

Special function, this function has special requirements see the notes.

Here is the call graph for this function:



#### 7.6.5.8 cryerror_t cryEncryptAES_ECB ( CRYDriver ∗ *cryp*, crykey_t *key_id*, size_t *size*, const uint8_t ∗ *in*, uint8_t ∗ *out* )

Encryption operation using AES-ECB.

**Note**

The function operates on data buffers whose length is a multiple of an AES block, this means that padding must be done by the caller.

**Parameters**

| | | |
|---|---|---|
| in | *cryp* | pointer to the CRYDriver object |
| in | *key←_id* | the key to be used for the operation, zero is the transient key, other values are keys stored in an unspecified way |
| in | *size* | size of both buffers, this number must be a multiple of 16 |
| in | *in* | buffer containing the input plaintext |
| out | *out* | buffer for the output cyphertext |

**Returns**

The operation status.

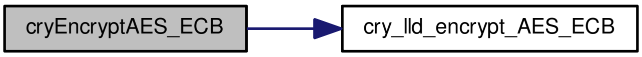
**Return values**

| | |
|---|---|
| *CRY_NOERROR* | if the operation succeeded. |
| *CRY_ERR_INV_ALGO* | if the operation is unsupported on this device instance. |
| *CRY_ERR_INV_KEY_TYPE* | the selected key is invalid for this operation. |
| *CRY_ERR_INV_KEY_ID* | if the specified key identifier is invalid or refers to an empty key slot. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.6.5.9 cryerror_t cryDecryptAES_ECB ( CRYDriver ∗ *cryp*, crykey_t *key_id*, size_t *size*, const uint8_t ∗ *in*, uint8_t ∗ *out* )

Decryption operation using AES-ECB.

**Note**

The function operates on data buffers whose length is a multiple of an AES block, this means that padding must be done by the caller.

**Parameters**

| | | |
|---|---|---|
| in | *cryp* | pointer to the CRYDriver object |
| in | *key↔_id* | the key to be used for the operation, zero is the transient key, other values are keys stored in an unspecified way |
| in | *size* | size of both buffers, this number must be a multiple of 16 |
| in | *in* | buffer containing the input cyphertext |
| out | *out* | buffer for the output plaintext |

**Returns**

The operation status.

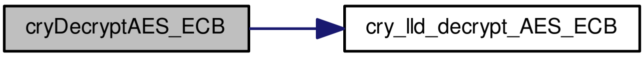
**Return values**

| | |
|---|---|
| *CRY_NOERROR* | if the operation succeeded. |
| *CRY_ERR_INV_ALGO* | if the operation is unsupported on this device instance. |
| *CRY_ERR_INV_KEY_TYPE* | the selected key is invalid for this operation. |
| *CRY_ERR_INV_KEY_ID* | if the specified key identifier is invalid or refers to an empty key slot. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.6.5.10 cryerror_t cryEncryptAES_CBC ( CRYDriver ∗ *cryp,* crykey_t *key_id,* size_t *size,* const uint8_t ∗ *in,* uint8_t ∗ *out,* const uint8_t ∗ *iv* )

Encryption operation using AES-CBC.

**Note**

The function operates on data buffers whose length is a multiple of an AES block, this means that padding must be done by the caller.

**Parameters**

| | | |
|---|---|---|
| in | *cryp* | pointer to the CRYDriver object |
| in | *key←_id* | the key to be used for the operation, zero is the transient key, other values are keys stored in an unspecified way |
| in | *size* | size of both buffers, this number must be a multiple of 16 |
| in | *in* | buffer containing the input plaintext |
| out | *out* | buffer for the output cyphertext |
| in | *iv* | 128 bits input vector |

**Returns**

The operation status.

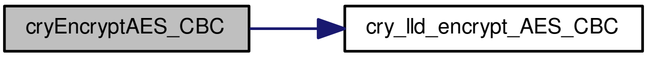
**Return values**

| | |
|---|---|
| *CRY_NOERROR* | if the operation succeeded. |
| *CRY_ERR_INV_ALGO* | if the operation is unsupported on this device instance. |
| *CRY_ERR_INV_KEY_TYPE* | the selected key is invalid for this operation. |
| *CRY_ERR_INV_KEY_ID* | if the specified key identifier is invalid or refers to an empty key slot. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.6.5.11 cryerror_t cryDecryptAES_CBC ( CRYDriver ∗ *cryp,* crykey_t *key_id,* size_t *size,* const uint8_t ∗ *in,* uint8_t ∗ *out,* const uint8_t ∗ *iv* )

Decryption operation using AES-CBC.

**Note**

The function operates on data buffers whose length is a multiple of an AES block, this means that padding must be done by the caller.

**Parameters**

| | | |
|---|---|---|
| `in` | *cryp* | pointer to the `CRYDriver` object |
| `in` | *key←<br>_id* | the key to be used for the operation, zero is the transient key, other values are keys stored in an unspecified way |
| `in` | *size* | size of both buffers, this number must be a multiple of 16 |
| `in` | *in* | buffer containing the input cyphertext |
| `out` | *out* | buffer for the output plaintext |
| `in` | *iv* | 128 bits input vector |

**Returns**

The operation status.

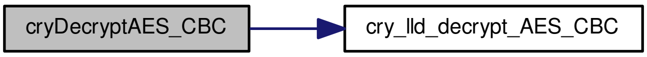
**Return values**

| | |
|---|---|
| *CRY_NOERROR* | if the operation succeeded. |
| *CRY_ERR_INV_ALGO* | if the operation is unsupported on this device instance. |
| *CRY_ERR_INV_KEY_TYPE* | the selected key is invalid for this operation. |
| *CRY_ERR_INV_KEY_ID* | if the specified key identifier is invalid or refers to an empty key slot. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



### 7.6.5.12 cryerror_t cryEncryptAES_CFB ( CRYDriver ∗ *cryp*, crykey_t *key_id*, size_t *size*, const uint8_t ∗ *in*, uint8_t ∗ *out*, const uint8_t ∗ *iv* )

Encryption operation using AES-CFB.

**Note**

The function operates on data buffers whose length is a multiple of an AES block, this means that padding must be done by the caller.

**Parameters**

| | | |
|---|---|---|
| in | *cryp* | pointer to the CRYDriver object |
| in | *key*←<br>*_id* | the key to be used for the operation, zero is the transient key, other values are keys stored in an unspecified way |
| in | *size* | size of both buffers, this number must be a multiple of 16 |
| in | *in* | buffer containing the input plaintext |
| out | *out* | buffer for the output cyphertext |
| in | *iv* | 128 bits input vector |

**Returns**

The operation status.

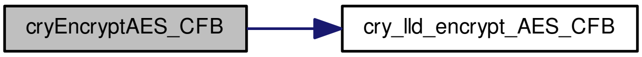
**Return values**

| | |
|---|---|
| *CRY_NOERROR* | if the operation succeeded. |
| *CRY_ERR_INV_ALGO* | if the operation is unsupported on this device instance. |
| *CRY_ERR_INV_KEY_TYPE* | the selected key is invalid for this operation. |
| *CRY_ERR_INV_KEY_ID* | if the specified key identifier is invalid or refers to an empty key slot. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.6.5.13 cryerror_t cryDecryptAES_CFB ( CRYDriver * *cryp,* crykey_t *key_id,* size_t *size,* const uint8_t * *in,* uint8_t * *out,* const uint8_t * *iv* )

Decryption operation using AES-CFB.

**Note**

The function operates on data buffers whose length is a multiple of an AES block, this means that padding must be done by the caller.

**Parameters**

| | | |
|---|---|---|
| in | *cryp* | pointer to the CRYDriver object |
| in | *key←_id* | the key to be used for the operation, zero is the transient key, other values are keys stored in an unspecified way |
| in | *size* | size of both buffers, this number must be a multiple of 16 |
| in | *in* | buffer containing the input cyphertext |
| out | *out* | buffer for the output plaintext |
| in | *iv* | 128 bits input vector |

**Returns**

The operation status.

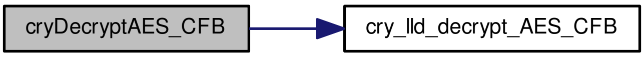
**Return values**

| | |
|---|---|
| *CRY_NOERROR* | if the operation succeeded. |
| *CRY_ERR_INV_ALGO* | if the operation is unsupported on this device instance. |
| *CRY_ERR_INV_KEY_TYPE* | the selected key is invalid for this operation. |
| *CRY_ERR_INV_KEY_ID* | if the specified key identifier is invalid or refers to an empty key slot. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.6.5.14 cryerror_t cryEncryptAES_CTR ( CRYDriver ∗ *cryp*, crykey_t *key_id*, size_t *size*, const uint8_t ∗ *in*, uint8_t ∗ *out*, const uint8_t ∗ *iv* )

Encryption operation using AES-CTR.

**Note**

The function operates on data buffers whose length is a multiple of an AES block, this means that padding must be done by the caller.

**Parameters**

| | | |
|---|---|---|
| in | *cryp* | pointer to the CRYDriver object |
| in | *key←_id* | the key to be used for the operation, zero is the transient key, other values are keys stored in an unspecified way |
| in | *size* | size of both buffers, this number must be a multiple of 16 |
| in | *in* | buffer containing the input plaintext |
| out | *out* | buffer for the output cyphertext |
| in | *iv* | 128 bits input vector + counter, it contains a 96 bits IV and a 32 bits counter |

**Returns**

The operation status.

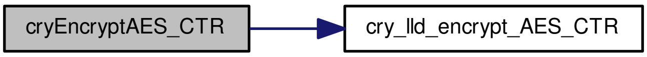
**Return values**

| | |
|---|---|
| *CRY_NOERROR* | if the operation succeeded. |
| *CRY_ERR_INV_ALGO* | if the operation is unsupported on this device instance. |
| *CRY_ERR_INV_KEY_TYPE* | the selected key is invalid for this operation. |
| *CRY_ERR_INV_KEY_ID* | if the specified key identifier is invalid or refers to an empty key slot. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



### 7.6.5.15 cryerror_t cryDecryptAES_CTR ( CRYDriver ∗ *cryp,* crykey_t *key_id,* size_t *size,* const uint8_t ∗ *in,* uint8_t ∗ *out,* const uint8_t ∗ *iv* )

Decryption operation using AES-CTR.

**Note**

The function operates on data buffers whose length is a multiple of an AES block, this means that padding must be done by the caller.

**Parameters**

| | | |
|---|---|---|
| in | *cryp* | pointer to the CRYDriver object |
| in | *key←<br>_id* | the key to be used for the operation, zero is the transient key, other values are keys stored in an unspecified way |
| in | *size* | size of both buffers, this number must be a multiple of 16 |
| in | *in* | buffer containing the input cyphertext |
| out | *out* | buffer for the output plaintext |
| in | *iv* | 128 bits input vector + counter, it contains a 96 bits IV and a 32 bits counter |

**Returns**

The operation status.

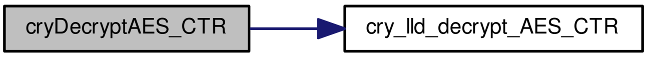
**Return values**

| | |
|---|---|
| *CRY_NOERROR* | if the operation succeeded. |
| *CRY_ERR_INV_ALGO* | if the operation is unsupported on this device instance. |
| *CRY_ERR_INV_KEY_TYPE* | the selected key is invalid for this operation. |
| *CRY_ERR_INV_KEY_ID* | if the specified key identifier is invalid or refers to an empty key slot. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.6.5.16 cryerror_t cryEncryptAES_GCM ( CRYDriver ∗ *cryp,* crykey_t *key_id,* size_t *size,* const uint8_t ∗ *in,* uint8_t ∗ *out,* const uint8_t ∗ *iv,* size_t *aadsize,* const uint8_t ∗ *aad,* uint8_t ∗ *authtag* )

Encryption operation using AES-GCM.

**Note**

The function operates on data buffers whose length is a multiple of an AES block, this means that padding must be done by the caller.

**Parameters**

| | | |
|---|---|---|
| in | *cryp* | pointer to the CRYDriver object |
| in | *key_id* | the key to be used for the operation, zero is the transient key, other values are keys stored in an unspecified way |
| in | *size* | size of the text buffers, this number must be a multiple of 16 |
| in | *in* | buffer containing the input plaintext |
| out | *out* | buffer for the output cyphertext |
| in | *iv* | 128 bits input vector + counter, it contains a 96 bits IV and a 32 bits counter |
| in | *aadsize* | size of the authentication data, this number must be a multiple of 16 |
| in | *aad* | buffer containing the authentication data |
| in | *authtag* | 128 bits buffer for the generated authentication tag |

**Returns**

The operation status.

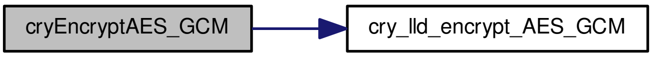
**Return values**

| | |
|---|---|
| *CRY_NOERROR* | if the operation succeeded. |
| *CRY_ERR_INV_ALGO* | if the operation is unsupported on this device instance. |
| *CRY_ERR_INV_KEY_TYPE* | the selected key is invalid for this operation. |
| *CRY_ERR_INV_KEY_ID* | if the specified key identifier is invalid or refers to an empty key slot. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



### 7.6.5.17 cryerror_t cryDecryptAES_GCM ( CRYDriver ∗ *cryp*, crykey_t *key_id*, size_t *size*, const uint8_t ∗ *in*, uint8_t ∗ *out*, const uint8_t ∗ *iv*, size_t *aadsize*, const uint8_t ∗ *aad*, uint8_t ∗ *authtag* )

Decryption operation using AES-GCM.

**Note**

The function operates on data buffers whose length is a multiple of an AES block, this means that padding must be done by the caller.

**Parameters**

| | | |
|---|---|---|
| in | *cryp* | pointer to the CRYDriver object |
| in | *key_id* | the key to be used for the operation, zero is the transient key, other values are keys stored in an unspecified way |
| in | *size* | size of the text buffers, this number must be a multiple of 16 |
| in | *in* | buffer for the output cyphertext |
| out | *out* | buffer containing the input plaintext |
| in | *iv* | 128 bits input vector + counter, it contains a 96 bits IV and a 32 bits counter |
| in | *aadsize* | size of the authentication data, this number must be a multiple of 16 |
| in | *aad* | buffer containing the authentication data |
| in | *authtag* | 128 bits buffer for the generated authentication tag |

**Returns**

The operation status.

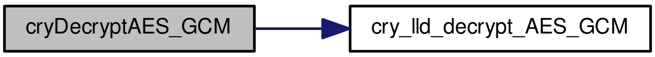
**Return values**

| | |
|---|---|
| *CRY_NOERROR* | if the operation succeeded. |
| *CRY_ERR_INV_ALGO* | if the operation is unsupported on this device instance. |
| *CRY_ERR_INV_KEY_TYPE* | the selected key is invalid for this operation. |
| *CRY_ERR_INV_KEY_ID* | if the specified key identifier is invalid or refers to an empty key slot. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.6.5.18 cryerror_t cryEncryptDES ( CRYDriver * *cryp*, crykey_t *key_id*, const uint8_t * *in*, uint8_t * *out* )

Encryption of a single block using (T)DES.

**Note**

The implementation of this function must guarantee that it can be called from any context.

**Parameters**

| | | |
|---|---|---|
| `in` | *cryp* | pointer to the `CRYDriver` object |
| `in` | *key←_id* | the key to be used for the operation, zero is the transient key, other values are keys stored in an unspecified way |
| `in` | *in* | buffer containing the input plaintext |
| `out` | *out* | buffer for the output cyphertext |

**Returns**

The operation status.

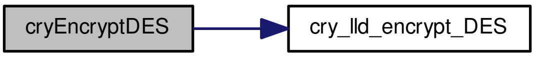
**Return values**

| | |
|---|---|
| *CRY_NOERROR* | if the operation succeeded. |
| *CRY_ERR_INV_ALGO* | if the operation is unsupported on this device instance. |
| *CRY_ERR_INV_KEY_TYPE* | the selected key is invalid for this operation. |
| *CRY_ERR_INV_KEY_ID* | if the specified key identifier is invalid or refers to an empty key slot. |

**Function Class:**

Special function, this function has special requirements see the notes.

Here is the call graph for this function:



#### 7.6.5.19 cryerror_t cryDecryptDES ( CRYDriver ∗ *cryp,* crykey_t *key_id,* const uint8_t ∗ *in,* uint8_t ∗ *out* )

Decryption of a single block using (T)DES.

**Note**

The implementation of this function must guarantee that it can be called from any context.

**Parameters**

| | | |
|---|---|---|
| in | *cryp* | pointer to the CRYDriver object |
| in | *key←_id* | the key to be used for the operation, zero is the transient key, other values are keys stored in an unspecified way |
| in | *in* | buffer containing the input cyphertext |
| out | *out* | buffer for the output plaintext |

**Returns**

The operation status.

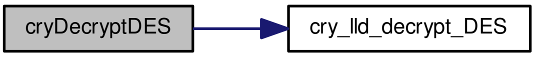
**Return values**

| | |
|---|---|
| *CRY_NOERROR* | if the operation succeeded. |
| *CRY_ERR_INV_ALGO* | if the operation is unsupported on this device instance. |
| *CRY_ERR_INV_KEY_TYPE* | the selected key is invalid for this operation. |
| *CRY_ERR_INV_KEY_ID* | if the specified key identifier is invalid or refers to an empty key slot. |

**Function Class:**

Special function, this function has special requirements see the notes.

Here is the call graph for this function:



#### 7.6.5.20 cryerror_t cryEncryptDES_ECB ( CRYDriver ∗ *cryp,* crykey_t *key_id,* size_t *size,* const uint8_t ∗ *in,* uint8_t ∗ *out* )

Encryption operation using (T)DES-ECB.

**Note**

The function operates on data buffers whose length is a multiple of an DES block, this means that padding must be done by the caller.

**Parameters**

| | | |
|---|---|---|
| in | *cryp* | pointer to the CRYDriver object |
| in | *key←<br>_id* | the key to be used for the operation, zero is the transient key, other values are keys stored in an unspecified way |
| in | *size* | size of both buffers, this number must be a multiple of 8 |
| in | *in* | buffer containing the input plaintext |
| out | *out* | buffer for the output cyphertext |

**Returns**

The operation status.

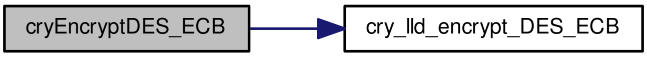
**Return values**

| | |
|---|---|
| *CRY_NOERROR* | if the operation succeeded. |
| *CRY_ERR_INV_ALGO* | if the operation is unsupported on this device instance. |
| *CRY_ERR_INV_KEY_TYPE* | the selected key is invalid for this operation. |
| *CRY_ERR_INV_KEY_ID* | if the specified key identifier is invalid or refers to an empty key slot. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.6.5.21 cryerror_t cryDecryptDES_ECB ( CRYDriver ∗ *cryp,* crykey_t *key_id,* size_t *size,* const uint8_t ∗ *in,* uint8_t ∗ *out* )

Decryption operation using (T)DES-ECB.

**Note**

The function operates on data buffers whose length is a multiple of an DES block, this means that padding must be done by the caller.

**Parameters**

| | | |
|---|---|---|
| in | *cryp* | pointer to the `CRYDriver` object |
| in | *key←_id* | the key to be used for the operation, zero is the transient key, other values are keys stored in an unspecified way |
| in | *size* | size of both buffers, this number must be a multiple of 8 |
| in | *in* | buffer containing the input cyphertext |
| out | *out* | buffer for the output plaintext |

**Returns**

The operation status.

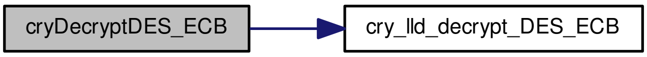
**Return values**

| | |
|---|---|
| *CRY_NOERROR* | if the operation succeeded. |
| *CRY_ERR_INV_ALGO* | if the operation is unsupported on this device instance. |
| *CRY_ERR_INV_KEY_TYPE* | the selected key is invalid for this operation. |
| *CRY_ERR_INV_KEY_ID* | if the specified key identifier is invalid or refers to an empty key slot. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.6.5.22 cryerror_t cryEncryptDES_CBC ( CRYDriver ∗ *cryp,* crykey_t *key_id,* size_t *size,* const uint8_t ∗ *in,* uint8_t ∗ *out,* const uint8_t ∗ *iv* )

Encryption operation using (T)DES-CBC.

**Note**

The function operates on data buffers whose length is a multiple of an DES block, this means that padding must be done by the caller.

**Parameters**

| | | |
|---|---|---|
| in | *cryp* | pointer to the CRYDriver object |
| in | *key*←<br>*_id* | the key to be used for the operation, zero is the transient key, other values are keys stored in an unspecified way |
| in | *size* | size of both buffers, this number must be a multiple of 8 |
| in | *in* | buffer containing the input plaintext |
| out | *out* | buffer for the output cyphertext |
| in | *iv* | 64 bits input vector |

**Returns**

The operation status.

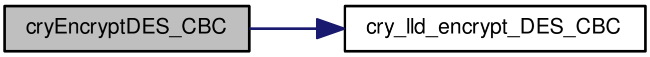
**Return values**

| | |
|---|---|
| *CRY_NOERROR* | if the operation succeeded. |
| *CRY_ERR_INV_ALGO* | if the operation is unsupported on this device instance. |
| *CRY_ERR_INV_KEY_TYPE* | the selected key is invalid for this operation. |
| *CRY_ERR_INV_KEY_ID* | if the specified key identifier is invalid or refers to an empty key slot. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.6.5.23 cryerror_t cryDecryptDES_CBC ( CRYDriver ∗ *cryp,* crykey_t *key_id,* size_t *size,* const uint8_t ∗ *in,* uint8_t ∗ *out,* const uint8_t ∗ *iv* )

Decryption operation using (T)DES-CBC.

**Note**

The function operates on data buffers whose length is a multiple of an DES block, this means that padding must be done by the caller.

**Parameters**

| | | |
|---|---|---|
| in | *cryp* | pointer to the CRYDriver object |
| in | *key←_id* | the key to be used for the operation, zero is the transient key, other values are keys stored in an unspecified way |
| in | *size* | size of both buffers, this number must be a multiple of 8 |
| in | *in* | buffer containing the input cyphertext |
| out | *out* | buffer for the output plaintext |
| in | *iv* | 64 bits input vector |

**Returns**

The operation status.

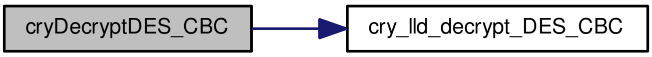
**Return values**

| | |
|---|---|
| *CRY_NOERROR* | if the operation succeeded. |
| *CRY_ERR_INV_ALGO* | if the operation is unsupported on this device instance. |
| *CRY_ERR_INV_KEY_TYPE* | the selected key is invalid for this operation. |
| *CRY_ERR_INV_KEY_ID* | if the specified key identifier is invalid or refers to an empty key slot. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.6.5.24 cryerror_t crySHA1Init ( CRYDriver ∗ *cryp*, SHA1Context ∗ *sha1ctxp* )

Hash initialization using SHA1.

**Note**

Use of this algorithm is not recommended because proven weak.

**Parameters**

| | | |
|---|---|---|
| in | *cryp* | pointer to the CRYDriver object |
| out | *sha1ctxp* | pointer to a SHA1 context to be initialized |

**Returns**

The operation status.

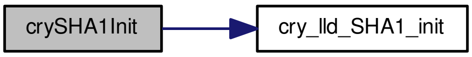
**Return values**

| | |
|---|---|
| *CRY_NOERROR* | if the operation succeeded. |
| *CRY_ERR_INV_ALGO* | if the operation is unsupported on this device instance. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.6.5.25 cryerror_t crySHA1Update ( CRYDriver * *cryp*, SHA1Context * *sha1ctxp*, size_t *size*, const uint8_t * *in* )

Hash update using SHA1.

**Note**

Use of this algorithm is not recommended because proven weak.

**Parameters**

| | | |
|---|---|---|
| in | *cryp* | pointer to the CRYDriver object |
| in | *sha1ctxp* | pointer to a SHA1 context |
| in | *size* | size of input buffer |
| in | *in* | buffer containing the input text |

**Returns**

The operation status.

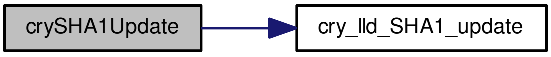
**Return values**

| | |
|---|---|
| *CRY_NOERROR* | if the operation succeeded. |
| *CRY_ERR_INV_ALGO* | if the operation is unsupported on this device instance. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.6.5.26 cryerror_t crySHA1Final ( CRYDriver * *cryp*, SHA1Context * *sha1ctxp*, uint8_t * *out* )

Hash finalization using SHA1.

**Note**

Use of this algorithm is not recommended because proven weak.

**Parameters**

| | | |
|---|---|---|
| in | *cryp* | pointer to the CRYDriver object |
| in | *sha1ctxp* | pointer to a SHA1 context |
| out | *out* | 160 bits output buffer |

**Returns**

The operation status.

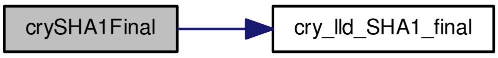
**Return values**

| | |
|---|---|
| *CRY_NOERROR* | if the operation succeeded. |
| *CRY_ERR_INV_ALGO* | if the operation is unsupported on this device instance. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.6.5.27 cryerror_t crySHA256Init ( CRYDriver ∗ *cryp*, SHA256Context ∗ *sha256ctxp* )

Hash initialization using SHA256.

**Note**

Use of this algorithm is not recommended because proven weak.

**Parameters**

| | | |
|---|---|---|
| `in` | *cryp* | pointer to the `CRYDriver` object |
| `out` | *sha256ctxp* | pointer to a SHA256 context to be initialized |

**Returns**

The operation status.

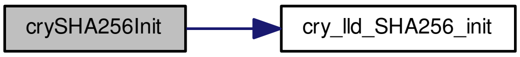
**Return values**

| | |
|---|---|
| *CRY_NOERROR* | if the operation succeeded. |
| *CRY_ERR_INV_ALGO* | if the operation is unsupported on this device instance. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.6.5.28 cryerror_t crySHA256Update ( CRYDriver ∗ *cryp*, SHA256Context ∗ *sha256ctxp*, size_t *size*, const uint8_t ∗ *in* )

Hash update using SHA256.

**Note**

Use of this algorithm is not recommended because proven weak.

**Parameters**

| | | |
|---|---|---|
| in | *cryp* | pointer to the CRYDriver object |
| in | *sha256ctxp* | pointer to a SHA256 context |
| in | *size* | size of input buffer |
| in | *in* | buffer containing the input text |

**Returns**

The operation status.

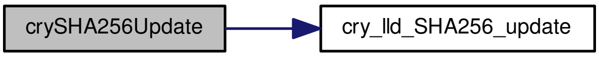
**Return values**

| | |
|---|---|
| *CRY_NOERROR* | if the operation succeeded. |
| *CRY_ERR_INV_ALGO* | if the operation is unsupported on this device instance. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.6.5.29 cryerror_t crySHA256Final ( CRYDriver ∗ *cryp*, SHA256Context ∗ *sha256ctxp*, uint8_t ∗ *out* )

Hash finalization using SHA256.

**Note**

Use of this algorithm is not recommended because proven weak.

**Parameters**

| | | |
|---|---|---|
| in | *cryp* | pointer to the CRYDriver object |
| in | *sha256ctxp* | pointer to a SHA256 context |
| out | *out* | 256 bits output buffer |

**Returns**

The operation status.

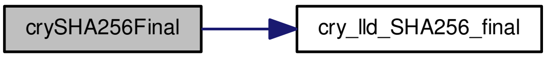
**Return values**

| | |
|---|---|
| *CRY_NOERROR* | if the operation succeeded. |
| *CRY_ERR_INV_ALGO* | if the operation is unsupported on this device instance. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.6.5.30 cryerror_t crySHA512Init ( CRYDriver ∗ *cryp*, SHA512Context ∗ *sha512ctxp* )

Hash initialization using SHA512.

**Note**

Use of this algorithm is not recommended because proven weak.

**Parameters**

| | | |
|---|---|---|
| in | *cryp* | pointer to the CRYDriver object |
| out | *sha512ctxp* | pointer to a SHA512 context to be initialized |

**Returns**

The operation status.

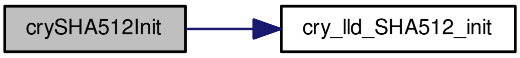
**Return values**

| | |
|---|---|
| *CRY_NOERROR* | if the operation succeeded. |
| *CRY_ERR_INV_ALGO* | if the operation is unsupported on this device instance. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.6.5.31 cryerror_t crySHA512Update ( CRYDriver ∗ *cryp,* SHA512Context ∗ *sha512ctxp,* size_t *size,* const uint8_t ∗ *in* )

Hash update using SHA512.

**Note**

Use of this algorithm is not recommended because proven weak.

**Parameters**

| | | |
|---|---|---|
| in | *cryp* | pointer to the `CRYDriver` object |
| in | *sha512ctxp* | pointer to a SHA512 context |
| in | *size* | size of input buffer |
| in | *in* | buffer containing the input text |

**Returns**

The operation status.

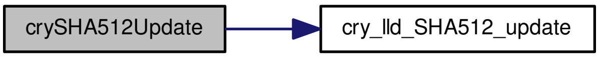
**Return values**

| | |
|---|---|
| *CRY_NOERROR* | if the operation succeeded. |
| *CRY_ERR_INV_ALGO* | if the operation is unsupported on this device instance. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



### 7.6.5.32 cryerror_t crySHA512Final ( CRYDriver * *cryp*, SHA512Context * *sha512ctxp*, uint8_t * *out* )

Hash finalization using SHA512.

**Note**

Use of this algorithm is not recommended because proven weak.

**Parameters**

| | | |
|---|---|---|
| in | *cryp* | pointer to the CRYDriver object |
| in | *sha512ctxp* | pointer to a SHA512 context |
| out | *out* | 512 bits output buffer |

**Returns**

The operation status.

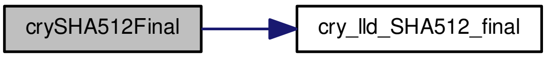
**Return values**

| | |
|---|---|
| *CRY_NOERROR* | if the operation succeeded. |
| *CRY_ERR_INV_ALGO* | if the operation is unsupported on this device instance. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.6.5.33 cryerror_t cryTRNG ( CRYDriver ∗ *cryp,* uint8_t ∗ *out* )

True random numbers generator.

**Parameters**

| | | |
|---|---|---|
| in | *cryp* | pointer to the CRYDriver object |
| out | *out* | 128 bits output buffer |

**Returns**

The operation status.

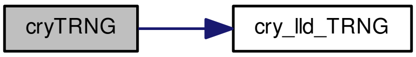
**Return values**

| | |
|---|---|
| *CRY_NOERROR* | if the operation succeeded. |
| *CRY_ERR_INV_ALGO* | if the operation is unsupported on this device instance. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.6.5.34 void cry_lld_init ( void )

Low level crypto driver initialization.

**Function Class:**

Not an API, this function is for internal use only.

#### 7.6.5.35 void cry_lld_start ( CRYDriver ∗ *cryp* )

Configures and activates the crypto peripheral.

**Parameters**

| | | |
|---|---|---|
| in | *cryp* | pointer to the CRYDriver object |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.6.5.36 void cry_lld_stop ( CRYDriver * *cryp* )

Deactivates the crypto peripheral.

**Parameters**

| | | |
|---|---|---|
| in | *cryp* | pointer to the CRYDriver object |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.6.5.37 cryerror_t cry_lld_loadkey ( CRYDriver * *cryp,* cryalgorithm_t *algorithm,* size_t *size,* const uint8_t * *keyp* )

Initializes the transient key for a specific algorithm.

**Parameters**

| | | |
|---|---|---|
| in | *cryp* | pointer to the CRYDriver object |
| in | *algorithm* | the algorithm identifier |
| in | *size* | key size in bytes |
| in | *keyp* | pointer to the key data |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *CRY_NOERROR* | if the operation succeeded. |
| *CRY_ERR_INV_ALGO* | if the specified algorithm is unknown or unsupported. |
| *CRY_ERR_INV_KEY_SIZE* | if the specified key size is invalid. |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.6.5.38 cryerror_t cry_lld_encrypt_AES ( CRYDriver * *cryp,* crykey_t *key_id,* const uint8_t * *in,* uint8_t * *out* )

Encryption of a single block using AES.

**Note**

The implementation of this function must guarantee that it can be called from any context.

**Parameters**

| | | |
|---|---|---|
| in | *cryp* | pointer to the CRYDriver object |
| in | *key←<br>_id* | the key to be used for the operation, zero is the transient key, other values are keys stored in an unspecified way |
| in | *in* | buffer containing the input plaintext |
| out | *out* | buffer for the output cyphertext |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *CRY_NOERROR* | if the operation succeeded. |
| *CRY_ERR_INV_ALGO* | if the operation is unsupported on this device instance. |
| *CRY_ERR_INV_KEY_TYPE* | the selected key is invalid for this operation. |
| *CRY_ERR_INV_KEY_ID* | if the specified key identifier is invalid or refers to an empty key slot. |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.6.5.39 cryerror_t cry_lld_decrypt_AES ( CRYDriver ∗ *cryp*, crykey_t *key_id*, const uint8_t ∗ *in*, uint8_t ∗ *out* )

Decryption of a single block using AES.

**Note**

The implementation of this function must guarantee that it can be called from any context.

**Parameters**

| | | |
|---|---|---|
| in | *cryp* | pointer to the CRYDriver object |
| in | *key←<br>_id* | the key to be used for the operation, zero is the transient key, other values are keys stored in an unspecified way |
| in | *in* | buffer containing the input cyphertext |
| out | *out* | buffer for the output plaintext |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *CRY_NOERROR* | if the operation succeeded. |
| *CRY_ERR_INV_ALGO* | if the operation is unsupported on this device instance. |
| *CRY_ERR_INV_KEY_TYPE* | the selected key is invalid for this operation. |
| *CRY_ERR_INV_KEY_ID* | if the specified key identifier is invalid or refers to an empty key slot. |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.6.5.40 cryerror_t cry_lld_encrypt_AES_ECB ( CRYDriver ∗ *cryp*, crykey_t *key_id*, size_t *size*, const uint8_t ∗ *in*, uint8_t ∗ *out* )

Encryption operation using AES-ECB.

**Note**

The function operates on data buffers whose lenght is a multiple of an AES block, this means that padding must be done by the caller.

**Parameters**

| | | |
|---|---|---|
| in | *cryp* | pointer to the CRYDriver object |
| in | *key←_id* | the key to be used for the operation, zero is the transient key, other values are keys stored in an unspecified way |
| in | *size* | size of the plaintext buffer, this number must be a multiple of the selected key size |
| in | *in* | buffer containing the input plaintext |
| out | *out* | buffer for the output cyphertext |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *CRY_NOERROR* | if the operation succeeded. |
| *CRY_ERR_INV_ALGO* | if the operation is unsupported on this device instance. |
| *CRY_ERR_INV_KEY_TYPE* | the selected key is invalid for this operation. |
| *CRY_ERR_INV_KEY_ID* | if the specified key identifier is invalid or refers to an empty key slot. |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.6.5.41 cryerror_t cry_lld_decrypt_AES_ECB ( CRYDriver ∗ *cryp*, crykey_t *key_id*, size_t *size*, const uint8_t ∗ *in*, uint8_t ∗ *out* )

Decryption operation using AES-ECB.

**Note**

The function operates on data buffers whose lenght is a multiple of an AES block, this means that padding must be done by the caller.

**Parameters**

| | | |
|---|---|---|
| in | *cryp* | pointer to the CRYDriver object |

**Parameters**

| | | |
|---|---|---|
| in | *key←_id* | the key to be used for the operation, zero is the transient key, other values are keys stored in an unspecified way |
| in | *size* | size of the plaintext buffer, this number must be a multiple of the selected key size |
| in | *in* | buffer containing the input plaintext |
| out | *out* | buffer for the output cyphertext |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *CRY_NOERROR* | if the operation succeeded. |
| *CRY_ERR_INV_ALGO* | if the operation is unsupported on this device instance. |
| *CRY_ERR_INV_KEY_TYPE* | the selected key is invalid for this operation. |
| *CRY_ERR_INV_KEY_ID* | if the specified key identifier is invalid or refers to an empty key slot. |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.6.5.42 cryerror_t cry_lld_encrypt_AES_CBC ( CRYDriver ∗ *cryp,* crykey_t *key_id,* size_t *size,* const uint8_t ∗ *in,* uint8_t ∗ *out,* const uint8_t ∗ *iv* )

Encryption operation using AES-CBC.

**Note**

The function operates on data buffers whose lenght is a multiple of an AES block, this means that padding must be done by the caller.

**Parameters**

| | | |
|---|---|---|
| in | *cryp* | pointer to the CRYDriver object |
| in | *key←_id* | the key to be used for the operation, zero is the transient key, other values are keys stored in an unspecified way |
| in | *size* | size of the plaintext buffer, this number must be a multiple of the selected key size |
| in | *in* | buffer containing the input plaintext |
| out | *out* | buffer for the output cyphertext |
| in | *iv* | 128 bits initial vector |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *CRY_NOERROR* | if the operation succeeded. |

**Return values**

| | |
|---|---|
| *CRY_ERR_INV_ALGO* | if the operation is unsupported on this device instance. |
| *CRY_ERR_INV_KEY_TYPE* | the selected key is invalid for this operation. |
| *CRY_ERR_INV_KEY_ID* | if the specified key identifier is invalid or refers to an empty key slot. |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.6.5.43 cryerror_t cry_lld_decrypt_AES_CBC ( CRYDriver * *cryp,* crykey_t *key_id,* size_t *size,* const uint8_t * *in,* uint8_t * *out,* const uint8_t * *iv* )

Decryption operation using AES-CBC.

**Note**

The function operates on data buffers whose lenght is a multiple of an AES block, this means that padding must be done by the caller.

**Parameters**

| | | |
|---|---|---|
| in | *cryp* | pointer to the `CRYDriver` object |
| in | *key←_id* | the key to be used for the operation, zero is the transient key, other values are keys stored in an unspecified way |
| in | *size* | size of the plaintext buffer, this number must be a multiple of the selected key size |
| in | *in* | buffer containing the input plaintext |
| out | *out* | buffer for the output cyphertext |
| in | *iv* | 128 bits initial vector |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *CRY_NOERROR* | if the operation succeeded. |
| *CRY_ERR_INV_ALGO* | if the operation is unsupported on this device instance. |
| *CRY_ERR_INV_KEY_TYPE* | the selected key is invalid for this operation. |
| *CRY_ERR_INV_KEY_ID* | if the specified key identifier is invalid or refers to an empty key slot. |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.6.5.44 cryerror_t cry_lld_encrypt_AES_CFB ( CRYDriver * *cryp,* crykey_t *key_id,* size_t *size,* const uint8_t * *in,* uint8_t * *out,* const uint8_t * *iv* )

Encryption operation using AES-CFB.

**Note**

The function operates on data buffers whose lenght is a multiple of an AES block, this means that padding must be done by the caller.

**Parameters**

| | | |
|---|---|---|
| in | *cryp* | pointer to the CRYDriver object |
| in | *key↩<br>_id* | the key to be used for the operation, zero is the transient key, other values are keys stored in an unspecified way |
| in | *size* | size of the plaintext buffer, this number must be a multiple of the selected key size |
| in | *in* | buffer containing the input plaintext |
| out | *out* | buffer for the output cyphertext |
| in | *iv* | 128 bits initial vector |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *CRY_NOERROR* | if the operation succeeded. |
| *CRY_ERR_INV_ALGO* | if the operation is unsupported on this device instance. |
| *CRY_ERR_INV_KEY_TYPE* | the selected key is invalid for this operation. |
| *CRY_ERR_INV_KEY_ID* | if the specified key identifier is invalid or refers to an empty key slot. |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.6.5.45 cryerror_t cry_lld_decrypt_AES_CFB ( CRYDriver ∗ *cryp,* crykey_t *key_id,* size_t *size,* const uint8_t ∗ *in,* uint8_t ∗ *out,* const uint8_t ∗ *iv* )

Decryption operation using AES-CFB.

**Note**

The function operates on data buffers whose lenght is a multiple of an AES block, this means that padding must be done by the caller.

**Parameters**

| | | |
|---|---|---|
| in | *cryp* | pointer to the CRYDriver object |
| in | *key↩<br>_id* | the key to be used for the operation, zero is the transient key, other values are keys stored in an unspecified way |
| in | *size* | size of the plaintext buffer, this number must be a multiple of the selected key size |
| in | *in* | buffer containing the input plaintext |
| out | *out* | buffer for the output cyphertext |
| in | *iv* | 128 bits initial vector |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *CRY_NOERROR* | if the operation succeeded. |
| *CRY_ERR_INV_ALGO* | if the operation is unsupported on this device instance. |
| *CRY_ERR_INV_KEY_TYPE* | the selected key is invalid for this operation. |
| *CRY_ERR_INV_KEY_ID* | if the specified key identifier is invalid or refers to an empty key slot. |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.6.5.46 cryerror_t cry_lld_encrypt_AES_CTR ( CRYDriver ∗ *cryp,* crykey_t *key_id,* size_t *size,* const uint8_t ∗ *in,* uint8_t ∗ *out,* const uint8_t ∗ *iv* )

Encryption operation using AES-CTR.

**Note**

The function operates on data buffers whose lenght is a multiple of an AES block, this means that padding must be done by the caller.

**Parameters**

| | | |
|---|---|---|
| in | *cryp* | pointer to the CRYDriver object |
| in | *key←_id* | the key to be used for the operation, zero is the transient key, other values are keys stored in an unspecified way |
| in | *size* | size of the plaintext buffer, this number must be a multiple of 16 |
| in | *in* | buffer containing the input plaintext |
| out | *out* | buffer for the output cyphertext |
| in | *iv* | 128 bits initial vector + counter, it contains a 96 bits IV and a 32 bits counter |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *CRY_NOERROR* | if the operation succeeded. |
| *CRY_ERR_INV_ALGO* | if the operation is unsupported on this device instance. |
| *CRY_ERR_INV_KEY_TYPE* | the selected key is invalid for this operation. |
| *CRY_ERR_INV_KEY_ID* | if the specified key identifier is invalid or refers to an empty key slot. |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.6.5.47 cryerror_t cry_lld_decrypt_AES_CTR ( CRYDriver ∗ *cryp,* crykey_t *key_id,* size_t *size,* const uint8_t ∗ *in,* uint8_t ∗ *out,* const uint8_t ∗ *iv* )

Decryption operation using AES-CTR.

**Note**

The function operates on data buffers whose lenght is a multiple of an AES block, this means that padding must be done by the caller.

**Parameters**

| | | |
|---|---|---|
| in | *cryp* | pointer to the CRYDriver object |
| in | *key←<br>_id* | the key to be used for the operation, zero is the transient key, other values are keys stored in an unspecified way |
| in | *size* | size of the plaintext buffer, this number must be a multiple of 16 |
| in | *in* | buffer containing the input cyphertext |
| out | *out* | buffer for the output plaintext |
| in | *iv* | 128 bits initial vector + counter, it contains a 96 bits IV and a 32 bits counter |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *CRY_NOERROR* | if the operation succeeded. |
| *CRY_ERR_INV_ALGO* | if the operation is unsupported on this device instance. |
| *CRY_ERR_INV_KEY_TYPE* | the selected key is invalid for this operation. |
| *CRY_ERR_INV_KEY_ID* | if the specified key identifier is invalid or refers to an empty key slot. |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.6.5.48 cryerror_t cry_lld_encrypt_AES_GCM ( CRYDriver ∗ *cryp,* crykey_t *key_id,* size_t *size,* const uint8_t ∗ *in,* uint8_t ∗ *out,* const uint8_t ∗ *iv,* size_t *aadsize,* const uint8_t ∗ *aad,* uint8_t ∗ *authtag* )

Encryption operation using AES-GCM.

**Note**

The function operates on data buffers whose lenght is a multiple of an AES block, this means that padding must be done by the caller.

**Parameters**

| | | |
|---|---|---|
| in | *cryp* | pointer to the CRYDriver object |
| in | *key_id* | the key to be used for the operation, zero is the transient key, other values are keys stored in an unspecified way |
| in | *size* | size of the text buffers, this number must be a multiple of 16 |
| in | *in* | buffer containing the input plaintext |

**Parameters**

| | | |
|---|---|---|
| out | *out* | buffer for the output cyphertext |
| in | *iv* | 128 bits initial vector + counter, it contains a 96 bits IV and a 32 bits counter |
| in | *aadsize* | size of the authentication data, this number must be a multiple of 16 |
| in | *aad* | buffer containing the authentication data |
| in | *authtag* | 128 bits buffer for the generated authentication tag |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *CRY_NOERROR* | if the operation succeeded. |
| *CRY_ERR_INV_ALGO* | if the operation is unsupported on this device instance. |
| *CRY_ERR_INV_KEY_TYPE* | the selected key is invalid for this operation. |
| *CRY_ERR_INV_KEY_ID* | if the specified key identifier is invalid or refers to an empty key slot. |

**Function Class:**

Not an API, this function is for internal use only.

### 7.6.5.49 cryerror_t cry_lld_decrypt_AES_GCM ( CRYDriver ∗ *cryp,* crykey_t *key_id,* size_t *size,* const uint8_t ∗ *in,* uint8_t ∗ *out,* const uint8_t ∗ *iv,* size_t *aadsize,* const uint8_t ∗ *aad,* uint8_t ∗ *authtag* )

Decryption operation using AES-GCM.

**Note**

The function operates on data buffers whose lenght is a multiple of an AES block, this means that padding must be done by the caller.

**Parameters**

| | | |
|---|---|---|
| in | *cryp* | pointer to the CRYDriver object |
| in | *key_id* | the key to be used for the operation, zero is the transient key, other values are keys stored in an unspecified way |
| in | *size* | size of the text buffers, this number must be a multiple of 16 |
| in | *in* | buffer for the output cyphertext |
| out | *out* | buffer containing the input plaintext |
| in | *iv* | 128 bits initial vector + counter, it contains a 96 bits IV and a 32 bits counter |
| in | *aadsize* | size of the authentication data, this number must be a multiple of 16 |
| in | *aad* | buffer containing the authentication data |
| in | *authtag* | 128 bits buffer for the generated authentication tag |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *CRY_NOERROR* | if the operation succeeded. |
| *CRY_ERR_INV_ALGO* | if the operation is unsupported on this device instance. |
| *CRY_ERR_INV_KEY_TYPE* | the selected key is invalid for this operation. |
| *CRY_ERR_INV_KEY_ID* | if the specified key identifier is invalid or refers to an empty key slot. |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.6.5.50 cryerror_t cry_lld_encrypt_DES ( CRYDriver * *cryp*, crykey_t *key_id*, const uint8_t * *in*, uint8_t * *out* )

Encryption of a single block using (T)DES.

**Note**

The implementation of this function must guarantee that it can be called from any context.

**Parameters**

| | | |
|---|---|---|
| `in` | *cryp* | pointer to the `CRYDriver` object |
| `in` | *key↩_id* | the key to be used for the operation, zero is the transient key, other values are keys stored in an unspecified way |
| `in` | *in* | buffer containing the input plaintext |
| `out` | *out* | buffer for the output cyphertext |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *CRY_NOERROR* | if the operation succeeded. |
| *CRY_ERR_INV_ALGO* | if the operation is unsupported on this device instance. |
| *CRY_ERR_INV_KEY_TYPE* | the selected key is invalid for this operation. |
| *CRY_ERR_INV_KEY_ID* | if the specified key identifier is invalid or refers to an empty key slot. |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.6.5.51 cryerror_t cry_lld_decrypt_DES ( CRYDriver * *cryp*, crykey_t *key_id*, const uint8_t * *in*, uint8_t * *out* )

Decryption of a single block using (T)DES.

**Note**

The implementation of this function must guarantee that it can be called from any context.

**Parameters**

| | | |
|---|---|---|
| in | *cryp* | pointer to the CRYDriver object |
| in | *key←_id* | the key to be used for the operation, zero is the transient key, other values are keys stored in an unspecified way |
| in | *in* | buffer containing the input cyphertext |
| out | *out* | buffer for the output plaintext |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *CRY_NOERROR* | if the operation succeeded. |
| *CRY_ERR_INV_ALGO* | if the operation is unsupported on this device instance. |
| *CRY_ERR_INV_KEY_TYPE* | the selected key is invalid for this operation. |
| *CRY_ERR_INV_KEY_ID* | if the specified key identifier is invalid or refers to an empty key slot. |

**Function Class:**

Not an API, this function is for internal use only.

### 7.6.5.52 cryerror_t cry_lld_encrypt_DES_ECB ( CRYDriver ∗ *cryp*, crykey_t *key_id*, size_t *size*, const uint8_t ∗ *in*, uint8_t ∗ *out* )

Encryption operation using (T)DES-ECB.

**Note**

The function operates on data buffers whose length is a multiple of an DES block, this means that padding must be done by the caller.

**Parameters**

| | | |
|---|---|---|
| in | *cryp* | pointer to the CRYDriver object |
| in | *key←_id* | the key to be used for the operation, zero is the transient key, other values are keys stored in an unspecified way |
| in | *size* | size of the plaintext buffer, this number must be a multiple of 8 |
| in | *in* | buffer containing the input plaintext |
| out | *out* | buffer for the output cyphertext |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *CRY_NOERROR* | if the operation succeeded. |
| *CRY_ERR_INV_ALGO* | if the operation is unsupported on this device instance. |

**Return values**

| | |
|---|---|
| *CRY_ERR_INV_KEY_TYPE* | the selected key is invalid for this operation. |
| *CRY_ERR_INV_KEY_ID* | if the specified key identifier is invalid or refers to an empty key slot. |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.6.5.53 cryerror_t cry_lld_decrypt_DES_ECB ( CRYDriver ∗ *cryp*, crykey_t *key_id*, size_t *size*, const uint8_t ∗ *in*, uint8_t ∗ *out* )

Decryption operation using (T)DES-ECB.

**Note**

The function operates on data buffers whose length is a multiple of an DES block, this means that padding must be done by the caller.

**Parameters**

| | | |
|---|---|---|
| in | *cryp* | pointer to the CRYDriver object |
| in | *key*↩<br>*_id* | the key to be used for the operation, zero is the transient key, other values are keys stored in an unspecified way |
| in | *size* | size of the plaintext buffer, this number must be a multiple of 8 |
| in | *in* | buffer containing the input cyphertext |
| out | *out* | buffer for the output plaintext |

**Returns**

T he operation status.

**Return values**

| | |
|---|---|
| *CRY_NOERROR* | if the operation succeeded. |
| *CRY_ERR_INV_ALGO* | if the operation is unsupported on this device instance. |
| *CRY_ERR_INV_KEY_TYPE* | the selected key is invalid for this operation. |
| *CRY_ERR_INV_KEY_ID* | if the specified key identifier is invalid or refers to an empty key slot. |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.6.5.54 cryerror_t cry_lld_encrypt_DES_CBC ( CRYDriver ∗ *cryp*, crykey_t *key_id*, size_t *size*, const uint8_t ∗ *in*, uint8_t ∗ *out*, const uint8_t ∗ *iv* )

Encryption operation using (T)DES-CBC.

**Note**

The function operates on data buffers whose length is a multiple of an DES block, this means that padding must be done by the caller.

**Parameters**

| | | |
|---|---|---|
| in | *cryp* | pointer to the CRYDriver object |
| in | *key←_id* | the key to be used for the operation, zero is the transient key, other values are keys stored in an unspecified way |
| in | *size* | size of the plaintext buffer, this number must be a multiple of 8 |
| in | *in* | buffer containing the input plaintext |
| out | *out* | buffer for the output cyphertext |
| in | *iv* | 64 bits input vector |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *CRY_NOERROR* | if the operation succeeded. |
| *CRY_ERR_INV_ALGO* | if the operation is unsupported on this device instance. |
| *CRY_ERR_INV_KEY_TYPE* | the selected key is invalid for this operation. |
| *CRY_ERR_INV_KEY_ID* | if the specified key identifier is invalid or refers to an empty key slot. |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.6.5.55 cryerror_t cry_lld_decrypt_DES_CBC ( CRYDriver ∗ *cryp,* crykey_t *key_id,* size_t *size,* const uint8_t ∗ *in,* uint8_t ∗ *out,* const uint8_t ∗ *iv* )

Decryption operation using (T)DES-CBC.

**Note**

The function operates on data buffers whose length is a multiple of an DES block, this means that padding must be done by the caller.

**Parameters**

| | | |
|---|---|---|
| in | *cryp* | pointer to the CRYDriver object |
| in | *key←_id* | the key to be used for the operation, zero is the transient key, other values are keys stored in an unspecified way |
| in | *size* | size of the plaintext buffer, this number must be a multiple of 8 |
| in | *in* | buffer containing the input cyphertext |
| out | *out* | buffer for the output plaintext |
| in | *iv* | 64 bits input vector |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *CRY_NOERROR* | if the operation succeeded. |
| *CRY_ERR_INV_ALGO* | if the operation is unsupported on this device instance. |
| *CRY_ERR_INV_KEY_TYPE* | the selected key is invalid for this operation. |
| *CRY_ERR_INV_KEY_ID* | if the specified key identifier is invalid or refers to an empty key slot. |

**Function Class:**

Not an API, this function is for internal use only.

### 7.6.5.56 cryerror_t cry_lld_SHA1_init ( CRYDriver ∗ *cryp*, SHA1Context ∗ *sha1ctxp* )

Hash initialization using SHA1.

**Note**

Use of this algorithm is not recommended because proven weak.

**Parameters**

| | | |
|---|---|---|
| in | *cryp* | pointer to the `CRYDriver` object |
| out | *sha1ctxp* | pointer to a SHA1 context to be initialized |

**Return values**

| | |
|---|---|
| *CRY_NOERROR* | if the operation succeeded. |
| *CRY_ERR_INV_ALGO* | if the operation is unsupported on this device instance. |

**Function Class:**

Not an API, this function is for internal use only.

### 7.6.5.57 cryerror_t cry_lld_SHA1_update ( CRYDriver ∗ *cryp*, SHA1Context ∗ *sha1ctxp*, size_t *size*, const uint8_t ∗ *in* )

Hash update using SHA1.

**Note**

Use of this algorithm is not recommended because proven weak.

**Parameters**

| | | |
|---|---|---|
| in | *cryp* | pointer to the `CRYDriver` object |
| in | *sha1ctxp* | pointer to a SHA1 context |
| in | *size* | size of input buffer |
| in | *in* | buffer containing the input text |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *CRY_NOERROR* | if the operation succeeded. |
| *CRY_ERR_INV_ALGO* | if the operation is unsupported on this device instance. |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.6.5.58 cryerror_t cry_lld_SHA1_final ( CRYDriver ∗ *cryp,* SHA1Context ∗ *sha1ctxp,* uint8_t ∗ *out* )

Hash finalization using SHA1.

**Note**

Use of this algorithm is not recommended because proven weak.

**Parameters**

| | | |
|---|---|---|
| `in` | *cryp* | pointer to the `CRYDriver` object |
| `in` | *sha1ctxp* | pointer to a SHA1 context |
| `out` | *out* | 160 bits output buffer |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *CRY_NOERROR* | if the operation succeeded. |
| *CRY_ERR_INV_ALGO* | if the operation is unsupported on this device instance. |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.6.5.59 cryerror_t cry_lld_SHA256_init ( CRYDriver ∗ *cryp,* SHA256Context ∗ *sha256ctxp* )

Hash initialization using SHA256.

**Parameters**

| | | |
|---|---|---|
| `in` | *cryp* | pointer to the `CRYDriver` object |
| `out` | *sha256ctxp* | pointer to a SHA256 context to be initialized |

**Return values**

| | |
|---|---|
| *CRY_NOERROR* | if the operation succeeded. |
| *CRY_ERR_INV_ALGO* | if the operation is unsupported on this device instance. |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.6.5.60 cryerror_t cry_lld_SHA256_update ( CRYDriver * *cryp,* SHA256Context * *sha256ctxp,* size_t *size,* const uint8_t * *in* )

Hash update using SHA256.

**Parameters**

| | | |
|---|---|---|
| `in` | *cryp* | pointer to the `CRYDriver` object |
| `in` | *sha256ctxp* | pointer to a SHA256 context |
| `in` | *size* | size of input buffer |
| `in` | *in* | buffer containing the input text |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *CRY_NOERROR* | if the operation succeeded. |
| *CRY_ERR_INV_ALGO* | if the operation is unsupported on this device instance. |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.6.5.61 cryerror_t cry_lld_SHA256_final ( CRYDriver * *cryp,* SHA256Context * *sha256ctxp,* uint8_t * *out* )

Hash finalization using SHA256.

**Parameters**

| | | |
|---|---|---|
| `in` | *cryp* | pointer to the `CRYDriver` object |
| `in` | *sha256ctxp* | pointer to a SHA256 context |
| `out` | *out* | 256 bits output buffer |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *CRY_NOERROR* | if the operation succeeded. |
| *CRY_ERR_INV_ALGO* | if the operation is unsupported on this device instance. |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.6.5.62 cryerror_t cry_lld_SHA512_init ( CRYDriver ∗ *cryp,* SHA512Context ∗ *sha512ctxp* )

Hash initialization using SHA512.

**Parameters**

| | | |
|---|---|---|
| in | *cryp* | pointer to the CRYDriver object |
| out | *sha512ctxp* | pointer to a SHA512 context to be initialized |

**Return values**

| | |
|---|---|
| *CRY_NOERROR* | if the operation succeeded. |
| *CRY_ERR_INV_ALGO* | if the operation is unsupported on this device instance. |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.6.5.63 cryerror_t cry_lld_SHA512_update ( CRYDriver ∗ *cryp,* SHA512Context ∗ *sha512ctxp,* size_t *size,* const uint8_t ∗ *in* )

Hash update using SHA512.

**Parameters**

| | | |
|---|---|---|
| in | *cryp* | pointer to the CRYDriver object |
| in | *sha512ctxp* | pointer to a SHA512 context |
| in | *size* | size of input buffer |
| in | *in* | buffer containing the input text |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *CRY_NOERROR* | if the operation succeeded. |
| *CRY_ERR_INV_ALGO* | if the operation is unsupported on this device instance. |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.6.5.64 cryerror_t cry_lld_SHA512_final ( CRYDriver * *cryp*, SHA512Context * *sha512ctxp*, uint8_t * *out* )

Hash finalization using SHA512.

**Parameters**

| | | |
|---|---|---|
| in | *cryp* | pointer to the `CRYDriver` object |
| in | *sha512ctxp* | pointer to a SHA512 context |
| out | *out* | 512 bits output buffer |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *CRY_NOERROR* | if the operation succeeded. |
| *CRY_ERR_INV_ALGO* | if the operation is unsupported on this device instance. |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.6.5.65 cryerror_t cry_lld_TRNG ( CRYDriver * *cryp*, uint8_t * *out* )

True random numbers generator.

**Parameters**

| | | |
|---|---|---|
| in | *cryp* | pointer to the `CRYDriver` object |
| out | *out* | 128 bits output buffer |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *CRY_NOERROR* | if the operation succeeded. |
| *CRY_ERR_INV_ALGO* | if the operation is unsupported on this device instance. |

**Function Class:**

Not an API, this function is for internal use only.

## 7.6.6 Variable Documentation

### 7.6.6.1 CRYDriver CRYD1

CRY1 driver identifier.

## 7.7 DAC Driver

Generic DAC Driver.

### 7.7.1 Detailed Description

Generic DAC Driver.

This module implements a generic DAC (Digital to Analog Converter) driver.

#### Precondition

In order to use the MAC driver the `HAL_USE_DAC` option must be enabled in `halconf.h`.

#### Macros

- #define DAC_MAX_CHANNELS 2

  *Maximum number of DAC channels per unit.*

#### DAC configuration options

- #define DAC_USE_WAIT TRUE

  *Enables synchronous APIs.*
- #define DAC_USE_MUTUAL_EXCLUSION TRUE

  *Enables the `dacAcquireBus()` and `dacReleaseBus()` APIs.*

#### Low level driver helper macros

- #define _dac_wait_s(dacp) osalThreadSuspendS(&(dacp)->thread)

  *Waits for operation completion.*
- #define _dac_reset_i(dacp) osalThreadResumeI(&(dacp)->thread, MSG_RESET)

  *Resumes a thread waiting for a conversion completion.*
- #define _dac_reset_s(dacp) osalThreadResumeS(&(dacp)->thread, MSG_RESET)

  *Resumes a thread waiting for a conversion completion.*
- #define _dac_wakeup_isr(dacp)

  *Wakes up the waiting thread.*
- #define _dac_timeout_isr(dacp)

  *Wakes up the waiting thread with a timeout message.*
- #define _dac_isr_half_code(dacp)

  *Common ISR code, half buffer event.*
- #define _dac_isr_full_code(dacp)

  *Common ISR code, full buffer event.*
- #define _dac_isr_error_code(dacp, err)

  *Common ISR code, error event.*

#### Configuration options

- #define PLATFORM_DAC_USE_DAC1 FALSE

  *DAC1 CH1 driver enable switch.*

## Typedefs

- typedef uint32_t dacchannel_t

  *Type of a DAC channel index.*
- typedef struct DACDriver DACDriver

  *Type of a structure representing an DAC driver.*
- typedef uint16_t dacsample_t

  *Type representing a DAC sample.*
- typedef void(* daccallback_t) (DACDriver *dacp, dacsample_t *buffer, size_t n)

  *DAC notification callback type.*
- typedef void(* dacerrorcallback_t) (DACDriver *dacp, dacerror_t err)

  *DAC error callback type.*

## Data Structures

- struct DACConversionGroup

  *DAC Conversion group structure.*
- struct DACConfig

  *Driver configuration structure.*
- struct DACDriver

  *Structure representing a DAC driver.*

## Functions

- void dacInit (void)

  *DAC Driver initialization.*
- void dacObjectInit (DACDriver *dacp)

  *Initializes the standard part of a `DACDriver` structure.*
- void dacStart (DACDriver *dacp, const DACConfig *config)

  *Configures and activates the DAC peripheral.*
- void dacStop (DACDriver *dacp)

  *Deactivates the DAC peripheral.*
- void dacPutChannelX (DACDriver *dacp, dacchannel_t channel, dacsample_t sample)

  *Outputs a value directly on a DAC channel.*
- void dacStartConversion (DACDriver *dacp, const DACConversionGroup *grpp, dacsample_t *samples, size_t depth)

  *Starts a DAC conversion.*
- void dacStartConversionI (DACDriver *dacp, const DACConversionGroup *grpp, dacsample_t *samples, size_t depth)

  *Starts a DAC conversion.*
- void dacStopConversion (DACDriver *dacp)

  *Stops an ongoing conversion.*
- void dacStopConversionI (DACDriver *dacp)

  *Stops an ongoing conversion.*
- msg_t dacConvert (DACDriver *dacp, const DACConversionGroup *grpp, dacsample_t *samples, size_t depth)

  *Performs a DAC conversion.*
- void dacAcquireBus (DACDriver *dacp)

  *Gains exclusive access to the DAC bus.*
- void dacReleaseBus (DACDriver *dacp)

  *Releases exclusive access to the DAC bus.*

- void dac_lld_init (void)

    *Low level DAC driver initialization.*
- void dac_lld_start (DACDriver ∗dacp)

    *Configures and activates the DAC peripheral.*
- void dac_lld_stop (DACDriver ∗dacp)

    *Deactivates the DAC peripheral.*
- void dac_lld_put_channel (DACDriver ∗dacp, dacchannel_t channel, dacsample_t sample)

    *Outputs a value directly on a DAC channel.*
- void dac_lld_start_conversion (DACDriver ∗dacp)

    *Starts a DAC conversion.*
- void dac_lld_stop_conversion (DACDriver ∗dacp)

    *Stops an ongoing conversion.*

## Enumerations

## Variables

- DACDriver DACD1

    *DAC1 driver identifier.*

## 7.7.2 Macro Definition Documentation

### 7.7.2.1 #define DAC_USE_WAIT TRUE

Enables synchronous APIs.

**Note**

> Disabling this option saves both code and data space.

### 7.7.2.2 #define DAC_USE_MUTUAL_EXCLUSION TRUE

Enables the `dacAcquireBus()` and `dacReleaseBus()` APIs.

**Note**

> Disabling this option saves both code and data space.

### 7.7.2.3 #define _dac_wait_s( *dacp* ) osalThreadSuspendS(&(dacp)->thread)

Waits for operation completion.

This function waits for the driver to complete the current operation.

**Precondition**

> An operation must be running while the function is invoked.

**Note**

> No more than one thread can wait on a DAC driver using this function.

**Parameters**

| | | |
|---|---|---|
| in | *dacp* | pointer to the DACDriver object |

**Function Class:**

Not an API, this function is for internal use only.

### 7.7.2.4 #define _dac_reset_i( *dacp* ) osalThreadResumeI(&(dacp)->thread, MSG_RESET)

Resumes a thread waiting for a conversion completion.

**Parameters**

| | | |
|---|---|---|
| in | *dacp* | pointer to the DACDriver object |

**Function Class:**

Not an API, this function is for internal use only.

### 7.7.2.5 #define _dac_reset_s( *dacp* ) osalThreadResumeS(&(dacp)->thread, MSG_RESET)

Resumes a thread waiting for a conversion completion.

**Parameters**

| | | |
|---|---|---|
| in | *dacp* | pointer to the DACDriver object |

**Function Class:**

Not an API, this function is for internal use only.

### 7.7.2.6 #define _dac_wakeup_isr( *dacp* )

**Value:**

```
{                                              \
  osalSysLockFromISR();
      \
  osalThreadResumeI(&(dacp)->thread, MSG_OK);
      \
  osalSysUnlockFromISR();                                                       \
}
```

Wakes up the waiting thread.

**Parameters**

| | | |
|---|---|---|
| in | *dacp* | pointer to the DACDriver object |

**Function Class:**

Not an API, this function is for internal use only.

### 7.7.2.7 #define _dac_timeout_isr( *dacp* )

**Value:**

```
{                                                    \
  osalSysLockFromISR();
      \
  osalThreadResumeI(&(dacp)->thread, MSG_TIMEOUT);
      \
  osalSysUnlockFromISR();                                                       \
}
```

Wakes up the waiting thread with a timeout message.

**Parameters**

| | | |
|---|---|---|
| in | *dacp* | pointer to the DACDriver object |

**Function Class:**

Not an API, this function is for internal use only.

### 7.7.2.8 #define _dac_isr_half_code( *dacp* )

**Value:**

```
{                                                  \
  if ((dacp)->grpp->end_cb != NULL) {                                           \
    (dacp)->grpp->end_cb(dacp, (dacp)->samples, (dacp)->depth / 2);             \
  }                                                                             \
}
```

Common ISR code, half buffer event.

This code handles the portable part of the ISR code:

- Callback invocation.

**Note**

This macro is meant to be used in the low level drivers implementation only.

**Parameters**

| | | |
|---|---|---|
| in | *dacp* | pointer to the DACDriver object |

**Function Class:**

Not an API, this function is for internal use only.

### 7.7.2.9 #define _dac_isr_full_code( *dacp* )

**Value:**

```
{                                                  \
  if ((dacp)->grpp->end_cb != NULL) {                                           \
    if ((dacp)->depth > 1) {                                                    \
      /* Invokes the callback passing the 2nd half of the buffer.*/         \
      size_t half = (dacp)->depth / 2;                                       \
      size_t half_index = half * (dacp)->grpp->num_channels;                 \
      (dacp)->grpp->end_cb(dacp, (dacp)->samples + half_index, half);        \
    }                                                                        \
    else {                                                                   \
      /* Invokes the callback passing the whole buffer.*/                    \
      (dacp)->grpp->end_cb(dacp, (dacp)->samples, (dacp)->depth);            \
    }                                                                        \
  }                                                                          \
}
```

Common ISR code, full buffer event.

This code handles the portable part of the ISR code:

- Callback invocation.
- Waiting thread wakeup, if any.
- Driver state transitions.

**Note**

This macro is meant to be used in the low level drivers implementation only.

**Parameters**

| | | |
|---|---|---|
| in | *dacp* | pointer to the DACDriver object |

**Function Class:**

Not an API, this function is for internal use only.

### 7.7.2.10 #define _dac_isr_error_code( *dacp, err* )

**Value:**

```
{                                     \
  dac_lld_stop_conversion(dacp);                                             \
  if ((dacp)->grpp->error_cb != NULL) {                                      \
    (dacp)->state = DAC_ERROR;                                               \
    (dacp)->grpp->error_cb(dacp, err);                                       \
    if ((dacp)->state == DAC_ERROR)                                          \
      (dacp)->state = DAC_READY;                                             \
  }                                                                          \
  (dacp)->grpp = NULL;                                                       \
  _dac_timeout_isr(dacp);                                                    \
}
```

Common ISR code, error event.

This code handles the portable part of the ISR code:

- Callback invocation.
- Waiting thread timeout signaling, if any.
- Driver state transitions.

**Note**

This macro is meant to be used in the low level drivers implementation only.

**Parameters**

| | | |
|---|---|---|
| in | *dacp* | pointer to the DACDriver object |
| in | *err* | platform dependent error code |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.7.2.11 #define DAC_MAX_CHANNELS 2

Maximum number of DAC channels per unit.

#### 7.7.2.12 #define PLATFORM_DAC_USE_DAC1 FALSE

DAC1 CH1 driver enable switch.

If set to TRUE the support for DAC1 channel 1 is included.

**Note**

The default is FALSE.

### 7.7.3 Typedef Documentation

#### 7.7.3.1 typedef uint32_t dacchannel_t

Type of a DAC channel index.

#### 7.7.3.2 typedef struct DACDriver DACDriver

Type of a structure representing an DAC driver.

#### 7.7.3.3 typedef uint16_t dacsample_t

Type representing a DAC sample.

#### 7.7.3.4 typedef void(* daccallback_t) (DACDriver *dacp, dacsample_t *buffer, size_t n)

DAC notification callback type.

**Parameters**

| | | |
|---|---|---|
| in | *dacp* | pointer to the DACDriver object triggering the |
| in | *buffer* | pointer to the next semi-buffer to be filled |
| in | *n* | number of buffer rows available starting from buffer callback |

#### 7.7.3.5 typedef void(* dacerrorcallback_t) (DACDriver *dacp, dacerror_t err)

DAC error callback type.

**Parameters**

| | | |
|---|---|---|
| in | *dacp* | pointer to the DACDriver object triggering the callback |
| in | *err* | DAC error code |

## 7.7.4 Enumeration Type Documentation

### 7.7.4.1 enum dacstate_t

Driver state machine possible states.

**Enumerator**

***DAC_UNINIT*** Not initialized.

***DAC_STOP*** Stopped.

***DAC_READY*** Ready.

***DAC_ACTIVE*** Exchanging data.

***DAC_COMPLETE*** Asynchronous operation complete.

***DAC_ERROR*** Error.

### 7.7.4.2 enum dacerror_t

Possible DAC failure causes.

**Note**

Error codes are architecture dependent and should not relied upon.

**Enumerator**

***DAC_ERR_DMAFAILURE*** DMA operations failure.

***DAC_ERR_UNDERFLOW*** DAC overflow condition.

## 7.7.5 Function Documentation

### 7.7.5.1 void dacInit ( void )

DAC Driver initialization.

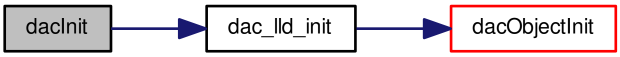
**Note**

This function is implicitly invoked by halInit(), there is no need to explicitly initialize the driver.

**Function Class:**

Initializer, this function just initializes an object and can be invoked before the kernel is initialized.

Here is the call graph for this function:



#### 7.7.5.2 void dacObjectInit ( DACDriver * *dacp* )

Initializes the standard part of a `DACDriver` structure.

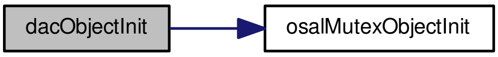
**Parameters**

| | | |
|---|---|---|
| `out` | *dacp* | pointer to the `DACDriver` object |

**Function Class:**

Initializer, this function just initializes an object and can be invoked before the kernel is initialized.

Here is the call graph for this function:



#### 7.7.5.3 void dacStart ( DACDriver * *dacp*, const DACConfig * *config* )

Configures and activates the DAC peripheral.

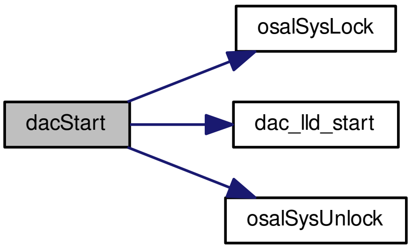
**Parameters**

| | | |
|---|---|---|
| `in` | *dacp* | pointer to the `DACDriver` object |
| `in` | *config* | pointer to the `DACConfig` object, it can be `NULL` if the low level driver implementation supports a default configuration |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



### 7.7.5.4 void dacStop ( DACDriver * *dacp* )

Deactivates the DAC peripheral.

**Note**

Deactivating the peripheral also enforces a release of the slave select line.

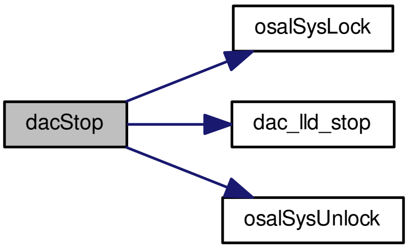
**Parameters**

| | | |
|---|---|---|
| in | *dacp* | pointer to the DACDriver object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.7.5.5 void dacPutChannelX ( **DACDriver** ∗ *dacp*, **dacchannel_t** *channel*, **dacsample_t** *sample* )

Outputs a value directly on a DAC channel.

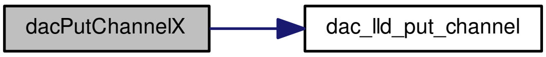
**Parameters**

| | | |
|---|---|---|
| in | *dacp* | pointer to the DACDriver object |
| in | *channel* | DAC channel number |
| in | *sample* | value to be output |

**Function Class:**

This is an **X-Class** API, this function can be invoked from any context.

Here is the call graph for this function:



#### 7.7.5.6 void dacStartConversion ( **DACDriver** ∗ *dacp*, const **DACConversionGroup** ∗ *grpp*, **dacsample_t** ∗ *samples*, size_t *depth* )

Starts a DAC conversion.

Starts an asynchronous conversion operation.

**Note**

The buffer is organized as a matrix of M∗N elements where M is the channels number configured into the conversion group and N is the buffer depth. The samples are sequentially written into the buffer with no gaps.

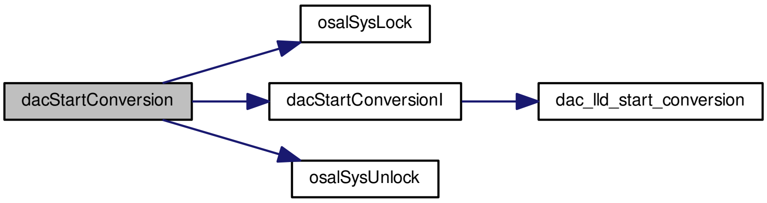
**Parameters**

| | | |
|---|---|---|
| in | *dacp* | pointer to the DACDriver object |
| in | *grpp* | pointer to a DACConversionGroup object |
| in | *samples* | pointer to the samples buffer |
| in | *depth* | buffer depth (matrix rows number). The buffer depth must be one or an even number. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.7.5.7 void dacStartConversionI ( DACDriver ∗ *dacp*, const DACConversionGroup ∗ *grpp*, dacsample_t ∗ *samples*, size_t *depth* )

Starts a DAC conversion.

Starts an asynchronous conversion operation.

**Postcondition**

The callbacks associated to the conversion group will be invoked on buffer fill and error events.

**Note**

The buffer is organized as a matrix of M∗N elements where M is the channels number configured into the conversion group and N is the buffer depth. The samples are sequentially written into the buffer with no gaps.

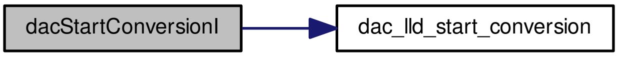
**Parameters**

| | | |
|---|---|---|
| `in` | *dacp* | pointer to the `DACDriver` object |
| `in` | *grpp* | pointer to a `DACConversionGroup` object |
| `in` | *samples* | pointer to the samples buffer |
| `in` | *depth* | buffer depth (matrix rows number). The buffer depth must be one or an even number. |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

Here is the call graph for this function:



#### 7.7.5.8 void dacStopConversion ( DACDriver ∗ *dacp* )

Stops an ongoing conversion.

This function stops the currently ongoing conversion and returns the driver in the `DAC_READY` state. If there was no conversion being processed then the function does nothing.

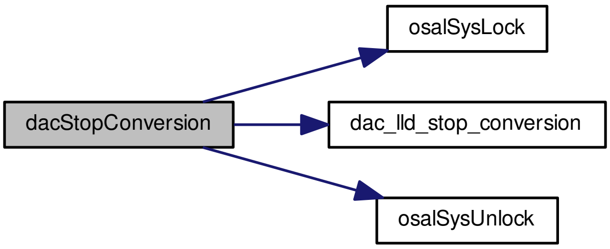
**Parameters**

| | | |
|---|---|---|
| in | *dacp* | pointer to the `DACDriver` object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.7.5.9 void dacStopConversionI ( DACDriver ∗ *dacp* )

Stops an ongoing conversion.

This function stops the currently ongoing conversion and returns the driver in the `DAC_READY` state. If there was no conversion being processed then the function does nothing.

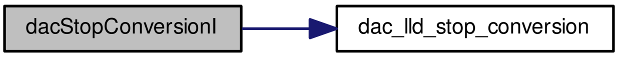
**Parameters**

| | | |
|---|---|---|
| in | *dacp* | pointer to the `DACDriver` object |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

Here is the call graph for this function:



### 7.7.5.10 msg_t dacConvert ( DACDriver ∗ *dacp*, const DACConversionGroup ∗ *grpp*, dacsample_t ∗ *samples*, size_t *depth* )

Performs a DAC conversion.

Performs a synchronous conversion operation.

**Note**

The buffer is organized as a matrix of M∗N elements where M is the channels number configured into the conversion group and N is the buffer depth. The samples are sequentially written into the buffer with no gaps.

**Parameters**

| | | |
|---|---|---|
| `in` | *dacp* | pointer to the `DACDriver` object |
| `in` | *grpp* | pointer to a `DACConversionGroup` object |
| `out` | *samples* | pointer to the samples buffer |
| `in` | *depth* | buffer depth (matrix rows number). The buffer depth must be one or an even number. |

**Returns**

The operation result.

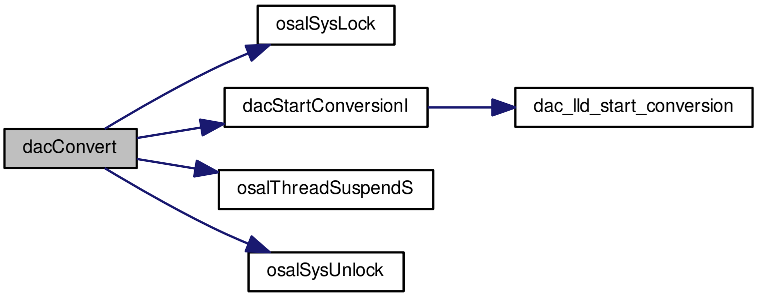
**Return values**

| | |
|---|---|
| *MSG_OK* | Conversion finished. |
| *MSG_RESET* | The conversion has been stopped using `acdStopConversion()` or `acdStopConversionI()`, the result buffer may contain incorrect data. |
| *MSG_TIMEOUT* | The conversion has been stopped because an hardware error. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.7.5.11 void dacAcquireBus ( DACDriver * *dacp* )

Gains exclusive access to the DAC bus.

This function tries to gain ownership to the DAC bus, if the bus is already being used then the invoking thread is queued.

**Precondition**

In order to use this function the option `DAC_USE_MUTUAL_EXCLUSION` must be enabled.

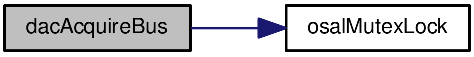
**Parameters**

| | | |
|---|---|---|
| `in` | *dacp* | pointer to the `DACDriver` object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.7.5.12 void dacReleaseBus ( DACDriver * *dacp* )

Releases exclusive access to the DAC bus.

**Precondition**

In order to use this function the option `DAC_USE_MUTUAL_EXCLUSION` must be enabled.

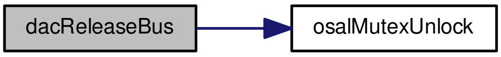
**Parameters**

| | | |
|---|---|---|
| in | *dacp* | pointer to the `DACDriver` object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



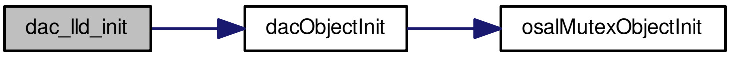
#### 7.7.5.13 void dac_lld_init ( void )

Low level DAC driver initialization.

**Function Class:**

Not an API, this function is for internal use only.

Here is the call graph for this function:



#### 7.7.5.14 void dac_lld_start ( DACDriver * *dacp* )

Configures and activates the DAC peripheral.

**Parameters**

| | | |
|---|---|---|
| in | *dacp* | pointer to the `DACDriver` object |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.7.5.15 void dac_lld_stop ( DACDriver ∗ *dacp* )

Deactivates the DAC peripheral.

**Parameters**

| | | |
|---|---|---|
| in | *dacp* | pointer to the DACDriver object |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.7.5.16 void dac_lld_put_channel ( DACDriver ∗ *dacp,* dacchannel_t *channel,* dacsample_t *sample* )

Outputs a value directly on a DAC channel.

**Parameters**

| | | |
|---|---|---|
| in | *dacp* | pointer to the DACDriver object |
| in | *channel* | DAC channel number |
| in | *sample* | value to be output |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.7.5.17 void dac_lld_start_conversion ( DACDriver ∗ *dacp* )

Starts a DAC conversion.

Starts an asynchronous conversion operation.

**Note**

In `DAC_DHRM_8BIT_RIGHT` mode the parameters passed to the callback are wrong because two samples are packed in a single dacsample_t element. This will not be corrected, do not rely on those parameters.
In `DAC_DHRM_8BIT_RIGHT_DUAL` mode two samples are treated as a single 16 bits sample and packed into a single dacsample_t element. The num_channels must be set to one in the group conversion configuration structure.

**Parameters**

| | | |
|---|---|---|
| in | *dacp* | pointer to the DACDriver object |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.7.5.18 void dac_lld_stop_conversion ( DACDriver * *dacp* )

Stops an ongoing conversion.

This function stops the currently ongoing conversion and returns the driver in the `DAC_READY` state. If there was no conversion being processed then the function does nothing.

**Parameters**

|  |  |  |
|---|---|---|
| in | *dacp* | pointer to the `DACDriver` object |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

### 7.7.6 Variable Documentation

#### 7.7.6.1 DACDriver DACD1

DAC1 driver identifier.

## 7.8 EXT Driver

Generic EXT Driver.

### 7.8.1 Detailed Description

Generic EXT Driver.

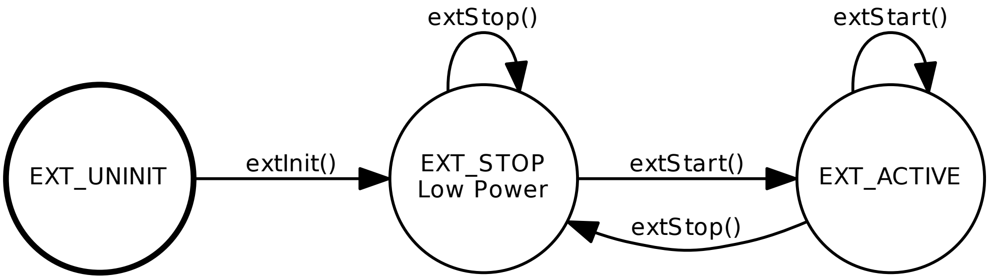
This module implements a generic EXT (EXTernal) driver.

#### Precondition

In order to use the EXT driver the `HAL_USE_EXT` option must be enabled in `halconf.h`.

### 7.8.2 Driver State Machine

The driver implements a state machine internally, not all the driver functionalities can be used in any moment, any transition not explicitly shown in the following diagram has to be considered an error and shall be captured by an assertion (if enabled).



### 7.8.3 EXT Operations.

This driver abstracts generic external interrupt sources, a callback is invoked when a programmable transition is detected on one of the configured channels. Several channel modes are possible.

- **EXT_CH_MODE_DISABLED**, channel not used.
- **EXT_CH_MODE_RISING_EDGE**, callback on a rising edge.
- **EXT_CH_MODE_FALLING_EDGE**, callback on a falling edge.
- **EXT_CH_MODE_BOTH_EDGES**, callback on a both edges.

#### Macros

- #define EXT_MAX_CHANNELS 20

  *Available number of EXT channels.*

### EXT channel modes

- #define EXT_CH_MODE_EDGES_MASK 3U

  *Mask of edges field.*
- #define EXT_CH_MODE_DISABLED 0U

  *Channel disabled.*
- #define EXT_CH_MODE_RISING_EDGE 1U

  *Rising edge callback.*
- #define EXT_CH_MODE_FALLING_EDGE 2U

  *Falling edge callback.*
- #define EXT_CH_MODE_BOTH_EDGES 3U

  *Both edges callback.*
- #define EXT_CH_MODE_LOW_LEVEL 5U

  *low level callback.*
- #define EXT_CH_MODE_AUTOSTART 4U

  *Channel started automatically on driver start.*

### Macro Functions

- #define extChannelEnableI(extp, channel) ext_lld_channel_enable(extp, channel)

  *Enables an EXT channel.*
- #define extChannelDisableI(extp, channel) ext_lld_channel_disable(extp, channel)

  *Disables an EXT channel.*
- #define extSetChannelMode(extp, channel, extcp)

  *Changes the operation mode of a channel.*

### PLATFORM configuration options

- #define PLATFORM_EXT_USE_EXT1 FALSE

  *EXT driver enable switch.*

### Typedefs

- typedef struct EXTDriver EXTDriver

  *Type of a structure representing a EXT driver.*
- typedef uint32_t expchannel_t

  *EXT channel identifier.*
- typedef void(∗ extcallback_t) (EXTDriver ∗extp, expchannel_t channel)

  *Type of an EXT generic notification callback.*

### Data Structures

- struct EXTChannelConfig

  *Channel configuration structure.*
- struct EXTConfig

  *Driver configuration structure.*
- struct EXTDriver

  *Structure representing an EXT driver.*

## Functions

- void extInit (void)

  *EXT Driver initialization.*
- void extObjectInit (EXTDriver ∗extp)

  *Initializes the standard part of a `EXTDriver` structure.*
- void extStart (EXTDriver ∗extp, const EXTConfig ∗config)

  *Configures and activates the EXT peripheral.*
- void extStop (EXTDriver ∗extp)

  *Deactivates the EXT peripheral.*
- void extChannelEnable (EXTDriver ∗extp, expchannel_t channel)

  *Enables an EXT channel.*
- void extChannelDisable (EXTDriver ∗extp, expchannel_t channel)

  *Disables an EXT channel.*
- void extSetChannelModeI (EXTDriver ∗extp, expchannel_t channel, const EXTChannelConfig ∗extcp)

  *Changes the operation mode of a channel.*
- void ext_lld_init (void)

  *Low level EXT driver initialization.*
- void ext_lld_start (EXTDriver ∗extp)

  *Configures and activates the EXT peripheral.*
- void ext_lld_stop (EXTDriver ∗extp)

  *Deactivates the EXT peripheral.*
- void ext_lld_channel_enable (EXTDriver ∗extp, expchannel_t channel)

  *Enables an EXT channel.*
- void ext_lld_channel_disable (EXTDriver ∗extp, expchannel_t channel)

  *Disables an EXT channel.*

## Enumerations

## Variables

- EXTDriver EXTD1

  *EXT1 driver identifier.*

## 7.8.4 Macro Definition Documentation

### 7.8.4.1 #define EXT_CH_MODE_EDGES_MASK 3U

Mask of edges field.

### 7.8.4.2 #define EXT_CH_MODE_DISABLED 0U

Channel disabled.

### 7.8.4.3 #define EXT_CH_MODE_RISING_EDGE 1U

Rising edge callback.

### 7.8.4.4 #define EXT_CH_MODE_FALLING_EDGE 2U

Falling edge callback.

#### 7.8.4.5 #define EXT_CH_MODE_BOTH_EDGES 3U

Both edges callback.

#### 7.8.4.6 #define EXT_CH_MODE_LOW_LEVEL 5U

low level callback.

#### 7.8.4.7 #define EXT_CH_MODE_AUTOSTART 4U

Channel started automatically on driver start.

#### 7.8.4.8 #define extChannelEnableI( *extp*, *channel* ) ext_lld_channel_enable(extp, channel)

Enables an EXT channel.

**Parameters**

| | | |
|---|---|---|
| in | *extp* | pointer to the EXTDriver object |
| in | *channel* | channel to be enabled |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

#### 7.8.4.9 #define extChannelDisableI( *extp*, *channel* ) ext_lld_channel_disable(extp, channel)

Disables an EXT channel.

**Parameters**

| | | |
|---|---|---|
| in | *extp* | pointer to the EXTDriver object |
| in | *channel* | channel to be disabled |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

#### 7.8.4.10 #define extSetChannelMode( *extp*, *channel*, *extcp* )

**Value:**

```
{                           \
  osalSysLock();
      \
  extSetChannelModeI(extp, channel, extcp);
      \
  osalSysUnlock();                                              \
}
```

Changes the operation mode of a channel.

**Note**

This function attempts to write over the current configuration structure that must have been not declared constant. This violates the `const` qualifier in `extStart()` but it is intentional. This function cannot be used if the configuration structure is declared `const`.

**Parameters**

| | | |
|---|---|---|
| in | *extp* | pointer to the `EXTDriver` object |
| in | *channel* | channel to be changed |
| in | *extcp* | new configuration for the channel |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.8.4.11 #define EXT_MAX_CHANNELS 20

Available number of EXT channels.

#### 7.8.4.12 #define PLATFORM_EXT_USE_EXT1 FALSE

EXT driver enable switch.

If set to `TRUE` the support for EXT1 is included.

**Note**

The default is `FALSE`.

### 7.8.5 Typedef Documentation

#### 7.8.5.1 typedef struct EXTDriver EXTDriver

Type of a structure representing a EXT driver.

#### 7.8.5.2 typedef uint32_t expchannel_t

EXT channel identifier.

#### 7.8.5.3 typedef void(∗ extcallback_t) (EXTDriver ∗extp, expchannel_t channel)

Type of an EXT generic notification callback.

**Parameters**

| | | |
|---|---|---|
| in | *extp* | pointer to the `EXPDriver` object triggering the callback |

### 7.8.6 Enumeration Type Documentation

#### 7.8.6.1 enum **extstate_t**

Driver state machine possible states.

**Enumerator**

***EXT_UNINIT*** Not initialized.

***EXT_STOP*** Stopped.

***EXT_ACTIVE*** Active.

### 7.8.7 Function Documentation

#### 7.8.7.1 void extInit ( void )

EXT Driver initialization.

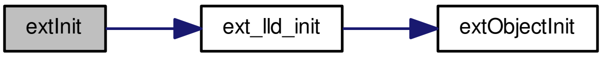
**Note**

This function is implicitly invoked by `halInit()`, there is no need to explicitly initialize the driver.

**Function Class:**

Initializer, this function just initializes an object and can be invoked before the kernel is initialized.

Here is the call graph for this function:



#### 7.8.7.2 void extObjectInit ( **EXTDriver** ∗ *extp* )

Initializes the standard part of a `EXTDriver` structure.

**Parameters**

| | | |
|---|---|---|
| `out` | *extp* | pointer to the `EXTDriver` object |

**Function Class:**

Initializer, this function just initializes an object and can be invoked before the kernel is initialized.

#### 7.8.7.3 void extStart ( **EXTDriver** ∗ *extp*, const **EXTConfig** ∗ *config* )

Configures and activates the EXT peripheral.

**Postcondition**

After activation all EXT channels are in the disabled state, use `extChannelEnable()` in order to activate them.

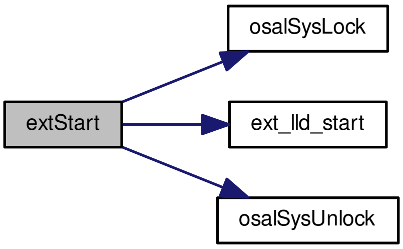
**Parameters**

| | | |
|---|---|---|
| in | *extp* | pointer to the `EXTDriver` object |
| in | *config* | pointer to the `EXTConfig` object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.8.7.4 void extStop ( EXTDriver * *extp* )

Deactivates the EXT peripheral.

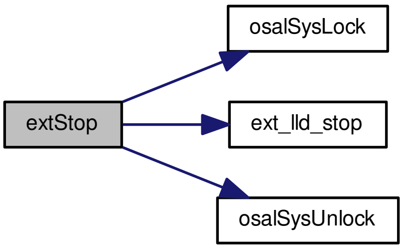
**Parameters**

| | | |
|---|---|---|
| in | *extp* | pointer to the `EXTDriver` object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



### 7.8.7.5 void extChannelEnable ( EXTDriver ∗ *extp*, expchannel_t *channel* )

Enables an EXT channel.

**Precondition**

The channel must not be in `EXT_CH_MODE_DISABLED` mode.

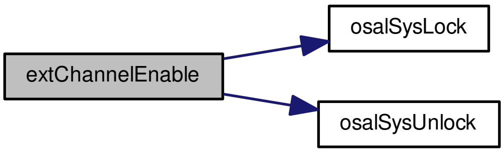
**Parameters**

| | | |
|---|---|---|
| in | *extp* | pointer to the `EXTDriver` object |
| in | *channel* | channel to be enabled |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



### 7.8.7.6 void extChannelDisable ( EXTDriver ∗ *extp*, expchannel_t *channel* )

Disables an EXT channel.

**Precondition**

The channel must not be in `EXT_CH_MODE_DISABLED` mode.

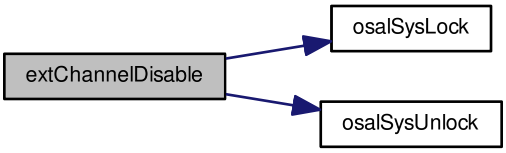
**Parameters**

| | | |
|---|---|---|
| `in` | *extp* | pointer to the `EXTDriver` object |
| `in` | *channel* | channel to be disabled |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.8.7.7 void extSetChannelModeI ( **EXTDriver** ∗ *extp*, **expchannel_t** *channel*, const **EXTChannelConfig** ∗ *extcp* )

Changes the operation mode of a channel.

**Note**

This function attempts to write over the current configuration structure that must have been not declared constant. This violates the `const` qualifier in `extStart()` but it is intentional.
This function cannot be used if the configuration structure is declared `const`.
The effect of this function on constant configuration structures is not defined.

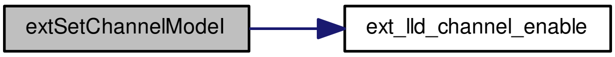
**Parameters**

| | | |
|---|---|---|
| `in` | *extp* | pointer to the `EXTDriver` object |
| `in` | *channel* | channel to be changed |
| `in` | *extcp* | new configuration for the channel |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

Here is the call graph for this function:



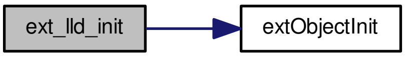
#### 7.8.7.8 void ext_lld_init ( void )

Low level EXT driver initialization.

**Function Class:**

Not an API, this function is for internal use only.

Here is the call graph for this function:



#### 7.8.7.9 void ext_lld_start ( **EXTDriver** ∗ *extp* )

Configures and activates the EXT peripheral.

**Parameters**

| | | |
|---|---|---|
| `in` | *extp* | pointer to the `EXTDriver` object |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.8.7.10 void ext_lld_stop ( **EXTDriver** ∗ *extp* )

Deactivates the EXT peripheral.

**Parameters**

| | | |
|---|---|---|
| `in` | *extp* | pointer to the `EXTDriver` object |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.8.7.11 void ext_lld_channel_enable ( **EXTDriver** ∗ *extp*, **expchannel_t** *channel* )

Enables an EXT channel.

**Parameters**

| | | |
|---|---|---|
| `in` | *extp* | pointer to the `EXTDriver` object |
| `in` | *channel* | channel to be enabled |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.8.7.12 void ext_lld_channel_disable ( **EXTDriver** ∗ *extp*, **expchannel_t** *channel* )

Disables an EXT channel.

**Parameters**

| | | |
|---|---|---|
| `in` | *extp* | pointer to the `EXTDriver` object |
| `in` | *channel* | channel to be disabled |

**Function Class:**

Not an API, this function is for internal use only.

### 7.8.8 Variable Documentation

#### 7.8.8.1 EXTDriver EXTD1

EXT1 driver identifier.

## 7.9 Generic Flash Driver Interface

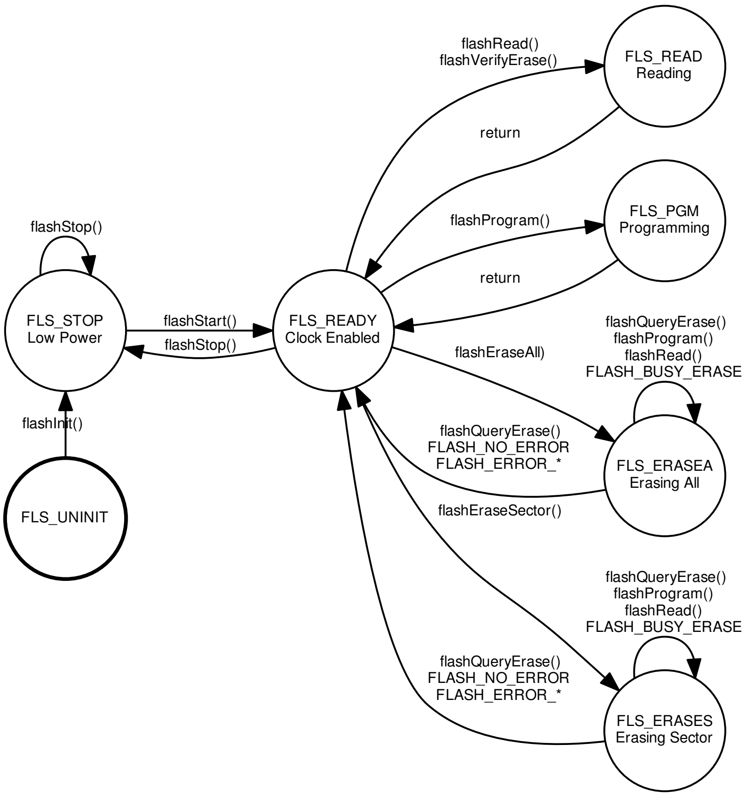
HAL Generic Flash Driver Interface.

### 7.9.1 Detailed Description

HAL Generic Flash Driver Interface.

### 7.9.2 Driver State Machine

The flash driver implements a state machine internally, not all the driver functionalities can be used in any moment, any transition not explicitly shown in the following diagram has to be considered an error and shall be captured by an assertion (if enabled).



## Macros

- #define _base_flash_methods_alone

  *BaseFlash specific methods.*
- #define _base_flash_methods

  *BaseFlash specific methods with inherited ones.*
- #define _base_flash_data

  *BaseFlash specific data.*

## Flash attributes

- #define **FLASH_ATTR_ERASED_IS_ONE** 0x00000001
- #define **FLASH_ATTR_MEMORY_MAPPED** 0x00000002
- #define **FLASH_ATTR_REWRITABLE** 0x00000004
- #define **FLASH_ATTR_READ_ECC_CAPABLE** 0x00000008
- #define **FLASH_ATTR_SUSPEND_ERASE_CAPABLE** 0x00000010

## Macro Functions (BaseFlash)

- #define getBaseFlash(ip) ((BaseFlash ∗)&(ip)->vmt)

  *Instance getter.*
- #define flashGetDescriptor(ip) (ip)->vmt->get_descriptor(ip)

  *Sensors get axes number.*
- #define flashRead(ip, offset, n, rp) (ip)->vmt->read(ip, offset, n, rp)

  *Read operation.*
- #define flashProgram(ip, offset, n, pp) (ip)->vmt->program(ip, offset, n, pp)

  *Program operation.*
- #define flashStartEraseAll(ip) (ip)->vmt->start_erase_all(ip)

  *Starts a whole-device erase operation.*
- #define flashStartEraseSector(ip, sector) (ip)->vmt->start_erase_sector(ip, sector)

  *Starts an sector erase operation.*
- #define flashQueryErase(ip, msec) (ip)->vmt->query_erase(ip, msec)

  *Queries the driver for erase operation progress.*
- #define flashVerifyErase(ip, sector) (ip)->vmt->verify_erase(ip, sector)

  *Returns the erase state of a sector.*

## Typedefs

- typedef uint32_t flash_offset_t

  *Type of a flash offset.*
- typedef uint32_t flash_sector_t

  *Type of a flash sector number.*

## Data Structures

- struct flash_sector_descriptor_t

  *Flash sector descriptor.*
- struct flash_descriptor_t

  *Type of a flash device descriptor.*
- struct BaseFlashVMT

  `BaseFlash` *virtual methods table.*
- struct BaseFlash

  *Base flash class.*

## Functions

- flash_error_t flashWaitErase (BaseFlash ∗devp)

  *Waits until the current erase operation is finished.*
- flash_offset_t flashGetSectorOffset (BaseFlash ∗devp, flash_sector_t sector)

  *Returns the offset of a sector.*
- uint32_t flashGetSectorSize (BaseFlash ∗devp, flash_sector_t sector)

  *Returns the size of a sector.*

## Enumerations

## 7.9.3 Macro Definition Documentation

### 7.9.3.1 #define _base_flash_methods_alone

**Value:**

```
/* Get flash device attributes.*/                                         \
  const flash_descriptor_t * (*get_descriptor)(void *instance);             \
  /* Read operation.*/                                                      \
  flash_error_t (*read)(void *instance, flash_offset_t offset,              \
                        size_t n, uint8_t *rp);                             \
  /* Program operation.*/                                                   \
  flash_error_t (*program)(void *instance, flash_offset_t offset,           \
                           size_t n, const uint8_t *pp);                    \
  /* Erase whole flash device.*/                                            \
  flash_error_t (*start_erase_all)(void *instance);                         \
  /* Erase single sector.*/                                                 \
  flash_error_t (*start_erase_sector)(void *instance,
      \
                                      flash_sector_t
      sector);                \
  flash_error_t (*query_erase)(void *instance, uint32_t *wait_time);        \
  /* Verify erase single sector.*/                                          \
  flash_error_t (*verify_erase)(void *instance, flash_sector_t sector);
```

BaseFlash specific methods.

**Note**

No methods so far, just a common ancestor interface.

### 7.9.3.2 #define _base_flash_methods

**Value:**

```
_base_object_methods                                                      \
  _base_flash_methods_alone
```

BaseFlash specific methods with inherited ones.

### 7.9.3.3 #define _base_flash_data

**Value:**

```
_base_object_data                                                         \
  /* Driver state.*/                                                        \
  flash_state_t         state;
```

BaseFlash specific data.

### 7.9.3.4 #define getBaseFlash( *ip* ) ((BaseFlash *)&(ip)->vmt)

Instance getter.

This special method is used to get the instance of this class object from a derived class.

### 7.9.3.5 #define flashGetDescriptor( *ip* ) (ip)->vmt->get_descriptor(ip)

Sensors get axes number.

**Parameters**

| | | |
|---|---|---|
| in | *ip* | pointer to a BaseFlash or derived class |

**Returns**

A flash device descriptor.

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.9.3.6 #define flashRead( *ip*, *offset*, *n*, *rp* ) (ip)->vmt->read(ip, offset, n, rp)

Read operation.

**Parameters**

| | | |
|---|---|---|
| in | *ip* | pointer to a BaseFlash or derived class |
| in | *offset* | flash offset |
| in | *n* | number of bytes to be read |
| out | *rp* | pointer to the data buffer |

**Returns**

An error code.

**Return values**

| | |
|---|---|
| *FLASH_NO_ERROR* | if there is no erase operation in progress. |
| *FLASH_BUSY_ERASING* | if there is an erase operation in progress. |
| *FLASH_ERROR_READ* | if the read operation failed. |
| *FLASH_ERROR_HW_FAILURE* | if access to the memory failed. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.9.3.7 #define flashProgram( *ip*, *offset*, *n*, *pp* ) (ip)->vmt->program(ip, offset, n, pp)

Program operation.

**Parameters**

| | | |
|---|---|---|
| in | *ip* | pointer to a BaseFlash or derived class |
| in | *offset* | flash offset |
| in | *n* | number of bytes to be programmed |
| in | *pp* | pointer to the data buffer |

**Returns**

An error code.

**Return values**

| | |
|---|---|
| *FLASH_NO_ERROR* | if there is no erase operation in progress. |
| *FLASH_BUSY_ERASING* | if there is an erase operation in progress. |
| *FLASH_ERROR_PROGRAM* | if the program operation failed. |
| *FLASH_ERROR_HW_FAILURE* | if access to the memory failed. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.9.3.8 #define flashStartEraseAll( *ip* ) (ip)->vmt->start_erase_all(ip)

Starts a whole-device erase operation.

**Parameters**

| | | |
|---|---|---|
| `in` | *ip* | pointer to a `BaseFlash` or derived class |

**Returns**

An error code.

**Return values**

| | |
|---|---|
| *FLASH_NO_ERROR* | if there is no erase operation in progress. |
| *FLASH_BUSY_ERASING* | if there is an erase operation in progress. |
| *FLASH_ERROR_HW_FAILURE* | if access to the memory failed. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.9.3.9 #define flashStartEraseSector( *ip, sector* ) (ip)->vmt->start_erase_sector(ip, sector)

Starts an sector erase operation.

**Parameters**

| | | |
|---|---|---|
| `in` | *ip* | pointer to a `BaseFlash` or derived class |
| `in` | *sector* | sector to be erased |

**Returns**

An error code.

**Return values**

| | |
|---|---|
| *FLASH_NO_ERROR* | if there is no erase operation in progress. |
| *FLASH_BUSY_ERASING* | if there is an erase operation in progress. |
| *FLASH_ERROR_HW_FAILURE* | if access to the memory failed. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.9.3.10 #define flashQueryErase( *ip,* *msec* ) (ip)->vmt->query_erase(ip, msec)

Queries the driver for erase operation progress.

**Parameters**

| | | |
|---|---|---|
| `in` | *ip* | pointer to a `BaseFlash` or derived class |
| `out` | *msec* | recommended time, in milliseconds, that what should be spent before calling this function again, can be `NULL` |

**Returns**

An error code.

**Return values**

| | |
|---|---|
| *FLASH_NO_ERROR* | if there is no erase operation in progress. |
| *FLASH_BUSY_ERASING* | if there is an erase operation in progress. |
| *FLASH_ERROR_ERASE* | if the erase operation failed. |
| *FLASH_ERROR_HW_FAILURE* | if access to the memory failed. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.9.3.11 #define flashVerifyErase( *ip,* *sector* ) (ip)->vmt->verify_erase(ip, sector)

Returns the erase state of a sector.

**Parameters**

| | | |
|---|---|---|
| `in` | *ip* | pointer to a `BaseFlash` or derived class |
| `in` | *sector* | sector to be verified |

**Returns**

An error code.

**Return values**

| | |
|---|---|
| *FLASH_NO_ERROR* | if the sector is erased. |
| *FLASH_BUSY_ERASING* | if there is an erase operation in progress. |
| *FLASH_ERROR_VERIFY* | if the verify operation failed. |
| *FLASH_ERROR_HW_FAILURE* | if access to the memory failed. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

## 7.9.4 Typedef Documentation

### 7.9.4.1 typedef uint32_t **flash_offset_t**

Type of a flash offset.

### 7.9.4.2 typedef uint32_t **flash_sector_t**

Type of a flash sector number.

## 7.9.5 Enumeration Type Documentation

### 7.9.5.1 enum **flash_state_t**

Driver state machine possible states.

### 7.9.5.2 enum **flash_error_t**

Type of a flash error code.

## 7.9.6 Function Documentation

### 7.9.6.1 **flash_error_t** flashWaitErase ( **BaseFlash** $*$ ***devp*** )

Waits until the current erase operation is finished.

**Parameters**

| | | |
|---|---|---|
| `in` | *devp* | pointer to a `BaseFlash` object |

**Returns**

An error code.

**Return values**

| | |
|---|---|
| *FLASH_NO_ERROR* | if there is no erase operation in progress. |
| *FLASH_ERROR_ERASE* | if the erase operation failed. |
| *FLASH_ERROR_HW_FAILURE* | if access to the memory failed. |

#### 7.9.6.2 flash_offset_t flashGetSectorOffset ( BaseFlash ∗ *devp*, flash_sector_t *sector* )

Returns the offset of a sector.

**Parameters**

| | | |
|---|---|---|
| in | *devp* | pointer to a BaseFlash object |
| in | *sector* | flash sector number |

**Returns**

the offset of the sector

#### 7.9.6.3 uint32_t flashGetSectorSize ( BaseFlash ∗ *devp*, flash_sector_t *sector* )

Returns the size of a sector.

**Parameters**

| | | |
|---|---|---|
| in | *devp* | pointer to a BaseFlash object |
| in | *sector* | flash sector number |

**Returns**

the size of the sector

## 7.10 GPT Driver

Generic GPT Driver.

### 7.10.1 Detailed Description

Generic GPT Driver.

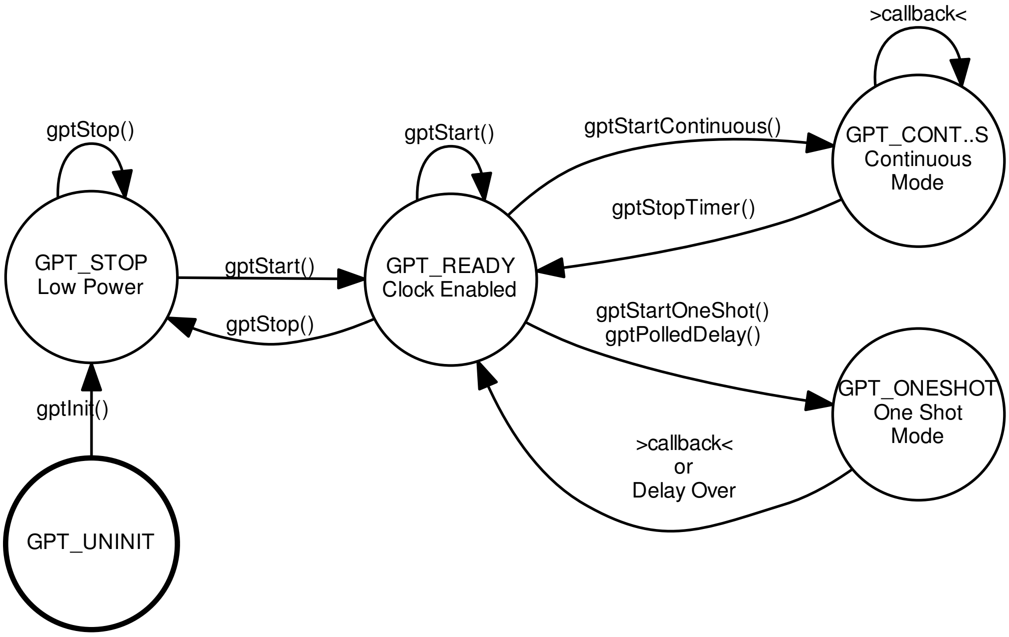
This module implements a generic GPT (General Purpose Timer) driver. The timer can be programmed in order to trigger callbacks after a specified time period or continuously with a specified interval.

**Precondition**

In order to use the GPT driver the `HAL_USE_GPT` option must be enabled in `halconf.h`.

### 7.10.2 Driver State Machine

The driver implements a state machine internally, not all the driver functionalities can be used in any moment, any transition not explicitly shown in the following diagram has to be considered an error and shall be captured by an assertion (if enabled).



### 7.10.3 GPT Operations.

This driver abstracts a generic timer composed of:

- A clock prescaler.
- A main up counter.

- A comparator register that resets the main counter to zero when the limit is reached. A callback is invoked when this happens.

The timer can operate in three different modes:

- **Continuous Mode**, a periodic callback is invoked until the driver is explicitly stopped.
- **One Shot Mode**, a callback is invoked after the programmed period and then the timer automatically stops.
- **Delay Mode**, the timer is used for inserting a brief delay into the execution flow, no callback is invoked in this mode.

## Macros

- #define gptChangeIntervalI(gptp, interval)

  *Changes the interval of GPT peripheral.*
- #define gptGetIntervalX(gptp) gpt_lld_get_interval(gptp)

  *Returns the interval of GPT peripheral.*
- #define gptGetCounterX(gptp) gpt_lld_get_counter(gptp)

  *Returns the counter value of GPT peripheral.*
- #define gpt_lld_change_interval(gptp, interval)

  *Changes the interval of GPT peripheral.*

## PLATFORM configuration options

- #define PLATFORM_GPT_USE_GPT1 FALSE

  *GPTD1 driver enable switch.*

## Typedefs

- typedef struct GPTDriver GPTDriver

  *Type of a structure representing a GPT driver.*
- typedef void(∗ gptcallback_t) (GPTDriver ∗gptp)

  *GPT notification callback type.*
- typedef uint32_t gptfreq_t

  *GPT frequency type.*
- typedef uint16_t gptcnt_t

  *GPT counter type.*

## Data Structures

- struct GPTConfig

  *Driver configuration structure.*
- struct GPTDriver

  *Structure representing a GPT driver.*

## Functions

- void gptInit (void)

  *GPT Driver initialization.*
- void gptObjectInit (GPTDriver ∗gptp)

  *Initializes the standard part of a `GPTDriver` structure.*
- void gptStart (GPTDriver ∗gptp, const GPTConfig ∗config)

  *Configures and activates the GPT peripheral.*
- void gptStop (GPTDriver ∗gptp)

  *Deactivates the GPT peripheral.*
- void gptChangeInterval (GPTDriver ∗gptp, gptcnt_t interval)

  *Changes the interval of GPT peripheral.*
- void gptStartContinuous (GPTDriver ∗gptp, gptcnt_t interval)

  *Starts the timer in continuous mode.*
- void gptStartContinuousI (GPTDriver ∗gptp, gptcnt_t interval)

  *Starts the timer in continuous mode.*
- void gptStartOneShot (GPTDriver ∗gptp, gptcnt_t interval)

  *Starts the timer in one shot mode.*
- void gptStartOneShotI (GPTDriver ∗gptp, gptcnt_t interval)

  *Starts the timer in one shot mode.*
- void gptStopTimer (GPTDriver ∗gptp)

  *Stops the timer.*
- void gptStopTimerI (GPTDriver ∗gptp)

  *Stops the timer.*
- void gptPolledDelay (GPTDriver ∗gptp, gptcnt_t interval)

  *Starts the timer in one shot mode and waits for completion.*
- void gpt_lld_init (void)

  *Low level GPT driver initialization.*
- void gpt_lld_start (GPTDriver ∗gptp)

  *Configures and activates the GPT peripheral.*
- void gpt_lld_stop (GPTDriver ∗gptp)

  *Deactivates the GPT peripheral.*
- void gpt_lld_start_timer (GPTDriver ∗gptp, gptcnt_t interval)

  *Starts the timer in continuous mode.*
- void gpt_lld_stop_timer (GPTDriver ∗gptp)

  *Stops the timer.*
- void gpt_lld_polled_delay (GPTDriver ∗gptp, gptcnt_t interval)

  *Starts the timer in one shot mode and waits for completion.*

## Enumerations

## Variables

- GPTDriver GPTD1

  *GPTD1 driver identifier.*

## 7.10.4 Macro Definition Documentation

### 7.10.4.1 #define gptChangeIntervalI( *gptp,* *interval* )

**Value:**

```
{                                          \
  gpt_lld_change_interval(gptp, interval);                                                  \
}
```

Changes the interval of GPT peripheral.

This function changes the interval of a running GPT unit.

**Precondition**

The GPT unit must be running in continuous mode.

**Postcondition**

The GPT unit interval is changed to the new value.

**Parameters**

| | | |
|---|---|---|
| in | *gptp* | pointer to a GPTDriver object |
| in | *interval* | new cycle time in timer ticks |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

### 7.10.4.2 #define gptGetIntervalX( *gptp* ) gpt_lld_get_interval(gptp)

Returns the interval of GPT peripheral.

**Precondition**

The GPT unit must be running in continuous mode.

**Parameters**

| | | |
|---|---|---|
| in | *gptp* | pointer to a GPTDriver object |

**Returns**

The current interval.

**Function Class:**

This is an **X-Class** API, this function can be invoked from any context.

### 7.10.4.3 #define gptGetCounterX( *gptp* ) gpt_lld_get_counter(gptp)

Returns the counter value of GPT peripheral.

Precondition

The GPT unit must be running in continuous mode.

Note

The nature of the counter is not defined, it may count upward or downward, it could be continuously running or not.

Parameters

| | | |
|---|---|---|
| in | *gptp* | pointer to a `GPTDriver` object |

Returns

The current counter value.

Function Class:

This is an **X-Class** API, this function can be invoked from any context.

#### 7.10.4.4 #define PLATFORM_GPT_USE_GPT1 FALSE

GPTD1 driver enable switch.

If set to `TRUE` the support for GPTD1 is included.

Note

The default is `FALSE`.

#### 7.10.4.5 #define gpt_lld_change_interval( *gptp,* *interval* )

**Value:**

```
{                             \
  (void)gptp;                                                          \
  (void)interval;                                                      \
}
```

Changes the interval of GPT peripheral.

This function changes the interval of a running GPT unit.

Precondition

The GPT unit must have been activated using `gptStart()`.
The GPT unit must have been running in continuous mode using `gptStartContinuous()`.

Postcondition

The GPT unit interval is changed to the new value.

Note

The function has effect at the next cycle start.

**Parameters**

| | | |
|---|---|---|
| in | *gptp* | pointer to a GPTDriver object |
| in | *interval* | new cycle time in timer ticks |

**Function Class:**

Not an API, this function is for internal use only.

## 7.10.5 Typedef Documentation

### 7.10.5.1 typedef struct GPTDriver GPTDriver

Type of a structure representing a GPT driver.

### 7.10.5.2 typedef void(∗ gptcallback_t) (GPTDriver ∗gptp)

GPT notification callback type.

**Parameters**

| | | |
|---|---|---|
| in | *gptp* | pointer to a GPTDriver object |

### 7.10.5.3 typedef uint32_t gptfreq_t

GPT frequency type.

### 7.10.5.4 typedef uint16_t gptcnt_t

GPT counter type.

## 7.10.6 Enumeration Type Documentation

### 7.10.6.1 enum gptstate_t

Driver state machine possible states.

**Enumerator**

***GPT_UNINIT*** Not initialized.

***GPT_STOP*** Stopped.

***GPT_READY*** Ready.

***GPT_CONTINUOUS*** Active in continuous mode.

***GPT_ONESHOT*** Active in one shot mode.

## 7.10.7 Function Documentation

### 7.10.7.1 void gptInit ( void )

GPT Driver initialization.

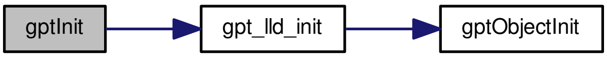
**Note**

This function is implicitly invoked by halInit(), there is no need to explicitly initialize the driver.

**Function Class:**

Initializer, this function just initializes an object and can be invoked before the kernel is initialized.

Here is the call graph for this function:



#### 7.10.7.2 void gptObjectInit ( GPTDriver * *gptp* )

Initializes the standard part of a GPTDriver structure.

**Parameters**

| | | |
|---|---|---|
| out | *gptp* | pointer to the GPTDriver object |

**Function Class:**

Initializer, this function just initializes an object and can be invoked before the kernel is initialized.

#### 7.10.7.3 void gptStart ( GPTDriver * *gptp*, const GPTConfig * *config* )

Configures and activates the GPT peripheral.

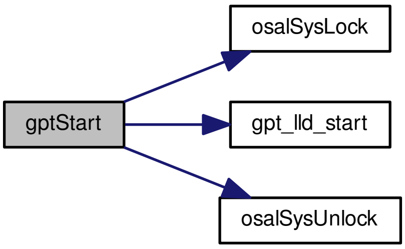
**Parameters**

| | | |
|---|---|---|
| in | *gptp* | pointer to the GPTDriver object |
| in | *config* | pointer to the GPTConfig object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.10.7.4 void gptStop ( GPTDriver * *gptp* )

Deactivates the GPT peripheral.

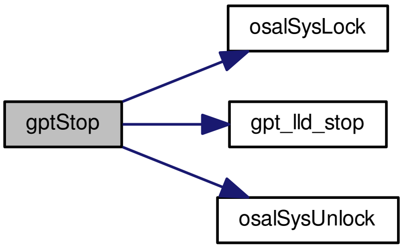
**Parameters**

| | | |
|---|---|---|
| in | *gptp* | pointer to the `GPTDriver` object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.10.7.5 void gptChangeInterval ( GPTDriver * *gptp*, gptcnt_t *interval* )

Changes the interval of GPT peripheral.

This function changes the interval of a running GPT unit.

**Precondition**

The GPT unit must be running in continuous mode.

**Postcondition**

The GPT unit interval is changed to the new value.

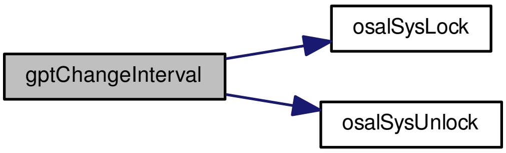
**Parameters**

| | | |
|---|---|---|
| in | *gptp* | pointer to a `GPTDriver` object |
| in | *interval* | new cycle time in timer ticks |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.10.7.6 void gptStartContinuous ( GPTDriver ∗ *gptp*, gptcnt_t *interval* )

Starts the timer in continuous mode.

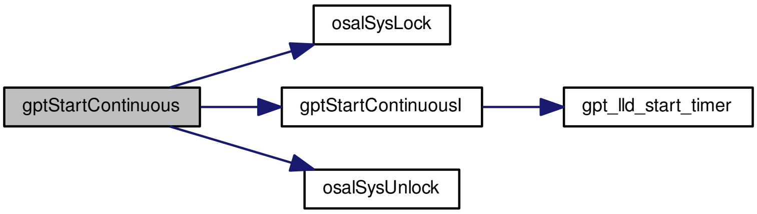
**Parameters**

| | | |
|---|---|---|
| in | *gptp* | pointer to the `GPTDriver` object |
| in | *interval* | period in ticks |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.10.7.7 void gptStartContinuousI ( GPTDriver ∗ *gptp*, gptcnt_t *interval* )

Starts the timer in continuous mode.

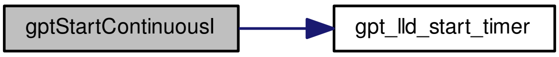
**Parameters**

| | | |
|---|---|---|
| in | *gptp* | pointer to the `GPTDriver` object |
| in | *interval* | period in ticks |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

Here is the call graph for this function:



#### 7.10.7.8 void gptStartOneShot ( GPTDriver ∗ *gptp*, gptcnt_t *interval* )

Starts the timer in one shot mode.

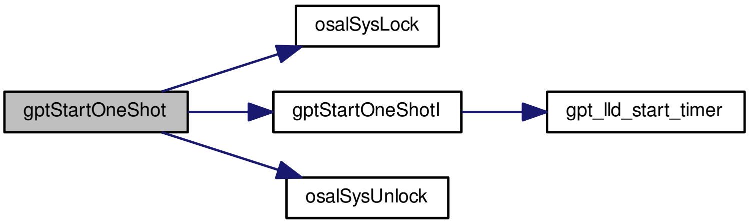
**Parameters**

| | | |
|---|---|---|
| in | *gptp* | pointer to the `GPTDriver` object |
| in | *interval* | time interval in ticks |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.10.7.9 void gptStartOneShotI ( GPTDriver ∗ *gptp*, gptcnt_t *interval* )

Starts the timer in one shot mode.

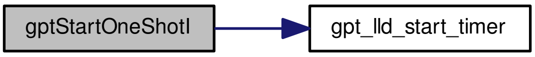
**Parameters**

| | | |
|---|---|---|
| in | *gptp* | pointer to the `GPTDriver` object |
| in | *interval* | time interval in ticks |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.10.7.10 void gptStopTimer ( GPTDriver ∗ *gptp* )

Stops the timer.

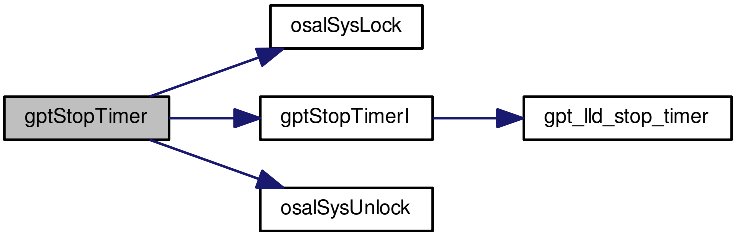
**Parameters**

| | | |
|---|---|---|
| in | *gptp* | pointer to the `GPTDriver` object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.10.7.11 void gptStopTimerI ( GPTDriver ∗ *gptp* )

Stops the timer.

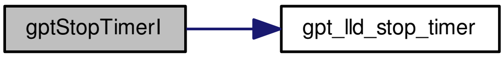
**Parameters**

| | | |
|---|---|---|
| in | *gptp* | pointer to the `GPTDriver` object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.10.7.12 void gptPolledDelay ( GPTDriver ∗ *gptp*, gptcnt_t *interval* )

Starts the timer in one shot mode and waits for completion.

This function specifically polls the timer waiting for completion in order to not have extra delays caused by interrupt servicing, this function is only recommended for short delays.

**Note**

The configured callback is not invoked when using this function.

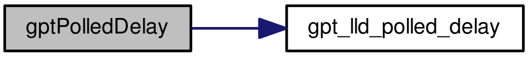
**Parameters**

| | | |
|---|---|---|
| in | *gptp* | pointer to the GPTDriver object |
| in | *interval* | time interval in ticks |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



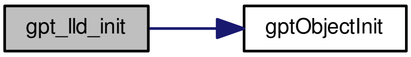
### 7.10.7.13 void gpt_lld_init ( void )

Low level GPT driver initialization.

**Function Class:**

Not an API, this function is for internal use only.

Here is the call graph for this function:



### 7.10.7.14 void gpt_lld_start ( GPTDriver ∗ *gptp* )

Configures and activates the GPT peripheral.

**Parameters**

| | | |
|---|---|---|
| in | *gptp* | pointer to the GPTDriver object |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.10.7.15 void gpt_lld_stop ( GPTDriver ∗ *gptp* )

Deactivates the GPT peripheral.

**Parameters**

| | | |
|---|---|---|
| in | *gptp* | pointer to the GPTDriver object |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.10.7.16 void gpt_lld_start_timer ( GPTDriver ∗ *gptp*, gptcnt_t *interval* )

Starts the timer in continuous mode.

**Parameters**

| | | |
|---|---|---|
| in | *gptp* | pointer to the GPTDriver object |
| in | *interval* | period in ticks |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.10.7.17 void gpt_lld_stop_timer ( GPTDriver ∗ *gptp* )

Stops the timer.

**Parameters**

| | | |
|---|---|---|
| in | *gptp* | pointer to the GPTDriver object |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.10.7.18 void gpt_lld_polled_delay ( GPTDriver ∗ *gptp*, gptcnt_t *interval* )

Starts the timer in one shot mode and waits for completion.

This function specifically polls the timer waiting for completion in order to not have extra delays caused by interrupt servicing, this function is only recommended for short delays.

**Parameters**

| | | |
|---|---|---|
| in | *gptp* | pointer to the GPTDriver object |
| in | *interval* | time interval in ticks |

**Function Class:**

Not an API, this function is for internal use only.

## 7.10.8 Variable Documentation

### 7.10.8.1 GPTDriver GPTD1

GPTD1 driver identifier.

## 7.11 Generic Gyroscope Interface

HAL Generic Gyroscope Interface.

### 7.11.1 Detailed Description

HAL Generic Gyroscope Interface.

#### Macros

- #define _base_gyroscope_methods_alone

  *BaseGyroscope specific methods.*
- #define _base_gyroscope_methods

  *BaseGyroscope specific methods with inherited ones.*
- #define _base_gyroscope_data _base_sensor_data

  *`BaseGyroscope` specific data.*

#### Macro Functions (BaseGyroscope)

- #define gyroscopeGetAxesNumber(ip) (ip)->vmt->get_channels_number(ip)

  *Gyroscope get axes number.*
- #define gyroscopeReadRaw(ip, dp) (ip)->vmt->read_raw(ip, dp)

  *Gyroscope read raw data.*
- #define gyroscopeReadCooked(ip, dp) (ip)->vmt->read_cooked(ip, dp)

  *Gyroscope read cooked data.*
- #define gyroscopeSampleBias(ip) (ip)->vmt->sample_bias(ip)

  *Gyroscope bias sampling procedure.*
- #define gyroscopeSetBias(ip, bp) (ip)->vmt->set_bias(ip, bp)

  *Updates gyroscope bias data from received buffer.*
- #define gyroscopeResetBias(ip) (ip)->vmt->reset_bias(ip)

  *Reset gyroscope bias data restoring it to zero.*
- #define gyroscopeSetSensitivity(ip, sp) (ip)->vmt->set_sensitivity(ip, sp)

  *Updates gyroscope sensitivity data from received buffer.*
- #define gyroscopeResetSensitivity(ip) (ip)->vmt->reset_sensitivity(ip)

  *Reset gyroscope sensitivity data restoring it to its typical value.*

#### Data Structures

- struct BaseGyroscopeVMT

  *`BaseGyroscope` virtual methods table.*
- struct BaseGyroscope

  *Base gyroscope class.*

### 7.11.2 Macro Definition Documentation

#### 7.11.2.1 #define _base_gyroscope_methods_alone

**Value:**

```
/* Invoke the sample bias procedure.*/                                   \
  msg_t (*sample_bias)(void *instance);                                   \
  /* Invoke the set bias procedure.*/                                     \
  msg_t (*set_bias)(void *instance, float biases[]);                      \
  /* Remove bias stored data.*/                                           \
  msg_t (*reset_bias)(void *instance);                                    \
  /* Invoke the set sensitivity procedure.*/                              \
  msg_t (*set_sensitivity)(void *instance, float sensitivities[]);        \
  /* Restore sensitivity stored data to default.*/                        \
  msg_t (*reset_sensitivity)(void *instance);
```

BaseGyroscope specific methods.

#### 7.11.2.2 #define _base_gyroscope_methods

**Value:**

```
_base_sensor_methods                                                     \
  _base_gyroscope_methods_alone
```

BaseGyroscope specific methods with inherited ones.

#### 7.11.2.3 #define _base_gyroscope_data _base_sensor_data

BaseGyroscope specific data.

#### 7.11.2.4 #define gyroscopeGetAxesNumber( *ip* ) (ip)->vmt->get_channels_number(ip)

Gyroscope get axes number.

**Parameters**

| | | |
|---|---|---|
| in | *ip* | pointer to a BaseGyroscope class. |

**Returns**

The number of axes of the BaseGyroscope

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.11.2.5 #define gyroscopeReadRaw( *ip*, *dp* ) (ip)->vmt->read_raw(ip, dp)

Gyroscope read raw data.

**Parameters**

| | | |
|---|---|---|
| in | *ip* | pointer to a BaseGyroscope class. |
| in | *dp* | pointer to a data array. |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *MSG_OK* | if the function succeeded. |
| *MSG_RESET* | if one or more errors occurred. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.11.2.6 #define gyroscopeReadCooked( *ip, dp* ) (ip)->vmt->read_cooked(ip, dp)

Gyroscope read cooked data.

**Parameters**

| | | |
|---|---|---|
| `in` | *ip* | pointer to a `BaseGyroscope` class. |
| `in` | *dp* | pointer to a data array. |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *MSG_OK* | if the function succeeded. |
| *MSG_RESET* | if one or more errors occurred. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.11.2.7 #define gyroscopeSampleBias( *ip* ) (ip)->vmt->sample_bias(ip)

Gyroscope bias sampling procedure.

**Note**

During this procedure gyroscope must be kept hold in the rest position. Sampled bias will be automatically removed after calling this procedure.

**Parameters**

| | | |
|---|---|---|
| `in` | *ip* | pointer to a `BaseGyroscope` class. |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *MSG_OK* | if the function succeeded. |
| *MSG_RESET* | if one or more errors occurred. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.11.2.8 #define gyroscopeSetBias( *ip, bp* ) (ip)->vmt->set_bias(ip, bp)

Updates gyroscope bias data from received buffer.

**Note**

The bias buffer must have the same length of the the gyroscope axes number.

**Parameters**

| | | |
|---|---|---|
| `in` | *ip* | pointer to a `BaseGyroscope` class. |
| `in` | *bp* | pointer to a buffer of bias values. |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *MSG_OK* | if the function succeeded. |
| *MSG_RESET* | if one or more errors occurred. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.11.2.9 #define gyroscopeResetBias( *ip* ) (ip)->vmt->reset_bias(ip)

Reset gyroscope bias data restoring it to zero.

**Parameters**

| | | |
|---|---|---|
| `in` | *ip* | pointer to a `BaseGyroscope` class. |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *MSG_OK* | if the function succeeded. |
| *MSG_RESET* | if one or more errors occurred. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.11.2.10 #define gyroscopeSetSensitivity( *ip*, *sp* ) (ip)->vmt->set_sensitivity(ip, sp)

Updates gyroscope sensitivity data from received buffer.

**Note**

The sensitivity buffer must have the same length of the the gyroscope axes number.

**Parameters**

| | | |
|---|---|---|
| in | *ip* | pointer to a BaseGyroscope class. |
| in | *sp* | pointer to a buffer of sensitivity values. |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *MSG_OK* | if the function succeeded. |
| *MSG_RESET* | if one or more errors occurred. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.11.2.11 #define gyroscopeResetSensitivity( *ip* ) (ip)->vmt->reset_sensitivity(ip)

Reset gyroscope sensitivity data restoring it to its typical value.

**Parameters**

| | | |
|---|---|---|
| in | *ip* | pointer to a BaseGyroscope class. |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *MSG_OK* | if the function succeeded. |
| *MSG_RESET* | if one or more errors occurred. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

## 7.12 HAL Driver

Hardware Abstraction Layer.

### 7.12.1 Detailed Description

Hardware Abstraction Layer.

The HAL (Hardware Abstraction Layer) driver performs the system initialization and includes the platform support code shared by the other drivers. This driver does contain any API function except for a general initialization function `halInit()` that must be invoked before any HAL service can be used, usually the HAL initialization should be performed immediately before the kernel initialization.
Some HAL driver implementations also offer a custom early clock setup function that can be invoked before the C runtime initialization in order to accelerate the startup time.

#### Macros

- #define _CHIBIOS_HAL_

  *ChibiOS/HAL identification macro.*
- #define CH_HAL_STABLE 1

  *Stable release flag.*

#### ChibiOS/HAL version identification

- #define HAL_VERSION "6.0.1"

  *HAL version string.*
- #define CH_HAL_MAJOR 6

  *HAL version major number.*
- #define CH_HAL_MINOR 0

  *HAL version minor number.*
- #define CH_HAL_PATCH 1

  *HAL version patch number.*

#### Return codes

- #define **HAL_SUCCESS** false
- #define **HAL_FAILED** true

#### Platform identification macros

- #define **PLATFORM_NAME** "templates"

#### Functions

- void halInit (void)

  *HAL initialization.*
- void hal_lld_init (void)

  *Low level HAL driver initialization.*

## 7.12.2 Macro Definition Documentation

### 7.12.2.1 #define _CHIBIOS_HAL_

ChibiOS/HAL identification macro.

### 7.12.2.2 #define CH_HAL_STABLE 1

Stable release flag.

### 7.12.2.3 #define HAL_VERSION "6.0.1"

HAL version string.

### 7.12.2.4 #define CH_HAL_MAJOR 6

HAL version major number.

### 7.12.2.5 #define CH_HAL_MINOR 0

HAL version minor number.

### 7.12.2.6 #define CH_HAL_PATCH 1

HAL version patch number.

## 7.12.3 Function Documentation

### 7.12.3.1 void halInit ( void )

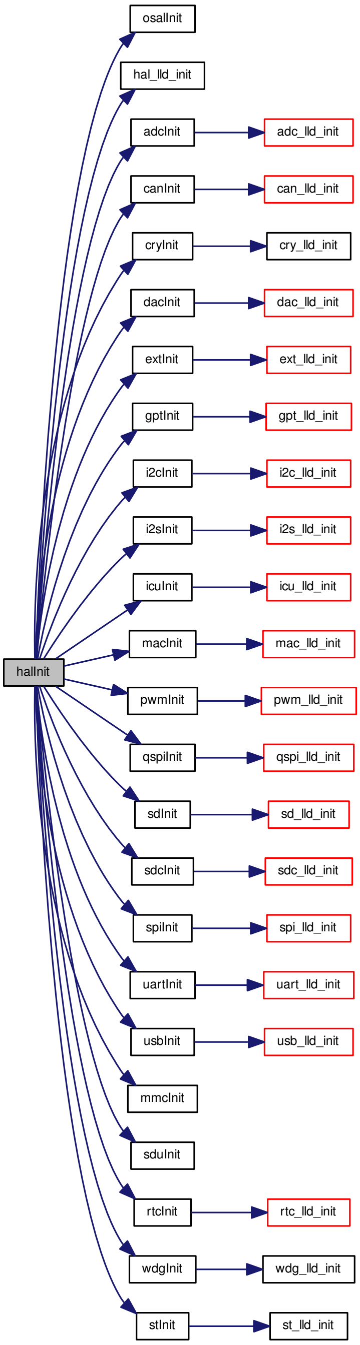
HAL initialization.

This function invokes the low level initialization code then initializes all the drivers enabled in the HAL. Finally the board-specific initialization is performed by invoking `boardInit()` (usually defined in `board.c`).

**Function Class:**

Initializer, this function just initializes an object and can be invoked before the kernel is initialized.

Here is the call graph for this function:



### 7.12.3.2 void hal_lld_init ( void )

Low level HAL driver initialization.

**Function Class:**

Not an API, this function is for internal use only.

## 7.13 I/O Buffers Queues

### 7.13.1 Detailed Description

Buffers Queues are used when there is the need to exchange fixed-length data buffers between ISRs and threads. On the ISR side data can be exchanged only using buffers, on the thread side data can be exchanged both using buffers and/or using an emulation of regular byte queues. There are several kind of buffers queues:

- **Input queue**, unidirectional queue where the writer is the ISR side and the reader is the thread side.
- **Output queue**, unidirectional queue where the writer is the ISR side and the reader is the thread side.
- **Full duplex queue**, bidirectional queue. Full duplex queues are implemented by pairing an input queue and an output queue together.

### Macros

- #define BQ_BUFFER_SIZE(n, size) (((size_t)(size) + sizeof (size_t)) ∗ (size_t)(n))

  *Computes the size of a buffers queue buffer size.*

### Macro Functions

- #define bqSizeX(bqp) ((bqp)->bn)

  *Returns the queue's number of buffers.*
- #define bqSpaceI(bqp) ((bqp)->bcounter)

  *Return the ready buffers number.*
- #define bqGetLinkX(bqp) ((bqp)->link)

  *Returns the queue application-defined link.*
- #define bqIsSuspendedX(bqp) ((bqp)->suspended)

  *Return the suspended state of the queue.*
- #define bqSuspendI(bqp)

  *Puts the queue in suspended state.*
- #define bqResumeX(bqp)

  *Resumes normal queue operations.*
- #define ibqIsEmptyI(ibqp) ((bool)(bqSpaceI(ibqp) == 0U))

  *Evaluates to `true` if the specified input buffers queue is empty.*
- #define ibqIsFullI(ibqp)

  *Evaluates to `true` if the specified input buffers queue is full.*
- #define obqIsEmptyI(obqp)

  *Evaluates to `true` if the specified output buffers queue is empty.*
- #define obqIsFullI(obqp) ((bool)(bqSpaceI(obqp) == 0U))

  *Evaluates to `true` if the specified output buffers queue is full.*

### Typedefs

- typedef struct io_buffers_queue io_buffers_queue_t

  *Type of a generic queue of buffers.*
- typedef void(∗ bqnotify_t) (io_buffers_queue_t ∗bqp)

  *Double buffer notification callback type.*
- typedef io_buffers_queue_t input_buffers_queue_t

  *Type of an input buffers queue.*
- typedef io_buffers_queue_t output_buffers_queue_t

  *Type of an output buffers queue.*

## Data Structures

- struct io_buffers_queue

  *Structure of a generic buffers queue.*

## Functions

- void ibqObjectInit (input_buffers_queue_t ∗ibqp, bool suspended, uint8_t ∗bp, size_t size, size_t n, bqnotify←_t infy, void ∗link)

  *Initializes an input buffers queue object.*
- void ibqResetI (input_buffers_queue_t ∗ibqp)

  *Resets an input buffers queue.*
- uint8_t ∗ ibqGetEmptyBufferI (input_buffers_queue_t ∗ibqp)

  *Gets the next empty buffer from the queue.*
- void ibqPostFullBufferI (input_buffers_queue_t ∗ibqp, size_t size)

  *Posts a new filled buffer to the queue.*
- msg_t ibqGetFullBufferTimeout (input_buffers_queue_t ∗ibqp, sysinterval_t timeout)

  *Gets the next filled buffer from the queue.*
- msg_t ibqGetFullBufferTimeoutS (input_buffers_queue_t ∗ibqp, sysinterval_t timeout)

  *Gets the next filled buffer from the queue.*
- void ibqReleaseEmptyBuffer (input_buffers_queue_t ∗ibqp)

  *Releases the buffer back in the queue.*
- void ibqReleaseEmptyBufferS (input_buffers_queue_t ∗ibqp)

  *Releases the buffer back in the queue.*
- msg_t ibqGetTimeout (input_buffers_queue_t ∗ibqp, sysinterval_t timeout)

  *Input queue read with timeout.*
- size_t ibqReadTimeout (input_buffers_queue_t ∗ibqp, uint8_t ∗bp, size_t n, sysinterval_t timeout)

  *Input queue read with timeout.*
- void obqObjectInit (output_buffers_queue_t ∗obqp, bool suspended, uint8_t ∗bp, size_t size, size_t n, bqnotify_t onfy, void ∗link)

  *Initializes an output buffers queue object.*
- void obqResetI (output_buffers_queue_t ∗obqp)

  *Resets an output buffers queue.*
- uint8_t ∗ obqGetFullBufferI (output_buffers_queue_t ∗obqp, size_t ∗sizep)

  *Gets the next filled buffer from the queue.*
- void obqReleaseEmptyBufferI (output_buffers_queue_t ∗obqp)

  *Releases the next filled buffer back in the queue.*
- msg_t obqGetEmptyBufferTimeout (output_buffers_queue_t ∗obqp, sysinterval_t timeout)

  *Gets the next empty buffer from the queue.*
- msg_t obqGetEmptyBufferTimeoutS (output_buffers_queue_t ∗obqp, sysinterval_t timeout)

  *Gets the next empty buffer from the queue.*
- void obqPostFullBuffer (output_buffers_queue_t ∗obqp, size_t size)

  *Posts a new filled buffer to the queue.*
- void obqPostFullBufferS (output_buffers_queue_t ∗obqp, size_t size)

  *Posts a new filled buffer to the queue.*
- msg_t obqPutTimeout (output_buffers_queue_t ∗obqp, uint8_t b, sysinterval_t timeout)

  *Output queue write with timeout.*
- size_t obqWriteTimeout (output_buffers_queue_t ∗obqp, const uint8_t ∗bp, size_t n, sysinterval_t timeout)

  *Output queue write with timeout.*
- bool obqTryFlushI (output_buffers_queue_t ∗obqp)

  *Flushes the current, partially filled, buffer to the queue.*
- void obqFlush (output_buffers_queue_t ∗obqp)

  *Flushes the current, partially filled, buffer to the queue.*

## 7.13.2 Macro Definition Documentation

### 7.13.2.1 #define BQ_BUFFER_SIZE( *n, size* ) (((size_t)(size) + sizeof (size_t)) ∗ (size_t)(n))

Computes the size of a buffers queue buffer size.

**Parameters**

| | | |
|---|---|---|
| in | *n* | number of buffers in the queue |
| in | *size* | size of the buffers |

### 7.13.2.2 #define bqSizeX( *bqp* ) ((bqp)->bn)

Returns the queue's number of buffers.

**Parameters**

| | | |
|---|---|---|
| in | *bqp* | pointer to an `io_buffers_queue_t` structure |

**Returns**

The number of buffers.

**Function Class:**

This is an **X-Class** API, this function can be invoked from any context.

### 7.13.2.3 #define bqSpaceI( *bqp* ) ((bqp)->bcounter)

Return the ready buffers number.

Returns the number of filled buffers if used on an input queue or the number of empty buffers if used on an output queue.

**Parameters**

| | | |
|---|---|---|
| in | *bqp* | pointer to an `io_buffers_queue_t` structure |

**Returns**

The number of ready buffers.

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

### 7.13.2.4 #define bqGetLinkX( *bqp* ) ((bqp)->link)

Returns the queue application-defined link.

**Parameters**

| | | |
|---|---|---|
| in | *bqp* | pointer to an `io_buffers_queue_t` structure |

**Returns**

The application-defined link.

**Function Class:**

Special function, this function has special requirements see the notes.

#### 7.13.2.5 #define bqIsSuspendedX( *bqp* ) ((bqp)->suspended)

Return the suspended state of the queue.

**Parameters**

| | | |
|---|---|---|
| in | *bqp* | pointer to an `io_buffers_queue_t` structure |

**Returns**

The suspended state.

**Return values**

| | |
|---|---|
| *false* | if blocking access to the queue is enabled. |
| *true* | if blocking access to the queue is suspended. |

**Function Class:**

This is an **X-Class** API, this function can be invoked from any context.

#### 7.13.2.6 #define bqSuspendI( *bqp* )

**Value:**

```
{                                                    \
  (bqp)->suspended = true;                                                \
  osalThreadDequeueAllI(&(bqp)->waiting, MSG_RESET);                      \
}
```

Puts the queue in suspended state.

When the queue is put in suspended state all waiting threads are woken with message `MSG_RESET` and subsequent attempt at waiting on the queue will result in an immediate return with `MSG_RESET` message.

**Note**

The content of the queue is not altered, queues can be accessed is suspended state until a blocking operation is met then a `MSG_RESET` occurs.

**Parameters**

| | | |
|---|---|---|
| in | *bqp* | pointer to an `io_buffers_queue_t` structure |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

#### 7.13.2.7 #define bqResumeX( *bqp* )

**Value:**

```
{                                                           \
  (bqp)->suspended = false;                                                 \
}
```

Resumes normal queue operations.

**Parameters**

| | | |
|---|---|---|
| in | *bqp* | pointer to an `io_buffers_queue_t` structure |

**Function Class:**

This is an **X-Class** API, this function can be invoked from any context.

#### 7.13.2.8 #define ibqIsEmptyI( *ibqp* ) ((bool)(bqSpaceI(ibqp) == 0U))

Evaluates to `true` if the specified input buffers queue is empty.

**Parameters**

| | | |
|---|---|---|
| in | *ibqp* | pointer to an `input_buffers_queue_t` structure |

**Returns**

The queue status.

**Return values**

| | |
|---|---|
| *false* | if the queue is not empty. |
| *true* | if the queue is empty. |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

#### 7.13.2.9 #define ibqIsFullI( *ibqp* )

**Value:**

```
/*lint -save -e9007 [13.5] No side effects, a pointer is passed.*/        \
  ((bool)(((ibqp)->bwrptr == (ibqp)->brdptr) && ((ibqp)->bcounter != 0U)))  \
  /*lint -restore*/
```

Evaluates to `true` if the specified input buffers queue is full.

**Parameters**

| | | |
|---|---|---|
| in | *ibqp* | pointer to an `input_buffers_queue_t` structure |

**Returns**

The queue status.

**Return values**

| | |
|---|---|
| *false* | if the queue is not full. |
| *true* | if the queue is full. |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

#### 7.13.2.10 #define obqIsEmptyI( *obqp* )

**Value:**

```
/*lint -save -e9007 [13.5] No side effects, a pointer is passed.*/        \
  ((bool)(((obqp)->bwrptr == (obqp)->brdptr) && ((obqp)->bcounter != 0U)))  \
  /*lint -restore*/
```

Evaluates to `true` if the specified output buffers queue is empty.

**Parameters**

| | | |
|---|---|---|
| in | *obqp* | pointer to an `output_buffers_queue_t` structure |

**Returns**

The queue status.

**Return values**

| | |
|---|---|
| *false* | if the queue is not empty. |
| *true* | if the queue is empty. |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

#### 7.13.2.11 #define obqIsFullI( *obqp* ) ((bool)(bqSpaceI(obqp) == 0U))

Evaluates to `true` if the specified output buffers queue is full.

**Parameters**

| | | |
|---|---|---|
| `in` | *obqp* | pointer to an `output_buffers_queue_t` structure |

**Returns**

The queue status.

**Return values**

| | |
|---|---|
| *false* | if the queue is not full. |
| *true* | if the queue is full. |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

### 7.13.3 Typedef Documentation

#### 7.13.3.1 typedef struct io_buffers_queue io_buffers_queue_t

Type of a generic queue of buffers.

#### 7.13.3.2 typedef void(∗ bqnotify_t) (io_buffers_queue_t ∗bqp)

Double buffer notification callback type.

**Parameters**

| | | |
|---|---|---|
| `in` | *iodbp* | the buffers queue pointer |

#### 7.13.3.3 typedef io_buffers_queue_t input_buffers_queue_t

Type of an input buffers queue.

#### 7.13.3.4 typedef io_buffers_queue_t output_buffers_queue_t

Type of an output buffers queue.

### 7.13.4 Function Documentation

#### 7.13.4.1 void ibqObjectInit ( input_buffers_queue_t * *ibqp*, bool *suspended*, uint8_t * *bp*, size_t *size*, size_t *n*, bqnotify_t *infy*, void * *link* )

Initializes an input buffers queue object.

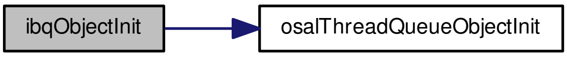
**Parameters**

| | | |
|---|---|---|
| out | *ibqp* | pointer to the `input_buffers_queue_t` object |
| in | *suspended* | initial state of the queue |
| in | *bp* | pointer to a memory area allocated for buffers |
| in | *size* | buffers size |
| in | *n* | number of buffers |
| in | *infy* | callback called when a buffer is returned to the queue |
| in | *link* | application defined pointer |

**Function Class:**

Initializer, this function just initializes an object and can be invoked before the kernel is initialized.

Here is the call graph for this function:



#### 7.13.4.2 void ibqResetI ( input_buffers_queue_t * *ibqp* )

Resets an input buffers queue.

All the data in the input buffers queue is erased and lost, any waiting thread is resumed with status `MSG_RESET`.

**Note**

A reset operation can be used by a low level driver in order to obtain immediate attention from the high level layers.

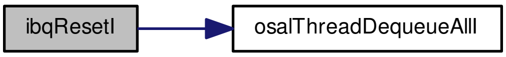
**Parameters**

| | | |
|---|---|---|
| in | *ibqp* | pointer to the `input_buffers_queue_t` object |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

Here is the call graph for this function:



#### 7.13.4.3 uint8_t * ibqGetEmptyBufferI ( input_buffers_queue_t * *ibqp* )

Gets the next empty buffer from the queue.

**Note**

The function always returns the same buffer if called repeatedly.

**Parameters**

| | | |
|---|---|---|
| in | *ibqp* | pointer to the `input_buffers_queue_t` object |

**Returns**

A pointer to the next buffer to be filled.

**Return values**

| | |
|---|---|
| *NULL* | if the queue is full. |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

#### 7.13.4.4 void ibqPostFullBufferI ( input_buffers_queue_t * *ibqp,* size_t *size* )

Posts a new filled buffer to the queue.

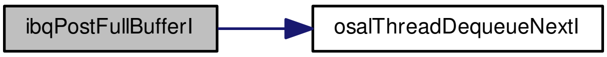
**Parameters**

| | | |
|---|---|---|
| in | *ibqp* | pointer to the `input_buffers_queue_t` object |
| in | *size* | used size of the buffer, cannot be zero |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

Here is the call graph for this function:



#### 7.13.4.5 msg_t ibqGetFullBufferTimeout ( input_buffers_queue_t * *ibqp,* sysinterval_t *timeout* )

Gets the next filled buffer from the queue.

**Note**

The function always acquires the same buffer if called repeatedly.

**Postcondition**

After calling the function the fields `ptr` and `top` are set at beginning and end of the buffer data or `NULL` if the queue is empty.

**Parameters**

| | | |
|---|---|---|
| `in` | *ibqp* | pointer to the `input_buffers_queue_t` object |
| `in` | *timeout* | the number of ticks before the operation timeouts, the following special values are allowed:<br>• *TIME_IMMEDIATE* immediate timeout.<br>• *TIME_INFINITE* no timeout. |

**Returns**

The operation status.

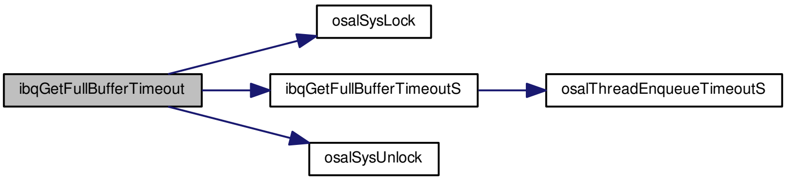
**Return values**

| | |
|---|---|
| *MSG_OK* | if a buffer has been acquired. |
| *MSG_TIMEOUT* | if the specified time expired. |
| *MSG_RESET* | if the queue has been reset or has been put in suspended state. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.13.4.6 msg_t ibqGetFullBufferTimeoutS ( input_buffers_queue_t ∗ *ibqp*, sysinterval_t *timeout* )

Gets the next filled buffer from the queue.

**Note**

The function always acquires the same buffer if called repeatedly.

**Postcondition**

After calling the function the fields `ptr` and `top` are set at beginning and end of the buffer data or `NULL` if the queue is empty.

**Parameters**

| | | |
|---|---|---|
| `in` | *ibqp* | pointer to the `input_buffers_queue_t` object |
| `in` | *timeout* | the number of ticks before the operation timeouts, the following special values are allowed:<br>• *TIME_IMMEDIATE* immediate timeout.<br>• *TIME_INFINITE* no timeout. |

**Returns**

The operation status.

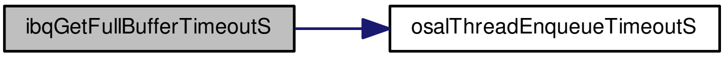
**Return values**

| | |
|---|---|
| *MSG_OK* | if a buffer has been acquired. |
| *MSG_TIMEOUT* | if the specified time expired. |
| *MSG_RESET* | if the queue has been reset or has been put in suspended state. |

**Function Class:**

This is an **S-Class** API, this function can be invoked from within a system lock zone by threads only.

Here is the call graph for this function:



#### 7.13.4.7 void ibqReleaseEmptyBuffer ( input_buffers_queue_t ∗ *ibqp* )

Releases the buffer back in the queue.

**Note**

The object callback is called after releasing the buffer.

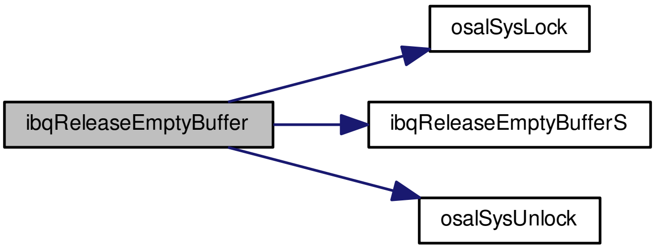
**Parameters**

| | | |
|---|---|---|
| in | *ibqp* | pointer to the `input_buffers_queue_t` object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.13.4.8 void ibqReleaseEmptyBufferS ( input_buffers_queue_t ∗ *ibqp* )

Releases the buffer back in the queue.

**Note**

The object callback is called after releasing the buffer.

**Parameters**

| | | |
|---|---|---|
| in | *ibqp* | pointer to the `input_buffers_queue_t` object |

**Function Class:**

This is an **S-Class** API, this function can be invoked from within a system lock zone by threads only.

#### 7.13.4.9 msg_t ibqGetTimeout ( input_buffers_queue_t ∗ *ibqp,* sysinterval_t *timeout* )

Input queue read with timeout.

This function reads a byte value from an input queue. If the queue is empty then the calling thread is suspended until a new buffer arrives in the queue or a timeout occurs.

**Parameters**

| | | |
|---|---|---|
| in | *ibqp* | pointer to the `input_buffers_queue_t` object |
| in | *timeout* | the number of ticks before the operation timeouts, the following special values are allowed:<br>• *TIME_IMMEDIATE* immediate timeout.<br>• *TIME_INFINITE* no timeout. |

**Returns**

A byte value from the queue.

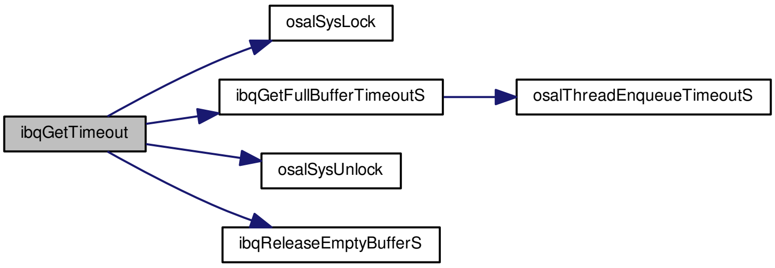
**Return values**

| | |
|---|---|
| *MSG_TIMEOUT* | if the specified time expired. |
| *MSG_RESET* | if the queue has been reset or has been put in suspended state. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



### 7.13.4.10 size_t ibqReadTimeout ( input_buffers_queue_t ∗ *ibqp,* uint8_t ∗ *bp,* size_t *n,* sysinterval_t *timeout* )

Input queue read with timeout.

The function reads data from an input queue into a buffer. The operation completes when the specified amount of data has been transferred or after the specified timeout or if the queue has been reset.

**Parameters**

| | | |
|---|---|---|
| `in` | *ibqp* | pointer to the `input_buffers_queue_t` object |
| `out` | *bp* | pointer to the data buffer |
| `in` | *n* | the maximum amount of data to be transferred, the value 0 is reserved |
| `in` | *timeout* | the number of ticks before the operation timeouts, the following special values are allowed:<br>• *TIME_IMMEDIATE* immediate timeout.<br>• *TIME_INFINITE* no timeout. |

**Returns**

The number of bytes effectively transferred.

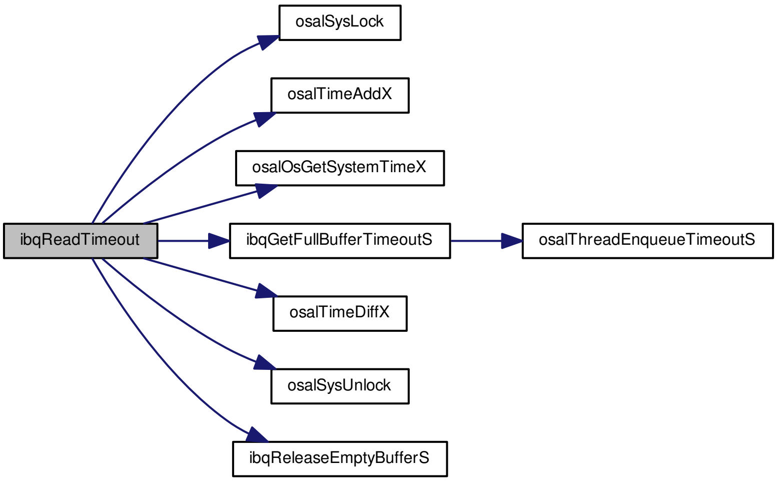
**Return values**

| | |
|---|---|
| *0* | if a timeout occurred. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.13.4.11 void obqObjectInit ( output_buffers_queue_t ∗ *obqp,* bool *suspended,* uint8_t ∗ *bp,* size_t *size,* size_t *n,* bqnotify_t *onfy,* void ∗ *link* )

Initializes an output buffers queue object.

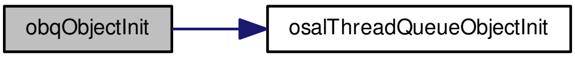
**Parameters**

| | | |
|---|---|---|
| out | *obqp* | pointer to the `output_buffers_queue_t` object |
| in | *suspended* | initial state of the queue |
| in | *bp* | pointer to a memory area allocated for buffers |
| in | *size* | buffers size |
| in | *n* | number of buffers |
| in | *onfy* | callback called when a buffer is posted in the queue |
| in | *link* | application defined pointer |

**Function Class:**

Initializer, this function just initializes an object and can be invoked before the kernel is initialized.

Here is the call graph for this function:



#### 7.13.4.12 void obqResetI ( output_buffers_queue_t ∗ *obqp* )

Resets an output buffers queue.

All the data in the output buffers queue is erased and lost, any waiting thread is resumed with status `MSG_RESET`.

**Note**

A reset operation can be used by a low level driver in order to obtain immediate attention from the high level layers.

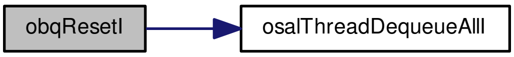
**Parameters**

| | | |
|---|---|---|
| in | *obqp* | pointer to the `output_buffers_queue_t` object |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

Here is the call graph for this function:



### 7.13.4.13 uint8_t * obqGetFullBufferI ( output_buffers_queue_t * *obqp*, size_t * *sizep* )

Gets the next filled buffer from the queue.

**Note**

The function always returns the same buffer if called repeatedly.

**Parameters**

| | | |
|---|---|---|
| in | *obqp* | pointer to the `output_buffers_queue_t` object |
| out | *sizep* | pointer to the filled buffer size |

**Returns**

A pointer to the filled buffer.

**Return values**

| | |
|---|---|
| *NULL* | if the queue is empty. |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

### 7.13.4.14 void obqReleaseEmptyBufferI ( output_buffers_queue_t * *obqp* )

Releases the next filled buffer back in the queue.

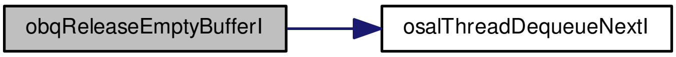
**Parameters**

| | | |
|---|---|---|
| in | *obqp* | pointer to the `output_buffers_queue_t` object |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

Here is the call graph for this function:



#### 7.13.4.15 msg_t obqGetEmptyBufferTimeout ( output_buffers_queue_t * *obqp,* sysinterval_t *timeout* )

Gets the next empty buffer from the queue.

**Note**

The function always acquires the same buffer if called repeatedly.

**Postcondition**

After calling the function the fields `ptr` and `top` are set at beginning and end of the buffer data or `NULL` if the queue is empty.

**Parameters**

| | | |
|---|---|---|
| `in` | *obqp* | pointer to the `output_buffers_queue_t` object |
| `in` | *timeout* | the number of ticks before the operation timeouts, the following special values are allowed:<br>• *TIME_IMMEDIATE* immediate timeout.<br>• *TIME_INFINITE* no timeout. |

**Returns**

The operation status.

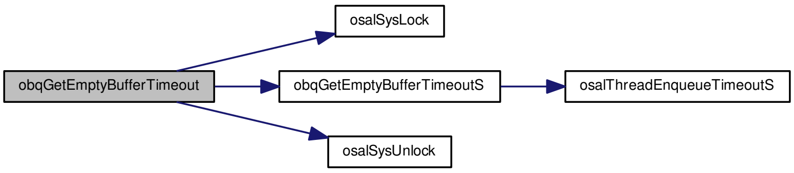
**Return values**

| | |
|---|---|
| *MSG_OK* | if a buffer has been acquired. |
| *MSG_TIMEOUT* | if the specified time expired. |
| *MSG_RESET* | if the queue has been reset or has been put in suspended state. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.13.4.16 msg_t obqGetEmptyBufferTimeoutS ( output_buffers_queue_t ∗ *obqp,* sysinterval_t *timeout* )

Gets the next empty buffer from the queue.

**Note**

The function always acquires the same buffer if called repeatedly.

**Postcondition**

After calling the function the fields `ptr` and `top` are set at beginning and end of the buffer data or `NULL` if the queue is empty.

**Parameters**

| | | |
|---|---|---|
| `in` | *obqp* | pointer to the `output_buffers_queue_t` object |
| `in` | *timeout* | the number of ticks before the operation timeouts, the following special values are allowed:<br>• *TIME_IMMEDIATE* immediate timeout.<br>• *TIME_INFINITE* no timeout. |

**Returns**

The operation status.

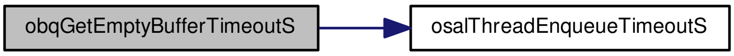
**Return values**

| | |
|---|---|
| *MSG_OK* | if a buffer has been acquired. |
| *MSG_TIMEOUT* | if the specified time expired. |
| *MSG_RESET* | if the queue has been reset or has been put in suspended state. |

**Function Class:**

This is an **S-Class** API, this function can be invoked from within a system lock zone by threads only.

Here is the call graph for this function:



#### 7.13.4.17 void obqPostFullBuffer ( output_buffers_queue_t ∗ *obqp,* size_t *size* )

Posts a new filled buffer to the queue.

**Note**

The object callback is called after releasing the buffer.

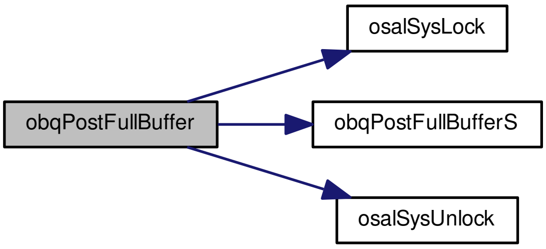
**Parameters**

| | | |
|---|---|---|
| `in` | *obqp* | pointer to the `output_buffers_queue_t` object |
| `in` | *size* | used size of the buffer, cannot be zero |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.13.4.18 void obqPostFullBufferS ( output_buffers_queue_t ∗ *obqp,* size_t *size* )

Posts a new filled buffer to the queue.

**Note**

The object callback is called after releasing the buffer.

**Parameters**

| | | |
|---|---|---|
| in | *obqp* | pointer to the `output_buffers_queue_t` object |
| in | *size* | used size of the buffer, cannot be zero |

**Function Class:**

This is an **S-Class** API, this function can be invoked from within a system lock zone by threads only.

#### 7.13.4.19 msg_t obqPutTimeout ( output_buffers_queue_t ∗ *obqp*, uint8_t *b*, sysinterval_t *timeout* )

Output queue write with timeout.

This function writes a byte value to an output queue. If the queue is full then the calling thread is suspended until a new buffer is freed in the queue or a timeout occurs.

**Parameters**

| | | |
|---|---|---|
| in | *obqp* | pointer to the `output_buffers_queue_t` object |
| in | *b* | byte value to be transferred |
| in | *timeout* | the number of ticks before the operation timeouts, the following special values are allowed:<br>• *TIME_IMMEDIATE* immediate timeout.<br>• *TIME_INFINITE* no timeout. |

**Returns**

A byte value from the queue.

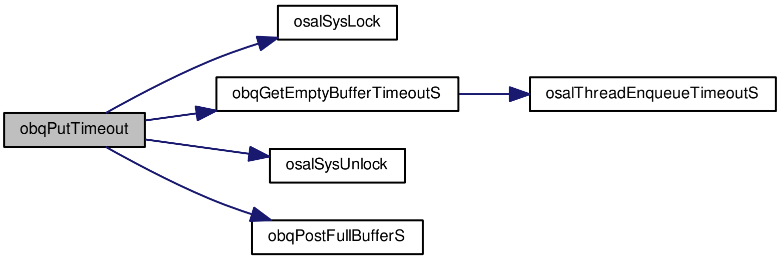
**Return values**

| | |
|---|---|
| *MSG_TIMEOUT* | if the specified time expired. |
| *MSG_RESET* | if the queue has been reset or has been put in suspended state. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.13.4.20 size_t obqWriteTimeout ( output_buffers_queue_t ∗ *obqp*, const uint8_t ∗ *bp*, size_t *n*, sysinterval_t *timeout* )

Output queue write with timeout.

The function writes data from a buffer to an output queue. The operation completes when the specified amount of data has been transferred or after the specified timeout or if the queue has been reset.

**Parameters**

| | | |
|---|---|---|
| in | *obqp* | pointer to the `output_buffers_queue_t` object |
| in | *bp* | pointer to the data buffer |
| in | *n* | the maximum amount of data to be transferred, the value 0 is reserved |
| in | *timeout* | the number of ticks before the operation timeouts, the following special values are allowed:<br>• *TIME_IMMEDIATE* immediate timeout.<br>• *TIME_INFINITE* no timeout. |

**Returns**

The number of bytes effectively transferred.

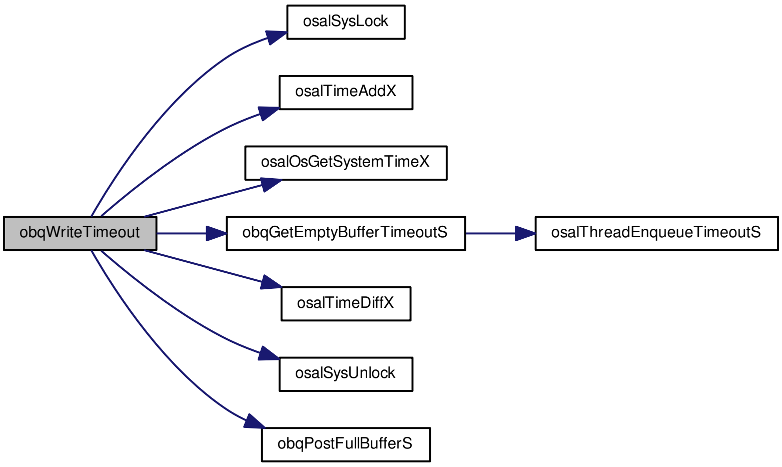
**Return values**

| | |
|---|---|
| *0* | if a timeout occurred. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.13.4.21 bool obqTryFlushI ( output_buffers_queue_t ∗ *obqp* )

Flushes the current, partially filled, buffer to the queue.

**Note**

The notification callback is not invoked because the function is meant to be called from ISR context. An operation status is returned instead.

**Parameters**

| | | |
|---|---|---|
| `in` | *obqp* | pointer to the `output_buffers_queue_t` object |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *false* | if no new filled buffer has been posted to the queue. |
| *true* | if a new filled buffer has been posted to the queue. |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

#### 7.13.4.22 void obqFlush ( output_buffers_queue_t ∗ *obqp* )

Flushes the current, partially filled, buffer to the queue.

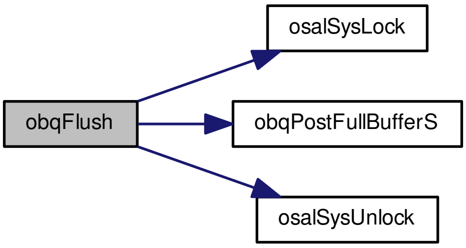
**Parameters**

| | | |
|---|---|---|
| in | *obqp* | pointer to the `output_buffers_queue_t` object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



## 7.14 Abstract I/O Channel

### 7.14.1 Detailed Description

This module defines an abstract interface for I/O channels by extending the `BaseSequentialStream` interface. Note that no code is present, I/O channels are just abstract interface like structures, you should look at the systems as to a set of abstract C++ classes (even if written in C). Specific device drivers can use/extend the interface and implement them.
This system has the advantage to make the access to channels independent from the implementation logic.

### Macros

- #define _base_channel_methods

  `BaseChannel` *specific methods.*
- #define _base_channel_data _base_sequential_stream_data

  `BaseChannel` *specific data.*
- #define _base_asynchronous_channel_methods _base_channel_methods \

  `BaseAsynchronousChannel` *specific methods.*
- #define _base_asynchronous_channel_data

  `BaseAsynchronousChannel` *specific data.*

### Default control operation codes.

- #define **CHN_CTL_INVALID** 0 /∗∗ @brief Invalid operation code. ∗/
- #define **CHN_CTL_NOP** 1 /∗∗ @brief Does nothing. ∗/
- #define **CHN_CTL_TX_WAIT** 2 /∗∗ @brief Wait for TX completion. ∗/

### Macro Functions (BaseChannel)

- #define chnPutTimeout(ip, b, time) ((ip)->vmt->putt(ip, b, time))

  *Channel blocking byte write with timeout.*
- #define chnGetTimeout(ip, time) ((ip)->vmt->gett(ip, time))

  *Channel blocking byte read with timeout.*
- #define chnWrite(ip, bp, n) streamWrite(ip, bp, n)

  *Channel blocking write.*
- #define chnWriteTimeout(ip, bp, n, time) ((ip)->vmt->writet(ip, bp, n, time))

  *Channel blocking write with timeout.*
- #define chnRead(ip, bp, n) streamRead(ip, bp, n)

  *Channel blocking read.*
- #define chnReadTimeout(ip, bp, n, time) ((ip)->vmt->readt(ip, bp, n, time))

  *Channel blocking read with timeout.*
- #define chnControl(ip, operation, arg) ((ip)->vmt->ctl(ip, operation, arg)

  *Control operation on a channel.*

### I/O status flags added to the event listener

- #define CHN_NO_ERROR (eventflags_t)0

  *No pending conditions.*
- #define CHN_CONNECTED (eventflags_t)1

  *Connection happened.*

- #define CHN_DISCONNECTED (eventflags_t)2

  *Disconnection happened.*
- #define CHN_INPUT_AVAILABLE (eventflags_t)4

  *Data available in the input queue.*
- #define CHN_OUTPUT_EMPTY (eventflags_t)8

  *Output queue empty.*
- #define CHN_TRANSMISSION_END (eventflags_t)16

  *Transmission end.*

### Macro Functions (BaseAsynchronousChannel)

- #define chnGetEventSource(ip) (&((ip)->event))

  *Returns the I/O condition event source.*
- #define chnAddFlagsI(ip, flags)

  *Adds status flags to the listeners's flags mask.*

### Data Structures

- struct BaseChannelVMT

  *BaseChannel virtual methods table.*
- struct BaseChannel

  *Base channel class.*
- struct BaseAsynchronousChannelVMT

  *BaseAsynchronousChannel virtual methods table.*
- struct BaseAsynchronousChannel

  *Base asynchronous channel class.*

## 7.14.2 Macro Definition Documentation

### 7.14.2.1 #define _base_channel_methods

**Value:**

```
_base_sequential_stream_methods                                           \
  /* Channel put method with timeout specification.*/                       \
  msg_t (*putt)(void *instance, uint8_t b, sysinterval_t time);             \
  /* Channel get method with timeout specification.*/                       \
  msg_t (*gett)(void *instance, sysinterval_t time);                        \
  /* Channel write method with timeout specification.*/                     \
  size_t (*writet)(void *instance, const uint8_t *bp,                       \
                   size_t n, sysinterval_t time);                           \
  /* Channel read method with timeout specification.*/                      \
  size_t (*readt)(void *instance, uint8_t *bp, size_t n,                    \
                  sysinterval_t time);
      \
  /* Channel control method.*/                                              \
  msg_t (*ctl)(void *instance, unsigned int operation, void *arg);
```

BaseChannel specific methods.

### 7.14.2.2 #define _base_channel_data _base_sequential_stream_data

BaseChannel specific data.

**Note**

It is empty because BaseChannel is only an interface without implementation.

#### 7.14.2.3 #define chnPutTimeout( *ip,* *b,* *time* ) ((ip)->vmt->putt(ip, b, time))

Channel blocking byte write with timeout.

This function writes a byte value to a channel. If the channel is not ready to accept data then the calling thread is suspended.

**Parameters**

| | | |
|---|---|---|
| in | *ip* | pointer to a BaseChannel or derived class |
| in | *b* | the byte value to be written to the channel |
| in | *time* | the number of ticks before the operation timeouts, the following special values are allowed:<br>• *TIME_IMMEDIATE* immediate timeout.<br>• *TIME_INFINITE* no timeout. |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *STM_OK* | if the operation succeeded. |
| *STM_TIMEOUT* | if the specified time expired. |
| *STM_RESET* | if the channel associated queue (if any) was reset. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.14.2.4 #define chnGetTimeout( *ip,* *time* ) ((ip)->vmt->gett(ip, time))

Channel blocking byte read with timeout.

This function reads a byte value from a channel. If the data is not available then the calling thread is suspended.

**Parameters**

| | | |
|---|---|---|
| in | *ip* | pointer to a BaseChannel or derived class |
| in | *time* | the number of ticks before the operation timeouts, the following special values are allowed:<br>• *TIME_IMMEDIATE* immediate timeout.<br>• *TIME_INFINITE* no timeout. |

**Returns**

A byte value from the queue.

**Return values**

| | |
|---|---|
| *STM_TIMEOUT* | if the specified time expired. |
| *STM_RESET* | if the channel associated queue (if any) has been reset. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.14.2.5 #define chnWrite( *ip, bp, n* ) streamWrite(ip, bp, n)

Channel blocking write.

The function writes data from a buffer to a channel. If the channel is not ready to accept data then the calling thread is suspended.

**Parameters**

| | | |
|---|---|---|
| in | *ip* | pointer to a `BaseChannel` or derived class |
| out | *bp* | pointer to the data buffer |
| in | *n* | the maximum amount of data to be transferred |

**Returns**

The number of bytes transferred.

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.14.2.6 #define chnWriteTimeout( *ip, bp, n, time* ) ((ip)->vmt->writet(ip, bp, n, time))

Channel blocking write with timeout.

The function writes data from a buffer to a channel. If the channel is not ready to accept data then the calling thread is suspended.

**Parameters**

| | | |
|---|---|---|
| in | *ip* | pointer to a `BaseChannel` or derived class |
| out | *bp* | pointer to the data buffer |
| in | *n* | the maximum amount of data to be transferred |
| in | *time* | the number of ticks before the operation timeouts, the following special values are allowed:<br>• *TIME_IMMEDIATE* immediate timeout.<br>• *TIME_INFINITE* no timeout. |

**Returns**

The number of bytes transferred.

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.14.2.7 #define chnRead( *ip, bp, n* ) streamRead(ip, bp, n)

Channel blocking read.

The function reads data from a channel into a buffer. If the data is not available then the calling thread is suspended.

Parameters

| | | |
|---|---|---|
| in | *ip* | pointer to a BaseChannel or derived class |
| in | *bp* | pointer to the data buffer |
| in | *n* | the maximum amount of data to be transferred |

Returns

The number of bytes transferred.

Function Class:

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.14.2.8 #define chnReadTimeout( *ip, bp, n, time* ) ((ip)->vmt->readt(ip, bp, n, time))

Channel blocking read with timeout.

The function reads data from a channel into a buffer. If the data is not available then the calling thread is suspended.

Parameters

| | | |
|---|---|---|
| in | *ip* | pointer to a BaseChannel or derived class |
| in | *bp* | pointer to the data buffer |
| in | *n* | the maximum amount of data to be transferred |
| in | *time* | the number of ticks before the operation timeouts, the following special values are allowed:<br>• *TIME_IMMEDIATE* immediate timeout.<br>• *TIME_INFINITE* no timeout. |

Returns

The number of bytes transferred.

Function Class:

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.14.2.9 #define chnControl( *ip, operation, arg* ) ((ip)->vmt->ctl(ip, operation, arg))

Control operation on a channel.

Parameters

| | | |
|---|---|---|
| in | *ip* | pointer to a BaseChannel or derived class |
| in | *operation* | control operation code |
| in,out | *arg* | operation argument |

Returns

The control operation status.

**Return values**

| | |
|---|---|
| *MSG_OK* | in case of success. |
| *MSG_TIMEOUT* | in case of operation timeout. |
| *MSG_RESET* | in case of operation reset. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

### 7.14.2.10 #define CHN_NO_ERROR (eventflags_t)0

No pending conditions.

### 7.14.2.11 #define CHN_CONNECTED (eventflags_t)1

Connection happened.

### 7.14.2.12 #define CHN_DISCONNECTED (eventflags_t)2

Disconnection happened.

### 7.14.2.13 #define CHN_INPUT_AVAILABLE (eventflags_t)4

Data available in the input queue.

### 7.14.2.14 #define CHN_OUTPUT_EMPTY (eventflags_t)8

Output queue empty.

### 7.14.2.15 #define CHN_TRANSMISSION_END (eventflags_t)16

Transmission end.

### 7.14.2.16 #define _base_asynchronous_channel_methods _base_channel_methods \

BaseAsynchronousChannel specific methods.

### 7.14.2.17 #define _base_asynchronous_channel_data

**Value:**

```
_base_channel_data                                                        \
  /* I/O condition event source.*/                                          \
  event_source_t          event;
```

BaseAsynchronousChannel specific data.

#### 7.14.2.18 #define chnGetEventSource( *ip* ) (&((ip)->event))

Returns the I/O condition event source.

The event source is broadcasted when an I/O condition happens.

**Parameters**

| | | |
|---|---|---|
| in | *ip* | pointer to a BaseAsynchronousChannel or derived class |

**Returns**

A pointer to an EventSource object.

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

### 7.14.2.19 #define chnAddFlagsI( *ip,* *flags* )

**Value:**

```
{                                          \
  osalEventBroadcastFlagsI(&(ip)->event, flags);                                \
}
```

Adds status flags to the listeners's flags mask.

This function is usually called from the I/O ISRs in order to notify I/O conditions such as data events, errors, signal changes etc.

**Parameters**

| | | |
|---|---|---|
| in | *ip* | pointer to a BaseAsynchronousChannel or derived class |
| in | *flags* | condition flags to be added to the listener flags mask |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

# 7.15 Abstract Files

## 7.15.1 Detailed Description

This module define an abstract interface for generic data files by extending the `BaseSequentialStream` interface. Note that no code is present, data files are just abstract interface-like structures, you should look at the systems as to a set of abstract C++ classes (even if written in C). This system has the advantage to make the access to streams independent from the implementation logic.
The data files interface can be used as base class for high level object types such as an API for a File System implementation.

### Macros

- #define _file_stream_methods

  *FileStream specific methods.*
- #define _file_stream_data _base_sequential_stream_data

  `FileStream` *specific data.*

### Files return codes

- #define FILE_OK STM_OK

  *No error return code.*
- #define FILE_ERROR STM_TIMEOUT

  *Error code from the file stream methods.*
- #define FILE_EOF STM_RESET

  *End-of-file condition for file get/put methods.*

### Macro Functions (FileStream)

- #define fileStreamWrite(ip, bp, n) streamWrite(ip, bp, n)

  *File stream write.*
- #define fileStreamRead(ip, bp, n) streamRead(ip, bp, n)

  *File stream read.*
- #define fileStreamPut(ip, b) streamPut(ip, b)

  *File stream blocking byte write.*
- #define fileStreamGet(ip) streamGet(ip)

  *File stream blocking byte read.*
- #define fileStreamClose(ip) ((ip)->vmt->close(ip))

  *File Stream close.*
- #define fileStreamGetError(ip) ((ip)->vmt->geterror(ip))

  *Returns an implementation dependent error code.*
- #define fileStreamGetSize(ip) ((ip)->vmt->getsize(ip))

  *Returns the current file size.*
- #define fileStreamGetPosition(ip) ((ip)->vmt->getposition(ip))

  *Returns the current file pointer position.*
- #define fileStreamSeek(ip, offset) ((ip)->vmt->lseek(ip, offset))

  *Moves the file current pointer to an absolute position.*

### Typedefs

- typedef uint32_t fileoffset_t

  *File offset type.*

## Data Structures

- struct FileStreamVMT

  *FileStream virtual methods table.*
- struct FileStream

  *Base file stream class.*

## 7.15.2 Macro Definition Documentation

### 7.15.2.1 #define FILE_OK STM_OK

No error return code.

### 7.15.2.2 #define FILE_ERROR STM_TIMEOUT

Error code from the file stream methods.

### 7.15.2.3 #define FILE_EOF STM_RESET

End-of-file condition for file get/put methods.

### 7.15.2.4 #define _file_stream_methods

**Value:**

```
_base_sequential_stream_methods                                           \
  /* File close method.*/                                                  \
  msg_t (*close)(void *instance);                                          \
  /* Get last error code method.*/                                         \
  msg_t (*geterror)(void *instance);                                       \
  /* File get size method.*/                                               \
  msg_t (*getsize)(void *instance);                                        \
  /* File get current position method.*/                                   \
  msg_t (*getposition)(void *instance);                                    \
  /* File seek method.*/                                                   \
  msg_t (*lseek)(void *instance, fileoffset_t offset);
```

FileStream specific methods.

### 7.15.2.5 #define _file_stream_data _base_sequential_stream_data

FileStream specific data.

**Note**

It is empty because FileStream is only an interface without implementation.

### 7.15.2.6 #define fileStreamWrite( *ip, bp, n* ) streamWrite(ip, bp, n)

File stream write.

The function writes data from a buffer to a file stream.

**Parameters**

| | | |
|---|---|---|
| in | *ip* | pointer to a FileStream or derived class |
| in | *bp* | pointer to the data buffer |
| in | *n* | the maximum amount of data to be transferred |

**Returns**

The number of bytes transferred. The return value can be less than the specified number of bytes if an end-of-file condition has been met.

**Return values**

| | |
|---|---|
| *FILE_ERROR* | operation failed. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.15.2.7 #define fileStreamRead( *ip*, *bp*, *n* ) streamRead(ip, bp, n)

File stream read.

The function reads data from a file stream into a buffer.

**Parameters**

| | | |
|---|---|---|
| in | *ip* | pointer to a FileStream or derived class |
| out | *bp* | pointer to the data buffer |
| in | *n* | the maximum amount of data to be transferred |

**Returns**

The number of bytes transferred. The return value can be less than the specified number of bytes if an end-of-file condition has been met.

**Return values**

| | |
|---|---|
| *FILE_ERROR* | operation failed. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.15.2.8 #define fileStreamPut( *ip*, *b* ) streamPut(ip, b)

File stream blocking byte write.

This function writes a byte value to a channel. If the channel is not ready to accept data then the calling thread is suspended.

**Parameters**

| | | |
|---|---|---|
| in | *ip* | pointer to a FileStream or derived class |
| in | *b* | the byte value to be written to the channel |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *FILE_OK* | if the operation succeeded. |
| *FILE_ERROR* | operation failed. |
| *FILE_EOF* | if an end-of-file condition has been met. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

### 7.15.2.9 #define fileStreamGet( *ip* ) streamGet(ip)

File stream blocking byte read.

This function reads a byte value from a channel. If the data is not available then the calling thread is suspended.

**Parameters**

| | | |
|---|---|---|
| `in` | *ip* | pointer to a `FileStream` or derived class |

**Returns**

A byte value from the queue.

**Return values**

| | |
|---|---|
| *FILE_ERROR* | operation failed. |
| *FILE_EOF* | if an end-of-file condition has been met. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

### 7.15.2.10 #define fileStreamClose( *ip* ) ((ip)->vmt->close(ip))

File Stream close.

The function closes a file stream.

**Parameters**

| | | |
|---|---|---|
| `in` | *ip* | pointer to a `FileStream` or derived class |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *FILE_OK* | no error. |
| *FILE_ERROR* | operation failed. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.15.2.11 #define fileStreamGetError( *ip* ) ((ip)->vmt->geterror(ip))

Returns an implementation dependent error code.

**Precondition**

The previously called function must have returned `FILE_ERROR`.

**Parameters**

| | | |
|---|---|---|
| in | *ip* | pointer to a `FileStream` or derived class |

**Returns**

Implementation dependent error code.

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.15.2.12 #define fileStreamGetSize( *ip* ) ((ip)->vmt->getsize(ip))

Returns the current file size.

**Parameters**

| | | |
|---|---|---|
| in | *ip* | pointer to a `FileStream` or derived class |

**Returns**

The file size.

**Return values**

| | |
|---|---|
| *FILE_ERROR* | operation failed. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.15.2.13 #define fileStreamGetPosition( *ip* ) ((ip)->vmt->getposition(ip))

Returns the current file pointer position.

**Parameters**

| | | |
|---|---|---|
| in | *ip* | pointer to a FileStream or derived class |

**Returns**

The current position inside the file.

**Return values**

| | |
|---|---|
| *FILE_ERROR* | operation failed. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.15.2.14 #define fileStreamSeek( *ip,* *offset* ) ((ip)->vmt->lseek(ip, offset))

Moves the file current pointer to an absolute position.

**Parameters**

| | | |
|---|---|---|
| in | *ip* | pointer to a FileStream or derived class |
| in | *offset* | new absolute position |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *FILE_OK* | no error. |
| *FILE_ERROR* | operation failed. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

### 7.15.3 Typedef Documentation

#### 7.15.3.1 typedef uint32_t fileoffset_t

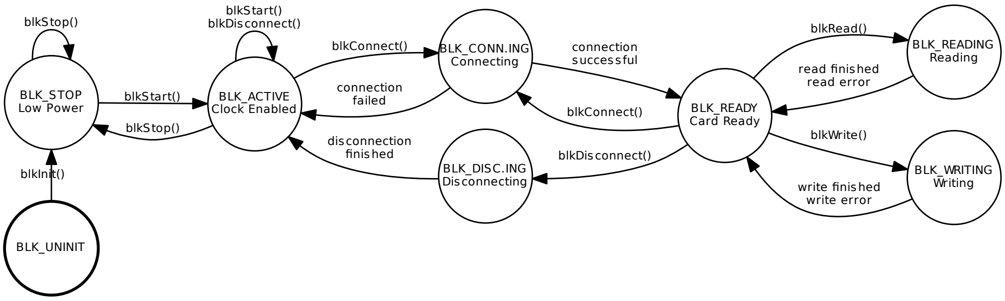
File offset type.

# 7.16 Abstract I/O Block Device

## 7.16.1 Detailed Description

## 7.16.2 Driver State Machine

The drivers implementing this interface shall implement the following state machine internally. Not all the driver functionalities can be used in any moment, any transition not explicitly shown in the following diagram has to be considered an error and shall be captured by an assertion (if enabled).



This module defines an abstract interface for accessing generic block devices.
Note that no code is present, just abstract interfaces-like structures, you should look at the system as to a set of abstract C++ classes (even if written in C). This system has then advantage to make the access to block devices independent from the implementation logic.

### Macros

- #define _base_block_device_methods

  *`BaseBlockDevice` specific methods.*
- #define _base_block_device_data

  *`BaseBlockDevice` specific data.*

### Macro Functions (BaseBlockDevice)

- #define blkGetDriverState(ip) ((ip)->state)

  *Returns the driver state.*
- #define blkIsTransferring(ip)

  *Determines if the device is transferring data.*
- #define blkIsInserted(ip) ((ip)->vmt->is_inserted(ip))

  *Returns the media insertion status.*
- #define blkIsWriteProtected(ip) ((ip)->vmt->is_protected(ip))

  *Returns the media write protection status.*
- #define blkConnect(ip) ((ip)->vmt->connect(ip))

  *Performs the initialization procedure on the block device.*
- #define blkDisconnect(ip) ((ip)->vmt->disconnect(ip))

*Terminates operations on the block device.*

- #define blkRead(ip, startblk, buf, n) ((ip)->vmt->read(ip, startblk, buf, n))

  *Reads one or more blocks.*

- #define blkWrite(ip, startblk, buf, n) ((ip)->vmt->write(ip, startblk, buf, n))

  *Writes one or more blocks.*

- #define blkSync(ip) ((ip)->vmt->sync(ip))

  *Ensures write synchronization.*

- #define blkGetInfo(ip, bdip) ((ip)->vmt->get_info(ip, bdip))

  *Returns a media information structure.*

## Data Structures

- struct BlockDeviceInfo

  *Block device info.*

- struct BaseBlockDeviceVMT

  *BaseBlockDevice virtual methods table.*

- struct BaseBlockDevice

  *Base block device class.*

## Enumerations

## 7.16.3 Macro Definition Documentation

### 7.16.3.1 #define _base_block_device_methods

**Value:**

```
_base_object_methods                                                    \
  /* Removable media detection.*/                                         \
  bool (*is_inserted)(void *instance);                                    \
  /* Removable write protection detection.*/                              \
  bool (*is_protected)(void *instance);                                   \
  /* Connection to the block device.*/                                    \
  bool (*connect)(void *instance);                                        \
  /* Disconnection from the block device.*/                               \
  bool (*disconnect)(void *instance);                                     \
  /* Reads one or more blocks.*/                                          \
  bool (*read)(void *instance, uint32_t startblk,                         \
               uint8_t *buffer, uint32_t n);                              \
  /* Writes one or more blocks.*/                                         \
  bool (*write)(void *instance, uint32_t startblk,                        \
                const uint8_t *buffer, uint32_t n);                       \
  /* Write operations synchronization.*/                                  \
  bool (*sync)(void *instance);                                           \
  /* Obtains info about the media.*/                                      \
  bool (*get_info)(void *instance, BlockDeviceInfo *bdip);
```

BaseBlockDevice specific methods.

### 7.16.3.2 #define _base_block_device_data

**Value:**

```
_base_object_data                                                       \
  /* Driver state.*/                                                      \
  blkstate_t            state;
```

BaseBlockDevice specific data.

#### 7.16.3.3 #define blkGetDriverState( *ip* ) ((ip)->state)

Returns the driver state.

**Note**

Can be called in ISR context.

**Parameters**

| | | |
|---|---|---|
| in | *ip* | pointer to a BaseBlockDevice or derived class |

**Returns**

The driver state.

**Function Class:**

Special function, this function has special requirements see the notes.

#### 7.16.3.4 #define blkIsTransferring( *ip* )

**Value:**

```
((((ip)->state) == BLK_CONNECTING) ||          \
                         (((ip)->state) == BLK_DISCONNECTING) ||       \
                         (((ip)->state) == BLK_READING) ||             \
                         (((ip)->state) == BLK_WRITING))
```

Determines if the device is transferring data.

**Note**

Can be called in ISR context.

**Parameters**

| | | |
|---|---|---|
| in | *ip* | pointer to a BaseBlockDevice or derived class |

**Returns**

The driver state.

**Return values**

| | |
|---|---|
| *false* | the device is not transferring data. |
| *true* | the device not transferring data. |

**Function Class:**

Special function, this function has special requirements see the notes.

#### 7.16.3.5 #define blkIsInserted( *ip* ) ((ip)->vmt->is_inserted(ip))

Returns the media insertion status.

**Note**

On some implementations this function can only be called if the device is not transferring data. The function `blkIsTransferring()` should be used before calling this function.

**Parameters**

| | | |
|---|---|---|
| `in` | *ip* | pointer to a `BaseBlockDevice` or derived class |

**Returns**

The media state.

**Return values**

| | |
|---|---|
| *false* | media not inserted. |
| *true* | media inserted. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.16.3.6 #define blkIsWriteProtected( *ip* ) ((ip)->vmt->is_protected(ip))

Returns the media write protection status.

**Parameters**

| | | |
|---|---|---|
| `in` | *ip* | pointer to a `BaseBlockDevice` or derived class |

**Returns**

The media state.

**Return values**

| | |
|---|---|
| *false* | writable media. |
| *true* | non writable media. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.16.3.7 #define blkConnect( *ip* ) ((ip)->vmt->connect(ip))

Performs the initialization procedure on the block device.

This function should be performed before I/O operations can be attempted on the block device and after insertion has been confirmed using `blkIsInserted()`.

**Parameters**

| | | |
|---|---|---|
| in | *ip* | pointer to a `BaseBlockDevice` or derived class |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *HAL_SUCCESS* | operation succeeded. |
| *HAL_FAILED* | operation failed. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.16.3.8 #define blkDisconnect( *ip* ) ((ip)->vmt->disconnect(ip))

Terminates operations on the block device.

This operation safely terminates operations on the block device.

**Parameters**

| | | |
|---|---|---|
| in | *ip* | pointer to a `BaseBlockDevice` or derived class |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *HAL_SUCCESS* | operation succeeded. |
| *HAL_FAILED* | operation failed. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.16.3.9 #define blkRead( *ip,* *startblk,* *buf,* *n* ) ((ip)->vmt->read(ip, startblk, buf, n))

Reads one or more blocks.

**Parameters**

| | | |
|---|---|---|
| in | *ip* | pointer to a `BaseBlockDevice` or derived class |
| in | *startblk* | first block to read |

**Parameters**

| | | |
|---|---|---|
| out | *buf* | pointer to the read buffer |
| in | *n* | number of blocks to read |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *HAL_SUCCESS* | operation succeeded. |
| *HAL_FAILED* | operation failed. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

### 7.16.3.10 #define blkWrite( *ip,* *startblk,* *buf,* *n* ) ((ip)->vmt->write(ip, startblk, buf, n))

Writes one or more blocks.

**Parameters**

| | | |
|---|---|---|
| in | *ip* | pointer to a `BaseBlockDevice` or derived class |
| in | *startblk* | first block to write |
| out | *buf* | pointer to the write buffer |
| in | *n* | number of blocks to write |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *HAL_SUCCESS* | operation succeeded. |
| *HAL_FAILED* | operation failed. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

### 7.16.3.11 #define blkSync( *ip* ) ((ip)->vmt->sync(ip))

Ensures write synchronization.

**Parameters**

| | | |
|---|---|---|
| in | *ip* | pointer to a `BaseBlockDevice` or derived class |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *HAL_SUCCESS* | operation succeeded. |
| *HAL_FAILED* | operation failed. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.16.3.12 #define blkGetInfo( *ip, bdip* ) ((ip)->vmt->get_info(ip, bdip))

Returns a media information structure.

**Parameters**

| | | |
|---|---|---|
| in | *ip* | pointer to a BaseBlockDevice or derived class |
| out | *bdip* | pointer to a BlockDeviceInfo structure |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *HAL_SUCCESS* | operation succeeded. |
| *HAL_FAILED* | operation failed. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

### 7.16.4 Enumeration Type Documentation

#### 7.16.4.1 enum blkstate_t

Driver state machine possible states.

**Enumerator**

***BLK_UNINIT*** Not initialized.
***BLK_STOP*** Stopped.
***BLK_ACTIVE*** Interface active.
***BLK_CONNECTING*** Connection in progress.
***BLK_DISCONNECTING*** Disconnection in progress.
***BLK_READY*** Device ready.
***BLK_READING*** Read operation in progress.
***BLK_WRITING*** Write operation in progress.
***BLK_SYNCING*** Sync. operation in progress.

## 7.17 Base Object

### 7.17.1 Detailed Description

HAL uses concepts of Object Oriented Programming even if it is written in C. Things like simple inheritance, multiple inheritance and interfaces are used through the system. This module defines a "base object" that is the ancestor of all classes in the system.

### Macros

- #define _base_object_methods

  *BaseObject specific methods.*
- #define _base_object_data

  *BaseObject specific data.*

### Macro Functions (BaseObject)

- #define objGetInstance(type, ip) (type)(((size_t)(ip)) - (ip)->vmt->instance_offset)

  *Returns the instance pointer starting from an interface pointer.*

### Data Structures

- struct BaseObjectVMT

  *BaseObject virtual methods table.*
- struct BaseObject

  *Base stream class.*

### 7.17.2 Macro Definition Documentation

#### 7.17.2.1 #define _base_object_methods

**Value:**

```
/* Instance offset, used for multiple inheritance, normally zero. It
     represents the offset between the current object and the container
     object*/                                                              \
  size_t instance_offset;
```

BaseObject specific methods.

**Note**

This object defines no methods.

#### 7.17.2.2 #define _base_object_data

BaseObject specific data.

**Note**

This object defines no data.

#### 7.17.2.3 #define objGetInstance( *type*, *ip* ) (type)(((size_t)(ip)) - (ip)->vmt->instance_offset)

Returns the instance pointer starting from an interface pointer.

**Parameters**

| | | |
|---|---|---|
| in | *type* | the type of the instance pointer, it is used for casting |
| in | *ip* | the interface pointer |

**Returns**

A pointer to the object implementing the interface

## 7.18 Abstract Peripheral Interfaces

HAL Abstract Peripheral Interfaces.

### 7.18.1 Detailed Description

HAL Abstract Peripheral Interfaces.

#### Modules

- Generic Accelerometer Interface

  *HAL Generic Accelerometer Interface.*
- Generic Barometer Interface

  *HAL Generic Barometer Interface.*
- Generic Compass Interface

  *HAL Generic Compass Interface.*
- Generic Flash Driver Interface

  *HAL Generic Flash Driver Interface.*
- Generic Gyroscope Interface

  *HAL Generic Gyroscope Interface.*
- Generic Hygrometer Interface

  *HAL Generic Hygrometer Interface.*
- JESD216 Compliant Flash Driver Interface

  *HAL JESD216 Compliant Flash Driver Interface.*
- Generic Sensor Interface

  *HAL Generic Sensor Interface.*
- Generic Thermometer Interface

  *HAL Generic Thermometer Interface.*

## 7.19 I/O Bytes Queues

### 7.19.1 Detailed Description

Queues are mostly used in serial-like device drivers. Serial device drivers are usually designed to have a lower side (lower driver, it is usually an interrupt service routine) and an upper side (upper driver, accessed by the application threads).
There are several kind of queues:

- **Input queue**, unidirectional queue where the writer is the lower side and the reader is the upper side.
- **Output queue**, unidirectional queue where the writer is the upper side and the reader is the lower side.
- **Full duplex queue**, bidirectional queue. Full duplex queues are implemented by pairing an input queue and an output queue together.

### Queue functions returned status value

- #define Q_OK MSG_OK

  *Operation successful.*
- #define Q_TIMEOUT MSG_TIMEOUT

  *Timeout condition.*
- #define Q_RESET MSG_RESET

  *Queue has been reset.*
- #define Q_EMPTY MSG_TIMEOUT

  *Queue empty.*
- #define Q_FULL MSG_TIMEOUT

  *Queue full,.*

### Macro Functions

- #define qSizeX(qp)

  *Returns the queue's buffer size.*
- #define qSpaceI(qp) ((qp)->q_counter)

  *Queue space.*
- #define qGetLink(qp) ((qp)->q_link)

  *Returns the queue application-defined link.*
- #define iqGetFullI(iqp) qSpaceI(iqp)

  *Returns the filled space into an input queue.*
- #define iqGetEmptyI(iqp) (qSizeX(iqp) - qSpaceI(iqp))

  *Returns the empty space into an input queue.*
- #define iqIsEmptyI(iqp) ((bool)(qSpaceI(iqp) == 0U))

  *Evaluates to `true` if the specified input queue is empty.*
- #define iqIsFullI(iqp)

  *Evaluates to `true` if the specified input queue is full.*
- #define iqGet(iqp) iqGetTimeout(iqp, TIME_INFINITE)

  *Input queue read.*
- #define oqGetFullI(oqp) (qSizeX(oqp) - qSpaceI(oqp))

  *Returns the filled space into an output queue.*
- #define oqGetEmptyI(oqp) qSpaceI(oqp)

  *Returns the empty space into an output queue.*

- #define oqIsEmptyI(oqp)

  *Evaluates to `true` if the specified output queue is empty.*
- #define oqIsFullI(oqp) ((bool)(qSpaceI(oqp) == 0U))

  *Evaluates to `true` if the specified output queue is full.*
- #define oqPut(oqp, b) oqPutTimeout(oqp, b, TIME_INFINITE)

  *Output queue write.*

## Typedefs

- typedef struct io_queue io_queue_t

  *Type of a generic I/O queue structure.*
- typedef void(∗ qnotify_t) (io_queue_t ∗qp)

  *Queue notification callback type.*
- typedef io_queue_t input_queue_t

  *Type of an input queue structure.*
- typedef io_queue_t output_queue_t

  *Type of an output queue structure.*

## Data Structures

- struct io_queue

  *Generic I/O queue structure.*

## Functions

- static size_t iq_read (input_queue_t ∗iqp, uint8_t ∗bp, size_t n)

  *Non-blocking input queue read.*
- static size_t oq_write (output_queue_t ∗oqp, const uint8_t ∗bp, size_t n)

  *Non-blocking output queue write.*
- void iqObjectInit (input_queue_t ∗iqp, uint8_t ∗bp, size_t size, qnotify_t infy, void ∗link)

  *Initializes an input queue.*
- void iqResetI (input_queue_t ∗iqp)

  *Resets an input queue.*
- msg_t iqPutI (input_queue_t ∗iqp, uint8_t b)

  *Input queue write.*
- msg_t iqGetI (input_queue_t ∗iqp)

  *Input queue non-blocking read.*
- msg_t iqGetTimeout (input_queue_t ∗iqp, sysinterval_t timeout)

  *Input queue read with timeout.*
- size_t iqReadI (input_queue_t ∗iqp, uint8_t ∗bp, size_t n)

  *Input queue non-blocking read.*
- size_t iqReadTimeout (input_queue_t ∗iqp, uint8_t ∗bp, size_t n, sysinterval_t timeout)

  *Input queue read with timeout.*
- void oqObjectInit (output_queue_t ∗oqp, uint8_t ∗bp, size_t size, qnotify_t onfy, void ∗link)

  *Initializes an output queue.*
- void oqResetI (output_queue_t ∗oqp)

  *Resets an output queue.*
- msg_t oqPutI (output_queue_t ∗oqp, uint8_t b)

  *Output queue non-blocking write.*
- msg_t oqPutTimeout (output_queue_t ∗oqp, uint8_t b, sysinterval_t timeout)

*Output queue write with timeout.*

- msg_t oqGetI (output_queue_t ∗oqp)

  *Output queue read.*
- size_t oqWriteI (output_queue_t ∗oqp, const uint8_t ∗bp, size_t n)

  *Output queue non-blocking write.*
- size_t oqWriteTimeout (output_queue_t ∗oqp, const uint8_t ∗bp, size_t n, sysinterval_t timeout)

  *Output queue write with timeout.*

## 7.19.2 Macro Definition Documentation

### 7.19.2.1 #define Q_OK MSG_OK

Operation successful.

### 7.19.2.2 #define Q_TIMEOUT MSG_TIMEOUT

Timeout condition.

### 7.19.2.3 #define Q_RESET MSG_RESET

Queue has been reset.

### 7.19.2.4 #define Q_EMPTY MSG_TIMEOUT

Queue empty.

### 7.19.2.5 #define Q_FULL MSG_TIMEOUT

Queue full,.

### 7.19.2.6 #define qSizeX( *qp* )

**Value:**

```
/*lint -save -e9033 [10.8] The cast is safe.*/                              \
  ((size_t)((qp)->q_top - (qp)->q_buffer))                                    \
  /*lint -restore*/
```

Returns the queue's buffer size.

**Parameters**

| | | |
|---|---|---|
| in | *qp* | pointer to a `io_queue_t` structure |

**Returns**

The buffer size.

**Function Class:**

This is an **X-Class** API, this function can be invoked from any context.

#### 7.19.2.7 #define qSpaceI( *qp* ) ((qp)->q_counter)

Queue space.

Returns the used space if used on an input queue or the empty space if used on an output queue.

**Parameters**

| | | |
|---|---|---|
| in | *qp* | pointer to a `io_queue_t` structure |

**Returns**

The buffer space.

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

#### 7.19.2.8 #define qGetLink( *qp* ) ((qp)->q_link)

Returns the queue application-defined link.

**Note**

This function can be called in any context.

**Parameters**

| | | |
|---|---|---|
| in | *qp* | pointer to a `io_queue_t` structure |

**Returns**

The application-defined link.

**Function Class:**

Special function, this function has special requirements see the notes.

#### 7.19.2.9 #define iqGetFullI( *iqp* ) qSpaceI(iqp)

Returns the filled space into an input queue.

**Parameters**

| | | |
|---|---|---|
| in | *iqp* | pointer to an `input_queue_t` structure |

**Returns**

The number of full bytes in the queue.

**Return values**

| | |
|---|---|
| *0* | if the queue is empty. |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

#### 7.19.2.10 #define iqGetEmptyI( *iqp* ) (qSizeX(iqp) - qSpaceI(iqp))

Returns the empty space into an input queue.

**Parameters**

| | | |
|---|---|---|
| `in` | *iqp* | pointer to an `input_queue_t` structure |

**Returns**

The number of empty bytes in the queue.

**Return values**

| | |
|---|---|
| *0* | if the queue is full. |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

#### 7.19.2.11 #define iqIsEmptyI( *iqp* ) ((bool)(qSpaceI(iqp) == 0U))

Evaluates to `true` if the specified input queue is empty.

**Parameters**

| | | |
|---|---|---|
| `in` | *iqp* | pointer to an `input_queue_t` structure |

**Returns**

The queue status.

**Return values**

| | |
|---|---|
| *false* | if the queue is not empty. |
| *true* | if the queue is empty. |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt

handlers.

#### 7.19.2.12 #define iqIsFullI( *iqp* )

**Value:**

```
/*lint -save -e9007 [13.5] No side effects, a pointer is passed.*/        \
  ((bool)(((iqp)->q_wrptr == (iqp)->q_rdptr) && ((iqp)->q_counter != 0U)))  \
  /*lint -restore*/
```

Evaluates to `true` if the specified input queue is full.

**Parameters**

| | | |
|---|---|---|
| in | *iqp* | pointer to an `input_queue_t` structure |

**Returns**

The queue status.

**Return values**

| | |
|---|---|
| *false* | if the queue is not full. |
| *true* | if the queue is full. |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

#### 7.19.2.13 #define iqGet( *iqp* ) iqGetTimeout(iqp, TIME_INFINITE)

Input queue read.

This function reads a byte value from an input queue. If the queue is empty then the calling thread is suspended until a byte arrives in the queue.

**Parameters**

| | | |
|---|---|---|
| in | *iqp* | pointer to an `input_queue_t` structure |

**Returns**

A byte value from the queue.

**Return values**

| | |
|---|---|
| *MSG_RESET* | if the queue has been reset. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.19.2.14 #define oqGetFullI( *oqp* ) (qSizeX(oqp) - qSpaceI(oqp))

Returns the filled space into an output queue.

**Parameters**

| | | |
|---|---|---|
| in | *oqp* | pointer to an `output_queue_t` structure |

**Returns**

The number of full bytes in the queue.

**Return values**

| | |
|---|---|
| *0* | if the queue is empty. |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

#### 7.19.2.15 #define oqGetEmptyI( *oqp* ) qSpaceI(oqp)

Returns the empty space into an output queue.

**Parameters**

| | | |
|---|---|---|
| in | *oqp* | pointer to an `output_queue_t` structure |

**Returns**

The number of empty bytes in the queue.

**Return values**

| | |
|---|---|
| *0* | if the queue is full. |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

#### 7.19.2.16 #define oqIsEmptyI( *oqp* )

**Value:**

```
/*lint -save -e9007 [13.5] No side effects, a pointer is passed.*/        \
  ((bool)(((oqp)->q_wrptr == (oqp)->q_rdptr) && ((oqp)->q_counter != 0U)))  \
  /*lint -restore*/
```

Evaluates to `true` if the specified output queue is empty.

**Parameters**

| | | |
|---|---|---|
| in | *oqp* | pointer to an `output_queue_t` structure |

**Returns**

The queue status.

**Return values**

| | |
|---|---|
| *false* | if the queue is not empty. |
| *true* | if the queue is empty. |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

#### 7.19.2.17 #define oqIsFullI( *oqp* ) ((bool)(qSpaceI(oqp) == 0U))

Evaluates to `true` if the specified output queue is full.

**Parameters**

| | | |
|---|---|---|
| in | *oqp* | pointer to an `output_queue_t` structure |

**Returns**

The queue status.

**Return values**

| | |
|---|---|
| *false* | if the queue is not full. |
| *true* | if the queue is full. |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

#### 7.19.2.18 #define oqPut( *oqp, b* ) oqPutTimeout(oqp, b, TIME_INFINITE)

Output queue write.

This function writes a byte value to an output queue. If the queue is full then the calling thread is suspended until there is space in the queue.

**Parameters**

| | | |
|---|---|---|
| in | *oqp* | pointer to an `output_queue_t` structure |
| in | *b* | the byte value to be written in the queue |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *MSG_OK* | if the operation succeeded. |
| *MSG_RESET* | if the queue has been reset. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

## 7.19.3 Typedef Documentation

### 7.19.3.1 typedef struct io_queue io_queue_t

Type of a generic I/O queue structure.

### 7.19.3.2 typedef void(∗ qnotify_t) (io_queue_t ∗qp)

Queue notification callback type.

**Parameters**

| | | |
|---|---|---|
| in | *qp* | the queue pointer |

### 7.19.3.3 typedef io_queue_t input_queue_t

Type of an input queue structure.

This structure represents a generic asymmetrical input queue. Writing to the queue is non-blocking and can be performed from interrupt handlers or from within a kernel lock zone. Reading the queue can be a blocking operation and is supposed to be performed by a system thread.

### 7.19.3.4 typedef io_queue_t output_queue_t

Type of an output queue structure.

This structure represents a generic asymmetrical output queue. Reading from the queue is non-blocking and can be performed from interrupt handlers or from within a kernel lock zone. Writing the queue can be a blocking operation and is supposed to be performed by a system thread.

## 7.19.4 Function Documentation

### 7.19.4.1 static size_t iq_read ( input_queue_t ∗ *iqp,* uint8_t ∗ *bp,* size_t *n* ) [static]

Non-blocking input queue read.

The function reads data from an input queue into a buffer. The operation completes when the specified amount of data has been transferred or when the input queue has been emptied.

**Parameters**

| | | |
|---|---|---|
| in | *iqp* | pointer to an `input_queue_t` structure |
| out | *bp* | pointer to the data buffer |
| in | *n* | the maximum amount of data to be transferred, the value 0 is reserved |

**Returns**

The number of bytes effectively transferred.

**Function Class:**

Not an API, this function is for internal use only.

#### 7.19.4.2 static size_t oq_write ( output_queue_t * *oqp*, const uint8_t * *bp*, size_t *n* ) [static]

Non-blocking output queue write.

The function writes data from a buffer to an output queue. The operation completes when the specified amount of data has been transferred or when the output queue has been filled.

**Parameters**

| | | |
|---|---|---|
| in | *oqp* | pointer to an `output_queue_t` structure |
| in | *bp* | pointer to the data buffer |
| in | *n* | the maximum amount of data to be transferred, the value 0 is reserved |

**Returns**

The number of bytes effectively transferred.

**Function Class:**

Not an API, this function is for internal use only.

#### 7.19.4.3 void iqObjectInit ( input_queue_t * *iqp*, uint8_t * *bp*, size_t *size*, qnotify_t *infy*, void * *link* )

Initializes an input queue.

A Semaphore is internally initialized and works as a counter of the bytes contained in the queue.

**Note**

The callback is invoked from within the S-Locked system state.

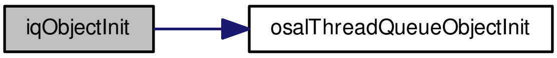
**Parameters**

| | | |
|---|---|---|
| out | *iqp* | pointer to an `input_queue_t` structure |
| in | *bp* | pointer to a memory area allocated as queue buffer |
| in | *size* | size of the queue buffer |
| in | *infy* | pointer to a callback function that is invoked when data is read from the queue. The value can be `NULL`. |
| in | *link* | application defined pointer |

**Function Class:**

Initializer, this function just initializes an object and can be invoked before the kernel is initialized.

Here is the call graph for this function:



#### 7.19.4.4 void iqResetI ( input_queue_t * *iqp* )

Resets an input queue.

All the data in the input queue is erased and lost, any waiting thread is resumed with status `MSG_RESET`.

**Note**

A reset operation can be used by a low level driver in order to obtain immediate attention from the high level layers.

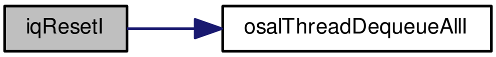
**Parameters**

| | | |
|---|---|---|
| in | *iqp* | pointer to an `input_queue_t` structure |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

Here is the call graph for this function:



#### 7.19.4.5 msg_t iqPutI ( input_queue_t * *iqp*, uint8_t *b* )

Input queue write.

A byte value is written into the low end of an input queue. The operation completes immediately.

**Parameters**

| | | |
|---|---|---|
| in | *iqp* | pointer to an `input_queue_t` structure |
| in | *b* | the byte value to be written in the queue |

**Returns**

The operation status.

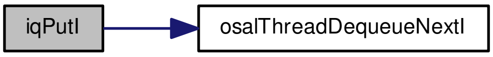
**Return values**

| | |
|---|---|
| *MSG_OK* | if the operation has been completed with success. |
| *MSG_TIMEOUT* | if the queue is full. |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

Here is the call graph for this function:



### 7.19.4.6 msg_t iqGetI ( input_queue_t * *iqp* )

Input queue non-blocking read.

This function reads a byte value from an input queue. The operation completes immediately.

**Note**

The callback is invoked after removing a character from the queue.

**Parameters**

| | | |
|---|---|---|
| in | *iqp* | pointer to an `input_queue_t` structure |

**Returns**

A byte value from the queue.

**Return values**

| | |
|---|---|
| *MSG_TIMEOUT* | if the queue is empty. |
| *MSG_RESET* | if the queue has been reset. |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

### 7.19.4.7 msg_t iqGetTimeout ( input_queue_t ∗ *iqp,* sysinterval_t *timeout* )

Input queue read with timeout.

This function reads a byte value from an input queue. If the queue is empty then the calling thread is suspended until a byte arrives in the queue or a timeout occurs.

**Note**

The callback is invoked after removing a character from the queue.

**Parameters**

| | | |
|---|---|---|
| `in` | *iqp* | pointer to an `input_queue_t` structure |
| `in` | *timeout* | the number of ticks before the operation timeouts, the following special values are allowed:<br>• *TIME_IMMEDIATE* immediate timeout.<br>• *TIME_INFINITE* no timeout. |

**Returns**

A byte value from the queue.

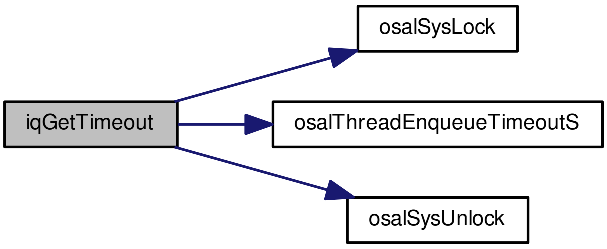
**Return values**

| | |
|---|---|
| *MSG_TIMEOUT* | if the specified time expired. |
| *MSG_RESET* | if the queue has been reset. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.19.4.8 size_t iqReadI ( input_queue_t ∗ *iqp,* uint8_t ∗ *bp,* size_t *n* )

Input queue non-blocking read.

The function reads data from an input queue into a buffer. The operation completes immediately.

**Parameters**

| | | |
|---|---|---|
| in | *iqp* | pointer to an `input_queue_t` structure |
| out | *bp* | pointer to the data buffer |
| in | *n* | the maximum amount of data to be transferred, the value 0 is reserved |

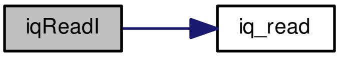
**Returns**

The number of bytes effectively transferred.

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

Here is the call graph for this function:



#### 7.19.4.9 size_t iqReadTimeout ( input_queue_t ∗ *iqp,* uint8_t ∗ *bp,* size_t *n,* sysinterval_t *timeout* )

Input queue read with timeout.

The function reads data from an input queue into a buffer. The operation completes when the specified amount of data has been transferred or after the specified timeout or if the queue has been reset.

**Note**

The function is not atomic, if you need atomicity it is suggested to use a semaphore or a mutex for mutual exclusion.
The callback is invoked after removing each character from the queue.

**Parameters**

| | | |
|---|---|---|
| in | *iqp* | pointer to an `input_queue_t` structure |
| out | *bp* | pointer to the data buffer |
| in | *n* | the maximum amount of data to be transferred, the value 0 is reserved |
| in | *timeout* | the number of ticks before the operation timeouts, the following special values are allowed:<br>• *TIME_IMMEDIATE* immediate timeout.<br>• *TIME_INFINITE* no timeout. |

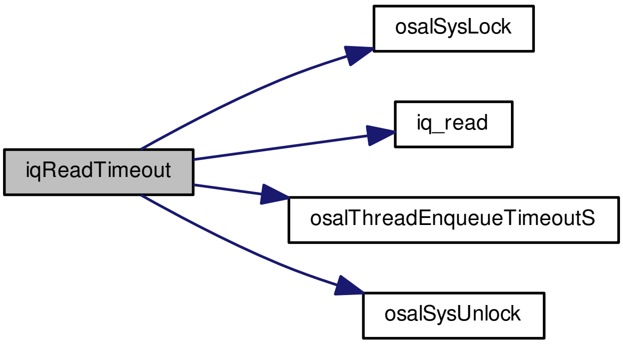
**Returns**

The number of bytes effectively transferred.

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



### 7.19.4.10 void oqObjectInit ( output_queue_t * *oqp*, uint8_t * *bp*, size_t *size*, qnotify_t *onfy*, void * *link* )

Initializes an output queue.

A Semaphore is internally initialized and works as a counter of the free bytes in the queue.

**Note**

The callback is invoked from within the S-Locked system state.

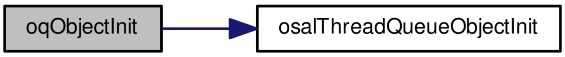
**Parameters**

| | | |
|---|---|---|
| out | *oqp* | pointer to an `output_queue_t` structure |
| in | *bp* | pointer to a memory area allocated as queue buffer |
| in | *size* | size of the queue buffer |
| in | *onfy* | pointer to a callback function that is invoked when data is written to the queue. The value can be `NULL`. |
| in | *link* | application defined pointer |

**Function Class:**

Initializer, this function just initializes an object and can be invoked before the kernel is initialized.

Here is the call graph for this function:



#### 7.19.4.11 void oqResetI ( **output_queue_t** ∗ *oqp* )

Resets an output queue.

All the data in the output queue is erased and lost, any waiting thread is resumed with status `MSG_RESET`.

**Note**

A reset operation can be used by a low level driver in order to obtain immediate attention from the high level layers.

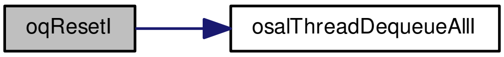
**Parameters**

| | | |
|---|---|---|
| `in` | *oqp* | pointer to an `output_queue_t` structure |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

Here is the call graph for this function:



#### 7.19.4.12 msg_t oqPutI ( **output_queue_t** ∗ *oqp*, uint8_t *b* )

Output queue non-blocking write.

This function writes a byte value to an output queue. The operation completes immediately.

**Parameters**

| | | |
|---|---|---|
| `in` | *oqp* | pointer to an `output_queue_t` structure |
| `in` | *b* | the byte value to be written in the queue |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *MSG_OK* | if the operation succeeded. |
| *MSG_TIMEOUT* | if the queue is full. |
| *MSG_RESET* | if the queue has been reset. |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

#### 7.19.4.13 msg_t oqPutTimeout ( output_queue_t * *oqp*, uint8_t *b*, sysinterval_t *timeout* )

Output queue write with timeout.

This function writes a byte value to an output queue. If the queue is full then the calling thread is suspended until there is space in the queue or a timeout occurs.

**Note**

The callback is invoked after putting the character into the queue.

**Parameters**

| | | |
|---|---|---|
| in | *oqp* | pointer to an `output_queue_t` structure |
| in | *b* | the byte value to be written in the queue |
| in | *timeout* | the number of ticks before the operation timeouts, the following special values are allowed:<br>• *TIME_IMMEDIATE* immediate timeout.<br>• *TIME_INFINITE* no timeout. |

**Returns**

The operation status.

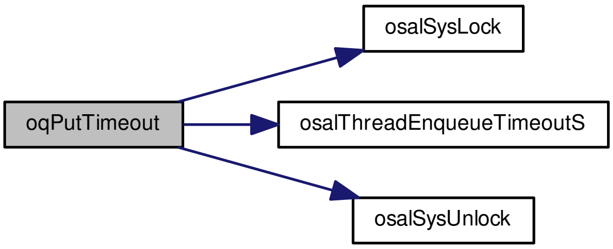
**Return values**

| | |
|---|---|
| *MSG_OK* | if the operation succeeded. |
| *MSG_TIMEOUT* | if the specified time expired. |
| *MSG_RESET* | if the queue has been reset. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.19.4.14 msg_t oqGetI ( output_queue_t * oqp )

Output queue read.

A byte value is read from the low end of an output queue. The operation completes immediately.

**Parameters**

| | | |
|---|---|---|
| in | *oqp* | pointer to an `output_queue_t` structure |

**Returns**

The byte value from the queue.

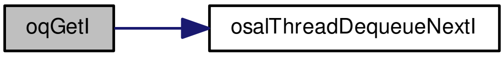
**Return values**

| | |
|---|---|
| *MSG_TIMEOUT* | if the queue is empty. |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

Here is the call graph for this function:



#### 7.19.4.15 size_t oqWriteI ( output_queue_t ∗ *oqp,* const uint8_t ∗ *bp,* size_t *n* )

Output queue non-blocking write.

The function writes data from a buffer to an output queue. The operation completes immediately.

**Parameters**

| | | |
|---|---|---|
| in | *oqp* | pointer to an `output_queue_t` structure |
| in | *bp* | pointer to the data buffer |
| in | *n* | the maximum amount of data to be transferred, the value 0 is reserved |

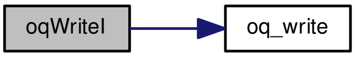
**Returns**

The number of bytes effectively transferred.

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

Here is the call graph for this function:



#### 7.19.4.16 size_t oqWriteTimeout ( output_queue_t ∗ *oqp,* const uint8_t ∗ *bp,* size_t *n,* sysinterval_t *timeout* )

Output queue write with timeout.

The function writes data from a buffer to an output queue. The operation completes when the specified amount of data has been transferred or after the specified timeout or if the queue has been reset.

**Note**

The function is not atomic, if you need atomicity it is suggested to use a semaphore or a mutex for mutual exclusion.
The callback is invoked after putting each character into the queue.

**Parameters**

| | | |
|---|---|---|
| in | *oqp* | pointer to an `output_queue_t` structure |
| in | *bp* | pointer to the data buffer |
| in | *n* | the maximum amount of data to be transferred, the value 0 is reserved |
| in | *timeout* | the number of ticks before the operation timeouts, the following special values are allowed:<br>• *TIME_IMMEDIATE* immediate timeout.<br>• *TIME_INFINITE* no timeout. |

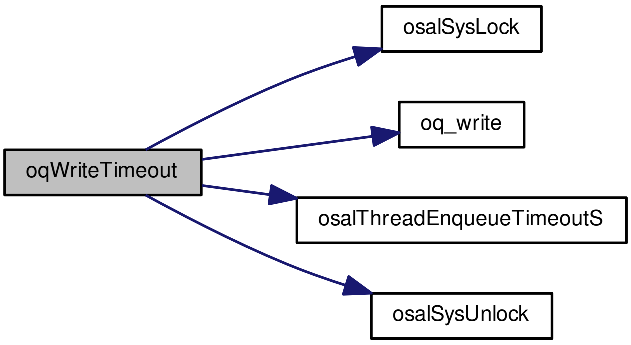
**Returns**

The number of bytes effectively transferred.

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



## 7.20 Abstract Streams

### 7.20.1 Detailed Description

This module define an abstract interface for generic data streams. Note that no code is present, just abstract interfaces-like structures, you should look at the system as to a set of abstract C++ classes (even if written in C). This system has then advantage to make the access to data streams independent from the implementation logic.

The stream interface can be used as base class for high level object types such as files, sockets, serial ports, pipes etc.

### Macros

- #define _base_sequential_stream_methods

  *BaseSequentialStream specific methods.*
- #define _base_sequential_stream_data _base_object_data

  `BaseSequentialStream` *specific data.*

### Streams return codes

- #define **STM_OK** MSG_OK
- #define **STM_TIMEOUT** MSG_TIMEOUT
- #define **STM_RESET** MSG_RESET

### Macro Functions (BaseSequentialStream)

- #define streamWrite(ip, bp, n) ((ip)->vmt->write(ip, bp, n))

  *Sequential Stream write.*
- #define streamRead(ip, bp, n) ((ip)->vmt->read(ip, bp, n))

  *Sequential Stream read.*
- #define streamPut(ip, b) ((ip)->vmt->put(ip, b))

  *Sequential Stream blocking byte write.*
- #define streamGet(ip) ((ip)->vmt->get(ip))

  *Sequential Stream blocking byte read.*

### Data Structures

- struct BaseSequentialStreamVMT

  `BaseSequentialStream` *virtual methods table.*
- struct BaseSequentialStream

  *Base stream class.*

### 7.20.2 Macro Definition Documentation

#### 7.20.2.1 #define _base_sequential_stream_methods

**Value:**

```
_base_object_methods                                                  \
  /* Stream write buffer method.*/                                      \
  size_t (*write)(void *instance, const uint8_t *bp, size_t n);         \
  /* Stream read buffer method.*/                                       \
  size_t (*read)(void *instance, uint8_t *bp, size_t n);                \
  /* Channel put method, blocking.*/                                    \
  msg_t (*put)(void *instance, uint8_t b);                                    \
  /* Channel get method, blocking.*/                                          \
  msg_t (*get)(void *instance);                                               \
```

BaseSequentialStream specific methods.

#### 7.20.2.2 #define _base_sequential_stream_data _base_object_data

BaseSequentialStream specific data.

**Note**

It is empty because BaseSequentialStream is only an interface without implementation.

#### 7.20.2.3 #define streamWrite( *ip,* *bp,* *n* ) ((ip)->vmt->write(ip, bp, n))

Sequential Stream write.

The function writes data from a buffer to a stream.

**Parameters**

| | | |
|---|---|---|
| in | *ip* | pointer to a BaseSequentialStream or derived class |
| in | *bp* | pointer to the data buffer |
| in | *n* | the maximum amount of data to be transferred |

**Returns**

The number of bytes transferred. The return value can be less than the specified number of bytes if an end-of-file condition has been met.

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.20.2.4 #define streamRead( *ip,* *bp,* *n* ) ((ip)->vmt->read(ip, bp, n))

Sequential Stream read.

The function reads data from a stream into a buffer.

**Parameters**

| | | |
|---|---|---|
| in | *ip* | pointer to a BaseSequentialStream or derived class |
| out | *bp* | pointer to the data buffer |
| in | *n* | the maximum amount of data to be transferred |

**Returns**

The number of bytes transferred. The return value can be less than the specified number of bytes if an end-of-file condition has been met.

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.20.2.5 #define streamPut( *ip,* *b* ) ((ip)->vmt->put(ip, b))

Sequential Stream blocking byte write.

This function writes a byte value to a channel. If the channel is not ready to accept data then the calling thread is suspended.

**Parameters**

| | | |
|---|---|---|
| in | *ip* | pointer to a BaseChannel or derived class |
| in | *b* | the byte value to be written to the channel |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *STM_OK* | if the operation succeeded. |
| *STM_RESET* | if an end-of-file condition has been met. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.20.2.6 #define streamGet( *ip* ) ((ip)->vmt->get(ip))

Sequential Stream blocking byte read.

This function reads a byte value from a channel. If the data is not available then the calling thread is suspended.

**Parameters**

| | | |
|---|---|---|
| in | *ip* | pointer to a BaseChannel or derived class |

**Returns**

A byte value from the queue.

**Return values**

| | |
|---|---|
| *STM_RESET* | if an end-of-file condition has been met. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

## 7.21 Generic Hygrometer Interface

HAL Generic Hygrometer Interface.

### 7.21.1 Detailed Description

HAL Generic Hygrometer Interface.

#### Macros

- #define _base_hygrometer_methods_alone

  *BaseHygrometer specific methods.*
- #define _base_hygrometer_methods

  *BaseHygrometer specific methods with inherited ones.*
- #define _base_hygrometer_data _base_sensor_data

  *`BaseHygrometer` specific data.*

#### Macro Functions (BaseHygrometer)

- #define hygrometerGetChannelsNumber(ip) (ip)->vmt->get_channels_number(ip)

  *Hygrometer get channels number.*
- #define hygrometerReadRaw(ip, dp) (ip)->vmt->read_raw(ip, dp)

  *Hygrometer read raw data.*
- #define hygrometerReadCooked(ip, dp) (ip)->vmt->read_cooked(ip, dp)

  *Hygrometer read cooked data.*
- #define hygrometerSetBias(ip, bp) (ip)->vmt->set_bias(ip, bp)

  *Updates hygrometer bias data from received buffer.*
- #define hygrometerResetBias(ip) (ip)->vmt->reset_bias(ip)

  *Reset hygrometer bias data restoring it to zero.*
- #define hygrometerSetSensitivity(ip, sp) (ip)->vmt->set_sensitivity(ip, sp)

  *Updates hygrometer sensitivity data from received buffer.*
- #define hygrometerResetSensitivity(ip) (ip)->vmt->reset_sensitivity(ip)

  *Reset hygrometer sensitivity data restoring it to its typical value.*

#### Data Structures

- struct BaseHygrometerVMT

  *`BaseHygrometer` virtual methods table.*
- struct BaseHygrometer

  *Base hygrometer class.*

### 7.21.2 Macro Definition Documentation

#### 7.21.2.1 #define _base_hygrometer_methods_alone

**Value:**

```
/* Invoke the set bias procedure.*/                                     \
  msg_t (*set_bias)(void *instance, float biases[]);                      \
  /* Remove bias stored data.*/                                           \
  msg_t (*reset_bias)(void *instance);                                    \
  /* Invoke the set sensitivity procedure.*/                              \
  msg_t (*set_sensitivity)(void *instance, float sensitivities[]);        \
  /* Restore sensitivity stored data to default.*/                        \
  msg_t (*reset_sensitivity)(void *instance);
```

BaseHygrometer specific methods.

#### 7.21.2.2 #define _base_hygrometer_methods

**Value:**

```
_base_sensor_methods                                                    \
  _base_hygrometer_methods_alone
```

BaseHygrometer specific methods with inherited ones.

#### 7.21.2.3 #define _base_hygrometer_data _base_sensor_data

BaseHygrometer specific data.

#### 7.21.2.4 #define hygrometerGetChannelsNumber( *ip* ) (ip)->vmt->get_channels_number(ip)

Hygrometer get channels number.

**Parameters**

| | | |
|---|---|---|
| in | *ip* | pointer to a BaseHygrometer class. |

**Returns**

The number of channels of the BaseHygrometer

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.21.2.5 #define hygrometerReadRaw( *ip, dp* ) (ip)->vmt->read_raw(ip, dp)

Hygrometer read raw data.

**Parameters**

| | | |
|---|---|---|
| in | *ip* | pointer to a BaseHygrometer class. |
| in | *dp* | pointer to a data array. |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *MSG_OK* | if the function succeeded. |
| *MSG_RESET* | if one or more errors occurred. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.21.2.6 #define hygrometerReadCooked( *ip,* *dp* ) (ip)->vmt->read_cooked(ip, dp)

Hygrometer read cooked data.

**Parameters**

| | | |
|---|---|---|
| in | *ip* | pointer to a `BaseHygrometer` class. |
| in | *dp* | pointer to a data array. |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *MSG_OK* | if the function succeeded. |
| *MSG_RESET* | if one or more errors occurred. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.21.2.7 #define hygrometerSetBias( *ip,* *bp* ) (ip)->vmt->set_bias(ip, bp)

Updates hygrometer bias data from received buffer.

**Note**

The bias buffer must have the same length of the the hygrometer channels number.

**Parameters**

| | | |
|---|---|---|
| in | *ip* | pointer to a `BaseHygrometer` class. |
| in | *bp* | pointer to a buffer of bias values. |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *MSG_OK* | if the function succeeded. |
| *MSG_RESET* | if one or more errors occurred. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.21.2.8 #define hygrometerResetBias( *ip* ) (ip)->vmt->reset_bias(ip)

Reset hygrometer bias data restoring it to zero.

**Parameters**

| | | |
|---|---|---|
| in | *ip* | pointer to a BaseHygrometer class. |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *MSG_OK* | if the function succeeded. |
| *MSG_RESET* | if one or more errors occurred. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.21.2.9 #define hygrometerSetSensitivity( *ip*, *sp* ) (ip)->vmt->set_sensitivity(ip, sp)

Updates hygrometer sensitivity data from received buffer.

**Note**

The sensitivity buffer must have the same length of the the hygrometer channels number.

**Parameters**

| | | |
|---|---|---|
| in | *ip* | pointer to a BaseHygrometer class. |
| in | *sp* | pointer to a buffer of sensitivity values. |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *MSG_OK* | if the function succeeded. |
| *MSG_RESET* | if one or more errors occurred. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.21.2.10 #define hygrometerResetSensitivity( *ip* ) (ip)->vmt->reset_sensitivity(ip)

Reset hygrometer sensitivity data restoring it to its typical value.

**Parameters**

| | | |
|---|---|---|
| in | *ip* | pointer to a `BaseHygrometer` class. |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *MSG_OK* | if the function succeeded. |
| *MSG_RESET* | if one or more errors occurred. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

## 7.22 I2C Driver

Generic I2C Driver.

### 7.22.1 Detailed Description

Generic I2C Driver.

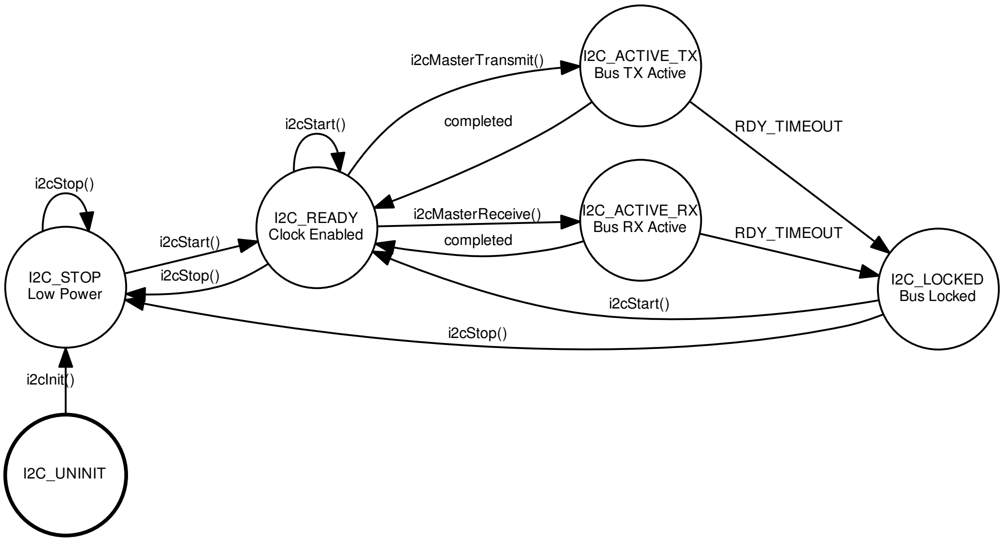
This module implements a generic I2C (Inter-Integrated Circuit) driver.

#### Precondition

In order to use the I2C driver the `HAL_USE_I2C` option must be enabled in `halconf.h`.

### 7.22.2 Driver State Machine

The driver implements a state machine internally, not all the driver functionalities can be used in any moment, any transition not explicitly shown in the following diagram has to be considered an error and shall be captured by an assertion (if enabled).



The driver is not thread safe for performance reasons, if you need to access the I2C bus from multiple threads then use the `i2cAcquireBus()` and `i2cReleaseBus()` APIs in order to gain exclusive access.

## Macros

- #define I2C_USE_MUTUAL_EXCLUSION TRUE

  *Enables the mutual exclusion APIs on the I2C bus.*
- #define _i2c_wakeup_isr(i2cp)

  *Wakes up the waiting thread notifying no errors.*
- #define _i2c_wakeup_error_isr(i2cp)

*Wakes up the waiting thread notifying errors.*

- #define i2cMasterTransmit(i2cp, addr, txbuf, txbytes, rxbuf, rxbytes)

  *Wrap i2cMasterTransmitTimeout function with TIME_INFINITE timeout.*
- #define i2cMasterReceive(i2cp, addr, rxbuf, rxbytes) (i2cMasterReceiveTimeout(i2cp, addr, rxbuf, rxbytes, TIME_INFINITE))

  *Wrap i2cMasterReceiveTimeout function with TIME_INFINITE timeout.*
- #define i2c_lld_get_errors(i2cp) ((i2cp)->errors)

  *Get errors from I2C driver.*

## I2C bus error conditions

- #define I2C_NO_ERROR 0x00

  *No error.*
- #define I2C_BUS_ERROR 0x01

  *Bus Error.*
- #define I2C_ARBITRATION_LOST 0x02

  *Arbitration Lost.*
- #define I2C_ACK_FAILURE 0x04

  *Acknowledge Failure.*
- #define I2C_OVERRUN 0x08

  *Overrun/Underrun.*
- #define I2C_PEC_ERROR 0x10

  *PEC Error in reception.*
- #define I2C_TIMEOUT 0x20

  *Hardware timeout.*
- #define I2C_SMB_ALERT 0x40

  *SMBus Alert.*

## PLATFORM configuration options

- #define PLATFORM_I2C_USE_I2C1 FALSE

  *I2C1 driver enable switch.*

## Typedefs

- typedef uint16_t i2caddr_t

  *Type representing an I2C address.*
- typedef uint32_t i2cflags_t

  *Type of I2C Driver condition flags.*
- typedef struct I2CDriver I2CDriver

  *Type of a structure representing an I2C driver.*

## Data Structures

- struct I2CConfig

  *Type of I2C driver configuration structure.*
- struct I2CDriver

  *Structure representing an I2C driver.*

### Functions

- void i2cInit (void)

  *I2C Driver initialization.*
- void i2cObjectInit (I2CDriver ∗i2cp)

  *Initializes the standard part of a `I2CDriver` structure.*
- void i2cStart (I2CDriver ∗i2cp, const I2CConfig ∗config)

  *Configures and activates the I2C peripheral.*
- void i2cStop (I2CDriver ∗i2cp)

  *Deactivates the I2C peripheral.*
- i2cflags_t i2cGetErrors (I2CDriver ∗i2cp)

  *Returns the errors mask associated to the previous operation.*
- msg_t i2cMasterTransmitTimeout (I2CDriver ∗i2cp, i2caddr_t addr, const uint8_t ∗txbuf, size_t txbytes, uint8_t ∗rxbuf, size_t rxbytes, sysinterval_t timeout)

  *Sends data via the I2C bus.*
- msg_t i2cMasterReceiveTimeout (I2CDriver ∗i2cp, i2caddr_t addr, uint8_t ∗rxbuf, size_t rxbytes, sysinterval↩_t timeout)

  *Receives data from the I2C bus.*
- void i2cAcquireBus (I2CDriver ∗i2cp)

  *Gains exclusive access to the I2C bus.*
- void i2cReleaseBus (I2CDriver ∗i2cp)

  *Releases exclusive access to the I2C bus.*
- void i2c_lld_init (void)

  *Low level I2C driver initialization.*
- void i2c_lld_start (I2CDriver ∗i2cp)

  *Configures and activates the I2C peripheral.*
- void i2c_lld_stop (I2CDriver ∗i2cp)

  *Deactivates the I2C peripheral.*
- msg_t i2c_lld_master_receive_timeout (I2CDriver ∗i2cp, i2caddr_t addr, uint8_t ∗rxbuf, size_t rxbytes, sysinterval_t timeout)

  *Receives data via the I2C bus as master.*
- msg_t i2c_lld_master_transmit_timeout (I2CDriver ∗i2cp, i2caddr_t addr, const uint8_t ∗txbuf, size_t txbytes, uint8_t ∗rxbuf, size_t rxbytes, sysinterval_t timeout)

  *Transmits data via the I2C bus as master.*

### Enumerations

### Variables

- I2CDriver I2CD1

  *I2C1 driver identifier.*

## 7.22.3 Macro Definition Documentation

### 7.22.3.1 #define I2C_NO_ERROR 0x00

No error.

### 7.22.3.2 #define I2C_BUS_ERROR 0x01

Bus Error.

#### 7.22.3.3 #define I2C_ARBITRATION_LOST 0x02

Arbitration Lost.

#### 7.22.3.4 #define I2C_ACK_FAILURE 0x04

Acknowledge Failure.

#### 7.22.3.5 #define I2C_OVERRUN 0x08

Overrun/Underrun.

#### 7.22.3.6 #define I2C_PEC_ERROR 0x10

PEC Error in reception.

#### 7.22.3.7 #define I2C_TIMEOUT 0x20

Hardware timeout.

#### 7.22.3.8 #define I2C_SMB_ALERT 0x40

SMBus Alert.

#### 7.22.3.9 #define I2C_USE_MUTUAL_EXCLUSION TRUE

Enables the mutual exclusion APIs on the I2C bus.

#### 7.22.3.10 #define _i2c_wakeup_isr( *i2cp* )

**Value:**

```
do {                                              \
  osalSysLockFromISR();
      \
  osalThreadResumeI(&(i2cp)->thread, MSG_OK);
      \
  osalSysUnlockFromISR();                                                      \
} while(0)
```

Wakes up the waiting thread notifying no errors.

**Parameters**

| | | |
|---|---|---|
| in | *i2cp* | pointer to the I2CDriver object |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.22.3.11 #define _i2c_wakeup_error_isr( *i2cp* )

**Value:**

```
do {                                    \
  osalSysLockFromISR();
      \
  osalThreadResumeI(&(i2cp)->thread, MSG_RESET);
      \
  osalSysUnlockFromISR();                                                 \
} while(0)
```

Wakes up the waiting thread notifying errors.

**Parameters**

| | | |
|---|---|---|
| in | *i2cp* | pointer to the I2CDriver object |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.22.3.12 #define i2cMasterTransmit( *i2cp, addr, txbuf, txbytes, rxbuf, rxbytes* )

**Value:**

```
(i2cMasterTransmitTimeout(i2cp, addr, txbuf, txbytes, rxbuf, rxbytes,     \
                              TIME_INFINITE))
```

Wrap i2cMasterTransmitTimeout function with TIME_INFINITE timeout.

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.22.3.13 #define i2cMasterReceive( *i2cp, addr, rxbuf, rxbytes* ) (i2cMasterReceiveTimeout(i2cp, addr, rxbuf, rxbytes, TIME_INFINITE))

Wrap i2cMasterReceiveTimeout function with TIME_INFINITE timeout.

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.22.3.14 #define PLATFORM_I2C_USE_I2C1 FALSE

I2C1 driver enable switch.

If set to `TRUE` the support for I2C1 is included.

**Note**

The default is `FALSE`.

#### 7.22.3.15 #define i2c_lld_get_errors( *i2cp* ) ((i2cp)->errors)

Get errors from I2C driver.

**Parameters**

| | | |
|---|---|---|
| in | *i2cp* | pointer to the I2CDriver object |

**Function Class:**

Not an API, this function is for internal use only.

## 7.22.4 Typedef Documentation

### 7.22.4.1 typedef uint16_t i2caddr_t

Type representing an I2C address.

### 7.22.4.2 typedef uint32_t i2cflags_t

Type of I2C Driver condition flags.

### 7.22.4.3 typedef struct I2CDriver I2CDriver

Type of a structure representing an I2C driver.

## 7.22.5 Enumeration Type Documentation

### 7.22.5.1 enum i2cstate_t

Driver state machine possible states.

**Enumerator**

***I2C_UNINIT*** Not initialized.

***I2C_STOP*** Stopped.

***I2C_READY*** Ready.

***I2C_ACTIVE_TX*** Transmitting.

***I2C_ACTIVE_RX*** Receiving.

## 7.22.6 Function Documentation

### 7.22.6.1 void i2cInit ( void )

I2C Driver initialization.

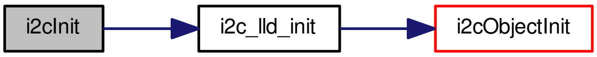
**Note**

This function is implicitly invoked by `halInit()`, there is no need to explicitly initialize the driver.

**Function Class:**

Initializer, this function just initializes an object and can be invoked before the kernel is initialized.

Here is the call graph for this function:



#### 7.22.6.2 void i2cObjectInit ( I2CDriver ∗ *i2cp* )

Initializes the standard part of a I2CDriver structure.

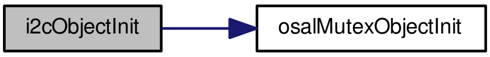
**Parameters**

| | | |
|---|---|---|
| out | *i2cp* | pointer to the I2CDriver object |

**Function Class:**

Initializer, this function just initializes an object and can be invoked before the kernel is initialized.

Here is the call graph for this function:



#### 7.22.6.3 void i2cStart ( I2CDriver ∗ *i2cp*, const I2CConfig ∗ *config* )

Configures and activates the I2C peripheral.

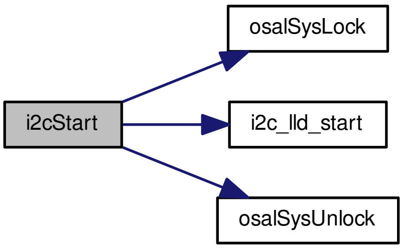
**Parameters**

| | | |
|---|---|---|
| in | *i2cp* | pointer to the I2CDriver object |
| in | *config* | pointer to the I2CConfig object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.22.6.4 void i2cStop ( I2CDriver ∗ *i2cp* )

Deactivates the I2C peripheral.

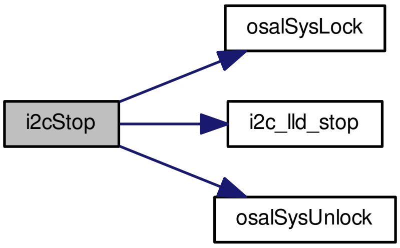
**Parameters**

| | | |
|---|---|---|
| in | *i2cp* | pointer to the `I2CDriver` object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.22.6.5 i2cflags_t i2cGetErrors ( I2CDriver ∗ *i2cp* )

Returns the errors mask associated to the previous operation.

**Parameters**

| | | |
|---|---|---|
| in | *i2cp* | pointer to the I2CDriver object |

**Returns**

The errors mask.

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.22.6.6 msg_t i2cMasterTransmitTimeout ( I2CDriver ∗ *i2cp*, i2caddr_t *addr*, const uint8_t ∗ *txbuf*, size_t *txbytes*, uint8_t ∗ *rxbuf*, size_t *rxbytes*, sysinterval_t *timeout* )

Sends data via the I2C bus.

Function designed to realize "read-through-write" transfer paradigm. If you want transmit data without any further read, than set **rxbytes** field to 0.

**Parameters**

| | | |
|---|---|---|
| in | *i2cp* | pointer to the I2CDriver object |
| in | *addr* | slave device address (7 bits) without R/W bit |
| in | *txbuf* | pointer to transmit buffer |
| in | *txbytes* | number of bytes to be transmitted |
| out | *rxbuf* | pointer to receive buffer |
| in | *rxbytes* | number of bytes to be received, set it to 0 if you want transmit only |
| in | *timeout* | the number of ticks before the operation timeouts, the following special values are allowed:<br>• *TIME_INFINITE* no timeout. |

**Returns**

The operation status.

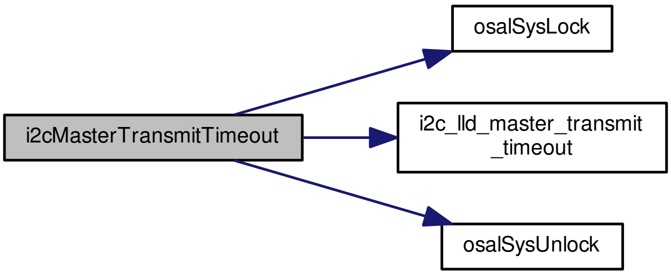
**Return values**

| | |
|---|---|
| *MSG_OK* | if the function succeeded. |
| *MSG_RESET* | if one or more I2C errors occurred, the errors can be retrieved using i2cGetErrors(). |
| *MSG_TIMEOUT* | if a timeout occurred before operation end. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



### 7.22.6.7 msg_t i2cMasterReceiveTimeout ( I2CDriver * *i2cp,* i2caddr_t *addr,* uint8_t * *rxbuf,* size_t *rxbytes,* sysinterval_t *timeout* )

Receives data from the I2C bus.

**Parameters**

| | | |
|---|---|---|
| in | *i2cp* | pointer to the `I2CDriver` object |
| in | *addr* | slave device address (7 bits) without R/W bit |
| out | *rxbuf* | pointer to receive buffer |
| in | *rxbytes* | number of bytes to be received |
| in | *timeout* | the number of ticks before the operation timeouts, the following special values are allowed:<br>• *TIME_INFINITE* no timeout. |

**Returns**

The operation status.

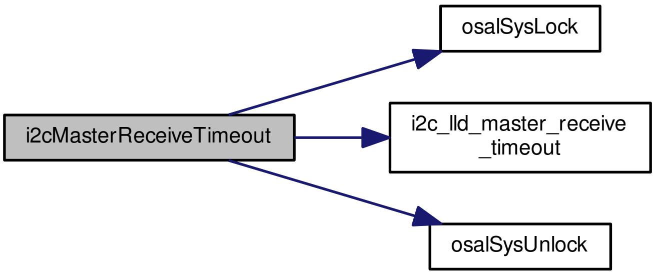
**Return values**

| | |
|---|---|
| *MSG_OK* | if the function succeeded. |
| *MSG_RESET* | if one or more I2C errors occurred, the errors can be retrieved using `i2cGetErrors()`. |
| *MSG_TIMEOUT* | if a timeout occurred before operation end. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.22.6.8 void i2cAcquireBus ( I2CDriver * *i2cp* )

Gains exclusive access to the I2C bus.

This function tries to gain ownership to the I2C bus, if the bus is already being used then the invoking thread is queued.

**Precondition**

In order to use this function the option `I2C_USE_MUTUAL_EXCLUSION` must be enabled.

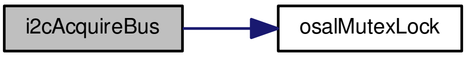
**Parameters**

| | | |
|---|---|---|
| in | *i2cp* | pointer to the `I2CDriver` object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.22.6.9 void i2cReleaseBus ( I2CDriver * *i2cp* )

Releases exclusive access to the I2C bus.

**Precondition**

In order to use this function the option `I2C_USE_MUTUAL_EXCLUSION` must be enabled.

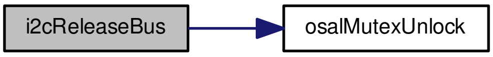
**Parameters**

| | | |
|---|---|---|
| in | *i2cp* | pointer to the `I2CDriver` object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



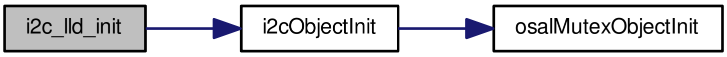
#### 7.22.6.10 void i2c_lld_init ( void )

Low level I2C driver initialization.

**Function Class:**

Not an API, this function is for internal use only.

Here is the call graph for this function:



#### 7.22.6.11 void i2c_lld_start ( I2CDriver * *i2cp* )

Configures and activates the I2C peripheral.

**Parameters**

| | | |
|---|---|---|
| in | *i2cp* | pointer to the `I2CDriver` object |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.22.6.12 void i2c_lld_stop ( I2CDriver * *i2cp* )

Deactivates the I2C peripheral.

**Parameters**

| | | |
|---|---|---|
| in | *i2cp* | pointer to the `I2CDriver` object |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.22.6.13 msg_t i2c_lld_master_receive_timeout ( I2CDriver * *i2cp*, i2caddr_t *addr*, uint8_t * *rxbuf*, size_t *rxbytes*, sysinterval_t *timeout* )

Receives data via the I2C bus as master.

**Parameters**

| | | |
|---|---|---|
| in | *i2cp* | pointer to the `I2CDriver` object |
| in | *addr* | slave device address |
| out | *rxbuf* | pointer to the receive buffer |
| in | *rxbytes* | number of bytes to be received |
| in | *timeout* | the number of ticks before the operation timeouts, the following special values are allowed:<br>• *TIME_INFINITE* no timeout. |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *MSG_OK* | if the function succeeded. |
| *MSG_RESET* | if one or more I2C errors occurred, the errors can be retrieved using `i2cGetErrors()`. |
| *MSG_TIMEOUT* | if a timeout occurred before operation end. **After a timeout the driver must be stopped and restarted because the bus is in an uncertain state**. |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.22.6.14 msg_t i2c_lld_master_transmit_timeout ( I2CDriver * *i2cp*, i2caddr_t *addr*, const uint8_t * *txbuf*, size_t *txbytes*, uint8_t * *rxbuf*, size_t *rxbytes*, sysinterval_t *timeout* )

Transmits data via the I2C bus as master.

**Parameters**

| | | |
|---|---|---|
| `in` | *i2cp* | pointer to the `I2CDriver` object |
| `in` | *addr* | slave device address |
| `in` | *txbuf* | pointer to the transmit buffer |
| `in` | *txbytes* | number of bytes to be transmitted |
| `out` | *rxbuf* | pointer to the receive buffer |
| `in` | *rxbytes* | number of bytes to be received |
| `in` | *timeout* | the number of ticks before the operation timeouts, the following special values are allowed:<br>• *TIME_INFINITE* no timeout. |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *MSG_OK* | if the function succeeded. |
| *MSG_RESET* | if one or more I2C errors occurred, the errors can be retrieved using `i2cGetErrors()`. |
| *MSG_TIMEOUT* | if a timeout occurred before operation end. **After a timeout the driver must be stopped and restarted because the bus is in an uncertain state**. |

**Function Class:**

Not an API, this function is for internal use only.

## 7.22.7 Variable Documentation

### 7.22.7.1 I2CDriver I2CD1

I2C1 driver identifier.

## 7.23 I2S Driver

Generic I2S Driver.

### 7.23.1 Detailed Description

Generic I2S Driver.

This module implements a generic I2S driver.

#### Precondition

In order to use the I2S driver the `HAL_USE_I2S` option must be enabled in `halconf.h`.

### 7.23.2 Driver State Machine

#### I2S modes

- #define **I2S_MODE_SLAVE** 0
- #define **I2S_MODE_MASTER** 1

#### Macro Functions

- #define i2sStartExchangeI(i2sp)

  *Starts a I2S data exchange.*
- #define i2sStopExchangeI(i2sp)

  *Stops the ongoing data exchange.*
- #define _i2s_isr_half_code(i2sp)

  *Common ISR code, half buffer event.*
- #define _i2s_isr_full_code(i2sp)

  *Common ISR code.*

#### PLATFORM configuration options

- #define PLATFORM_I2S_USE_I2S1 FALSE

  *I2SD1 driver enable switch.*

#### Typedefs

- typedef struct I2SDriver I2SDriver

  *Type of a structure representing an I2S driver.*
- typedef void(∗ i2scallback_t) (I2SDriver ∗i2sp, size_t offset, size_t n)

  *I2S notification callback type.*

#### Data Structures

- struct I2SConfig

  *Driver configuration structure.*
- struct I2SDriver

  *Structure representing an I2S driver.*

## Functions

- void i2sInit (void)

  *I2S Driver initialization.*
- void i2sObjectInit (I2SDriver ∗i2sp)

  *Initializes the standard part of a `I2SDriver` structure.*
- void i2sStart (I2SDriver ∗i2sp, const I2SConfig ∗config)

  *Configures and activates the I2S peripheral.*
- void i2sStop (I2SDriver ∗i2sp)

  *Deactivates the I2S peripheral.*
- void i2sStartExchange (I2SDriver ∗i2sp)

  *Starts a I2S data exchange.*
- void i2sStopExchange (I2SDriver ∗i2sp)

  *Stops the ongoing data exchange.*
- void i2s_lld_init (void)

  *Low level I2S driver initialization.*
- void i2s_lld_start (I2SDriver ∗i2sp)

  *Configures and activates the I2S peripheral.*
- void i2s_lld_stop (I2SDriver ∗i2sp)

  *Deactivates the I2S peripheral.*
- void i2s_lld_start_exchange (I2SDriver ∗i2sp)

  *Starts a I2S data exchange.*
- void i2s_lld_stop_exchange (I2SDriver ∗i2sp)

  *Stops the ongoing data exchange.*

## Enumerations

## Variables

- I2SDriver I2SD1

  *I2S2 driver identifier.*

## 7.23.3 Macro Definition Documentation

### 7.23.3.1 #define i2sStartExchangeI( *i2sp* )

**Value:**

```
{                                                   \
  i2s_lld_start_exchange(i2sp);                                                \
  (i2sp)->state = I2S_ACTIVE;                                                  \
}
```

Starts a I2S data exchange.

**Parameters**

| | | |
|---|---|---|
| in | *i2sp* | pointer to the `I2SDriver` object |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

### 7.23.3.2 #define i2sStopExchangeI( *i2sp* )

**Value:**

```
{                                             \
  i2s_lld_stop_exchange(i2sp);                                      \
  (i2sp)->state = I2S_READY;                                        \
}
```

Stops the ongoing data exchange.

The ongoing data exchange, if any, is stopped, if the driver was not active the function does nothing.

**Parameters**

| | | |
|---|---|---|
| in | *i2sp* | pointer to the I2SDriver object |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

### 7.23.3.3 #define _i2s_isr_half_code( *i2sp* )

**Value:**

```
{                                           \
  if ((i2sp)->config->end_cb != NULL) {                             \
    (i2sp)->config->end_cb(i2sp, 0, (i2sp)->config->size / 2);      \
  }                                                                 \
}
```

Common ISR code, half buffer event.

This code handles the portable part of the ISR code:

- Callback invocation.

**Note**

This macro is meant to be used in the low level drivers implementation only.

**Parameters**

| | | |
|---|---|---|
| in | *i2sp* | pointer to the I2CDriver object |

**Function Class:**

Not an API, this function is for internal use only.

### 7.23.3.4 #define _i2s_isr_full_code( *i2sp* )

**Value:**

```
{                                                \
  if ((i2sp)->config->end_cb) {                                     \
    (i2sp)->state = I2S_COMPLETE;                                           \
    (i2sp)->config->end_cb(i2sp,                                            \
                           (i2sp)->config->size / 2,                        \
                           (i2sp)->config->size / 2);                       \
    if ((i2sp)->state == I2S_COMPLETE)                                      \
      (i2sp)->state = I2S_READY;                                            \
  }                                                                         \
  else                                                                      \
    (i2sp)->state = I2S_READY;                                              \
}
```

Common ISR code.

This code handles the portable part of the ISR code:

- Callback invocation.
- Driver state transitions.

**Note**

This macro is meant to be used in the low level drivers implementation only.

**Parameters**

| | | |
|---|---|---|
| in | *i2sp* | pointer to the I2CDriver object |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.23.3.5 #define PLATFORM_I2S_USE_I2S1 FALSE

I2SD1 driver enable switch.

If set to TRUE the support for I2S1 is included.

**Note**

The default is FALSE.

### 7.23.4 Typedef Documentation

#### 7.23.4.1 typedef struct I2SDriver I2SDriver

Type of a structure representing an I2S driver.

#### 7.23.4.2 typedef void(∗ i2scallback_t) (I2SDriver ∗i2sp, size_t offset, size_t n)

I2S notification callback type.

**Parameters**

| | | |
|---|---|---|
| in | *i2sp* | pointer to the I2SDriver object |
| in | *offset* | offset in buffers of the data to read/write |
| in | *n* | number of samples to read/write |

## 7.23.5 Enumeration Type Documentation

### 7.23.5.1 enum i2sstate_t

Driver state machine possible states.

**Enumerator**

- ***I2S_UNINIT*** Not initialized.
- ***I2S_STOP*** Stopped.
- ***I2S_READY*** Ready.
- ***I2S_ACTIVE*** Active.
- ***I2S_COMPLETE*** Transmission complete.

## 7.23.6 Function Documentation

### 7.23.6.1 void i2sInit ( void )

I2S Driver initialization.

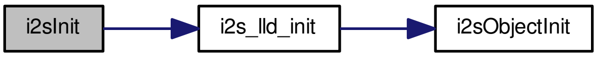
**Note**

> This function is implicitly invoked by `halInit()`, there is no need to explicitly initialize the driver.

**Function Class:**

> Initializer, this function just initializes an object and can be invoked before the kernel is initialized.

Here is the call graph for this function:



### 7.23.6.2 void i2sObjectInit ( **I2SDriver** ∗ *i2sp* )

Initializes the standard part of a `I2SDriver` structure.

**Parameters**

| | | |
|---|---|---|
| `out` | *i2sp* | pointer to the `I2SDriver` object |

**Function Class:**

> Initializer, this function just initializes an object and can be invoked before the kernel is initialized.

### 7.23.6.3 void i2sStart ( I2SDriver ∗ *i2sp*, const I2SConfig ∗ *config* )

Configures and activates the I2S peripheral.

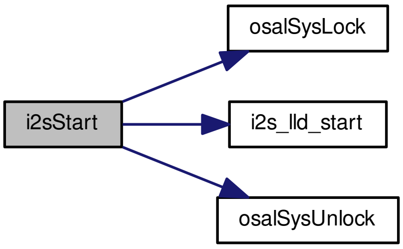
**Parameters**

| | | |
|---|---|---|
| `in` | *i2sp* | pointer to the `I2SDriver` object |
| `in` | *config* | pointer to the `I2SConfig` object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



### 7.23.6.4 void i2sStop ( I2SDriver ∗ *i2sp* )

Deactivates the I2S peripheral.

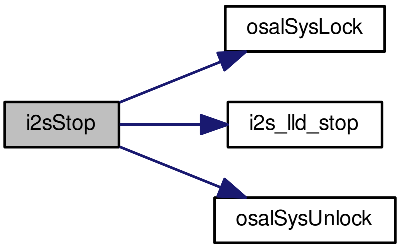
**Parameters**

| | | |
|---|---|---|
| `in` | *i2sp* | pointer to the `I2SDriver` object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.23.6.5 void i2sStartExchange ( I2SDriver * *i2sp* )

Starts a I2S data exchange.

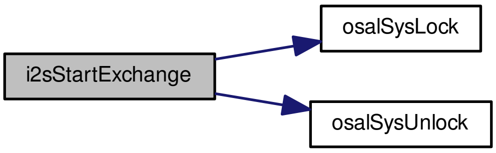
**Parameters**

| | | |
|---|---|---|
| in | *i2sp* | pointer to the `I2SDriver` object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.23.6.6 void i2sStopExchange ( I2SDriver * *i2sp* )

Stops the ongoing data exchange.

The ongoing data exchange, if any, is stopped, if the driver was not active the function does nothing.

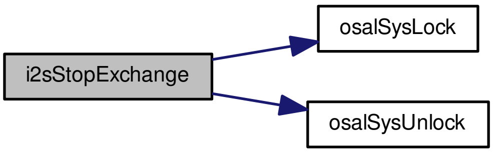
**Parameters**

| | | |
|---|---|---|
| in | *i2sp* | pointer to the `I2SDriver` object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



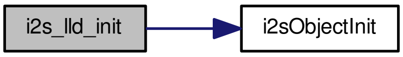
#### 7.23.6.7 void i2s_lld_init ( void )

Low level I2S driver initialization.

**Function Class:**

Not an API, this function is for internal use only.

Here is the call graph for this function:



#### 7.23.6.8 void i2s_lld_start ( I2SDriver * *i2sp* )

Configures and activates the I2S peripheral.

**Parameters**

| | | |
|---|---|---|
| in | *i2sp* | pointer to the `I2SDriver` object |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.23.6.9 void i2s_lld_stop ( I2SDriver * *i2sp* )

Deactivates the I2S peripheral.

**Parameters**

| | | |
|---|---|---|
| in | *i2sp* | pointer to the I2SDriver object |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.23.6.10 void i2s_lld_start_exchange ( I2SDriver ∗ *i2sp* )

Starts a I2S data exchange.

**Parameters**

| | | |
|---|---|---|
| in | *i2sp* | pointer to the I2SDriver object |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.23.6.11 void i2s_lld_stop_exchange ( I2SDriver ∗ *i2sp* )

Stops the ongoing data exchange.

The ongoing data exchange, if any, is stopped, if the driver was not active the function does nothing.

**Parameters**

| | | |
|---|---|---|
| in | *i2sp* | pointer to the I2SDriver object |

**Function Class:**

Not an API, this function is for internal use only.

### 7.23.7 Variable Documentation

#### 7.23.7.1 I2SDriver I2SD1

I2S2 driver identifier.

## 7.24 ICU Driver

Generic ICU Driver.

### 7.24.1 Detailed Description

Generic ICU Driver.

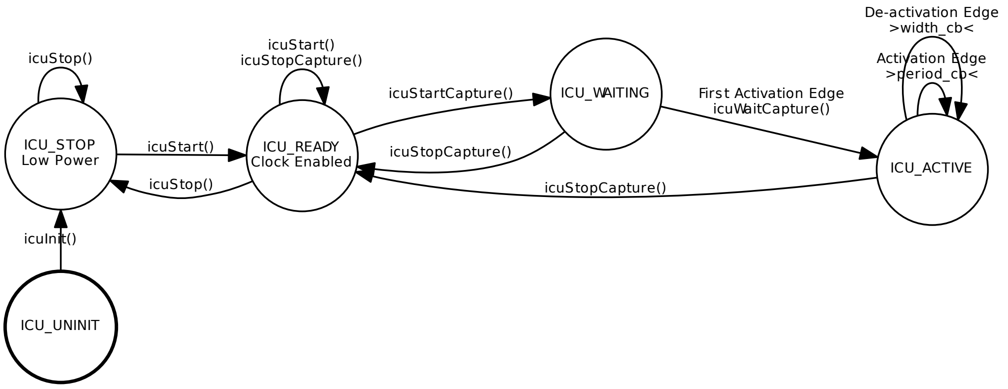
This module implements a generic ICU (Input Capture Unit) driver. The purpose of the driver is to measure period and duty cycle of an input digital signal (PWM input).

#### Precondition

In order to use the ICU driver the `HAL_USE_ICU` option must be enabled in `halconf.h`.

### 7.24.2 Driver State Machine

The driver implements a state machine internally, not all the driver functionalities can be used in any moment, any transition not explicitly shown in the following diagram has to be considered an error and shall be captured by an assertion (if enabled).



### 7.24.3 ICU Operations.

This driver abstracts a generic Input Capture Unit composed of:

- A clock prescaler.
- A main up counter.
- Two capture registers triggered by the rising and falling edges on the sampled input.

The ICU unit can be programmed to synchronize on the rising or falling edge of the sample input:

- **ICU_INPUT_ACTIVE_HIGH**, a rising edge is the start signal.

- **ICU_INPUT_ACTIVE_LOW**, a falling edge is the start signal.

Callbacks are optionally invoked when:

- On the PWM de-activation edge.
- On the PWM activation edge, measurements for the previous cycle are available from this callback and can be retrieved using `icuGetPeriodX()` and `icuGetWidthX()`.

### Macros

- #define icu_lld_get_width(icup) 0

  *Returns the width of the latest pulse.*
- #define icu_lld_get_period(icup) 0

  *Returns the width of the latest cycle.*
- #define icu_lld_are_notifications_enabled(icup) false

  *Check on notifications status.*

### Macro Functions

- #define icuStartCaptureI(icup)

  *Starts the input capture.*
- #define icuStopCaptureI(icup)

  *Stops the input capture.*
- #define icuEnableNotificationsI(icup) icu_lld_enable_notifications(icup)

  *Enables notifications.*
- #define icuDisableNotificationsI(icup) icu_lld_disable_notifications(icup)

  *Disables notifications.*
- #define icuAreNotificationsEnabledX(icup) icu_lld_are_notifications_enabled(icup)

  *Check on notifications status.*
- #define icuGetWidthX(icup) icu_lld_get_width(icup)

  *Returns the width of the latest pulse.*
- #define icuGetPeriodX(icup) icu_lld_get_period(icup)

  *Returns the width of the latest cycle.*

### Low level driver helper macros

- #define _icu_isr_invoke_width_cb(icup)

  *Common ISR code, ICU width event.*
- #define _icu_isr_invoke_period_cb(icup)

  *Common ISR code, ICU period event.*
- #define _icu_isr_invoke_overflow_cb(icup)

  *Common ISR code, ICU timer overflow event.*

### PLATFORM configuration options

- #define PLATFORM_ICU_USE_ICU1 FALSE

  *ICUD1 driver enable switch.*

## Typedefs

- typedef struct ICUDriver ICUDriver

  *Type of a structure representing an ICU driver.*
- typedef void(∗ icucallback_t) (ICUDriver ∗icup)

  *ICU notification callback type.*
- typedef uint32_t icufreq_t

  *ICU frequency type.*
- typedef uint32_t icucnt_t

  *ICU counter type.*

## Data Structures

- struct ICUConfig

  *Driver configuration structure.*
- struct ICUDriver

  *Structure representing an ICU driver.*

## Functions

- void icuInit (void)

  *ICU Driver initialization.*
- void icuObjectInit (ICUDriver ∗icup)

  *Initializes the standard part of a `ICUDriver` structure.*
- void icuStart (ICUDriver ∗icup, const ICUConfig ∗config)

  *Configures and activates the ICU peripheral.*
- void icuStop (ICUDriver ∗icup)

  *Deactivates the ICU peripheral.*
- void icuStartCapture (ICUDriver ∗icup)

  *Starts the input capture.*
- bool icuWaitCapture (ICUDriver ∗icup)

  *Waits for a completed capture.*
- void icuStopCapture (ICUDriver ∗icup)

  *Stops the input capture.*
- void icuEnableNotifications (ICUDriver ∗icup)

  *Enables notifications.*
- void icuDisableNotifications (ICUDriver ∗icup)

  *Disables notifications.*
- void icu_lld_init (void)

  *Low level ICU driver initialization.*
- void icu_lld_start (ICUDriver ∗icup)

  *Configures and activates the ICU peripheral.*
- void icu_lld_stop (ICUDriver ∗icup)

  *Deactivates the ICU peripheral.*
- void icu_lld_start_capture (ICUDriver ∗icup)

  *Starts the input capture.*
- bool icu_lld_wait_capture (ICUDriver ∗icup)

  *Waits for a completed capture.*
- void icu_lld_stop_capture (ICUDriver ∗icup)

  *Stops the input capture.*

- void icu_lld_enable_notifications (ICUDriver ∗icup)

  *Enables notifications.*
- void icu_lld_disable_notifications (ICUDriver ∗icup)

  *Disables notifications.*

## Enumerations

## Variables

- ICUDriver ICUD1

  *ICUD1 driver identifier.*

## 7.24.4 Macro Definition Documentation

### 7.24.4.1 #define icuStartCaptureI( *icup* )

**Value:**

```
do {                                                    \
  icu_lld_start_capture(icup);                                           \
  (icup)->state = ICU_WAITING;                                           \
} while (false)
```

Starts the input capture.

**Parameters**

| | | |
|---|---|---|
| in | *icup* | pointer to the `ICUDriver` object |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

### 7.24.4.2 #define icuStopCaptureI( *icup* )

**Value:**

```
do {                                                     \
  icu_lld_stop_capture(icup);                                            \
  (icup)->state = ICU_READY;                                             \
} while (false)
```

Stops the input capture.

**Parameters**

| | | |
|---|---|---|
| in | *icup* | pointer to the `ICUDriver` object |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

#### 7.24.4.3 #define icuEnableNotificationsI( *icup* ) icu_lld_enable_notifications(icup)

Enables notifications.

**Precondition**

The ICU unit must have been activated using `icuStart()` and the capture started using `icuStartCapture()`.

**Note**

If the notification is already enabled then the call has no effect.

**Parameters**

| | | |
|---|---|---|
| in | *icup* | pointer to the `ICUDriver` object |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

#### 7.24.4.4 #define icuDisableNotificationsI( *icup* ) icu_lld_disable_notifications(icup)

Disables notifications.

**Precondition**

The ICU unit must have been activated using `icuStart()` and the capture started using `icuStartCapture()`.

**Note**

If the notification is already disabled then the call has no effect.

**Parameters**

| | | |
|---|---|---|
| in | *icup* | pointer to the `ICUDriver` object |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

#### 7.24.4.5 #define icuAreNotificationsEnabledX( *icup* ) icu_lld_are_notifications_enabled(icup)

Check on notifications status.

**Parameters**

| | | |
|---|---|---|
| in | *icup* | pointer to the `ICUDriver` object |

**Returns**

The notifications status.

**Return values**

| | |
|---|---|
| *false* | if notifications are not enabled. |
| *true* | if notifications are enabled. |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.24.4.6 #define icuGetWidthX( *icup* ) icu_lld_get_width(icup)

Returns the width of the latest pulse.

The pulse width is defined as number of ticks between the start edge and the stop edge.

**Note**

This function is meant to be invoked from the width capture callback.

**Parameters**

| | | |
|---|---|---|
| in | *icup* | pointer to the `ICUDriver` object |

**Returns**

The number of ticks.

**Function Class:**

This is an **X-Class** API, this function can be invoked from any context.

#### 7.24.4.7 #define icuGetPeriodX( *icup* ) icu_lld_get_period(icup)

Returns the width of the latest cycle.

The cycle width is defined as number of ticks between a start edge and the next start edge.

**Note**

This function is meant to be invoked from the width capture callback.

**Parameters**

| | | |
|---|---|---|
| in | *icup* | pointer to the `ICUDriver` object |

**Returns**

The number of ticks.

**Function Class:**

This is an **X-Class** API, this function can be invoked from any context.

### 7.24.4.8 #define _icu_isr_invoke_width_cb( *icup* )

**Value:**

```
do {                                 \
  if (((icup)->state == ICU_ACTIVE) &&                                      \
      ((icup)->config->width_cb != NULL))                                   \
    (icup)->config->width_cb(icup);                                         \
} while (0)
```

Common ISR code, ICU width event.

**Parameters**

| | | |
|---|---|---|
| in | *icup* | pointer to the `ICUDriver` object |

**Function Class:**

Not an API, this function is for internal use only.

### 7.24.4.9 #define _icu_isr_invoke_period_cb( *icup* )

**Value:**

```
do {                                \
  if (((icup)->state == ICU_ACTIVE) &&                                      \
      ((icup)->config->period_cb != NULL))                                  \
    (icup)->config->period_cb(icup);                                        \
  (icup)->state = ICU_ACTIVE;                                               \
} while (0)
```

Common ISR code, ICU period event.

**Note**

A period event brings the driver into the `ICU_ACTIVE` state.

**Parameters**

| | | |
|---|---|---|
| in | *icup* | pointer to the `ICUDriver` object |

**Function Class:**

Not an API, this function is for internal use only.

### 7.24.4.10 #define _icu_isr_invoke_overflow_cb( *icup* )

**Value:**

```
do {                                                    \
  (icup)->config->overflow_cb(icup);                                      \
  (icup)->state = ICU_WAITING;                                            \
} while (0)
```

Common ISR code, ICU timer overflow event.

**Note**

An overflow always brings the driver back to the `ICU_WAITING` state.

**Parameters**

| | | |
|---|---|---|
| in | *icup* | pointer to the `ICUDriver` object |

**Function Class:**

Not an API, this function is for internal use only.

### 7.24.4.11 #define PLATFORM_ICU_USE_ICU1 FALSE

ICUD1 driver enable switch.

If set to `TRUE` the support for ICUD1 is included.

**Note**

The default is `FALSE`.

### 7.24.4.12 #define icu_lld_get_width( *icup* ) 0

Returns the width of the latest pulse.

The pulse width is defined as number of ticks between the start edge and the stop edge.

**Parameters**

| | | |
|---|---|---|
| in | *icup* | pointer to the `ICUDriver` object |

**Returns**

The number of ticks.

**Function Class:**

Not an API, this function is for internal use only.

### 7.24.4.13 #define icu_lld_get_period( *icup* ) 0

Returns the width of the latest cycle.

The cycle width is defined as number of ticks between a start edge and the next start edge.

**Parameters**

| | | |
|---|---|---|
| in | *icup* | pointer to the `ICUDriver` object |

**Returns**

The number of ticks.

**Function Class:**

Not an API, this function is for internal use only.

#### 7.24.4.14 #define icu_lld_are_notifications_enabled( *icup* ) false

Check on notifications status.

**Parameters**

| | | |
|---|---|---|
| in | *icup* | pointer to the ICUDriver object |

**Returns**

The notifications status.

**Return values**

| | |
|---|---|
| *false* | if notifications are not enabled. |
| *true* | if notifications are enabled. |

**Function Class:**

Not an API, this function is for internal use only.

### 7.24.5 Typedef Documentation

#### 7.24.5.1 typedef struct ICUDriver ICUDriver

Type of a structure representing an ICU driver.

#### 7.24.5.2 typedef void(∗ icucallback_t) (ICUDriver ∗icup)

ICU notification callback type.

**Parameters**

| | | |
|---|---|---|
| in | *icup* | pointer to a ICUDriver object |

#### 7.24.5.3 typedef uint32_t icufreq_t

ICU frequency type.

#### 7.24.5.4 typedef uint32_t icucnt_t

ICU counter type.

## 7.24.6 Enumeration Type Documentation

### 7.24.6.1 enum **icustate_t**

Driver state machine possible states.

**Enumerator**

***ICU_UNINIT*** Not initialized.

***ICU_STOP*** Stopped.

***ICU_READY*** Ready.

***ICU_WAITING*** Waiting for first front.

***ICU_ACTIVE*** First front detected.

### 7.24.6.2 enum **icumode_t**

ICU driver mode.

**Enumerator**

***ICU_INPUT_ACTIVE_HIGH*** Trigger on rising edge.

***ICU_INPUT_ACTIVE_LOW*** Trigger on falling edge.

## 7.24.7 Function Documentation

### 7.24.7.1 void iculnit ( void )

ICU Driver initialization.

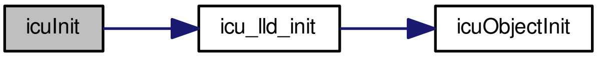
**Note**

This function is implicitly invoked by `halInit()`, there is no need to explicitly initialize the driver.

**Function Class:**

Initializer, this function just initializes an object and can be invoked before the kernel is initialized.

Here is the call graph for this function:



### 7.24.7.2 void icuObjectInit ( **ICUDriver** ∗ *icup* )

Initializes the standard part of a `ICUDriver` structure.

**Parameters**

| | | |
|---|---|---|
| out | *icup* | pointer to the ICUDriver object |

**Function Class:**

Initializer, this function just initializes an object and can be invoked before the kernel is initialized.

#### 7.24.7.3 void icuStart ( ICUDriver ∗ *icup*, const ICUConfig ∗ *config* )

Configures and activates the ICU peripheral.

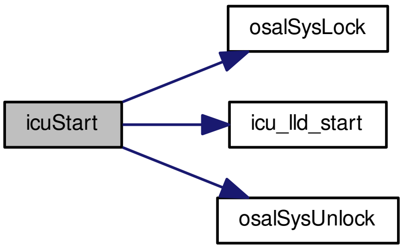
**Parameters**

| | | |
|---|---|---|
| in | *icup* | pointer to the ICUDriver object |
| in | *config* | pointer to the ICUConfig object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.24.7.4 void icuStop ( ICUDriver ∗ *icup* )

Deactivates the ICU peripheral.

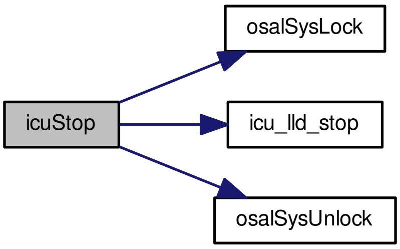
**Parameters**

| | | |
|---|---|---|
| in | *icup* | pointer to the ICUDriver object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.24.7.5 void icuStartCapture ( ICUDriver ∗ *icup* )

Starts the input capture.

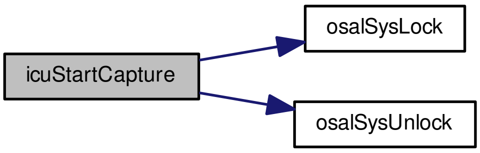
**Parameters**

| | | |
|---|---|---|
| in | *icup* | pointer to the ICUDriver object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.24.7.6 bool icuWaitCapture ( ICUDriver ∗ *icup* )

Waits for a completed capture.

**Note**

The operation could be performed in polled mode depending on.
In order to use this function notifications must be disabled.

**Precondition**

The driver must be in ICU_WAITING or ICU_ACTIVE states.

**Postcondition**

After the capture is available the driver is in ICU_ACTIVE state. If a capture fails then the driver is in ICU_WAITING state.

**Parameters**

| | | |
|---|---|---|
| in | *icup* | pointer to the ICUDriver object |

**Returns**

The capture status.

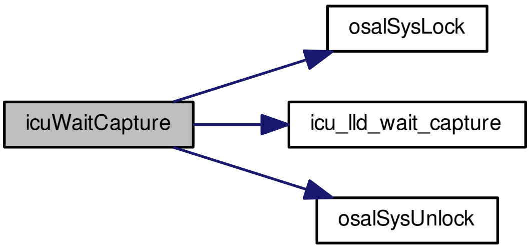
**Return values**

| | |
|---|---|
| *false* | if the capture is successful. |
| *true* | if a timer overflow occurred. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



### 7.24.7.7 void icuStopCapture ( ICUDriver * *icup* )

Stops the input capture.

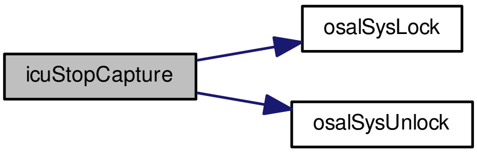
**Parameters**

| | | |
|---|---|---|
| in | *icup* | pointer to the ICUDriver object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



### 7.24.7.8 void icuEnableNotifications ( ICUDriver * *icup* )

Enables notifications.

**Precondition**

The ICU unit must have been activated using `icuStart()` and the capture started using `icuStartCapture()`.

**Note**

If the notification is already enabled then the call has no effect.

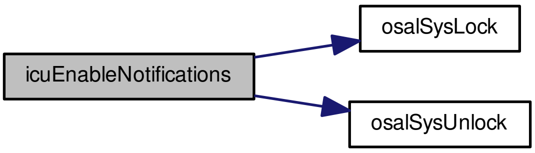
**Parameters**

| | | |
|---|---|---|
| in | *icup* | pointer to the `ICUDriver` object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.24.7.9 void icuDisableNotifications ( ICUDriver * *icup* )

Disables notifications.

**Precondition**

The ICU unit must have been activated using icuStart() and the capture started using icuStartCapture().

**Note**

If the notification is already disabled then the call has no effect.

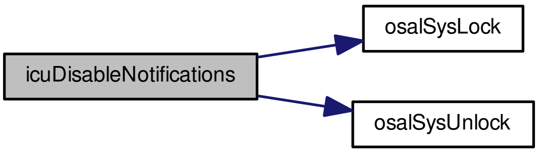
**Parameters**

| | | |
|---|---|---|
| in | *icup* | pointer to the ICUDriver object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



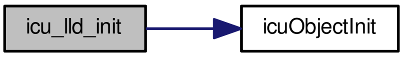
#### 7.24.7.10 void icu_lld_init ( void )

Low level ICU driver initialization.

**Function Class:**

Not an API, this function is for internal use only.

Here is the call graph for this function:



#### 7.24.7.11 void icu_lld_start ( **ICUDriver** * *icup* )

Configures and activates the ICU peripheral.

**Parameters**

| | | |
|---|---|---|
| in | *icup* | pointer to the ICUDriver object |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.24.7.12 void icu_lld_stop ( **ICUDriver** * *icup* )

Deactivates the ICU peripheral.

**Parameters**

| | | |
|---|---|---|
| in | *icup* | pointer to the ICUDriver object |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.24.7.13 void icu_lld_start_capture ( **ICUDriver** * *icup* )

Starts the input capture.

**Parameters**

| | | |
|---|---|---|
| in | *icup* | pointer to the ICUDriver object |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.24.7.14 bool icu_lld_wait_capture ( **ICUDriver** * *icup* )

Waits for a completed capture.

**Note**

The operation is performed in polled mode.
In order to use this function notifications must be disabled.

**Parameters**

| | | |
|---|---|---|
| in | *icup* | pointer to the ICUDriver object |

**Returns**

The capture status.

**Return values**

| | |
|---|---|
| *false* | if the capture is successful. |
| *true* | if a timer overflow occurred. |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.24.7.15 void icu_lld_stop_capture ( ICUDriver * *icup* )

Stops the input capture.

**Parameters**

| | | |
|---|---|---|
| in | *icup* | pointer to the ICUDriver object |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.24.7.16 void icu_lld_enable_notifications ( ICUDriver * *icup* )

Enables notifications.

**Precondition**

The ICU unit must have been activated using icuStart() and the capture started using icuStartCapture().

**Note**

If the notification is already enabled then the call has no effect.

**Parameters**

| | | |
|---|---|---|
| in | *icup* | pointer to the ICUDriver object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.24.7.17 void icu_lld_disable_notifications ( ICUDriver * *icup* )

Disables notifications.

**Precondition**

The ICU unit must have been activated using `icuStart()` and the capture started using `icuStartCapture()`.

**Note**

If the notification is already disabled then the call has no effect.

**Parameters**

|  |  |  |
|---|---|---|
| `in` | *icup* | pointer to the `ICUDriver` object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

## 7.24.8 Variable Documentation

### 7.24.8.1 ICUDriver ICUD1

ICUD1 driver identifier.

**Note**

The driver ICUD1 allocates the complex timer TIM1 when enabled.

## 7.25 JESD216 Compliant Flash Driver Interface

HAL JESD216 Compliant Flash Driver Interface.

### 7.25.1 Detailed Description

HAL JESD216 Compliant Flash Driver Interface.

#### Macros

- #define _jesd216_flash_methods_alone

  *JESD215Flash specific methods.*
- #define _jesd216_flash_methods

  *JESD215Flash specific methods with inherited ones.*
- #define _jesd216_flash_data _base_flash_data

  *JESD215Flash specific data.*

#### Common command codes

- #define **JESD216_CMD_READ_ID** 0x9FU
- #define **JESD216_CMD_READ** 0x03U
- #define **JESD216_CMD_WRITE_ENABLE** 0x06U
- #define **JESD216_CMD_WRITE_DISABLE** 0x04U
- #define **JESD216_CMD_READ_STATUS_REGISTER** 0x05U
- #define **JESD216_CMD_WRITE_STATUS_REGISTER** 0x01U
- #define **JESD216_CMD_PAGE_PROGRAM** 0x02U
- #define **JESD216_CMD_ERASE_4K** 0x20U
- #define **JESD216_CMD_ERASE_BULK** 0xC7U
- #define **JESD216_CMD_PROGRAM_ERASE_RESUME** 0x7AU
- #define **JESD216_CMD_PROGRAM_ERASE_SUSPEND** 0x75U
- #define **JESD216_CMD_READ_OTP_ARRAY** 0x4BU
- #define **JESD216_CMD_PROGRAM_OTP_ARRAY** 0x42U

#### Command options

- #define **JESD216_CMD_EXTENDED_ADDRESSING** 0x80000000U

#### Bus interface.

- #define **JESD216_BUS_MODE_SPI** 0U
- #define **JESD216_BUS_MODE_QSPI1L** 1U
- #define **JESD216_BUS_MODE_QSPI2L** 2U
- #define **JESD216_BUS_MODE_QSPI4L** 4U

#### Configuration options

- #define JESD216_BUS_MODE JESD216_BUS_MODE_QSPI4L

  *Physical transport interface.*
- #define JESD216_SHARED_BUS TRUE

  *Shared bus switch.*

### Data Structures

- struct JESD215FlashVMT

  *JESD215Flash virtual methods table.*
- struct JESD215Flash

  *Base flash class.*

## 7.25.2 Macro Definition Documentation

### 7.25.2.1 #define JESD216_BUS_MODE JESD216_BUS_MODE_QSPI4L

Physical transport interface.

### 7.25.2.2 #define JESD216_SHARED_BUS TRUE

Shared bus switch.

If set to TRUE the device acquires bus ownership on each transaction.

**Note**

Requires SPI_USE_MUTUAL_EXCLUSION or SPI_USE_MUTUAL_EXCLUSION.

### 7.25.2.3 #define _jesd216_flash_methods_alone

**Value:**

```
/* Read SFDP.*/                                                     \
  flash_error_t (*read_sfdp)(void *instance,
      \
                 flash_offset_t offset,
      \
                 size_t n,                                           \
                 uint8_t *rp);
```

JESD215Flash specific methods.

### 7.25.2.4 #define _jesd216_flash_methods

**Value:**

```
_base_flash_methods                                                 \
  _jesd216_flash_methods_alone
```

JESD215Flash specific methods with inherited ones.

### 7.25.2.5 #define _jesd216_flash_data _base_flash_data

JESD215Flash specific data.

# 7.26 MAC Driver

Generic MAC Driver.

## 7.26.1 Detailed Description

Generic MAC Driver.

This module implements a generic MAC (Media Access Control) driver for Ethernet controllers.

### Precondition

In order to use the MAC driver the `HAL_USE_MAC` option must be enabled in `halconf.h`.

### Macros

- #define MAC_SUPPORTS_ZERO_COPY TRUE

  *This implementation supports the zero-copy mode API.*

### MAC configuration options

- #define MAC_USE_ZERO_COPY FALSE

  *Enables an event sources for incoming packets.*
- #define MAC_USE_EVENTS TRUE

  *Enables an event sources for incoming packets.*

### Macro Functions

- #define macGetReceiveEventSource(macp) (&(macp)->rdevent)

  *Enables the zero-copy API.*
- #define macWriteTransmitDescriptor(tdp, buf, size) mac_lld_write_transmit_descriptor(tdp, buf, size)

  *Writes to a transmit descriptor's stream.*
- #define macReadReceiveDescriptor(rdp, buf, size) mac_lld_read_receive_descriptor(rdp, buf, size)

  *Reads from a receive descriptor's stream.*
- #define macGetNextTransmitBuffer(tdp, size, sizep) mac_lld_get_next_transmit_buffer(tdp, size, sizep)

  *Returns a pointer to the next transmit buffer in the descriptor chain.*
- #define macGetNextReceiveBuffer(rdp, sizep) mac_lld_get_next_receive_buffer(rdp, sizep)

  *Returns a pointer to the next receive buffer in the descriptor chain.*

### PLATFORM configuration options

- #define PLATFORM_MAC_USE_MAC1 FALSE

  *MAC driver enable switch.*

### Typedefs

- typedef struct MACDriver MACDriver

  *Type of a structure representing a MAC driver.*

## Data Structures

- struct MACConfig

  *Driver configuration structure.*
- struct MACDriver

  *Structure representing a MAC driver.*
- struct MACTransmitDescriptor

  *Structure representing a transmit descriptor.*
- struct MACReceiveDescriptor

  *Structure representing a receive descriptor.*

## Functions

- void macInit (void)

  *MAC Driver initialization.*
- void macObjectInit (MACDriver ∗macp)

  *Initialize the standard part of a `MACDriver` structure.*
- void macStart (MACDriver ∗macp, const MACConfig ∗config)

  *Configures and activates the MAC peripheral.*
- void macStop (MACDriver ∗macp)

  *Deactivates the MAC peripheral.*
- msg_t macWaitTransmitDescriptor (MACDriver ∗macp, MACTransmitDescriptor ∗tdp, sysinterval_t timeout)

  *Allocates a transmission descriptor.*
- void macReleaseTransmitDescriptor (MACTransmitDescriptor ∗tdp)

  *Releases a transmit descriptor and starts the transmission of the enqueued data as a single frame.*
- msg_t macWaitReceiveDescriptor (MACDriver ∗macp, MACReceiveDescriptor ∗rdp, sysinterval_t timeout)

  *Waits for a received frame.*
- void macReleaseReceiveDescriptor (MACReceiveDescriptor ∗rdp)

  *Releases a receive descriptor.*
- bool macPollLinkStatus (MACDriver ∗macp)

  *Updates and returns the link status.*
- void mac_lld_init (void)

  *Low level MAC initialization.*
- void mac_lld_start (MACDriver ∗macp)

  *Configures and activates the MAC peripheral.*
- void mac_lld_stop (MACDriver ∗macp)

  *Deactivates the MAC peripheral.*
- msg_t mac_lld_get_transmit_descriptor (MACDriver ∗macp, MACTransmitDescriptor ∗tdp)

  *Returns a transmission descriptor.*
- void mac_lld_release_transmit_descriptor (MACTransmitDescriptor ∗tdp)

  *Releases a transmit descriptor and starts the transmission of the enqueued data as a single frame.*
- msg_t mac_lld_get_receive_descriptor (MACDriver ∗macp, MACReceiveDescriptor ∗rdp)

  *Returns a receive descriptor.*
- void mac_lld_release_receive_descriptor (MACReceiveDescriptor ∗rdp)

  *Releases a receive descriptor.*
- bool mac_lld_poll_link_status (MACDriver ∗macp)

  *Updates and returns the link status.*
- size_t mac_lld_write_transmit_descriptor (MACTransmitDescriptor ∗tdp, uint8_t ∗buf, size_t size)

  *Writes to a transmit descriptor's stream.*
- size_t mac_lld_read_receive_descriptor (MACReceiveDescriptor ∗rdp, uint8_t ∗buf, size_t size)

  *Reads from a receive descriptor's stream.*

- uint8_t ∗ mac_lld_get_next_transmit_buffer (MACTransmitDescriptor ∗tdp, size_t size, size_t ∗sizep)

  *Returns a pointer to the next transmit buffer in the descriptor chain.*
- const uint8_t ∗ mac_lld_get_next_receive_buffer (MACReceiveDescriptor ∗rdp, size_t ∗sizep)

  *Returns a pointer to the next receive buffer in the descriptor chain.*

## Enumerations

## Variables

- MACDriver ETHD1

  *MAC1 driver identifier.*

## 7.26.2 Macro Definition Documentation

### 7.26.2.1 #define MAC_USE_ZERO_COPY FALSE

Enables an event sources for incoming packets.

### 7.26.2.2 #define MAC_USE_EVENTS TRUE

Enables an event sources for incoming packets.

### 7.26.2.3 #define macGetReceiveEventSource( *macp* ) (&(macp)->rdevent)

Enables the zero-copy API.

**Parameters**

| | | |
|---|---|---|
| in | *macp* | pointer to the MACDriver object |

**Returns**

The pointer to the EventSource structure.

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

### 7.26.2.4 #define macWriteTransmitDescriptor( *tdp*, *buf*, *size* ) mac_lld_write_transmit_descriptor(tdp, buf, size)

Writes to a transmit descriptor's stream.

**Parameters**

| | | |
|---|---|---|
| in | *tdp* | pointer to a MACTransmitDescriptor structure |
| in | *buf* | pointer to the buffer containing the data to be written |
| in | *size* | number of bytes to be written |

**Returns**

The number of bytes written into the descriptor's stream, this value can be less than the amount specified in the parameter `size` if the maximum frame size is reached.

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.26.2.5 #define macReadReceiveDescriptor( *rdp,* *buf,* *size* ) **mac_lld_read_receive_descriptor**(rdp, buf, size)

Reads from a receive descriptor's stream.

**Parameters**

| | | |
|---|---|---|
| `in` | *rdp* | pointer to a `MACReceiveDescriptor` structure |
| `in` | *buf* | pointer to the buffer that will receive the read data |
| `in` | *size* | number of bytes to be read |

**Returns**

The number of bytes read from the descriptor's stream, this value can be less than the amount specified in the parameter `size` if there are no more bytes to read.

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.26.2.6 #define macGetNextTransmitBuffer( *tdp,* *size,* *sizep* ) **mac_lld_get_next_transmit_buffer**(tdp, size, sizep)

Returns a pointer to the next transmit buffer in the descriptor chain.

**Note**

The API guarantees that enough buffers can be requested to fill a whole frame.

**Parameters**

| | | |
|---|---|---|
| `in` | *tdp* | pointer to a `MACTransmitDescriptor` structure |
| `in` | *size* | size of the requested buffer. Specify the frame size on the first call then scale the value down subtracting the amount of data already copied into the previous buffers. |
| `out` | *sizep* | pointer to variable receiving the real buffer size. The returned value can be less than the amount requested, this means that more buffers must be requested in order to fill the frame data entirely. |

**Returns**

Pointer to the returned buffer.

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.26.2.7 #define macGetNextReceiveBuffer( *rdp,* *sizep* ) mac_lld_get_next_receive_buffer(rdp, sizep)

Returns a pointer to the next receive buffer in the descriptor chain.

**Note**

The API guarantees that the descriptor chain contains a whole frame.

**Parameters**

| | | |
|---|---|---|
| `in` | *rdp* | pointer to a `MACReceiveDescriptor` structure |
| `out` | *sizep* | pointer to variable receiving the buffer size, it is zero when the last buffer has already been returned. |

**Returns**

Pointer to the returned buffer.

**Return values**

| | |
|---|---|
| *NULL* | if the buffer chain has been entirely scanned. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.26.2.8 #define MAC_SUPPORTS_ZERO_COPY TRUE

This implementation supports the zero-copy mode API.

#### 7.26.2.9 #define PLATFORM_MAC_USE_MAC1 FALSE

MAC driver enable switch.

If set to `TRUE` the support for MAC1 is included.

**Note**

The default is `FALSE`.

### 7.26.3 Typedef Documentation

#### 7.26.3.1 typedef struct MACDriver MACDriver

Type of a structure representing a MAC driver.

### 7.26.4 Enumeration Type Documentation

#### 7.26.4.1 enum macstate_t

Driver state machine possible states.

**Enumerator**

***MAC_UNINIT*** Not initialized.

***MAC_STOP*** Stopped.

***MAC_ACTIVE*** Active.

## 7.26.5 Function Documentation

### 7.26.5.1 void macInit ( void )

MAC Driver initialization.

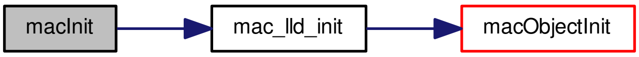
**Note**

This function is implicitly invoked by `halInit()`, there is no need to explicitly initialize the driver.

**Function Class:**

Initializer, this function just initializes an object and can be invoked before the kernel is initialized.

Here is the call graph for this function:



### 7.26.5.2 void macObjectInit ( MACDriver * *macp* )

Initialize the standard part of a `MACDriver` structure.

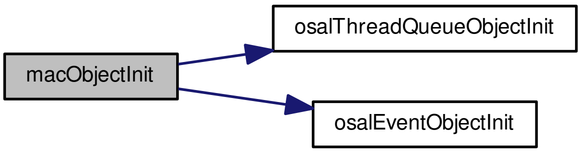
**Parameters**

| | | |
|---|---|---|
| out | *macp* | pointer to the `MACDriver` object |

**Function Class:**

Initializer, this function just initializes an object and can be invoked before the kernel is initialized.

Here is the call graph for this function:



#### 7.26.5.3 void macStart ( MACDriver ∗ *macp*, const MACConfig ∗ *config* )

Configures and activates the MAC peripheral.

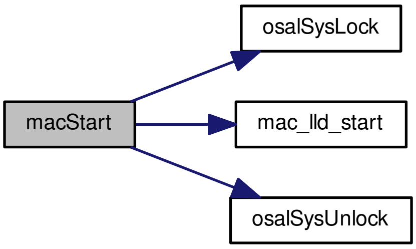
**Parameters**

| | | |
|---|---|---|
| `in` | *macp* | pointer to the `MACDriver` object |
| `in` | *config* | pointer to the `MACConfig` object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.26.5.4 void macStop ( MACDriver ∗ *macp* )

Deactivates the MAC peripheral.

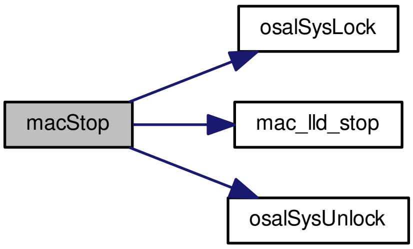
**Parameters**

| | | |
|---|---|---|
| `in` | *macp* | pointer to the `MACDriver` object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



### 7.26.5.5 msg_t macWaitTransmitDescriptor ( MACDriver ∗ *macp*, MACTransmitDescriptor ∗ *tdp*, sysinterval_t *timeout* )

Allocates a transmission descriptor.

One of the available transmission descriptors is locked and returned. If a descriptor is not currently available then the invoking thread is queued until one is freed.

**Parameters**

| | | |
|---|---|---|
| in | *macp* | pointer to the `MACDriver` object |
| out | *tdp* | pointer to a `MACTransmitDescriptor` structure |
| in | *timeout* | the number of ticks before the operation timeouts, the following special values are allowed:<br>• *TIME_IMMEDIATE* immediate timeout.<br>• *TIME_INFINITE* no timeout. |

**Returns**

The operation status.

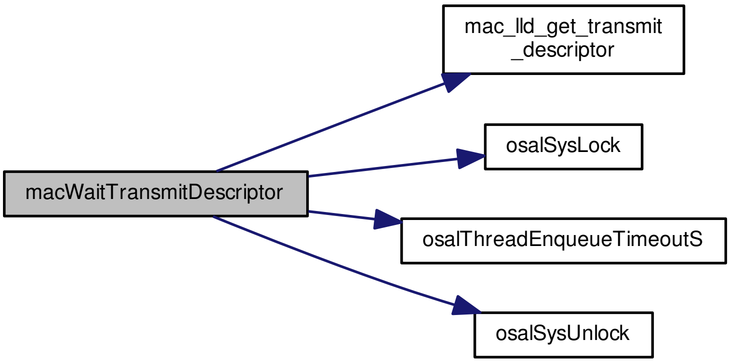
**Return values**

| | |
|---|---|
| *MSG_OK* | the descriptor was obtained. |
| *MSG_TIMEOUT* | the operation timed out, descriptor not initialized. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.26.5.6 void macReleaseTransmitDescriptor ( **MACTransmitDescriptor** ∗ *tdp* )

Releases a transmit descriptor and starts the transmission of the enqueued data as a single frame.

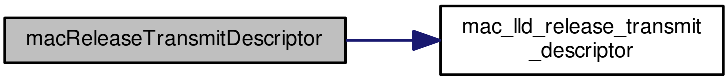
**Parameters**

| | | |
|---|---|---|
| in | *tdp* | the pointer to the `MACTransmitDescriptor` structure |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.26.5.7 msg_t macWaitReceiveDescriptor ( **MACDriver** ∗ *macp,* **MACReceiveDescriptor** ∗ *rdp,* **sysinterval_t** *timeout* )

Waits for a received frame.

Stops until a frame is received and buffered. If a frame is not immediately available then the invoking thread is queued until one is received.

**Parameters**

| | | |
|---|---|---|
| in | *macp* | pointer to the MACDriver object |
| out | *rdp* | pointer to a MACReceiveDescriptor structure |
| in | *timeout* | the number of ticks before the operation timeouts, the following special values are allowed:<br>• *TIME_IMMEDIATE* immediate timeout.<br>• *TIME_INFINITE* no timeout. |

**Returns**

The operation status.

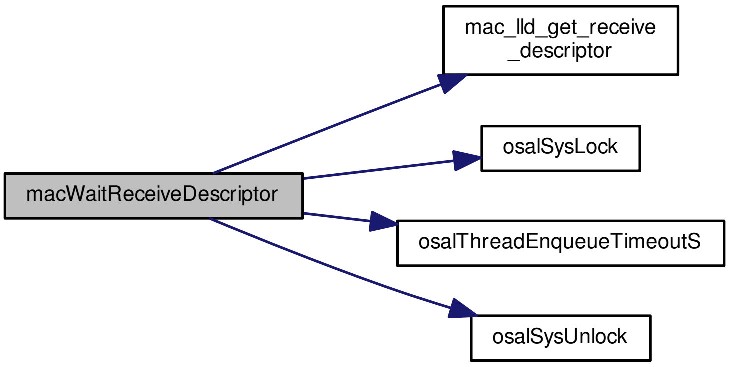
**Return values**

| | |
|---|---|
| *MSG_OK* | the descriptor was obtained. |
| *MSG_TIMEOUT* | the operation timed out, descriptor not initialized. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



### 7.26.5.8 void macReleaseReceiveDescriptor ( MACReceiveDescriptor ∗ *rdp* )

Releases a receive descriptor.

The descriptor and its buffer are made available for more incoming frames.

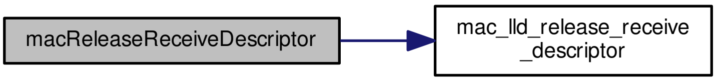
**Parameters**

| | | |
|---|---|---|
| in | *rdp* | the pointer to the MACReceiveDescriptor structure |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:


macReleaseReceiveDescriptor
mac_lld_release_receive _descriptor

#### 7.26.5.9 bool macPollLinkStatus ( MACDriver * *macp* )

Updates and returns the link status.

**Parameters**

| | | |
|---|---|---|
| in | *macp* | pointer to the MACDriver object |

**Returns**

The link status.

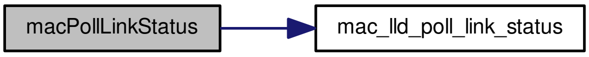
**Return values**

| | |
|---|---|
| *true* | if the link is active. |
| *false* | if the link is down. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



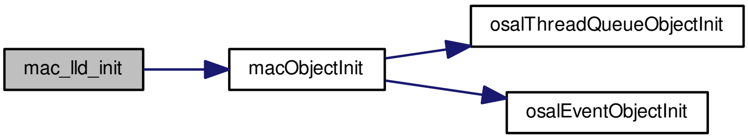
#### 7.26.5.10 void mac_lld_init ( void )

Low level MAC initialization.

**Function Class:**

Not an API, this function is for internal use only.

Here is the call graph for this function:



### 7.26.5.11 void mac_lld_start ( MACDriver ∗ *macp* )

Configures and activates the MAC peripheral.

**Parameters**

| | | |
|---|---|---|
| in | *macp* | pointer to the MACDriver object |

**Function Class:**

Not an API, this function is for internal use only.

### 7.26.5.12 void mac_lld_stop ( MACDriver ∗ *macp* )

Deactivates the MAC peripheral.

**Parameters**

| | | |
|---|---|---|
| in | *macp* | pointer to the MACDriver object |

**Function Class:**

Not an API, this function is for internal use only.

### 7.26.5.13 msg_t mac_lld_get_transmit_descriptor ( MACDriver ∗ *macp,* MACTransmitDescriptor ∗ *tdp* )

Returns a transmission descriptor.

One of the available transmission descriptors is locked and returned.

**Parameters**

| | | |
|---|---|---|
| in | *macp* | pointer to the MACDriver object |
| out | *tdp* | pointer to a MACTransmitDescriptor structure |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *MSG_OK* | the descriptor has been obtained. |
| *MSG_TIMEOUT* | descriptor not available. |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.26.5.14 void mac_lld_release_transmit_descriptor ( **MACTransmitDescriptor** ∗ *tdp* )

Releases a transmit descriptor and starts the transmission of the enqueued data as a single frame.

**Parameters**

| | | |
|---|---|---|
| in | *tdp* | the pointer to the MACTransmitDescriptor structure |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.26.5.15 msg_t mac_lld_get_receive_descriptor ( **MACDriver** ∗ *macp*, **MACReceiveDescriptor** ∗ *rdp* )

Returns a receive descriptor.

**Parameters**

| | | |
|---|---|---|
| in | *macp* | pointer to the MACDriver object |
| out | *rdp* | pointer to a MACReceiveDescriptor structure |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *MSG_OK* | the descriptor has been obtained. |
| *MSG_TIMEOUT* | descriptor not available. |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.26.5.16 void mac_lld_release_receive_descriptor ( **MACReceiveDescriptor** ∗ *rdp* )

Releases a receive descriptor.

The descriptor and its buffer are made available for more incoming frames.

**Parameters**

| | | |
|---|---|---|
| in | *rdp* | the pointer to the MACReceiveDescriptor structure |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.26.5.17 bool mac_lld_poll_link_status ( MACDriver * *macp* )

Updates and returns the link status.

**Parameters**

| | | |
|---|---|---|
| in | *macp* | pointer to the MACDriver object |

**Returns**

The link status.

**Return values**

| | |
|---|---|
| *true* | if the link is active. |
| *false* | if the link is down. |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.26.5.18 size_t mac_lld_write_transmit_descriptor ( MACTransmitDescriptor * *tdp*, uint8_t * *buf*, size_t *size* )

Writes to a transmit descriptor's stream.

**Parameters**

| | | |
|---|---|---|
| in | *tdp* | pointer to a MACTransmitDescriptor structure |
| in | *buf* | pointer to the buffer containing the data to be written |
| in | *size* | number of bytes to be written |

**Returns**

The number of bytes written into the descriptor's stream, this value can be less than the amount specified in the parameter `size` if the maximum frame size is reached.

**Function Class:**

Not an API, this function is for internal use only.

#### 7.26.5.19 size_t mac_lld_read_receive_descriptor ( **MACReceiveDescriptor** ∗ *rdp,* uint8_t ∗ *buf,* size_t *size* )

Reads from a receive descriptor's stream.

**Parameters**

| | | |
|---|---|---|
| in | *rdp* | pointer to a `MACReceiveDescriptor` structure |
| in | *buf* | pointer to the buffer that will receive the read data |
| in | *size* | number of bytes to be read |

**Returns**

The number of bytes read from the descriptor's stream, this value can be less than the amount specified in the parameter `size` if there are no more bytes to read.

**Function Class:**

Not an API, this function is for internal use only.

#### 7.26.5.20 uint8_t ∗ mac_lld_get_next_transmit_buffer ( **MACTransmitDescriptor** ∗ *tdp,* size_t *size,* size_t ∗ *sizep* )

Returns a pointer to the next transmit buffer in the descriptor chain.

**Note**

The API guarantees that enough buffers can be requested to fill a whole frame.

**Parameters**

| | | |
|---|---|---|
| in | *tdp* | pointer to a `MACTransmitDescriptor` structure |
| in | *size* | size of the requested buffer. Specify the frame size on the first call then scale the value down subtracting the amount of data already copied into the previous buffers. |
| out | *sizep* | pointer to variable receiving the buffer size, it is zero when the last buffer has already been returned. Note that a returned size lower than the amount requested means that more buffers must be requested in order to fill the frame data entirely. |

**Returns**

Pointer to the returned buffer.

**Return values**

| | |
|---|---|
| *NULL* | if the buffer chain has been entirely scanned. |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.26.5.21 const uint8_t ∗ mac_lld_get_next_receive_buffer ( **MACReceiveDescriptor** ∗ *rdp,* size_t ∗ *sizep* )

Returns a pointer to the next receive buffer in the descriptor chain.

**Note**

The API guarantees that the descriptor chain contains a whole frame.

**Parameters**

| | | |
|---|---|---|
| in | *rdp* | pointer to a MACReceiveDescriptor structure |
| out | *sizep* | pointer to variable receiving the buffer size, it is zero when the last buffer has already been returned. |

**Returns**

Pointer to the returned buffer.

**Return values**

| | |
|---|---|
| *NULL* | if the buffer chain has been entirely scanned. |

**Function Class:**

Not an API, this function is for internal use only.

## 7.26.6 Variable Documentation

### 7.26.6.1 MACDriver ETHD1

MAC1 driver identifier.

# 7.27 HAL

Hardware Abstraction Layer.

## 7.27.1 Detailed Description

Hardware Abstraction Layer.

Under ChibiOS the set of the various device driver interfaces is called the HAL subsystem: Hardware Abstraction Layer. The HAL is the abstract interface between ChibiOS applications and hardware.

## 7.27.2 HAL Device Drivers Architecture

The HAL contains several kind of modules:

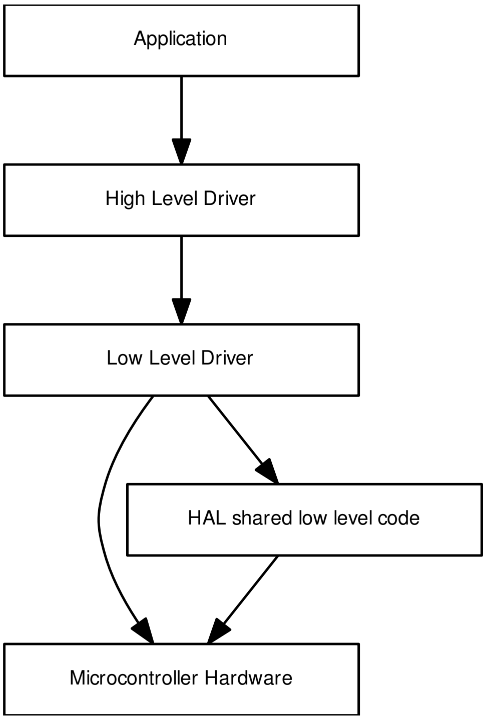
- Normal Device Drivers
- Complex Device Drivers
- Interfaces
- Inner Code

## 7.27.3 HAL Normal Device Drivers

Normal device are meant to interface the application to the underlying hardware through an high level API. Normal Device Drivers are split in two layers:

- High Level Device Driver (**HLD**). This layer contains the definitions of the driver's APIs and the platform independent part of the driver.
  An HLD is composed by two files:
  - `<driver>`.c, the HLD implementation file. This file must be included in the Makefile in order to use the driver.
  - `<driver>`.h, the HLD header file. This file is implicitly included by the HAL header file `hal.h`.
- Low Level Device Driver (**LLD**). This layer contains the platform dependent part of the driver.
  A LLD is composed by two files:
  - `<driver>_lld.c`, the LLD implementation file. This file must be included in the Makefile in order to use the driver.
  - `<driver>_lld.h`, the LLD header file. This file is implicitly included by the HLD header file.

#### 7.27.3.1 Diagram



### 7.27.4 HAL Complex Device Drivers

It is a class of device drivers that offer an high level API but do not use the hardware directly. Complex device drivers use other drivers for accessing the machine resources.

### 7.27.5 HAL Interfaces

An interface is a binary structure allowing the access to a service using virtual functions. This allows to create drivers that can be accessed using a common interface. The concept of interface is commonly found in object-oriented languages like Java or C++, their meaning in ChibiOS/HAL is exactly the same.

### 7.27.6 HAL Inner Code

Some modules are shared among multiple device drivers and are not necessarily meant to be used by the application layer.

## Modules

- Configuration

  *HAL Configuration.*
- Normal Drivers

*HAL Normal Drivers.*

- Complex Drivers

  *HAL Complex Drivers.*

- Interfaces and Classes

  *HAL Interfaces and Classes.*

- Inner Code

  *HAL Inner Code.*

- Support Code

  *HAL Support Code.*

- OSAL

  *Operating System Abstraction Layer.*

## 7.28 Configuration

HAL Configuration.

### 7.28.1 Detailed Description

HAL Configuration.

The file `halconf.h` contains the high level settings for all the drivers supported by the HAL. The low level, platform dependent, settings are contained in the `mcuconf.h` file instead and are describe in the various platforms reference manuals.

### Macros

- #define HAL_USE_PAL TRUE

  *Enables the PAL subsystem.*
- #define HAL_USE_ADC TRUE

  *Enables the ADC subsystem.*
- #define HAL_USE_CAN TRUE

  *Enables the CAN subsystem.*
- #define HAL_USE_CRY TRUE

  *Enables the cryptographic subsystem.*
- #define HAL_USE_DAC TRUE

  *Enables the DAC subsystem.*
- #define HAL_USE_EXT TRUE

  *Enables the EXT subsystem.*
- #define HAL_USE_GPT TRUE

  *Enables the GPT subsystem.*
- #define HAL_USE_I2C TRUE

  *Enables the I2C subsystem.*
- #define HAL_USE_I2S TRUE

  *Enables the I2S subsystem.*
- #define HAL_USE_ICU TRUE

  *Enables the ICU subsystem.*
- #define HAL_USE_MAC TRUE

  *Enables the MAC subsystem.*
- #define HAL_USE_MMC_SPI TRUE

  *Enables the MMC_SPI subsystem.*
- #define HAL_USE_PWM TRUE

  *Enables the PWM subsystem.*
- #define HAL_USE_QSPI TRUE

  *Enables the QSPI subsystem.*
- #define HAL_USE_RTC TRUE

  *Enables the RTC subsystem.*
- #define HAL_USE_SDC TRUE

  *Enables the SDC subsystem.*
- #define HAL_USE_SERIAL TRUE

  *Enables the SERIAL subsystem.*
- #define HAL_USE_SERIAL_USB TRUE

  *Enables the SERIAL over USB subsystem.*
- #define HAL_USE_SPI TRUE

*Enables the SPI subsystem.*

- #define HAL_USE_UART TRUE

  *Enables the UART subsystem.*
- #define HAL_USE_USB TRUE

  *Enables the USB subsystem.*
- #define HAL_USE_WDG TRUE

  *Enables the WDG subsystem.*
- #define PAL_USE_CALLBACKS FALSE

  *Enables synchronous APIs.*
- #define PAL_USE_WAIT FALSE

  *Enables synchronous APIs.*
- #define ADC_USE_WAIT TRUE

  *Enables synchronous APIs.*
- #define ADC_USE_MUTUAL_EXCLUSION TRUE

  *Enables the `adcAcquireBus()` and `adcReleaseBus()` APIs.*
- #define CAN_USE_SLEEP_MODE TRUE

  *Sleep mode related APIs inclusion switch.*
- #define CAN_ENFORCE_USE_CALLBACKS FALSE

  *Enforces the driver to use direct callbacks rather than OSAL events.*
- #define HAL_CRY_USE_FALLBACK FALSE

  *Enables the SW fall-back of the cryptographic driver.*
- #define HAL_CRY_ENFORCE_FALLBACK FALSE

  *Makes the driver forcibly use the fall-back implementations.*
- #define DAC_USE_WAIT TRUE

  *Enables synchronous APIs.*
- #define DAC_USE_MUTUAL_EXCLUSION TRUE

  *Enables the `dacAcquireBus()` and `dacReleaseBus()` APIs.*
- #define I2C_USE_MUTUAL_EXCLUSION TRUE

  *Enables the mutual exclusion APIs on the I2C bus.*
- #define MAC_USE_ZERO_COPY TRUE

  *Enables the zero-copy API.*
- #define MAC_USE_EVENTS TRUE

  *Enables an event sources for incoming packets.*
- #define MMC_NICE_WAITING TRUE

  *Delays insertions.*
- #define QSPI_USE_WAIT TRUE

  *Enables synchronous APIs.*
- #define QSPI_USE_MUTUAL_EXCLUSION TRUE

  *Enables the `qspiAcquireBus()` and `qspiReleaseBus()` APIs.*
- #define SDC_INIT_RETRY 100

  *Number of initialization attempts before rejecting the card.*
- #define SDC_MMC_SUPPORT TRUE

  *Include support for MMC cards.*
- #define SDC_NICE_WAITING TRUE

  *Delays insertions.*
- #define SDC_INIT_OCR_V20 0x50FF8000U

  *OCR initialization constant for V20 cards.*
- #define SDC_INIT_OCR 0x80100000U

  *OCR initialization constant for non-V20 cards.*
- #define SERIAL_DEFAULT_BITRATE 38400

  *Default bit rate.*

- #define SERIAL_BUFFERS_SIZE 16

  *Serial buffers size.*
- #define SERIAL_USB_BUFFERS_SIZE 256

  *Serial over USB buffers size.*
- #define SERIAL_USB_BUFFERS_NUMBER 2

  *Serial over USB number of buffers.*
- #define SPI_USE_WAIT TRUE

  *Enables synchronous APIs.*
- #define SPI_USE_CIRCULAR FALSE

  *Enables circular transfers APIs.*
- #define SPI_USE_MUTUAL_EXCLUSION TRUE

  *Enables the `spiAcquireBus()` and `spiReleaseBus()` APIs.*
- #define SPI_SELECT_MODE SPI_SELECT_MODE_PAD

  *Handling method for SPI CS line.*
- #define UART_USE_WAIT TRUE

  *Enables synchronous APIs.*
- #define UART_USE_MUTUAL_EXCLUSION TRUE

  *Enables the `uartAcquireBus()` and `uartReleaseBus()` APIs.*
- #define USB_USE_WAIT TRUE

  *Enables synchronous APIs.*

## 7.28.2 Macro Definition Documentation

### 7.28.2.1 #define HAL_USE_PAL TRUE

Enables the PAL subsystem.

### 7.28.2.2 #define HAL_USE_ADC TRUE

Enables the ADC subsystem.

### 7.28.2.3 #define HAL_USE_CAN TRUE

Enables the CAN subsystem.

### 7.28.2.4 #define HAL_USE_CRY TRUE

Enables the cryptographic subsystem.

### 7.28.2.5 #define HAL_USE_DAC TRUE

Enables the DAC subsystem.

### 7.28.2.6 #define HAL_USE_EXT TRUE

Enables the EXT subsystem.

### 7.28.2.7 #define HAL_USE_GPT TRUE

Enables the GPT subsystem.

#### 7.28.2.8 #define HAL_USE_I2C TRUE

Enables the I2C subsystem.

#### 7.28.2.9 #define HAL_USE_I2S TRUE

Enables the I2S subsystem.

#### 7.28.2.10 #define HAL_USE_ICU TRUE

Enables the ICU subsystem.

#### 7.28.2.11 #define HAL_USE_MAC TRUE

Enables the MAC subsystem.

#### 7.28.2.12 #define HAL_USE_MMC_SPI TRUE

Enables the MMC_SPI subsystem.

#### 7.28.2.13 #define HAL_USE_PWM TRUE

Enables the PWM subsystem.

#### 7.28.2.14 #define HAL_USE_QSPI TRUE

Enables the QSPI subsystem.

#### 7.28.2.15 #define HAL_USE_RTC TRUE

Enables the RTC subsystem.

#### 7.28.2.16 #define HAL_USE_SDC TRUE

Enables the SDC subsystem.

#### 7.28.2.17 #define HAL_USE_SERIAL TRUE

Enables the SERIAL subsystem.

#### 7.28.2.18 #define HAL_USE_SERIAL_USB TRUE

Enables the SERIAL over USB subsystem.

#### 7.28.2.19 #define HAL_USE_SPI TRUE

Enables the SPI subsystem.

#### 7.28.2.20 #define HAL_USE_UART TRUE

Enables the UART subsystem.

#### 7.28.2.21 #define HAL_USE_USB TRUE

Enables the USB subsystem.

#### 7.28.2.22 #define HAL_USE_WDG TRUE

Enables the WDG subsystem.

#### 7.28.2.23 #define PAL_USE_CALLBACKS FALSE

Enables synchronous APIs.

**Note**

Disabling this option saves both code and data space.

#### 7.28.2.24 #define PAL_USE_WAIT FALSE

Enables synchronous APIs.

**Note**

Disabling this option saves both code and data space.

#### 7.28.2.25 #define ADC_USE_WAIT TRUE

Enables synchronous APIs.

**Note**

Disabling this option saves both code and data space.

#### 7.28.2.26 #define ADC_USE_MUTUAL_EXCLUSION TRUE

Enables the `adcAcquireBus()` and `adcReleaseBus()` APIs.

**Note**

Disabling this option saves both code and data space.

#### 7.28.2.27 #define CAN_USE_SLEEP_MODE TRUE

Sleep mode related APIs inclusion switch.

#### 7.28.2.28 #define CAN_ENFORCE_USE_CALLBACKS FALSE

Enforces the driver to use direct callbacks rather than OSAL events.

#### 7.28.2.29 #define HAL_CRY_USE_FALLBACK FALSE

Enables the SW fall-back of the cryptographic driver.

When enabled, this option, activates a fall-back software implementation for algorithms not supported by the underlying hardware.

**Note**

Fall-back implementations may not be present for all algorithms.

#### 7.28.2.30 #define HAL_CRY_ENFORCE_FALLBACK FALSE

Makes the driver forcibly use the fall-back implementations.

#### 7.28.2.31 #define DAC_USE_WAIT TRUE

Enables synchronous APIs.

**Note**

Disabling this option saves both code and data space.

#### 7.28.2.32 #define DAC_USE_MUTUAL_EXCLUSION TRUE

Enables the `dacAcquireBus()` and `dacReleaseBus()` APIs.

**Note**

Disabling this option saves both code and data space.

#### 7.28.2.33 #define I2C_USE_MUTUAL_EXCLUSION TRUE

Enables the mutual exclusion APIs on the I2C bus.

#### 7.28.2.34 #define MAC_USE_ZERO_COPY TRUE

Enables the zero-copy API.

#### 7.28.2.35 #define MAC_USE_EVENTS TRUE

Enables an event sources for incoming packets.

#### 7.28.2.36 #define MMC_NICE_WAITING TRUE

Delays insertions.

If enabled this options inserts delays into the MMC waiting routines releasing some extra CPU time for the threads with lower priority, this may slow down the driver a bit however. This option is recommended also if the SPI driver does not use a DMA channel and heavily loads the CPU.

#### 7.28.2.37 #define QSPI_USE_WAIT TRUE

Enables synchronous APIs.

**Note**

Disabling this option saves both code and data space.

#### 7.28.2.38 #define QSPI_USE_MUTUAL_EXCLUSION TRUE

Enables the `qspiAcquireBus()` and `qspiReleaseBus()` APIs.

**Note**

Disabling this option saves both code and data space.

#### 7.28.2.39 #define SDC_INIT_RETRY 100

Number of initialization attempts before rejecting the card.

**Note**

Attempts are performed at 10mS intervals.

#### 7.28.2.40 #define SDC_MMC_SUPPORT TRUE

Include support for MMC cards.

**Note**

MMC support is not yet implemented so this option must be kept at `FALSE`.

#### 7.28.2.41 #define SDC_NICE_WAITING TRUE

Delays insertions.

If enabled this options inserts delays into the MMC waiting routines releasing some extra CPU time for the threads with lower priority, this may slow down the driver a bit however.

#### 7.28.2.42 #define SDC_INIT_OCR_V20 0x50FF8000U

OCR initialization constant for V20 cards.

#### 7.28.2.43 #define SDC_INIT_OCR 0x80100000U

OCR initialization constant for non-V20 cards.

#### 7.28.2.44 #define SERIAL_DEFAULT_BITRATE 38400

Default bit rate.

Configuration parameter, this is the baud rate selected for the default configuration.

#### 7.28.2.45 #define SERIAL_BUFFERS_SIZE 16

Serial buffers size.

Configuration parameter, you can change the depth of the queue buffers depending on the requirements of your application.

**Note**

The default is 16 bytes for both the transmission and receive buffers.

#### 7.28.2.46 #define SERIAL_USB_BUFFERS_SIZE 256

Serial over USB buffers size.

Configuration parameter, the buffer size must be a multiple of the USB data endpoint maximum packet size.

**Note**

The default is 256 bytes for both the transmission and receive buffers.

#### 7.28.2.47 #define SERIAL_USB_BUFFERS_NUMBER 2

Serial over USB number of buffers.

**Note**

The default is 2 buffers.

#### 7.28.2.48 #define SPI_USE_WAIT TRUE

Enables synchronous APIs.

**Note**

Disabling this option saves both code and data space.

#### 7.28.2.49 #define SPI_USE_CIRCULAR FALSE

Enables circular transfers APIs.

**Note**

Disabling this option saves both code and data space.

#### 7.28.2.50 #define SPI_USE_MUTUAL_EXCLUSION TRUE

Enables the `spiAcquireBus()` and `spiReleaseBus()` APIs.

**Note**

Disabling this option saves both code and data space.

#### 7.28.2.51 #define SPI_SELECT_MODE SPI_SELECT_MODE_PAD

Handling method for SPI CS line.

**Note**

Disabling this option saves both code and data space.

#### 7.28.2.52 #define UART_USE_WAIT TRUE

Enables synchronous APIs.

**Note**

Disabling this option saves both code and data space.

#### 7.28.2.53 #define UART_USE_MUTUAL_EXCLUSION TRUE

Enables the `uartAcquireBus()` and `uartReleaseBus()` APIs.

**Note**

Disabling this option saves both code and data space.

#### 7.28.2.54 #define USB_USE_WAIT TRUE

Enables synchronous APIs.

**Note**

Disabling this option saves both code and data space.

## 7.29 Normal Drivers

HAL Normal Drivers.

### 7.29.1 Detailed Description

HAL Normal Drivers.

### Modules

- ADC Driver

  *Generic ADC Driver.*
- CAN Driver

  *Generic CAN Driver.*
- Crypto Driver

  *Generic Crypto Driver.*
- DAC Driver

  *Generic DAC Driver.*
- EXT Driver

  *Generic EXT Driver.*
- GPT Driver

  *Generic GPT Driver.*
- HAL Driver

  *Hardware Abstraction Layer.*
- I2C Driver

  *Generic I2C Driver.*
- I2S Driver

  *Generic I2S Driver.*
- ICU Driver

  *Generic ICU Driver.*
- MAC Driver

  *Generic MAC Driver.*
- PAL Driver

  *I/O Ports Abstraction Layer.*
- PWM Driver

  *Generic PWM Driver.*
- QSPI Driver

  *Generic QSPI Driver.*
- RTC Driver

  *Generic RTC Driver.*
- SDC Driver

  *Generic SD Card Driver.*
- Serial Driver

  *Generic Serial Driver.*
- SPI Driver

  *Generic SPI Driver.*
- ST Driver

  *Generic System Tick Driver.*
- UART Driver

  *Generic UART Driver.*

- USB Driver

  *Generic USB Driver.*
- WDG Driver

  *Generic WDG Driver.*

# 7.30 Complex Drivers

HAL Complex Drivers.

## 7.30.1 Detailed Description

HAL Complex Drivers.

### Modules

- Managed Flash Storage Driver

  *Managed Flash Storage Driver.*
- MMC over SPI Driver

  *Generic MMC driver.*
- Serial over USB Driver

  *Serial over USB Driver.*

## 7.31 Interfaces and Classes

HAL Interfaces and Classes.

### 7.31.1 Detailed Description

HAL Interfaces and Classes.

#### Modules

- Abstract I/O Channel
- Abstract Files
- Abstract I/O Block Device
- Base Object
- Abstract Peripheral Interfaces

  *HAL Abstract Peripheral Interfaces.*
- Abstract Streams

## 7.32 Inner Code

HAL Inner Code.

### 7.32.1 Detailed Description

HAL Inner Code.

#### Modules

- I/O Buffers Queues
- I/O Bytes Queues
- MMC/SD Block Device

## 7.33 Support Code

HAL Support Code.

### 7.33.1 Detailed Description

HAL Support Code.

#### Modules

- MII/RMII Header

  *MII/RMII Support Header.*
- USB CDC Header

  *USB CDC Support Header.*

## 7.34 OSAL

Operating System Abstraction Layer.

### 7.34.1 Detailed Description

Operating System Abstraction Layer.

#### The OSAL

The OSAL is the link between ChibiOS/HAL and services provided by operating systems like:

- Critical Zones handling.
- Interrupts handling.
- Runtime Errors management.
- Inter-task synchronization.
- Task-ISR synchronization.
- Time management.
- Events.

ChibiOS/HAL is designed to tightly integrate with the underlying RTOS in order to provide the best experience to developers and minimize integration issues.
This section describes the API that OSALs are expected to expose to the HAL.

#### RTOS Requirements

The OSAL API closely resembles the ChibiOS/RT API, for obvious reasons, however an OSAL module can be implemented for any reasonably complete RTOS or even a RTOS-less bare metal machine, if required.
In order to be able to support an HAL an RTOS should support the following minimal set of features:

- Task-level critical zones API.
- ISR-level critical zones API, only required on those CPU architectures supporting preemptable ISRs like Cortex-Mx cores.
- Ability to invoke API functions from inside a task critical zone. Functions that are required to support this feature are marked with an "I" or "S" letter at the end of the name.
- Ability to invoke API functions from inside an ISR critical zone. Functions that are required to support this feature are marked with an "I" letter at the end of the name.
- Tasks Queues or Counting Semaphores with Timeout capability.
- Ability to suspend a task and wakeup it from ISR with Timeout capability.
- Event flags, the mechanism can be simulated using callbacks in case the RTOS does not support it.
- Mutual Exclusion mechanism like Semaphores or Mutexes.

All the above requirements can be satisfied even on naked HW with a very think SW layer. In case that the HAL is required to work without an RTOS.

#### Supported RTOSes

The RTOSes supported out of the box are:

- ChibiOS/RT
- ChibiOS/NIL

Implementations have also been successfully created on RTOSes not belonging to the ChibiOS products family but are not supported as a core feature of ChibiOS/HAL.

### Macros

- #define OSAL_DBG_ENABLE_ASSERTS FALSE

  *Enables OSAL assertions.*
- #define OSAL_DBG_ENABLE_CHECKS FALSE

  *Enables OSAL functions parameters checks.*

### Common constants

- #define **FALSE** 0
- #define **TRUE** 1
- #define **OSAL_SUCCESS** false
- #define **OSAL_FAILED** true

### Messages

- #define **MSG_OK** (msg_t)0
- #define **MSG_TIMEOUT** (msg_t)-1
- #define **MSG_RESET** (msg_t)-2

### Special time constants

- #define **TIME_IMMEDIATE** ((sysinterval_t)0)
- #define **TIME_INFINITE** ((sysinterval_t)-1)

### Systick modes.

- #define **OSAL_ST_MODE_NONE** 0
- #define **OSAL_ST_MODE_PERIODIC** 1
- #define **OSAL_ST_MODE_FREERUNNING** 2

### Systick parameters.

- #define OSAL_ST_RESOLUTION 32

  *Size in bits of the `systick_t` type.*
- #define OSAL_ST_FREQUENCY 1000

  *Required systick frequency or resolution.*
- #define OSAL_ST_MODE OSAL_ST_MODE_PERIODIC

  *Systick mode required by the underlying OS.*

### IRQ-related constants

- #define OSAL_IRQ_PRIORITY_LEVELS 16U

  *Total priority levels.*
- #define OSAL_IRQ_MAXIMUM_PRIORITY 0U

  *Highest IRQ priority for HAL drivers.*

### Debug related macros

- #define osalDbgAssert(c, remark)

  *Condition assertion.*
- #define osalDbgCheck(c)

  *Function parameters check.*
- #define osalDbgCheckClassI()

  *I-Class state check.*
- #define osalDbgCheckClassS()

  *S-Class state check.*

### IRQ service routines wrappers

- #define OSAL_IRQ_IS_VALID_PRIORITY(n) (((n) >= OSAL_IRQ_MAXIMUM_PRIORITY) && ((n) < OS↵ AL_IRQ_PRIORITY_LEVELS))

  *Priority level verification macro.*
- #define OSAL_IRQ_PROLOGUE()

  *IRQ prologue code.*
- #define OSAL_IRQ_EPILOGUE()

  *IRQ epilogue code.*
- #define OSAL_IRQ_HANDLER(id) void id(void)

  *IRQ handler function declaration.*

### Time conversion utilities

- #define OSAL_S2I(secs) ((sysinterval_t)((uint32_t)(secs) ∗ (uint32_t)OSAL_ST_FREQUENCY))

  *Seconds to system ticks.*
- #define OSAL_MS2I(msecs)

  *Milliseconds to system ticks.*
- #define OSAL_US2I(usecs)

  *Microseconds to system ticks.*

### Time conversion utilities for the realtime counter

- #define OSAL_S2RTC(freq, sec) ((freq) ∗ (sec))

  *Seconds to realtime counter.*
- #define OSAL_MS2RTC(freq, msec) (rtcnt_t)((((freq) + 999UL) / 1000UL) ∗ (msec))

  *Milliseconds to realtime counter.*
- #define OSAL_US2RTC(freq, usec) (rtcnt_t)((((freq) + 999999UL) / 1000000UL) ∗ (usec))

  *Microseconds to realtime counter.*

### Sleep macros using absolute time

- #define osalThreadSleepSeconds(secs) osalThreadSleep(OSAL_S2I(secs))

  *Delays the invoking thread for the specified number of seconds.*
- #define osalThreadSleepMilliseconds(msecs) osalThreadSleep(OSAL_MS2I(msecs))

  *Delays the invoking thread for the specified number of milliseconds.*
- #define osalThreadSleepMicroseconds(usecs) osalThreadSleep(OSAL_US2I(usecs))

  *Delays the invoking thread for the specified number of microseconds.*

### Typedefs

- typedef uint32_t syssts_t

  *Type of a system status word.*
- typedef int32_t msg_t

  *Type of a message.*
- typedef uint32_t systime_t

  *Type of system time counter.*
- typedef uint32_t sysinterval_t

  *Type of system time interval.*
- typedef uint32_t rtcnt_t

  *Type of realtime counter.*
- typedef void ∗ thread_reference_t

  *Type of a thread reference.*
- typedef uint32_t eventflags_t

  *Type of an event flags mask.*
- typedef struct event_source event_source_t

  *Type of an event flags object.*
- typedef void(∗ eventcallback_t) (event_source_t ∗esp)

  *Type of an event source callback.*
- typedef uint32_t mutex_t

  *Type of a mutex.*

### Data Structures

- struct event_source

  *Events source object.*
- struct threads_queue_t

  *Type of a thread queue.*

### Functions

- void osalInit (void)

  *OSAL module initialization.*
- void osalSysHalt (const char ∗reason)

  *System halt with error message.*
- void osalSysPolledDelayX (rtcnt_t cycles)

  *Polled delay.*
- void osalOsTimerHandlerI (void)

  *System timer handler.*
- void osalOsRescheduleS (void)

*Checks if a reschedule is required and performs it.*

- systime_t osalOsGetSystemTimeX (void)

  *Current system time.*
- void osalThreadSleepS (sysinterval_t time)

  *Suspends the invoking thread for the specified time.*
- void osalThreadSleep (sysinterval_t time)

  *Suspends the invoking thread for the specified time.*
- msg_t osalThreadSuspendS (thread_reference_t ∗trp)

  *Sends the current thread sleeping and sets a reference variable.*
- msg_t osalThreadSuspendTimeoutS (thread_reference_t ∗trp, sysinterval_t timeout)

  *Sends the current thread sleeping and sets a reference variable.*
- void osalThreadResumeI (thread_reference_t ∗trp, msg_t msg)

  *Wakes up a thread waiting on a thread reference object.*
- void osalThreadResumeS (thread_reference_t ∗trp, msg_t msg)

  *Wakes up a thread waiting on a thread reference object.*
- msg_t osalThreadEnqueueTimeoutS (threads_queue_t ∗tqp, sysinterval_t timeout)

  *Enqueues the caller thread.*
- void osalThreadDequeueNextI (threads_queue_t ∗tqp, msg_t msg)

  *Dequeues and wakes up one thread from the queue, if any.*
- void osalThreadDequeueAllI (threads_queue_t ∗tqp, msg_t msg)

  *Dequeues and wakes up all threads from the queue.*
- void osalEventBroadcastFlagsI (event_source_t ∗esp, eventflags_t flags)

  *Add flags to an event source object.*
- void osalEventBroadcastFlags (event_source_t ∗esp, eventflags_t flags)

  *Add flags to an event source object.*
- void osalEventSetCallback (event_source_t ∗esp, eventcallback_t cb, void ∗param)

  *Event callback setup.*
- void osalMutexLock (mutex_t ∗mp)

  *Locks the specified mutex.*
- void osalMutexUnlock (mutex_t ∗mp)

  *Unlocks the specified mutex.*
- static void osalSysDisable (void)

  *Disables interrupts globally.*
- static void osalSysEnable (void)

  *Enables interrupts globally.*
- static void osalSysLock (void)

  *Enters a critical zone from thread context.*
- static void osalSysUnlock (void)

  *Leaves a critical zone from thread context.*
- static void osalSysLockFromISR (void)

  *Enters a critical zone from ISR context.*
- static void osalSysUnlockFromISR (void)

  *Leaves a critical zone from ISR context.*
- static syssts_t osalSysGetStatusAndLockX (void)

  *Returns the execution status and enters a critical zone.*
- static void osalSysRestoreStatusX (syssts_t sts)

  *Restores the specified execution status and leaves a critical zone.*
- static systime_t osalTimeAddX (systime_t systime, sysinterval_t interval)

  *Adds an interval to a system time returning a system time.*
- static sysinterval_t osalTimeDiffX (systime_t start, systime_t end)

  *Subtracts two system times returning an interval.*

- static bool osalTimeIsInRangeX (systime_t time, systime_t start, systime_t end)

  *Checks if the specified time is within the specified time window.*
- static void osalThreadQueueObjectInit (threads_queue_t ∗tqp)

  *Initializes a threads queue object.*
- static void osalEventObjectInit (event_source_t ∗esp)

  *Initializes an event source object.*
- static void osalMutexObjectInit (mutex_t ∗mp)

  *Initializes s `mutex_t` object.*

### Variables

- const char ∗ osal_halt_msg

  *Pointer to a halt error message.*
- const char ∗ osal_halt_msg

  *Pointer to a halt error message.*

## 7.34.2 Macro Definition Documentation

### 7.34.2.1 #define OSAL_ST_RESOLUTION 32

Size in bits of the `systick_t` type.

### 7.34.2.2 #define OSAL_ST_FREQUENCY 1000

Required systick frequency or resolution.

### 7.34.2.3 #define OSAL_ST_MODE OSAL_ST_MODE_PERIODIC

Systick mode required by the underlying OS.

### 7.34.2.4 #define OSAL_IRQ_PRIORITY_LEVELS 16U

Total priority levels.

Implementation not mandatory.

### 7.34.2.5 #define OSAL_IRQ_MAXIMUM_PRIORITY 0U

Highest IRQ priority for HAL drivers.

Implementation not mandatory.

### 7.34.2.6 #define OSAL_DBG_ENABLE_ASSERTS FALSE

Enables OSAL assertions.

### 7.34.2.7 #define OSAL_DBG_ENABLE_CHECKS FALSE

Enables OSAL functions parameters checks.

#### 7.34.2.8 #define osalDbgAssert( *c,* *remark* )

**Value:**

```
do {                                       \
  /*lint -save -e506 -e774 [2.1, 14.3] Can be a constant by design.*/       \
  if (OSAL_DBG_ENABLE_ASSERTS != FALSE) {                                   \
    if (!(c)) {                                                             \
  /*lint -restore*/                                                         \
      osalSysHalt(__func__);                                                \
    }                                                                       \
  }                                                                         \
} while (false)
```

Condition assertion.

If the condition check fails then the OSAL panics with a message and halts.

**Note**

The condition is tested only if the `OSAL_ENABLE_ASSERTIONS` switch is enabled.
The remark string is not currently used except for putting a comment in the code about the assertion.

**Parameters**

| | | |
|---|---|---|
| in | *c* | the condition to be verified to be true |
| in | *remark* | a remark string |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.34.2.9 #define osalDbgCheck( *c* )

**Value:**

```
do {                                                \
  /*lint -save -e506 -e774 [2.1, 14.3] Can be a constant by design.*/       \
  if (OSAL_DBG_ENABLE_CHECKS != FALSE) {                                    \
    if (!(c)) {                                                             \
  /*lint -restore*/                                                         \
      osalSysHalt(__func__);                                                \
    }                                                                       \
  }                                                                         \
} while (false)
```

Function parameters check.

If the condition check fails then the OSAL panics and halts.

**Note**

The condition is tested only if the `OSAL_ENABLE_CHECKS` switch is enabled.

**Parameters**

| | | |
|---|---|---|
| in | *c* | the condition to be verified to be true |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.34.2.10 #define osalDbgCheckClassI( )

I-Class state check.

**Note**

Implementation is optional.

#### 7.34.2.11 #define osalDbgCheckClassS( )

S-Class state check.

**Note**

Implementation is optional.

#### 7.34.2.12 #define OSAL_IRQ_IS_VALID_PRIORITY( *n* ) (((n) >= OSAL_IRQ_MAXIMUM_PRIORITY) && ((n) < OSAL_IRQ_PRIORITY_LEVELS))

Priority level verification macro.

#### 7.34.2.13 #define OSAL_IRQ_PROLOGUE( )

IRQ prologue code.

This macro must be inserted at the start of all IRQ handlers.

#### 7.34.2.14 #define OSAL_IRQ_EPILOGUE( )

IRQ epilogue code.

This macro must be inserted at the end of all IRQ handlers.

#### 7.34.2.15 #define OSAL_IRQ_HANDLER( *id* ) void id(void)

IRQ handler function declaration.

This macro hides the details of an ISR function declaration.

**Parameters**

| | | |
|---|---|---|
| `in` | *id* | a vector name as defined in `vectors.s` |

#### 7.34.2.16 #define OSAL_S2I( *secs* ) ((sysinterval_t)((uint32_t)(secs) $*$ (uint32_t)OSAL_ST_FREQUENCY))

Seconds to system ticks.

Converts from seconds to system ticks number.

**Note**

The result is rounded upward to the next tick boundary.

**Parameters**

| | | |
|---|---|---|
| in | *secs* | number of seconds |

**Returns**

The number of ticks.

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

### 7.34.2.17 #define OSAL_MS2I( *msecs* )

**Value:**

```
((sysinterval_t)((((((uint32_t)(msecs)) *                                   \
                  ((uint32_t)OSAL_ST_FREQUENCY)) - 1UL) / 1000UL) + 1UL))
```

Milliseconds to system ticks.

Converts from milliseconds to system ticks number.

**Note**

The result is rounded upward to the next tick boundary.

**Parameters**

| | | |
|---|---|---|
| in | *msecs* | number of milliseconds |

**Returns**

The number of ticks.

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

### 7.34.2.18 #define OSAL_US2I( *usecs* )

**Value:**

```
((sysinterval_t)((((((uint32_t)(usecs)) *                                   \
                  ((uint32_t)OSAL_ST_FREQUENCY)) - 1UL) / 1000000UL) + 1UL))
```

Microseconds to system ticks.

Converts from microseconds to system ticks number.

**Note**

The result is rounded upward to the next tick boundary.

**Parameters**

| | | |
|---|---|---|
| in | *usecs* | number of microseconds |

**Returns**

The number of ticks.

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.34.2.19 #define OSAL_S2RTC( *freq,* *sec* ) ((freq) ∗ (sec))

Seconds to realtime counter.

Converts from seconds to realtime counter cycles.

**Note**

The macro assumes that `freq` >= `1`.

**Parameters**

| | | |
|---|---|---|
| in | *freq* | clock frequency, in Hz, of the realtime counter |
| in | *sec* | number of seconds |

**Returns**

The number of cycles.

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.34.2.20 #define OSAL_MS2RTC( *freq,* *msec* ) (rtcnt_t)((((freq) + 999UL) / 1000UL) ∗ (msec))

Milliseconds to realtime counter.

Converts from milliseconds to realtime counter cycles.

**Note**

The result is rounded upward to the next millisecond boundary.
The macro assumes that `freq` >= `1000`.

**Parameters**

| | | |
|---|---|---|
| in | *freq* | clock frequency, in Hz, of the realtime counter |
| in | *msec* | number of milliseconds |

**Returns**

The number of cycles.

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.34.2.21 #define OSAL_US2RTC( *freq,* *usec* ) (rtcnt_t)((((freq) + 999999UL) / 1000000UL) ∗ (usec))

Microseconds to realtime counter.

Converts from microseconds to realtime counter cycles.

**Note**

The result is rounded upward to the next microsecond boundary.
The macro assumes that `freq` >= `1000000`.

**Parameters**

| | | |
|---|---|---|
| `in` | *freq* | clock frequency, in Hz, of the realtime counter |
| `in` | *usec* | number of microseconds |

**Returns**

The number of cycles.

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.34.2.22 #define osalThreadSleepSeconds( *secs* ) osalThreadSleep(OSAL_S2I(secs))

Delays the invoking thread for the specified number of seconds.

**Note**

The specified time is rounded up to a value allowed by the real system tick clock.
The maximum specifiable value is implementation dependent.

**Parameters**

| | | |
|---|---|---|
| `in` | *secs* | time in seconds, must be different from zero |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.34.2.23 #define osalThreadSleepMilliseconds( *msecs* ) osalThreadSleep(OSAL_MS2I(msecs))

Delays the invoking thread for the specified number of milliseconds.

**Note**

The specified time is rounded up to a value allowed by the real system tick clock.
The maximum specifiable value is implementation dependent.

**Parameters**

| | | |
|---|---|---|
| `in` | *msecs* | time in milliseconds, must be different from zero |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.34.2.24 #define osalThreadSleepMicroseconds( *usecs* ) osalThreadSleep(OSAL_US2I(usecs))

Delays the invoking thread for the specified number of microseconds.

**Note**

The specified time is rounded up to a value allowed by the real system tick clock.
The maximum specifiable value is implementation dependent.

**Parameters**

| | | |
|---|---|---|
| `in` | *usecs* | time in microseconds, must be different from zero |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

### 7.34.3 Typedef Documentation

#### 7.34.3.1 typedef uint32_t syssts_t

Type of a system status word.

#### 7.34.3.2 typedef int32_t msg_t

Type of a message.

#### 7.34.3.3 typedef uint32_t systime_t

Type of system time counter.

#### 7.34.3.4 typedef uint32_t sysinterval_t

Type of system time interval.

#### 7.34.3.5 typedef uint32_t rtcnt_t

Type of realtime counter.

#### 7.34.3.6 typedef void∗ thread_reference_t

Type of a thread reference.

#### 7.34.3.7 typedef uint32_t eventflags_t

Type of an event flags mask.

#### 7.34.3.8 typedef struct event_source event_source_t

Type of an event flags object.

**Note**

> The content of this structure is not part of the API and should not be relied upon. Implementers may define this structure in an entirely different way.
> Retrieval and clearing of the flags are not defined in this API and are implementation-dependent.

#### 7.34.3.9 typedef void(∗ eventcallback_t) (event_source_t ∗esp)

Type of an event source callback.

**Note**

> This type is not part of the OSAL API and is provided exclusively as an example and for convenience.

#### 7.34.3.10 typedef uint32_t mutex_t

Type of a mutex.

**Note**

> If the OS does not support mutexes or there is no OS then them mechanism can be simulated.

### 7.34.4 Function Documentation

#### 7.34.4.1 void osalInit ( void )

OSAL module initialization.

**Function Class:**

> Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.34.4.2 void osalSysHalt ( const char ∗ *reason* )

System halt with error message.

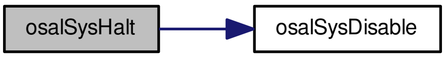
**Parameters**

| | | |
|---|---|---|
| `in` | *reason* | the halt message pointer |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.34.4.3 void osalSysPolledDelayX ( rtcnt_t *cycles* )

Polled delay.

**Note**

The real delay is always few cycles in excess of the specified value.

**Parameters**

| | | |
|---|---|---|
| `in` | *cycles* | number of cycles |

**Function Class:**

This is an **X-Class** API, this function can be invoked from any context.

#### 7.34.4.4 void osalOsTimerHandlerI ( void )

System timer handler.

The handler is used for scheduling and Virtual Timers management.

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

#### 7.34.4.5 void osalOsRescheduleS ( void )

Checks if a reschedule is required and performs it.

**Note**

I-Class functions invoked from thread context must not reschedule by themselves, an explicit reschedule using this function is required in this scenario.
Not implemented in this simplified OSAL.

**Function Class:**

This is an **S-Class** API, this function can be invoked from within a system lock zone by threads only.

#### 7.34.4.6 systime_t osalOsGetSystemTimeX ( void )

Current system time.

Returns the number of system ticks since the `osalInit()` invocation.

**Note**

The counter can reach its maximum and then restart from zero.
This function can be called from any context but its atomicity is not guaranteed on architectures whose word size is less than `systime_t` size.

**Returns**

The system time in ticks.

**Function Class:**

This is an **X-Class** API, this function can be invoked from any context.

#### 7.34.4.7 void osalThreadSleepS ( sysinterval_t *time* )

Suspends the invoking thread for the specified time.

**Parameters**

| | | |
|---|---|---|
| `in` | *time* | the delay in system ticks, the special values are handled as follow:<br>• *TIME_INFINITE* is allowed but interpreted as a normal time specification.<br>• *TIME_IMMEDIATE* this value is not allowed. |

**Function Class:**

This is an **S-Class** API, this function can be invoked from within a system lock zone by threads only.

#### 7.34.4.8 void osalThreadSleep ( sysinterval_t *time* )

Suspends the invoking thread for the specified time.

**Parameters**

| | | |
|---|---|---|
| `in` | *time* | the delay in system ticks, the special values are handled as follow:<br>• *TIME_INFINITE* is allowed but interpreted as a normal time specification.<br>• *TIME_IMMEDIATE* this value is not allowed. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.34.4.9 msg_t osalThreadSuspendS ( thread_reference_t * *trp* )

Sends the current thread sleeping and sets a reference variable.

**Note**

This function must reschedule, it can only be called from thread context.

**Parameters**

| | | |
|---|---|---|
| in | *trp* | a pointer to a thread reference object |

**Returns**

The wake up message.

**Function Class:**

This is an **S-Class** API, this function can be invoked from within a system lock zone by threads only.

#### 7.34.4.10 msg_t osalThreadSuspendTimeoutS ( thread_reference_t * *trp,* sysinterval_t *timeout* )

Sends the current thread sleeping and sets a reference variable.

**Note**

This function must reschedule, it can only be called from thread context.

**Parameters**

| | | |
|---|---|---|
| in | *trp* | a pointer to a thread reference object |
| in | *timeout* | the timeout in system ticks, the special values are handled as follow:<br>• *TIME_INFINITE* the thread enters an infinite sleep state.<br>• *TIME_IMMEDIATE* the thread is not enqueued and the function returns `MSG_TIMEOUT` as if a timeout occurred. |

**Returns**

The wake up message.

**Return values**

| | |
|---|---|
| *MSG_TIMEOUT* | if the operation timed out. |

**Function Class:**

This is an **S-Class** API, this function can be invoked from within a system lock zone by threads only.

#### 7.34.4.11 void osalThreadResumeI ( thread_reference_t * *trp,* msg_t *msg* )

Wakes up a thread waiting on a thread reference object.

**Note**

This function must not reschedule because it can be called from ISR context.

**Parameters**

| | | |
|---|---|---|
| in | *trp* | a pointer to a thread reference object |
| in | *msg* | the message code |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

#### 7.34.4.12 void osalThreadResumeS ( thread_reference_t * *trp,* msg_t *msg* )

Wakes up a thread waiting on a thread reference object.

**Note**

This function must reschedule, it can only be called from thread context.

**Parameters**

| | | |
|---|---|---|
| in | *trp* | a pointer to a thread reference object |
| in | *msg* | the message code |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

#### 7.34.4.13 msg_t osalThreadEnqueueTimeoutS ( threads_queue_t * *tqp,* sysinterval_t *timeout* )

Enqueues the caller thread.

The caller thread is enqueued and put to sleep until it is dequeued or the specified timeouts expires.

**Parameters**

| | | |
|---|---|---|
| in | *tqp* | pointer to the threads queue object |
| in | *timeout* | the timeout in system ticks, the special values are handled as follow:<br>• *TIME_INFINITE* the thread enters an infinite sleep state.<br>• *TIME_IMMEDIATE* the thread is not enqueued and the function returns `MSG_TIMEOUT` as if a timeout occurred. |

**Returns**

The message from `osalQueueWakeupOneI()` or `osalQueueWakeupAllI()` functions.

**Return values**

| | |
|---|---|
| *MSG_TIMEOUT* | if the thread has not been dequeued within the specified timeout or if the function has been invoked with `TIME_IMMEDIATE` as timeout specification. |

**Function Class:**

This is an **S-Class** API, this function can be invoked from within a system lock zone by threads only.

#### 7.34.4.14 void osalThreadDequeueNextI ( threads_queue_t ∗ *tqp,* msg_t *msg* )

Dequeues and wakes up one thread from the queue, if any.

**Parameters**

| | | |
|---|---|---|
| `in` | *tqp* | pointer to the threads queue object |
| `in` | *msg* | the message code |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

#### 7.34.4.15 void osalThreadDequeueAllI ( threads_queue_t ∗ *tqp,* msg_t *msg* )

Dequeues and wakes up all threads from the queue.

**Parameters**

| | | |
|---|---|---|
| `in` | *tqp* | pointer to the threads queue object |
| `in` | *msg* | the message code |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

#### 7.34.4.16 void osalEventBroadcastFlagsI ( event_source_t ∗ *esp,* eventflags_t *flags* )

Add flags to an event source object.

**Parameters**

| | | |
|---|---|---|
| `in` | *esp* | pointer to the event flags object |
| `in` | *flags* | flags to be ORed to the flags mask |

**Function Class:**

> This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

#### 7.34.4.17 void osalEventBroadcastFlags ( event_source_t ∗ *esp,* eventflags_t *flags* )

Add flags to an event source object.

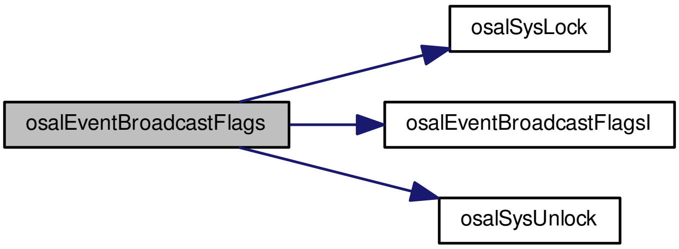
**Parameters**

| | | |
|---|---|---|
| in | *esp* | pointer to the event flags object |
| in | *flags* | flags to be ORed to the flags mask |

**Function Class:**

> This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

Here is the call graph for this function:



#### 7.34.4.18 void osalEventSetCallback ( event_source_t ∗ *esp,* eventcallback_t *cb,* void ∗ *param* )

Event callback setup.

**Note**

> The callback is invoked from ISR context and can only invoke I-Class functions. The callback is meant to wakeup the task that will handle the event by calling `osalEventGetAndClearFlagsI()`.
> This function is not part of the OSAL API and is provided exclusively as an example and for convenience.

**Parameters**

| | | |
|---|---|---|
| in | *esp* | pointer to the event flags object |
| in | *cb* | pointer to the callback function |
| in | *param* | parameter to be passed to the callback function |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

### 7.34.4.19 void osalMutexLock ( mutex_t ∗ *mp* )

Locks the specified mutex.

**Postcondition**

The mutex is locked and inserted in the per-thread stack of owned mutexes.

**Parameters**

| | | |
|---|---|---|
| `in,out` | *mp* | pointer to the `mutex_t` object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

### 7.34.4.20 void osalMutexUnlock ( mutex_t ∗ *mp* )

Unlocks the specified mutex.

**Note**

The HAL guarantees to release mutex in reverse lock order. The mutex being unlocked is guaranteed to be the last locked mutex by the invoking thread. The implementation can rely on this behavior and eventually ignore the `mp` parameter which is supplied in order to support those OSes not supporting a stack of the owned mutexes.

**Parameters**

| | | |
|---|---|---|
| `in,out` | *mp* | pointer to the `mutex_t` object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

### 7.34.4.21 static void osalSysDisable ( void ) `[inline]`, `[static]`

Disables interrupts globally.

**Function Class:**

Special function, this function has special requirements see the notes.

### 7.34.4.22 static void osalSysEnable ( void ) `[inline]`, `[static]`

Enables interrupts globally.

**Function Class:**

Special function, this function has special requirements see the notes.

#### 7.34.4.23 static void osalSysLock ( void ) [inline], [static]

Enters a critical zone from thread context.

**Note**

This function cannot be used for reentrant critical zones.

**Function Class:**

Special function, this function has special requirements see the notes.

#### 7.34.4.24 static void osalSysUnlock ( void ) [inline], [static]

Leaves a critical zone from thread context.

**Note**

This function cannot be used for reentrant critical zones.

**Function Class:**

Special function, this function has special requirements see the notes.

#### 7.34.4.25 static void osalSysLockFromISR ( void ) [inline], [static]

Enters a critical zone from ISR context.

**Note**

This function cannot be used for reentrant critical zones.

**Function Class:**

Special function, this function has special requirements see the notes.

#### 7.34.4.26 static void osalSysUnlockFromISR ( void ) [inline], [static]

Leaves a critical zone from ISR context.

**Note**

This function cannot be used for reentrant critical zones.

**Function Class:**

Special function, this function has special requirements see the notes.

#### 7.34.4.27 static syssts_t osalSysGetStatusAndLockX ( void ) [inline], [static]

Returns the execution status and enters a critical zone.

This functions enters into a critical zone and can be called from any context. Because its flexibility it is less efficient than `chSysLock()` which is preferable when the calling context is known.

**Postcondition**

The system is in a critical zone.

**Returns**

The previous system status, the encoding of this status word is architecture-dependent and opaque.

**Function Class:**

This is an **X-Class** API, this function can be invoked from any context.

#### 7.34.4.28 static void osalSysRestoreStatusX ( syssts_t *sts* ) [inline], [static]

Restores the specified execution status and leaves a critical zone.

**Note**

A call to `chSchRescheduleS()` is automatically performed if exiting the critical zone and if not in ISR context.

**Parameters**

| | | |
|---|---|---|
| in | *sts* | the system status to be restored. |

**Function Class:**

This is an **X-Class** API, this function can be invoked from any context.

#### 7.34.4.29 static systime_t osalTimeAddX ( systime_t *systime,* sysinterval_t *interval* ) [inline], [static]

Adds an interval to a system time returning a system time.

**Parameters**

| | | |
|---|---|---|
| in | *systime* | base system time |
| in | *interval* | interval to be added |

**Returns**

The new system time.

**Function Class:**

This is an **X-Class** API, this function can be invoked from any context.

#### 7.34.4.30 static sysinterval_t osalTimeDiffX ( systime_t *start*, systime_t *end* ) [inline], [static]

Subtracts two system times returning an interval.

**Parameters**

| | | |
|---|---|---|
| in | *start* | first system time |
| in | *end* | second system time |

**Returns**

The interval representing the time difference.

**Function Class:**

This is an **X-Class** API, this function can be invoked from any context.

#### 7.34.4.31 static bool osalTimeIsInRangeX ( systime_t *time*, systime_t *start*, systime_t *end* ) [inline], [static]

Checks if the specified time is within the specified time window.

**Note**

When start==end then the function returns always true because the whole time range is specified.
This function can be called from any context.

**Parameters**

| | | |
|---|---|---|
| in | *time* | the time to be verified |
| in | *start* | the start of the time window (inclusive) |
| in | *end* | the end of the time window (non inclusive) |

**Return values**

| | |
|---|---|
| *true* | current time within the specified time window. |
| *false* | current time not within the specified time window. |

**Function Class:**

This is an **X-Class** API, this function can be invoked from any context.

#### 7.34.4.32 static void osalThreadQueueObjectInit ( threads_queue_t ∗ *tqp* ) [inline], [static]

Initializes a threads queue object.

**Parameters**

| | | |
|---|---|---|
| out | *tqp* | pointer to the threads queue object |

**Function Class:**

Initializer, this function just initializes an object and can be invoked before the kernel is initialized.

#### 7.34.4.33 static void osalEventObjectInit ( event_source_t * *esp* ) [inline], [static]

Initializes an event source object.

**Parameters**

| | | |
|---|---|---|
| out | *esp* | pointer to the event source object |

**Function Class:**

Initializer, this function just initializes an object and can be invoked before the kernel is initialized.

#### 7.34.4.34 static void osalMutexObjectInit ( mutex_t * *mp* ) [inline], [static]

Initializes s `mutex_t` object.

**Parameters**

| | | |
|---|---|---|
| out | *mp* | pointer to the `mutex_t` object |

**Function Class:**

Initializer, this function just initializes an object and can be invoked before the kernel is initialized.

### 7.34.5 Variable Documentation

#### 7.34.5.1 const char* osal_halt_msg

Pointer to a halt error message.

**Note**

The message is meant to be retrieved by the debugger after the system halt caused by an unexpected error.

#### 7.34.5.2 const char* osal_halt_msg

Pointer to a halt error message.

**Note**

The message is meant to be retrieved by the debugger after the system halt caused by an unexpected error.

## 7.35 Managed Flash Storage Driver

Managed Flash Storage Driver.

### 7.35.1 Detailed Description

Managed Flash Storage Driver.

This module implements a managed flash storage able to store a finite number of variable-size records. Records are retrieved by their index number.
The driver is automatically performs:

- Wear leveling.
- Auto repair after power loss.
- Garbage collection in order to remove erased data.

### Macros

- #define RET_ON_ERROR(err)

  *Error check helper.*

### Configuration options

- #define MFS_CFG_MAX_RECORDS 32

  *Maximum number of indexed records in the managed storage.*
- #define MFS_CFG_MAX_REPAIR_ATTEMPTS 3

  *Maximum number of repair attempts on partition mount.*
- #define MFS_CFG_WRITE_VERIFY TRUE

  *Verify written data.*
- #define MFS_CFG_STRONG_CHECKING TRUE

  *Enables a stronger and slower check procedure on mount.*
- #define MFS_CFG_BUFFER_SIZE 32

  *Size of the buffer used for data copying.*

### Error codes handling macros

- #define **MFS_IS_ERROR**(err) ((err) < MFS_NO_ERROR)
- #define **MFS_IS_WARNING**(err) ((err) > MFS_NO_ERROR)

### Typedefs

- typedef uint32_t mfs_id_t

  *Type of a record identifier.*

## Data Structures

- union mfs_bank_header_t

  *Type of a bank header.*
- union mfs_data_header_t

  *Type of a data block header.*
- struct MFSConfig

  *Type of a MFS configuration structure.*
- struct MFSDriver

  *Type of an MFS instance.*

## Functions

- static mfs_error_t mfs_flash_read (MFSDriver ∗mfsp, flash_offset_t offset, size_t n, uint8_t ∗rp)

  *Flash read.*
- static mfs_error_t mfs_flash_write (MFSDriver ∗mfsp, flash_offset_t offset, size_t n, const uint8_t ∗wp)

  *Flash write.*
- static mfs_error_t mfs_flash_copy (MFSDriver ∗mfsp, flash_offset_t doffset, flash_offset_t soffset, uint32_t n)

  *Flash copy.*
- static mfs_error_t mfs_record_check (MFSDriver ∗mfsp, mfs_data_header_t ∗dhdrp, flash_offset_t offset, flash_offset_t limit, mfs_record_state_t ∗sts)

  *Verifies integrity of a record.*
- static mfs_error_t mfs_bank_erase (MFSDriver ∗mfsp, mfs_bank_t bank)

  *Erases and verifies all sectors belonging to a bank.*
- static mfs_error_t mfs_bank_verify_erase (MFSDriver ∗mfsp, mfs_bank_t bank)

  *Erases and verifies all sectors belonging to a bank.*
- static mfs_error_t mfs_bank_write_header (MFSDriver ∗mfsp, mfs_bank_t bank, uint32_t cnt)

  *Writes the validation header in a bank.*
- static mfs_error_t mfs_bank_scan_records (MFSDriver ∗mfsp, mfs_bank_t bank, mfs_bank_state_t ∗statep)

  *Scans blocks searching for records.*
- static mfs_error_t mfs_bank_get_state (MFSDriver ∗mfsp, mfs_bank_t bank, mfs_bank_state_t ∗statep, uint32_t ∗cntp)

  *Determines the state of a bank.*
- static mfs_error_t mfs_bank_mount (MFSDriver ∗mfsp, mfs_bank_t bank, mfs_bank_state_t ∗statep)

  *Selects a bank as current.*
- static mfs_error_t mfs_garbage_collect (MFSDriver ∗mfsp)

  *Enforces a garbage collection.*
- static mfs_error_t mfs_try_mount (MFSDriver ∗mfsp)

  *Performs a flash partition mount attempt.*
- mfs_error_t mfs_mount (MFSDriver ∗mfsp)

  *Configures and activates a MFS driver.*
- void mfsObjectInit (MFSDriver ∗mfsp)

  *Initializes an instance.*
- mfs_error_t mfsStart (MFSDriver ∗mfsp, const MFSConfig ∗config)

  *Configures and activates a MFS driver.*
- void mfsStop (MFSDriver ∗mfsp)

  *Deactivates a MFS driver.*
- mfs_error_t mfsErase (MFSDriver ∗mfsp)

  *Destroys the state of the managed storage by erasing the flash.*
- mfs_error_t mfsReadRecord (MFSDriver ∗mfsp, mfs_id_t id, size_t ∗np, uint8_t ∗buffer)

  *Retrieves and reads a data record.*

- mfs_error_t mfsWriteRecord (MFSDriver ∗mfsp, mfs_id_t id, size_t n, const uint8_t ∗buffer)

  *Creates or updates a data record.*
- mfs_error_t mfsEraseRecord (MFSDriver ∗mfsp, mfs_id_t id)

  *Erases a data record.*
- mfs_error_t mfsPerformGarbageCollection (MFSDriver ∗mfsp)

  *Enforces a garbage collection operation.*

## Enumerations

## 7.35.2 Macro Definition Documentation

### 7.35.2.1 #define RET_ON_ERROR( *err* )

**Value:**

```
do {                                               \
  mfs_error_t e = (err);                                                     \
  if (e != MFS_NO_ERROR) {                                                   \
    return e;                                                                \
  }                                                                          \
} while (false)
```

Error check helper.

### 7.35.2.2 #define MFS_CFG_MAX_RECORDS 32

Maximum number of indexed records in the managed storage.

**Note**

Record indexes go from 0 to `MFS_CFG_MAX_RECORDS` - 1.

### 7.35.2.3 #define MFS_CFG_MAX_REPAIR_ATTEMPTS 3

Maximum number of repair attempts on partition mount.

### 7.35.2.4 #define MFS_CFG_WRITE_VERIFY TRUE

Verify written data.

### 7.35.2.5 #define MFS_CFG_STRONG_CHECKING TRUE

Enables a stronger and slower check procedure on mount.

Strong checking requires reading of the whole written data and this can be slow, normal checking only checks integrity of metadata, data errors would be detected on read.

### 7.35.2.6 #define MFS_CFG_BUFFER_SIZE 32

Size of the buffer used for data copying.

**Note**

The buffer size must be a power of two and not smaller than 16 bytes.
Larger buffers improve performance, buffers with size multiple of the flash program page size work better.

## 7.35.3 Typedef Documentation

### 7.35.3.1 typedef uint32_t mfs_id_t

Type of a record identifier.

## 7.35.4 Enumeration Type Documentation

### 7.35.4.1 enum mfs_bank_t

Type of a flash bank.

### 7.35.4.2 enum mfs_state_t

Type of driver state machine states.

### 7.35.4.3 enum mfs_error_t

Type of an MFS error code.

**Note**

Errors are negative integers, informative warnings are positive integers.

### 7.35.4.4 enum mfs_bank_state_t

Type of a bank state assessment.

### 7.35.4.5 enum mfs_record_state_t

Type of a record state assessment.

## 7.35.5 Function Documentation

### 7.35.5.1 static mfs_error_t mfs_flash_read ( MFSDriver ∗ *mfsp*, flash_offset_t *offset*, size_t *n*, uint8_t ∗ *rp* ) [static]

Flash read.

**Parameters**

| | | |
|---|---|---|
| in | *mfsp* | pointer to the MFSDriver object |
| in | *offset* | flash offset |
| in | *n* | number of bytes to be read |
| out | *rp* | pointer to the data buffer |

**Returns**

The operation status.

**Function Class:**

Not an API, this function is for internal use only.

#### 7.35.5.2 static mfs_error_t mfs_flash_write ( MFSDriver * *mfsp*, flash_offset_t *offset*, size_t *n*, const uint8_t * *wp* ) [static]

Flash write.

**Note**

If the option MFS_CFG_WRITE_VERIFY is enabled then the flash is also read back for verification.

**Parameters**

| | | |
|---|---|---|
| in | *mfsp* | pointer to the MFSDriver object |
| in | *offset* | flash offset |
| in | *n* | number of bytes to be written |
| in | *wp* | pointer to the data buffer |

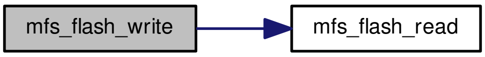
**Returns**

The operation status.

**Function Class:**

Not an API, this function is for internal use only.

Here is the call graph for this function:



#### 7.35.5.3 static mfs_error_t mfs_flash_copy ( MFSDriver * *mfsp*, flash_offset_t *doffset*, flash_offset_t *soffset*, uint32_t *n* ) [static]

Flash copy.

**Note**

If the option MFS_CFG_WRITE_VERIFY is enabled then the flash is also read back for verification.

**Parameters**

| | | |
|---|---|---|
| in | *mfsp* | pointer to the MFSDriver object |
| in | *doffset* | destination flash offset |
| in | *soffset* | source flash offset |
| in | *n* | number of bytes to be copied |

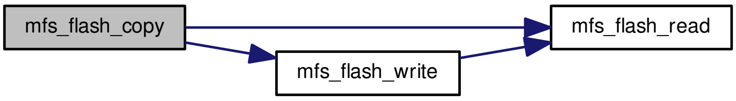
**Returns**

The operation status.

**Function Class:**

Not an API, this function is for internal use only.

Here is the call graph for this function:



#### 7.35.5.4 static mfs_error_t mfs_record_check ( MFSDriver ∗ *mfsp*, mfs_data_header_t ∗ *dhdrp*, flash_offset_t *offset*, flash_offset_t *limit*, mfs_record_state_t ∗ *sts* ) [static]

Verifies integrity of a record.

**Parameters**

| | | |
|---|---|---|
| in | *mfsp* | pointer to the MFSDriver object |
| in | *dhdrp* | pointer to the header to be checked |
| in | *offset* | flash offset of the header to be checked |
| in | *limit* | flash limit offset |
| out | *sts* | assessed record state |

**Returns**

The operation status.

**Function Class:**

Not an API, this function is for internal use only.

#### 7.35.5.5 static mfs_error_t mfs_bank_erase ( MFSDriver ∗ *mfsp*, mfs_bank_t *bank* ) [static]

Erases and verifies all sectors belonging to a bank.

**Parameters**

| | | |
|---|---|---|
| in | *mfsp* | pointer to the MFSDriver object |
| in | *bank* | bank to be erased |

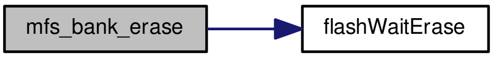
**Returns**

The operation status.

**Function Class:**

Not an API, this function is for internal use only.

Here is the call graph for this function:



#### 7.35.5.6 static mfs_error_t mfs_bank_verify_erase ( MFSDriver * *mfsp*, mfs_bank_t *bank* ) [static]

Erases and verifies all sectors belonging to a bank.

**Parameters**

| | | |
|---|---|---|
| in | *mfsp* | pointer to the MFSDriver object |
| in | *bank* | bank to be verified |

**Returns**

The operation status.

**Function Class:**

Not an API, this function is for internal use only.

#### 7.35.5.7 static mfs_error_t mfs_bank_write_header ( MFSDriver * *mfsp*, mfs_bank_t *bank*, uint32_t *cnt* ) [static]

Writes the validation header in a bank.

**Parameters**

| | | |
|---|---|---|
| in | *mfsp* | pointer to the MFSDriver object |
| in | *bank* | bank to be validated |
| in | *cnt* | value for the flash usage counter |

**Returns**

The operation status.

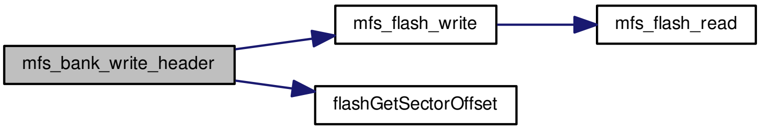
**Return values**

| | |
|---|---|
| *MFS_NO_ERROR* | if the operation has been successfully completed. |

**Function Class:**

Not an API, this function is for internal use only.

Here is the call graph for this function:



### 7.35.5.8 static mfs_error_t mfs_bank_scan_records ( MFSDriver * *mfsp*, mfs_bank_t *bank*, mfs_bank_state_t * *statep* ) [static]

Scans blocks searching for records.

**Note**

The block integrity is strongly checked.

**Parameters**

| | | |
|---|---|---|
| in | *mfsp* | pointer to the MFSDriver object |
| in | *bank* | the bank identifier |
| out | *statep* | bank state, it can be:<br>• MFS_BANK_PARTIAL<br>• MFS_BANK_OK |

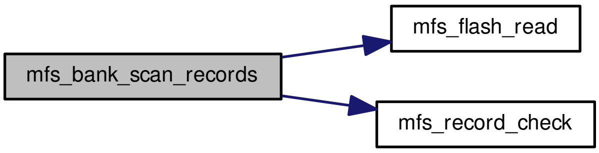
**Returns**

The operation status.

**Function Class:**

Not an API, this function is for internal use only.

Here is the call graph for this function:



#### 7.35.5.9 static mfs_error_t mfs_bank_get_state ( MFSDriver ∗ *mfsp*, mfs_bank_t *bank*, mfs_bank_state_t ∗ *statep*, uint32_t ∗ *cntp* ) [static]

Determines the state of a bank.

**Note**

This function does not test the bank integrity by scanning the data area, it just checks the header.

**Parameters**

| | | |
|---|---|---|
| in | *mfsp* | pointer to the MFSDriver object |
| in | *bank* | bank to be checked |
| out | *statep* | bank state, it can be:<br>• MFS_BANK_ERASED<br>• MFS_BANK_GARBAGE<br>• MFS_BANK_OK |
| out | *cntp* | bank counter |

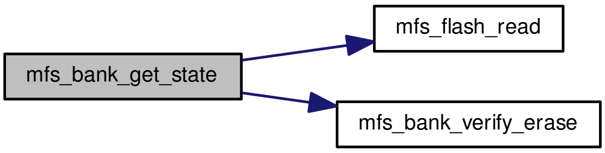
**Returns**

The operation status.

**Function Class:**

Not an API, this function is for internal use only.

Here is the call graph for this function:



#### 7.35.5.10 static mfs_error_t mfs_bank_mount ( MFSDriver * *mfsp*, mfs_bank_t *bank*, mfs_bank_state_t * *statep* ) [static]

Selects a bank as current.

**Note**

The bank header is assumed to be valid.

**Parameters**

| | | |
|---|---|---|
| in | *mfsp* | pointer to the MFSDriver object |
| in | *bank* | bank to be scanned |
| out | *statep* | bank state, it can be:<br>• MFS_BANK_ERASED<br>• MFS_BANK_GARBAGE<br>• MFS_BANK_PARTIAL<br>• MFS_BANK_OK |

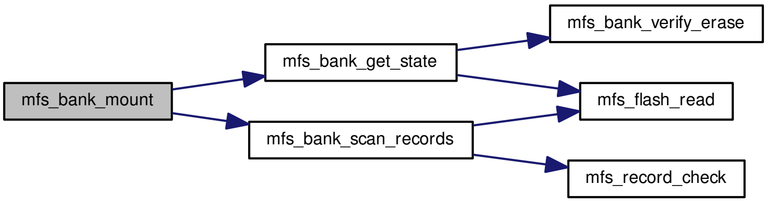
**Returns**

The operation status.

**Function Class:**

Not an API, this function is for internal use only.

Here is the call graph for this function:



#### 7.35.5.11 static mfs_error_t mfs_garbage_collect ( MFSDriver ∗ *mfsp* ) [static]

Enforces a garbage collection.

Storage data is compacted into a single bank.

**Parameters**

| | | |
|---|---|---|
| out | *mfsp* | pointer to the MFSDriver object |

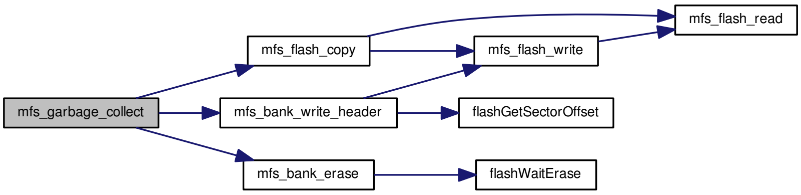
**Returns**

The operation status.

**Function Class:**

Not an API, this function is for internal use only.

Here is the call graph for this function:



#### 7.35.5.12 static mfs_error_t mfs_try_mount ( MFSDriver * *mfsp* ) [static]

Performs a flash partition mount attempt.

**Parameters**

| | | |
|---|---|---|
| in | *mfsp* | pointer to the MFSDriver object |

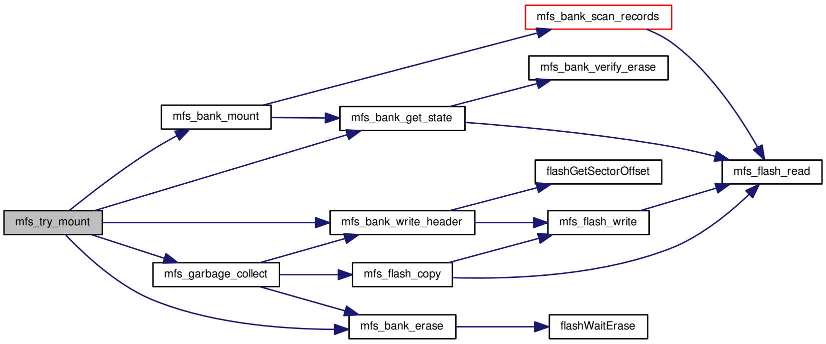
**Returns**

The operation status.

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.35.5.13 mfs_error_t mfs_mount ( MFSDriver * *mfsp* )

Configures and activates a MFS driver.

**Parameters**

| | | |
|---|---|---|
| in | *mfsp* | pointer to the MFSDriver object |

**Returns**

The operation status.

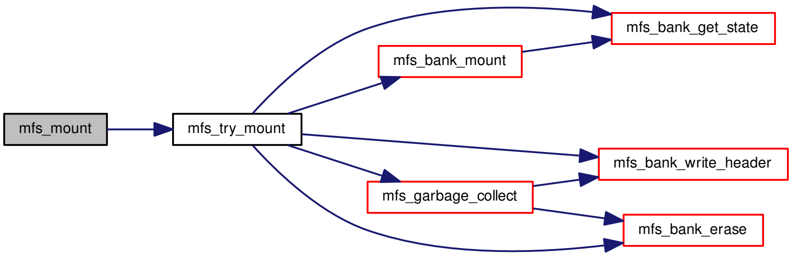
**Return values**

| | |
|---|---|
| *MFS_NO_ERROR* | if the operation has been successfully completed. |
| *MFS_WARN_GC* | if the operation triggered a garbage collection. |
| *MFS_ERR_FLASH_FAILURE* | if the flash memory is unusable because HW failures. Makes the driver enter the MFS_ERROR state. |
| *MFS_ERR_INTERNAL* | if an internal logic failure is detected. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.35.5.14 void mfsObjectInit ( **MFSDriver** ∗ *mfsp* )

Initializes an instance.

**Parameters**

| | | |
|---|---|---|
| out | *mfsp* | pointer to the MFSDriver object |

**Function Class:**

Initializer, this function just initializes an object and can be invoked before the kernel is initialized.

#### 7.35.5.15 **mfs_error_t** mfsStart ( **MFSDriver** ∗ *mfsp,* const **MFSConfig** ∗ *config* )

Configures and activates a MFS driver.

**Parameters**

| | | |
|---|---|---|
| in | *mfsp* | pointer to the MFSDriver object |
| in | *config* | pointer to the configuration |

**Returns**

The operation status.

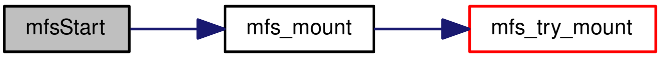
**Return values**

| | |
|---|---|
| *MFS_NO_ERROR* | if the operation has been successfully completed. |
| *MFS_WARN_GC* | if the operation triggered a garbage collection. |
| *MFS_ERR_FLASH_FAILURE* | if the flash memory is unusable because HW failures. Makes the driver enter the MFS_ERROR state. |
| *MFS_ERR_INTERNAL* | if an internal logic failure is detected. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



### 7.35.5.16 void mfsStop ( MFSDriver * *mfsp* )

Deactivates a MFS driver.

**Parameters**

| | | |
|---|---|---|
| in | *mfsp* | pointer to the MFSDriver object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

### 7.35.5.17 mfs_error_t mfsErase ( MFSDriver * *mfsp* )

Destroys the state of the managed storage by erasing the flash.

**Parameters**

| | | |
|---|---|---|
| in | *mfsp* | pointer to the MFSDriver object |

**Returns**

The operation status.

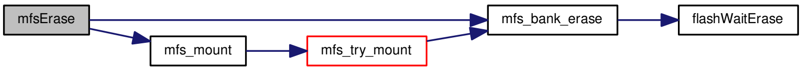
**Return values**

| | |
|---|---|
| *MFS_ERR_INV_STATE* | if the driver is in not in MSG_READY state. |
| *MFS_NO_ERROR* | if the operation has been successfully completed. |
| *MFS_ERR_FLASH_FAILURE* | if the flash memory is unusable because HW failures. Makes the driver enter the MFS_ERROR state. |
| *MFS_ERR_INTERNAL* | if an internal logic failure is detected. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



### 7.35.5.18 mfs_error_t mfsReadRecord ( MFSDriver ∗ *mfsp,* mfs_id_t *id,* size_t ∗ *np,* uint8_t ∗ *buffer* )

Retrieves and reads a data record.

**Parameters**

| | | |
|---|---|---|
| in | *mfsp* | pointer to the MFSDriver object |
| in | *id* | record numeric identifier, the valid range is between 1 and MFS_CFG_MAX_RECORDS |
| in,out | *np* | on input is the maximum buffer size, on return it is the size of the data copied into the buffer |
| out | *buffer* | pointer to a buffer for record data |

**Returns**

The operation status.

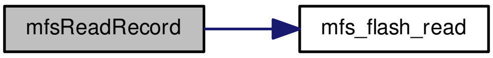
**Return values**

| | |
|---|---|
| *MFS_NO_ERROR* | if the operation has been successfully completed. |
| *MFS_ERR_INV_STATE* | if the driver is in not in MSG_READY state. |
| *MFS_ERR_INV_SIZE* | if the passed buffer is not large enough to contain the record data. |
| *MFS_ERR_NOT_FOUND* | if the specified id does not exists. |
| *MFS_ERR_FLASH_FAILURE* | if the flash memory is unusable because HW failures. Makes the driver enter the MFS_ERROR state. |
| *MFS_ERR_INTERNAL* | if an internal logic failure is detected. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.35.5.19 mfs_error_t mfsWriteRecord ( MFSDriver ∗ *mfsp,* mfs_id_t *id,* size_t *n,* const uint8_t ∗ *buffer* )

Creates or updates a data record.

**Parameters**

| | | |
|---|---|---|
| in | *mfsp* | pointer to the MFSDriver object |
| in | *id* | record numeric identifier, the valid range is between 1 and MFS_CFG_MAX_RECORDS |
| in | *n* | size of data to be written, it cannot be zero |
| in | *buffer* | pointer to a buffer for record data |

**Returns**

The operation status.

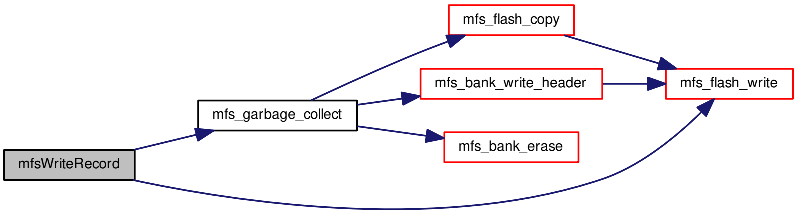
**Return values**

| | |
|---|---|
| *MFS_NO_ERROR* | if the operation has been successfully completed. |
| *MFS_WARN_GC* | if the operation triggered a garbage collection. |
| *MFS_ERR_INV_STATE* | if the driver is in not in MSG_READY state. |
| *MFS_ERR_OUT_OF_MEM* | if there is not enough flash space for the operation. |
| *MFS_ERR_FLASH_FAILURE* | if the flash memory is unusable because HW failures. Makes the driver enter the MFS_ERROR state. |
| *MFS_ERR_INTERNAL* | if an internal logic failure is detected. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.35.5.20 mfs_error_t mfsEraseRecord ( MFSDriver ∗ *mfsp,* mfs_id_t *id* )

Erases a data record.

**Parameters**

| | | |
|---|---|---|
| in | *mfsp* | pointer to the MFSDriver object |
| in | *id* | record numeric identifier, the valid range is between 1 and MFS_CFG_MAX_RECORDS |

**Returns**

The operation status.

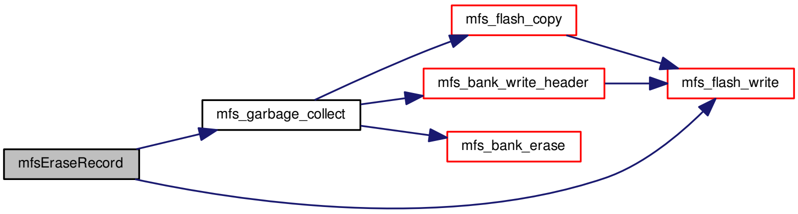
**Return values**

| | |
|---|---|
| *MFS_NO_ERROR* | if the operation has been successfully completed. |
| *MFS_WARN_GC* | if the operation triggered a garbage collection. |
| *MFS_ERR_INV_STATE* | if the driver is in not in `MSG_READY` state. |
| *MFS_ERR_FLASH_FAILURE* | if the flash memory is unusable because HW failures. Makes the driver enter the `MFS_ERROR` state. |
| *MFS_ERR_INTERNAL* | if an internal logic failure is detected. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



### 7.35.5.21 mfs_error_t mfsPerformGarbageCollection ( MFSDriver * mfsp )

Enforces a garbage collection operation.

Garbage collection involves: integrity check, optionally repairs, obsolete data removal, data compaction and a flash bank swap.

**Parameters**

| | | |
|---|---|---|
| `in` | *mfsp* | pointer to the `MFSDriver` object |

**Returns**

The operation status.

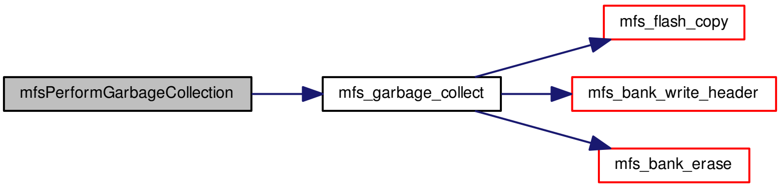
**Return values**

| | |
|---|---|
| *MFS_NO_ERROR* | if the operation has been successfully completed. |
| *MFS_ERR_INV_STATE* | if the driver is in not in `MSG_READY` state. |
| *MFS_ERR_FLASH_FAILURE* | if the flash memory is unusable because HW failures. Makes the driver enter the `MFS_ERROR` state. |
| *MFS_ERR_INTERNAL* | if an internal logic failure is detected. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



## 7.36 MII/RMII Header

MII/RMII Support Header.

### 7.36.1 Detailed Description

MII/RMII Support Header.

This header contains definitions and types related to MII/RMII.

#### Generic MII registers

- #define MII_BMCR 0x00
- #define MII_BMSR 0x01
- #define MII_PHYSID1 0x02
- #define MII_PHYSID2 0x03
- #define MII_ADVERTISE 0x04
- #define MII_LPA 0x05
- #define MII_EXPANSION 0x06
- #define MII_ANNPTR 0x07
- #define MII_CTRL1000 0x09
- #define MII_STAT1000 0x0a
- #define MII_ESTATUS 0x0f
- #define MII_PHYSTS 0x10
- #define MII_MICR 0x11
- #define MII_DCOUNTER 0x12
- #define MII_FCSCOUNTER 0x13
- #define MII_NWAYTEST 0x14
- #define MII_RERRCOUNTER 0x15
- #define MII_SREVISION 0x16
- #define MII_RESV1 0x17
- #define MII_LBRERROR 0x18
- #define MII_PHYADDR 0x19
- #define MII_RESV2 0x1a
- #define MII_TPISTATUS 0x1b
- #define MII_NCONFIG 0x1c

#### Basic mode control register

- #define BMCR_RESV 0x007f
- #define BMCR_CTST 0x0080
- #define BMCR_FULLDPLX 0x0100
- #define BMCR_ANRESTART 0x0200
- #define BMCR_ISOLATE 0x0400
- #define BMCR_PDOWN 0x0800
- #define BMCR_ANENABLE 0x1000
- #define BMCR_SPEED100 0x2000
- #define BMCR_LOOPBACK 0x4000
- #define BMCR_RESET 0x8000

### Basic mode status register

- #define BMSR_ERCAP 0x0001
- #define BMSR_JCD 0x0002
- #define BMSR_LSTATUS 0x0004
- #define BMSR_ANEGCAPABLE 0x0008
- #define BMSR_RFAULT 0x0010
- #define BMSR_ANEGCOMPLETE 0x0020
- #define BMSR_MFPRESUPPCAP 0x0040
- #define BMSR_RESV 0x0780
- #define BMSR_10HALF 0x0800
- #define BMSR_10FULL 0x1000
- #define BMSR_100HALF 0x2000
- #define BMSR_100FULL 0x4000
- #define BMSR_100BASE4 0x8000

### Advertisement control register

- #define ADVERTISE_SLCT 0x001f
- #define ADVERTISE_CSMA 0x0001
- #define ADVERTISE_10HALF 0x0020
- #define ADVERTISE_10FULL 0x0040
- #define ADVERTISE_100HALF 0x0080
- #define ADVERTISE_100FULL 0x0100
- #define ADVERTISE_100BASE4 0x0200
- #define ADVERTISE_PAUSE_CAP 0x0400
- #define ADVERTISE_PAUSE_ASYM 0x0800
- #define ADVERTISE_RESV 0x1000
- #define ADVERTISE_RFAULT 0x2000
- #define ADVERTISE_LPACK 0x4000
- #define ADVERTISE_NPAGE 0x8000
- #define **ADVERTISE_FULL**
- #define **ADVERTISE_ALL**

### Link partner ability register

- #define LPA_SLCT 0x001f
- #define LPA_10HALF 0x0020
- #define LPA_10FULL 0x0040
- #define LPA_100HALF 0x0080
- #define LPA_100FULL 0x0100
- #define LPA_100BASE4 0x0200
- #define LPA_PAUSE_CAP 0x0400
- #define LPA_PAUSE_ASYM 0x0800
- #define LPA_RESV 0x1000
- #define LPA_RFAULT 0x2000
- #define LPA_LPACK 0x4000
- #define LPA_NPAGE 0x8000
- #define **LPA_DUPLEX** (LPA_10FULL | LPA_100FULL)
- #define **LPA_100** (LPA_100FULL | LPA_100HALF | LPA_100BASE4)

### Expansion register for auto-negotiation

- #define EXPANSION_NWAY 0x0001
- #define EXPANSION_LCWP 0x0002
- #define EXPANSION_ENABLENPAGE 0x0004
- #define EXPANSION_NPCAPABLE 0x0008
- #define EXPANSION_MFAULTS 0x0010
- #define EXPANSION_RESV 0xffe0

### N-way test register

- #define NWAYTEST_RESV1 0x00ff
- #define NWAYTEST_LOOPBACK 0x0100
- #define NWAYTEST_RESV2 0xfe00

### PHY identifiers

- #define **MII_DM9161_ID** 0x0181b8a0
- #define **MII_AM79C875_ID** 0x00225540
- #define **MII_KSZ8081_ID** 0x00221560
- #define **MII_KS8721_ID** 0x00221610
- #define **MII_STE101P_ID** 0x00061C50
- #define **MII_DP83848I_ID** 0x20005C90
- #define **MII_LAN8710A_ID** 0x0007C0F1
- #define **MII_LAN8720_ID** 0x0007C0F0
- #define **MII_LAN8742A_ID** 0x0007C130

## 7.36.2 Macro Definition Documentation

### 7.36.2.1 #define MII_BMCR 0x00

Basic mode control register.

### 7.36.2.2 #define MII_BMSR 0x01

Basic mode status register.

### 7.36.2.3 #define MII_PHYSID1 0x02

PHYS ID 1.

### 7.36.2.4 #define MII_PHYSID2 0x03

PHYS ID 2.

### 7.36.2.5 #define MII_ADVERTISE 0x04

Advertisement control reg.

#### 7.36.2.6 #define MII_LPA 0x05

Link partner ability reg.

#### 7.36.2.7 #define MII_EXPANSION 0x06

Expansion register.

#### 7.36.2.8 #define MII_ANNPTR 0x07

1000BASE-T control.

#### 7.36.2.9 #define MII_CTRL1000 0x09

1000BASE-T control.

#### 7.36.2.10 #define MII_STAT1000 0x0a

1000BASE-T status.

#### 7.36.2.11 #define MII_ESTATUS 0x0f

Extended Status.

#### 7.36.2.12 #define MII_PHYSTS 0x10

PHY Status register.

#### 7.36.2.13 #define MII_MICR 0x11

MII Interrupt ctrl register.

#### 7.36.2.14 #define MII_DCOUNTER 0x12

Disconnect counter.

#### 7.36.2.15 #define MII_FCSCOUNTER 0x13

False carrier counter.

#### 7.36.2.16 #define MII_NWAYTEST 0x14

N-way auto-neg test reg.

#### 7.36.2.17 #define MII_RERRCOUNTER 0x15

Receive error counter.

#### 7.36.2.18 #define MII_SREVISION 0x16

Silicon revision.

#### 7.36.2.19 #define MII_RESV1 0x17

Reserved.

#### 7.36.2.20 #define MII_LBRERROR 0x18

Lpback, rx, bypass error.

#### 7.36.2.21 #define MII_PHYADDR 0x19

PHY address.

#### 7.36.2.22 #define MII_RESV2 0x1a

Reserved.

#### 7.36.2.23 #define MII_TPISTATUS 0x1b

TPI status for 10Mbps.

#### 7.36.2.24 #define MII_NCONFIG 0x1c

Network interface config.

#### 7.36.2.25 #define BMCR_RESV 0x007f

Unused.

#### 7.36.2.26 #define BMCR_CTST 0x0080

Collision test.

#### 7.36.2.27 #define BMCR_FULLDPLX 0x0100

Full duplex.

#### 7.36.2.28 #define BMCR_ANRESTART 0x0200

Auto negotiation restart.

#### 7.36.2.29 #define BMCR_ISOLATE 0x0400

Disconnect DP83840 from MII.

#### 7.36.2.30 #define BMCR_PDOWN 0x0800

Powerdown.

#### 7.36.2.31 #define BMCR_ANENABLE 0x1000

Enable auto negotiation.

#### 7.36.2.32 #define BMCR_SPEED100 0x2000

Select 100Mbps.

#### 7.36.2.33 #define BMCR_LOOPBACK 0x4000

TXD loopback bit.

#### 7.36.2.34 #define BMCR_RESET 0x8000

Reset.

#### 7.36.2.35 #define BMSR_ERCAP 0x0001

Ext-reg capability.

#### 7.36.2.36 #define BMSR_JCD 0x0002

Jabber detected.

#### 7.36.2.37 #define BMSR_LSTATUS 0x0004

Link status.

#### 7.36.2.38 #define BMSR_ANEGCAPABLE 0x0008

Able to do auto-negotiation.

#### 7.36.2.39 #define BMSR_RFAULT 0x0010

Remote fault detected.

#### 7.36.2.40 #define BMSR_ANEGCOMPLETE 0x0020

Auto-negotiation complete.

#### 7.36.2.41 #define BMSR_MFPRESUPPCAP 0x0040

Able to suppress preamble.

#### 7.36.2.42 #define BMSR_RESV 0x0780

Unused.

#### 7.36.2.43 #define BMSR_10HALF 0x0800

Can do 10mbps, half-duplex.

#### 7.36.2.44 #define BMSR_10FULL 0x1000

Can do 10mbps, full-duplex.

#### 7.36.2.45 #define BMSR_100HALF 0x2000

Can do 100mbps, half-duplex.

#### 7.36.2.46 #define BMSR_100FULL 0x4000

Can do 100mbps, full-duplex.

#### 7.36.2.47 #define BMSR_100BASE4 0x8000

Can do 100mbps, 4k packets.

#### 7.36.2.48 #define ADVERTISE_SLCT 0x001f

Selector bits.

#### 7.36.2.49 #define ADVERTISE_CSMA 0x0001

Only selector supported.

#### 7.36.2.50 #define ADVERTISE_10HALF 0x0020

Try for 10mbps half-duplex.

#### 7.36.2.51 #define ADVERTISE_10FULL 0x0040

Try for 10mbps full-duplex.

#### 7.36.2.52 #define ADVERTISE_100HALF 0x0080

Try for 100mbps half-duplex.

#### 7.36.2.53 #define ADVERTISE_100FULL 0x0100

Try for 100mbps full-duplex.

#### 7.36.2.54 #define ADVERTISE_100BASE4 0x0200

Try for 100mbps 4k packets.

#### 7.36.2.55 #define ADVERTISE_PAUSE_CAP 0x0400

Try for pause.

#### 7.36.2.56 #define ADVERTISE_PAUSE_ASYM 0x0800

Try for asymetric pause.

#### 7.36.2.57 #define ADVERTISE_RESV 0x1000

Unused.

#### 7.36.2.58 #define ADVERTISE_RFAULT 0x2000

Say we can detect faults.

#### 7.36.2.59 #define ADVERTISE_LPACK 0x4000

Ack link partners response.

#### 7.36.2.60 #define ADVERTISE_NPAGE 0x8000

Next page bit.

#### 7.36.2.61 #define LPA_SLCT 0x001f

Same as advertise selector.

#### 7.36.2.62 #define LPA_10HALF 0x0020

Can do 10mbps half-duplex.

#### 7.36.2.63 #define LPA_10FULL 0x0040

Can do 10mbps full-duplex.

#### 7.36.2.64 #define LPA_100HALF 0x0080

Can do 100mbps half-duplex.

#### 7.36.2.65 #define LPA_100FULL 0x0100

Can do 100mbps full-duplex.

#### 7.36.2.66 #define LPA_100BASE4 0x0200

Can do 100mbps 4k packets.

#### 7.36.2.67 #define LPA_PAUSE_CAP 0x0400

Can pause.

#### 7.36.2.68 #define LPA_PAUSE_ASYM 0x0800

Can pause asymetrically.

#### 7.36.2.69 #define LPA_RESV 0x1000

Unused.

#### 7.36.2.70 #define LPA_RFAULT 0x2000

Link partner faulted.

#### 7.36.2.71 #define LPA_LPACK 0x4000

Link partner acked us.

#### 7.36.2.72 #define LPA_NPAGE 0x8000

Next page bit.

#### 7.36.2.73 #define EXPANSION_NWAY 0x0001

Can do N-way auto-nego.

#### 7.36.2.74 #define EXPANSION_LCWP 0x0002

Got new RX page code word.

#### 7.36.2.75 #define EXPANSION_ENABLENPAGE 0x0004

This enables npage words.

#### 7.36.2.76 #define EXPANSION_NPCAPABLE 0x0008

Link partner supports npage.

#### 7.36.2.77 #define EXPANSION_MFAULTS 0x0010

Multiple faults detected.

#### 7.36.2.78 #define EXPANSION_RESV 0xffe0

Unused.

#### 7.36.2.79 #define NWAYTEST_RESV1 0x00ff

Unused.

#### 7.36.2.80 #define NWAYTEST_LOOPBACK 0x0100

Enable loopback for N-way.

#### 7.36.2.81 #define NWAYTEST_RESV2 0xfe00

Unused.

# 7.37 MMC over SPI Driver

Generic MMC driver.

## 7.37.1 Detailed Description

Generic MMC driver.

This module implements a portable MMC/SD driver that uses a SPI driver as physical layer. Hot plugging and removal are supported through kernel events.

### Precondition

> In order to use the MMC_SPI driver the `HAL_USE_MMC_SPI` and `HAL_USE_SPI` options must be enabled in `halconf.h`.

## 7.37.2 Driver State Machine

This driver implements a state machine internally, see the Abstract I/O Block Device module documentation for details.

## 7.37.3 Driver Operations

This driver allows to read or write single or multiple 512 bytes blocks on a SD Card.

### Macros

- #define _mmc_driver_methods _mmcsd_block_device_methods

  *`MMCDriver` specific methods.*

### MMC_SPI configuration options

- #define MMC_NICE_WAITING TRUE

  *Delays insertions.*

### Macro Functions

- #define mmcIsCardInserted(mmcp) mmc_lld_is_card_inserted(mmcp)

  *Returns the card insertion status.*
- #define mmcIsWriteProtected(mmcp) mmc_lld_is_write_protected(mmcp)

  *Returns the write protect status.*

### Data Structures

- struct MMCConfig

  *MMC/SD over SPI driver configuration structure.*
- struct MMCDriverVMT

  *`MMCDriver` virtual methods table.*
- struct MMCDriver

  *Structure representing a MMC/SD over SPI driver.*

## Functions

- static uint8_t crc7 (uint8_t crc, const uint8_t ∗buffer, size_t len)

  *Calculate the MMC standard CRC-7 based on a lookup table.*
- static void wait (MMCDriver ∗mmcp)

  *Waits an idle condition.*
- static void send_hdr (MMCDriver ∗mmcp, uint8_t cmd, uint32_t arg)

  *Sends a command header.*
- static uint8_t recvr1 (MMCDriver ∗mmcp)

  *Receives a single byte response.*
- static uint8_t recvr3 (MMCDriver ∗mmcp, uint8_t ∗buffer)

  *Receives a three byte response.*
- static uint8_t send_command_R1 (MMCDriver ∗mmcp, uint8_t cmd, uint32_t arg)

  *Sends a command an returns a single byte response.*
- static uint8_t send_command_R3 (MMCDriver ∗mmcp, uint8_t cmd, uint32_t arg, uint8_t ∗response)

  *Sends a command which returns a five bytes response (R3).*
- static bool read_CxD (MMCDriver ∗mmcp, uint8_t cmd, uint32_t cxd[4])

  *Reads the CSD.*
- static void sync (MMCDriver ∗mmcp)

  *Waits that the card reaches an idle state.*
- void mmcInit (void)

  *MMC over SPI driver initialization.*
- void mmcObjectInit (MMCDriver ∗mmcp)

  *Initializes an instance.*
- void mmcStart (MMCDriver ∗mmcp, const MMCConfig ∗config)

  *Configures and activates the MMC peripheral.*
- void mmcStop (MMCDriver ∗mmcp)

  *Disables the MMC peripheral.*
- bool mmcConnect (MMCDriver ∗mmcp)

  *Performs the initialization procedure on the inserted card.*
- bool mmcDisconnect (MMCDriver ∗mmcp)

  *Brings the driver in a state safe for card removal.*
- bool mmcStartSequentialRead (MMCDriver ∗mmcp, uint32_t startblk)

  *Starts a sequential read.*
- bool mmcSequentialRead (MMCDriver ∗mmcp, uint8_t ∗buffer)

  *Reads a block within a sequential read operation.*
- bool mmcStopSequentialRead (MMCDriver ∗mmcp)

  *Stops a sequential read gracefully.*
- bool mmcStartSequentialWrite (MMCDriver ∗mmcp, uint32_t startblk)

  *Starts a sequential write.*
- bool mmcSequentialWrite (MMCDriver ∗mmcp, const uint8_t ∗buffer)

  *Writes a block within a sequential write operation.*
- bool mmcStopSequentialWrite (MMCDriver ∗mmcp)

  *Stops a sequential write gracefully.*
- bool mmcSync (MMCDriver ∗mmcp)

  *Waits for card idle condition.*
- bool mmcGetInfo (MMCDriver ∗mmcp, BlockDeviceInfo ∗bdip)

  *Returns the media info.*
- bool mmcErase (MMCDriver ∗mmcp, uint32_t startblk, uint32_t endblk)

  *Erases blocks.*

## Variables

- static const struct MMCDriverVMT mmc_vmt

  *Virtual methods table.*
- static const uint8_t crc7_lookup_table [256]

  *Lookup table for CRC-7 ( based on polynomial x^ 7 + x^ 3 + 1).*

## 7.37.4 Macro Definition Documentation

### 7.37.4.1 #define MMC_NICE_WAITING TRUE

Delays insertions.

If enabled this options inserts delays into the MMC waiting routines releasing some extra CPU time for the threads with lower priority, this may slow down the driver a bit however. This option is recommended also if the SPI driver does not use a DMA channel and heavily loads the CPU.

### 7.37.4.2 #define _mmc_driver_methods _mmcsd_block_device_methods

`MMCDriver` specific methods.

### 7.37.4.3 #define mmcIsCardInserted( *mmcp* ) mmc_lld_is_card_inserted(mmcp)

Returns the card insertion status.

**Note**

This macro wraps a low level function named `sdc_lld_is_card_inserted()`, this function must be provided by the application because it is not part of the SDC driver.

**Parameters**

| | | |
|---|---|---|
| `in` | *mmcp* | pointer to the `MMCDriver` object |

**Returns**

The card state.

**Return values**

| | |
|---|---|
| *false* | card not inserted. |
| *true* | card inserted. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

### 7.37.4.4 #define mmcIsWriteProtected( *mmcp* ) mmc_lld_is_write_protected(mmcp)

Returns the write protect status.

**Parameters**

| | | |
|---|---|---|
| in | *mmcp* | pointer to the MMCDriver object |

**Returns**

The card state.

**Return values**

| | |
|---|---|
| *false* | card not inserted. |
| *true* | card inserted. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

## 7.37.5 Function Documentation

### 7.37.5.1 static uint8_t crc7 ( uint8_t *crc,* const uint8_t * *buffer,* size_t *len* ) [static]

Calculate the MMC standard CRC-7 based on a lookup table.

**Parameters**

| | | |
|---|---|---|
| in | *crc* | start value for CRC |
| in | *buffer* | pointer to data buffer |
| in | *len* | length of data |

**Returns**

Calculated CRC

### 7.37.5.2 static void wait ( MMCDriver * *mmcp* ) [static]

Waits an idle condition.

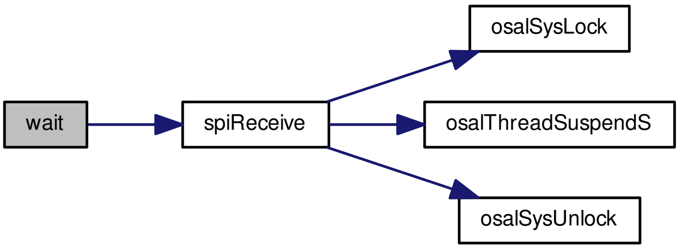
**Parameters**

| | | |
|---|---|---|
| in | *mmcp* | pointer to the MMCDriver object |

**Function Class:**

Not an API, this function is for internal use only.

Here is the call graph for this function:



#### 7.37.5.3 static void send_hdr ( **MMCDriver** ∗ *mmcp,* uint8_t *cmd,* uint32_t *arg* ) [static]

Sends a command header.

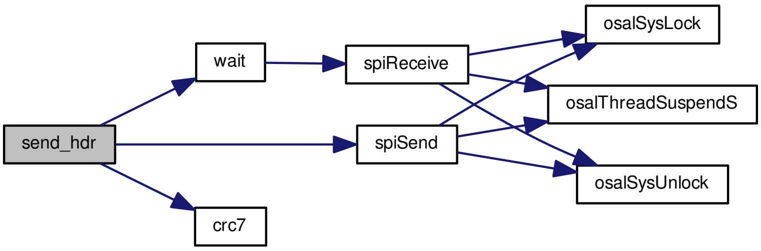
**Parameters**

| | | |
|---|---|---|
| in | *mmcp* | pointer to the MMCDriver object |
| in | *cmd* | the command id |
| in | *arg* | the command argument |

**Function Class:**

Not an API, this function is for internal use only.

Here is the call graph for this function:



#### 7.37.5.4 static uint8_t recvr1 ( **MMCDriver** ∗ *mmcp* ) [static]

Receives a single byte response.

**Parameters**

| | | |
|---|---|---|
| in | *mmcp* | pointer to the `MMCDriver` object |

**Returns**

The response as an `uint8_t` value.

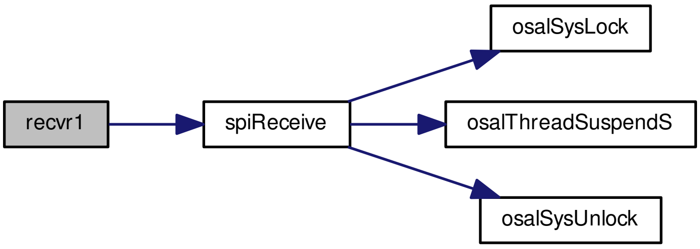
**Return values**

| | |
|---|---|
| *0xFF* | timed out. |

**Function Class:**

Not an API, this function is for internal use only.

Here is the call graph for this function:



### 7.37.5.5 static uint8_t recvr3 ( MMCDriver ∗ *mmcp,* uint8_t ∗ *buffer* ) [static]

Receives a three byte response.

**Parameters**

| | | |
|---|---|---|
| in | *mmcp* | pointer to the `MMCDriver` object |
| out | *buffer* | pointer to four bytes wide buffer |

**Returns**

First response byte as an `uint8_t` value.

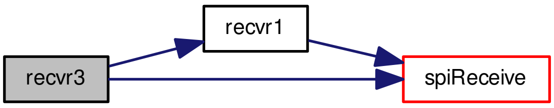
**Return values**

| | |
|---|---|
| *0xFF* | timed out. |

**Function Class:**

Not an API, this function is for internal use only.

Here is the call graph for this function:



### 7.37.5.6 static uint8_t send_command_R1 ( MMCDriver ∗ *mmcp*, uint8_t *cmd*, uint32_t *arg* ) [static]

Sends a command an returns a single byte response.

**Parameters**

| | | |
|---|---|---|
| in | *mmcp* | pointer to the MMCDriver object |
| in | *cmd* | the command id |
| in | *arg* | the command argument |

**Returns**

The response as an uint8_t value.

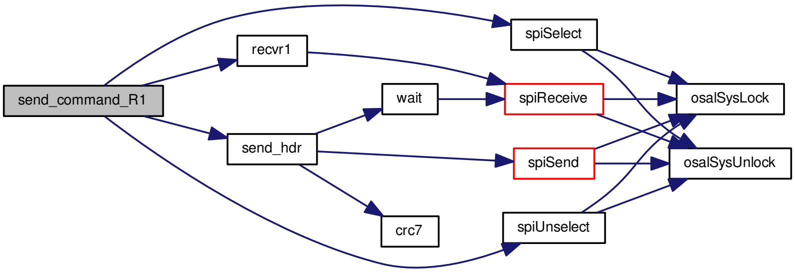
**Return values**

| | |
|---|---|
| *0xFF* | timed out. |

**Function Class:**

Not an API, this function is for internal use only.

Here is the call graph for this function:



#### 7.37.5.7 static uint8_t send_command_R3 ( **MMCDriver** ∗ *mmcp,* uint8_t *cmd,* uint32_t *arg,* uint8_t ∗ *response* ) [static]

Sends a command which returns a five bytes response (R3).

**Parameters**

| | | |
|---|---|---|
| in | *mmcp* | pointer to the MMCDriver object |
| in | *cmd* | the command id |
| in | *arg* | the command argument |
| out | *response* | pointer to four bytes wide uint8_t buffer |

**Returns**

The first byte of the response (R1) as an uint8_t value.

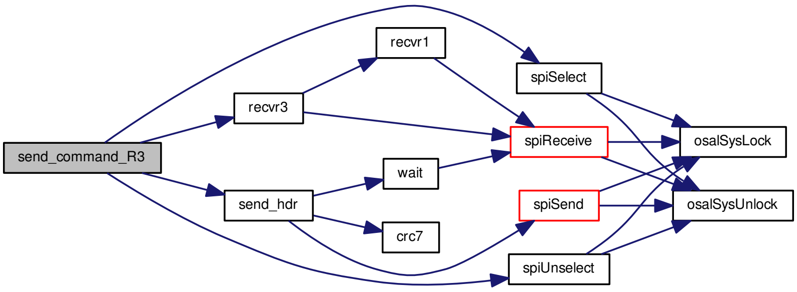
**Return values**

| | |
|---|---|
| *0xFF* | timed out. |

**Function Class:**

Not an API, this function is for internal use only.

Here is the call graph for this function:



#### 7.37.5.8 static bool read_CxD ( **MMCDriver** ∗ *mmcp,* uint8_t *cmd,* uint32_t *cxd[4]* ) [static]

Reads the CSD.

**Parameters**

| | | |
|---|---|---|
| in | *mmcp* | pointer to the MMCDriver object |
| out | *cmd* | command |
| out | *cxd* | pointer to the CSD/CID buffer |

**Returns**

The operation status.

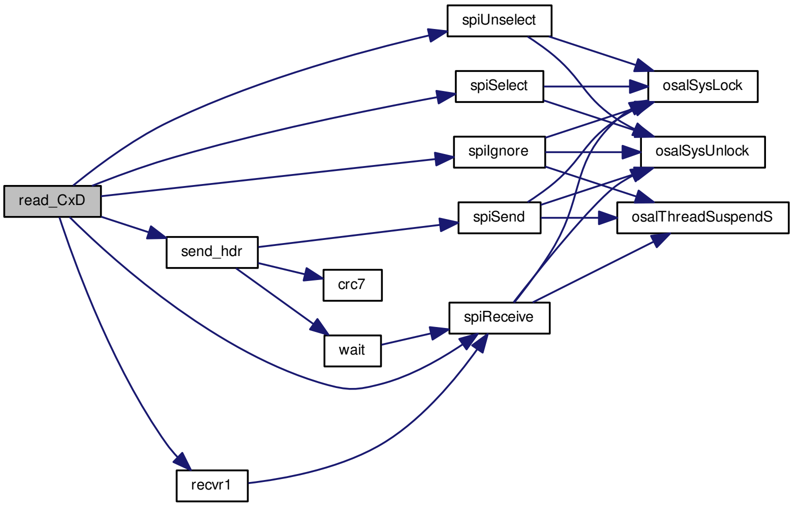
**Return values**

| | |
|---|---|
| *HAL_SUCCESS* | the operation succeeded. |
| *HAL_FAILED* | the operation failed. |

**Function Class:**

Not an API, this function is for internal use only.

Here is the call graph for this function:



### 7.37.5.9 static void sync ( MMCDriver * *mmcp* ) [static]

Waits that the card reaches an idle state.

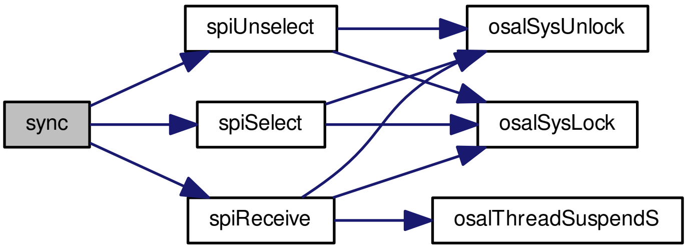
**Parameters**

| | | |
|---|---|---|
| in | *mmcp* | pointer to the MMCDriver object |

**Function Class:**

Not an API, this function is for internal use only.

Here is the call graph for this function:



#### 7.37.5.10 void mmcInit ( void )

MMC over SPI driver initialization.

**Note**

This function is implicitly invoked by `halInit()`, there is no need to explicitly initialize the driver.

**Function Class:**

Initializer, this function just initializes an object and can be invoked before the kernel is initialized.

#### 7.37.5.11 void mmcObjectInit ( **MMCDriver** ∗ *mmcp* )

Initializes an instance.

**Parameters**

| | | |
|---|---|---|
| out | *mmcp* | pointer to the `MMCDriver` object |

**Function Class:**

Initializer, this function just initializes an object and can be invoked before the kernel is initialized.

#### 7.37.5.12 void mmcStart ( **MMCDriver** ∗ *mmcp,* const **MMCConfig** ∗ *config* )

Configures and activates the MMC peripheral.

**Parameters**

| | | |
|---|---|---|
| in | *mmcp* | pointer to the `MMCDriver` object |
| in | *config* | pointer to the `MMCConfig` object. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.37.5.13 void mmcStop ( MMCDriver * *mmcp* )

Disables the MMC peripheral.

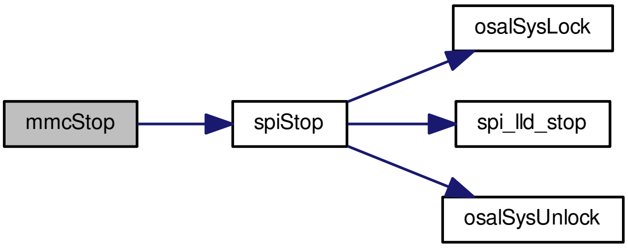
**Parameters**

|  |  |  |
|---|---|---|
| in | *mmcp* | pointer to the MMCDriver object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.37.5.14 bool mmcConnect ( MMCDriver * *mmcp* )

Performs the initialization procedure on the inserted card.

This function should be invoked when a card is inserted and brings the driver in the `MMC_READY` state where it is possible to perform read and write operations.

**Note**

It is possible to invoke this function from the insertion event handler.

**Parameters**

|  |  |  |
|---|---|---|
| in | *mmcp* | pointer to the MMCDriver object |

**Returns**

The operation status.

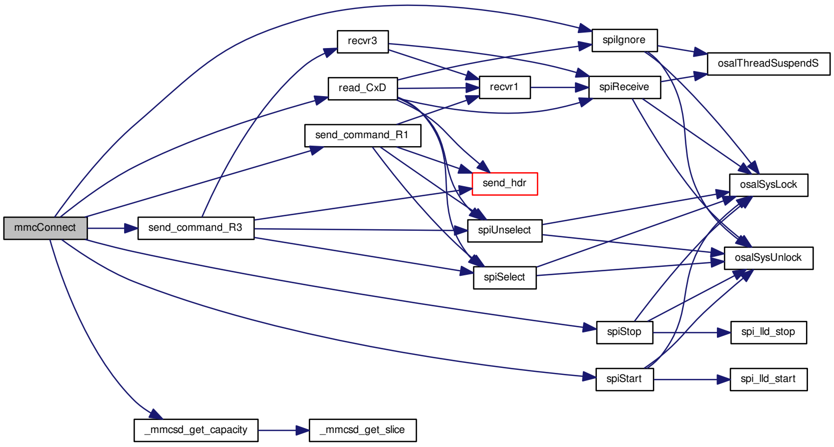
**Return values**

| | |
|---|---|
| *HAL_SUCCESS* | the operation succeeded and the driver is now in the `MMC_READY` state. |
| *HAL_FAILED* | the operation failed. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



### 7.37.5.15 bool mmcDisconnect ( **MMCDriver** ∗ *mmcp* )

Brings the driver in a state safe for card removal.

**Parameters**

| | | |
|---|---|---|
| `in` | *mmcp* | pointer to the `MMCDriver` object |

**Returns**

The operation status.

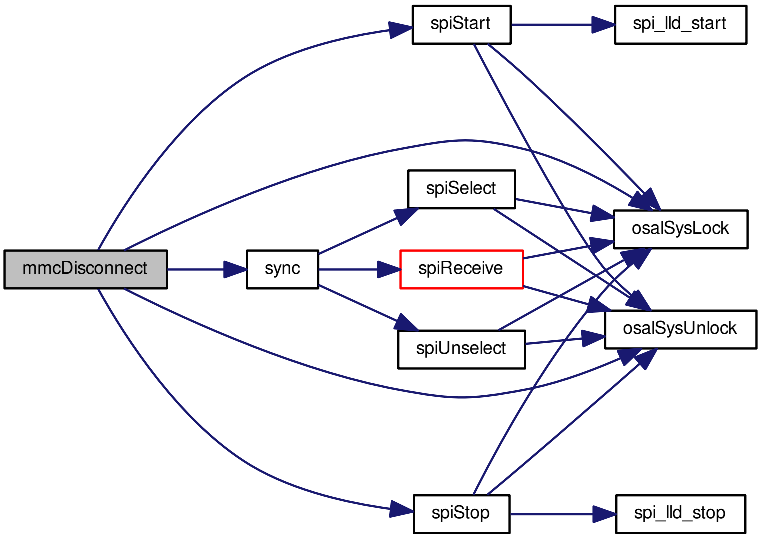
**Return values**

| | |
|---|---|
| *HAL_SUCCESS* | the operation succeeded and the driver is now in the `MMC_INSERTED` state. |
| *HAL_FAILED* | the operation failed. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



### 7.37.5.16 bool mmcStartSequentialRead ( MMCDriver ∗ *mmcp,* uint32_t *startblk* )

Starts a sequential read.

**Parameters**

| | | |
|---|---|---|
| in | *mmcp* | pointer to the MMCDriver object |
| in | *startblk* | first block to read |

**Returns**

The operation status.

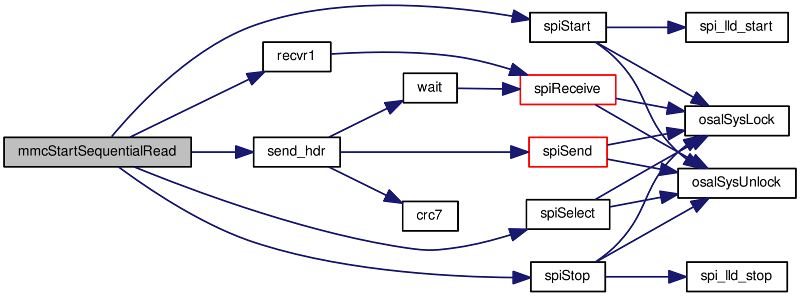
**Return values**

| | |
|---|---|
| *HAL_SUCCESS* | the operation succeeded. |
| *HAL_FAILED* | the operation failed. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.37.5.17 bool mmcSequentialRead ( MMCDriver ∗ *mmcp*, uint8_t ∗ *buffer* )

Reads a block within a sequential read operation.

**Parameters**

| | | |
|---|---|---|
| in | *mmcp* | pointer to the MMCDriver object |
| out | *buffer* | pointer to the read buffer |

**Returns**

The operation status.

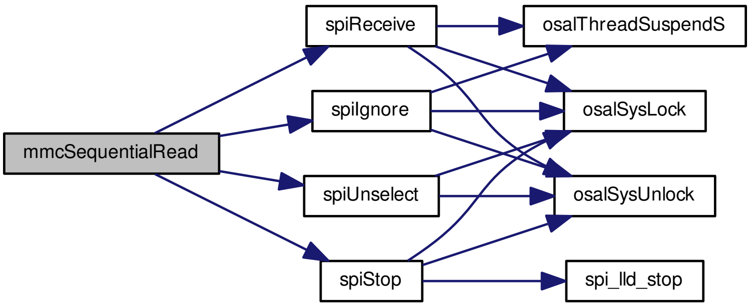
**Return values**

| | |
|---|---|
| *HAL_SUCCESS* | the operation succeeded. |
| *HAL_FAILED* | the operation failed. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.37.5.18 bool mmcStopSequentialRead ( MMCDriver ∗ *mmcp* )

Stops a sequential read gracefully.

**Parameters**

| | | |
|---|---|---|
| in | *mmcp* | pointer to the MMCDriver object |

**Returns**

The operation status.

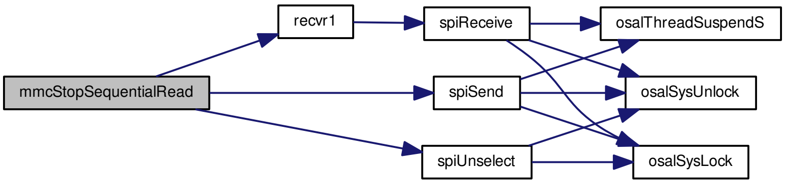
**Return values**

| | |
|---|---|
| *HAL_SUCCESS* | the operation succeeded. |
| *HAL_FAILED* | the operation failed. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



### 7.37.5.19 bool mmcStartSequentialWrite ( **MMCDriver** ∗ *mmcp,* uint32_t *startblk* )

Starts a sequential write.

**Parameters**

| | | |
|---|---|---|
| in | *mmcp* | pointer to the MMCDriver object |
| in | *startblk* | first block to write |

**Returns**

The operation status.

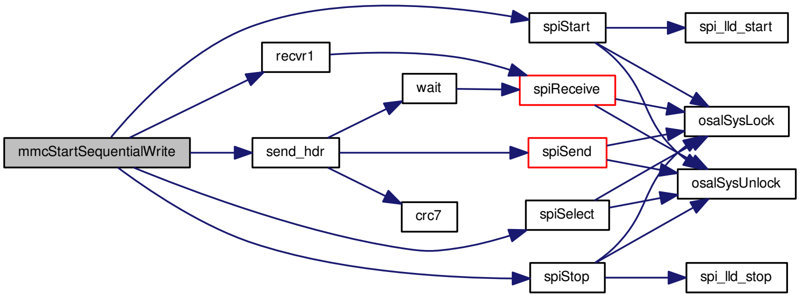
**Return values**

| | |
|---|---|
| *HAL_SUCCESS* | the operation succeeded. |
| *HAL_FAILED* | the operation failed. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



### 7.37.5.20 bool mmcSequentialWrite ( **MMCDriver** ∗ *mmcp,* const uint8_t ∗ *buffer* )

Writes a block within a sequential write operation.

**Parameters**

| | | |
|---|---|---|
| in | *mmcp* | pointer to the MMCDriver object |
| out | *buffer* | pointer to the write buffer |

**Returns**

The operation status.

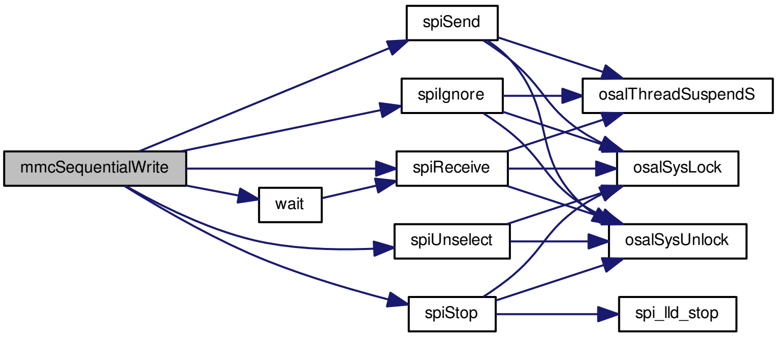
**Return values**

| | |
|---|---|
| *HAL_SUCCESS* | the operation succeeded. |
| *HAL_FAILED* | the operation failed. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.37.5.21 bool mmcStopSequentialWrite ( MMCDriver ∗ *mmcp* )

Stops a sequential write gracefully.

**Parameters**

| | | |
|---|---|---|
| in | *mmcp* | pointer to the `MMCDriver` object |

**Returns**

The operation status.

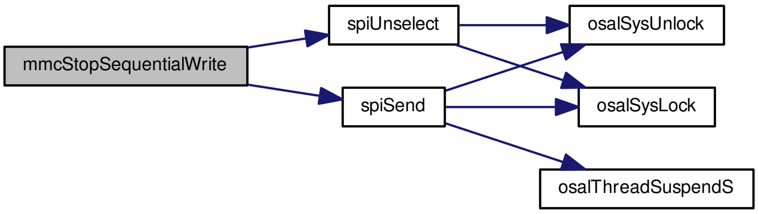
**Return values**

| | |
|---|---|
| *HAL_SUCCESS* | the operation succeeded. |
| *HAL_FAILED* | the operation failed. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.37.5.22 bool mmcSync ( MMCDriver ∗ *mmcp* )

Waits for card idle condition.

**Parameters**

| | | |
|---|---|---|
| in | *mmcp* | pointer to the MMCDriver object |

**Returns**

The operation status.

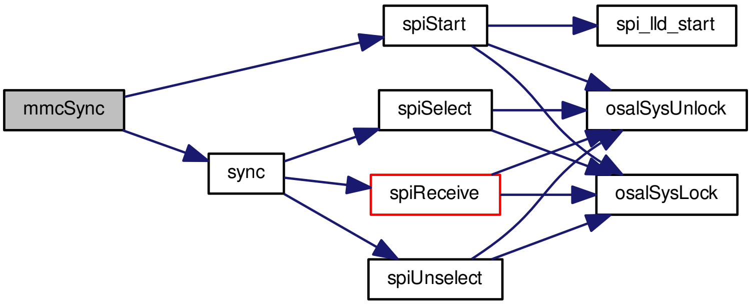
**Return values**

| | |
|---|---|
| *HAL_SUCCESS* | the operation succeeded. |
| *HAL_FAILED* | the operation failed. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.37.5.23 bool mmcGetInfo ( MMCDriver ∗ *mmcp*, BlockDeviceInfo ∗ *bdip* )

Returns the media info.

**Parameters**

| | | |
|---|---|---|
| in | *mmcp* | pointer to the `MMCDriver` object |
| out | *bdip* | pointer to a `BlockDeviceInfo` structure |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *HAL_SUCCESS* | the operation succeeded. |
| *HAL_FAILED* | the operation failed. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.37.5.24 bool mmcErase ( MMCDriver ∗ *mmcp*, uint32_t *startblk*, uint32_t *endblk* )

Erases blocks.

**Parameters**

| | | |
|---|---|---|
| in | *mmcp* | pointer to the `MMCDriver` object |
| in | *startblk* | starting block number |
| in | *endblk* | ending block number |

**Returns**

The operation status.

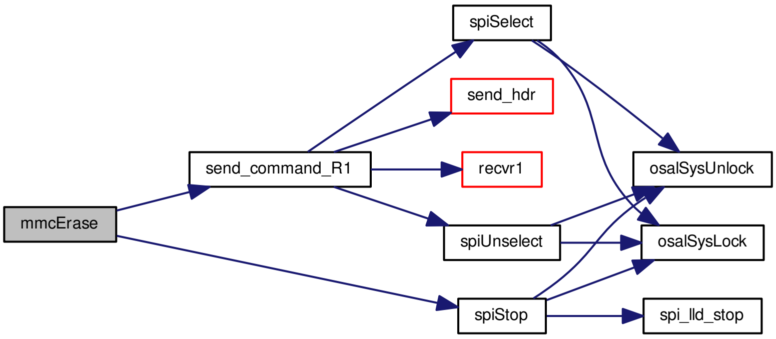
**Return values**

| | |
|---|---|
| *HAL_SUCCESS* | the operation succeeded. |
| *HAL_FAILED* | the operation failed. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



### 7.37.6 Variable Documentation

#### 7.37.6.1 const struct MMCDriverVMT mmc_vmt [static]

**Initial value:**

```
= {
  (size_t)0,
  (bool (*)(void *))mmc_lld_is_card_inserted,
  (bool (*)(void *))mmc_lld_is_write_protected,
  (bool (*)(void *))mmcConnect,
  (bool (*)(void *))mmcDisconnect,
  mmc_read,
  mmc_write,
  (bool (*)(void *))mmcSync,
  (bool (*)(void *, BlockDeviceInfo *))mmcGetInfo
}
```

Virtual methods table.

#### 7.37.6.2 const uint8_t crc7_lookup_table[256] [static]

**Initial value:**

```
= {
  0x00, 0x09, 0x12, 0x1b, 0x24, 0x2d, 0x36, 0x3f, 0x48, 0x41, 0x5a, 0x53,
  0x6c, 0x65, 0x7e, 0x77, 0x19, 0x10, 0x0b, 0x02, 0x3d, 0x34, 0x2f, 0x26,
  0x51, 0x58, 0x43, 0x4a, 0x75, 0x7c, 0x67, 0x6e, 0x32, 0x3b, 0x20, 0x29,
  0x16, 0x1f, 0x04, 0x0d, 0x7a, 0x73, 0x68, 0x61, 0x5e, 0x57, 0x4c, 0x45,
  0x2b, 0x22, 0x39, 0x30, 0x0f, 0x06, 0x1d, 0x14, 0x63, 0x6a, 0x71, 0x78,
  0x47, 0x4e, 0x55, 0x5c, 0x64, 0x6d, 0x76, 0x7f, 0x40, 0x49, 0x52, 0x5b,
  0x2c, 0x25, 0x3e, 0x37, 0x08, 0x01, 0x1a, 0x13, 0x7d, 0x74, 0x6f, 0x66,
  0x59, 0x50, 0x4b, 0x42, 0x35, 0x3c, 0x27, 0x2e, 0x11, 0x18, 0x03, 0x0a,
  0x56, 0x5f, 0x44, 0x4d, 0x72, 0x7b, 0x60, 0x69, 0x1e, 0x17, 0x0c, 0x05,
  0x3a, 0x33, 0x28, 0x21, 0x4f, 0x46, 0x5d, 0x54, 0x6b, 0x62, 0x79, 0x70,
  0x07, 0x0e, 0x15, 0x1c, 0x23, 0x2a, 0x31, 0x38, 0x41, 0x48, 0x53, 0x5a,
  0x65, 0x6c, 0x77, 0x7e, 0x09, 0x00, 0x1b, 0x12, 0x2d, 0x24, 0x3f, 0x36,
  0x58, 0x51, 0x4a, 0x43, 0x7c, 0x75, 0x6e, 0x67, 0x10, 0x19, 0x02, 0x0b,
  0x34, 0x3d, 0x26, 0x2f, 0x73, 0x7a, 0x61, 0x68, 0x57, 0x5e, 0x45, 0x4c,
  0x3b, 0x32, 0x29, 0x20, 0x1f, 0x16, 0x0d, 0x04, 0x6a, 0x63, 0x78, 0x71,
  0x4e, 0x47, 0x5c, 0x55, 0x22, 0x2b, 0x30, 0x39, 0x06, 0x0f, 0x14, 0x1d,
  0x25, 0x2c, 0x37, 0x3e, 0x01, 0x08, 0x13, 0x1a, 0x6d, 0x64, 0x7f, 0x76,
  0x49, 0x40, 0x5b, 0x52, 0x3c, 0x35, 0x2e, 0x27, 0x18, 0x11, 0x0a, 0x03,
  0x74, 0x7d, 0x66, 0x6f, 0x50, 0x59, 0x42, 0x4b, 0x17, 0x1e, 0x05, 0x0c,
  0x33, 0x3a, 0x21, 0x28, 0x5f, 0x56, 0x4d, 0x44, 0x7b, 0x72, 0x69, 0x60,
  0x0e, 0x07, 0x1c, 0x15, 0x2a, 0x23, 0x38, 0x31, 0x46, 0x4f, 0x54, 0x5d,
  0x62, 0x6b, 0x70, 0x79
}
```

Lookup table for CRC-7 ( based on polynomial x^7 + x^3 + 1).

## 7.38 MMC/SD Block Device

### 7.38.1 Detailed Description

This module implements a common ancestor for all device drivers accessing MMC or SD cards. This interface inherits the state machine and the interface from the Abstract I/O Block Device module.

### Macros

- #define MMCSD_BLOCK_SIZE 512U

  *Fixed block size for MMC/SD block devices.*
- #define MMCSD_R1_ERROR_MASK 0xFDFFE008U

  *Mask of error bits in R1 responses.*
- #define MMCSD_CMD8_PATTERN 0x000001AAU

  *Fixed pattern for CMD8.*
- #define _mmcsd_block_device_methods _base_block_device_methods

  *`MMCSDBlockDevice` specific methods.*
- #define _mmcsd_block_device_data

  *`MMCSDBlockDevice` specific data.*

### SD/MMC status conditions

- #define **MMCSD_STS_IDLE** 0U
- #define **MMCSD_STS_READY** 1U
- #define **MMCSD_STS_IDENT** 2U
- #define **MMCSD_STS_STBY** 3U
- #define **MMCSD_STS_TRAN** 4U
- #define **MMCSD_STS_DATA** 5U
- #define **MMCSD_STS_RCV** 6U
- #define **MMCSD_STS_PRG** 7U
- #define **MMCSD_STS_DIS** 8U

### SD/MMC commands

- #define **MMCSD_CMD_GO_IDLE_STATE** 0U
- #define **MMCSD_CMD_INIT** 1U
- #define **MMCSD_CMD_ALL_SEND_CID** 2U
- #define **MMCSD_CMD_SEND_RELATIVE_ADDR** 3U
- #define **MMCSD_CMD_SET_BUS_WIDTH** 6U
- #define **MMCSD_CMD_SWITCH** MMCSD_CMD_SET_BUS_WIDTH
- #define **MMCSD_CMD_SEL_DESEL_CARD** 7U
- #define **MMCSD_CMD_SEND_IF_COND** 8U
- #define **MMCSD_CMD_SEND_EXT_CSD** MMCSD_CMD_SEND_IF_COND
- #define **MMCSD_CMD_SEND_CSD** 9U
- #define **MMCSD_CMD_SEND_CID** 10U
- #define **MMCSD_CMD_STOP_TRANSMISSION** 12U
- #define **MMCSD_CMD_SEND_STATUS** 13U
- #define **MMCSD_CMD_SET_BLOCKLEN** 16U
- #define **MMCSD_CMD_READ_SINGLE_BLOCK** 17U
- #define **MMCSD_CMD_READ_MULTIPLE_BLOCK** 18U
- #define **MMCSD_CMD_SET_BLOCK_COUNT** 23U
- #define **MMCSD_CMD_WRITE_BLOCK** 24U

- #define **MMCSD_CMD_WRITE_MULTIPLE_BLOCK** 25U
- #define **MMCSD_CMD_ERASE_RW_BLK_START** 32U
- #define **MMCSD_CMD_ERASE_RW_BLK_END** 33U
- #define **MMCSD_CMD_ERASE** 38U
- #define **MMCSD_CMD_APP_OP_COND** 41U
- #define **MMCSD_CMD_LOCK_UNLOCK** 42U
- #define **MMCSD_CMD_APP_CMD** 55U
- #define **MMCSD_CMD_READ_OCR** 58U

## CSD record offsets

- #define MMCSD_CSD_MMC_CSD_STRUCTURE_SLICE 127U,126U

  *Slice position of values in CSD register.*
- #define **MMCSD_CSD_MMC_SPEC_VERS_SLICE** 125U,122U
- #define **MMCSD_CSD_MMC_TAAC_SLICE** 119U,112U
- #define **MMCSD_CSD_MMC_NSAC_SLICE** 111U,104U
- #define **MMCSD_CSD_MMC_TRAN_SPEED_SLICE** 103U,96U
- #define **MMCSD_CSD_MMC_CCC_SLICE** 95U,84U
- #define **MMCSD_CSD_MMC_READ_BL_LEN_SLICE** 83U,80U
- #define **MMCSD_CSD_MMC_READ_BL_PARTIAL_SLICE** 79U,79U
- #define **MMCSD_CSD_MMC_WRITE_BLK_MISALIGN_SLICE** 78U,78U
- #define **MMCSD_CSD_MMC_READ_BLK_MISALIGN_SLICE** 77U,77U
- #define **MMCSD_CSD_MMC_DSR_IMP_SLICE** 76U,76U
- #define **MMCSD_CSD_MMC_C_SIZE_SLICE** 73U,62U
- #define **MMCSD_CSD_MMC_VDD_R_CURR_MIN_SLICE** 61U,59U
- #define **MMCSD_CSD_MMC_VDD_R_CURR_MAX_SLICE** 58U,56U
- #define **MMCSD_CSD_MMC_VDD_W_CURR_MIN_SLICE** 55U,53U
- #define **MMCSD_CSD_MMC_VDD_W_CURR_MAX_SLICE** 52U,50U
- #define **MMCSD_CSD_MMC_C_SIZE_MULT_SLICE** 49U,47U
- #define **MMCSD_CSD_MMC_ERASE_GRP_SIZE_SLICE** 46U,42U
- #define **MMCSD_CSD_MMC_ERASE_GRP_MULT_SLICE** 41U,37U
- #define **MMCSD_CSD_MMC_WP_GRP_SIZE_SLICE** 36U,32U
- #define **MMCSD_CSD_MMC_WP_GRP_ENABLE_SLICE** 31U,31U
- #define **MMCSD_CSD_MMC_DEFAULT_ECC_SLICE** 30U,29U
- #define **MMCSD_CSD_MMC_R2W_FACTOR_SLICE** 28U,26U
- #define **MMCSD_CSD_MMC_WRITE_BL_LEN_SLICE** 25U,22U
- #define **MMCSD_CSD_MMC_WRITE_BL_PARTIAL_SLICE** 21U,21U
- #define **MMCSD_CSD_MMC_CONTENT_PROT_APP_SLICE** 16U,16U
- #define **MMCSD_CSD_MMC_FILE_FORMAT_GRP_SLICE** 15U,15U
- #define **MMCSD_CSD_MMC_COPY_SLICE** 14U,14U
- #define **MMCSD_CSD_MMC_PERM_WRITE_PROTECT_SLICE** 13U,13U
- #define **MMCSD_CSD_MMC_TMP_WRITE_PROTECT_SLICE** 12U,12U
- #define **MMCSD_CSD_MMC_FILE_FORMAT_SLICE** 11U,10U
- #define **MMCSD_CSD_MMC_ECC_SLICE** 9U,8U
- #define **MMCSD_CSD_MMC_CRC_SLICE** 7U,1U
- #define **MMCSD_CSD_20_CRC_SLICE** 7U,1U
- #define **MMCSD_CSD_20_FILE_FORMAT_SLICE** 11U,10U
- #define **MMCSD_CSD_20_TMP_WRITE_PROTECT_SLICE** 12U,12U
- #define **MMCSD_CSD_20_PERM_WRITE_PROTECT_SLICE** 13U,13U
- #define **MMCSD_CSD_20_COPY_SLICE** 14U,14U
- #define **MMCSD_CSD_20_FILE_FORMAT_GRP_SLICE** 15U,15U
- #define **MMCSD_CSD_20_WRITE_BL_PARTIAL_SLICE** 21U,21U
- #define **MMCSD_CSD_20_WRITE_BL_LEN_SLICE** 25U,12U
- #define **MMCSD_CSD_20_R2W_FACTOR_SLICE** 28U,26U

- #define **MMCSD_CSD_20_WP_GRP_ENABLE_SLICE** 31U,31U
- #define **MMCSD_CSD_20_WP_GRP_SIZE_SLICE** 38U,32U
- #define **MMCSD_CSD_20_ERASE_SECTOR_SIZE_SLICE** 45U,39U
- #define **MMCSD_CSD_20_ERASE_BLK_EN_SLICE** 46U,46U
- #define **MMCSD_CSD_20_C_SIZE_SLICE** 69U,48U
- #define **MMCSD_CSD_20_DSR_IMP_SLICE** 76U,76U
- #define **MMCSD_CSD_20_READ_BLK_MISALIGN_SLICE** 77U,77U
- #define **MMCSD_CSD_20_WRITE_BLK_MISALIGN_SLICE** 78U,78U
- #define **MMCSD_CSD_20_READ_BL_PARTIAL_SLICE** 79U,79U
- #define **MMCSD_CSD_20_READ_BL_LEN_SLICE** 83U,80U
- #define **MMCSD_CSD_20_CCC_SLICE** 95U,84U
- #define **MMCSD_CSD_20_TRANS_SPEED_SLICE** 103U,96U
- #define **MMCSD_CSD_20_NSAC_SLICE** 111U,104U
- #define **MMCSD_CSD_20_TAAC_SLICE** 119U,112U
- #define **MMCSD_CSD_20_CSD_STRUCTURE_SLICE** 127U,126U
- #define **MMCSD_CSD_10_CRC_SLICE** MMCSD_CSD_20_CRC_SLICE
- #define **MMCSD_CSD_10_FILE_FORMAT_SLICE** MMCSD_CSD_20_FILE_FORMAT_SLICE
- #define **MMCSD_CSD_10_TMP_WRITE_PROTECT_SLICE** MMCSD_CSD_20_TMP_WRITE_PROTECT_SLICE
- #define **MMCSD_CSD_10_PERM_WRITE_PROTECT_SLICE** MMCSD_CSD_20_PERM_WRITE_PROTECT_SLICE
- #define **MMCSD_CSD_10_COPY_SLICE** MMCSD_CSD_20_COPY_SLICE
- #define **MMCSD_CSD_10_FILE_FORMAT_GRP_SLICE** MMCSD_CSD_20_FILE_FORMAT_GRP_SLICE
- #define **MMCSD_CSD_10_WRITE_BL_PARTIAL_SLICE** MMCSD_CSD_20_WRITE_BL_PARTIAL_SLICE
- #define **MMCSD_CSD_10_WRITE_BL_LEN_SLICE** MMCSD_CSD_20_WRITE_BL_LEN_SLICE
- #define **MMCSD_CSD_10_R2W_FACTOR_SLICE** MMCSD_CSD_20_R2W_FACTOR_SLICE
- #define **MMCSD_CSD_10_WP_GRP_ENABLE_SLICE** MMCSD_CSD_20_WP_GRP_ENABLE_SLICE
- #define **MMCSD_CSD_10_WP_GRP_SIZE_SLICE** MMCSD_CSD_20_WP_GRP_SIZE_SLICE
- #define **MMCSD_CSD_10_ERASE_SECTOR_SIZE_SLICE** MMCSD_CSD_20_ERASE_SECTOR_SIZE_SLICE
- #define **MMCSD_CSD_10_ERASE_BLK_EN_SLICE** MMCSD_CSD_20_ERASE_BLK_EN_SLICE
- #define **MMCSD_CSD_10_C_SIZE_MULT_SLICE** 49U,47U
- #define **MMCSD_CSD_10_VDD_W_CURR_MAX_SLICE** 52U,50U
- #define **MMCSD_CSD_10_VDD_W_CURR_MIN_SLICE** 55U,53U
- #define **MMCSD_CSD_10_VDD_R_CURR_MAX_SLICE** 58U,56U
- #define **MMCSD_CSD_10_VDD_R_CURR_MIX_SLICE** 61U,59U
- #define **MMCSD_CSD_10_C_SIZE_SLICE** 73U,62U
- #define **MMCSD_CSD_10_DSR_IMP_SLICE** MMCSD_CSD_20_DSR_IMP_SLICE
- #define **MMCSD_CSD_10_READ_BLK_MISALIGN_SLICE** MMCSD_CSD_20_READ_BLK_MISALIGN_SLICE
- #define **MMCSD_CSD_10_WRITE_BLK_MISALIGN_SLICE** MMCSD_CSD_20_WRITE_BLK_MISALIGN_SLICE
- #define **MMCSD_CSD_10_READ_BL_PARTIAL_SLICE** MMCSD_CSD_20_READ_BL_PARTIAL_SLICE
- #define **MMCSD_CSD_10_READ_BL_LEN_SLICE** 83U,80U
- #define **MMCSD_CSD_10_CCC_SLICE** MMCSD_CSD_20_CCC_SLICE
- #define **MMCSD_CSD_10_TRANS_SPEED_SLICE** MMCSD_CSD_20_TRANS_SPEED_SLICE
- #define **MMCSD_CSD_10_NSAC_SLICE** MMCSD_CSD_20_NSAC_SLICE
- #define **MMCSD_CSD_10_TAAC_SLICE** MMCSD_CSD_20_TAAC_SLICE
- #define **MMCSD_CSD_10_CSD_STRUCTURE_SLICE** MMCSD_CSD_20_CSD_STRUCTURE_SLICE

## CID record offsets

- #define MMCSD_CID_SDC_CRC_SLICE 7U,1U

  *Slice position of values in CID register.*
- #define **MMCSD_CID_SDC_MDT_M_SLICE** 11U,8U
- #define **MMCSD_CID_SDC_MDT_Y_SLICE** 19U,12U
- #define **MMCSD_CID_SDC_PSN_SLICE** 55U,24U
- #define **MMCSD_CID_SDC_PRV_M_SLICE** 59U,56U
- #define **MMCSD_CID_SDC_PRV_N_SLICE** 63U,60U
- #define **MMCSD_CID_SDC_PNM0_SLICE** 71U,64U
- #define **MMCSD_CID_SDC_PNM1_SLICE** 79U,72U
- #define **MMCSD_CID_SDC_PNM2_SLICE** 87U,80U
- #define **MMCSD_CID_SDC_PNM3_SLICE** 95U,88U
- #define **MMCSD_CID_SDC_PNM4_SLICE** 103U,96U
- #define **MMCSD_CID_SDC_OID_SLICE** 119U,104U
- #define **MMCSD_CID_SDC_MID_SLICE** 127U,120U
- #define **MMCSD_CID_MMC_CRC_SLICE** 7U,1U
- #define **MMCSD_CID_MMC_MDT_Y_SLICE** 11U,8U
- #define **MMCSD_CID_MMC_MDT_M_SLICE** 15U,12U
- #define **MMCSD_CID_MMC_PSN_SLICE** 47U,16U
- #define **MMCSD_CID_MMC_PRV_M_SLICE** 51U,48U
- #define **MMCSD_CID_MMC_PRV_N_SLICE** 55U,52U
- #define **MMCSD_CID_MMC_PNM0_SLICE** 63U,56U
- #define **MMCSD_CID_MMC_PNM1_SLICE** 71U,64U
- #define **MMCSD_CID_MMC_PNM2_SLICE** 79U,72U
- #define **MMCSD_CID_MMC_PNM3_SLICE** 87U,80U
- #define **MMCSD_CID_MMC_PNM4_SLICE** 95U,88U
- #define **MMCSD_CID_MMC_PNM5_SLICE** 103U,96U
- #define **MMCSD_CID_MMC_OID_SLICE** 119U,104U
- #define **MMCSD_CID_MMC_MID_SLICE** 127U,120U

## R1 response utilities

- #define MMCSD_R1_ERROR(r1) (((r1) & MMCSD_R1_ERROR_MASK) != 0U)

  *Evaluates to `true` if the R1 response contains error flags.*
- #define MMCSD_R1_STS(r1) (((r1) >> 9U) & 15U)

  *Returns the status field of an R1 response.*
- #define MMCSD_R1_IS_CARD_LOCKED(r1) ((((r1) >> 21U) & 1U) != 0U)

  *Evaluates to `true` if the R1 response indicates a locked card.*

## Macro Functions

- #define mmcsdGetCardCapacity(ip) ((ip)->capacity)

  *Returns the card capacity in blocks.*

## Data Structures

- struct MMCSDBlockDeviceVMT

  *`MMCSDBlockDevice` virtual methods table.*
- struct MMCSDBlockDevice

  *MCC/SD block device class.*
- struct unpacked_sdc_cid_t

*Unpacked CID register from SDC.*
- struct unpacked_mmc_cid_t

  *Unpacked CID register from MMC.*
- struct unpacked_sdc_csd_10_t

  *Unpacked CSD v1.0 register from SDC.*
- struct unpacked_sdc_csd_20_t

  *Unpacked CSD v2.0 register from SDC.*
- struct unpacked_mmc_csd_t

  *Unpacked CSD register from MMC.*

### Functions

- uint32_t _mmcsd_get_slice (const uint32_t ∗data, uint32_t end, uint32_t start)

  *Gets a bit field from a words array.*
- uint32_t _mmcsd_get_capacity (const uint32_t ∗csd)

  *Extract card capacity from a CSD.*
- uint32_t _mmcsd_get_capacity_ext (const uint8_t ∗ext_csd)

  *Extract MMC card capacity from EXT_CSD.*
- void _mmcsd_unpack_sdc_cid (const MMCSDBlockDevice ∗sdcp, unpacked_sdc_cid_t ∗cidsdc)

  *Unpacks SDC CID array in structure.*
- void _mmcsd_unpack_mmc_cid (const MMCSDBlockDevice ∗sdcp, unpacked_mmc_cid_t ∗cidmmc)

  *Unpacks MMC CID array in structure.*
- void _mmcsd_unpack_csd_mmc (const MMCSDBlockDevice ∗sdcp, unpacked_mmc_csd_t ∗csdmmc)

  *Unpacks MMC CSD array in structure.*
- void _mmcsd_unpack_csd_v10 (const MMCSDBlockDevice ∗sdcp, unpacked_sdc_csd_10_t ∗csd10)

  *Unpacks SDC CSD v1.0 array in structure.*
- void _mmcsd_unpack_csd_v20 (const MMCSDBlockDevice ∗sdcp, unpacked_sdc_csd_20_t ∗csd20)

  *Unpacks SDC CSD v2.0 array in structure.*

## 7.38.2 Macro Definition Documentation

### 7.38.2.1 #define MMCSD_BLOCK_SIZE 512U

Fixed block size for MMC/SD block devices.

### 7.38.2.2 #define MMCSD_R1_ERROR_MASK 0xFDFFE008U

Mask of error bits in R1 responses.

### 7.38.2.3 #define MMCSD_CMD8_PATTERN 0x000001AAU

Fixed pattern for CMD8.

### 7.38.2.4 #define MMCSD_CSD_MMC_CSD_STRUCTURE_SLICE 127U,126U

Slice position of values in CSD register.

### 7.38.2.5 #define MMCSD_CID_SDC_CRC_SLICE 7U,1U

Slice position of values in CID register.

#### 7.38.2.6 #define _mmcsd_block_device_methods _base_block_device_methods

MMCSDBlockDevice specific methods.

#### 7.38.2.7 #define _mmcsd_block_device_data

**Value:**

```
_base_block_device_data                                                       \
  /* Card CID.*/                                                                \
  uint32_t              cid[4];                                                 \
  /* Card CSD.*/                                                                \
  uint32_t              csd[4];                                                 \
  /* Total number of blocks in card.*/                                          \
  uint32_t              capacity;
```

MMCSDBlockDevice specific data.

**Note**

It is empty because MMCSDBlockDevice is only an interface without implementation.

#### 7.38.2.8 #define MMCSD_R1_ERROR( *r1* ) (((r1) & MMCSD_R1_ERROR_MASK) != 0U)

Evaluates to `true` if the R1 response contains error flags.

**Parameters**

| | | |
|---|---|---|
| in | *r1* | the r1 response |

#### 7.38.2.9 #define MMCSD_R1_STS( *r1* ) (((r1) >> 9U) & 15U)

Returns the status field of an R1 response.

**Parameters**

| | | |
|---|---|---|
| in | *r1* | the r1 response |

#### 7.38.2.10 #define MMCSD_R1_IS_CARD_LOCKED( *r1* ) ((((r1) >> 21U) & 1U) != 0U)

Evaluates to `true` if the R1 response indicates a locked card.

**Parameters**

| | | |
|---|---|---|
| in | *r1* | the r1 response |

#### 7.38.2.11 #define mmcsdGetCardCapacity( *ip* ) ((ip)->capacity)

Returns the card capacity in blocks.

**Parameters**

| | | |
|---|---|---|
| in | *ip* | pointer to a MMCSDBlockDevice or derived class |

**Returns**

The card capacity.

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

## 7.38.3 Function Documentation

### 7.38.3.1 uint32_t _mmcsd_get_slice ( const uint32_t ∗ *data,* uint32_t *end,* uint32_t *start* )

Gets a bit field from a words array.

**Note**

The bit zero is the LSb of the first word.

**Parameters**

| | | |
|---|---|---|
| in | *data* | pointer to the words array |
| in | *end* | bit offset of the last bit of the field, inclusive |
| in | *start* | bit offset of the first bit of the field, inclusive |

**Returns**

The bits field value, left aligned.

**Function Class:**

Not an API, this function is for internal use only.

### 7.38.3.2 uint32_t _mmcsd_get_capacity ( const uint32_t ∗ *csd* )

Extract card capacity from a CSD.

The capacity is returned as number of available blocks.

**Parameters**

| | | |
|---|---|---|
| in | *csd* | the CSD record |

**Returns**

The card capacity.

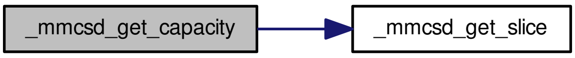
**Return values**

| | |
|---|---|
| *0* | CSD format error |

**Function Class:**

Not an API, this function is for internal use only.

Here is the call graph for this function:



#### 7.38.3.3 uint32_t _mmcsd_get_capacity_ext ( const uint8_t * *ext_csd* )

Extract MMC card capacity from EXT_CSD.

The capacity is returned as number of available blocks.

**Parameters**

| | | |
|---|---|---|
| in | *ext_csd* | the extended CSD record |

**Returns**

The card capacity.

**Function Class:**

Not an API, this function is for internal use only.

#### 7.38.3.4 void _mmcsd_unpack_sdc_cid ( const **MMCSDBlockDevice** * *sdcp*, **unpacked_sdc_cid_t** * *cidsdc* )

Unpacks SDC CID array in structure.

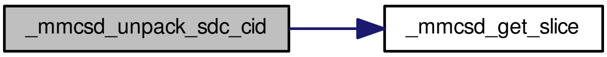
**Parameters**

| | | |
|---|---|---|
| in | *sdcp* | pointer to the `MMCSDBlockDevice` object |
| out | *cidsdc* | pointer to the `unpacked_sdc_cid_t` object |

**Function Class:**

Not an API, this function is for internal use only.

Here is the call graph for this function:



#### 7.38.3.5 void _mmcsd_unpack_mmc_cid ( const MMCSDBlockDevice * *sdcp*, unpacked_mmc_cid_t * *cidmmc* )

Unpacks MMC CID array in structure.

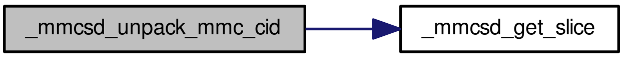
**Parameters**

| | | |
|---|---|---|
| in | *sdcp* | pointer to the MMCSDBlockDevice object |
| out | *cidmmc* | pointer to the unpacked_mmc_cid_t object |

**Function Class:**

Not an API, this function is for internal use only.

Here is the call graph for this function:



#### 7.38.3.6 void _mmcsd_unpack_csd_mmc ( const MMCSDBlockDevice * *sdcp*, unpacked_mmc_csd_t * *csdmmc* )

Unpacks MMC CSD array in structure.

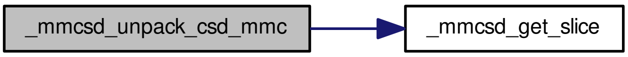
**Parameters**

| | | |
|---|---|---|
| in | *sdcp* | pointer to the MMCSDBlockDevice object |
| out | *csdmmc* | pointer to the unpacked_mmc_csd_t object |

**Function Class:**

Not an API, this function is for internal use only.

Here is the call graph for this function:



### 7.38.3.7 void _mmcsd_unpack_csd_v10 ( const **MMCSDBlockDevice** ∗ *sdcp*, **unpacked_sdc_csd_10_t** ∗ *csd10* )

Unpacks SDC CSD v1.0 array in structure.

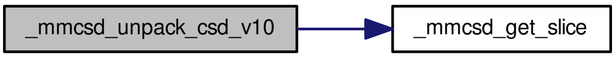
**Parameters**

| | | |
|---|---|---|
| in | *sdcp* | pointer to the MMCSDBlockDevice object |
| out | *csd10* | pointer to the unpacked_sdc_csd_10_t object |

**Function Class:**

Not an API, this function is for internal use only.

Here is the call graph for this function:



### 7.38.3.8 void _mmcsd_unpack_csd_v20 ( const **MMCSDBlockDevice** ∗ *sdcp*, **unpacked_sdc_csd_20_t** ∗ *csd20* )

Unpacks SDC CSD v2.0 array in structure.

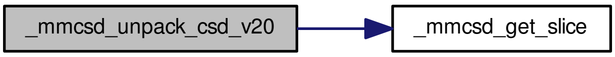
**Parameters**

| | | |
|---|---|---|
| in | *sdcp* | pointer to the MMCSDBlockDevice object |
| out | *csd20* | pointer to the unpacked_sdc_csd_20_t object |

**Function Class:**

Not an API, this function is for internal use only.

Here is the call graph for this function:



# 7.39 PAL Driver

I/O Ports Abstraction Layer.

## 7.39.1 Detailed Description

I/O Ports Abstraction Layer.

This module defines an abstract interface for digital I/O ports. Note that most I/O ports functions are just macros. The macros have default software implementations that can be redefined in a PAL Low Level Driver if the target hardware supports special features like, for example, atomic bit set/reset/masking. Please refer to the ports specific documentation for details.
The PAL Driver driver has the advantage to make the access to the I/O ports platform independent and still be optimized for the specific architectures.
Note that the PAL Low Level Driver may also offer non standard macro and functions in order to support specific features but, of course, the use of such interfaces would not be portable. Such interfaces shall be marked with the architecture name inside the function names.

**Precondition**

In order to use the PAL driver the `HAL_USE_PAL` option must be enabled in `halconf.h`.

## 7.39.2 Implementation Rules

In implementing a PAL Low Level Driver there are some rules/behaviors that should be respected.

### 7.39.2.1 Writing on input pads

The behavior is not specified but there are implementations better than others, this is the list of possible implementations, preferred options are on top:

1. The written value is not actually output but latched, should the pads be reprogrammed as outputs the value would be in effect.
2. The write operation is ignored.
3. The write operation has side effects, as example disabling/enabling pull up/down resistors or changing the pad direction. This scenario is discouraged, please try to avoid this scenario.

### 7.39.2.2 Reading from output pads

The behavior is not specified but there are implementations better than others, this is the list of possible implementations, preferred options are on top:

1. The actual pads states are read (not the output latch).
2. The output latch value is read (regardless of the actual pads states).
3. Unspecified, please try to avoid this scenario.

### 7.39.2.3 Writing unused or unimplemented port bits

The behavior is not specified.

#### 7.39.2.4 Reading from unused or unimplemented port bits

The behavior is not specified.

#### 7.39.2.5 Reading or writing on pins associated to other functionalities

The behavior is not specified.

### Macros

- #define PAL_PORT_BIT(n) ((ioportmask_t)(1U << (n)))

  *Port bit helper macro.*
- #define PAL_GROUP_MASK(width) ((ioportmask_t)(1U << (width)) - 1U)

  *Bits group mask helper.*
- #define _IOBUS_DATA(name, port, width, offset) {port, PAL_GROUP_MASK(width), offset}

  *Data part of a static I/O bus initializer.*
- #define IOBUS_DECL(name, port, width, offset) IOBus name = _IOBUS_DATA(name, port, width, offset)

  *Static I/O bus initializer.*
- #define IOPORT1 0

  *First I/O port identifier.*
- #define pal_lld_init(config) _pal_lld_init(config)

  *Low level PAL subsystem initialization.*
- #define pal_lld_readport(port) 0U

  *Reads the physical I/O port states.*
- #define pal_lld_readlatch(port) 0U

  *Reads the output latch.*
- #define pal_lld_writeport(port, bits)

  *Writes a bits mask on a I/O port.*
- #define pal_lld_setport(port, bits)

  *Sets a bits mask on a I/O port.*
- #define pal_lld_clearport(port, bits)

  *Clears a bits mask on a I/O port.*
- #define pal_lld_toggleport(port, bits)

  *Toggles a bits mask on a I/O port.*
- #define pal_lld_readgroup(port, mask, offset) 0U

  *Reads a group of bits.*
- #define pal_lld_writegroup(port, mask, offset, bits)

  *Writes a group of bits.*
- #define pal_lld_setgroupmode(port, mask, offset, mode) _pal_lld_setgroupmode(port, mask << offset, mode)

  *Pads group mode setup.*
- #define pal_lld_readpad(port, pad) PAL_LOW

  *Reads a logical state from an I/O pad.*
- #define pal_lld_writepad(port, pad, bit)

  *Writes a logical state on an output pad.*
- #define pal_lld_setpad(port, pad)

  *Sets a pad logical state to `PAL_HIGH`.*
- #define pal_lld_clearpad(port, pad)

  *Clears a pad logical state to `PAL_LOW`.*
- #define pal_lld_togglepad(port, pad)

  *Toggles a pad logical state.*

- #define pal_lld_setpadmode(port, pad, mode)

  *Pad mode setup.*
- #define pal_lld_get_pad_event(port, pad) &_pal_events[0]; (void)(port); (void)pad

  *Returns a PAL event structure associated to a pad.*
- #define pal_lld_get_line_event(line) &_pal_events[0]; (void)line

  *Returns a PAL event structure associated to a line.*

## Pads mode constants

- #define PAL_MODE_RESET 0U

  *After reset state.*
- #define PAL_MODE_UNCONNECTED 1U

  *Safe state for* ***unconnected*** *pads.*
- #define PAL_MODE_INPUT 2U

  *Regular input high-Z pad.*
- #define PAL_MODE_INPUT_PULLUP 3U

  *Input pad with weak pull up resistor.*
- #define PAL_MODE_INPUT_PULLDOWN 4U

  *Input pad with weak pull down resistor.*
- #define PAL_MODE_INPUT_ANALOG 5U

  *Analog input mode.*
- #define PAL_MODE_OUTPUT_PUSHPULL 6U

  *Push-pull output pad.*
- #define PAL_MODE_OUTPUT_OPENDRAIN 7U

  *Open-drain output pad.*

## Logic level constants

- #define PAL_LOW 0U

  *Logical low state.*
- #define PAL_HIGH 1U

  *Logical high state.*

## PAL event modes

- #define PAL_EVENT_MODE_EDGES_MASK 3U

  *Mask of edges field.*
- #define PAL_EVENT_MODE_DISABLED 0U

  *Channel disabled.*
- #define PAL_EVENT_MODE_RISING_EDGE 1U

  *Rising edge callback.*
- #define PAL_EVENT_MODE_FALLING_EDGE 2U

  *Falling edge callback.*
- #define PAL_EVENT_MODE_BOTH_EDGES 3U

  *Both edges callback.*

## PAL configuration options

- #define PAL_USE_CALLBACKS TRUE

  *Enables synchronous APIs.*
- #define PAL_USE_WAIT TRUE

  *Enables synchronous APIs.*

## Low level driver helper macros

- #define _pal_init_event(e)

  *Initializes a PAL event object.*
- #define _pal_init_event(e)

  *Initializes a PAL event object.*
- #define _pal_init_event(e)

  *Initializes a PAL event object.*
- #define _pal_clear_event(e)

  *Clears a PAL event object.*
- #define _pal_clear_event(e)

  *Clears a PAL event object.*
- #define _pal_clear_event(e)

  *Clears a PAL event object.*
- #define _pal_isr_code(e)

  *Common ISR code.*
- #define _pal_isr_code(e)

  *Common ISR code.*
- #define _pal_isr_code(e)

  *Common ISR code.*

## Macro Functions

- #define palInit() pal_lld_init()

  *PAL subsystem initialization.*
- #define palReadPort(port) ((void)(port), 0U)

  *Reads the physical I/O port states.*
- #define palReadLatch(port) ((void)(port), 0U)

  *Reads the output latch.*
- #define palWritePort(port, bits) ((void)(port), (void)(bits))

  *Writes a bits mask on a I/O port.*
- #define palSetPort(port, bits) palWritePort(port, palReadLatch(port) | (bits))

  *Sets a bits mask on a I/O port.*
- #define palClearPort(port, bits) palWritePort(port, palReadLatch(port) & ∼(bits))

  *Clears a bits mask on a I/O port.*
- #define palTogglePort(port, bits) palWritePort(port, palReadLatch(port) ^ (bits))

  *Toggles a bits mask on a I/O port.*
- #define palReadGroup(port, mask, offset) ((palReadPort(port) >> (offset)) & (mask))

  *Reads a group of bits.*
- #define palWriteGroup(port, mask, offset, bits)

  *Writes a group of bits.*
- #define palSetGroupMode(port, mask, offset, mode)

  *Pads group mode setup.*

- #define palReadPad(port, pad) ((palReadPort(port) >> (pad)) & 1U)

  *Reads an input pad logic state.*
- #define palWritePad(port, pad, bit)

  *Writes a logic state on an output pad.*
- #define palSetPad(port, pad) palSetPort(port, PAL_PORT_BIT(pad))

  *Sets a pad logic state to `PAL_HIGH`.*
- #define palClearPad(port, pad) palClearPort(port, PAL_PORT_BIT(pad))

  *Clears a pad logic state to `PAL_LOW`.*
- #define palTogglePad(port, pad) palTogglePort(port, PAL_PORT_BIT(pad))

  *Toggles a pad logic state.*
- #define palSetPadMode(port, pad, mode) palSetGroupMode(port, PAL_PORT_BIT(pad), 0U, mode)

  *Pad mode setup.*
- #define palReadLine(line) palReadPad(PAL_PORT(line), PAL_PAD(line))

  *Reads an input line logic state.*
- #define palWriteLine(line, bit) palWritePad(PAL_PORT(line), PAL_PAD(line), bit)

  *Writes a logic state on an output line.*
- #define palSetLine(line) palSetPad(PAL_PORT(line), PAL_PAD(line))

  *Sets a line logic state to `PAL_HIGH`.*
- #define palClearLine(line) palClearPad(PAL_PORT(line), PAL_PAD(line))

  *Clears a line logic state to `PAL_LOW`.*
- #define palToggleLine(line) palTogglePad(PAL_PORT(line), PAL_PAD(line))

  *Toggles a line logic state.*
- #define palSetLineMode(line, mode) palSetPadMode(PAL_PORT(line), PAL_PAD(line), mode)

  *Line mode setup.*
- #define palEnablePadEventI(port, pad, mode)

  *Pad event enable.*
- #define palDisablePadEventI(port, pad)

  *Pad event disable.*
- #define palEnablePadEvent(port, pad, mode)

  *Pad event enable.*
- #define palDisablePadEvent(port, pad)

  *Pad event disable.*
- #define palEnableLineEventI(line, mode) palEnablePadEventI(PAL_PORT(line), PAL_PAD(line), mode)

  *Line event enable.*
- #define palDisableLineEventI(line) palDisablePadEventI(PAL_PORT(line), PAL_PAD(line))

  *Line event disable.*
- #define palEnableLineEvent(line, mode)

  *Line event enable.*
- #define palDisableLineEvent(line)

  *Line event disable.*
- #define palSetPadCallback(port, pad, cb, arg)

  *Associates a callback to a pad.*
- #define palSetLineCallback(line, cb, arg)

  *Associates a callback to a line.*

## Port related definitions

- #define PAL_IOPORTS_WIDTH 16U

  *Width, in bits, of an I/O port.*
- #define PAL_WHOLE_PORT ((ioportmask_t)0xFFFFU)

  *Whole port mask.*

## Line handling macros

- #define PAL_LINE(port, pad) ((ioline_t)((uint32_t)(port)) | ((uint32_t)(pad)))

  *Forms a line identifier.*
- #define PAL_PORT(line) ((stm32_gpio_t ∗)(((uint32_t)(line)) & 0xFFFFFFF0U))

  *Decodes a port identifier from a line identifier.*
- #define PAL_PAD(line) ((uint32_t)((uint32_t)(line) & 0x0000000FU))

  *Decodes a pad identifier from a line identifier.*
- #define PAL_NOLINE 0U

  *Value identifying an invalid line.*

## Typedefs

- typedef void(∗ palcallback_t) (void ∗arg)

  *Type of a PAL event callback.*
- typedef uint32_t ioportmask_t

  *Digital I/O port sized unsigned type.*
- typedef uint32_t iomode_t

  *Digital I/O modes.*
- typedef uint32_t ioline_t

  *Type of an I/O line.*
- typedef uint32_t ioportid_t

  *Port Identifier.*
- typedef uint32_t iopadid_t

  *Type of an pad identifier.*

## Data Structures

- struct palevent_t

  *Type of a PAL event record.*
- struct IOBus

  *I/O bus descriptor.*
- struct PALConfig

  *Generic I/O ports static initializer.*

## Functions

- ioportmask_t palReadBus (const IOBus ∗bus)

  *Read from an I/O bus.*
- void palWriteBus (const IOBus ∗bus, ioportmask_t bits)

  *Write to an I/O bus.*
- void palSetBusMode (const IOBus ∗bus, iomode_t mode)

  *Programs a bus with the specified mode.*
- void palSetPadCallbackI (ioportid_t port, iopadid_t pad, palcallback_t cb, void ∗arg)

  *Associates a callback to a port/pad.*
- void palSetLineCallbackI (ioline_t line, palcallback_t cb, void ∗arg)

  *Associates a callback to a line.*
- msg_t palWaitPadTimeoutS (ioportid_t port, iopadid_t pad, sysinterval_t timeout)

  *Waits for an edge on the specified port/pad.*
- msg_t palWaitPadTimeout (ioportid_t port, iopadid_t pad, sysinterval_t timeout)

*Waits for an edge on the specified port/pad.*
- msg_t palWaitLineTimeoutS (ioline_t line, sysinterval_t timeout)

  *Waits for an edge on the specified line.*
- msg_t palWaitLineTimeout (ioline_t line, sysinterval_t timeout)

  *Waits for an edge on the specified line.*
- void _pal_lld_init (const PALConfig ∗config)

  *STM32 I/O ports configuration.*
- void _pal_lld_setgroupmode (ioportid_t port, ioportmask_t mask, iomode_t mode)

  *Pads mode setup.*

## 7.39.3 Macro Definition Documentation

### 7.39.3.1 #define PAL_MODE_RESET 0U

After reset state.

The state itself is not specified and is architecture dependent, it is guaranteed to be equal to the after-reset state. It is usually an input state.

### 7.39.3.2 #define PAL_MODE_UNCONNECTED 1U

Safe state for **unconnected** pads.

The state itself is not specified and is architecture dependent, it may be mapped on `PAL_MODE_INPUT_PULLUP`, `PAL_MODE_INPUT_PULLDOWN` or `PAL_MODE_OUTPUT_PUSHPULL` for example.

### 7.39.3.3 #define PAL_MODE_INPUT 2U

Regular input high-Z pad.

### 7.39.3.4 #define PAL_MODE_INPUT_PULLUP 3U

Input pad with weak pull up resistor.

### 7.39.3.5 #define PAL_MODE_INPUT_PULLDOWN 4U

Input pad with weak pull down resistor.

### 7.39.3.6 #define PAL_MODE_INPUT_ANALOG 5U

Analog input mode.

### 7.39.3.7 #define PAL_MODE_OUTPUT_PUSHPULL 6U

Push-pull output pad.

### 7.39.3.8 #define PAL_MODE_OUTPUT_OPENDRAIN 7U

Open-drain output pad.

#### 7.39.3.9 #define PAL_LOW 0U

Logical low state.

#### 7.39.3.10 #define PAL_HIGH 1U

Logical high state.

#### 7.39.3.11 #define PAL_EVENT_MODE_EDGES_MASK 3U

Mask of edges field.

#### 7.39.3.12 #define PAL_EVENT_MODE_DISABLED 0U

Channel disabled.

#### 7.39.3.13 #define PAL_EVENT_MODE_RISING_EDGE 1U

Rising edge callback.

#### 7.39.3.14 #define PAL_EVENT_MODE_FALLING_EDGE 2U

Falling edge callback.

#### 7.39.3.15 #define PAL_EVENT_MODE_BOTH_EDGES 3U

Both edges callback.

#### 7.39.3.16 #define PAL_USE_CALLBACKS TRUE

Enables synchronous APIs.

**Note**

Disabling this option saves both code and data space.

#### 7.39.3.17 #define PAL_USE_WAIT TRUE

Enables synchronous APIs.

**Note**

Disabling this option saves both code and data space.

#### 7.39.3.18 #define PAL_PORT_BIT( *n* ) ((ioportmask_t)(1U << (n)))

Port bit helper macro.

This macro calculates the mask of a bit within a port.

**Parameters**

|  |  |  |
|---|---|---|
| in | *n* | bit position within the port |

**Returns**

The bit mask.

#### 7.39.3.19 #define PAL_GROUP_MASK( *width* ) ((ioportmask_t)(1U << (width)) - 1U)

Bits group mask helper.

This macro calculates the mask of a bits group.

**Parameters**

|  |  |  |
|---|---|---|
| in | *width* | group width |

**Returns**

The group mask.

#### 7.39.3.20 #define _IOBUS_DATA( *name, port, width, offset* ) {port, PAL_GROUP_MASK(width), offset}

Data part of a static I/O bus initializer.

This macro should be used when statically initializing an I/O bus that is part of a bigger structure.

**Parameters**

|  |  |  |
|---|---|---|
| in | *name* | name of the IOBus variable |
| in | *port* | I/O port descriptor |
| in | *width* | bus width in bits |
| in | *offset* | bus bit offset within the port |

#### 7.39.3.21 #define IOBUS_DECL( *name, port, width, offset* ) IOBus name = _IOBUS_DATA(name, port, width, offset)

Static I/O bus initializer.

**Parameters**

|  |  |  |
|---|---|---|
| in | *name* | name of the IOBus variable |
| in | *port* | I/O port descriptor |
| in | *width* | bus width in bits |
| in | *offset* | bus bit offset within the port |

#### 7.39.3.22 #define _pal_init_event( *e* )

**Value:**

```
do {                                                                      \
    osalThreadQueueObjectInit(&_pal_events[e].threads);                     \
    _pal_events[e].cb = NULL;                                               \
    _pal_events[e].arg = NULL;                                              \
  } while (false)
```

Initializes a PAL event object.

**Parameters**

| | | |
|---|---|---|
| in | *e* | event index |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.39.3.23 #define _pal_init_event( *e* )

**Value:**

```
do {                                                                      \
    _pal_events[e].cb = NULL;                                               \
    _pal_events[e].arg = NULL;                                              \
  } while (false)
```

Initializes a PAL event object.

**Parameters**

| | | |
|---|---|---|
| in | *e* | event index |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.39.3.24 #define _pal_init_event( *e* )

**Value:**

```
do {                                                                      \
    osalThreadQueueObjectInit(&_pal_events[e].threads);                     \
  } while (false)
```

Initializes a PAL event object.

**Parameters**

| | | |
|---|---|---|
| in | *e* | event index |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.39.3.25 #define _pal_clear_event( e )

**Value:**

```
do {                                                                    \
    osalThreadDequeueAllI(&_pal_events[pad].threads, MSG_RESET);          \
    _pal_events[e].cb = NULL;                                             \
    _pal_events[e].arg = NULL;                                            \
  } while (false)
```

Clears a PAL event object.

**Parameters**

| | | |
|---|---|---|
| in | *e* | event index |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.39.3.26 #define _pal_clear_event( e )

**Value:**

```
do {                                                                    \
    _pal_events[e].cb = NULL;                                             \
    _pal_events[e].arg = NULL;                                            \
  } while (false)
```

Clears a PAL event object.

**Parameters**

| | | |
|---|---|---|
| in | *e* | event index |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.39.3.27 #define _pal_clear_event( e )

**Value:**

```
do {                                                                    \
    osalThreadDequeueAllI(&_pal_events[pad].threads, MSG_RESET);          \
  } while (false)
```

Clears a PAL event object.

**Parameters**

| | | |
|---|---|---|
| in | *e* | event index |

**Function Class:**

Not an API, this function is for internal use only.

### 7.39.3.28 #define _pal_isr_code( *e* )

**Value:**

```
do {                                               \
  if (_pal_events[e].cb != NULL) {                                          \
    _pal_events[e].cb(_pal_events[e].arg);                                  \
  }                                                                         \
  osalSysLockFromISR();
      \
  osalThreadDequeueAllI(&_pal_events[e].threads, MSG_OK);
      \
  osalSysUnlockFromISR();                                                   \
} while (false)
```

Common ISR code.

**Note**

This macro is meant to be used in the low level drivers implementation only.

**Parameters**

|  |  |  |
|---|---|---|
| in | *e* | event index |

**Function Class:**

Not an API, this function is for internal use only.

### 7.39.3.29 #define _pal_isr_code( *e* )

**Value:**

```
do {                                               \
  if (_pal_events[e].cb != NULL) {                                          \
    _pal_events[e].cb(_pal_events[e].arg);                                  \
  }                                                                         \
} while (false)
```

Common ISR code.

**Note**

This macro is meant to be used in the low level drivers implementation only.

**Parameters**

|  |  |  |
|---|---|---|
| in | *e* | event index |

**Function Class:**

Not an API, this function is for internal use only.

### 7.39.3.30 #define _pal_isr_code( *e* )

**Value:**

```
do {                                               \
  osalSysLockFromISR();
      \
  osalThreadDequeueAllI(&_pal_events[e].threads, MSG_OK);
      \
  osalSysUnlockFromISR();                                             \
} while (false)
```

Common ISR code.

**Note**

This macro is meant to be used in the low level drivers implementation only.

**Parameters**

| | | |
|---|---|---|
| in | *e* | event index |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.39.3.31 #define palInit( ) pal_lld_init()

PAL subsystem initialization.

**Note**

This function is implicitly invoked by `halInit()`, there is no need to explicitly initialize the driver.

**Function Class:**

Initializer, this function just initializes an object and can be invoked before the kernel is initialized.

#### 7.39.3.32 #define palReadPort( *port* ) ((void)(port), 0U)

Reads the physical I/O port states.

**Note**

The function can be called from any context.

**Parameters**

| | | |
|---|---|---|
| in | *port* | port identifier |

**Returns**

The port logic states.

**Function Class:**

Special function, this function has special requirements see the notes.

#### 7.39.3.33 #define palReadLatch( *port* ) ((void)(port), 0U)

Reads the output latch.

The purpose of this function is to read back the latched output value.

**Note**

The function can be called from any context.

**Parameters**

| | | |
|---|---|---|
| in | *port* | port identifier |

**Returns**

The latched logic states.

**Function Class:**

Special function, this function has special requirements see the notes.

#### 7.39.3.34 #define palWritePort( *port,* *bits* ) ((void)(port), (void)(bits))

Writes a bits mask on a I/O port.

**Note**

The function can be called from any context.

**Parameters**

| | | |
|---|---|---|
| in | *port* | port identifier |
| in | *bits* | bits to be written on the specified port |

**Function Class:**

Special function, this function has special requirements see the notes.

#### 7.39.3.35 #define palSetPort( *port,* *bits* ) palWritePort(port, palReadLatch(port) | (bits))

Sets a bits mask on a I/O port.

**Note**

The operation is not guaranteed to be atomic on all the architectures, for atomicity and/or portability reasons you may need to enclose port I/O operations between `osalSysLock()` and `osalSysUnlock()`.
The function can be called from any context.

**Parameters**

| | | |
|---|---|---|
| in | *port* | port identifier |
| in | *bits* | bits to be ORed on the specified port |

**Function Class:**

Special function, this function has special requirements see the notes.

#### 7.39.3.36 #define palClearPort( *port, bits* ) **palWritePort**(port, **palReadLatch**(port) & ∼(bits))

Clears a bits mask on a I/O port.

**Note**

The operation is not guaranteed to be atomic on all the architectures, for atomicity and/or portability reasons you may need to enclose port I/O operations between `osalSysLock()` and `osalSysUnlock()`.
The function can be called from any context.

**Parameters**

| | | |
|---|---|---|
| `in` | *port* | port identifier |
| `in` | *bits* | bits to be cleared on the specified port |

**Function Class:**

Special function, this function has special requirements see the notes.

#### 7.39.3.37 #define palTogglePort( *port, bits* ) **palWritePort**(port, **palReadLatch**(port) ^ (bits))

Toggles a bits mask on a I/O port.

**Note**

The operation is not guaranteed to be atomic on all the architectures, for atomicity and/or portability reasons you may need to enclose port I/O operations between `osalSysLock()` and `osalSysUnlock()`.
The function can be called from any context.

**Parameters**

| | | |
|---|---|---|
| `in` | *port* | port identifier |
| `in` | *bits* | bits to be XORed on the specified port |

**Function Class:**

Special function, this function has special requirements see the notes.

#### 7.39.3.38 #define palReadGroup( *port, mask, offset* ) ((**palReadPort**(port) >> (offset)) & (mask))

Reads a group of bits.

**Note**

The function can be called from any context.

**Parameters**

| | | |
|---|---|---|
| in | *port* | port identifier |
| in | *mask* | group mask, a logic AND is performed on the input data |
| in | *offset* | group bit offset within the port |

**Returns**

The group logic states.

**Function Class:**

Special function, this function has special requirements see the notes.

#### 7.39.3.39 #define palWriteGroup( *port, mask, offset, bits* )

**Value:**

```
palWritePort(port, (palReadLatch(port) & ~((mask) << (offset))) |          \
                          (((bits) & (mask)) << (offset)))
```

Writes a group of bits.

**Note**

The operation is not guaranteed to be atomic on all the architectures, for atomicity and/or portability reasons you may need to enclose port I/O operations between `osalSysLock()` and `osalSysUnlock()`.
The function can be called from any context.

**Parameters**

| | | |
|---|---|---|
| in | *port* | port identifier |
| in | *mask* | group mask, a logic AND is performed on the output data |
| in | *offset* | group bit offset within the port |
| in | *bits* | bits to be written. Values exceeding the group width are masked. |

**Function Class:**

Special function, this function has special requirements see the notes.

#### 7.39.3.40 #define palSetGroupMode( *port, mask, offset, mode* )

Pads group mode setup.

This function programs a pads group belonging to the same port with the specified mode.

**Note**

The operation is not guaranteed to be atomic on all the architectures, for atomicity and/or portability reasons you may need to enclose port I/O operations between `osalSysLock()` and `osalSysUnlock()`.
Programming an unknown or unsupported mode is silently ignored.
The function can be called from any context.

**Parameters**

| | | |
|---|---|---|
| in | *port* | port identifier |
| in | *mask* | group mask |
| in | *offset* | group bit offset within the port |
| in | *mode* | group mode |

**Function Class:**

Special function, this function has special requirements see the notes.

#### 7.39.3.41 #define palReadPad( *port,* *pad* ) ((palReadPort(port) >> (pad)) & 1U)

Reads an input pad logic state.

**Note**

The function can be called from any context.

**Parameters**

| | | |
|---|---|---|
| in | *port* | port identifier |
| in | *pad* | pad number within the port |

**Returns**

The logic state.

**Return values**

| | |
|---|---|
| *PAL_LOW* | low logic state. |
| *PAL_HIGH* | high logic state. |

**Function Class:**

Special function, this function has special requirements see the notes.

#### 7.39.3.42 #define palWritePad( *port,* *pad,* *bit* )

**Value:**

```
palWritePort(port, (palReadLatch(port) & ~PAL_PORT_BIT(pad)) |
          \
                     (((bit) & 1U) << pad))
```

Writes a logic state on an output pad.

**Note**

The operation is not guaranteed to be atomic on all the architectures, for atomicity and/or portability reasons you may need to enclose port I/O operations between osalSysLock() and osalSysUnlock().
The function can be called from any context.

**Parameters**

| | | |
|---|---|---|
| in | *port* | port identifier |
| in | *pad* | pad number within the port |
| in | *bit* | logic value, the value must be `PAL_LOW` or `PAL_HIGH` |

**Function Class:**

Special function, this function has special requirements see the notes.

#### 7.39.3.43 #define palSetPad( *port,* *pad* ) palSetPort(port, PAL_PORT_BIT(pad))

Sets a pad logic state to `PAL_HIGH`.

**Note**

The operation is not guaranteed to be atomic on all the architectures, for atomicity and/or portability reasons you may need to enclose port I/O operations between `osalSysLock()` and `osalSysUnlock()`.
The function can be called from any context.

**Parameters**

| | | |
|---|---|---|
| in | *port* | port identifier |
| in | *pad* | pad number within the port |

**Function Class:**

Special function, this function has special requirements see the notes.

#### 7.39.3.44 #define palClearPad( *port,* *pad* ) palClearPort(port, PAL_PORT_BIT(pad))

Clears a pad logic state to `PAL_LOW`.

**Note**

The operation is not guaranteed to be atomic on all the architectures, for atomicity and/or portability reasons you may need to enclose port I/O operations between `osalSysLock()` and `osalSysUnlock()`.
The function can be called from any context.

**Parameters**

| | | |
|---|---|---|
| in | *port* | port identifier |
| in | *pad* | pad number within the port |

**Function Class:**

Special function, this function has special requirements see the notes.

#### 7.39.3.45 #define palTogglePad( *port*, *pad* ) **palTogglePort**(port, **PAL_PORT_BIT**(pad))

Toggles a pad logic state.

**Note**

The operation is not guaranteed to be atomic on all the architectures, for atomicity and/or portability reasons you may need to enclose port I/O operations between `osalSysLock()` and `osalSysUnlock()`.
The function can be called from any context.

**Parameters**

| | | |
|---|---|---|
| `in` | *port* | port identifier |
| `in` | *pad* | pad number within the port |

**Function Class:**

Special function, this function has special requirements see the notes.

#### 7.39.3.46 #define palSetPadMode( *port*, *pad*, *mode* ) **palSetGroupMode**(port, **PAL_PORT_BIT**(pad), 0U, mode)

Pad mode setup.

This function programs a pad with the specified mode.

**Note**

The operation is not guaranteed to be atomic on all the architectures, for atomicity and/or portability reasons you may need to enclose port I/O operations between `osalSysLock()` and `osalSysUnlock()`.
Programming an unknown or unsupported mode is silently ignored.
The function can be called from any context.

**Parameters**

| | | |
|---|---|---|
| `in` | *port* | port identifier |
| `in` | *pad* | pad number within the port |
| `in` | *mode* | pad mode |

**Function Class:**

Special function, this function has special requirements see the notes.

#### 7.39.3.47 #define palReadLine( *line* ) **palReadPad**(**PAL_PORT**(line), **PAL_PAD**(line))

Reads an input line logic state.

**Note**

The function can be called from any context.

**Parameters**

| | | |
|---|---|---|
| `in` | *line* | line identifier |

**Returns**

The logic state.

**Return values**

| | |
|---|---|
| *PAL_LOW* | low logic state. |
| *PAL_HIGH* | high logic state. |

**Function Class:**

Special function, this function has special requirements see the notes.

#### 7.39.3.48 #define palWriteLine( *line*, *bit* ) palWritePad(PAL_PORT(line), PAL_PAD(line), bit)

Writes a logic state on an output line.

**Note**

The operation is not guaranteed to be atomic on all the architectures, for atomicity and/or portability reasons you may need to enclose port I/O operations between `osalSysLock()` and `osalSysUnlock()`.
The function can be called from any context.

**Parameters**

| | | |
|---|---|---|
| in | *line* | line identifier |
| in | *bit* | logic value, the value must be `PAL_LOW` or `PAL_HIGH` |

**Function Class:**

Special function, this function has special requirements see the notes.

#### 7.39.3.49 #define palSetLine( *line* ) palSetPad(PAL_PORT(line), PAL_PAD(line))

Sets a line logic state to `PAL_HIGH`.

**Note**

The operation is not guaranteed to be atomic on all the architectures, for atomicity and/or portability reasons you may need to enclose port I/O operations between `osalSysLock()` and `osalSysUnlock()`.
The function can be called from any context.

**Parameters**

| | | |
|---|---|---|
| in | *line* | line identifier |

**Function Class:**

Special function, this function has special requirements see the notes.

#### 7.39.3.50 #define palClearLine( *line* ) palClearPad(PAL_PORT(line), PAL_PAD(line))

Clears a line logic state to `PAL_LOW`.

**Note**

The operation is not guaranteed to be atomic on all the architectures, for atomicity and/or portability reasons you may need to enclose port I/O operations between `osalSysLock()` and `osalSysUnlock()`.
The function can be called from any context.

**Parameters**

| | | |
|---|---|---|
| in | *line* | line identifier |

**Function Class:**

Special function, this function has special requirements see the notes.

#### 7.39.3.51 #define palToggleLine( *line* ) palTogglePad(PAL_PORT(line), PAL_PAD(line))

Toggles a line logic state.

**Note**

The operation is not guaranteed to be atomic on all the architectures, for atomicity and/or portability reasons you may need to enclose port I/O operations between `osalSysLock()` and `osalSysUnlock()`.
The function can be called from any context.

**Parameters**

| | | |
|---|---|---|
| in | *line* | line identifier |

**Function Class:**

Special function, this function has special requirements see the notes.

#### 7.39.3.52 #define palSetLineMode( *line,* *mode* ) palSetPadMode(PAL_PORT(line), PAL_PAD(line), mode)

Line mode setup.

**Note**

The operation is not guaranteed to be atomic on all the architectures, for atomicity and/or portability reasons you may need to enclose port I/O operations between `osalSysLock()` and `osalSysUnlock()`.
The function can be called from any context.

**Parameters**

| | | |
|---|---|---|
| in | *line* | line identifier |
| in | *mode* | pad mode |

**Function Class:**

Special function, this function has special requirements see the notes.

#### 7.39.3.53 #define palEnablePadEventI( *port,* *pad,* *mode* )

Pad event enable.

**Note**

Programming an unknown or unsupported mode is silently ignored.

**Parameters**

| | | |
|---|---|---|
| in | *port* | port identifier |
| in | *pad* | pad number within the port |
| in | *mode* | pad event mode |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

#### 7.39.3.54 #define palDisablePadEventI( *port,* *pad* )

Pad event disable.

This function also disables previously programmed event callbacks.

**Parameters**

| | | |
|---|---|---|
| in | *port* | port identifier |
| in | *pad* | pad number within the port |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

#### 7.39.3.55 #define palEnablePadEvent( *port,* *pad,* *mode* )

**Value:**

```
do {                                                              \
    osalSysLock();
      \
    palEnablePadEventI(port, pad, mode);
      \
    osalSysUnlock();                                                \
  } while (false)
```

Pad event enable.

**Note**

Programming an unknown or unsupported mode is silently ignored.

**Parameters**

| | | |
|---|---|---|
| in | *port* | port identifier |
| in | *pad* | pad number within the port |
| in | *mode* | pad event mode |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

### 7.39.3.56 #define palDisablePadEvent( *port, pad* )

**Value:**

```
do {                                                              \
    osalSysLock();
      \
    palDisablePadEventI(port, pad);
      \
    osalSysUnlock();                                               \
  } while (false)
```

Pad event disable.

This function also disables previously programmed event callbacks.

**Parameters**

| | | |
|---|---|---|
| in | *port* | port identifier |
| in | *pad* | pad number within the port |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

### 7.39.3.57 #define palEnableLineEventI( *line, mode* ) palEnablePadEventI(PAL_PORT(line), PAL_PAD(line), mode)

Line event enable.

**Note**

Programming an unknown or unsupported mode is silently ignored.

**Parameters**

| | | |
|---|---|---|
| in | *line* | line identifier |
| in | *mode* | line event mode |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

#### 7.39.3.58 #define palDisableLineEventI( *line* ) palDisablePadEventI(PAL_PORT(line), PAL_PAD(line))

Line event disable.

This function also disables previously programmed event callbacks.

**Parameters**

|  |  |  |
|---|---|---|
| in | *line* | line identifier |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

#### 7.39.3.59 #define palEnableLineEvent( *line, mode* )

**Value:**

```
do {                                                                       \
    osalSysLock();
      \
    palEnableLineEventI(line, mode);
      \
    osalSysUnlock();                                                         \
  } while (false)
```

Line event enable.

**Note**

Programming an unknown or unsupported mode is silently ignored.

**Parameters**

|  |  |  |
|---|---|---|
| in | *line* | line identifier |
| in | *mode* | line event mode |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.39.3.60 #define palDisableLineEvent( *line* )

**Value:**

```
do {                                                                       \
    osalSysLock();
      \
    palDisableLineEventI(line);
      \
    osalSysUnlock();                                                         \
  } while (false)
```

Line event disable.

This function also disables previously programmed event callbacks.

**Parameters**

| | | |
|---|---|---|
| in | *line* | line identifier |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

### 7.39.3.61 #define palSetPadCallback( *port,* *pad,* *cb,* *arg* )

**Value:**

```
do {                                                                    \
    osalSysLock();
      \
    palSetPadCallbackI(port, pad, cb, arg);
      \
    osalSysUnlock();                                                      \
  } while (false)
```

Associates a callback to a pad.

**Parameters**

| | | |
|---|---|---|
| in | *port* | port identifier |
| in | *pad* | pad number within the port |
| in | *cb* | event callback function |
| in | *arg* | callback argument |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

### 7.39.3.62 #define palSetLineCallback( *line,* *cb,* *arg* )

**Value:**

```
do {                                                                    \
    osalSysLock();
      \
    palSetLineCallbackI(line, cb, arg);
      \
    osalSysUnlock();                                                      \
  } while (false)
```

Associates a callback to a line.

**Parameters**

| | | |
|---|---|---|
| in | *line* | line identifier |
| in | *cb* | event callback function |
| in | *arg* | callback argument |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt

handlers.

#### 7.39.3.63 #define PAL_IOPORTS_WIDTH 16U

Width, in bits, of an I/O port.

#### 7.39.3.64 #define PAL_WHOLE_PORT ((ioportmask_t)0xFFFFU)

Whole port mask.

This macro specifies all the valid bits into a port.

#### 7.39.3.65 #define PAL_LINE( *port,* *pad* ) ((ioline_t)((uint32_t)(port)) | ((uint32_t)(pad)))

Forms a line identifier.

A port/pad pair are encoded into an `ioline_t` type. The encoding of this type is platform-dependent.

#### 7.39.3.66 #define PAL_PORT( *line* ) ((stm32_gpio_t *)(((uint32_t)(line)) & 0xFFFFFFF0U))

Decodes a port identifier from a line identifier.

#### 7.39.3.67 #define PAL_PAD( *line* ) ((uint32_t)((uint32_t)(line) & 0x0000000FU))

Decodes a pad identifier from a line identifier.

#### 7.39.3.68 #define PAL_NOLINE 0U

Value identifying an invalid line.

#### 7.39.3.69 #define IOPORT1 0

First I/O port identifier.

Low level drivers can define multiple ports, it is suggested to use this naming convention.

#### 7.39.3.70 #define pal_lld_init( *config* ) _pal_lld_init(config)

Low level PAL subsystem initialization.

**Parameters**

| | | |
|---|---|---|
| `in` | *config* | architecture-dependent ports configuration |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.39.3.71 #define pal_lld_readport( *port* ) 0U

Reads the physical I/O port states.

**Parameters**

| | | |
|---|---|---|
| in | *port* | port identifier |

**Returns**

The port bits.

**Function Class:**

Not an API, this function is for internal use only.

#### 7.39.3.72 #define pal_lld_readlatch( *port* ) 0U

Reads the output latch.

The purpose of this function is to read back the latched output value.

**Parameters**

| | | |
|---|---|---|
| in | *port* | port identifier |

**Returns**

The latched logical states.

**Function Class:**

Not an API, this function is for internal use only.

#### 7.39.3.73 #define pal_lld_writeport( *port, bits* )

**Value:**

```
do {                                                                      \
    (void)port;                                                            \
    (void)bits;                                                            \
  } while (false)
```

Writes a bits mask on a I/O port.

**Parameters**

| | | |
|---|---|---|
| in | *port* | port identifier |
| in | *bits* | bits to be written on the specified port |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.39.3.74 #define pal_lld_setport( *port, bits* )

**Value:**

```
do {                                                                    \
    (void)port;                                                          \
    (void)bits;                                                          \
  } while (false)
```

Sets a bits mask on a I/O port.

**Note**

> The PAL Driver provides a default software implementation of this functionality, implement this function if can optimize it by using special hardware functionalities or special coding.

**Parameters**

| | | |
|---|---|---|
| in | *port* | port identifier |
| in | *bits* | bits to be ORed on the specified port |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.39.3.75 #define pal_lld_clearport( *port, bits* )

**Value:**

```
do {                                                                    \
    (void)port;                                                          \
    (void)bits;                                                          \
  } while (false)
```

Clears a bits mask on a I/O port.

**Note**

> The PAL Driver provides a default software implementation of this functionality, implement this function if can optimize it by using special hardware functionalities or special coding.

**Parameters**

| | | |
|---|---|---|
| in | *port* | port identifier |
| in | *bits* | bits to be cleared on the specified port |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.39.3.76 #define pal_lld_toggleport( *port, bits* )

**Value:**

```
do {                                                                    \
    (void)port;                                                          \
    (void)bits;                                                          \
  } while (false)
```

Toggles a bits mask on a I/O port.

**Note**

The PAL Driver provides a default software implementation of this functionality, implement this function if can optimize it by using special hardware functionalities or special coding.

**Parameters**

| | | |
|---|---|---|
| in | *port* | port identifier |
| in | *bits* | bits to be XORed on the specified port |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.39.3.77 #define pal_lld_readgroup( *port,* *mask,* *offset* ) 0U

Reads a group of bits.

**Note**

The PAL Driver provides a default software implementation of this functionality, implement this function if can optimize it by using special hardware functionalities or special coding.

**Parameters**

| | | |
|---|---|---|
| in | *port* | port identifier |
| in | *mask* | group mask |
| in | *offset* | group bit offset within the port |

**Returns**

The group logical states.

**Function Class:**

Not an API, this function is for internal use only.

#### 7.39.3.78 #define pal_lld_writegroup( *port,* *mask,* *offset,* *bits* )

**Value:**

```
do {                                                                   \
    (void)port;                                                          \
    (void)mask;                                                          \
    (void)offset;                                                        \
    (void)bits;                                                          \
  } while (false)
```

Writes a group of bits.

**Note**

The PAL Driver provides a default software implementation of this functionality, implement this function if can optimize it by using special hardware functionalities or special coding.

**Parameters**

| | | |
|---|---|---|
| in | *port* | port identifier |
| in | *mask* | group mask |
| in | *offset* | group bit offset within the port |
| in | *bits* | bits to be written. Values exceeding the group width are masked. |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.39.3.79 #define pal_lld_setgroupmode( *port*, *mask*, *offset*, *mode* ) _pal_lld_setgroupmode(port, mask << offset, mode)

Pads group mode setup.

This function programs a pads group belonging to the same port with the specified mode.

**Note**

Programming an unknown or unsupported mode is silently ignored.

**Parameters**

| | | |
|---|---|---|
| in | *port* | port identifier |
| in | *mask* | group mask |
| in | *offset* | group bit offset within the port |
| in | *mode* | group mode |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.39.3.80 #define pal_lld_readpad( *port*, *pad* ) PAL_LOW

Reads a logical state from an I/O pad.

**Note**

The PAL Driver provides a default software implementation of this functionality, implement this function if can optimize it by using special hardware functionalities or special coding.

**Parameters**

| | | |
|---|---|---|
| in | *port* | port identifier |
| in | *pad* | pad number within the port |

**Returns**

The logical state.

**Return values**

| | |
|---|---|
| *PAL_LOW* | low logical state. |
| *PAL_HIGH* | high logical state. |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.39.3.81 #define pal_lld_writepad( *port, pad, bit* )

**Value:**

```
do {                                                                    \
    (void)port;                                                           \
    (void)pad;                                                            \
    (void)bit;                                                            \
  } while (false)
```

Writes a logical state on an output pad.

**Note**

This function is not meant to be invoked directly by the application code.
The PAL Driver provides a default software implementation of this functionality, implement this function if can optimize it by using special hardware functionalities or special coding.

**Parameters**

| | | |
|---|---|---|
| in | *port* | port identifier |
| in | *pad* | pad number within the port |
| in | *bit* | logical value, the value must be `PAL_LOW` or `PAL_HIGH` |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.39.3.82 #define pal_lld_setpad( *port, pad* )

**Value:**

```
do {                                                                    \
    (void)port;                                                           \
    (void)pad;                                                            \
  } while (false)
```

Sets a pad logical state to `PAL_HIGH`.

**Note**

The PAL Driver provides a default software implementation of this functionality, implement this function if can optimize it by using special hardware functionalities or special coding.

**Parameters**

|  |  |  |
|---|---|---|
| in | *port* | port identifier |
| in | *pad* | pad number within the port |

**Function Class:**

Not an API, this function is for internal use only.

### 7.39.3.83 #define pal_lld_clearpad( *port,* *pad* )

**Value:**

```
do {                                                                 \
    (void)port;                                                       \
    (void)pad;                                                        \
  } while (false)
```

Clears a pad logical state to PAL_LOW.

**Note**

The PAL Driver provides a default software implementation of this functionality, implement this function if can optimize it by using special hardware functionalities or special coding.

**Parameters**

|  |  |  |
|---|---|---|
| in | *port* | port identifier |
| in | *pad* | pad number within the port |

**Function Class:**

Not an API, this function is for internal use only.

### 7.39.3.84 #define pal_lld_togglepad( *port,* *pad* )

**Value:**

```
do {                                                                 \
    (void)port;                                                       \
    (void)pad;                                                        \
  } while (false)
```

Toggles a pad logical state.

**Note**

The PAL Driver provides a default software implementation of this functionality, implement this function if can optimize it by using special hardware functionalities or special coding.

**Parameters**

|  |  |  |
|---|---|---|
| in | *port* | port identifier |
| in | *pad* | pad number within the port |

**Function Class:**

Not an API, this function is for internal use only.

### 7.39.3.85 #define pal_lld_setpadmode( *port,* *pad,* *mode* )

**Value:**

```
do {                                                                   \
    (void)port;                                                          \
    (void)pad;                                                           \
    (void)mode;                                                          \
  } while (false)
```

Pad mode setup.

This function programs a pad with the specified mode.

**Note**

The PAL Driver provides a default software implementation of this functionality, implement this function if can optimize it by using special hardware functionalities or special coding.
Programming an unknown or unsupported mode is silently ignored.

**Parameters**

| | | |
|---|---|---|
| in | *port* | port identifier |
| in | *pad* | pad number within the port |
| in | *mode* | pad mode |

**Function Class:**

Not an API, this function is for internal use only.

### 7.39.3.86 #define pal_lld_get_pad_event( *port,* *pad* ) &_pal_events[0]; (void)(port); (void)pad

Returns a PAL event structure associated to a pad.

**Parameters**

| | | |
|---|---|---|
| in | *port* | port identifier |
| in | *pad* | pad number within the port |

**Function Class:**

Not an API, this function is for internal use only.

### 7.39.3.87 #define pal_lld_get_line_event( *line* ) &_pal_events[0]; (void)line

Returns a PAL event structure associated to a line.

**Parameters**

| | | |
|---|---|---|
| in | *line* | line identifier |

**Function Class:**

Not an API, this function is for internal use only.

## 7.39.4 Typedef Documentation

### 7.39.4.1 typedef void(∗ palcallback_t) (void ∗arg)

Type of a PAL event callback.

### 7.39.4.2 typedef uint32_t ioportmask_t

Digital I/O port sized unsigned type.

### 7.39.4.3 typedef uint32_t iomode_t

Digital I/O modes.

### 7.39.4.4 typedef uint32_t ioline_t

Type of an I/O line.

### 7.39.4.5 typedef uint32_t ioportid_t

Port Identifier.

This type can be a scalar or some kind of pointer, do not make any assumption about it, use the provided macros when populating variables of this type.

### 7.39.4.6 typedef uint32_t iopadid_t

Type of an pad identifier.

## 7.39.5 Function Documentation

### 7.39.5.1 ioportmask_t palReadBus ( const IOBus ∗ *bus* )

Read from an I/O bus.

**Note**

The operation is not guaranteed to be atomic on all the architectures, for atomicity and/or portability reasons you may need to enclose port I/O operations between `osalSysLock()` and `osalSysUnlock()`.
The function internally uses the `palReadGroup()` macro. The use of this function is preferred when you value code size, readability and error checking over speed.
The function can be called from any context.

**Parameters**

| | | |
|---|---|---|
| `in` | *bus* | the I/O bus, pointer to a `IOBus` structure |

**Returns**

The bus logical states.

**Function Class:**

Special function, this function has special requirements see the notes.

#### 7.39.5.2 void palWriteBus ( const IOBus * *bus*, ioportmask_t *bits* )

Write to an I/O bus.

**Note**

The operation is not guaranteed to be atomic on all the architectures, for atomicity and/or portability reasons you may need to enclose port I/O operations between `osalSysLock()` and `osalSysUnlock()`.
The default implementation is non atomic and not necessarily optimal. Low level drivers may optimize the function by using specific hardware or coding.
The function can be called from any context.

**Parameters**

| | | |
|---|---|---|
| `in` | *bus* | the I/O bus, pointer to a `IOBus` structure |
| `in` | *bits* | the bits to be written on the I/O bus. Values exceeding the bus width are masked so most significant bits are lost. |

**Function Class:**

Special function, this function has special requirements see the notes.

#### 7.39.5.3 void palSetBusMode ( const IOBus * *bus*, iomode_t *mode* )

Programs a bus with the specified mode.

**Note**

The operation is not guaranteed to be atomic on all the architectures, for atomicity and/or portability reasons you may need to enclose port I/O operations between `osalSysLock()` and `osalSysUnlock()`.
The default implementation is non atomic and not necessarily optimal. Low level drivers may optimize the function by using specific hardware or coding.
The function can be called from any context.

**Parameters**

| | | |
|---|---|---|
| `in` | *bus* | the I/O bus, pointer to a `IOBus` structure |
| `in` | *mode* | the mode |

**Function Class:**

Special function, this function has special requirements see the notes.

#### 7.39.5.4 void palSetPadCallbackI ( ioportid_t *port*, iopadid_t *pad*, palcallback_t *cb*, void ∗ *arg* )

Associates a callback to a port/pad.

**Parameters**

| | | |
|---|---|---|
| in | *port* | port identifier |
| in | *pad* | pad number within the port |
| in | *cb* | event callback function |
| in | *arg* | callback argument |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.39.5.5 void palSetLineCallbackI ( ioline_t *line*, palcallback_t *cb*, void ∗ *arg* )

Associates a callback to a line.

**Parameters**

| | | |
|---|---|---|
| in | *line* | line identifier |
| in | *cb* | event callback function |
| in | *arg* | callback argument |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.39.5.6 msg_t palWaitPadTimeoutS ( ioportid_t *port*, iopadid_t *pad*, sysinterval_t *timeout* )

Waits for an edge on the specified port/pad.

**Parameters**

| | | |
|---|---|---|
| in | *port* | port identifier |
| in | *pad* | pad number within the port |
| in | *timeout* | the number of ticks before the operation timeouts, the following special values are allowed:<br>• *TIME_IMMEDIATE* immediate timeout.<br>• *TIME_INFINITE* no timeout. |

**Returns**

The operation state.

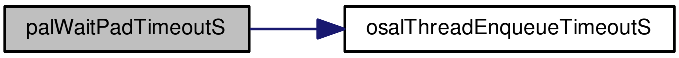
**Return values**

| | |
|---|---|
| *MSG_OK* | if an edge has been detected. |
| *MSG_TIMEOUT* | if a timeout occurred before an edge could be detected. |
| *MSG_RESET* | if the event has been disabled while the thread was waiting for an edge. |

**Function Class:**

This is an **S-Class** API, this function can be invoked from within a system lock zone by threads only.

Here is the call graph for this function:



#### 7.39.5.7 msg_t palWaitPadTimeout ( ioportid_t *port*, iopadid_t *pad*, sysinterval_t *timeout* )

Waits for an edge on the specified port/pad.

**Parameters**

| | | |
|---|---|---|
| in | *port* | port identifier |
| in | *pad* | pad number within the port |
| in | *timeout* | the number of ticks before the operation timeouts, the following special values are allowed:<br>• *TIME_IMMEDIATE* immediate timeout.<br>• *TIME_INFINITE* no timeout. |

**Returns**

The operation state.

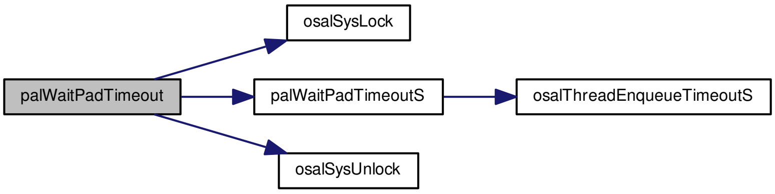
**Return values**

| | |
|---|---|
| *MSG_OK* | if an edge has been detected. |
| *MSG_TIMEOUT* | if a timeout occurred before an edge cound be detected. |
| *MSG_RESET* | if the event has been disabled while the thread was waiting for an edge. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



### 7.39.5.8 msg_t palWaitLineTimeoutS ( ioline_t *line,* sysinterval_t *timeout* )

Waits for an edge on the specified line.

**Parameters**

| | | |
|---|---|---|
| in | *line* | line identifier |
| in | *timeout* | operation timeout |

**Returns**

The operation state.

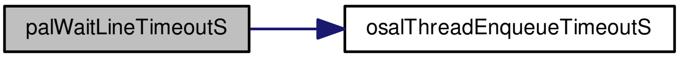
**Return values**

| | |
|---|---|
| *MSG_OK* | if an edge has been detected. |
| *MSG_TIMEOUT* | if a timeout occurred before an edge could be detected. |
| *MSG_RESET* | if the event has been disabled while the thread was waiting for an edge. |

**Function Class:**

This is an **S-Class** API, this function can be invoked from within a system lock zone by threads only.

Here is the call graph for this function:



### 7.39.5.9 msg_t palWaitLineTimeout ( ioline_t *line,* sysinterval_t *timeout* )

Waits for an edge on the specified line.

**Parameters**

| | | |
|---|---|---|
| in | *line* | line identifier |
| in | *timeout* | operation timeout |

**Returns**

The operation state.

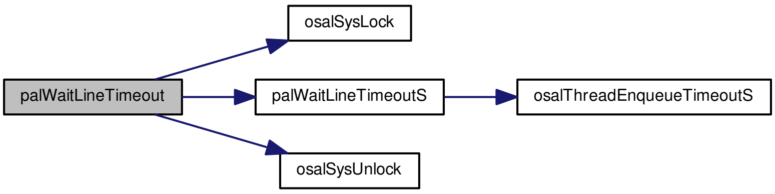
**Return values**

| | |
|---|---|
| *MSG_OK* | if an edge has been detected. |
| *MSG_TIMEOUT* | if a timeout occurred before an edge cound be detected. |
| *MSG_RESET* | if the event has been disabled while the thread was waiting for an edge. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.39.5.10 void _pal_lld_init ( const PALConfig ∗ *config* )

STM32 I/O ports configuration.

Ports A-D(E, F, G, H) clocks enabled.

**Parameters**

| | | |
|---|---|---|
| in | *config* | the STM32 ports configuration |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.39.5.11 void _pal_lld_setgroupmode ( ioportid_t *port,* ioportmask_t *mask,* iomode_t *mode* )

Pads mode setup.

This function programs a pads group belonging to the same port with the specified mode.

**Parameters**

| | | |
|---|---|---|
| in | *port* | the port identifier |
| in | *mask* | the group mask |
| in | *mode* | the mode |

**Function Class:**

Not an API, this function is for internal use only.

## 7.40 PWM Driver

Generic PWM Driver.

### 7.40.1 Detailed Description

Generic PWM Driver.

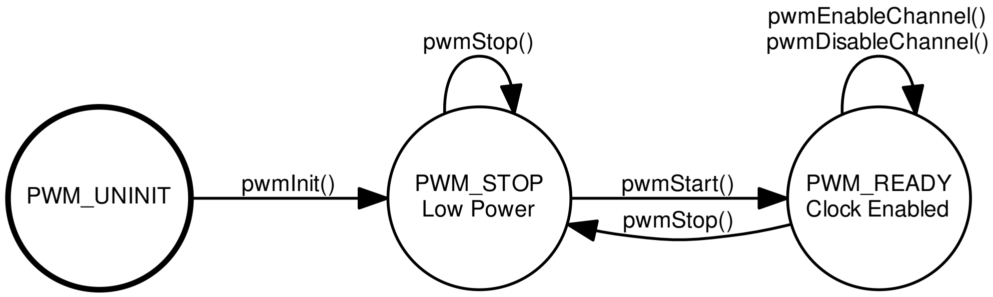
This module implements a generic PWM (Pulse Width Modulation) driver.

**Precondition**

In order to use the PWM driver the `HAL_USE_PWM` option must be enabled in `halconf.h`.

### 7.40.2 Driver State Machine

The driver implements a state machine internally, not all the driver functionalities can be used in any moment, any transition not explicitly shown in the following diagram has to be considered an error and shall be captured by an assertion (if enabled).



### 7.40.3 PWM Operations.

This driver abstracts a generic PWM timer composed of:

- A clock prescaler.
- A main up counter.
- A comparator register that resets the main counter to zero when the limit is reached. An optional callback can be generated when this happens.
- An array of `PWM_CHANNELS` PWM channels, each channel has an output, a comparator and is able to invoke an optional callback when a comparator match with the main counter happens.

A PWM channel output can be in two different states:

- **IDLE**, when the channel is disabled or after a match occurred.
- **ACTIVE**, when the channel is enabled and a match didn't occur yet in the current PWM cycle.

Note that the two states can be associated to both logical zero or one in the `PWMChannelConfig` structure.

## Macros

- #define PWM_CHANNELS 4

  *Number of PWM channels per PWM driver.*
- #define pwm_lld_change_period(pwmp, period)

  *Changes the period the PWM peripheral.*

## PWM output mode macros

- #define PWM_OUTPUT_MASK 0x0FU

  *Standard output modes mask.*
- #define PWM_OUTPUT_DISABLED 0x00U

  *Output not driven, callback only.*
- #define PWM_OUTPUT_ACTIVE_HIGH 0x01U

  *Positive PWM logic, active is logic level one.*
- #define PWM_OUTPUT_ACTIVE_LOW 0x02U

  *Inverse PWM logic, active is logic level zero.*

## PWM duty cycle conversion

- #define PWM_FRACTION_TO_WIDTH(pwmp, denominator, numerator)

  *Converts from fraction to pulse width.*
- #define PWM_DEGREES_TO_WIDTH(pwmp, degrees) PWM_FRACTION_TO_WIDTH(pwmp, 36000, degrees)

  *Converts from degrees to pulse width.*
- #define PWM_PERCENTAGE_TO_WIDTH(pwmp, percentage) PWM_FRACTION_TO_WIDTH(pwmp, 10000, percentage)

  *Converts from percentage to pulse width.*

## Macro Functions

- #define pwmChangePeriodI(pwmp, value)

  *Changes the period the PWM peripheral.*
- #define pwmEnableChannelI(pwmp, channel, width)

  *Enables a PWM channel.*
- #define pwmDisableChannelI(pwmp, channel)

  *Disables a PWM channel.*
- #define pwmIsChannelEnabledI(pwmp, channel) (((pwmp)->enabled & ((pwmchnmsk_t)1U << (pwmchnmsk↩_t)(channel))) != 0U)

  *Returns a PWM channel status.*
- #define pwmEnablePeriodicNotificationI(pwmp) pwm_lld_enable_periodic_notification(pwmp)

  *Enables the periodic activation edge notification.*
- #define pwmDisablePeriodicNotificationI(pwmp) pwm_lld_disable_periodic_notification(pwmp)

  *Disables the periodic activation edge notification.*
- #define pwmEnableChannelNotificationI(pwmp, channel) pwm_lld_enable_channel_notification(pwmp, channel)

  *Enables a channel de-activation edge notification.*
- #define pwmDisableChannelNotificationI(pwmp, channel) pwm_lld_disable_channel_notification(pwmp, channel)

  *Disables a channel de-activation edge notification.*

### PLATFORM configuration options

- #define PLATFORM_PWM_USE_PWM1 FALSE

  *PWMD1 driver enable switch.*

### Typedefs

- typedef struct PWMDriver PWMDriver

  *Type of a structure representing a PWM driver.*
- typedef void(∗ pwmcallback_t) (PWMDriver ∗pwmp)

  *Type of a PWM notification callback.*
- typedef uint32_t pwmmode_t

  *Type of a PWM mode.*
- typedef uint8_t pwmchannel_t

  *Type of a PWM channel.*
- typedef uint32_t pwmchnmsk_t

  *Type of a channels mask.*
- typedef uint32_t pwmcnt_t

  *Type of a PWM counter.*

### Data Structures

- struct PWMChannelConfig

  *Type of a PWM driver channel configuration structure.*
- struct PWMConfig

  *Type of a PWM driver configuration structure.*
- struct PWMDriver

  *Structure representing a PWM driver.*

### Functions

- void pwmInit (void)

  *PWM Driver initialization.*
- void pwmObjectInit (PWMDriver ∗pwmp)

  *Initializes the standard part of a `PWMDriver` structure.*
- void pwmStart (PWMDriver ∗pwmp, const PWMConfig ∗config)

  *Configures and activates the PWM peripheral.*
- void pwmStop (PWMDriver ∗pwmp)

  *Deactivates the PWM peripheral.*
- void pwmChangePeriod (PWMDriver ∗pwmp, pwmcnt_t period)

  *Changes the period the PWM peripheral.*
- void pwmEnableChannel (PWMDriver ∗pwmp, pwmchannel_t channel, pwmcnt_t width)

  *Enables a PWM channel.*
- void pwmDisableChannel (PWMDriver ∗pwmp, pwmchannel_t channel)

  *Disables a PWM channel and its notification.*
- void pwmEnablePeriodicNotification (PWMDriver ∗pwmp)

  *Enables the periodic activation edge notification.*
- void pwmDisablePeriodicNotification (PWMDriver ∗pwmp)

  *Disables the periodic activation edge notification.*
- void pwmEnableChannelNotification (PWMDriver ∗pwmp, pwmchannel_t channel)

*Enables a channel de-activation edge notification.*

- void pwmDisableChannelNotification (PWMDriver ∗pwmp, pwmchannel_t channel)

  *Disables a channel de-activation edge notification.*
- void pwm_lld_init (void)

  *Low level PWM driver initialization.*
- void pwm_lld_start (PWMDriver ∗pwmp)

  *Configures and activates the PWM peripheral.*
- void pwm_lld_stop (PWMDriver ∗pwmp)

  *Deactivates the PWM peripheral.*
- void pwm_lld_enable_channel (PWMDriver ∗pwmp, pwmchannel_t channel, pwmcnt_t width)

  *Enables a PWM channel.*
- void pwm_lld_disable_channel (PWMDriver ∗pwmp, pwmchannel_t channel)

  *Disables a PWM channel and its notification.*
- void pwm_lld_enable_periodic_notification (PWMDriver ∗pwmp)

  *Enables the periodic activation edge notification.*
- void pwm_lld_disable_periodic_notification (PWMDriver ∗pwmp)

  *Disables the periodic activation edge notification.*
- void pwm_lld_enable_channel_notification (PWMDriver ∗pwmp, pwmchannel_t channel)

  *Enables a channel de-activation edge notification.*
- void pwm_lld_disable_channel_notification (PWMDriver ∗pwmp, pwmchannel_t channel)

  *Disables a channel de-activation edge notification.*

## Enumerations

## Variables

- PWMDriver PWMD1

  *PWMD1 driver identifier.*

## 7.40.4 Macro Definition Documentation

### 7.40.4.1 #define PWM_OUTPUT_MASK 0x0FU

Standard output modes mask.

### 7.40.4.2 #define PWM_OUTPUT_DISABLED 0x00U

Output not driven, callback only.

### 7.40.4.3 #define PWM_OUTPUT_ACTIVE_HIGH 0x01U

Positive PWM logic, active is logic level one.

### 7.40.4.4 #define PWM_OUTPUT_ACTIVE_LOW 0x02U

Inverse PWM logic, active is logic level zero.

### 7.40.4.5 #define PWM_FRACTION_TO_WIDTH( *pwmp,* *denominator,* *numerator* )

**Value:**

```
((pwmcnt_t)((((pwmcnt_t)(pwmp)->period) *                        \
                 (pwmcnt_t)(numerator)) / (pwmcnt_t)(denominator)))
```

Converts from fraction to pulse width.

**Note**

Be careful with rounding errors, this is integer math not magic. You can specify tenths of thousandth but make sure you have the proper hardware resolution by carefully choosing the clock source and prescaler settings, see `PWM_COMPUTE_PSC`.

**Parameters**

| | | |
|---|---|---|
| in | *pwmp* | pointer to a `PWMDriver` object |
| in | *denominator* | denominator of the fraction |
| in | *numerator* | numerator of the fraction |

**Returns**

The pulse width to be passed to `pwmEnableChannel()`.

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

### 7.40.4.6 #define PWM_DEGREES_TO_WIDTH( *pwmp,* *degrees* ) PWM_FRACTION_TO_WIDTH(pwmp, 36000, degrees)

Converts from degrees to pulse width.

**Note**

Be careful with rounding errors, this is integer math not magic. You can specify hundredths of degrees but make sure you have the proper hardware resolution by carefully choosing the clock source and prescaler settings, see `PWM_COMPUTE_PSC`.

**Parameters**

| | | |
|---|---|---|
| in | *pwmp* | pointer to a `PWMDriver` object |
| in | *degrees* | degrees as an integer between 0 and 36000 |

**Returns**

The pulse width to be passed to `pwmEnableChannel()`.

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.40.4.7 #define PWM_PERCENTAGE_TO_WIDTH( *pwmp,* *percentage* ) PWM_FRACTION_TO_WIDTH(pwmp, 10000, percentage)

Converts from percentage to pulse width.

**Note**

Be careful with rounding errors, this is integer math not magic. You can specify tenths of thousandth but make sure you have the proper hardware resolution by carefully choosing the clock source and prescaler settings, see `PWM_COMPUTE_PSC`.

**Parameters**

| | | |
|---|---|---|
| in | *pwmp* | pointer to a `PWMDriver` object |
| in | *percentage* | percentage as an integer between 0 and 10000 |

**Returns**

The pulse width to be passed to `pwmEnableChannel()`.

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.40.4.8 #define pwmChangePeriodI( *pwmp,* *value* )

**Value:**

```
{                                           \
  (pwmp)->period = (value);                                        \
  pwm_lld_change_period(pwmp, value);                              \
}
```

Changes the period the PWM peripheral.

This function changes the period of a PWM unit that has already been activated using `pwmStart()`.

**Precondition**

The PWM unit must have been activated using `pwmStart()`.

**Postcondition**

The PWM unit period is changed to the new value.

**Note**

If a period is specified that is shorter than the pulse width programmed in one of the channels then the behavior is not guaranteed.

**Parameters**

| | | |
|---|---|---|
| in | *pwmp* | pointer to a `PWMDriver` object |
| in | *value* | new cycle time in ticks |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

### 7.40.4.9 #define pwmEnableChannelI( *pwmp*, *channel*, *width* )

**Value:**

```
do {                        \
  (pwmp)->enabled |= ((pwmchnmsk_t)1U << (pwmchnmsk_t)(channel));
      \
  pwm_lld_enable_channel(pwmp, channel, width);                             \
} while (false)
```

Enables a PWM channel.

**Precondition**

The PWM unit must have been activated using `pwmStart()`.

**Postcondition**

The channel is active using the specified configuration.

**Note**

Depending on the hardware implementation this function has effect starting on the next cycle (recommended implementation) or immediately (fallback implementation).

**Parameters**

| | | |
|---|---|---|
| in | *pwmp* | pointer to a `PWMDriver` object |
| in | *channel* | PWM channel identifier (0...channels-1) |
| in | *width* | PWM pulse width as clock pulses number |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

### 7.40.4.10 #define pwmDisableChannelI( *pwmp*, *channel* )

**Value:**

```
do {                              \
  (pwmp)->enabled &= ~((pwmchnmsk_t)1U << (pwmchnmsk_t)(channel));
      \
  pwm_lld_disable_channel(pwmp, channel);                                   \
} while (false)
```

Disables a PWM channel.

**Precondition**

The PWM unit must have been activated using `pwmStart()`.

**Postcondition**

The channel is disabled and its output line returned to the idle state.

**Note**

Depending on the hardware implementation this function has effect starting on the next cycle (recommended implementation) or immediately (fallback implementation).

**Parameters**

| | | |
|---|---|---|
| in | *pwmp* | pointer to a `PWMDriver` object |
| in | *channel* | PWM channel identifier (0...channels-1) |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

#### 7.40.4.11 #define pwmIsChannelEnabledI( *pwmp*, *channel* ) (((pwmp)->enabled & ((pwmchnmsk_t)1U << (pwmchnmsk_t)(channel))) != 0U)

Returns a PWM channel status.

**Precondition**

The PWM unit must have been activated using `pwmStart()`.

**Parameters**

| | | |
|---|---|---|
| in | *pwmp* | pointer to a `PWMDriver` object |
| in | *channel* | PWM channel identifier (0...channels-1) |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

#### 7.40.4.12 #define pwmEnablePeriodicNotificationI( *pwmp* ) pwm_lld_enable_periodic_notification(pwmp)

Enables the periodic activation edge notification.

**Precondition**

The PWM unit must have been activated using `pwmStart()`.

**Note**

If the notification is already enabled then the call has no effect.

**Parameters**

| | | |
|---|---|---|
| in | *pwmp* | pointer to a `PWMDriver` object |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

#### 7.40.4.13 #define pwmDisablePeriodicNotificationI( *pwmp* ) pwm_lld_disable_periodic_notification(pwmp)

Disables the periodic activation edge notification.

**Precondition**

The PWM unit must have been activated using `pwmStart()`.

**Note**

If the notification is already disabled then the call has no effect.

**Parameters**

| | | |
|---|---|---|
| in | *pwmp* | pointer to a `PWMDriver` object |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

#### 7.40.4.14 #define pwmEnableChannelNotificationI( *pwmp, channel* ) pwm_lld_enable_channel_notification(pwmp, channel)

Enables a channel de-activation edge notification.

**Precondition**

The PWM unit must have been activated using `pwmStart()`.
The channel must have been activated using `pwmEnableChannel()`.

**Note**

If the notification is already enabled then the call has no effect.

**Parameters**

| | | |
|---|---|---|
| in | *pwmp* | pointer to a `PWMDriver` object |
| in | *channel* | PWM channel identifier (0...channels-1) |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

#### 7.40.4.15 #define pwmDisableChannelNotificationI( *pwmp,* *channel* ) pwm_lld_disable_channel_notification(pwmp, channel)

Disables a channel de-activation edge notification.

**Precondition**

The PWM unit must have been activated using `pwmStart()`.
The channel must have been activated using `pwmEnableChannel()`.

**Note**

If the notification is already disabled then the call has no effect.

**Parameters**

| | | |
|---|---|---|
| in | *pwmp* | pointer to a `PWMDriver` object |
| in | *channel* | PWM channel identifier (0...channels-1) |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

#### 7.40.4.16 #define PWM_CHANNELS 4

Number of PWM channels per PWM driver.

#### 7.40.4.17 #define PLATFORM_PWM_USE_PWM1 FALSE

PWMD1 driver enable switch.

If set to `TRUE` the support for PWM1 is included.

**Note**

The default is `FALSE`.

#### 7.40.4.18 #define pwm_lld_change_period( *pwmp,* *period* )

Changes the period the PWM peripheral.

This function changes the period of a PWM unit that has already been activated using `pwmStart()`.

**Precondition**

The PWM unit must have been activated using `pwmStart()`.

**Postcondition**

The PWM unit period is changed to the new value.

**Note**

The function has effect at the next cycle start.
If a period is specified that is shorter than the pulse width programmed in one of the channels then the behavior is not guaranteed.

**Parameters**

| | | |
|---|---|---|
| in | *pwmp* | pointer to a `PWMDriver` object |
| in | *period* | new cycle time in ticks |

**Function Class:**

Not an API, this function is for internal use only.

## 7.40.5 Typedef Documentation

### 7.40.5.1 typedef struct PWMDriver PWMDriver

Type of a structure representing a PWM driver.

### 7.40.5.2 typedef void(∗ pwmcallback_t) (PWMDriver ∗pwmp)

Type of a PWM notification callback.

**Parameters**

| | | |
|---|---|---|
| in | *pwmp* | pointer to a `PWMDriver` object |

### 7.40.5.3 typedef uint32_t pwmmode_t

Type of a PWM mode.

### 7.40.5.4 typedef uint8_t pwmchannel_t

Type of a PWM channel.

### 7.40.5.5 typedef uint32_t pwmchnmsk_t

Type of a channels mask.

### 7.40.5.6 typedef uint32_t pwmcnt_t

Type of a PWM counter.

## 7.40.6 Enumeration Type Documentation

### 7.40.6.1 enum **pwmstate_t**

Driver state machine possible states.

**Enumerator**

***PWM_UNINIT*** Not initialized.

***PWM_STOP*** Stopped.

***PWM_READY*** Ready.

## 7.40.7 Function Documentation

### 7.40.7.1 void pwmInit ( void )

PWM Driver initialization.

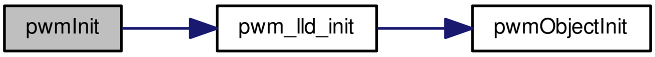
**Note**

This function is implicitly invoked by `halInit()`, there is no need to explicitly initialize the driver.

**Function Class:**

Initializer, this function just initializes an object and can be invoked before the kernel is initialized.

Here is the call graph for this function:



### 7.40.7.2 void pwmObjectInit ( **PWMDriver** ∗ *pwmp* )

Initializes the standard part of a `PWMDriver` structure.

**Parameters**

| | | |
|---|---|---|
| out | *pwmp* | pointer to a `PWMDriver` object |

**Function Class:**

Initializer, this function just initializes an object and can be invoked before the kernel is initialized.

### 7.40.7.3 void pwmStart ( **PWMDriver** ∗ *pwmp*, const **PWMConfig** ∗ *config* )

Configures and activates the PWM peripheral.

#### Note

Starting a driver that is already in the PWM_READY state disables all the active channels.

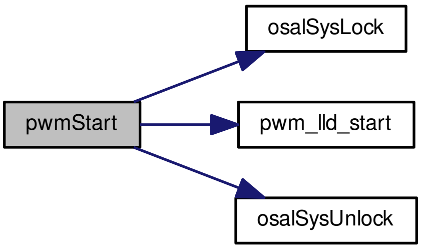
#### Parameters

| | | |
|---|---|---|
| in | *pwmp* | pointer to a PWMDriver object |
| in | *config* | pointer to a PWMConfig object |

#### Function Class:

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



### 7.40.7.4 void pwmStop ( **PWMDriver** ∗ *pwmp* )

Deactivates the PWM peripheral.

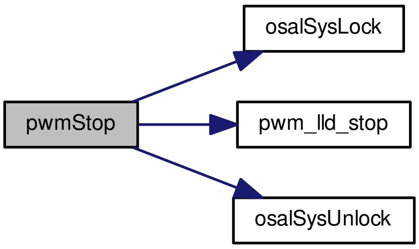
#### Parameters

| | | |
|---|---|---|
| in | *pwmp* | pointer to a PWMDriver object |

#### Function Class:

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.40.7.5 void pwmChangePeriod ( PWMDriver ∗ *pwmp*, pwmcnt_t *period* )

Changes the period the PWM peripheral.

This function changes the period of a PWM unit that has already been activated using `pwmStart()`.

**Precondition**

The PWM unit must have been activated using `pwmStart()`.

**Postcondition**

The PWM unit period is changed to the new value.

**Note**

If a period is specified that is shorter than the pulse width programmed in one of the channels then the behavior is not guaranteed.

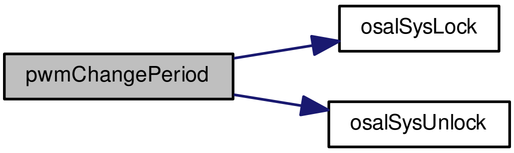
**Parameters**

| | | |
|---|---|---|
| in | *pwmp* | pointer to a `PWMDriver` object |
| in | *period* | new cycle time in ticks |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.40.7.6 void pwmEnableChannel ( PWMDriver ∗ *pwmp,* pwmchannel_t *channel,* pwmcnt_t *width* )

Enables a PWM channel.

**Precondition**

The PWM unit must have been activated using `pwmStart()`.

**Postcondition**

The channel is active using the specified configuration.

**Note**

Depending on the hardware implementation this function has effect starting on the next cycle (recommended implementation) or immediately (fallback implementation).

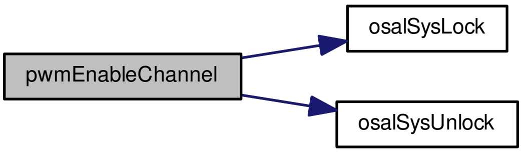
**Parameters**

| | | |
|---|---|---|
| `in` | *pwmp* | pointer to a `PWMDriver` object |
| `in` | *channel* | PWM channel identifier (0...channels-1) |
| `in` | *width* | PWM pulse width as clock pulses number |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.40.7.7 void pwmDisableChannel ( PWMDriver ∗ *pwmp,* pwmchannel_t *channel* )

Disables a PWM channel and its notification.

**Precondition**

The PWM unit must have been activated using `pwmStart()`.

**Postcondition**

The channel is disabled and its output line returned to the idle state.

**Note**

Depending on the hardware implementation this function has effect starting on the next cycle (recommended implementation) or immediately (fallback implementation).

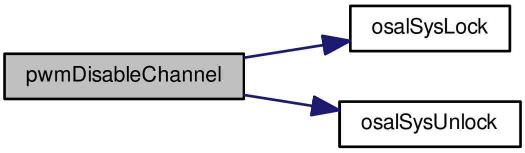
**Parameters**

| | | |
|---|---|---|
| `in` | *pwmp* | pointer to a `PWMDriver` object |
| `in` | *channel* | PWM channel identifier (0...channels-1) |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.40.7.8 void pwmEnablePeriodicNotification ( **PWMDriver** ∗ *pwmp* )

Enables the periodic activation edge notification.

**Precondition**

The PWM unit must have been activated using `pwmStart()`.

**Note**

If the notification is already enabled then the call has no effect.

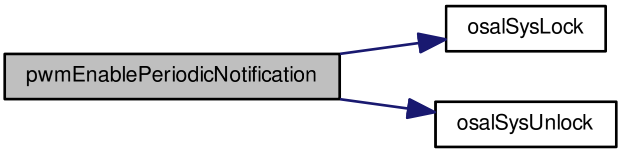
**Parameters**

|  |  |  |
|---|---|---|
| in | *pwmp* | pointer to a `PWMDriver` object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.40.7.9 void pwmDisablePeriodicNotification ( **PWMDriver** ∗ *pwmp* )

Disables the periodic activation edge notification.

**Precondition**

The PWM unit must have been activated using `pwmStart()`.

**Note**

If the notification is already disabled then the call has no effect.

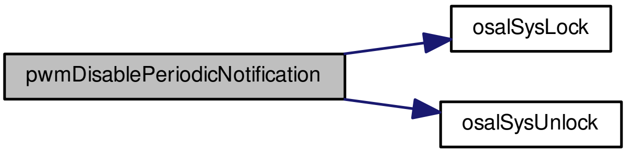
**Parameters**

|  |  |  |
|---|---|---|
| in | *pwmp* | pointer to a `PWMDriver` object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.40.7.10 void pwmEnableChannelNotification ( PWMDriver * *pwmp*, pwmchannel_t *channel* )

Enables a channel de-activation edge notification.

**Precondition**

The PWM unit must have been activated using `pwmStart()`.
The channel must have been activated using `pwmEnableChannel()`.

**Note**

If the notification is already enabled then the call has no effect.

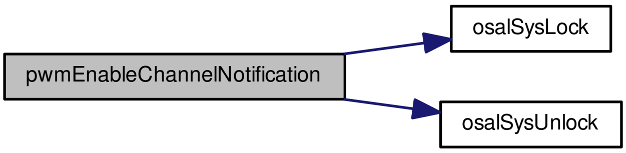
**Parameters**

| | | |
|---|---|---|
| in | *pwmp* | pointer to a `PWMDriver` object |
| in | *channel* | PWM channel identifier (0...channels-1) |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.40.7.11 void pwmDisableChannelNotification ( PWMDriver * *pwmp*, pwmchannel_t *channel* )

Disables a channel de-activation edge notification.

**Precondition**

The PWM unit must have been activated using `pwmStart()`.
The channel must have been activated using `pwmEnableChannel()`.

**Note**

If the notification is already disabled then the call has no effect.

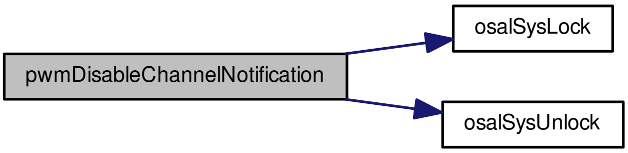
**Parameters**

| | | |
|---|---|---|
| in | *pwmp* | pointer to a `PWMDriver` object |
| in | *channel* | PWM channel identifier (0...channels-1) |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



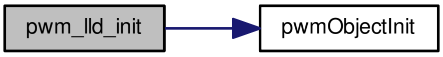
#### 7.40.7.12 void pwm_lld_init ( void )

Low level PWM driver initialization.

**Function Class:**

Not an API, this function is for internal use only.

Here is the call graph for this function:



#### 7.40.7.13 void pwm_lld_start ( **PWMDriver** * *pwmp* )

Configures and activates the PWM peripheral.

**Note**

Starting a driver that is already in the `PWM_READY` state disables all the active channels.

**Parameters**

| | | |
|---|---|---|
| in | *pwmp* | pointer to a `PWMDriver` object |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.40.7.14 void pwm_lld_stop ( **PWMDriver** * *pwmp* )

Deactivates the PWM peripheral.

**Parameters**

| | | |
|---|---|---|
| in | *pwmp* | pointer to a `PWMDriver` object |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.40.7.15 void pwm_lld_enable_channel ( **PWMDriver** * *pwmp,* **pwmchannel_t** *channel,* **pwmcnt_t** *width* )

Enables a PWM channel.

**Precondition**

The PWM unit must have been activated using `pwmStart()`.

**Postcondition**

The channel is active using the specified configuration.

**Note**

The function has effect at the next cycle start.
Channel notification is not enabled.

**Parameters**

| | | |
|---|---|---|
| in | *pwmp* | pointer to a `PWMDriver` object |
| in | *channel* | PWM channel identifier (0...channels-1) |
| in | *width* | PWM pulse width as clock pulses number |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.40.7.16 void pwm_lld_disable_channel ( PWMDriver * *pwmp*, pwmchannel_t *channel* )

Disables a PWM channel and its notification.

**Precondition**

The PWM unit must have been activated using `pwmStart()`.

**Postcondition**

The channel is disabled and its output line returned to the idle state.

**Note**

The function has effect at the next cycle start.

**Parameters**

| | | |
|---|---|---|
| `in` | *pwmp* | pointer to a `PWMDriver` object |
| `in` | *channel* | PWM channel identifier (0...channels-1) |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.40.7.17 void pwm_lld_enable_periodic_notification ( PWMDriver * *pwmp* )

Enables the periodic activation edge notification.

**Precondition**

The PWM unit must have been activated using `pwmStart()`.

**Note**

If the notification is already enabled then the call has no effect.

**Parameters**

| | | |
|---|---|---|
| `in` | *pwmp* | pointer to a `PWMDriver` object |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.40.7.18 void pwm_lld_disable_periodic_notification ( **PWMDriver** ∗ *pwmp* )

Disables the periodic activation edge notification.

**Precondition**

The PWM unit must have been activated using `pwmStart()`.

**Note**

If the notification is already disabled then the call has no effect.

**Parameters**

| | | |
|---|---|---|
| `in` | *pwmp* | pointer to a `PWMDriver` object |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.40.7.19 void pwm_lld_enable_channel_notification ( **PWMDriver** ∗ *pwmp*, **pwmchannel_t** *channel* )

Enables a channel de-activation edge notification.

**Precondition**

The PWM unit must have been activated using `pwmStart()`.
The channel must have been activated using `pwmEnableChannel()`.

**Note**

If the notification is already enabled then the call has no effect.

**Parameters**

| | | |
|---|---|---|
| `in` | *pwmp* | pointer to a `PWMDriver` object |
| `in` | *channel* | PWM channel identifier (0...channels-1) |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.40.7.20 void pwm_lld_disable_channel_notification ( **PWMDriver** ∗ *pwmp*, **pwmchannel_t** *channel* )

Disables a channel de-activation edge notification.

**Precondition**

The PWM unit must have been activated using `pwmStart()`.
The channel must have been activated using `pwmEnableChannel()`.

**Note**

If the notification is already disabled then the call has no effect.

**Parameters**

| | | |
|---|---|---|
| `in` | *pwmp* | pointer to a `PWMDriver` object |
| `in` | *channel* | PWM channel identifier (0...channels-1) |

**Function Class:**

Not an API, this function is for internal use only.

## 7.40.8 Variable Documentation

### 7.40.8.1 PWMDriver PWMD1

PWMD1 driver identifier.

**Note**

The driver PWMD1 allocates the complex timer TIM1 when enabled.

## 7.41 QSPI Driver

Generic QSPI Driver.

### 7.41.1 Detailed Description

Generic QSPI Driver.

This module defines an abstract interface for a Quad SPI communication interface.

#### Precondition

In order to use the QSPI driver the `HAL_USE_QSPI` option must be enabled in `halconf.h`.

### Transfer options

- #define **QSPI_CFG_CMD_MASK** (0xFFLU << 0LU)
- #define **QSPI_CFG_CMD**(n) ((n) << 0LU)
- #define **QSPI_CFG_CMD_MODE_MASK** (3LU << 8LU)
- #define **QSPI_CFG_CMD_MODE_NONE** (0LU << 8LU)
- #define **QSPI_CFG_CMD_MODE_ONE_LINE** (1LU << 8LU)
- #define **QSPI_CFG_CMD_MODE_TWO_LINES** (2LU << 8LU)
- #define **QSPI_CFG_CMD_MODE_FOUR_LINES** (3LU << 8LU)
- #define **QSPI_CFG_ADDR_MODE_MASK** (3LU << 10LU)
- #define **QSPI_CFG_ADDR_MODE_NONE** (0LU << 10LU)
- #define **QSPI_CFG_ADDR_MODE_ONE_LINE** (1LU << 10LU)
- #define **QSPI_CFG_ADDR_MODE_TWO_LINES** (2LU << 10LU)
- #define **QSPI_CFG_ADDR_MODE_FOUR_LINES** (3LU << 10LU)
- #define **QSPI_CFG_ADDR_SIZE_MASK** (3LU << 12LU)
- #define **QSPI_CFG_ADDR_SIZE_8** (0LU << 12LU)
- #define **QSPI_CFG_ADDR_SIZE_16** (1LU << 12LU)
- #define **QSPI_CFG_ADDR_SIZE_24** (2LU << 12LU)
- #define **QSPI_CFG_ADDR_SIZE_32** (3LU << 12LU)
- #define **QSPI_CFG_ALT_MODE_MASK** (3LU << 14LU)
- #define **QSPI_CFG_ALT_MODE_NONE** (0LU << 14LU)
- #define **QSPI_CFG_ALT_MODE_ONE_LINE** (1LU << 14LU)
- #define **QSPI_CFG_ALT_MODE_TWO_LINES** (2LU << 14LU)
- #define **QSPI_CFG_ALT_MODE_FOUR_LINES** (3LU << 14LU)
- #define **QSPI_CFG_ALT_SIZE_MASK** (3LU << 16LU)
- #define **QSPI_CFG_ALT_SIZE_8** (0LU << 16LU)
- #define **QSPI_CFG_ALT_SIZE_16** (1LU << 16LU)
- #define **QSPI_CFG_ALT_SIZE_24** (2LU << 16LU)
- #define **QSPI_CFG_ALT_SIZE_32** (3LU << 16LU)
- #define **QSPI_CFG_DUMMY_CYCLES_MASK** (0x1FLU << 18LU)
- #define **QSPI_CFG_DUMMY_CYCLES**(n) ((n) << 18LU)
- #define **QSPI_CFG_DATA_MODE_MASK** (3LU << 24LU)
- #define **QSPI_CFG_DATA_MODE_NONE** (0LU << 24LU)
- #define **QSPI_CFG_DATA_MODE_ONE_LINE** (1LU << 24LU)
- #define **QSPI_CFG_DATA_MODE_TWO_LINES** (2LU << 24LU)
- #define **QSPI_CFG_DATA_MODE_FOUR_LINES** (3LU << 24LU)
- #define **QSPI_CFG_SIOO** (1LU << 28LU)
- #define **QSPI_CFG_DDRM** (1LU << 31LU)

### QSPI configuration options

- #define QSPI_USE_WAIT TRUE

  *Enables synchronous APIs.*
- #define QSPI_USE_MUTUAL_EXCLUSION TRUE

  *Enables the `qspiAcquireBus()` and `qspiReleaseBus()` APIs.*

### Macro Functions

- #define qspiStartCommandI(qspip, cmdp)

  *Sends a command without data phase.*
- #define qspiStartSendI(qspip, cmdp, n, txbuf)

  *Sends data over the QSPI bus.*
- #define qspiStartReceiveI(qspip, cmdp, n, rxbuf)

  *Receives data from the QSPI bus.*
- #define qspiMapFlashI(qspip, cmdp, addrp) qspi_lld_map_flash(qspip, cmdp, addrp)

  *Maps in memory space a QSPI flash device.*
- #define qspiUnmapFlashI(qspip) qspi_lld_unmap_flash(qspip)

  *Maps in memory space a QSPI flash device.*

### Low level driver helper macros

- #define _qspi_wakeup_isr(qspip)

  *Wakes up the waiting thread.*
- #define _qspi_isr_code(qspip)

  *Common ISR code.*

### QSPI capabilities

- #define **QSPI_SUPPORTS_MEMMAP** TRUE

### Configuration options

- #define PLATFORM_QSPI_USE_QSPI1 FALSE

  *QSPID1 driver enable switch.*

### Typedefs

- typedef struct QSPIDriver QSPIDriver

  *Type of a structure representing an QSPI driver.*
- typedef void(∗ qspicallback_t) (QSPIDriver ∗qspip)

  *Type of a QSPI notification callback.*

### Data Structures

- struct qspi_command_t

  *Type of a QSPI command descriptor.*
- struct QSPIConfig

  *Driver configuration structure.*
- struct QSPIDriver

  *Structure representing an QSPI driver.*

## Functions

- void qspiInit (void)

  *QSPI Driver initialization.*
- void qspiObjectInit (QSPIDriver ∗qspip)

  *Initializes the standard part of a `QSPIDriver` structure.*
- void qspiStart (QSPIDriver ∗qspip, const QSPIConfig ∗config)

  *Configures and activates the QSPI peripheral.*
- void qspiStop (QSPIDriver ∗qspip)

  *Deactivates the QSPI peripheral.*
- void qspiStartCommand (QSPIDriver ∗qspip, const qspi_command_t ∗cmdp)

  *Sends a command without data phase.*
- void qspiStartSend (QSPIDriver ∗qspip, const qspi_command_t ∗cmdp, size_t n, const uint8_t ∗txbuf)

  *Sends a command with data over the QSPI bus.*
- void qspiStartReceive (QSPIDriver ∗qspip, const qspi_command_t ∗cmdp, size_t n, uint8_t ∗rxbuf)

  *Sends a command then receives data over the QSPI bus.*
- void qspiCommand (QSPIDriver ∗qspip, const qspi_command_t ∗cmdp)

  *Sends a command without data phase.*
- void qspiSend (QSPIDriver ∗qspip, const qspi_command_t ∗cmdp, size_t n, const uint8_t ∗txbuf)

  *Sends a command with data over the QSPI bus.*
- void qspiReceive (QSPIDriver ∗qspip, const qspi_command_t ∗cmdp, size_t n, uint8_t ∗rxbuf)

  *Sends a command then receives data over the QSPI bus.*
- void qspiMapFlash (QSPIDriver ∗qspip, const qspi_command_t ∗cmdp, uint8_t ∗∗addrp)

  *Maps in memory space a QSPI flash device.*
- void qspiUnmapFlash (QSPIDriver ∗qspip)

  *Unmaps from memory space a QSPI flash device.*
- void qspiAcquireBus (QSPIDriver ∗qspip)

  *Gains exclusive access to the QSPI bus.*
- void qspiReleaseBus (QSPIDriver ∗qspip)

  *Releases exclusive access to the QSPI bus.*
- void qspi_lld_init (void)

  *Low level QSPI driver initialization.*
- void qspi_lld_start (QSPIDriver ∗qspip)

  *Configures and activates the QSPI peripheral.*
- void qspi_lld_stop (QSPIDriver ∗qspip)

  *Deactivates the QSPI peripheral.*
- void qspi_lld_command (QSPIDriver ∗qspip, const qspi_command_t ∗cmdp)

  *Sends a command without data phase.*
- void qspi_lld_send (QSPIDriver ∗qspip, const qspi_command_t ∗cmdp, size_t n, const uint8_t ∗txbuf)

  *Sends a command with data over the QSPI bus.*
- void qspi_lld_receive (QSPIDriver ∗qspip, const qspi_command_t ∗cmdp, size_t n, uint8_t ∗rxbuf)

  *Sends a command then receives data over the QSPI bus.*
- void qspi_lld_map_flash (QSPIDriver ∗qspip, const qspi_command_t ∗cmdp, uint8_t ∗∗addrp)

  *Maps in memory space a QSPI flash device.*
- void qspi_lld_unmap_flash (QSPIDriver ∗qspip)

  *Unmaps from memory space a QSPI flash device.*

## Enumerations

## Variables

- QSPIDriver QSPID1

  *QSPID1 driver identifier.*

## 7.41.2 Macro Definition Documentation

### 7.41.2.1 #define QSPI_USE_WAIT TRUE

Enables synchronous APIs.

**Note**

Disabling this option saves both code and data space.

### 7.41.2.2 #define QSPI_USE_MUTUAL_EXCLUSION TRUE

Enables the `qspiAcquireBus()` and `qspiReleaseBus()` APIs.

**Note**

Disabling this option saves both code and data space.

### 7.41.2.3 #define qspiStartCommandI( *qspip,* *cmdp* )

**Value:**

```
{                                     \
  osalDbgAssert(((cmdp)->cfg & QSPI_CFG_DATA_MODE_MASK) ==                    \
                QSPI_CFG_DATA_MODE_NONE,                                      \
                "data mode specified");                                       \
  (qspip)->state = QSPI_ACTIVE;
      \
  qspi_lld_command(qspip, cmdp);                                              \
}
```

Sends a command without data phase.

**Postcondition**

At the end of the operation the configured callback is invoked.

**Parameters**

| | | |
|---|---|---|
| in | *qspip* | pointer to the `QSPIDriver` object |
| in | *cmdp* | pointer to the command descriptor |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

### 7.41.2.4 #define qspiStartSendI( *qspip,* *cmdp,* *n,* *txbuf* )

**Value:**

```
{                              \
  osalDbgAssert(((cmdp)->cfg & QSPI_CFG_DATA_MODE_MASK) !=                    \
                QSPI_CFG_DATA_MODE_NONE,                                      \
                "data mode required");                                        \
  (qspip)->state = QSPI_ACTIVE;
      \
  qspi_lld_send(qspip, cmdp, n, txbuf);                                        \
}
```

Sends data over the QSPI bus.

This asynchronous function starts a transmit operation.

#### Postcondition

At the end of the operation the configured callback is invoked.

#### Parameters

| | | |
|---|---|---|
| in | *qspip* | pointer to the QSPIDriver object |
| in | *cmdp* | pointer to the command descriptor |
| in | *n* | number of bytes to send or zero if no data phase |
| in | *txbuf* | the pointer to the transmit buffer |

#### Function Class:

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

### 7.41.2.5 #define qspiStartReceiveI( *qspip,* *cmdp,* *n,* *rxbuf* )

**Value:**

```
{                                        \
  osalDbgAssert(((cmdp)->cfg & QSPI_CFG_DATA_MODE_MASK) !=                     \
                QSPI_CFG_DATA_MODE_NONE,                                       \
                "data mode required");                                         \
  (qspip)->state = QSPI_ACTIVE;
      \
  qspi_lld_receive(qspip, cmdp, n, rxbuf);                                     \
}
```

Receives data from the QSPI bus.

This asynchronous function starts a receive operation.

#### Postcondition

At the end of the operation the configured callback is invoked.

#### Parameters

| | | |
|---|---|---|
| in | *qspip* | pointer to the QSPIDriver object |
| in | *cmdp* | pointer to the command descriptor |
| in | *n* | number of bytes to receive or zero if no data phase |
| out | *rxbuf* | the pointer to the receive buffer |

#### Function Class:

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

### 7.41.2.6 #define qspiMapFlashI( *qspip, cmdp, addrp* ) **qspi_lld_map_flash**(qspip, cmdp, addrp)

Maps in memory space a QSPI flash device.

**Precondition**

The memory flash device must be initialized appropriately before mapping it in memory space.

**Parameters**

| | | |
|---|---|---|
| `in` | *qspip* | pointer to the `QSPIDriver` object |
| `in` | *cmdp* | pointer to the command descriptor |
| `out` | *addrp* | pointer to the memory start address of the mapped flash or `NULL` |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

### 7.41.2.7 #define qspiUnmapFlashI( *qspip* ) **qspi_lld_unmap_flash**(qspip)

Maps in memory space a QSPI flash device.

**Postcondition**

The memory flash device must be re-initialized for normal commands exchange.

**Parameters**

| | | |
|---|---|---|
| `in` | *qspip* | pointer to the `QSPIDriver` object |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

### 7.41.2.8 #define _qspi_wakeup_isr( *qspip* )

**Value:**

```
{                                            \
  osalSysLockFromISR();
      \
  osalThreadResumeI(&(qspip)->thread, MSG_OK);
      \
  osalSysUnlockFromISR();                                                     \
}
```

Wakes up the waiting thread.

**Parameters**

| | | |
|---|---|---|
| `in` | *qspip* | pointer to the `QSPIDriver` object |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.41.2.9 #define _qspi_isr_code( *qspip* )

**Value:**

```
{                                             \
  if ((qspip)->config->end_cb) {                                    \
    (qspip)->state = QSPI_COMPLETE;                                 \
    (qspip)->config->end_cb(qspip);                                 \
    if ((qspip)->state == QSPI_COMPLETE)                            \
      (qspip)->state = QSPI_READY;                                  \
  }                                                                 \
  else                                                              \
    (qspip)->state = QSPI_READY;
      \
  _qspi_wakeup_isr(qspip);                                          \
}
```

Common ISR code.

This code handles the portable part of the ISR code:

- Callback invocation.
- Waiting thread wakeup, if any.
- Driver state transitions.

**Note**

This macro is meant to be used in the low level drivers implementation only.

**Parameters**

| | | |
|---|---|---|
| in | *qspip* | pointer to the QSPIDriver object |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.41.2.10 #define PLATFORM_QSPI_USE_QSPI1 FALSE

QSPID1 driver enable switch.

If set to TRUE the support for QSPID1 is included.

**Note**

The default is FALSE.

### 7.41.3 Typedef Documentation

#### 7.41.3.1 typedef struct QSPIDriver QSPIDriver

Type of a structure representing an QSPI driver.

#### 7.41.3.2 typedef void(∗ qspicallback_t) (QSPIDriver ∗qspip)

Type of a QSPI notification callback.

**Parameters**

| | | |
|---|---|---|
| in | *qspip* | pointer to the `QSPIDriver` object triggering the callback |

### 7.41.4 Enumeration Type Documentation

#### 7.41.4.1 enum qspistate_t

Driver state machine possible states.

**Enumerator**

***QSPI_UNINIT*** Not initialized.

***QSPI_STOP*** Stopped.

***QSPI_READY*** Ready.

***QSPI_ACTIVE*** Exchanging data.

***QSPI_COMPLETE*** Asynchronous operation complete.

***QSPI_MEMMAP*** In memory mapped mode.

### 7.41.5 Function Documentation

#### 7.41.5.1 void qspiInit ( void )

QSPI Driver initialization.

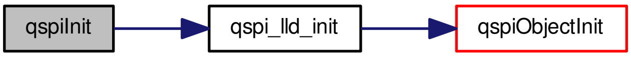
**Note**

This function is implicitly invoked by `halInit()`, there is no need to explicitly initialize the driver.

**Function Class:**

Initializer, this function just initializes an object and can be invoked before the kernel is initialized.

Here is the call graph for this function:



#### 7.41.5.2 void qspiObjectInit ( QSPIDriver ∗ *qspip* )

Initializes the standard part of a `QSPIDriver` structure.

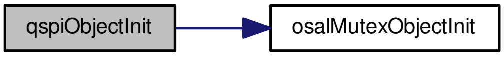
**Parameters**

| | | |
|---|---|---|
| out | *qspip* | pointer to the QSPIDriver object |

**Function Class:**

Initializer, this function just initializes an object and can be invoked before the kernel is initialized.

Here is the call graph for this function:



### 7.41.5.3 void qspiStart ( **QSPIDriver** ∗ *qspip*, const **QSPIConfig** ∗ *config* )

Configures and activates the QSPI peripheral.

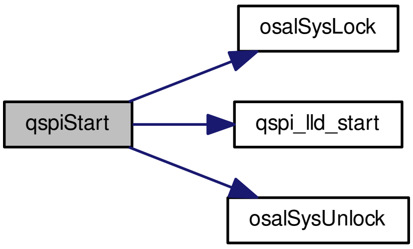
**Parameters**

| | | |
|---|---|---|
| in | *qspip* | pointer to the QSPIDriver object |
| in | *config* | pointer to the QSPIConfig object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.41.5.4 void qspiStop ( QSPIDriver ∗ *qspip* )

Deactivates the QSPI peripheral.

**Note**

Deactivating the peripheral also enforces a release of the slave select line.

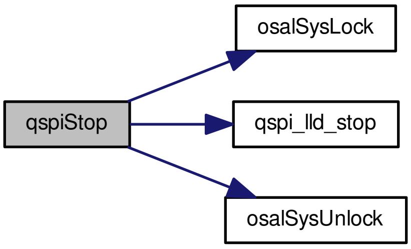
**Parameters**

| | | |
|---|---|---|
| in | *qspip* | pointer to the QSPIDriver object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.41.5.5 void qspiStartCommand ( QSPIDriver ∗ *qspip*, const qspi_command_t ∗ *cmdp* )

Sends a command without data phase.

**Postcondition**

At the end of the operation the configured callback is invoked.

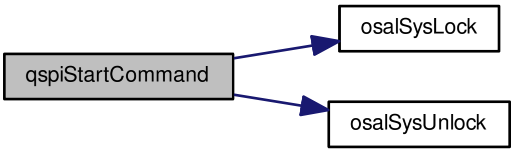
**Parameters**

| | | |
|---|---|---|
| in | *qspip* | pointer to the QSPIDriver object |
| in | *cmdp* | pointer to the command descriptor |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.41.5.6 void qspiStartSend ( QSPIDriver ∗ *qspip*, const qspi_command_t ∗ *cmdp*, size_t *n*, const uint8_t ∗ *txbuf* )

Sends a command with data over the QSPI bus.

**Postcondition**

At the end of the operation the configured callback is invoked.

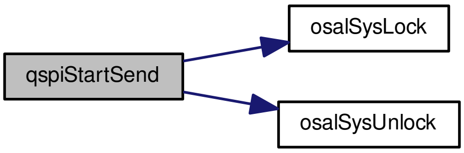
**Parameters**

| | | |
|---|---|---|
| `in` | *qspip* | pointer to the `QSPIDriver` object |
| `in` | *cmdp* | pointer to the command descriptor |
| `in` | *n* | number of bytes to send |
| `in` | *txbuf* | the pointer to the transmit buffer |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.41.5.7 void qspiStartReceive ( QSPIDriver ∗ *qspip*, const qspi_command_t ∗ *cmdp*, size_t *n*, uint8_t ∗ *rxbuf* )

Sends a command then receives data over the QSPI bus.

**Postcondition**

At the end of the operation the configured callback is invoked.

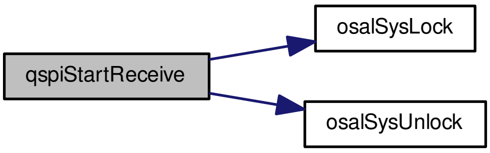
**Parameters**

| | | |
|---|---|---|
| in | *qspip* | pointer to the QSPIDriver object |
| in | *cmdp* | pointer to the command descriptor |
| in | *n* | number of bytes to send |
| out | *rxbuf* | the pointer to the receive buffer |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



### 7.41.5.8 void qspiCommand ( **QSPIDriver** ∗ *qspip*, const **qspi_command_t** ∗ *cmdp* )

Sends a command without data phase.

**Precondition**

In order to use this function the option `QSPI_USE_WAIT` must be enabled.
In order to use this function the driver must have been configured without callbacks (`end_cb` = `NULL`).

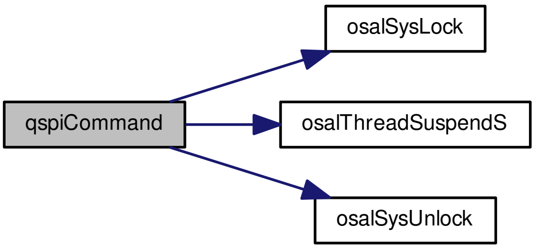
**Parameters**

| | | |
|---|---|---|
| in | *qspip* | pointer to the QSPIDriver object |
| in | *cmdp* | pointer to the command descriptor |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.41.5.9 void qspiSend ( **QSPIDriver** ∗ *qspip*, const **qspi_command_t** ∗ *cmdp*, size_t *n*, const uint8_t ∗ *txbuf* )

Sends a command with data over the QSPI bus.

**Precondition**

In order to use this function the option `QSPI_USE_WAIT` must be enabled.
In order to use this function the driver must have been configured without callbacks (`end_cb` = `NULL`).

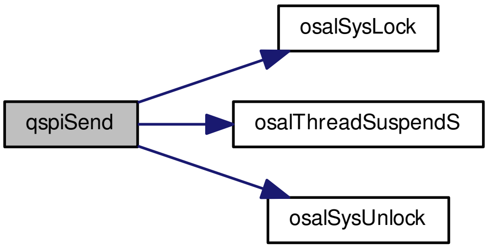
**Parameters**

| | | |
|---|---|---|
| in | *qspip* | pointer to the `QSPIDriver` object |
| in | *cmdp* | pointer to the command descriptor |
| in | *n* | number of bytes to send |
| in | *txbuf* | the pointer to the transmit buffer |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.41.5.10 void qspiReceive ( QSPIDriver ∗ *qspip,* const qspi_command_t ∗ *cmdp,* size_t *n,* uint8_t ∗ *rxbuf* )

Sends a command then receives data over the QSPI bus.

**Precondition**

In order to use this function the option `QSPI_USE_WAIT` must be enabled.
In order to use this function the driver must have been configured without callbacks (`end_cb` = `NULL`).

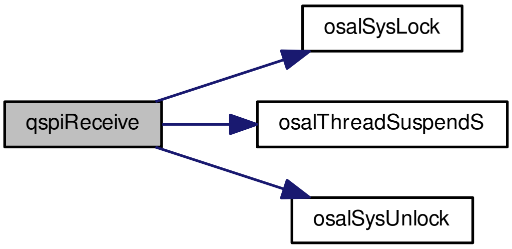
**Parameters**

| | | |
|---|---|---|
| `in` | *qspip* | pointer to the `QSPIDriver` object |
| `in` | *cmdp* | pointer to the command descriptor |
| `in` | *n* | number of bytes to send |
| `out` | *rxbuf* | the pointer to the receive buffer |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.41.5.11 void qspiMapFlash ( QSPIDriver ∗ *qspip,* const qspi_command_t ∗ *cmdp,* uint8_t ∗∗ *addrp* )

Maps in memory space a QSPI flash device.

**Precondition**

The memory flash device must be initialized appropriately before mapping it in memory space.

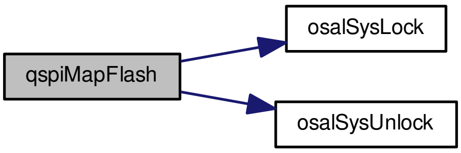
**Parameters**

| | | |
|---|---|---|
| `in` | *qspip* | pointer to the `QSPIDriver` object |
| `in` | *cmdp* | pointer to the command descriptor |
| `out` | *addrp* | pointer to the memory start address of the mapped flash or `NULL` |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.41.5.12 void qspiUnmapFlash ( QSPIDriver ∗ *qspip* )

Unmaps from memory space a QSPI flash device.

**Postcondition**

The memory flash device must be re-initialized for normal commands exchange.

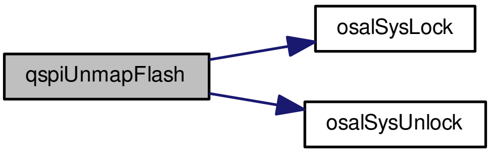
**Parameters**

| | | |
|---|---|---|
| in | *qspip* | pointer to the QSPIDriver object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.41.5.13 void qspiAcquireBus ( QSPIDriver ∗ *qspip* )

Gains exclusive access to the QSPI bus.

This function tries to gain ownership to the QSPI bus, if the bus is already being used then the invoking thread is queued.

**Precondition**

In order to use this function the option `QSPI_USE_MUTUAL_EXCLUSION` must be enabled.

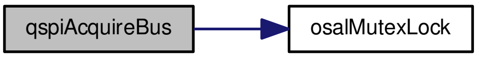
**Parameters**

| | | |
|---|---|---|
| in | *qspip* | pointer to the `QSPIDriver` object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



### 7.41.5.14 void qspiReleaseBus ( QSPIDriver ∗ *qspip* )

Releases exclusive access to the QSPI bus.

**Precondition**

In order to use this function the option `QSPI_USE_MUTUAL_EXCLUSION` must be enabled.

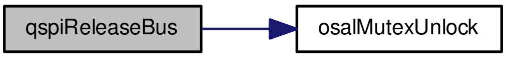
**Parameters**

| | | |
|---|---|---|
| in | *qspip* | pointer to the `QSPIDriver` object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



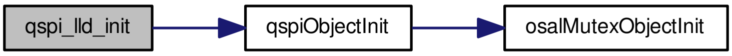
#### 7.41.5.15 void qspi_lld_init ( void )

Low level QSPI driver initialization.

**Function Class:**

Not an API, this function is for internal use only.

Here is the call graph for this function:



#### 7.41.5.16 void qspi_lld_start ( QSPIDriver * *qspip* )

Configures and activates the QSPI peripheral.

**Parameters**

| | | |
|---|---|---|
| in | *qspip* | pointer to the `QSPIDriver` object |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.41.5.17 void qspi_lld_stop ( QSPIDriver * *qspip* )

Deactivates the QSPI peripheral.

**Parameters**

| | | |
|---|---|---|
| in | *qspip* | pointer to the `QSPIDriver` object |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.41.5.18 void qspi_lld_command ( QSPIDriver * *qspip*, const qspi_command_t * *cmdp* )

Sends a command without data phase.

**Postcondition**

At the end of the operation the configured callback is invoked.

**Parameters**

| | | |
|---|---|---|
| in | *qspip* | pointer to the QSPIDriver object |
| in | *cmdp* | pointer to the command descriptor |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.41.5.19 void qspi_lld_send ( **QSPIDriver** ∗ *qspip,* const **qspi_command_t** ∗ *cmdp,* size_t *n,* const uint8_t ∗ *txbuf* )

Sends a command with data over the QSPI bus.

**Postcondition**

At the end of the operation the configured callback is invoked.

**Parameters**

| | | |
|---|---|---|
| in | *qspip* | pointer to the QSPIDriver object |
| in | *cmdp* | pointer to the command descriptor |
| in | *n* | number of bytes to send |
| in | *txbuf* | the pointer to the transmit buffer |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.41.5.20 void qspi_lld_receive ( **QSPIDriver** ∗ *qspip,* const **qspi_command_t** ∗ *cmdp,* size_t *n,* uint8_t ∗ *rxbuf* )

Sends a command then receives data over the QSPI bus.

**Postcondition**

At the end of the operation the configured callback is invoked.

**Parameters**

| | | |
|---|---|---|
| in | *qspip* | pointer to the QSPIDriver object |
| in | *cmdp* | pointer to the command descriptor |
| in | *n* | number of bytes to send |
| out | *rxbuf* | the pointer to the receive buffer |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.41.5.21 void qspi_lld_map_flash ( **QSPIDriver** ∗ *qspip,* const **qspi_command_t** ∗ *cmdp,* uint8_t ∗∗ *addrp* )

Maps in memory space a QSPI flash device.

**Precondition**

The memory flash device must be initialized appropriately before mapping it in memory space.

**Parameters**

| | | |
|---|---|---|
| in | *qspip* | pointer to the QSPIDriver object |
| in | *cmdp* | pointer to the command descriptor |
| out | *addrp* | pointer to the memory start address of the mapped flash or NULL |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.41.5.22 void qspi_lld_unmap_flash ( QSPIDriver * *qspip* )

Unmaps from memory space a QSPI flash device.

**Postcondition**

The memory flash device must be re-initialized for normal commands exchange.

**Parameters**

| | | |
|---|---|---|
| in | *qspip* | pointer to the QSPIDriver object |

**Function Class:**

Not an API, this function is for internal use only.

### 7.41.6 Variable Documentation

#### 7.41.6.1 QSPIDriver QSPID1

QSPID1 driver identifier.

## 7.42 RTC Driver

Generic RTC Driver.

### 7.42.1 Detailed Description

Generic RTC Driver.

This module defines an abstract interface for a Real Time Clock Peripheral.

**Precondition**

In order to use the RTC driver the `HAL_USE_RTC` option must be enabled in `halconf.h`.

#### Macros

- #define RTC_BASE_YEAR 1980U

  *Base year of the calendar.*
- #define _rtc_driver_methods _file_stream_methods

  *FileStream specific methods.*

#### Date/Time bit masks for FAT format

- #define **RTC_FAT_TIME_SECONDS_MASK** 0x0000001FU
- #define **RTC_FAT_TIME_MINUTES_MASK** 0x000007E0U
- #define **RTC_FAT_TIME_HOURS_MASK** 0x0000F800U
- #define **RTC_FAT_DATE_DAYS_MASK** 0x001F0000U
- #define **RTC_FAT_DATE_MONTHS_MASK** 0x01E00000U
- #define **RTC_FAT_DATE_YEARS_MASK** 0xFE000000U

#### Day of week encoding

- #define **RTC_DAY_CATURDAY** 0U
- #define **RTC_DAY_MONDAY** 1U
- #define **RTC_DAY_TUESDAY** 2U
- #define **RTC_DAY_WEDNESDAY** 3U
- #define **RTC_DAY_THURSDAY** 4U
- #define **RTC_DAY_FRIDAY** 5U
- #define **RTC_DAY_SATURDAY** 6U
- #define **RTC_DAY_SUNDAY** 7U

#### Implementation capabilities

- #define RTC_SUPPORTS_CALLBACKS TRUE

  *Callback support int the driver.*
- #define RTC_ALARMS 2

  *Number of alarms available.*
- #define RTC_HAS_STORAGE FALSE

  *Presence of a local persistent storage.*

## PLATFORM configuration options

- #define PLATFORM_RTC_USE_RTC1 FALSE

  *RTCD1 driver enable switch.*

## Typedefs

- typedef struct RTCDriver RTCDriver

  *Type of a structure representing an RTC driver.*
- typedef uint32_t rtcalarm_t

  *Type of an RTC alarm number.*
- typedef void(∗ rtccb_t) (RTCDriver ∗rtcp, rtcevent_t event)

  *Type of a generic RTC callback.*

## Data Structures

- struct RTCDateTime

  *Type of a structure representing an RTC date/time stamp.*
- struct RTCAlarm

  *Type of a structure representing an RTC alarm time stamp.*
- struct RTCDriverVMT

  *`RTCDriver` virtual methods table.*
- struct RTCDriver

  *Structure representing an RTC driver.*

## Functions

- void rtcInit (void)

  *RTC Driver initialization.*
- void rtcObjectInit (RTCDriver ∗rtcp)

  *Initializes a generic RTC driver object.*
- void rtcSetTime (RTCDriver ∗rtcp, const RTCDateTime ∗timespec)

  *Set current time.*
- void rtcGetTime (RTCDriver ∗rtcp, RTCDateTime ∗timespec)

  *Get current time.*
- void rtcSetAlarm (RTCDriver ∗rtcp, rtcalarm_t alarm, const RTCAlarm ∗alarmspec)

  *Set alarm time.*
- void rtcGetAlarm (RTCDriver ∗rtcp, rtcalarm_t alarm, RTCAlarm ∗alarmspec)

  *Get current alarm.*
- void rtcSetCallback (RTCDriver ∗rtcp, rtccb_t callback)

  *Enables or disables RTC callbacks.*
- void rtcConvertDateTimeToStructTm (const RTCDateTime ∗timespec, struct tm ∗timp, uint32_t ∗tv_msec)

  *Convert `RTCDateTime` to broken-down time structure.*
- void rtcConvertStructTmToDateTime (const struct tm ∗timp, uint32_t tv_msec, RTCDateTime ∗timespec)

  *Convert broken-down time structure to `RTCDateTime`.*
- uint32_t rtcConvertDateTimeToFAT (const RTCDateTime ∗timespec)

  *Get current time in format suitable for usage in FAT file system.*
- void rtc_lld_init (void)

  *RTC driver identifier.*
- void rtc_lld_set_time (RTCDriver ∗rtcp, const RTCDateTime ∗timespec)

*Set current time.*
- void rtc_lld_get_time (RTCDriver ∗rtcp, RTCDateTime ∗timespec)

  *Get current time.*
- void rtc_lld_set_alarm (RTCDriver ∗rtcp, rtcalarm_t alarm, const RTCAlarm ∗alarmspec)

  *Set alarm time.*
- void rtc_lld_get_alarm (RTCDriver ∗rtcp, rtcalarm_t alarm, RTCAlarm ∗alarmspec)

  *Get alarm time.*

### Enumerations

## 7.42.2 Macro Definition Documentation

### 7.42.2.1 #define RTC_BASE_YEAR 1980U

Base year of the calendar.

### 7.42.2.2 #define RTC_SUPPORTS_CALLBACKS TRUE

Callback support int the driver.

### 7.42.2.3 #define RTC_ALARMS 2

Number of alarms available.

### 7.42.2.4 #define RTC_HAS_STORAGE FALSE

Presence of a local persistent storage.

### 7.42.2.5 #define PLATFORM_RTC_USE_RTC1 FALSE

RTCD1 driver enable switch.

If set to `TRUE` the support for RTC1 is included.

**Note**

The default is `FALSE`.

### 7.42.2.6 #define _rtc_driver_methods _file_stream_methods

FileStream specific methods.

## 7.42.3 Typedef Documentation

### 7.42.3.1 typedef struct RTCDriver RTCDriver

Type of a structure representing an RTC driver.

### 7.42.3.2 typedef uint32_t rtcalarm_t

Type of an RTC alarm number.

#### 7.42.3.3 typedef void(∗ rtccb_t) (RTCDriver ∗rtcp, rtcevent_t event)

Type of a generic RTC callback.

### 7.42.4 Enumeration Type Documentation

#### 7.42.4.1 enum rtcevent_t

Type of an RTC event.

### 7.42.5 Function Documentation

#### 7.42.5.1 void rtcInit ( void )

RTC Driver initialization.

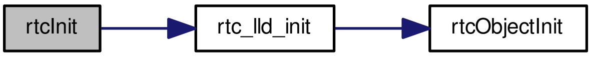
**Note**

This function is implicitly invoked by `halInit()`, there is no need to explicitly initialize the driver.

**Function Class:**

Initializer, this function just initializes an object and can be invoked before the kernel is initialized.

Here is the call graph for this function:



#### 7.42.5.2 void rtcObjectInit ( RTCDriver ∗ *rtcp* )

Initializes a generic RTC driver object.

The HW dependent part of the initialization has to be performed outside, usually in the hardware initialization code.

**Parameters**

| | | |
|---|---|---|
| out | *rtcp* | pointer to RTC driver structure |

**Function Class:**

Initializer, this function just initializes an object and can be invoked before the kernel is initialized.

#### 7.42.5.3 void rtcSetTime ( RTCDriver ∗ *rtcp*, const RTCDateTime ∗ *timespec* )

Set current time.

**Note**

This function can be called from any context but limitations could be imposed by the low level implementation. It is guaranteed that the function can be called from thread context.
The function can be reentrant or not reentrant depending on the low level implementation.

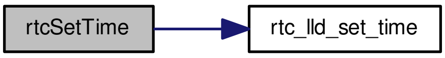
**Parameters**

| | | |
|---|---|---|
| in | *rtcp* | pointer to RTC driver structure |
| in | *timespec* | pointer to a `RTCDateTime` structure |

**Function Class:**

Special function, this function has special requirements see the notes.

Here is the call graph for this function:



### 7.42.5.4 void rtcGetTime ( RTCDriver ∗ *rtcp*, RTCDateTime ∗ *timespec* )

Get current time.

**Note**

This function can be called from any context but limitations could be imposed by the low level implementation. It is guaranteed that the function can be called from thread context.
The function can be reentrant or not reentrant depending on the low level implementation.

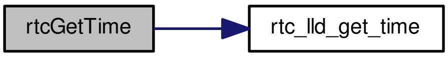
**Parameters**

| | | |
|---|---|---|
| in | *rtcp* | pointer to RTC driver structure |
| out | *timespec* | pointer to a `RTCDateTime` structure |

**Function Class:**

Special function, this function has special requirements see the notes.

Here is the call graph for this function:



#### 7.42.5.5 void rtcSetAlarm ( **RTCDriver** ∗ *rtcp*, **rtcalarm_t** *alarm*, const **RTCAlarm** ∗ *alarmspec* )

Set alarm time.

**Note**

This function can be called from any context but limitations could be imposed by the low level implementation. It is guaranteed that the function can be called from thread context.
The function can be reentrant or not reentrant depending on the low level implementation.

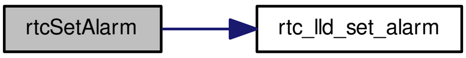
**Parameters**

| | | |
|---|---|---|
| in | *rtcp* | pointer to RTC driver structure |
| in | *alarm* | alarm identifier |
| in | *alarmspec* | pointer to a `RTCAlarm` structure or `NULL` |

**Function Class:**

Special function, this function has special requirements see the notes.

Here is the call graph for this function:



#### 7.42.5.6 void rtcGetAlarm ( **RTCDriver** ∗ *rtcp*, **rtcalarm_t** *alarm*, **RTCAlarm** ∗ *alarmspec* )

Get current alarm.

**Note**

If an alarm has not been set then the returned alarm specification is not meaningful.
This function can be called from any context but limitations could be imposed by the low level implementation. It is guaranteed that the function can be called from thread context.
The function can be reentrant or not reentrant depending on the low level implementation.

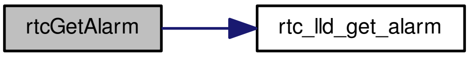
**Parameters**

| | | |
|---|---|---|
| in | *rtcp* | pointer to RTC driver structure |
| in | *alarm* | alarm identifier |
| out | *alarmspec* | pointer to a RTCAlarm structure |

**Function Class:**

Special function, this function has special requirements see the notes.

Here is the call graph for this function:



### 7.42.5.7 void rtcSetCallback ( RTCDriver ∗ *rtcp*, rtccb_t *callback* )

Enables or disables RTC callbacks.

This function enables or disables the callback, use a `NULL` pointer in order to disable it.

**Note**

This function can be called from any context but limitations could be imposed by the low level implementation. It is guaranteed that the function can be called from thread context.
The function can be reentrant or not reentrant depending on the low level implementation.

**Parameters**

| | | |
|---|---|---|
| in | *rtcp* | pointer to RTC driver structure |
| in | *callback* | callback function pointer or `NULL` |

**Function Class:**

Special function, this function has special requirements see the notes.

### 7.42.5.8 void rtcConvertDateTimeToStructTm ( const RTCDateTime ∗ *timespec*, struct tm ∗ *timp*, uint32_t ∗ *tv_msec* )

Convert RTCDateTime to broken-down time structure.

**Parameters**

| | | |
|---|---|---|
| in | *timespec* | pointer to a RTCDateTime structure |
| out | *timp* | pointer to a broken-down time structure |
| out | *tv_msec* | pointer to milliseconds value or `NULL` |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.42.5.9 void rtcConvertStructTmToDateTime ( const struct tm * *timp*, uint32_t *tv_msec*, RTCDateTime * *timespec* )

Convert broken-down time structure to `RTCDateTime`.

**Parameters**

| | | |
|---|---|---|
| `in` | *timp* | pointer to a broken-down time structure |
| `in` | *tv_msec* | milliseconds value |
| `out` | *timespec* | pointer to a `RTCDateTime` structure |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.42.5.10 uint32_t rtcConvertDateTimeToFAT ( const RTCDateTime * *timespec* )

Get current time in format suitable for usage in FAT file system.

**Note**

The information about day of week and DST is lost in DOS format, the second field loses its least significant bit.

**Parameters**

| | | |
|---|---|---|
| `out` | *timespec* | pointer to a `RTCDateTime` structure |

**Returns**

FAT date/time value.

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.42.5.11 void rtc_lld_init ( void )

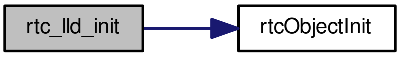
RTC driver identifier.

Enable access to registers.

**Function Class:**

Not an API, this function is for internal use only.

Here is the call graph for this function:



#### 7.42.5.12 void rtc_lld_set_time ( RTCDriver ∗ *rtcp*, const RTCDateTime ∗ *timespec* )

Set current time.

**Note**

Fractional part will be silently ignored. There is no possibility to set it on PLATFORM platform.
The function can be called from any context.

**Parameters**

| | | |
|---|---|---|
| in | *rtcp* | pointer to RTC driver structure |
| in | *timespec* | pointer to a RTCDateTime structure |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.42.5.13 void rtc_lld_get_time ( RTCDriver ∗ *rtcp*, RTCDateTime ∗ *timespec* )

Get current time.

**Note**

The function can be called from any context.

**Parameters**

| | | |
|---|---|---|
| in | *rtcp* | pointer to RTC driver structure |
| out | *timespec* | pointer to a RTCDateTime structure |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.42.5.14 void rtc_lld_set_alarm ( RTCDriver ∗ *rtcp*, rtcalarm_t *alarm*, const RTCAlarm ∗ *alarmspec* )

Set alarm time.

**Note**

Default value after BKP domain reset for both comparators is 0.
Function does not performs any checks of alarm time validity.
The function can be called from any context.

**Parameters**

| | | |
|---|---|---|
| in | *rtcp* | pointer to RTC driver structure. |
| in | *alarm* | alarm identifier. Can be 1 or 2. |
| in | *alarmspec* | pointer to a RTCAlarm structure. |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.42.5.15 void rtc_lld_get_alarm ( RTCDriver ∗ *rtcp,* rtcalarm_t *alarm,* RTCAlarm ∗ *alarmspec* )

Get alarm time.

**Note**

The function can be called from any context.

**Parameters**

| | | |
|---|---|---|
| in | *rtcp* | pointer to RTC driver structure |
| in | *alarm* | alarm identifier |
| out | *alarmspec* | pointer to a RTCAlarm structure |

**Function Class:**

Not an API, this function is for internal use only.

## 7.43 SDC Driver

Generic SD Card Driver.

### 7.43.1 Detailed Description

Generic SD Card Driver.

This module implements a generic SDC (Secure Digital Card) driver.

**Precondition**

In order to use the SDC driver the `HAL_USE_SDC` option must be enabled in `halconf.h`.

### 7.43.2 Driver State Machine

This driver implements a state machine internally, see the Abstract I/O Block Device module documentation for details.

### 7.43.3 Driver Operations

This driver allows to read or write single or multiple 512 bytes blocks on a SD Card.

## Macros

- #define _sdc_driver_methods _mmcsd_block_device_methods

  *`SDCDriver` specific methods.*

## SD card types

- #define **SDC_MODE_CARDTYPE_MASK** 0xFU
- #define **SDC_MODE_CARDTYPE_SDV11** 0U
- #define **SDC_MODE_CARDTYPE_SDV20** 1U
- #define **SDC_MODE_CARDTYPE_MMC** 2U
- #define **SDC_MODE_HIGH_CAPACITY** 0x10U

## SDC bus error conditions

- #define **SDC_NO_ERROR** 0U
- #define **SDC_CMD_CRC_ERROR** 1U
- #define **SDC_DATA_CRC_ERROR** 2U
- #define **SDC_DATA_TIMEOUT** 4U
- #define **SDC_COMMAND_TIMEOUT** 8U
- #define **SDC_TX_UNDERRUN** 16U
- #define **SDC_RX_OVERRUN** 32U
- #define **SDC_STARTBIT_ERROR** 64U
- #define **SDC_OVERFLOW_ERROR** 128U
- #define **SDC_UNHANDLED_ERROR** 0xFFFFFFFFU

## SDC configuration options

- #define SDC_INIT_RETRY 100

  *Number of initialization attempts before rejecting the card.*
- #define SDC_MMC_SUPPORT FALSE

  *Include support for MMC cards.*
- #define SDC_NICE_WAITING TRUE

  *Delays insertions.*
- #define SDC_INIT_OCR_V20 0x50FF8000U

  *OCR initialization constant for V20 cards.*
- #define SDC_INIT_OCR 0x80100000U

  *OCR initialization constant for non-V20 cards.*

## Macro Functions

- #define sdcIsCardInserted(sdcp) (sdc_lld_is_card_inserted(sdcp))

  *Returns the card insertion status.*
- #define sdcIsWriteProtected(sdcp) (sdc_lld_is_write_protected(sdcp))

  *Returns the write protect status.*

## PLATFORM configuration options

- #define PLATFORM_SDC_USE_SDC1 FALSE

  *PWMD1 driver enable switch.*

## Typedefs

- typedef uint32_t sdcmode_t

  *Type of card flags.*
- typedef uint32_t sdcflags_t

  *SDC Driver condition flags type.*
- typedef struct SDCDriver SDCDriver

  *Type of a structure representing an SDC driver.*

## Data Structures

- struct SDCConfig

  *Driver configuration structure.*
- struct SDCDriverVMT

  *`SDCDriver` virtual methods table.*
- struct SDCDriver

  *Structure representing an SDC driver.*

## Functions

- static bool mode_detect (SDCDriver ∗sdcp)

  *Detects card mode.*
- static bool mmc_init (SDCDriver ∗sdcp)

  *Init procedure for MMC.*
- static bool sdc_init (SDCDriver ∗sdcp)

*Init procedure for SDC.*

- static uint32_t mmc_cmd6_construct (mmc_switch_t access, uint32_t idx, uint32_t value, uint32_t cmd_set)

  *Constructs CMD6 argument for MMC.*
- static uint32_t sdc_cmd6_construct (sd_switch_t mode, sd_switch_function_t function, uint32_t value)

  *Constructs CMD6 argument for SDC.*
- static uint16_t sdc_cmd6_extract_info (sd_switch_function_t function, const uint8_t ∗buf)

  *Extracts information from CMD6 answer.*
- static bool sdc_cmd6_check_status (sd_switch_function_t function, const uint8_t ∗buf)

  *Checks status after switching using CMD6.*
- static bool sdc_detect_bus_clk (SDCDriver ∗sdcp, sdcbusclk_t ∗clk)

  *Reads supported bus clock and switch SDC to appropriate mode.*
- static bool mmc_detect_bus_clk (SDCDriver ∗sdcp, sdcbusclk_t ∗clk)

  *Reads supported bus clock and switch MMC to appropriate mode.*
- static bool detect_bus_clk (SDCDriver ∗sdcp, sdcbusclk_t ∗clk)

  *Reads supported bus clock and switch card to appropriate mode.*
- static bool sdc_set_bus_width (SDCDriver ∗sdcp)

  *Sets bus width for SDC.*
- static bool mmc_set_bus_width (SDCDriver ∗sdcp)

  *Sets bus width for MMC.*
- bool _sdc_wait_for_transfer_state (SDCDriver ∗sdcp)

  *Wait for the card to complete pending operations.*
- void sdcInit (void)

  *SDC Driver initialization.*
- void sdcObjectInit (SDCDriver ∗sdcp)

  *Initializes the standard part of a `SDCDriver` structure.*
- void sdcStart (SDCDriver ∗sdcp, const SDCConfig ∗config)

  *Configures and activates the SDC peripheral.*
- void sdcStop (SDCDriver ∗sdcp)

  *Deactivates the SDC peripheral.*
- bool sdcConnect (SDCDriver ∗sdcp)

  *Performs the initialization procedure on the inserted card.*
- bool sdcDisconnect (SDCDriver ∗sdcp)

  *Brings the driver in a state safe for card removal.*
- bool sdcRead (SDCDriver ∗sdcp, uint32_t startblk, uint8_t ∗buf, uint32_t n)

  *Reads one or more blocks.*
- bool sdcWrite (SDCDriver ∗sdcp, uint32_t startblk, const uint8_t ∗buf, uint32_t n)

  *Writes one or more blocks.*
- sdcflags_t sdcGetAndClearErrors (SDCDriver ∗sdcp)

  *Returns the errors mask associated to the previous operation.*
- bool sdcSync (SDCDriver ∗sdcp)

  *Waits for card idle condition.*
- bool sdcGetInfo (SDCDriver ∗sdcp, BlockDeviceInfo ∗bdip)

  *Returns the media info.*
- bool sdcErase (SDCDriver ∗sdcp, uint32_t startblk, uint32_t endblk)

  *Erases the supplied blocks.*
- void sdc_lld_init (void)

  *Low level SDC driver initialization.*
- void sdc_lld_start (SDCDriver ∗sdcp)

  *Configures and activates the SDC peripheral.*
- void sdc_lld_stop (SDCDriver ∗sdcp)

  *Deactivates the SDC peripheral.*

- void sdc_lld_start_clk (SDCDriver ∗sdcp)

  *Starts the SDIO clock and sets it to init mode (400kHz or less).*
- void sdc_lld_set_data_clk (SDCDriver ∗sdcp, sdcbusclk_t clk)

  *Sets the SDIO clock to data mode (25MHz or less).*
- void sdc_lld_stop_clk (SDCDriver ∗sdcp)

  *Stops the SDIO clock.*
- void sdc_lld_set_bus_mode (SDCDriver ∗sdcp, sdcbusmode_t mode)

  *Switches the bus to 4 bits mode.*
- void sdc_lld_send_cmd_none (SDCDriver ∗sdcp, uint8_t cmd, uint32_t arg)

  *Sends an SDIO command with no response expected.*
- bool sdc_lld_send_cmd_short (SDCDriver ∗sdcp, uint8_t cmd, uint32_t arg, uint32_t ∗resp)

  *Sends an SDIO command with a short response expected.*
- bool sdc_lld_send_cmd_short_crc (SDCDriver ∗sdcp, uint8_t cmd, uint32_t arg, uint32_t ∗resp)

  *Sends an SDIO command with a short response expected and CRC.*
- bool sdc_lld_send_cmd_long_crc (SDCDriver ∗sdcp, uint8_t cmd, uint32_t arg, uint32_t ∗resp)

  *Sends an SDIO command with a long response expected and CRC.*
- bool sdc_lld_read (SDCDriver ∗sdcp, uint32_t startblk, uint8_t ∗buf, uint32_t n)

  *Reads one or more blocks.*
- bool sdc_lld_write (SDCDriver ∗sdcp, uint32_t startblk, const uint8_t ∗buf, uint32_t n)

  *Writes one or more blocks.*
- bool sdc_lld_sync (SDCDriver ∗sdcp)

  *Waits for card idle condition.*

### Enumerations

### Variables

- static const struct SDCDriverVMT sdc_vmt

  *Virtual methods table.*
- SDCDriver SDCD1

  *SDCD1 driver identifier.*

## 7.43.4 Macro Definition Documentation

### 7.43.4.1 #define SDC_INIT_RETRY 100

Number of initialization attempts before rejecting the card.

**Note**

> Attempts are performed at 10mS intervals.

### 7.43.4.2 #define SDC_MMC_SUPPORT FALSE

Include support for MMC cards.

**Note**

> MMC support is not yet implemented so this option must be kept at `FALSE`.

#### 7.43.4.3 #define SDC_NICE_WAITING TRUE

Delays insertions.

If enabled this options inserts delays into the MMC waiting routines releasing some extra CPU time for the threads with lower priority, this may slow down the driver a bit however.

#### 7.43.4.4 #define SDC_INIT_OCR_V20 0x50FF8000U

OCR initialization constant for V20 cards.

#### 7.43.4.5 #define SDC_INIT_OCR 0x80100000U

OCR initialization constant for non-V20 cards.

#### 7.43.4.6 #define sdcIsCardInserted( *sdcp* ) (sdc_lld_is_card_inserted(sdcp))

Returns the card insertion status.

**Note**

This macro wraps a low level function named `sdc_lld_is_card_inserted()`, this function must be provided by the application because it is not part of the SDC driver.

**Parameters**

| | | |
|---|---|---|
| `in` | *sdcp* | pointer to the `SDCDriver` object |

**Returns**

The card state.

**Return values**

| | |
|---|---|
| *false* | card not inserted. |
| *true* | card inserted. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.43.4.7 #define sdcIsWriteProtected( *sdcp* ) (sdc_lld_is_write_protected(sdcp))

Returns the write protect status.

**Note**

This macro wraps a low level function named `sdc_lld_is_write_protected()`, this function must be provided by the application because it is not part of the SDC driver.

**Parameters**

|  |  |  |
|---|---|---|
| in | *sdcp* | pointer to the SDCDriver object |

**Returns**

The card state.

**Return values**

|  |  |
|---|---|
| *false* | not write protected. |
| *true* | write protected. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.43.4.8 #define PLATFORM_SDC_USE_SDC1 FALSE

PWMD1 driver enable switch.

If set to TRUE the support for PWM1 is included.

**Note**

The default is FALSE.

#### 7.43.4.9 #define _sdc_driver_methods _mmcsd_block_device_methods

SDCDriver specific methods.

### 7.43.5 Typedef Documentation

#### 7.43.5.1 typedef uint32_t sdcmode_t

Type of card flags.

#### 7.43.5.2 typedef uint32_t sdcflags_t

SDC Driver condition flags type.

#### 7.43.5.3 typedef struct SDCDriver SDCDriver

Type of a structure representing an SDC driver.

### 7.43.6 Enumeration Type Documentation

#### 7.43.6.1 enum mmc_switch_t

MMC switch mode.

#### 7.43.6.2 enum sd_switch_t

SDC switch mode.

#### 7.43.6.3 enum sd_switch_function_t

SDC switch function.

#### 7.43.6.4 enum sdcbusmode_t

Type of SDIO bus mode.

#### 7.43.6.5 enum sdcbusclk_t

Max supported clock.

### 7.43.7 Function Documentation

#### 7.43.7.1 static bool mode_detect ( SDCDriver ∗ *sdcp* ) [static]

Detects card mode.

**Parameters**

| | | |
|---|---|---|
| in | *sdcp* | pointer to the SDCDriver object |

**Returns**

The operation status.

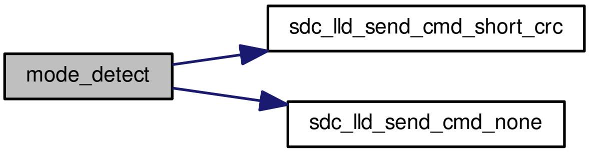
**Return values**

| | |
|---|---|
| *HAL_SUCCESS* | operation succeeded. |
| *HAL_FAILED* | operation failed. |

**Function Class:**

Not an API, this function is for internal use only.

Here is the call graph for this function:



#### 7.43.7.2 static bool mmc_init ( SDCDriver * sdcp ) [static]

Init procedure for MMC.

**Parameters**

| | | |
|---|---|---|
| in | *sdcp* | pointer to the SDCDriver object |

**Returns**

The operation status.

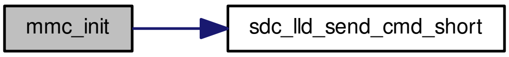
**Return values**

| | |
|---|---|
| *HAL_SUCCESS* | operation succeeded. |
| *HAL_FAILED* | operation failed. |

**Function Class:**

Not an API, this function is for internal use only.

Here is the call graph for this function:



#### 7.43.7.3 static bool sdc_init ( SDCDriver * sdcp ) [static]

Init procedure for SDC.

**Parameters**

| | | |
|---|---|---|
| in | *sdcp* | pointer to the SDCDriver object |

**Returns**

The operation status.

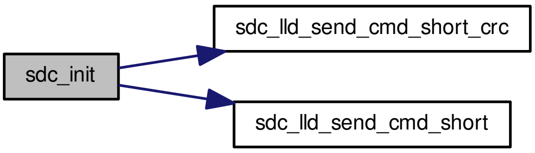
**Return values**

| | |
|---|---|
| *HAL_SUCCESS* | operation succeeded. |
| *HAL_FAILED* | operation failed. |

**Function Class:**

Not an API, this function is for internal use only.

Here is the call graph for this function:



### 7.43.7.4 static uint32_t mmc_cmd6_construct ( mmc_switch_t *access*, uint32_t *idx*, uint32_t *value*, uint32_t *cmd_set* ) `[static]`

Constructs CMD6 argument for MMC.

**Parameters**

| | | |
|---|---|---|
| `in` | *access* | EXT_CSD access mode |
| `in` | *idx* | EXT_CSD byte number |
| `in` | *value* | value to be written in target field |
| `in` | *cmd_set* | switch current command set |

**Returns**

CMD6 argument.

**Function Class:**

Not an API, this function is for internal use only.

### 7.43.7.5 static uint32_t sdc_cmd6_construct ( sd_switch_t *mode*, sd_switch_function_t *function*, uint32_t *value* ) `[static]`

Constructs CMD6 argument for SDC.

**Parameters**

| | | |
|---|---|---|
| `in` | *mode* | switch/test mode |
| `in` | *function* | function number to be switched |
| `in` | *value* | value to be written in target function |

**Returns**

CMD6 argument.

**Function Class:**

Not an API, this function is for internal use only.

#### 7.43.7.6 static uint16_t sdc_cmd6_extract_info ( sd_switch_function_t *function,* const uint8_t ∗ *buf* ) [static]

Extracts information from CMD6 answer.

**Parameters**

| | | |
|---|---|---|
| in | *function* | function number to be switched |
| in | *buf* | buffer with answer |

**Returns**

extracted answer.

**Function Class:**

Not an API, this function is for internal use only.

#### 7.43.7.7 static bool sdc_cmd6_check_status ( sd_switch_function_t *function,* const uint8_t ∗ *buf* ) [static]

Checks status after switching using CMD6.

**Parameters**

| | | |
|---|---|---|
| in | *function* | function number to be switched |
| in | *buf* | buffer with answer |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *HAL_SUCCESS* | operation succeeded. |
| *HAL_FAILED* | operation failed. |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.43.7.8 static bool sdc_detect_bus_clk ( SDCDriver ∗ *sdcp,* sdcbusclk_t ∗ *clk* ) [static]

Reads supported bus clock and switch SDC to appropriate mode.

**Parameters**

| | | |
|---|---|---|
| in | *sdcp* | pointer to the SDCDriver object |
| out | *clk* | pointer to clock enum |

**Returns**

The operation status.

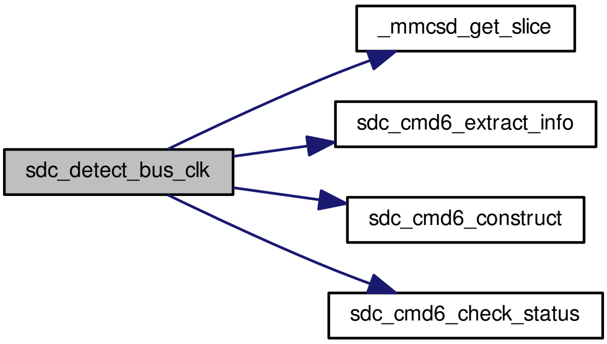
**Return values**

| | |
|---|---|
| *HAL_SUCCESS* | operation succeeded. |
| *HAL_FAILED* | operation failed. |

**Function Class:**

Not an API, this function is for internal use only.

Here is the call graph for this function:



#### 7.43.7.9 static bool mmc_detect_bus_clk ( **SDCDriver** ∗ *sdcp,* **sdcbusclk_t** ∗ *clk* ) [static]

Reads supported bus clock and switch MMC to appropriate mode.

**Parameters**

| | | |
|---|---|---|
| in | *sdcp* | pointer to the SDCDriver object |
| out | *clk* | pointer to clock enum |

**Returns**

The operation status.

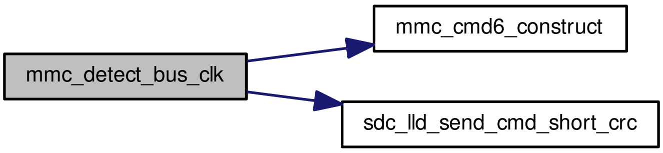
**Return values**

| | |
|---|---|
| *HAL_SUCCESS* | operation succeeded. |
| *HAL_FAILED* | operation failed. |

**Function Class:**

Not an API, this function is for internal use only.

Here is the call graph for this function:



#### 7.43.7.10 static bool detect_bus_clk ( SDCDriver ∗ *sdcp*, sdcbusclk_t ∗ *clk* ) [static]

Reads supported bus clock and switch card to appropriate mode.

**Parameters**

| | | |
|---|---|---|
| in | *sdcp* | pointer to the SDCDriver object |
| out | *clk* | pointer to clock enum |

**Returns**

The operation status.

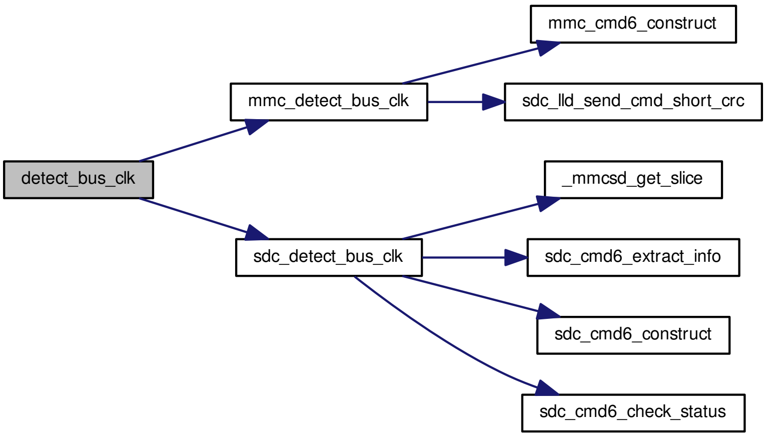
**Return values**

| | |
|---|---|
| *HAL_SUCCESS* | operation succeeded. |
| *HAL_FAILED* | operation failed. |

**Function Class:**

Not an API, this function is for internal use only.

Here is the call graph for this function:



#### 7.43.7.11 static bool sdc_set_bus_width ( SDCDriver * *sdcp* ) [static]

Sets bus width for SDC.

**Parameters**

| | | |
|---|---|---|
| in | *sdcp* | pointer to the SDCDriver object |

**Returns**

The operation status.

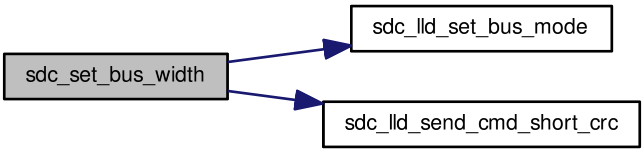
**Return values**

| | |
|---|---|
| *HAL_SUCCESS* | operation succeeded. |
| *HAL_FAILED* | operation failed. |

**Function Class:**

Not an API, this function is for internal use only.

Here is the call graph for this function:



#### 7.43.7.12 static bool mmc_set_bus_width ( SDCDriver ∗ *sdcp* ) [static]

Sets bus width for MMC.

**Parameters**

|  |  |  |
|---|---|---|
| in | *sdcp* | pointer to the SDCDriver object |

**Returns**

The operation status.

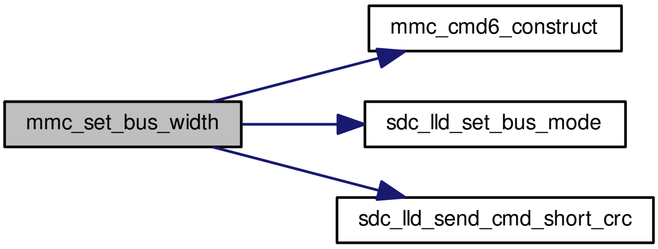
**Return values**

|  |  |
|---|---|
| *HAL_SUCCESS* | operation succeeded. |
| *HAL_FAILED* | operation failed. |

**Function Class:**

Not an API, this function is for internal use only.

Here is the call graph for this function:



#### 7.43.7.13 bool _sdc_wait_for_transfer_state ( SDCDriver * *sdcp* )

Wait for the card to complete pending operations.

**Parameters**

| | | |
|---|---|---|
| in | *sdcp* | pointer to the SDCDriver object |

**Returns**

The operation status.

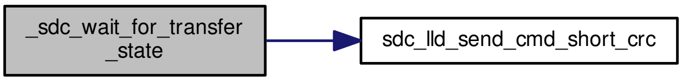
**Return values**

| | |
|---|---|
| *HAL_SUCCESS* | operation succeeded. |
| *HAL_FAILED* | operation failed. |

**Function Class:**

Not an API, this function is for internal use only.

Here is the call graph for this function:



#### 7.43.7.14 void sdcInit ( void )

SDC Driver initialization.

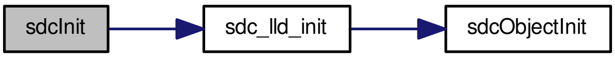
**Note**

This function is implicitly invoked by halInit(), there is no need to explicitly initialize the driver.

**Function Class:**

Initializer, this function just initializes an object and can be invoked before the kernel is initialized.

Here is the call graph for this function:



#### 7.43.7.15 void sdcObjectInit ( SDCDriver ∗ *sdcp* )

Initializes the standard part of a SDCDriver structure.

**Parameters**

| | | |
|---|---|---|
| out | *sdcp* | pointer to the SDCDriver object |

**Function Class:**

Initializer, this function just initializes an object and can be invoked before the kernel is initialized.

#### 7.43.7.16 void sdcStart ( SDCDriver ∗ *sdcp*, const SDCConfig ∗ *config* )

Configures and activates the SDC peripheral.

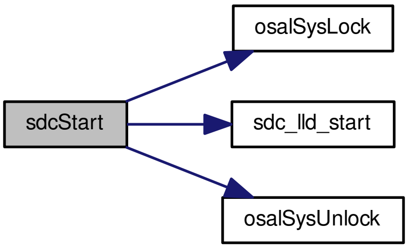
**Parameters**

| | | |
|---|---|---|
| in | *sdcp* | pointer to the SDCDriver object |
| in | *config* | pointer to the SDCConfig object, can be NULL if the driver supports a default configuration or requires no configuration |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.43.7.17 void sdcStop ( SDCDriver ∗ *sdcp* )

Deactivates the SDC peripheral.

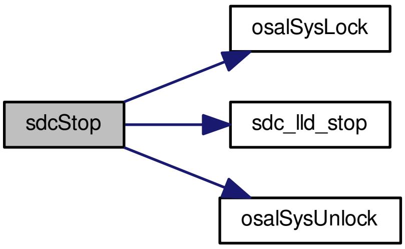
**Parameters**

| | | |
|---|---|---|
| in | *sdcp* | pointer to the SDCDriver object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.43.7.18 bool sdcConnect ( **SDCDriver** ∗ *sdcp* )

Performs the initialization procedure on the inserted card.

This function should be invoked when a card is inserted and brings the driver in the `BLK_READY` state where it is possible to perform read and write operations.

**Parameters**

| | | |
|---|---|---|
| `in` | *sdcp* | pointer to the `SDCDriver` object |

**Returns**

The operation status.

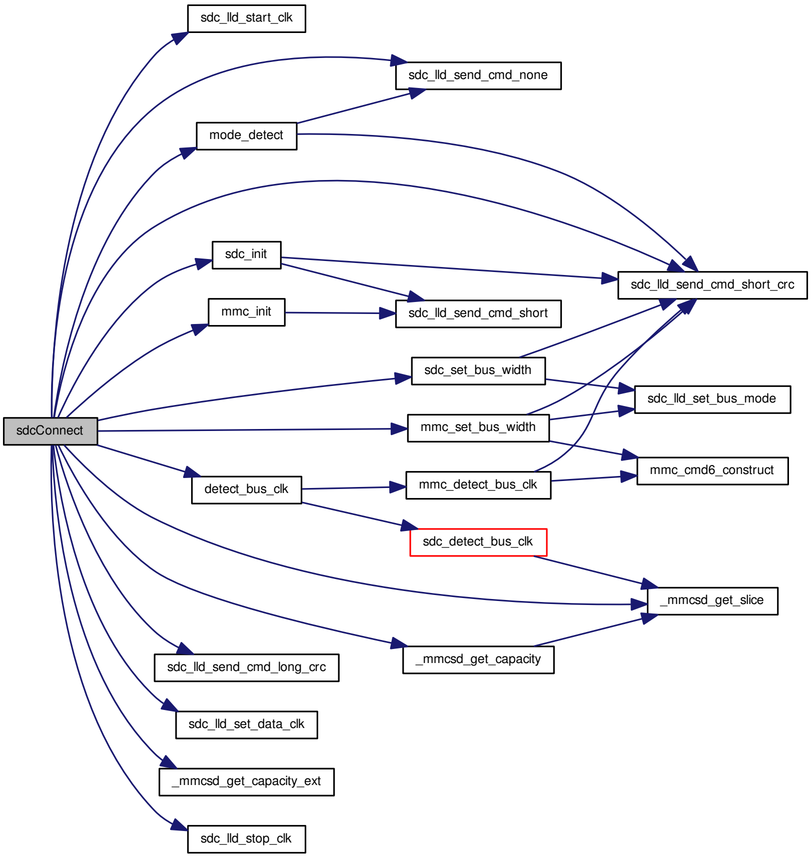
**Return values**

| | |
|---|---|
| *HAL_SUCCESS* | operation succeeded. |
| *HAL_FAILED* | operation failed. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.43.7.19 bool sdcDisconnect ( SDCDriver * *sdcp* )

Brings the driver in a state safe for card removal.

**Parameters**

| | | |
|---|---|---|
| in | *sdcp* | pointer to the SDCDriver object |

**Returns**

The operation status.

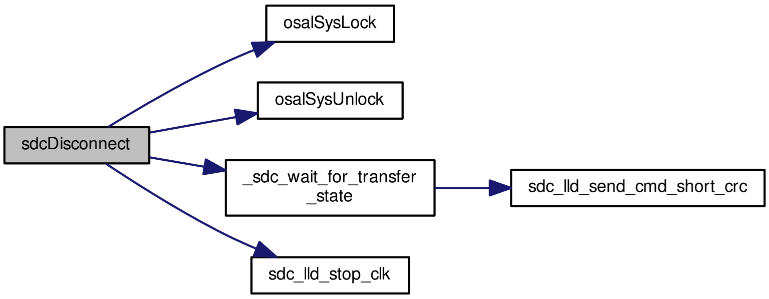
**Return values**

| | |
|---|---|
| *HAL_SUCCESS* | operation succeeded. |
| *HAL_FAILED* | operation failed. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



### 7.43.7.20 bool sdcRead ( SDCDriver ∗ *sdcp,* uint32_t *startblk,* uint8_t ∗ *buf,* uint32_t *n* )

Reads one or more blocks.

**Precondition**

The driver must be in the `BLK_READY` state after a successful sdcConnect() invocation.

**Parameters**

| | | |
|---|---|---|
| `in` | *sdcp* | pointer to the `SDCDriver` object |
| `in` | *startblk* | first block to read |
| `out` | *buf* | pointer to the read buffer |
| `in` | *n* | number of blocks to read |

**Returns**

The operation status.

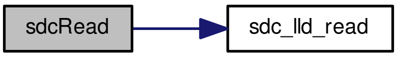
**Return values**

| | |
|---|---|
| *HAL_SUCCESS* | operation succeeded. |
| *HAL_FAILED* | operation failed. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.43.7.21 bool sdcWrite ( **SDCDriver** ∗ *sdcp,* uint32_t *startblk,* const uint8_t ∗ *buf,* uint32_t *n* )

Writes one or more blocks.

**Precondition**

The driver must be in the `BLK_READY` state after a successful sdcConnect() invocation.

**Parameters**

| | | |
|---|---|---|
| `in` | *sdcp* | pointer to the `SDCDriver` object |
| `in` | *startblk* | first block to write |
| `out` | *buf* | pointer to the write buffer |
| `in` | *n* | number of blocks to write |

**Returns**

The operation status.

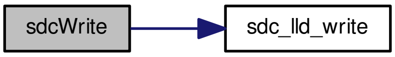
**Return values**

| | |
|---|---|
| *HAL_SUCCESS* | operation succeeded. |
| *HAL_FAILED* | operation failed. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.43.7.22 sdcflags_t sdcGetAndClearErrors ( SDCDriver * *sdcp* )

Returns the errors mask associated to the previous operation.

**Parameters**

| | | |
|---|---|---|
| in | *sdcp* | pointer to the SDCDriver object |

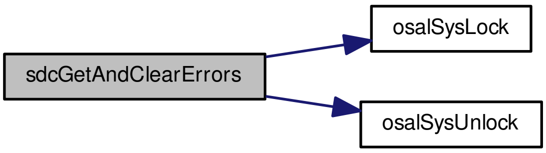
**Returns**

The errors mask.

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.43.7.23 bool sdcSync ( SDCDriver * *sdcp* )

Waits for card idle condition.

**Parameters**

| | | |
|---|---|---|
| in | *sdcp* | pointer to the SDCDriver object |

**Returns**

The operation status.

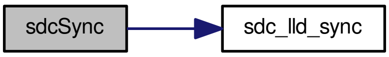
**Return values**

| | |
|---|---|
| *HAL_SUCCESS* | the operation succeeded. |
| *HAL_FAILED* | the operation failed. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.43.7.24 bool sdcGetInfo ( **SDCDriver** ∗ *sdcp*, **BlockDeviceInfo** ∗ *bdip* )

Returns the media info.

**Parameters**

| | | |
|---|---|---|
| in | *sdcp* | pointer to the SDCDriver object |
| out | *bdip* | pointer to a BlockDeviceInfo structure |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *HAL_SUCCESS* | the operation succeeded. |
| *HAL_FAILED* | the operation failed. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.43.7.25 bool sdcErase ( **SDCDriver** ∗ *sdcp*, uint32_t *startblk*, uint32_t *endblk* )

Erases the supplied blocks.

**Parameters**

| | | |
|---|---|---|
| in | *sdcp* | pointer to the SDCDriver object |
| in | *startblk* | starting block number |
| in | *endblk* | ending block number |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *HAL_SUCCESS* | the operation succeeded. |

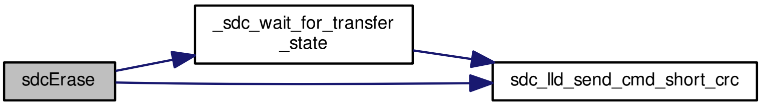
**Return values**

|  |  |
|---|---|
| *HAL_FAILED* | the operation failed. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



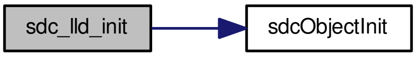
#### 7.43.7.26 void sdc_lld_init ( void )

Low level SDC driver initialization.

**Function Class:**

Not an API, this function is for internal use only.

Here is the call graph for this function:



#### 7.43.7.27 void sdc_lld_start ( SDCDriver * *sdcp* )

Configures and activates the SDC peripheral.

**Parameters**

|  |  |  |
|---|---|---|
| in | *sdcp* | pointer to the SDCDriver object |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.43.7.28 void sdc_lld_stop ( SDCDriver * *sdcp* )

Deactivates the SDC peripheral.

**Parameters**

| | | |
|---|---|---|
| in | *sdcp* | pointer to the SDCDriver object |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.43.7.29 void sdc_lld_start_clk ( SDCDriver * *sdcp* )

Starts the SDIO clock and sets it to init mode (400kHz or less).

**Parameters**

| | | |
|---|---|---|
| in | *sdcp* | pointer to the SDCDriver object |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.43.7.30 void sdc_lld_set_data_clk ( SDCDriver * *sdcp,* sdcbusclk_t *clk* )

Sets the SDIO clock to data mode (25MHz or less).

**Parameters**

| | | |
|---|---|---|
| in | *sdcp* | pointer to the SDCDriver object |
| in | *clk* | the clock mode |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.43.7.31 void sdc_lld_stop_clk ( SDCDriver * *sdcp* )

Stops the SDIO clock.

**Parameters**

| | | |
|---|---|---|
| in | *sdcp* | pointer to the SDCDriver object |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.43.7.32 void sdc_lld_set_bus_mode ( SDCDriver ∗ *sdcp,* sdcbusmode_t *mode* )

Switches the bus to 4 bits mode.

**Parameters**

| | | |
|---|---|---|
| in | *sdcp* | pointer to the SDCDriver object |
| in | *mode* | bus mode |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.43.7.33 void sdc_lld_send_cmd_none ( SDCDriver ∗ *sdcp,* uint8_t *cmd,* uint32_t *arg* )

Sends an SDIO command with no response expected.

**Parameters**

| | | |
|---|---|---|
| in | *sdcp* | pointer to the SDCDriver object |
| in | *cmd* | card command |
| in | *arg* | command argument |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.43.7.34 bool sdc_lld_send_cmd_short ( SDCDriver ∗ *sdcp,* uint8_t *cmd,* uint32_t *arg,* uint32_t ∗ *resp* )

Sends an SDIO command with a short response expected.

**Note**

The CRC is not verified.

**Parameters**

| | | |
|---|---|---|
| in | *sdcp* | pointer to the SDCDriver object |
| in | *cmd* | card command |
| in | *arg* | command argument |
| out | *resp* | pointer to the response buffer (one word) |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *HAL_SUCCESS* | operation succeeded. |
| *HAL_FAILED* | operation failed. |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.43.7.35 bool sdc_lld_send_cmd_short_crc ( SDCDriver ∗ *sdcp*, uint8_t *cmd*, uint32_t *arg*, uint32_t ∗ *resp* )

Sends an SDIO command with a short response expected and CRC.

**Parameters**

| | | |
|---|---|---|
| in | *sdcp* | pointer to the SDCDriver object |
| in | *cmd* | card command |
| in | *arg* | command argument |
| out | *resp* | pointer to the response buffer (one word) |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *HAL_SUCCESS* | operation succeeded. |
| *HAL_FAILED* | operation failed. |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.43.7.36 bool sdc_lld_send_cmd_long_crc ( SDCDriver ∗ *sdcp*, uint8_t *cmd*, uint32_t *arg*, uint32_t ∗ *resp* )

Sends an SDIO command with a long response expected and CRC.

**Parameters**

| | | |
|---|---|---|
| in | *sdcp* | pointer to the SDCDriver object |
| in | *cmd* | card command |
| in | *arg* | command argument |
| out | *resp* | pointer to the response buffer (four words) |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *HAL_SUCCESS* | operation succeeded. |
| *HAL_FAILED* | operation failed. |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.43.7.37 bool sdc_lld_read ( SDCDriver * *sdcp,* uint32_t *startblk,* uint8_t * *buf,* uint32_t *n* )

Reads one or more blocks.

**Parameters**

| | | |
|---|---|---|
| `in` | *sdcp* | pointer to the `SDCDriver` object |
| `in` | *startblk* | first block to read |
| `out` | *buf* | pointer to the read buffer |
| `in` | *n* | number of blocks to read |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *HAL_SUCCESS* | operation succeeded. |
| *HAL_FAILED* | operation failed. |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.43.7.38 bool sdc_lld_write ( SDCDriver * *sdcp,* uint32_t *startblk,* const uint8_t * *buf,* uint32_t *n* )

Writes one or more blocks.

**Parameters**

| | | |
|---|---|---|
| `in` | *sdcp* | pointer to the `SDCDriver` object |
| `in` | *startblk* | first block to write |
| `out` | *buf* | pointer to the write buffer |
| `in` | *n* | number of blocks to write |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *HAL_SUCCESS* | operation succeeded. |
| *HAL_FAILED* | operation failed. |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.43.7.39 bool sdc_lld_sync ( SDCDriver * *sdcp* )

Waits for card idle condition.

**Parameters**

| | | |
|---|---|---|
| in | *sdcp* | pointer to the SDCDriver object |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *HAL_SUCCESS* | the operation succeeded. |
| *HAL_FAILED* | the operation failed. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

### 7.43.8 Variable Documentation

#### 7.43.8.1 const struct SDCDriverVMT sdc_vmt [static]

**Initial value:**

```
= {
  (size_t)0,
  (bool (*)(void *))sdc_lld_is_card_inserted,
  (bool (*)(void *))sdc_lld_is_write_protected,
  (bool (*)(void *))sdcConnect,
  (bool (*)(void *))sdcDisconnect,
  (bool (*)(void *, uint32_t, uint8_t *, uint32_t))sdcRead,
  (bool (*)(void *, uint32_t, const uint8_t *, uint32_t))sdcWrite,
  (bool (*)(void *))sdcSync,
  (bool (*)(void *, BlockDeviceInfo *))sdcGetInfo
}
```

Virtual methods table.

#### 7.43.8.2 SDCDriver SDCD1

SDCD1 driver identifier.

## 7.44 Generic Sensor Interface

HAL Generic Sensor Interface.

### 7.44.1 Detailed Description

HAL Generic Sensor Interface.

#### Macros

- #define _base_sensor_methods_alone

  *BaseSensor specific methods.*
- #define _base_sensor_methods

  *BaseSensor specific methods with inherited ones.*
- #define _base_sensor_data

  *BaseSensor specific data.*

#### Macro Functions (BaseSensor)

- #define sensorGetChannelNumber(ip) (ip)->vmt->get_channels_number(ip)

  *Sensors get channels number.*
- #define sensorReadRaw(ip, dp) (ip)->vmt->read_raw(ip, dp)

  *Sensors read raw data.*
- #define sensorReadCooked(ip, dp) (ip)->vmt->read_cooked(ip, dp)

  *Sensors read cooked data.*

#### Data Structures

- struct BaseSensorVMT

  *BaseSensor virtual methods table.*
- struct BaseSensor

  *Base stream class.*

### 7.44.2 Macro Definition Documentation

#### 7.44.2.1 #define _base_sensor_methods_alone

**Value:**

```
/* Get number of channels.*/                                          \
  size_t (*get_channels_number)(void *instance);                       \
  /* Reads the sensor raw data.*/                                      \
  msg_t (*read_raw)(void *instance, int32_t axes[]);                   \
  /* Reads the sensor returning normalized data.*/                     \
  msg_t (*read_cooked)(void *instance, float axes[]);
```

BaseSensor specific methods.

#### 7.44.2.2 #define _base_sensor_methods

**Value:**

```
_base_object_methods                                                   \
  _base_sensor_methods_alone
```

BaseSensor specific methods with inherited ones.

#### 7.44.2.3 #define _base_sensor_data

`BaseSensor` specific data.

**Note**

It is empty because `BaseSensor` is only an interface without implementation.

#### 7.44.2.4 #define sensorGetChannelNumber( *ip* ) (ip)->vmt->get_channels_number(ip)

Sensors get channels number.

**Parameters**

| | | |
|---|---|---|
| `in` | *ip* | pointer to a `BaseSensor` or derived class. |

**Returns**

The number of channels of the BaseSensor

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.44.2.5 #define sensorReadRaw( *ip,* *dp* ) (ip)->vmt->read_raw(ip, dp)

Sensors read raw data.

**Parameters**

| | | |
|---|---|---|
| `in` | *ip* | pointer to a `BaseSensor` or derived class. |
| `in` | *dp* | pointer to a data array. |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *MSG_OK* | if the function succeeded. |
| *MSG_RESET* | if one or more errors occurred. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.44.2.6 #define sensorReadCooked( *ip, dp* ) (ip)->vmt->read_cooked(ip, dp)

Sensors read cooked data.

**Parameters**

| | | |
|---|---|---|
| in | *ip* | pointer to a BaseSensor or derived class. |
| in | *dp* | pointer to a data array. |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *MSG_OK* | if the function succeeded. |
| *MSG_RESET* | if one or more errors occurred. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

## 7.45 Serial Driver

Generic Serial Driver.

### 7.45.1 Detailed Description

Generic Serial Driver.

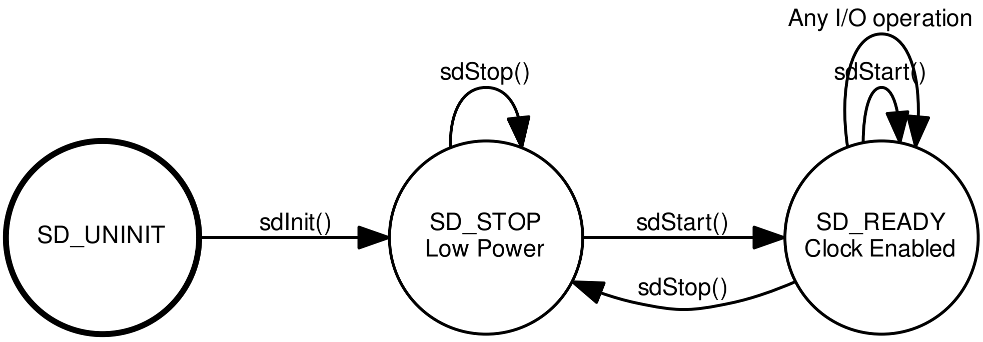
This module implements a generic full duplex serial driver. The driver implements a `SerialDriver` interface and uses I/O Queues for communication between the upper and the lower driver. Event flags are used to notify the application about incoming data, outgoing data and other I/O events.
The module also contains functions that make the implementation of the interrupt service routines much easier.

**Precondition**

> In order to use the SERIAL driver the `HAL_USE_SERIAL` option must be enabled in `halconf.h`.

### 7.45.2 Driver State Machine

The driver implements a state machine internally, not all the driver functionalities can be used in any moment, any transition not explicitly shown in the following diagram has to be considered an error and shall be captured by an assertion (if enabled).



#### Macros

- #define _serial_driver_methods _base_asynchronous_channel_methods

  *`SerialDriver` specific methods.*
- #define _serial_driver_data

  *`SerialDriver` specific data.*

#### Serial status flags

- #define SD_PARITY_ERROR (eventflags_t)32

*Parity.*

- #define SD_FRAMING_ERROR (eventflags_t)64

  *Framing.*
- #define SD_OVERRUN_ERROR (eventflags_t)128

  *Overflow.*
- #define SD_NOISE_ERROR (eventflags_t)256

  *Line noise.*
- #define SD_BREAK_DETECTED (eventflags_t)512

  *LIN Break.*
- #define SD_QUEUE_FULL_ERROR (eventflags_t)1024

  *Queue full.*

### Serial configuration options

- #define SERIAL_DEFAULT_BITRATE 38400

  *Default bit rate.*
- #define SERIAL_BUFFERS_SIZE 16

  *Serial buffers size.*

### Macro Functions

- #define sdPutI(sdp, b) oqPutI(&(sdp)->oqueue, b)

  *Direct write to a `SerialDriver`.*
- #define sdPut(sdp, b) oqPut(&(sdp)->oqueue, b)

  *Direct write to a `SerialDriver`.*
- #define sdPutTimeout(sdp, b, t) oqPutTimeout(&(sdp)->oqueue, b, t)

  *Direct write to a `SerialDriver` with timeout specification.*
- #define sdGetI(sdp) iqGetI(&(sdp)->iqueue)

  *Direct read from a `SerialDriver`.*
- #define sdGet(sdp) iqGet(&(sdp)->iqueue)

  *Direct read from a `SerialDriver`.*
- #define sdGetTimeout(sdp, t) iqGetTimeout(&(sdp)->iqueue, t)

  *Direct read from a `SerialDriver` with timeout specification.*
- #define sdWriteI(sdp, b, n) oqWriteI(&(sdp)->oqueue, b, n)

  *Direct blocking write to a `SerialDriver`.*
- #define sdWrite(sdp, b, n) oqWriteTimeout(&(sdp)->oqueue, b, n, TIME_INFINITE)

  *Direct blocking write to a `SerialDriver`.*
- #define sdWriteTimeout(sdp, b, n, t) oqWriteTimeout(&(sdp)->oqueue, b, n, t)

  *Direct blocking write to a `SerialDriver` with timeout specification.*
- #define sdAsynchronousWrite(sdp, b, n) oqWriteTimeout(&(sdp)->oqueue, b, n, TIME_IMMEDIATE)

  *Direct non-blocking write to a `SerialDriver`.*
- #define sdReadI(sdp, b, n) iqReadI(&(sdp)->iqueue, b, n, TIME_INFINITE)

  *Direct blocking read from a `SerialDriver`.*
- #define sdRead(sdp, b, n) iqReadTimeout(&(sdp)->iqueue, b, n, TIME_INFINITE)

  *Direct blocking read from a `SerialDriver`.*
- #define sdReadTimeout(sdp, b, n, t) iqReadTimeout(&(sdp)->iqueue, b, n, t)

  *Direct blocking read from a `SerialDriver` with timeout specification.*
- #define sdAsynchronousRead(sdp, b, n) iqReadTimeout(&(sdp)->iqueue, b, n, TIME_IMMEDIATE)

  *Direct non-blocking read from a `SerialDriver`.*

## PLATFORM configuration options

- #define PLATFORM_SERIAL_USE_USART1 FALSE

  *USART1 driver enable switch.*

## Typedefs

- typedef struct SerialDriver SerialDriver

  *Structure representing a serial driver.*

## Data Structures

- struct SerialDriverVMT

  *`SerialDriver` virtual methods table.*
- struct SerialDriver

  *Full duplex serial driver class.*
- struct SerialConfig

  *PLATFORM Serial Driver configuration structure.*

## Functions

- void sdInit (void)

  *Serial Driver initialization.*
- void sdObjectInit (SerialDriver ∗sdp, qnotify_t inotify, qnotify_t onotify)

  *Initializes a generic full duplex driver object.*
- void sdStart (SerialDriver ∗sdp, const SerialConfig ∗config)

  *Configures and starts the driver.*
- void sdStop (SerialDriver ∗sdp)

  *Stops the driver.*
- void sdIncomingDataI (SerialDriver ∗sdp, uint8_t b)

  *Handles incoming data.*
- msg_t sdRequestDataI (SerialDriver ∗sdp)

  *Handles outgoing data.*
- bool sdPutWouldBlock (SerialDriver ∗sdp)

  *Direct output check on a `SerialDriver`.*
- bool sdGetWouldBlock (SerialDriver ∗sdp)

  *Direct input check on a `SerialDriver`.*
- msg_t sdControl (SerialDriver ∗sdp, unsigned int operation, void ∗arg)

  *Control operation on a serial port.*
- void sd_lld_init (void)

  *Low level serial driver initialization.*
- void sd_lld_start (SerialDriver ∗sdp, const SerialConfig ∗config)

  *Low level serial driver configuration and (re)start.*
- void sd_lld_stop (SerialDriver ∗sdp)

  *Low level serial driver stop.*

### Enumerations

### Variables

- SerialDriver SD1

  *USART1 serial driver identifier.*
- static const SerialConfig default_config

  *Driver default configuration.*

## 7.45.3 Macro Definition Documentation

### 7.45.3.1 #define SD_PARITY_ERROR (eventflags_t)32

Parity.

### 7.45.3.2 #define SD_FRAMING_ERROR (eventflags_t)64

Framing.

### 7.45.3.3 #define SD_OVERRUN_ERROR (eventflags_t)128

Overflow.

### 7.45.3.4 #define SD_NOISE_ERROR (eventflags_t)256

Line noise.

### 7.45.3.5 #define SD_BREAK_DETECTED (eventflags_t)512

LIN Break.

### 7.45.3.6 #define SD_QUEUE_FULL_ERROR (eventflags_t)1024

Queue full.

### 7.45.3.7 #define SERIAL_DEFAULT_BITRATE 38400

Default bit rate.

Configuration parameter, this is the baud rate selected for the default configuration.

### 7.45.3.8 #define SERIAL_BUFFERS_SIZE 16

Serial buffers size.

Configuration parameter, you can change the depth of the queue buffers depending on the requirements of your application.

**Note**

The default is 16 bytes for both the transmission and receive buffers.
This is a global setting and it can be overridden by low level driver specific settings.

#### 7.45.3.9 #define _serial_driver_methods _base_asynchronous_channel_methods

SerialDriver specific methods.

#### 7.45.3.10 #define sdPutI( *sdp,* *b* ) oqPutI(&(sdp)->oqueue, b)

Direct write to a SerialDriver.

**Note**

This function bypasses the indirect access to the channel and writes directly on the output queue. This is faster but cannot be used to write to different channels implementations.

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

#### 7.45.3.11 #define sdPut( *sdp,* *b* ) oqPut(&(sdp)->oqueue, b)

Direct write to a SerialDriver.

**Note**

This function bypasses the indirect access to the channel and writes directly on the output queue. This is faster but cannot be used to write to different channels implementations.

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.45.3.12 #define sdPutTimeout( *sdp,* *b,* *t* ) oqPutTimeout(&(sdp)->oqueue, b, t)

Direct write to a SerialDriver with timeout specification.

**Note**

This function bypasses the indirect access to the channel and writes directly on the output queue. This is faster but cannot be used to write to different channels implementations.

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.45.3.13 #define sdGetI( *sdp* ) iqGetI(&(sdp)->iqueue)

Direct read from a SerialDriver.

**Note**

This function bypasses the indirect access to the channel and reads directly from the input queue. This is faster but cannot be used to read from different channels implementations.

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

#### 7.45.3.14 #define sdGet( *sdp* ) iqGet(&(sdp)->iqueue)

Direct read from a SerialDriver.

**Note**

This function bypasses the indirect access to the channel and reads directly from the input queue. This is faster but cannot be used to read from different channels implementations.

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.45.3.15 #define sdGetTimeout( *sdp, t* ) iqGetTimeout(&(sdp)->iqueue, t)

Direct read from a SerialDriver with timeout specification.

**Note**

This function bypasses the indirect access to the channel and reads directly from the input queue. This is faster but cannot be used to read from different channels implementations.

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.45.3.16 #define sdWriteI( *sdp, b, n* ) oqWriteI(&(sdp)->oqueue, b, n)

Direct blocking write to a SerialDriver.

**Note**

This function bypasses the indirect access to the channel and writes directly to the output queue. This is faster but cannot be used to write from different channels implementations.

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

#### 7.45.3.17 #define sdWrite( *sdp, b, n* ) oqWriteTimeout(&(sdp)->oqueue, b, n, TIME_INFINITE)

Direct blocking write to a SerialDriver.

**Note**

This function bypasses the indirect access to the channel and writes directly to the output queue. This is faster but cannot be used to write from different channels implementations.

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.45.3.18 #define sdWriteTimeout( *sdp, b, n, t* ) oqWriteTimeout(&(sdp)->oqueue, b, n, t)

Direct blocking write to a `SerialDriver` with timeout specification.

**Note**

This function bypasses the indirect access to the channel and writes directly to the output queue. This is faster but cannot be used to write to different channels implementations.

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.45.3.19 #define sdAsynchronousWrite( *sdp, b, n* ) oqWriteTimeout(&(sdp)->oqueue, b, n, TIME_IMMEDIATE)

Direct non-blocking write to a `SerialDriver`.

**Note**

This function bypasses the indirect access to the channel and writes directly to the output queue. This is faster but cannot be used to write to different channels implementations.

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.45.3.20 #define sdReadI( *sdp, b, n* ) iqReadI(&(sdp)->iqueue, b, n, TIME_INFINITE)

Direct blocking read from a `SerialDriver`.

**Note**

This function bypasses the indirect access to the channel and reads directly from the input queue. This is faster but cannot be used to read from different channels implementations.

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

#### 7.45.3.21 #define sdRead( *sdp, b, n* ) iqReadTimeout(&(sdp)->iqueue, b, n, TIME_INFINITE)

Direct blocking read from a `SerialDriver`.

**Note**

This function bypasses the indirect access to the channel and reads directly from the input queue. This is faster but cannot be used to read from different channels implementations.

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.45.3.22 #define sdReadTimeout( *sdp,* *b,* *n,* *t* ) iqReadTimeout(&(sdp)->iqueue, b, n, t)

Direct blocking read from a `SerialDriver` with timeout specification.

**Note**

This function bypasses the indirect access to the channel and reads directly from the input queue. This is faster but cannot be used to read from different channels implementations.

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.45.3.23 #define sdAsynchronousRead( *sdp,* *b,* *n* ) iqReadTimeout(&(sdp)->iqueue, b, n, TIME_IMMEDIATE)

Direct non-blocking read from a `SerialDriver`.

**Note**

This function bypasses the indirect access to the channel and reads directly from the input queue. This is faster but cannot be used to read from different channels implementations.

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.45.3.24 #define PLATFORM_SERIAL_USE_USART1 FALSE

USART1 driver enable switch.

If set to `TRUE` the support for USART1 is included.

**Note**

The default is `FALSE`.

#### 7.45.3.25 #define _serial_driver_data

**Value:**

```
_base_asynchronous_channel_data                                         \
  /* Driver state.*/                                                      \
  sdstate_t                  state;                                       \
  /* Input queue.*/                                                       \
  input_queue_t              iqueue;                                      \
  /* Output queue.*/                                                      \
  output_queue_t             oqueue;                                      \
  /* Input circular buffer.*/                                             \
  uint8_t                    ib[SERIAL_BUFFERS_SIZE];                     \
  /* Output circular buffer.*/                                            \
  uint8_t                    ob[SERIAL_BUFFERS_SIZE];                     \
  /* End of the mandatory fields.*/
```

`SerialDriver` specific data.

### 7.45.4 Typedef Documentation

#### 7.45.4.1 typedef struct SerialDriver SerialDriver

Structure representing a serial driver.

## 7.45.5 Enumeration Type Documentation

### 7.45.5.1 enum sdstate_t

Driver state machine possible states.

**Enumerator**

***SD_UNINIT*** Not initialized.

***SD_STOP*** Stopped.

***SD_READY*** Ready.

## 7.45.6 Function Documentation

### 7.45.6.1 void sdInit ( void )

Serial Driver initialization.

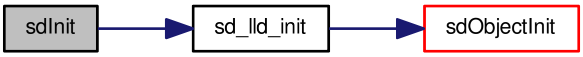
**Note**

This function is implicitly invoked by `halInit()`, there is no need to explicitly initialize the driver.

**Function Class:**

Initializer, this function just initializes an object and can be invoked before the kernel is initialized.

Here is the call graph for this function:



### 7.45.6.2 void sdObjectInit ( SerialDriver * *sdp*, qnotify_t *inotify*, qnotify_t *onotify* )

Initializes a generic full duplex driver object.

The HW dependent part of the initialization has to be performed outside, usually in the hardware initialization code.

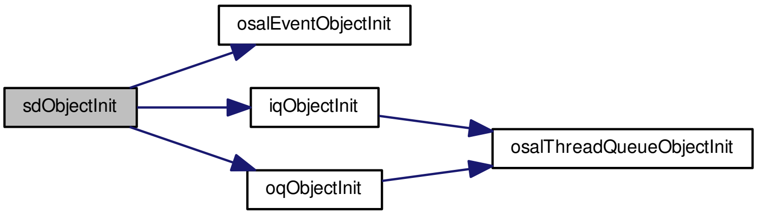
**Parameters**

| | | |
|---|---|---|
| `out` | *sdp* | pointer to a `SerialDriver` structure |
| `in` | *inotify* | pointer to a callback function that is invoked when some data is read from the Queue. The value can be `NULL`. |
| `in` | *onotify* | pointer to a callback function that is invoked when some data is written in the Queue. The value can be `NULL`. |

**Function Class:**

Initializer, this function just initializes an object and can be invoked before the kernel is initialized.

Here is the call graph for this function:



#### 7.45.6.3 void sdStart ( SerialDriver * *sdp*, const SerialConfig * *config* )

Configures and starts the driver.

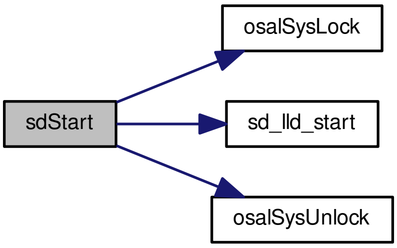
**Parameters**

| | | |
|---|---|---|
| in | *sdp* | pointer to a `SerialDriver` object |
| in | *config* | the architecture-dependent serial driver configuration. If this parameter is set to `NULL` then a default configuration is used. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.45.6.4 void sdStop ( SerialDriver * *sdp* )

Stops the driver.

Any thread waiting on the driver's queues will be awakened with the message `MSG_RESET`.

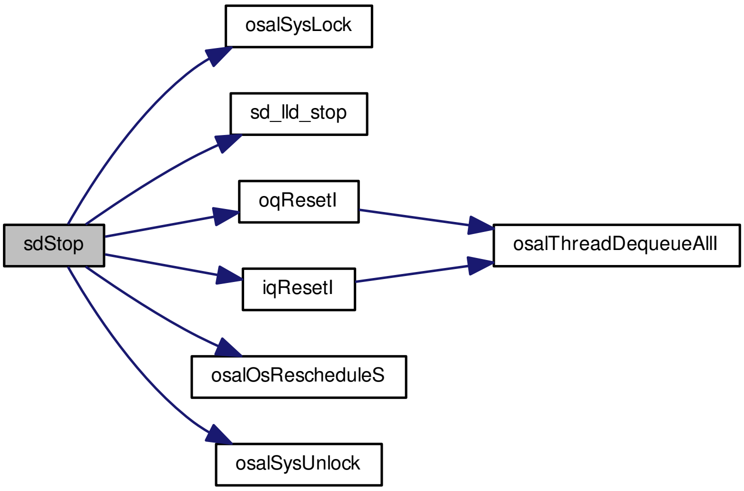
**Parameters**

| | | |
|---|---|---|
| in | *sdp* | pointer to a SerialDriver object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



### 7.45.6.5 void sdIncomingDataI ( SerialDriver ∗ *sdp*, uint8_t *b* )

Handles incoming data.

This function must be called from the input interrupt service routine in order to enqueue incoming data and generate the related events.

**Note**

The incoming data event is only generated when the input queue becomes non-empty.
In order to gain some performance it is suggested to not use this function directly but copy this code directly into the interrupt service routine.

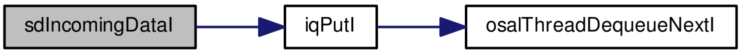
**Parameters**

| | | |
|---|---|---|
| in | *sdp* | pointer to a SerialDriver structure |
| in | *b* | the byte to be written in the driver's Input Queue |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

Here is the call graph for this function:



#### 7.45.6.6 msg_t sdRequestDataI ( SerialDriver ∗ *sdp* )

Handles outgoing data.

Must be called from the output interrupt service routine in order to get the next byte to be transmitted.

**Note**

In order to gain some performance it is suggested to not use this function directly but copy this code directly into the interrupt service routine.

**Parameters**

| | | |
|---|---|---|
| in | *sdp* | pointer to a SerialDriver structure |

**Returns**

The byte value read from the driver's output queue.

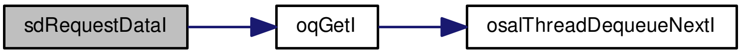
**Return values**

| | |
|---|---|
| *MSG_TIMEOUT* | if the queue is empty (the lower driver usually disables the interrupt source when this happens). |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

Here is the call graph for this function:



#### 7.45.6.7 bool sdPutWouldBlock ( SerialDriver ∗ *sdp* )

Direct output check on a `SerialDriver`.

**Note**

This function bypasses the indirect access to the channel and checks directly the output queue. This is faster but cannot be used to check different channels implementations.

**Parameters**

| | | |
|---|---|---|
| in | *sdp* | pointer to a `SerialDriver` structure |

**Returns**

The queue status.

**Return values**

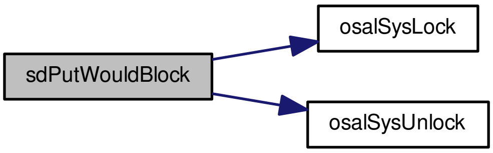
| | |
|---|---|
| *false* | if the next write operation would not block. |
| *true* | if the next write operation would block. |

**Deprecated**

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.45.6.8 bool sdGetWouldBlock ( SerialDriver ∗ *sdp* )

Direct input check on a `SerialDriver`.

**Note**

This function bypasses the indirect access to the channel and checks directly the input queue. This is faster but cannot be used to check different channels implementations.

**Parameters**

| | | |
|---|---|---|
| in | *sdp* | pointer to a SerialDriver structure |

**Returns**

The queue status.

**Return values**

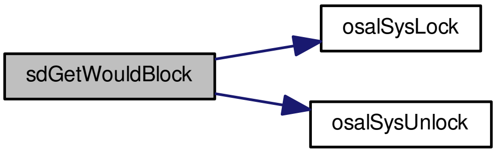
| | |
|---|---|
| *false* | if the next write operation would not block. |
| *true* | if the next write operation would block. |

**Deprecated**

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



### 7.45.6.9 msg_t sdControl ( SerialDriver * *sdp,* unsigned int *operation,* void * *arg* )

Control operation on a serial port.

**Parameters**

| | | |
|---|---|---|
| in | *sdp* | pointer to a SerialDriver object |
| in | *operation* | control operation code |
| in,out | *arg* | operation argument |

**Returns**

The control operation status.

**Return values**

| | |
|---|---|
| *MSG_OK* | in case of success. |

**Return values**

| | |
|---|---|
| *MSG_TIMEOUT* | in case of operation timeout. |
| *MSG_RESET* | in case of operation reset. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

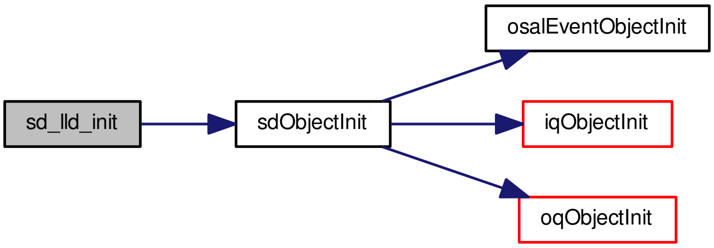
### 7.45.6.10 void sd_lld_init ( void )

Low level serial driver initialization.

**Function Class:**

Not an API, this function is for internal use only.

Here is the call graph for this function:



### 7.45.6.11 void sd_lld_start ( **SerialDriver** ∗ *sdp,* const **SerialConfig** ∗ *config* )

Low level serial driver configuration and (re)start.

**Parameters**

| | | |
|---|---|---|
| in | *sdp* | pointer to a `SerialDriver` object |
| in | *config* | the architecture-dependent serial driver configuration. If this parameter is set to `NULL` then a default configuration is used. |

**Function Class:**

Not an API, this function is for internal use only.

### 7.45.6.12 void sd_lld_stop ( **SerialDriver** ∗ *sdp* )

Low level serial driver stop.

De-initializes the USART, stops the associated clock, resets the interrupt vector.

**Parameters**

| | | |
|---|---|---|
| in | *sdp* | pointer to a SerialDriver object |

**Function Class:**

Not an API, this function is for internal use only.

## 7.45.7 Variable Documentation

### 7.45.7.1 SerialDriver SD1

USART1 serial driver identifier.

### 7.45.7.2 const SerialConfig default_config [static]

**Initial value:**

```
= {
  38400
}
```

Driver default configuration.

## 7.46 Serial over USB Driver

Serial over USB Driver.

### 7.46.1 Detailed Description

Serial over USB Driver.

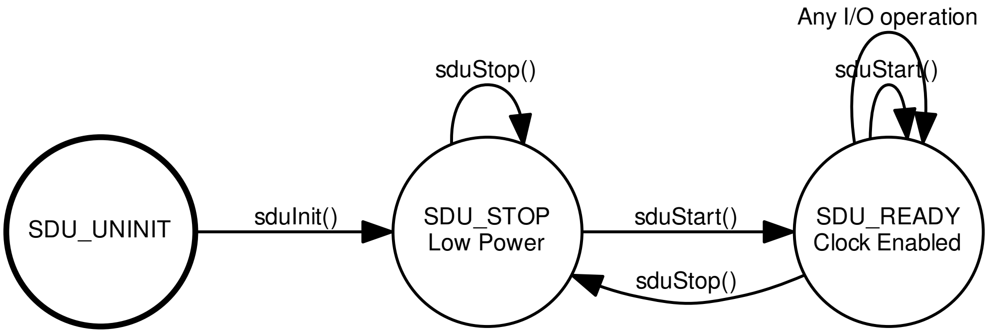
This module implements an USB Communication Device Class (CDC) as a normal serial communication port accessible from the device application.

**Precondition**

> In order to use the USB over Serial driver the `HAL_USE_SERIAL_USB` option must be enabled in `halconf.h`.

### 7.46.2 Driver State Machine

The driver implements a state machine internally, not all the driver functionalities can be used in any moment, any transition not explicitly shown in the following diagram has to be considered an error and shall be captured by an assertion (if enabled).



### Macros

- #define _serial_usb_driver_data

  *`SerialDriver` specific data.*
- #define _serial_usb_driver_methods _base_asynchronous_channel_methods

  *`SerialUSBDriver` specific methods.*

### SERIAL_USB configuration options

- #define SERIAL_USB_BUFFERS_SIZE 256

  *Serial over USB buffers size.*

- #define SERIAL_USB_BUFFERS_NUMBER 2

  *Serial over USB number of buffers.*

## Typedefs

- typedef struct SerialUSBDriver SerialUSBDriver

  *Structure representing a serial over USB driver.*

## Data Structures

- struct SerialUSBConfig

  *Serial over USB Driver configuration structure.*
- struct SerialUSBDriverVMT

  *`SerialDriver` virtual methods table.*
- struct SerialUSBDriver

  *Full duplex serial driver class.*

## Functions

- static void ibnotify (io_buffers_queue_t ∗bqp)

  *Notification of empty buffer released into the input buffers queue.*
- static void obnotify (io_buffers_queue_t ∗bqp)

  *Notification of filled buffer inserted into the output buffers queue.*
- void sduInit (void)

  *Serial Driver initialization.*
- void sduObjectInit (SerialUSBDriver ∗sdup)

  *Initializes a generic full duplex driver object.*
- void sduStart (SerialUSBDriver ∗sdup, const SerialUSBConfig ∗config)

  *Configures and starts the driver.*
- void sduStop (SerialUSBDriver ∗sdup)

  *Stops the driver.*
- void sduSuspendHookI (SerialUSBDriver ∗sdup)

  *USB device suspend handler.*
- void sduWakeupHookI (SerialUSBDriver ∗sdup)

  *USB device wakeup handler.*
- void sduConfigureHookI (SerialUSBDriver ∗sdup)

  *USB device configured handler.*
- bool sduRequestsHook (USBDriver ∗usbp)

  *Default requests hook.*
- void sduSOFHookI (SerialUSBDriver ∗sdup)

  *SOF handler.*
- void sduDataTransmitted (USBDriver ∗usbp, usbep_t ep)

  *Default data transmitted callback.*
- void sduDataReceived (USBDriver ∗usbp, usbep_t ep)

  *Default data received callback.*
- void sduInterruptTransmitted (USBDriver ∗usbp, usbep_t ep)

  *Default data received callback.*
- msg_t sduControl (USBDriver ∗usbp, unsigned int operation, void ∗arg)

  *Control operation on a serial USB port.*

## Enumerations

## 7.46.3 Macro Definition Documentation

### 7.46.3.1 #define SERIAL_USB_BUFFERS_SIZE 256

Serial over USB buffers size.

Configuration parameter, the buffer size must be a multiple of the USB data endpoint maximum packet size.

**Note**

The default is 256 bytes for both the transmission and receive buffers.

### 7.46.3.2 #define SERIAL_USB_BUFFERS_NUMBER 2

Serial over USB number of buffers.

**Note**

The default is 2 buffers.

### 7.46.3.3 #define _serial_usb_driver_data

**Value:**

```
_base_asynchronous_channel_data                                           \
  /* Driver state.*/                                                        \
  sdustate_t                 state;                                         \
  /* Input buffers queue.*/                                                 \
  input_buffers_queue_t      ibqueue;                                       \
  /* Output queue.*/                                                        \
  output_buffers_queue_t     obqueue;                                       \
  /* Input buffer.*/                                                        \
  uint8_t                    ib[BQ_BUFFER_SIZE(
      SERIAL_USB_BUFFERS_NUMBER,    \
                                              SERIAL_USB_BUFFERS_SIZE)];    \
  /* Output buffer.*/                                                       \
  uint8_t                    ob[BQ_BUFFER_SIZE(
      SERIAL_USB_BUFFERS_NUMBER,    \
                                              SERIAL_USB_BUFFERS_SIZE)];    \
  /* End of the mandatory fields.*/                                         \
  /* Current configuration data.*/                                          \
  const SerialUSBConfig      *config;
```

SerialDriver specific data.

### 7.46.3.4 #define _serial_usb_driver_methods _base_asynchronous_channel_methods

SerialUSBDriver specific methods.

## 7.46.4 Typedef Documentation

### 7.46.4.1 typedef struct SerialUSBDriver SerialUSBDriver

Structure representing a serial over USB driver.

## 7.46.5 Enumeration Type Documentation

### 7.46.5.1 enum **sdustate_t**

Driver state machine possible states.

**Enumerator**

***SDU_UNINIT*** Not initialized.

***SDU_STOP*** Stopped.

***SDU_READY*** Ready.

## 7.46.6 Function Documentation

### 7.46.6.1 static void ibnotify ( **io_buffers_queue_t** * *bqp* ) [static]

Notification of empty buffer released into the input buffers queue.

**Parameters**

| | | |
|---|---|---|
| in | *bqp* | the buffers queue pointer. |

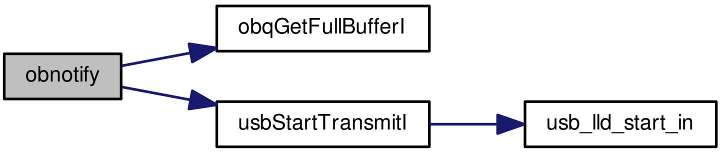
### 7.46.6.2 static void obnotify ( **io_buffers_queue_t** * *bqp* ) [static]

Notification of filled buffer inserted into the output buffers queue.

**Parameters**

| | | |
|---|---|---|
| in | *bqp* | the buffers queue pointer. |

Here is the call graph for this function:



### 7.46.6.3 void sduInit ( void )

Serial Driver initialization.

**Note**

This function is implicitly invoked by `halInit()`, there is no need to explicitly initialize the driver.

**Function Class:**

Initializer, this function just initializes an object and can be invoked before the kernel is initialized.

#### 7.46.6.4 void sduObjectInit ( **SerialUSBDriver** ∗ *sdup* )

Initializes a generic full duplex driver object.

The HW dependent part of the initialization has to be performed outside, usually in the hardware initialization code.

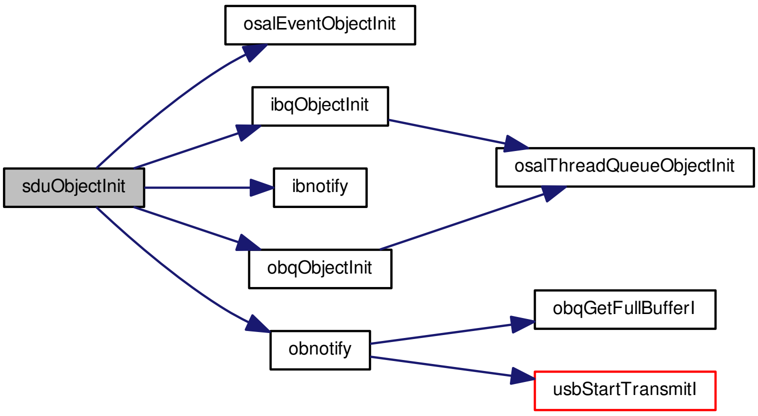
**Parameters**

| | | |
|---|---|---|
| out | *sdup* | pointer to a `SerialUSBDriver` structure |

**Function Class:**

Initializer, this function just initializes an object and can be invoked before the kernel is initialized.

Here is the call graph for this function:



#### 7.46.6.5 void sduStart ( **SerialUSBDriver** ∗ *sdup,* const **SerialUSBConfig** ∗ *config* )

Configures and starts the driver.

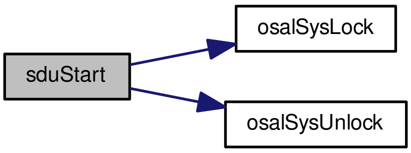
**Parameters**

| | | |
|---|---|---|
| in | *sdup* | pointer to a `SerialUSBDriver` object |
| in | *config* | the serial over USB driver configuration |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.46.6.6 void sduStop ( SerialUSBDriver ∗ *sdup* )

Stops the driver.

Any thread waiting on the driver's queues will be awakened with the message `MSG_RESET`.

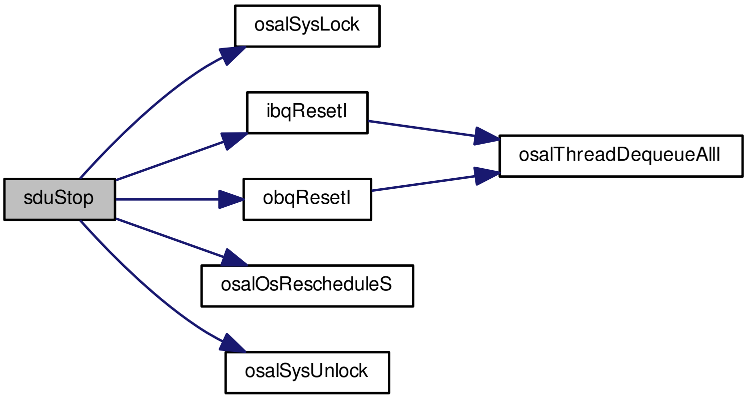
**Parameters**

| | | |
|---|---|---|
| `in` | *sdup* | pointer to a `SerialUSBDriver` object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.46.6.7 void sduSuspendHookI ( **SerialUSBDriver** ∗ *sdup* )

USB device suspend handler.

Generates a `CHN_DISCONNECT` event and puts queues in non-blocking mode, this way the application cannot get stuck in the middle of an I/O operations.

**Note**

If this function is not called from an ISR then an explicit call to `osalOsRescheduleS()` in necessary afterward.

**Parameters**

| | | |
|---|---|---|
| in | *sdup* | pointer to a `SerialUSBDriver` object |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

#### 7.46.6.8 void sduWakeupHookI ( **SerialUSBDriver** ∗ *sdup* )

USB device wakeup handler.

Generates a `CHN_CONNECT` event and resumes normal queues operations.

**Note**

If this function is not called from an ISR then an explicit call to `osalOsRescheduleS()` in necessary afterward.

**Parameters**

| | | |
|---|---|---|
| in | *sdup* | pointer to a `SerialUSBDriver` object |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

#### 7.46.6.9 void sduConfigureHookI ( **SerialUSBDriver** ∗ *sdup* )

USB device configured handler.

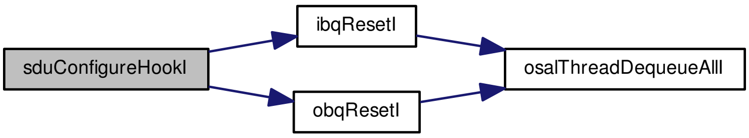
**Parameters**

| | | |
|---|---|---|
| in | *sdup* | pointer to a `SerialUSBDriver` object |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

Here is the call graph for this function:



### 7.46.6.10 bool sduRequestsHook ( USBDriver ∗ *usbp* )

Default requests hook.

Applications wanting to use the Serial over USB driver can use this function as requests hook in the USB configuration. The following requests are emulated:

- CDC_GET_LINE_CODING.
- CDC_SET_LINE_CODING.
- CDC_SET_CONTROL_LINE_STATE.

**Parameters**

| | | |
|---|---|---|
| in | *usbp* | pointer to the USBDriver object |

**Returns**

The hook status.

**Return values**

| | |
|---|---|
| *true* | Message handled internally. |
| *false* | Message not handled. |

### 7.46.6.11 void sduSOFHookI ( SerialUSBDriver ∗ *sdup* )

SOF handler.

The SOF interrupt is used for automatic flushing of incomplete buffers pending in the output queue.

**Parameters**

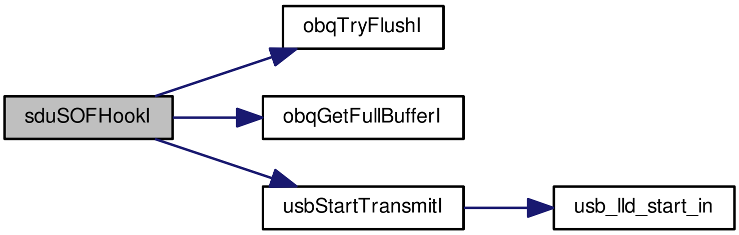
| | | |
|---|---|---|
| in | *sdup* | pointer to a SerialUSBDriver object |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt

handlers.

Here is the call graph for this function:



#### 7.46.6.12 void sduDataTransmitted ( USBDriver * *usbp*, usbep_t *ep* )

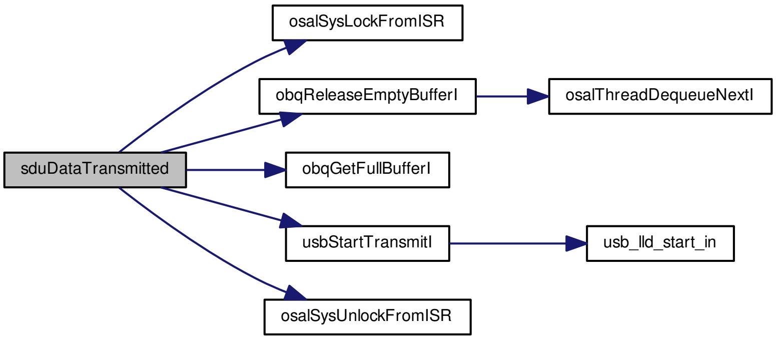
Default data transmitted callback.

The application must use this function as callback for the IN data endpoint.

**Parameters**

| | | |
|---|---|---|
| in | *usbp* | pointer to the USBDriver object |
| in | *ep* | IN endpoint number |

Here is the call graph for this function:



#### 7.46.6.13 void sduDataReceived ( USBDriver * *usbp*, usbep_t *ep* )

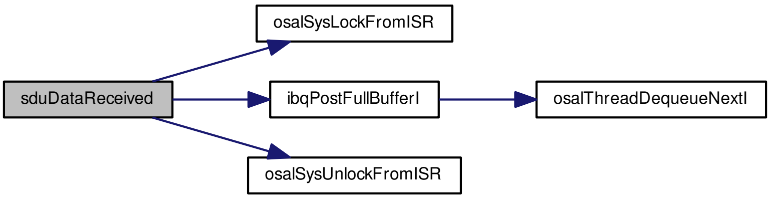
Default data received callback.

The application must use this function as callback for the OUT data endpoint.

**Parameters**

| | | |
|---|---|---|
| in | *usbp* | pointer to the `USBDriver` object |
| in | *ep* | OUT endpoint number |

Here is the call graph for this function:



#### 7.46.6.14 void sduInterruptTransmitted ( USBDriver ∗ *usbp*, usbep_t *ep* )

Default data received callback.

The application must use this function as callback for the IN interrupt endpoint.

**Parameters**

| | | |
|---|---|---|
| in | *usbp* | pointer to the `USBDriver` object |
| in | *ep* | endpoint number |

#### 7.46.6.15 msg_t sduControl ( USBDriver ∗ *usbp*, unsigned int *operation*, void ∗ *arg* )

Control operation on a serial USB port.

**Parameters**

| | | |
|---|---|---|
| in | *usbp* | pointer to a `USBDriver` object |
| in | *operation* | control operation code |
| in,out | *arg* | operation argument |

**Returns**

The control operation status.

**Return values**

| | |
|---|---|
| *MSG_OK* | in case of success. |
| *MSG_TIMEOUT* | in case of operation timeout. |
| *MSG_RESET* | in case of operation reset. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

## 7.47 SPI Driver

Generic SPI Driver.

### 7.47.1 Detailed Description

Generic SPI Driver.

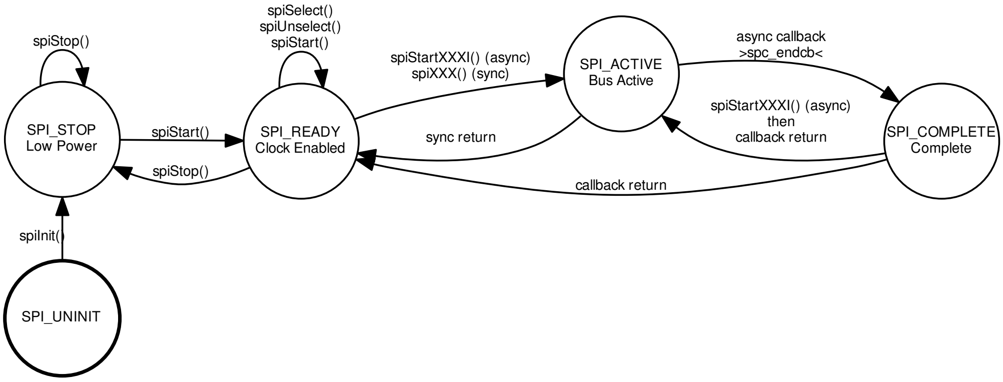
This module implements a generic SPI (Serial Peripheral Interface) driver allowing bidirectional and monodirectional transfers, complex atomic transactions are supported as well.

**Precondition**

> In order to use the SPI driver the `HAL_USE_SPI` option must be enabled in `halconf.h`.

### 7.47.2 Driver State Machine

The driver implements a state machine internally, not all the driver functionalities can be used in any moment, any transition not explicitly shown in the following diagram has to be considered an error and shall be captured by an assertion (if enabled).



The driver is not thread safe for performance reasons, if you need to access the SPI bus from multiple threads then use the `spiAcquireBus()` and `spiReleaseBus()` APIs in order to gain exclusive access.

## Macros

- #define SPI_SUPPORTS_CIRCULAR TRUE

  *Circular mode support flag.*

## Chip Select modes

- #define **SPI_SELECT_MODE_NONE**
- #define **SPI_SELECT_MODE_PAD** 1 /∗∗ @brief Legacy mode. ∗/
- #define **SPI_SELECT_MODE_PORT** 2 /∗∗ @brief Fastest mode. ∗/

- #define **SPI_SELECT_MODE_LINE** 3 /∗∗ @brief Packed mode. ∗/
- #define **SPI_SELECT_MODE_LLD** 4 /∗∗ @brief LLD-defined mode.∗/

### SPI configuration options

- #define SPI_USE_WAIT TRUE

  *Enables synchronous APIs.*
- #define SPI_USE_CIRCULAR FALSE

  *Enables circular transfers APIs.*
- #define SPI_USE_MUTUAL_EXCLUSION TRUE

  *Enables the `spiAcquireBus()` and `spiReleaseBus()` APIs.*
- #define SPI_SELECT_MODE SPI_SELECT_MODE_PAD

  *Handling method for SPI CS line.*

### Macro Functions

- #define spiSelectI(spip)

  *Asserts the slave select signal and prepares for transfers.*
- #define spiUnselectI(spip)

  *Deasserts the slave select signal.*
- #define spiStartIgnoreI(spip, n)

  *Ignores data on the SPI bus.*
- #define spiStartExchangeI(spip, n, txbuf, rxbuf)

  *Exchanges data on the SPI bus.*
- #define spiStartSendI(spip, n, txbuf)

  *Sends data over the SPI bus.*
- #define spiStartReceiveI(spip, n, rxbuf)

  *Receives data from the SPI bus.*
- #define spiPolledExchange(spip, frame) spi_lld_polled_exchange(spip, frame)

  *Exchanges one frame using a polled wait.*

### Low level driver helper macros

- #define _spi_wakeup_isr(spip)

  *Wakes up the waiting thread.*
- #define _spi_isr_code(spip)

  *Common ISR code.*
- #define _spi_isr_code_half1(spip)

  *Common ISR code in circular mode.*
- #define _spi_isr_code_half2(spip)

  *Common ISR code in circular mode.*

### PLATFORM configuration options

- #define PLATFORM_SPI_USE_SPI1 FALSE

  *SPI1 driver enable switch.*

## Typedefs

- typedef struct SPIDriver SPIDriver

  *Type of a structure representing an SPI driver.*
- typedef void(∗ spicallback_t) (SPIDriver ∗spip)

  *SPI notification callback type.*

## Data Structures

- struct SPIConfig

  *Driver configuration structure.*
- struct SPIDriver

  *Structure representing an SPI driver.*

## Functions

- void spiInit (void)

  *SPI Driver initialization.*
- void spiObjectInit (SPIDriver ∗spip)

  *Initializes the standard part of a `SPIDriver` structure.*
- void spiStart (SPIDriver ∗spip, const SPIConfig ∗config)

  *Configures and activates the SPI peripheral.*
- void spiStop (SPIDriver ∗spip)

  *Deactivates the SPI peripheral.*
- void spiSelect (SPIDriver ∗spip)

  *Asserts the slave select signal and prepares for transfers.*
- void spiUnselect (SPIDriver ∗spip)

  *Deasserts the slave select signal.*
- void spiStartIgnore (SPIDriver ∗spip, size_t n)

  *Ignores data on the SPI bus.*
- void spiStartExchange (SPIDriver ∗spip, size_t n, const void ∗txbuf, void ∗rxbuf)

  *Exchanges data on the SPI bus.*
- void spiStartSend (SPIDriver ∗spip, size_t n, const void ∗txbuf)

  *Sends data over the SPI bus.*
- void spiStartReceive (SPIDriver ∗spip, size_t n, void ∗rxbuf)

  *Receives data from the SPI bus.*
- void spiAbortI (SPIDriver ∗spip)

  *Aborts the ongoing SPI operation.*
- void spiAbort (SPIDriver ∗spip)

  *Aborts the ongoing SPI operation, if any.*
- void spiIgnore (SPIDriver ∗spip, size_t n)

  *Ignores data on the SPI bus.*
- void spiExchange (SPIDriver ∗spip, size_t n, const void ∗txbuf, void ∗rxbuf)

  *Exchanges data on the SPI bus.*
- void spiSend (SPIDriver ∗spip, size_t n, const void ∗txbuf)

  *Sends data over the SPI bus.*
- void spiReceive (SPIDriver ∗spip, size_t n, void ∗rxbuf)

  *Receives data from the SPI bus.*
- void spiAcquireBus (SPIDriver ∗spip)

  *Gains exclusive access to the SPI bus.*

- void spiReleaseBus (SPIDriver ∗spip)

  *Releases exclusive access to the SPI bus.*
- void spi_lld_init (void)

  *Low level SPI driver initialization.*
- void spi_lld_start (SPIDriver ∗spip)

  *Configures and activates the SPI peripheral.*
- void spi_lld_stop (SPIDriver ∗spip)

  *Deactivates the SPI peripheral.*
- void spi_lld_select (SPIDriver ∗spip)

  *Asserts the slave select signal and prepares for transfers.*
- void spi_lld_unselect (SPIDriver ∗spip)

  *Deasserts the slave select signal.*
- void spi_lld_ignore (SPIDriver ∗spip, size_t n)

  *Ignores data on the SPI bus.*
- void spi_lld_exchange (SPIDriver ∗spip, size_t n, const void ∗txbuf, void ∗rxbuf)

  *Exchanges data on the SPI bus.*
- void spi_lld_send (SPIDriver ∗spip, size_t n, const void ∗txbuf)

  *Sends data over the SPI bus.*
- void spi_lld_receive (SPIDriver ∗spip, size_t n, void ∗rxbuf)

  *Receives data from the SPI bus.*
- void spi_lld_abort (SPIDriver ∗spip)

  *Aborts the ongoing SPI operation, if any.*
- uint16_t spi_lld_polled_exchange (SPIDriver ∗spip, uint16_t frame)

  *Exchanges one frame using a polled wait.*

### Enumerations

### Variables

- SPIDriver SPID1

  *SPI1 driver identifier.*

## 7.47.3 Macro Definition Documentation

### 7.47.3.1 #define SPI_USE_WAIT TRUE

Enables synchronous APIs.

**Note**

> Disabling this option saves both code and data space.

### 7.47.3.2 #define SPI_USE_CIRCULAR FALSE

Enables circular transfers APIs.

**Note**

> Disabling this option saves both code and data space.

#### 7.47.3.3 #define SPI_USE_MUTUAL_EXCLUSION TRUE

Enables the spiAcquireBus() and spiReleaseBus() APIs.

**Note**

Disabling this option saves both code and data space.

#### 7.47.3.4 #define SPI_SELECT_MODE SPI_SELECT_MODE_PAD

Handling method for SPI CS line.

**Note**

Disabling this option saves both code and data space.

#### 7.47.3.5 #define spiSelectI( *spip* )

**Value:**

```
do {                                                                \
  spi_lld_select(spip);                                             \
} while (false)
```

Asserts the slave select signal and prepares for transfers.

**Parameters**

| | | |
|---|---|---|
| in | *spip* | pointer to the SPIDriver object |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

#### 7.47.3.6 #define spiUnselectI( *spip* )

**Value:**

```
do {                                                                \
  spi_lld_unselect(spip);                                           \
} while (false)
```

Deasserts the slave select signal.

The previously selected peripheral is unselected.

**Parameters**

| | | |
|---|---|---|
| in | *spip* | pointer to the SPIDriver object |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

### 7.47.3.7 #define spiStartIgnoreI( *spip,* *n* )

**Value:**

```
{                                                    \
  (spip)->state = SPI_ACTIVE;
       \
  spi_lld_ignore(spip, n);                                                         \
}
```

Ignores data on the SPI bus.

This asynchronous function starts the transmission of a series of idle words on the SPI bus and ignores the received data.

**Precondition**

A slave must have been selected using `spiSelect()` or `spiSelectI()`.

**Postcondition**

At the end of the operation the configured callback is invoked.

**Parameters**

| | | |
|---|---|---|
| in | *spip* | pointer to the `SPIDriver` object |
| in | *n* | number of words to be ignored |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

### 7.47.3.8 #define spiStartExchangeI( *spip,* *n,* *txbuf,* *rxbuf* )

**Value:**

```
{                                  \
  (spip)->state = SPI_ACTIVE;
       \
  spi_lld_exchange(spip, n, txbuf, rxbuf);                                         \
}
```

Exchanges data on the SPI bus.

This asynchronous function starts a simultaneous transmit/receive operation.

**Precondition**

A slave must have been selected using `spiSelect()` or `spiSelectI()`.

**Postcondition**

At the end of the operation the configured callback is invoked.

**Note**

The buffers are organized as uint8_t arrays for data sizes below or equal to 8 bits else it is organized as uint16_t arrays.

**Parameters**

| | | |
|---|---|---|
| in | *spip* | pointer to the SPIDriver object |
| in | *n* | number of words to be exchanged |
| in | *txbuf* | the pointer to the transmit buffer |
| out | *rxbuf* | the pointer to the receive buffer |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

### 7.47.3.9 #define spiStartSendI( *spip, n, txbuf* )

**Value:**

```
{                                                    \
  (spip)->state = SPI_ACTIVE;
      \
  spi_lld_send(spip, n, txbuf);                                                      \
}
```

Sends data over the SPI bus.

This asynchronous function starts a transmit operation.

**Precondition**

A slave must have been selected using spiSelect() or spiSelectI().

**Postcondition**

At the end of the operation the configured callback is invoked.

**Note**

The buffers are organized as uint8_t arrays for data sizes below or equal to 8 bits else it is organized as uint16_t arrays.

**Parameters**

| | | |
|---|---|---|
| in | *spip* | pointer to the SPIDriver object |
| in | *n* | number of words to send |
| in | *txbuf* | the pointer to the transmit buffer |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

### 7.47.3.10 #define spiStartReceiveI( *spip, n, rxbuf* )

**Value:**

```
{                                                          \
  (spip)->state = SPI_ACTIVE;
      \
  spi_lld_receive(spip, n, rxbuf);                                                \
}
```

Receives data from the SPI bus.

This asynchronous function starts a receive operation.

**Precondition**

A slave must have been selected using `spiSelect()` or `spiSelectI()`.

**Postcondition**

At the end of the operation the configured callback is invoked.

**Note**

The buffers are organized as uint8_t arrays for data sizes below or equal to 8 bits else it is organized as uint16_t arrays.

**Parameters**

| | | |
|---|---|---|
| `in` | *spip* | pointer to the `SPIDriver` object |
| `in` | *n* | number of words to receive |
| `out` | *rxbuf* | the pointer to the receive buffer |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

#### 7.47.3.11 #define spiPolledExchange( *spip,* *frame* ) **spi_lld_polled_exchange**(spip, frame)

Exchanges one frame using a polled wait.

This synchronous function exchanges one frame using a polled synchronization method. This function is useful when exchanging small amount of data on high speed channels, usually in this situation is much more efficient just wait for completion using polling than suspending the thread waiting for an interrupt.

**Note**

This API is implemented as a macro in order to minimize latency.

**Parameters**

| | | |
|---|---|---|
| `in` | *spip* | pointer to the `SPIDriver` object |
| `in` | *frame* | the data frame to send over the SPI bus |

**Returns**

The received data frame from the SPI bus.

#### 7.47.3.12 #define _spi_wakeup_isr( *spip* )

**Value:**

```
{                                                    \
  osalSysLockFromISR();
      \
  osalThreadResumeI(&(spip)->thread, MSG_OK);
      \
  osalSysUnlockFromISR();                                                          \
}
```

Wakes up the waiting thread.

**Parameters**

| | | |
|---|---|---|
| in | *spip* | pointer to the SPIDriver object |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.47.3.13 #define _spi_isr_code( *spip* )

**Value:**

```
{                                                      \
  if ((spip)->config->end_cb) {                                                     \
    (spip)->state = SPI_COMPLETE;                                                   \
    (spip)->config->end_cb(spip);                                                   \
    if ((spip)->state == SPI_COMPLETE)                                              \
      (spip)->state = SPI_READY;                                                    \
  }                                                                                 \
  else                                                                              \
    (spip)->state = SPI_READY;
      \
  _spi_wakeup_isr(spip);                                                            \
}
```

Common ISR code.

This code handles the portable part of the ISR code:

- Callback invocation.
- Waiting thread wakeup, if any.
- Driver state transitions.

**Note**

This macro is meant to be used in the low level drivers implementation only.

**Parameters**

| | | |
|---|---|---|
| in | *spip* | pointer to the SPIDriver object |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.47.3.14 #define _spi_isr_code_half1( *spip* )

**Value:**

```
{                                          \
  if ((spip)->config->end_cb) {                                     \
    (spip)->config->end_cb(spip);                                   \
  }                                                                 \
}
```

Common ISR code in circular mode.

This code handles the portable part of the ISR code:

- Callback invocation.

**Note**

This macro is meant to be used in the low level drivers implementation only.

**Parameters**

| | | |
|---|---|---|
| in | *spip* | pointer to the SPIDriver object |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.47.3.15 #define _spi_isr_code_half2( *spip* )

**Value:**

```
{                                          \
  if ((spip)->config->end_cb) {                                     \
    (spip)->state = SPI_COMPLETE;                                   \
    (spip)->config->end_cb(spip);                                   \
    if ((spip)->state == SPI_COMPLETE)                              \
      (spip)->state = SPI_ACTIVE;                                   \
  }                                                                 \
}
```

Common ISR code in circular mode.

This code handles the portable part of the ISR code:

- Callback invocation.
- Driver state transitions.

**Note**

This macro is meant to be used in the low level drivers implementation only.

**Parameters**

| | | |
|---|---|---|
| in | *spip* | pointer to the SPIDriver object |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.47.3.16 #define SPI_SUPPORTS_CIRCULAR TRUE

Circular mode support flag.

#### 7.47.3.17 #define PLATFORM_SPI_USE_SPI1 FALSE

SPI1 driver enable switch.

If set to `TRUE` the support for SPI1 is included.

**Note**

The default is `FALSE`.

### 7.47.4 Typedef Documentation

#### 7.47.4.1 typedef struct SPIDriver SPIDriver

Type of a structure representing an SPI driver.

#### 7.47.4.2 typedef void(∗ spicallback_t) (SPIDriver ∗spip)

SPI notification callback type.

**Parameters**

| | | |
|---|---|---|
| in | *spip* | pointer to the `SPIDriver` object triggering the callback |

### 7.47.5 Enumeration Type Documentation

#### 7.47.5.1 enum spistate_t

Driver state machine possible states.

**Enumerator**

***SPI_UNINIT*** Not initialized.

***SPI_STOP*** Stopped.

***SPI_READY*** Ready.

***SPI_ACTIVE*** Exchanging data.

***SPI_COMPLETE*** Asynchronous operation complete.

### 7.47.6 Function Documentation

#### 7.47.6.1 void spiInit ( void )

SPI Driver initialization.

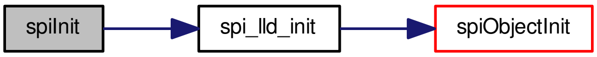
**Note**

This function is implicitly invoked by halInit(), there is no need to explicitly initialize the driver.

**Function Class:**

Initializer, this function just initializes an object and can be invoked before the kernel is initialized.

Here is the call graph for this function:



#### 7.47.6.2 void spiObjectInit ( SPIDriver * *spip* )

Initializes the standard part of a SPIDriver structure.

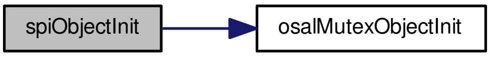
**Parameters**

| | | |
|---|---|---|
| out | *spip* | pointer to the SPIDriver object |

**Function Class:**

Initializer, this function just initializes an object and can be invoked before the kernel is initialized.

Here is the call graph for this function:



#### 7.47.6.3 void spiStart ( SPIDriver * *spip*, const SPIConfig * *config* )

Configures and activates the SPI peripheral.

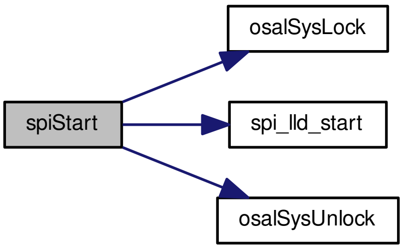
**Parameters**

| | | |
|---|---|---|
| in | *spip* | pointer to the SPIDriver object |
| in | *config* | pointer to the SPIConfig object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



### 7.47.6.4 void spiStop ( SPIDriver * *spip* )

Deactivates the SPI peripheral.

**Note**

Deactivating the peripheral also enforces a release of the slave select line.

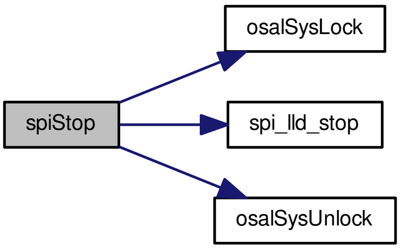
**Parameters**

| | | |
|---|---|---|
| in | *spip* | pointer to the `SPIDriver` object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.47.6.5 void spiSelect ( SPIDriver * *spip* )

Asserts the slave select signal and prepares for transfers.

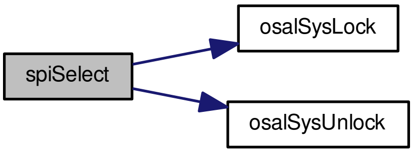
**Parameters**

| | | |
|---|---|---|
| in | *spip* | pointer to the SPIDriver object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.47.6.6 void spiUnselect ( SPIDriver * *spip* )

Deasserts the slave select signal.

The previously selected peripheral is unselected.

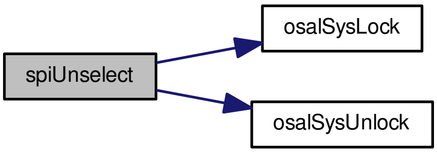
**Parameters**

| | | |
|---|---|---|
| in | *spip* | pointer to the SPIDriver object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.47.6.7 void spiStartIgnore ( SPIDriver ∗ *spip,* size_t *n* )

Ignores data on the SPI bus.

This asynchronous function starts the transmission of a series of idle words on the SPI bus and ignores the received data.

**Precondition**

A slave must have been selected using `spiSelect()` or `spiSelectI()`.

**Postcondition**

At the end of the operation the configured callback is invoked.

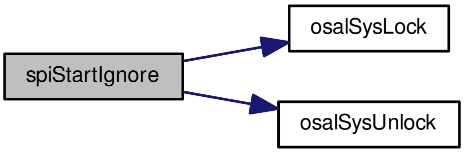
**Parameters**

| | | |
|---|---|---|
| `in` | *spip* | pointer to the `SPIDriver` object |
| `in` | *n* | number of words to be ignored |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.47.6.8 void spiStartExchange ( SPIDriver ∗ *spip,* size_t *n,* const void ∗ *txbuf,* void ∗ *rxbuf* )

Exchanges data on the SPI bus.

This asynchronous function starts a simultaneous transmit/receive operation.

**Precondition**

A slave must have been selected using `spiSelect()` or `spiSelectI()`.

**Postcondition**

At the end of the operation the configured callback is invoked.

**Note**

The buffers are organized as uint8_t arrays for data sizes below or equal to 8 bits else it is organized as uint16_t arrays.

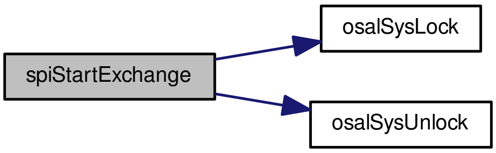
**Parameters**

| | | |
|---|---|---|
| in | *spip* | pointer to the SPIDriver object |
| in | *n* | number of words to be exchanged |
| in | *txbuf* | the pointer to the transmit buffer |
| out | *rxbuf* | the pointer to the receive buffer |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.47.6.9 void spiStartSend ( SPIDriver ∗ *spip,* size_t *n,* const void ∗ *txbuf* )

Sends data over the SPI bus.

This asynchronous function starts a transmit operation.

**Precondition**

A slave must have been selected using spiSelect() or spiSelectI().

**Postcondition**

At the end of the operation the configured callback is invoked.

**Note**

The buffers are organized as uint8_t arrays for data sizes below or equal to 8 bits else it is organized as uint16_t arrays.

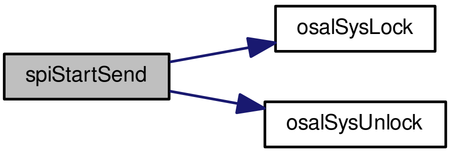
**Parameters**

| | | |
|---|---|---|
| in | *spip* | pointer to the SPIDriver object |
| in | *n* | number of words to send |
| in | *txbuf* | the pointer to the transmit buffer |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



### 7.47.6.10 void spiStartReceive ( SPIDriver ∗ *spip*, size_t *n*, void ∗ *rxbuf* )

Receives data from the SPI bus.

This asynchronous function starts a receive operation.

**Precondition**

A slave must have been selected using `spiSelect()` or `spiSelectI()`.

**Postcondition**

At the end of the operation the configured callback is invoked.

**Note**

The buffers are organized as uint8_t arrays for data sizes below or equal to 8 bits else it is organized as uint16_t arrays.

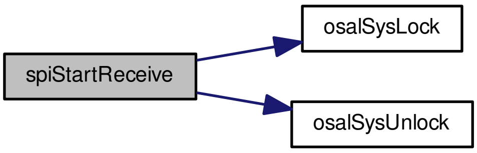
**Parameters**

| | | |
|---|---|---|
| `in` | *spip* | pointer to the `SPIDriver` object |
| `in` | *n* | number of words to receive |
| `out` | *rxbuf* | the pointer to the receive buffer |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



### 7.47.6.11 void spiAbortI ( SPIDriver * *spip* )

Aborts the ongoing SPI operation.

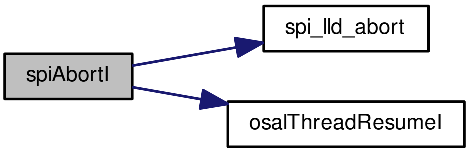
**Parameters**

| | | |
|---|---|---|
| in | *spip* | pointer to the SPIDriver object |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

Here is the call graph for this function:



### 7.47.6.12 void spiAbort ( SPIDriver * *spip* )

Aborts the ongoing SPI operation, if any.

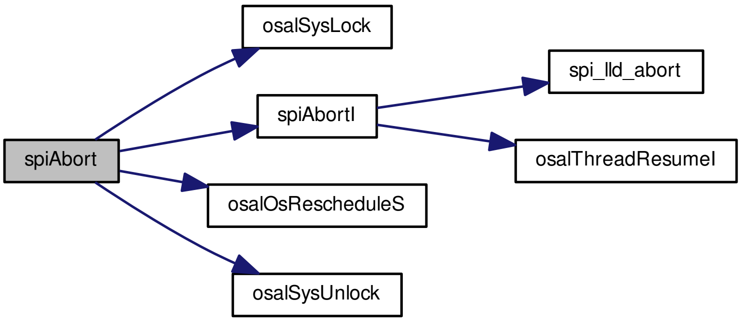
**Parameters**

| | | |
|---|---|---|
| in | *spip* | pointer to the SPIDriver object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



### 7.47.6.13 void spiIgnore ( SPIDriver ∗ *spip,* size_t *n* )

Ignores data on the SPI bus.

This synchronous function performs the transmission of a series of idle words on the SPI bus and ignores the received data.

**Precondition**

In order to use this function the option `SPI_USE_WAIT` must be enabled.
In order to use this function the driver must have been configured without callbacks (`end_cb` = `NULL`).

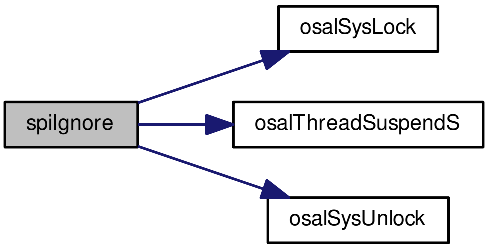
**Parameters**

| | | |
|---|---|---|
| `in` | *spip* | pointer to the `SPIDriver` object |
| `in` | *n* | number of words to be ignored |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



### 7.47.6.14 void spiExchange ( SPIDriver * *spip*, size_t *n*, const void * *txbuf*, void * *rxbuf* )

Exchanges data on the SPI bus.

This synchronous function performs a simultaneous transmit/receive operation.

**Precondition**

In order to use this function the option `SPI_USE_WAIT` must be enabled.
In order to use this function the driver must have been configured without callbacks (`end_cb` = `NULL`).

**Note**

The buffers are organized as uint8_t arrays for data sizes below or equal to 8 bits else it is organized as uint16_t arrays.

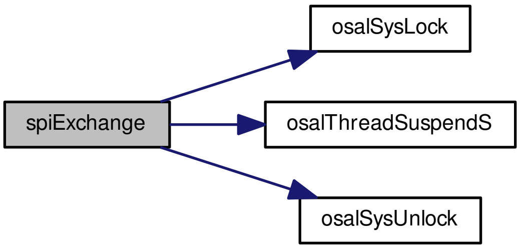
**Parameters**

| | | |
|---|---|---|
| in | *spip* | pointer to the `SPIDriver` object |
| in | *n* | number of words to be exchanged |
| in | *txbuf* | the pointer to the transmit buffer |
| out | *rxbuf* | the pointer to the receive buffer |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



### 7.47.6.15 void spiSend ( SPIDriver * *spip,* size_t *n,* const void * *txbuf* )

Sends data over the SPI bus.

This synchronous function performs a transmit operation.

**Precondition**

In order to use this function the option `SPI_USE_WAIT` must be enabled.
In order to use this function the driver must have been configured without callbacks (`end_cb` = `NULL`).

**Note**

The buffers are organized as uint8_t arrays for data sizes below or equal to 8 bits else it is organized as uint16_t arrays.

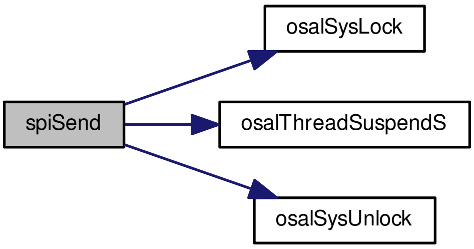
**Parameters**

| | | |
|---|---|---|
| in | *spip* | pointer to the `SPIDriver` object |
| in | *n* | number of words to send |
| in | *txbuf* | the pointer to the transmit buffer |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.47.6.16 void spiReceive ( SPIDriver * *spip*, size_t *n*, void * *rxbuf* )

Receives data from the SPI bus.

This synchronous function performs a receive operation.

**Precondition**

In order to use this function the option `SPI_USE_WAIT` must be enabled.
In order to use this function the driver must have been configured without callbacks (`end_cb` = `NULL`).

**Note**

The buffers are organized as uint8_t arrays for data sizes below or equal to 8 bits else it is organized as uint16_t arrays.

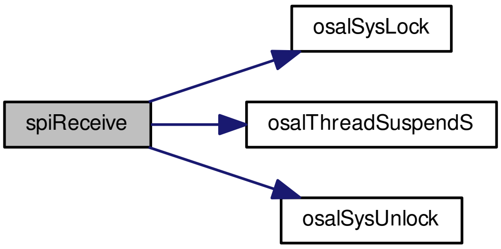
**Parameters**

| | | |
|---|---|---|
| `in` | *spip* | pointer to the `SPIDriver` object |
| `in` | *n* | number of words to receive |
| `out` | *rxbuf* | the pointer to the receive buffer |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.47.6.17 void spiAcquireBus ( SPIDriver * *spip* )

Gains exclusive access to the SPI bus.

This function tries to gain ownership to the SPI bus, if the bus is already being used then the invoking thread is queued.

**Precondition**

In order to use this function the option `SPI_USE_MUTUAL_EXCLUSION` must be enabled.

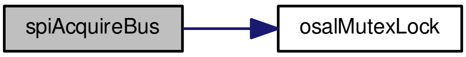
**Parameters**

| | | |
|---|---|---|
| in | *spip* | pointer to the `SPIDriver` object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.47.6.18 void spiReleaseBus ( SPIDriver * *spip* )

Releases exclusive access to the SPI bus.

**Precondition**

In order to use this function the option `SPI_USE_MUTUAL_EXCLUSION` must be enabled.

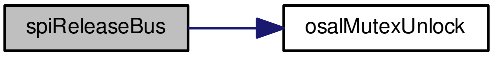
**Parameters**

| | | |
|---|---|---|
| in | *spip* | pointer to the `SPIDriver` object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



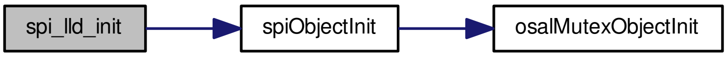
#### 7.47.6.19 void spi_lld_init ( void )

Low level SPI driver initialization.

**Function Class:**

Not an API, this function is for internal use only.

Here is the call graph for this function:



#### 7.47.6.20 void spi_lld_start ( SPIDriver * *spip* )

Configures and activates the SPI peripheral.

**Parameters**

| | | |
|---|---|---|
| in | *spip* | pointer to the `SPIDriver` object |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.47.6.21 void spi_lld_stop ( SPIDriver ∗ *spip* )

Deactivates the SPI peripheral.

**Parameters**

| | | |
|---|---|---|
| in | *spip* | pointer to the `SPIDriver` object |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.47.6.22 void spi_lld_select ( SPIDriver ∗ *spip* )

Asserts the slave select signal and prepares for transfers.

**Parameters**

| | | |
|---|---|---|
| in | *spip* | pointer to the `SPIDriver` object |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.47.6.23 void spi_lld_unselect ( SPIDriver ∗ *spip* )

Deasserts the slave select signal.

The previously selected peripheral is unselected.

**Parameters**

| | | |
|---|---|---|
| in | *spip* | pointer to the `SPIDriver` object |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.47.6.24 void spi_lld_ignore ( SPIDriver ∗ *spip,* size_t *n* )

Ignores data on the SPI bus.

This asynchronous function starts the transmission of a series of idle words on the SPI bus and ignores the received data.

**Postcondition**

At the end of the operation the configured callback is invoked.

**Parameters**

| | | |
|---|---|---|
| in | *spip* | pointer to the SPIDriver object |
| in | *n* | number of words to be ignored |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.47.6.25 void spi_lld_exchange ( SPIDriver ∗ *spip,* size_t *n,* const void ∗ *txbuf,* void ∗ *rxbuf* )

Exchanges data on the SPI bus.

This asynchronous function starts a simultaneous transmit/receive operation.

**Postcondition**

At the end of the operation the configured callback is invoked.

**Note**

The buffers are organized as uint8_t arrays for data sizes below or equal to 8 bits else it is organized as uint16_t arrays.

**Parameters**

| | | |
|---|---|---|
| in | *spip* | pointer to the SPIDriver object |
| in | *n* | number of words to be exchanged |
| in | *txbuf* | the pointer to the transmit buffer |
| out | *rxbuf* | the pointer to the receive buffer |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.47.6.26 void spi_lld_send ( SPIDriver ∗ *spip,* size_t *n,* const void ∗ *txbuf* )

Sends data over the SPI bus.

This asynchronous function starts a transmit operation.

**Postcondition**

At the end of the operation the configured callback is invoked.

**Note**

The buffers are organized as uint8_t arrays for data sizes below or equal to 8 bits else it is organized as uint16_t arrays.

**Parameters**

| | | |
|---|---|---|
| in | *spip* | pointer to the SPIDriver object |
| in | *n* | number of words to send |
| in | *txbuf* | the pointer to the transmit buffer |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.47.6.27 void spi_lld_receive ( SPIDriver * *spip*, size_t *n*, void * *rxbuf* )

Receives data from the SPI bus.

This asynchronous function starts a receive operation.

**Postcondition**

At the end of the operation the configured callback is invoked.

**Note**

The buffers are organized as uint8_t arrays for data sizes below or equal to 8 bits else it is organized as uint16_t arrays.

**Parameters**

| | | |
|---|---|---|
| in | *spip* | pointer to the SPIDriver object |
| in | *n* | number of words to receive |
| out | *rxbuf* | the pointer to the receive buffer |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.47.6.28 void spi_lld_abort ( SPIDriver * *spip* )

Aborts the ongoing SPI operation, if any.

**Parameters**

| | | |
|---|---|---|
| in | *spip* | pointer to the SPIDriver object |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.47.6.29 uint16_t spi_lld_polled_exchange ( SPIDriver * *spip*, uint16_t *frame* )

Exchanges one frame using a polled wait.

This synchronous function exchanges one frame using a polled synchronization method. This function is useful when exchanging small amount of data on high speed channels, usually in this situation is much more efficient just wait for completion using polling than suspending the thread waiting for an interrupt.

**Parameters**

| | | |
|---|---|---|
| in | *spip* | pointer to the SPIDriver object |
| in | *frame* | the data frame to send over the SPI bus |

**Returns**

The received data frame from the SPI bus.

**Function Class:**

Not an API, this function is for internal use only.

## 7.47.7 Variable Documentation

### 7.47.7.1 SPIDriver SPID1

SPI1 driver identifier.

## 7.48 ST Driver

Generic System Tick Driver.

### 7.48.1 Detailed Description

Generic System Tick Driver.

This module implements a system tick timer in order to support the underlying operating system.

#### Macro Functions

- #define stGetCounter() st_lld_get_counter()

  *Returns the time counter value.*
- #define stIsAlarmActive() st_lld_is_alarm_active()

  *Determines if the alarm is active.*

#### Functions

- void stInit (void)

  *ST Driver initialization.*
- void stStartAlarm (systime_t abstime)

  *Starts the alarm.*
- void stStopAlarm (void)

  *Stops the alarm interrupt.*
- void stSetAlarm (systime_t abstime)

  *Sets the alarm time.*
- systime_t stGetAlarm (void)

  *Returns the current alarm time.*
- void st_lld_init (void)

  *Low level ST driver initialization.*
- static systime_t st_lld_get_counter (void)

  *Returns the time counter value.*
- static void st_lld_start_alarm (systime_t abstime)

  *Starts the alarm.*
- static void st_lld_stop_alarm (void)

  *Stops the alarm interrupt.*
- static void st_lld_set_alarm (systime_t abstime)

  *Sets the alarm time.*
- static systime_t st_lld_get_alarm (void)

  *Returns the current alarm time.*
- static bool st_lld_is_alarm_active (void)

  *Determines if the alarm is active.*

### 7.48.2 Macro Definition Documentation

#### 7.48.2.1 #define stGetCounter( ) st_lld_get_counter()

Returns the time counter value.

**Note**

This functionality is only available in free running mode, the behaviour in periodic mode is undefined.

**Returns**

The counter value.

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.48.2.2 #define stIsAlarmActive( ) st_lld_is_alarm_active()

Determines if the alarm is active.

**Returns**

The alarm status.

**Return values**

| | |
|---|---|
| *false* | if the alarm is not active. |
| *true* | is the alarm is active |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

### 7.48.3 Function Documentation

#### 7.48.3.1 void stInit ( void )

ST Driver initialization.

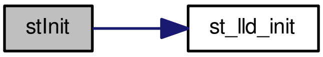
**Note**

This function is implicitly invoked by `halInit()`, there is no need to explicitly initialize the driver.

**Function Class:**

Initializer, this function just initializes an object and can be invoked before the kernel is initialized.

Here is the call graph for this function:



#### 7.48.3.2 void stStartAlarm ( systime_t *abstime* )

Starts the alarm.

**Note**

Makes sure that no spurious alarms are triggered after this call.
This functionality is only available in free running mode, the behavior in periodic mode is undefined.

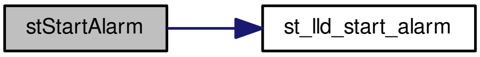
**Parameters**

| | | |
|---|---|---|
| in | *abstime* | the time to be set for the first alarm |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.48.3.3 void stStopAlarm ( void )

Stops the alarm interrupt.

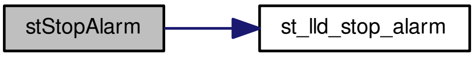
**Note**

This functionality is only available in free running mode, the behavior in periodic mode is undefined.

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.48.3.4 void stSetAlarm ( systime_t *abstime* )

Sets the alarm time.

**Note**

This functionality is only available in free running mode, the behavior in periodic mode is undefined.

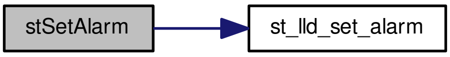
**Parameters**

| | | |
|---|---|---|
| in | *abstime* | the time to be set for the next alarm |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.48.3.5 systime_t stGetAlarm ( void )

Returns the current alarm time.

**Note**

This functionality is only available in free running mode, the behavior in periodic mode is undefined.

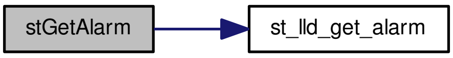
**Returns**

The currently set alarm time.

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.48.3.6 void st_lld_init ( void )

Low level ST driver initialization.

**Function Class:**

Not an API, this function is for internal use only.

#### 7.48.3.7 static systime_t st_lld_get_counter ( void ) [inline], [static]

Returns the time counter value.

**Returns**

The counter value.

**Function Class:**

Not an API, this function is for internal use only.

#### 7.48.3.8 static void st_lld_start_alarm ( systime_t *abstime* ) [inline], [static]

Starts the alarm.

**Note**

Makes sure that no spurious alarms are triggered after this call.

**Parameters**

| | | |
|---|---|---|
| in | *abstime* | the time to be set for the first alarm |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.48.3.9 static void st_lld_stop_alarm ( void ) [inline], [static]

Stops the alarm interrupt.

**Function Class:**

Not an API, this function is for internal use only.

#### 7.48.3.10 static void st_lld_set_alarm ( systime_t *abstime* ) [inline], [static]

Sets the alarm time.

**Parameters**

| | | |
|---|---|---|
| in | *abstime* | the time to be set for the next alarm |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.48.3.11 static systime_t st_lld_get_alarm ( void ) [inline], [static]

Returns the current alarm time.

**Returns**

The currently set alarm time.

**Function Class:**

Not an API, this function is for internal use only.

#### 7.48.3.12 static bool st_lld_is_alarm_active ( void ) [inline], [static]

Determines if the alarm is active.

**Returns**

The alarm status.

**Return values**

| | |
|---|---|
| *false* | if the alarm is not active. |
| *true* | is the alarm is active |

**Function Class:**

Not an API, this function is for internal use only.

## 7.49 Generic Thermometer Interface

HAL Generic Thermometer Interface.

### 7.49.1 Detailed Description

HAL Generic Thermometer Interface.

#### Macros

- #define _base_thermometer_methods_alone

  *BaseThermometer specific methods.*
- #define _base_thermometer_methods

  *BaseThermometer specific methods with inherited ones.*
- #define _base_thermometer_data _base_sensor_data

  *`BaseThermometer` specific data.*

#### Macro Functions (BaseThermometer)

- #define thermometerGetChannelsNumber(ip) (ip)->vmt->get_channels_number(ip)

  *Thermometer get channels number.*
- #define thermometerReadRaw(ip, dp) (ip)->vmt->read_raw(ip, dp)

  *Thermometer read raw data.*
- #define thermometerReadCooked(ip, dp) (ip)->vmt->read_cooked(ip, dp)

  *Thermometer read cooked data.*
- #define thermometerSetBias(ip, bp) (ip)->vmt->set_bias(ip, bp)

  *Updates thermometer bias data from received buffer.*
- #define thermometerResetBias(ip) (ip)->vmt->reset_bias(ip)

  *Reset thermometer bias data restoring it to zero.*
- #define thermometerSetSensitivity(ip, sp) (ip)->vmt->set_sensitivity(ip, sp)

  *Updates thermometer sensitivity data from received buffer.*
- #define thermometerResetSensitivity(ip) (ip)->vmt->reset_sensitivity(ip)

  *Reset thermometer sensitivity data restoring it to its typical value.*

#### Data Structures

- struct BaseThermometerVMT

  *`BaseThermometer` virtual methods table.*
- struct BaseThermometer

  *Base thermometer class.*

### 7.49.2 Macro Definition Documentation

#### 7.49.2.1 #define _base_thermometer_methods_alone

**Value:**

```
/* Invoke the set bias procedure.*/                                  \
  msg_t (*set_bias)(void *instance, float biases[]);                  \
  /* Remove bias stored data.*/                                       \
  msg_t (*reset_bias)(void *instance);                                \
  /* Invoke the set sensitivity procedure.*/                          \
  msg_t (*set_sensitivity)(void *instance, float sensitivities[]);    \
  /* Restore sensitivity stored data to default.*/                    \
  msg_t (*reset_sensitivity)(void *instance);
```

BaseThermometer specific methods.

#### 7.49.2.2 #define _base_thermometer_methods

**Value:**

```
_base_sensor_methods                                                 \
  _base_thermometer_methods_alone
```

BaseThermometer specific methods with inherited ones.

#### 7.49.2.3 #define _base_thermometer_data _base_sensor_data

BaseThermometer specific data.

#### 7.49.2.4 #define thermometerGetChannelsNumber( *ip* ) (ip)->vmt->get_channels_number(ip)

Thermometer get channels number.

**Parameters**

| | | |
|---|---|---|
| in | *ip* | pointer to a BaseThermometer class. |

**Returns**

The number of channels of the BaseThermometer

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.49.2.5 #define thermometerReadRaw( *ip*, *dp* ) (ip)->vmt->read_raw(ip, dp)

Thermometer read raw data.

**Parameters**

| | | |
|---|---|---|
| in | *ip* | pointer to a BaseThermometer class. |
| in | *dp* | pointer to a data array. |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *MSG_OK* | if the function succeeded. |
| *MSG_RESET* | if one or more errors occurred. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.49.2.6 #define thermometerReadCooked( *ip,* *dp* ) (ip)->vmt->read_cooked(ip, dp)

Thermometer read cooked data.

**Parameters**

| | | |
|---|---|---|
| in | *ip* | pointer to a BaseThermometer class. |
| in | *dp* | pointer to a data array. |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *MSG_OK* | if the function succeeded. |
| *MSG_RESET* | if one or more errors occurred. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.49.2.7 #define thermometerSetBias( *ip,* *bp* ) (ip)->vmt->set_bias(ip, bp)

Updates thermometer bias data from received buffer.

**Note**

The bias buffer must have the same length of the the thermometer channels number.

**Parameters**

| | | |
|---|---|---|
| in | *ip* | pointer to a BaseThermometer class. |
| in | *bp* | pointer to a buffer of bias values. |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *MSG_OK* | if the function succeeded. |
| *MSG_RESET* | if one or more errors occurred. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.49.2.8 #define thermometerResetBias( *ip* ) (ip)->vmt->reset_bias(ip)

Reset thermometer bias data restoring it to zero.

**Parameters**

| | | |
|---|---|---|
| `in` | *ip* | pointer to a `BaseThermometer` class. |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *MSG_OK* | if the function succeeded. |
| *MSG_RESET* | if one or more errors occurred. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.49.2.9 #define thermometerSetSensitivity( *ip, sp* ) (ip)->vmt->set_sensitivity(ip, sp)

Updates thermometer sensitivity data from received buffer.

**Note**

The sensitivity buffer must have the same length of the the thermometer channels number.

**Parameters**

| | | |
|---|---|---|
| `in` | *ip* | pointer to a `BaseThermometer` class. |
| `in` | *sp* | pointer to a buffer of sensitivity values. |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *MSG_OK* | if the function succeeded. |
| *MSG_RESET* | if one or more errors occurred. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.49.2.10 #define thermometerResetSensitivity( *ip* ) (ip)->vmt->reset_sensitivity(ip)

Reset thermometer sensitivity data restoring it to its typical value.

**Parameters**

| | | |
|---|---|---|
| in | *ip* | pointer to a `BaseThermometer` class. |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *MSG_OK* | if the function succeeded. |
| *MSG_RESET* | if one or more errors occurred. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

## 7.50 UART Driver

Generic UART Driver.

### 7.50.1 Detailed Description

Generic UART Driver.

This driver abstracts a generic UART (Universal Asynchronous Receiver Transmitter) peripheral, the API is designed to be:

- Unbuffered and copy-less, transfers are always directly performed from/to the application-level buffers without extra copy operations.
- Asynchronous, the API is always non blocking.
- Callbacks capable, operations completion and other events are notified using callbacks.

Special hardware features like deep hardware buffers, DMA transfers are hidden to the user but fully supportable by the low level implementations.
This driver model is best used where communication events are meant to drive an higher level state machine, as example:

- RS485 drivers.
- Multipoint network drivers.
- Serial protocol decoders.

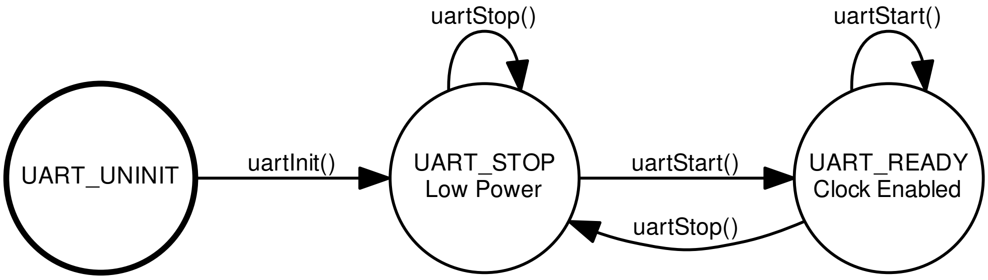
If your application requires a synchronous buffered driver then the Serial Driver should be used instead.

**Precondition**

In order to use the UART driver the `HAL_USE_UART` option must be enabled in `halconf.h`.

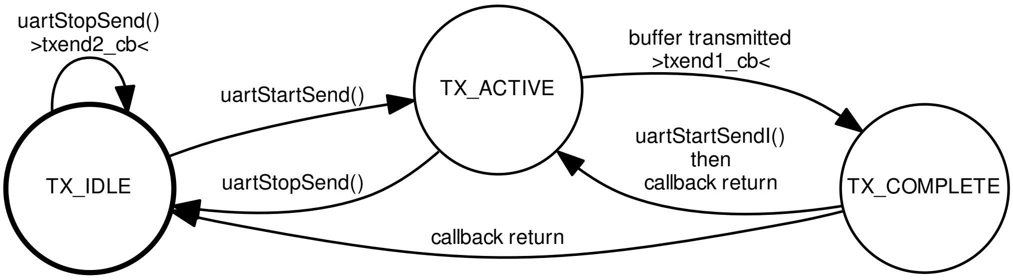
### 7.50.2 Driver State Machine

The driver implements a state machine internally, not all the driver functionalities can be used in any moment, any transition not explicitly shown in the following diagram has to be considered an error and shall be captured by an assertion (if enabled).



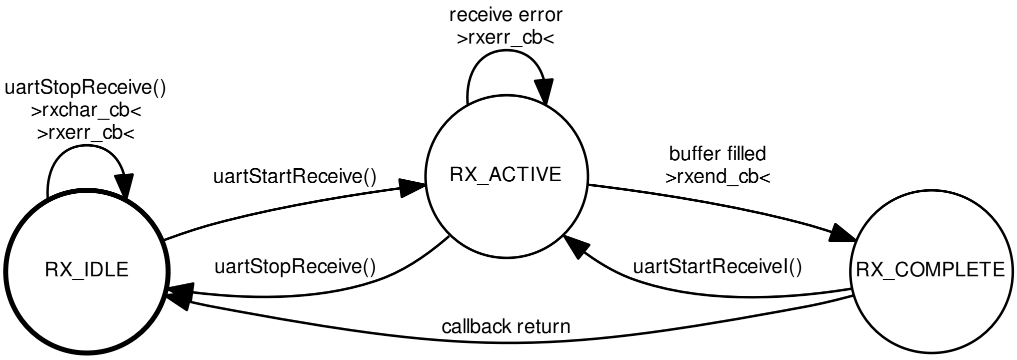
#### 7.50.2.1 Transmitter sub State Machine

The follow diagram describes the transmitter state machine, this diagram is valid while the driver is in the UART_READY state. This state machine is automatically reset to the TX_IDLE state each time the driver enters the UART_READY state.



#### 7.50.2.2 Receiver sub State Machine

The follow diagram describes the receiver state machine, this diagram is valid while the driver is in the UART_READY state. This state machine is automatically reset to the RX_IDLE state each time the driver enters the UART_READY state.



## UART status flags

- #define UART_NO_ERROR 0

  *No pending conditions.*
- #define UART_PARITY_ERROR 4

  *Parity error happened.*
- #define UART_FRAMING_ERROR 8

*Framing error happened.*

- #define UART_OVERRUN_ERROR 16

  *Overflow happened.*
- #define UART_NOISE_ERROR 32

  *Noise on the line.*
- #define UART_BREAK_DETECTED 64

  *Break detected.*

### UART error conditions

- #define **UART_ERR_NOT_ACTIVE** (size_t)-1

### UART configuration options

- #define UART_USE_WAIT FALSE

  *Enables synchronous APIs.*
- #define UART_USE_MUTUAL_EXCLUSION FALSE

  *Enables the `uartAcquireBus()` and `uartReleaseBus()` APIs.*

### Low level driver helper macros

- #define _uart_wakeup_tx1_isr(uartp)

  *Wakes up the waiting thread in case of early TX complete.*
- #define _uart_wakeup_tx2_isr(uartp)

  *Wakes up the waiting thread in case of late TX complete.*
- #define _uart_wakeup_rx_complete_isr(uartp)

  *Wakes up the waiting thread in case of RX complete.*
- #define _uart_wakeup_rx_error_isr(uartp)

  *Wakes up the waiting thread in case of RX error.*
- #define _uart_wakeup_rx_timeout_isr(uartp)

  *Wakes up the waiting thread in case of RX timeout.*
- #define _uart_tx1_isr_code(uartp)

  *Common ISR code for early TX.*
- #define _uart_tx2_isr_code(uartp)

  *Common ISR code for late TX.*
- #define _uart_rx_complete_isr_code(uartp)

  *Common ISR code for RX complete.*
- #define _uart_rx_error_isr_code(uartp, errors)

  *Common ISR code for RX error.*
- #define _uart_rx_idle_code(uartp)

  *Common ISR code for RX on idle.*
- #define _uart_timeout_isr_code(uartp)

  *Timeout ISR code for receiver.*

### PLATFORM configuration options

- #define PLATFORM_UART_USE_UART1 FALSE

  *UART driver enable switch.*

## Typedefs

- typedef uint32_t uartflags_t

  *UART driver condition flags type.*
- typedef struct UARTDriver UARTDriver

  *Type of structure representing an UART driver.*
- typedef void(∗ uartcb_t) (UARTDriver ∗uartp)

  *Generic UART notification callback type.*
- typedef void(∗ uartccb_t) (UARTDriver ∗uartp, uint16_t c)

  *Character received UART notification callback type.*
- typedef void(∗ uartecb_t) (UARTDriver ∗uartp, uartflags_t e)

  *Receive error UART notification callback type.*

## Data Structures

- struct UARTConfig

  *Driver configuration structure.*
- struct UARTDriver

  *Structure representing an UART driver.*

## Functions

- void uartInit (void)

  *UART Driver initialization.*
- void uartObjectInit (UARTDriver ∗uartp)

  *Initializes the standard part of a `UARTDriver` structure.*
- void uartStart (UARTDriver ∗uartp, const UARTConfig ∗config)

  *Configures and activates the UART peripheral.*
- void uartStop (UARTDriver ∗uartp)

  *Deactivates the UART peripheral.*
- void uartStartSend (UARTDriver ∗uartp, size_t n, const void ∗txbuf)

  *Starts a transmission on the UART peripheral.*
- void uartStartSendI (UARTDriver ∗uartp, size_t n, const void ∗txbuf)

  *Starts a transmission on the UART peripheral.*
- size_t uartStopSend (UARTDriver ∗uartp)

  *Stops any ongoing transmission.*
- size_t uartStopSendI (UARTDriver ∗uartp)

  *Stops any ongoing transmission.*
- void uartStartReceive (UARTDriver ∗uartp, size_t n, void ∗rxbuf)

  *Starts a receive operation on the UART peripheral.*
- void uartStartReceiveI (UARTDriver ∗uartp, size_t n, void ∗rxbuf)

  *Starts a receive operation on the UART peripheral.*
- size_t uartStopReceive (UARTDriver ∗uartp)

  *Stops any ongoing receive operation.*
- size_t uartStopReceiveI (UARTDriver ∗uartp)

  *Stops any ongoing receive operation.*
- msg_t uartSendTimeout (UARTDriver ∗uartp, size_t ∗np, const void ∗txbuf, sysinterval_t timeout)

  *Performs a transmission on the UART peripheral.*
- msg_t uartSendFullTimeout (UARTDriver ∗uartp, size_t ∗np, const void ∗txbuf, sysinterval_t timeout)

  *Performs a transmission on the UART peripheral.*

- msg_t uartReceiveTimeout (UARTDriver ∗uartp, size_t ∗np, void ∗rxbuf, sysinterval_t timeout)

    *Performs a receive operation on the UART peripheral.*
- void uartAcquireBus (UARTDriver ∗uartp)

    *Gains exclusive access to the UART bus.*
- void uartReleaseBus (UARTDriver ∗uartp)

    *Releases exclusive access to the UART bus.*
- void uart_lld_init (void)

    *Low level UART driver initialization.*
- void uart_lld_start (UARTDriver ∗uartp)

    *Configures and activates the UART peripheral.*
- void uart_lld_stop (UARTDriver ∗uartp)

    *Deactivates the UART peripheral.*
- void uart_lld_start_send (UARTDriver ∗uartp, size_t n, const void ∗txbuf)

    *Starts a transmission on the UART peripheral.*
- size_t uart_lld_stop_send (UARTDriver ∗uartp)

    *Stops any ongoing transmission.*
- void uart_lld_start_receive (UARTDriver ∗uartp, size_t n, void ∗rxbuf)

    *Starts a receive operation on the UART peripheral.*
- size_t uart_lld_stop_receive (UARTDriver ∗uartp)

    *Stops any ongoing receive operation.*

### Enumerations

### Variables

- UARTDriver UARTD1

    *UART1 driver identifier.*

## 7.50.3 Macro Definition Documentation

### 7.50.3.1 #define UART_NO_ERROR 0

No pending conditions.

### 7.50.3.2 #define UART_PARITY_ERROR 4

Parity error happened.

### 7.50.3.3 #define UART_FRAMING_ERROR 8

Framing error happened.

### 7.50.3.4 #define UART_OVERRUN_ERROR 16

Overflow happened.

### 7.50.3.5 #define UART_NOISE_ERROR 32

Noise on the line.

#### 7.50.3.6 #define UART_BREAK_DETECTED 64

Break detected.

#### 7.50.3.7 #define UART_USE_WAIT FALSE

Enables synchronous APIs.

**Note**

Disabling this option saves both code and data space.

#### 7.50.3.8 #define UART_USE_MUTUAL_EXCLUSION FALSE

Enables the `uartAcquireBus()` and `uartReleaseBus()` APIs.

**Note**

Disabling this option saves both code and data space.

#### 7.50.3.9 #define _uart_wakeup_tx1_isr( *uartp* )

**Value:**

```
{                                       \
  if ((uartp)->early == true) {                                             \
    osalSysLockFromISR();
      \
    osalThreadResumeI(&(uartp)->threadtx, MSG_OK);
      \
    osalSysUnlockFromISR();                                                 \
  }                                                                         \
}
```

Wakes up the waiting thread in case of early TX complete.

**Parameters**

| | | |
|---|---|---|
| in | *uartp* | pointer to the `UARTDriver` object |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.50.3.10 #define _uart_wakeup_tx2_isr( *uartp* )

**Value:**

```
{                                       \
  if ((uartp)->early == false) {                                            \
    osalSysLockFromISR();
      \
    osalThreadResumeI(&(uartp)->threadtx, MSG_OK);
      \
    osalSysUnlockFromISR();                                                 \
  }                                                                         \
}
```

Wakes up the waiting thread in case of late TX complete.

**Parameters**

| | | |
|---|---|---|
| in | *uartp* | pointer to the UARTDriver object |

**Function Class:**

Not an API, this function is for internal use only.

### 7.50.3.11 #define _uart_wakeup_rx_complete_isr( *uartp* )

**Value:**

```
{                                \
  osalSysLockFromISR();
      \
  osalThreadResumeI(&(uartp)->threadrx, MSG_OK);
      \
  osalSysUnlockFromISR();                                          \
}
```

Wakes up the waiting thread in case of RX complete.

**Parameters**

| | | |
|---|---|---|
| in | *uartp* | pointer to the UARTDriver object |

**Function Class:**

Not an API, this function is for internal use only.

### 7.50.3.12 #define _uart_wakeup_rx_error_isr( *uartp* )

**Value:**

```
{                                   \
  osalSysLockFromISR();
      \
  osalThreadResumeI(&(uartp)->threadrx, MSG_RESET);
      \
  osalSysUnlockFromISR();                                          \
}
```

Wakes up the waiting thread in case of RX error.

**Parameters**

| | | |
|---|---|---|
| in | *uartp* | pointer to the UARTDriver object |

**Function Class:**

Not an API, this function is for internal use only.

### 7.50.3.13 #define _uart_wakeup_rx_timeout_isr( *uartp* )

**Value:**

```
{                                   \
  osalSysLockFromISR();
      \
  osalThreadResumeI(&(uartp)->threadrx, MSG_TIMEOUT);
      \
  osalSysUnlockFromISR();                                                     \
}
```

Wakes up the waiting thread in case of RX timeout.

**Parameters**

| | | |
|---|---|---|
| in | *uartp* | pointer to the UARTDriver object |

**Function Class:**

Not an API, this function is for internal use only.

### 7.50.3.14 #define _uart_tx1_isr_code( *uartp* )

**Value:**

```
{                                             \
  (uartp)->txstate = UART_TX_COMPLETE;                                        \
  if ((uartp)->config->txend1_cb != NULL) {                                   \
    (uartp)->config->txend1_cb(uartp);                                        \
  }                                                                           \
  if ((uartp)->txstate == UART_TX_COMPLETE) {                                 \
    (uartp)->txstate = UART_TX_IDLE;                                          \
  }                                                                           \
  _uart_wakeup_tx1_isr(uartp);                                                \
}
```

Common ISR code for early TX.

This code handles the portable part of the ISR code:

- Callback invocation.
- Waiting thread wakeup, if any.
- Driver state transitions.

**Note**

This macro is meant to be used in the low level drivers implementation only.

**Parameters**

| | | |
|---|---|---|
| in | *uartp* | pointer to the UARTDriver object |

**Function Class:**

Not an API, this function is for internal use only.

### 7.50.3.15 #define _uart_tx2_isr_code( *uartp* )

**Value:**

```
{                                          \
  if ((uartp)->config->txend2_cb != NULL) {                                \
    (uartp)->config->txend2_cb(uartp);                                     \
  }                                                                        \
  _uart_wakeup_tx2_isr(uartp);                                             \
}
```

Common ISR code for late TX.

This code handles the portable part of the ISR code:

- Callback invocation.
- Waiting thread wakeup, if any.
- Driver state transitions.

**Note**

This macro is meant to be used in the low level drivers implementation only.

**Parameters**

| | | |
|---|---|---|
| in | *uartp* | pointer to the UARTDriver object |

**Function Class:**

Not an API, this function is for internal use only.

### 7.50.3.16 #define _uart_rx_complete_isr_code( *uartp* )

**Value:**

```
{                                  \
  (uartp)->rxstate = UART_RX_COMPLETE;                                     \
  if ((uartp)->config->rxend_cb != NULL) {                                 \
    (uartp)->config->rxend_cb(uartp);                                      \
  }                                                                        \
  if ((uartp)->rxstate == UART_RX_COMPLETE) {                              \
    (uartp)->rxstate = UART_RX_IDLE;                                       \
    uart_enter_rx_idle_loop(uartp);                                        \
  }                                                                        \
  _uart_wakeup_rx_complete_isr(uartp);                                     \
}
```

Common ISR code for RX complete.

This code handles the portable part of the ISR code:

- Callback invocation.
- Waiting thread wakeup, if any.
- Driver state transitions.

**Note**

This macro is meant to be used in the low level drivers implementation only.

**Parameters**

| | | |
|---|---|---|
| in | *uartp* | pointer to the UARTDriver object |

**Function Class:**

Not an API, this function is for internal use only.

### 7.50.3.17 #define _uart_rx_error_isr_code( *uartp, errors* )

**Value:**

```
{                            \
  if ((uartp)->config->rxerr_cb != NULL) {                                  \
    (uartp)->config->rxerr_cb(uartp, errors);                               \
  }                                                                         \
  _uart_wakeup_rx_error_isr(uartp);                                         \
}
```

Common ISR code for RX error.

This code handles the portable part of the ISR code:

- Callback invocation.
- Waiting thread wakeup, if any.
- Driver state transitions.

**Note**

This macro is meant to be used in the low level drivers implementation only.

**Parameters**

| | | |
|---|---|---|
| in | *uartp* | pointer to the UARTDriver object |
| in | *errors* | mask of errors to be reported |

**Function Class:**

Not an API, this function is for internal use only.

### 7.50.3.18 #define _uart_rx_idle_code( *uartp* )

**Value:**

```
{                                         \
  if ((uartp)->config->rxchar_cb != NULL)                                   \
    (uartp)->config->rxchar_cb(uartp, (uartp)->rxbuf);                      \
}
```

Common ISR code for RX on idle.

This code handles the portable part of the ISR code:

- Callback invocation.

- Waiting thread wakeup, if any.
- Driver state transitions.

**Note**

This macro is meant to be used in the low level drivers implementation only.

**Parameters**

| | | |
|---|---|---|
| in | *uartp* | pointer to the UARTDriver object |

**Function Class:**

Not an API, this function is for internal use only.

### 7.50.3.19 #define _uart_timeout_isr_code( *uartp* )

**Value:**

```
{                                     \
  if ((uartp)->config->timeout_cb != NULL) {                                \
    (uartp)->config->timeout_cb(uartp);                                     \
  }                                                                         \
  _uart_wakeup_rx_timeout_isr(uartp);                                       \
}
```

Timeout ISR code for receiver.

This code handles the portable part of the ISR code:

- Callback invocation.
- Waiting thread wakeup, if any.
- Driver state transitions.

**Note**

This macro is meant to be used in the low level drivers implementation only.

**Parameters**

| | | |
|---|---|---|
| in | *uartp* | pointer to the UARTDriver object |

**Function Class:**

Not an API, this function is for internal use only.

### 7.50.3.20 #define PLATFORM_UART_USE_UART1 FALSE

UART driver enable switch.

If set to TRUE the support for UART1 is included.

Note

The default is FALSE.

## 7.50.4 Typedef Documentation

### 7.50.4.1 typedef uint32_t **uartflags_t**

UART driver condition flags type.

### 7.50.4.2 typedef struct **UARTDriver UARTDriver**

Type of structure representing an UART driver.

### 7.50.4.3 typedef void(∗ uartcb_t) (**UARTDriver** ∗uartp)

Generic UART notification callback type.

Parameters

| | | |
|---|---|---|
| in | *uartp* | pointer to the UARTDriver object |

### 7.50.4.4 typedef void(∗ uartccb_t) (**UARTDriver** ∗uartp, uint16_t c)

Character received UART notification callback type.

Parameters

| | | |
|---|---|---|
| in | *uartp* | pointer to the UARTDriver object triggering the callback |
| in | *c* | received character |

### 7.50.4.5 typedef void(∗ uartecb_t) (**UARTDriver** ∗uartp, **uartflags_t** e)

Receive error UART notification callback type.

Parameters

| | | |
|---|---|---|
| in | *uartp* | pointer to the UARTDriver object triggering the callback |
| in | *e* | receive error mask |

## 7.50.5 Enumeration Type Documentation

### 7.50.5.1 enum **uartstate_t**

Driver state machine possible states.

Enumerator

***UART_UNINIT*** Not initialized.

***UART_STOP*** Stopped.

***UART_READY*** Ready.

#### 7.50.5.2 enum uarttxstate_t

Transmitter state machine states.

**Enumerator**

***UART_TX_IDLE*** Not transmitting.

***UART_TX_ACTIVE*** Transmitting.

***UART_TX_COMPLETE*** Buffer complete.

#### 7.50.5.3 enum uartrxstate_t

Receiver state machine states.

**Enumerator**

***UART_RX_IDLE*** Not receiving.

***UART_RX_ACTIVE*** Receiving.

***UART_RX_COMPLETE*** Buffer complete.

### 7.50.6 Function Documentation

#### 7.50.6.1 void uartInit ( void )

UART Driver initialization.

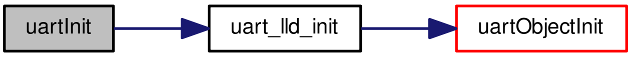
**Note**

This function is implicitly invoked by `halInit()`, there is no need to explicitly initialize the driver.

**Function Class:**

Initializer, this function just initializes an object and can be invoked before the kernel is initialized.

Here is the call graph for this function:



#### 7.50.6.2 void uartObjectInit ( UARTDriver * *uartp* )

Initializes the standard part of a `UARTDriver` structure.

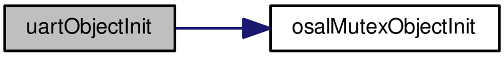
**Parameters**

| | | |
|---|---|---|
| out | *uartp* | pointer to the UARTDriver object |

**Function Class:**

Initializer, this function just initializes an object and can be invoked before the kernel is initialized.

Here is the call graph for this function:



#### 7.50.6.3 void uartStart ( UARTDriver ∗ *uartp*, const UARTConfig ∗ *config* )

Configures and activates the UART peripheral.

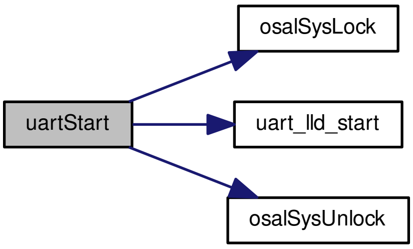
**Parameters**

| | | |
|---|---|---|
| in | *uartp* | pointer to the UARTDriver object |
| in | *config* | pointer to the UARTConfig object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.50.6.4 void uartStop ( UARTDriver ∗ *uartp* )

Deactivates the UART peripheral.

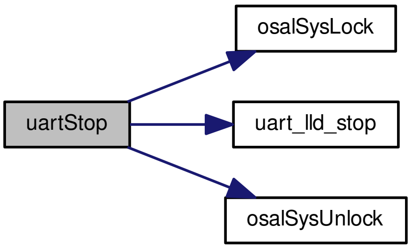
**Parameters**

| | | |
|---|---|---|
| `in` | *uartp* | pointer to the `UARTDriver` object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.50.6.5 void uartStartSend ( UARTDriver ∗ *uartp,* size_t *n,* const void ∗ *txbuf* )

Starts a transmission on the UART peripheral.

**Note**

The buffers are organized as uint8_t arrays for data sizes below or equal to 8 bits else it is organized as uint16_t arrays.

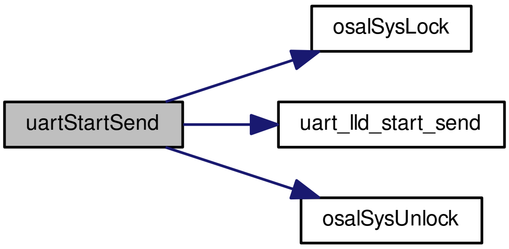
**Parameters**

| | | |
|---|---|---|
| `in` | *uartp* | pointer to the `UARTDriver` object |
| `in` | *n* | number of data frames to send |
| `in` | *txbuf* | the pointer to the transmit buffer |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.50.6.6 void uartStartSendI ( UARTDriver * *uartp*, size_t *n*, const void * *txbuf* )

Starts a transmission on the UART peripheral.

**Note**

The buffers are organized as uint8_t arrays for data sizes below or equal to 8 bits else it is organized as uint16_t arrays.
This function has to be invoked from a lock zone.

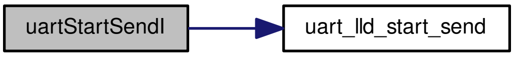
**Parameters**

| | | |
|---|---|---|
| in | *uartp* | pointer to the UARTDriver object |
| in | *n* | number of data frames to send |
| in | *txbuf* | the pointer to the transmit buffer |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

Here is the call graph for this function:



#### 7.50.6.7 size_t uartStopSend ( UARTDriver * *uartp* )

Stops any ongoing transmission.

**Note**

Stopping a transmission also suppresses the transmission callbacks.

**Parameters**

| | | |
|---|---|---|
| in | *uartp* | pointer to the UARTDriver object |

**Returns**

The number of data frames not transmitted by the stopped transmit operation.

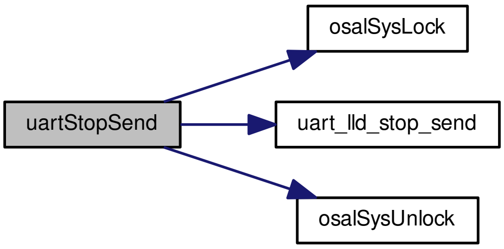
**Return values**

| | |
|---|---|
| *UART_ERR_NOT_ACTIVE* | if there was no transmit operation in progress. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.50.6.8 size_t uartStopSendI ( **UARTDriver** ∗ *uartp* )

Stops any ongoing transmission.

**Note**

Stopping a transmission also suppresses the transmission callbacks.
This function has to be invoked from a lock zone.

**Parameters**

| | | |
|---|---|---|
| in | *uartp* | pointer to the UARTDriver object |

**Returns**

The number of data frames not transmitted by the stopped transmit operation.

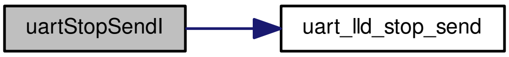
**Return values**

| | |
|---|---|
| *UART_ERR_NOT_ACTIVE* | if there was no transmit operation in progress. |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

Here is the call graph for this function:



#### 7.50.6.9 void uartStartReceive ( UARTDriver ∗ *uartp,* size_t *n,* void ∗ *rxbuf* )

Starts a receive operation on the UART peripheral.

**Note**

The buffers are organized as uint8_t arrays for data sizes below or equal to 8 bits else it is organized as uint16_t arrays.

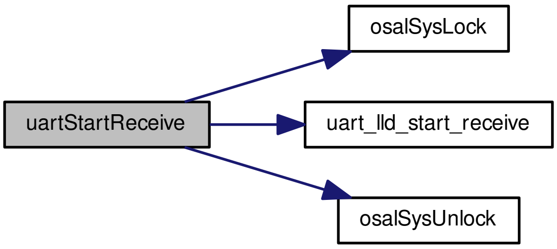
**Parameters**

| | | |
|---|---|---|
| `in` | *uartp* | pointer to the `UARTDriver` object |
| `in` | *n* | number of data frames to receive |
| `in` | *rxbuf* | the pointer to the receive buffer |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.50.6.10 void uartStartReceiveI ( UARTDriver ∗ *uartp*, size_t *n*, void ∗ *rxbuf* )

Starts a receive operation on the UART peripheral.

**Note**

The buffers are organized as uint8_t arrays for data sizes below or equal to 8 bits else it is organized as uint16_t arrays.
This function has to be invoked from a lock zone.

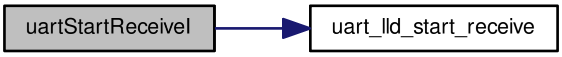
**Parameters**

| | | |
|---|---|---|
| in | *uartp* | pointer to the UARTDriver object |
| in | *n* | number of data frames to receive |
| out | *rxbuf* | the pointer to the receive buffer |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

Here is the call graph for this function:



#### 7.50.6.11 size_t uartStopReceive ( UARTDriver ∗ *uartp* )

Stops any ongoing receive operation.

**Note**

Stopping a receive operation also suppresses the receive callbacks.

**Parameters**

| | | |
|---|---|---|
| in | *uartp* | pointer to the UARTDriver object |

**Returns**

The number of data frames not received by the stopped receive operation.

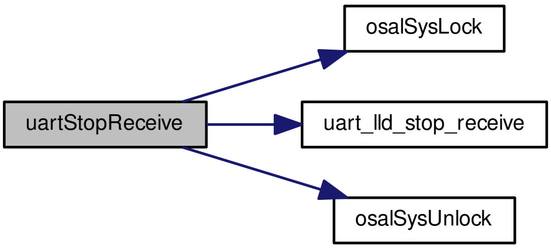
**Return values**

| | |
|---|---|
| *UART_ERR_NOT_ACTIVE* | if there was no receive operation in progress. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.50.6.12 size_t uartStopReceiveI ( UARTDriver * *uartp* )

Stops any ongoing receive operation.

**Note**

Stopping a receive operation also suppresses the receive callbacks.
This function has to be invoked from a lock zone.

**Parameters**

| | | |
|---|---|---|
| in | *uartp* | pointer to the UARTDriver object |

**Returns**

The number of data frames not received by the stopped receive operation.

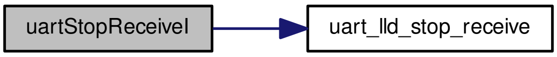
**Return values**

| | |
|---|---|
| *UART_ERR_NOT_ACTIVE* | if there was no receive operation in progress. |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

Here is the call graph for this function:



#### 7.50.6.13 msg_t uartSendTimeout ( **UARTDriver** ∗ *uartp*, size_t ∗ *np*, const void ∗ *txbuf*, **sysinterval_t** *timeout* )

Performs a transmission on the UART peripheral.

**Note**

The function returns when the specified number of frames have been sent to the UART or on timeout.
The buffers are organized as uint8_t arrays for data sizes below or equal to 8 bits else it is organized as uint16_t arrays.
This function implements a software timeout, it does not use any underlying HW timeout mechanism.

**Parameters**

| | | |
|---|---|---|
| `in` | *uartp* | pointer to the `UARTDriver` object |
| `in,out` | *np* | number of data frames to transmit, on exit the number of frames actually transmitted |
| `in` | *txbuf* | the pointer to the transmit buffer |
| `in` | *timeout* | operation timeout |

**Returns**

The operation status.

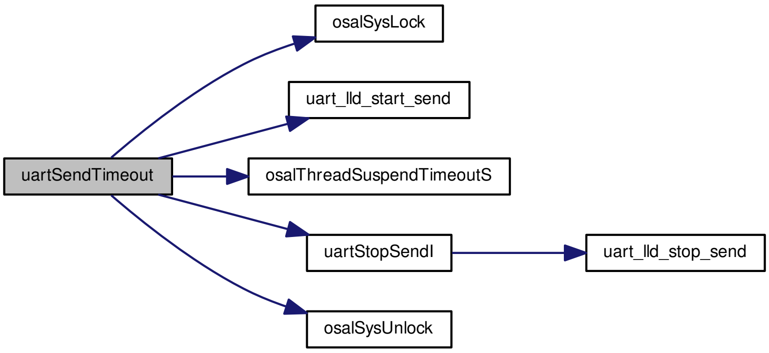
**Return values**

| | |
|---|---|
| *MSG_OK* | if the operation completed successfully. |
| *MSG_TIMEOUT* | if the operation timed out. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.50.6.14 msg_t uartSendFullTimeout ( UARTDriver * *uartp*, size_t * *np*, const void * *txbuf*, sysinterval_t *timeout* )

Performs a transmission on the UART peripheral.

**Note**

The function returns when the specified number of frames have been physically transmitted or on timeout.
The buffers are organized as uint8_t arrays for data sizes below or equal to 8 bits else it is organized as uint16_t arrays.
This function implements a software timeout, it does not use any underlying HW timeout mechanism.

**Parameters**

| | | |
|---|---|---|
| `in` | *uartp* | pointer to the `UARTDriver` object |
| `in,out` | *np* | number of data frames to transmit, on exit the number of frames actually transmitted |
| `in` | *txbuf* | the pointer to the transmit buffer |
| `in` | *timeout* | operation timeout |

**Returns**

The operation status.

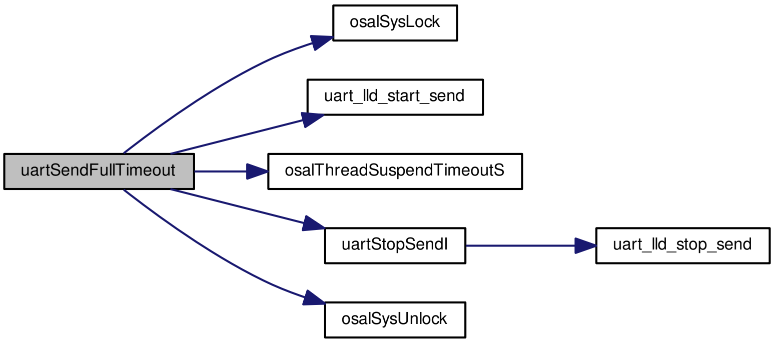
**Return values**

| | |
|---|---|
| *MSG_OK* | if the operation completed successfully. |
| *MSG_TIMEOUT* | if the operation timed out. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.50.6.15 msg_t uartReceiveTimeout ( UARTDriver ∗ *uartp*, size_t ∗ *np*, void ∗ *rxbuf*, sysinterval_t *timeout* )

Performs a receive operation on the UART peripheral.

**Note**

The function returns when the specified number of frames have been received or on error/timeout.
The buffers are organized as uint8_t arrays for data sizes below or equal to 8 bits else it is organized as uint16_t arrays.
This function implements a software timeout, it does not use any underlying HW timeout mechanism.

**Parameters**

| | | |
|---|---|---|
| `in` | *uartp* | pointer to the `UARTDriver` object |
| `in,out` | *np* | number of data frames to receive, on exit the number of frames actually received |
| `in` | *rxbuf* | the pointer to the receive buffer |
| `in` | *timeout* | operation timeout |

**Returns**

The operation status.

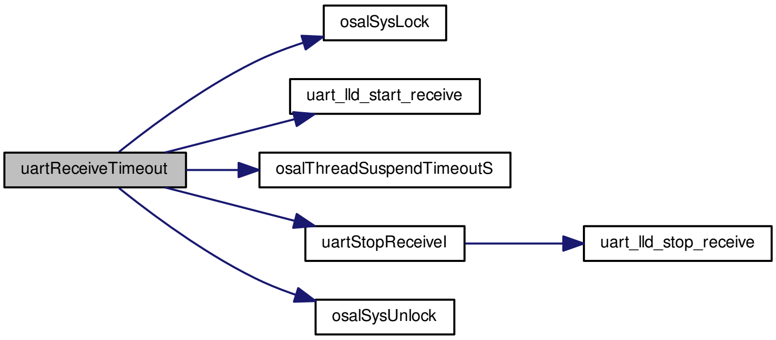
**Return values**

| | |
|---|---|
| *MSG_OK* | if the operation completed successfully. |
| *MSG_TIMEOUT* | if the operation timed out. |
| *MSG_RESET* | in case of a receive error. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.50.6.16 void uartAcquireBus ( UARTDriver ∗ *uartp* )

Gains exclusive access to the UART bus.

This function tries to gain ownership to the UART bus, if the bus is already being used then the invoking thread is queued.

**Precondition**

In order to use this function the option `UART_USE_MUTUAL_EXCLUSION` must be enabled.

**Parameters**

| | | |
|---|---|---|
| in | *uartp* | pointer to the `UARTDriver` object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:

uartAcquireBus
osalMutexLock

#### 7.50.6.17 void uartReleaseBus ( UARTDriver ∗ *uartp* )

Releases exclusive access to the UART bus.

**Precondition**

In order to use this function the option UART_USE_MUTUAL_EXCLUSION must be enabled.

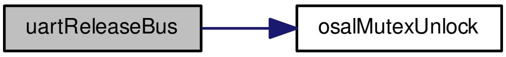
**Parameters**

| | | |
|---|---|---|
| in | *uartp* | pointer to the UARTDriver object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



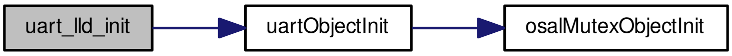
### 7.50.6.18 void uart_lld_init ( void )

Low level UART driver initialization.

**Function Class:**

Not an API, this function is for internal use only.

Here is the call graph for this function:



### 7.50.6.19 void uart_lld_start ( UARTDriver ∗ *uartp* )

Configures and activates the UART peripheral.

**Parameters**

| | | |
|---|---|---|
| in | *uartp* | pointer to the UARTDriver object |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.50.6.20 void uart_lld_stop ( UARTDriver * *uartp* )

Deactivates the UART peripheral.

**Parameters**

| | | |
|---|---|---|
| in | *uartp* | pointer to the `UARTDriver` object |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.50.6.21 void uart_lld_start_send ( UARTDriver * *uartp*, size_t *n*, const void * *txbuf* )

Starts a transmission on the UART peripheral.

**Note**

The buffers are organized as uint8_t arrays for data sizes below or equal to 8 bits else it is organized as uint16_t arrays.

**Parameters**

| | | |
|---|---|---|
| in | *uartp* | pointer to the `UARTDriver` object |
| in | *n* | number of data frames to send |
| in | *txbuf* | the pointer to the transmit buffer |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.50.6.22 size_t uart_lld_stop_send ( UARTDriver * *uartp* )

Stops any ongoing transmission.

**Note**

Stopping a transmission also suppresses the transmission callbacks.

**Parameters**

| | | |
|---|---|---|
| in | *uartp* | pointer to the `UARTDriver` object |

**Returns**

The number of data frames not transmitted by the stopped transmit operation.

**Function Class:**

Not an API, this function is for internal use only.

#### 7.50.6.23 void uart_lld_start_receive ( UARTDriver ∗ *uartp,* size_t *n,* void ∗ *rxbuf* )

Starts a receive operation on the UART peripheral.

**Note**

The buffers are organized as uint8_t arrays for data sizes below or equal to 8 bits else it is organized as uint16_t arrays.

**Parameters**

| | | |
|---|---|---|
| `in` | *uartp* | pointer to the `UARTDriver` object |
| `in` | *n* | number of data frames to send |
| `out` | *rxbuf* | the pointer to the receive buffer |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.50.6.24 size_t uart_lld_stop_receive ( UARTDriver ∗ *uartp* )

Stops any ongoing receive operation.

**Note**

Stopping a receive operation also suppresses the receive callbacks.

**Parameters**

| | | |
|---|---|---|
| `in` | *uartp* | pointer to the `UARTDriver` object |

**Returns**

The number of data frames not received by the stopped receive operation.

**Function Class:**

Not an API, this function is for internal use only.

### 7.50.7 Variable Documentation

#### 7.50.7.1 UARTDriver UARTD1

UART1 driver identifier.

## 7.51 USB Driver

Generic USB Driver.

### 7.51.1 Detailed Description

Generic USB Driver.

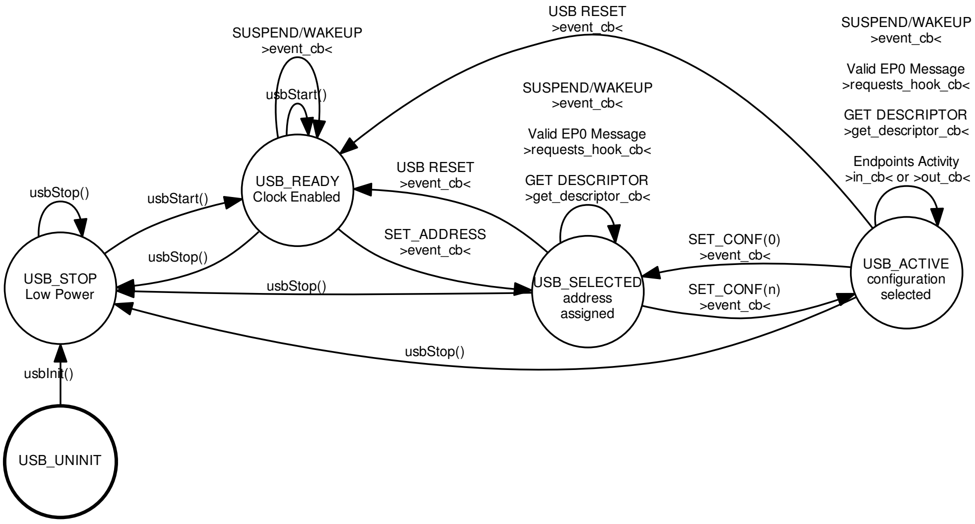
This module implements a generic USB (Universal Serial Bus) driver supporting device-mode operations.

**Precondition**

In order to use the USB driver the `HAL_USE_USB` option must be enabled in `halconf.h`.

### 7.51.2 Driver State Machine

The driver implements a state machine internally, not all the driver functionalities can be used in any moment, any transition not explicitly shown in the following diagram has to be considered an error and shall be captured by an assertion (if enabled).



### 7.51.3 USB Operations

The USB driver is quite complex and USB is complex in itself, it is recommended to study the USB specification before trying to use the driver.

#### 7.51.3.1 USB Implementation

The USB driver abstracts the inner details of the underlying USB hardware. The driver works asynchronously and communicates with the application using callbacks. The application is responsible of the descriptors and strings required by the USB device class to be implemented and of the handling of the specific messages sent over the endpoint zero. Standard messages are handled internally to the driver. The application can use hooks in order to handle custom messages or override the handling of the default handling of standard messages.

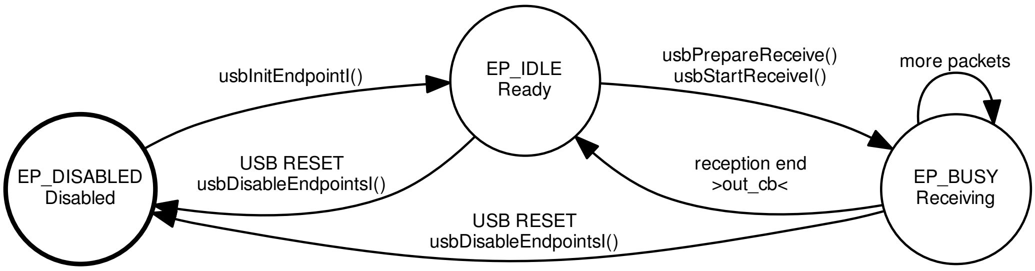
#### 7.51.3.2 USB Endpoints

USB endpoints are the objects that the application uses to exchange data with the host. There are two kind of endpoints:

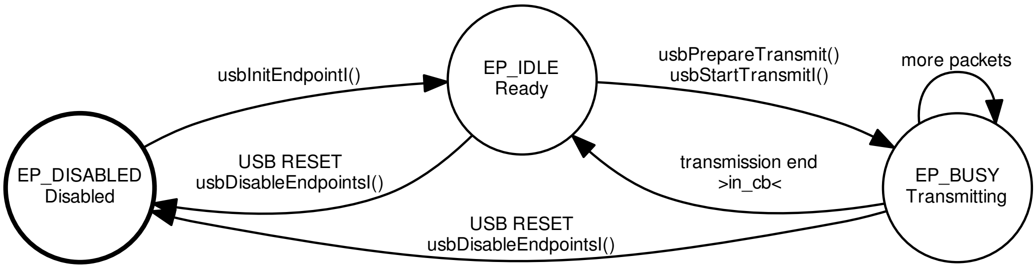
- **IN** endpoints are used by the application to transmit data to the host.

- **OUT** endpoints are used by the application to receive data from the host.

The driver invokes a callback after finishing an IN or OUT transaction. States diagram for OUT endpoints in transaction mode:



States diagram for IN endpoints in transaction mode:



#### 7.51.3.3 USB Callbacks

The USB driver uses callbacks in order to interact with the application. There are several kinds of callbacks to be handled:

- Driver events callback. As example errors, suspend event, reset event etc.
- Messages Hook callback. This hook allows the application to implement handling of custom messages or to override the default handling of standard messages on endpoint zero.
- Descriptor Requested callback. When the driver endpoint zero handler receives a GET DESCRIPTOR message and needs to send a descriptor to the host it queries the application using this callback.
- Start of Frame callback. This callback is invoked each time a SOF packet is received.
- Endpoint callbacks. Each endpoint informs the application about I/O conditions using those callbacks.

## Macros

- #define USB_USE_WAIT FALSE

  *Enables synchronous APIs.*
- #define USB_MAX_ENDPOINTS 4

  *Maximum endpoint address.*
- #define USB_EP0_STATUS_STAGE USB_EP0_STATUS_STAGE_SW

  *Status stage handling method.*
- #define USB_SET_ADDRESS_MODE USB_LATE_SET_ADDRESS

  *The address can be changed immediately upon packet reception.*
- #define USB_SET_ADDRESS_ACK_HANDLING USB_SET_ADDRESS_ACK_SW

  *Method for set address acknowledge.*
- #define usb_lld_get_frame_number(usbp) 0

  *Returns the current frame number.*
- #define usb_lld_get_transaction_size(usbp, ep) ((usbp)->epc[ep]->out_state->rxcnt)

  *Returns the exact size of a receive transaction.*
- #define usb_lld_connect_bus(usbp)

  *Connects the USB device.*
- #define usb_lld_disconnect_bus(usbp)

  *Disconnect the USB device.*
- #define usb_lld_wakeup_host(usbp)

  *Start of host wake-up procedure.*

## Helper macros for USB descriptors

- #define USB_DESC_INDEX(i) ((uint8_t)(i))

  *Helper macro for index values into descriptor strings.*
- #define USB_DESC_BYTE(b) ((uint8_t)(b))

  *Helper macro for byte values into descriptor strings.*
- #define USB_DESC_WORD(w)

  *Helper macro for word values into descriptor strings.*
- #define USB_DESC_BCD(bcd)

  *Helper macro for BCD values into descriptor strings.*
- #define **USB_DESC_DEVICE_SIZE** 18U
- #define USB_DESC_DEVICE(bcdUSB, bDeviceClass, bDeviceSubClass, bDeviceProtocol, bMaxPacket↩ Size, idVendor, idProduct, bcdDevice, iManufacturer, iProduct, iSerialNumber, bNumConfigurations)

*Device Descriptor helper macro.*
- #define USB_DESC_CONFIGURATION_SIZE 9U

  *Configuration Descriptor size.*
- #define USB_DESC_CONFIGURATION(wTotalLength, bNumInterfaces, bConfigurationValue, iConfiguration, bmAttributes, bMaxPower)

  *Configuration Descriptor helper macro.*
- #define USB_DESC_INTERFACE_SIZE 9U

  *Interface Descriptor size.*
- #define USB_DESC_INTERFACE(bInterfaceNumber, bAlternateSetting, bNumEndpoints, bInterfaceClass, bInterfaceSubClass, bInterfaceProtocol, iInterface)

  *Interface Descriptor helper macro.*
- #define USB_DESC_INTERFACE_ASSOCIATION_SIZE 8U

  *Interface Association Descriptor size.*
- #define USB_DESC_INTERFACE_ASSOCIATION(bFirstInterface, bInterfaceCount, bFunctionClass, b←FunctionSubClass, bFunctionProcotol, iInterface)

  *Interface Association Descriptor helper macro.*
- #define USB_DESC_ENDPOINT_SIZE 7U

  *Endpoint Descriptor size.*
- #define USB_DESC_ENDPOINT(bEndpointAddress, bmAttributes, wMaxPacketSize, bInterval)

  *Endpoint Descriptor helper macro.*

### Endpoint types and settings

- #define USB_EP_MODE_TYPE 0x0003U
- #define USB_EP_MODE_TYPE_CTRL 0x0000U
- #define USB_EP_MODE_TYPE_ISOC 0x0001U
- #define USB_EP_MODE_TYPE_BULK 0x0002U
- #define USB_EP_MODE_TYPE_INTR 0x0003U

### Macro Functions

- #define usbGetDriverStateI(usbp) ((usbp)->state)

  *Returns the driver state.*
- #define usbConnectBus(usbp) usb_lld_connect_bus(usbp)

  *Connects the USB device.*
- #define usbDisconnectBus(usbp) usb_lld_disconnect_bus(usbp)

  *Disconnect the USB device.*
- #define usbGetFrameNumberX(usbp) usb_lld_get_frame_number(usbp)

  *Returns the current frame number.*
- #define usbGetTransmitStatusI(usbp, ep) (((usbp)->transmitting & (uint16_t)((unsigned)1U << (unsigned)(ep))) != 0U)

  *Returns the status of an IN endpoint.*
- #define usbGetReceiveStatusI(usbp, ep) (((usbp)->receiving & (uint16_t)((unsigned)1U << (unsigned)(ep))) != 0U)

  *Returns the status of an OUT endpoint.*
- #define usbGetReceiveTransactionSizeX(usbp, ep) usb_lld_get_transaction_size(usbp, ep)

  *Returns the exact size of a receive transaction.*
- #define usbSetupTransfer(usbp, buf, n, endcb)

  *Request transfer setup.*
- #define usbReadSetup(usbp, ep, buf) usb_lld_read_setup(usbp, ep, buf)

  *Reads a setup packet from the dedicated packet buffer.*

### Low level driver helper macros

- #define _usb_isr_invoke_event_cb(usbp, evt)

  *Common ISR code, usb event callback.*
- #define _usb_isr_invoke_sof_cb(usbp)

  *Common ISR code, SOF callback.*
- #define _usb_isr_invoke_setup_cb(usbp, ep)

  *Common ISR code, setup packet callback.*
- #define _usb_isr_invoke_in_cb(usbp, ep)

  *Common ISR code, IN endpoint callback.*
- #define _usb_isr_invoke_out_cb(usbp, ep)

  *Common ISR code, OUT endpoint event.*

### PLATFORM configuration options

- #define PLATFORM_USB_USE_USB1 FALSE

  *USB driver enable switch.*

### Typedefs

- typedef struct USBDriver USBDriver

  *Type of a structure representing an USB driver.*
- typedef uint8_t usbep_t

  *Type of an endpoint identifier.*
- typedef void(∗ usbcallback_t) (USBDriver ∗usbp)

  *Type of an USB generic notification callback.*
- typedef void(∗ usbepcallback_t) (USBDriver ∗usbp, usbep_t ep)

  *Type of an USB endpoint callback.*
- typedef void(∗ usbeventcb_t) (USBDriver ∗usbp, usbevent_t event)

  *Type of an USB event notification callback.*
- typedef bool(∗ usbreqhandler_t) (USBDriver ∗usbp)

  *Type of a requests handler callback.*
- typedef const USBDescriptor ∗(∗ usbgetdescriptor_t) (USBDriver ∗usbp, uint8_t dtype, uint8_t dindex, uint16_t lang)

  *Type of an USB descriptor-retrieving callback.*

### Data Structures

- struct USBDescriptor

  *Type of an USB descriptor.*
- struct USBInEndpointState

  *Type of an IN endpoint state structure.*
- struct USBOutEndpointState

  *Type of an OUT endpoint state structure.*
- struct USBEndpointConfig

  *Type of an USB endpoint configuration structure.*
- struct USBConfig

  *Type of an USB driver configuration structure.*
- struct USBDriver

  *Structure representing an USB driver.*

## Functions

- static void set_address (USBDriver ∗usbp)

  *SET ADDRESS transaction callback.*
- static bool default_handler (USBDriver ∗usbp)

  *Standard requests handler.*
- void usbInit (void)

  *USB Driver initialization.*
- void usbObjectInit (USBDriver ∗usbp)

  *Initializes the standard part of a `USBDriver` structure.*
- void usbStart (USBDriver ∗usbp, const USBConfig ∗config)

  *Configures and activates the USB peripheral.*
- void usbStop (USBDriver ∗usbp)

  *Deactivates the USB peripheral.*
- void usbInitEndpointI (USBDriver ∗usbp, usbep_t ep, const USBEndpointConfig ∗epcp)

  *Enables an endpoint.*
- void usbDisableEndpointsI (USBDriver ∗usbp)

  *Disables all the active endpoints.*
- void usbStartReceiveI (USBDriver ∗usbp, usbep_t ep, uint8_t ∗buf, size_t n)

  *Starts a receive transaction on an OUT endpoint.*
- void usbStartTransmitI (USBDriver ∗usbp, usbep_t ep, const uint8_t ∗buf, size_t n)

  *Starts a transmit transaction on an IN endpoint.*
- msg_t usbReceive (USBDriver ∗usbp, usbep_t ep, uint8_t ∗buf, size_t n)

  *Performs a receive transaction on an OUT endpoint.*
- msg_t usbTransmit (USBDriver ∗usbp, usbep_t ep, const uint8_t ∗buf, size_t n)

  *Performs a transmit transaction on an IN endpoint.*
- bool usbStallReceiveI (USBDriver ∗usbp, usbep_t ep)

  *Stalls an OUT endpoint.*
- bool usbStallTransmitI (USBDriver ∗usbp, usbep_t ep)

  *Stalls an IN endpoint.*
- void usbWakeupHost (USBDriver ∗usbp)

  *Host wake-up procedure.*
- void _usb_reset (USBDriver ∗usbp)

  *USB reset routine.*
- void _usb_suspend (USBDriver ∗usbp)

  *USB suspend routine.*
- void _usb_wakeup (USBDriver ∗usbp)

  *USB wake-up routine.*
- void _usb_ep0setup (USBDriver ∗usbp, usbep_t ep)

  *Default EP0 SETUP callback.*
- void _usb_ep0in (USBDriver ∗usbp, usbep_t ep)

  *Default EP0 IN callback.*
- void _usb_ep0out (USBDriver ∗usbp, usbep_t ep)

  *Default EP0 OUT callback.*
- void usb_lld_init (void)

  *Low level USB driver initialization.*
- void usb_lld_start (USBDriver ∗usbp)

  *Configures and activates the USB peripheral.*
- void usb_lld_stop (USBDriver ∗usbp)

  *Deactivates the USB peripheral.*
- void usb_lld_reset (USBDriver ∗usbp)

*USB low level reset routine.*

- void usb_lld_set_address (USBDriver ∗usbp)

  *Sets the USB address.*
- void usb_lld_init_endpoint (USBDriver ∗usbp, usbep_t ep)

  *Enables an endpoint.*
- void usb_lld_disable_endpoints (USBDriver ∗usbp)

  *Disables all the active endpoints except the endpoint zero.*
- usbepstatus_t usb_lld_get_status_out (USBDriver ∗usbp, usbep_t ep)

  *Returns the status of an OUT endpoint.*
- usbepstatus_t usb_lld_get_status_in (USBDriver ∗usbp, usbep_t ep)

  *Returns the status of an IN endpoint.*
- void usb_lld_read_setup (USBDriver ∗usbp, usbep_t ep, uint8_t ∗buf)

  *Reads a setup packet from the dedicated packet buffer.*
- void usb_lld_prepare_receive (USBDriver ∗usbp, usbep_t ep)

  *Prepares for a receive operation.*
- void usb_lld_prepare_transmit (USBDriver ∗usbp, usbep_t ep)

  *Prepares for a transmit operation.*
- void usb_lld_start_out (USBDriver ∗usbp, usbep_t ep)

  *Starts a receive operation on an OUT endpoint.*
- void usb_lld_start_in (USBDriver ∗usbp, usbep_t ep)

  *Starts a transmit operation on an IN endpoint.*
- void usb_lld_stall_out (USBDriver ∗usbp, usbep_t ep)

  *Brings an OUT endpoint in the stalled state.*
- void usb_lld_stall_in (USBDriver ∗usbp, usbep_t ep)

  *Brings an IN endpoint in the stalled state.*
- void usb_lld_clear_out (USBDriver ∗usbp, usbep_t ep)

  *Brings an OUT endpoint in the active state.*
- void usb_lld_clear_in (USBDriver ∗usbp, usbep_t ep)

  *Brings an IN endpoint in the active state.*

## Enumerations

## Variables

- USBDriver USBD1

  *USB1 driver identifier.*
- union {
  USBInEndpointState in
  *IN EP0 state.*
  USBOutEndpointState out
  *OUT EP0 state.*
  } ep0_state

  *EP0 state.*
- static const USBEndpointConfig ep0config

  *EP0 initialization structure.*

## 7.51.4 Macro Definition Documentation

### 7.51.4.1 #define USB_DESC_INDEX( *i* ) ((uint8_t)(i))

Helper macro for index values into descriptor strings.

#### 7.51.4.2 #define USB_DESC_BYTE( *b* ) ((uint8_t)(b))

Helper macro for byte values into descriptor strings.

#### 7.51.4.3 #define USB_DESC_WORD( *w* )

**Value:**

```
(uint8_t)((w) & 255U),                                                      \
  (uint8_t)(((w) >> 8) & 255U)
```

Helper macro for word values into descriptor strings.

#### 7.51.4.4 #define USB_DESC_BCD( *bcd* )

**Value:**

```
(uint8_t)((bcd) & 255U),                                                    \
  (uint8_t)(((bcd) >> 8) & 255)
```

Helper macro for BCD values into descriptor strings.

#### 7.51.4.5 #define USB_DESC_DEVICE( *bcdUSB, bDeviceClass, bDeviceSubClass, bDeviceProtocol, bMaxPacketSize, idVendor, idProduct, bcdDevice, iManufacturer, iProduct, iSerialNumber, bNumConfigurations* )

**Value:**

```
USB_DESC_BYTE(USB_DESC_DEVICE_SIZE),
      \
  USB_DESC_BYTE(USB_DESCRIPTOR_DEVICE),
      \
  USB_DESC_BCD(bcdUSB),
      \
  USB_DESC_BYTE(bDeviceClass),
      \
  USB_DESC_BYTE(bDeviceSubClass),
      \
  USB_DESC_BYTE(bDeviceProtocol),
      \
  USB_DESC_BYTE(bMaxPacketSize),
      \
  USB_DESC_WORD(idVendor),
      \
  USB_DESC_WORD(idProduct),
      \
  USB_DESC_BCD(bcdDevice),
      \
  USB_DESC_INDEX(iManufacturer),
      \
  USB_DESC_INDEX(iProduct),
      \
  USB_DESC_INDEX(iSerialNumber),
      \
  USB_DESC_BYTE(bNumConfigurations)
```

Device Descriptor helper macro.

#### 7.51.4.6 #define USB_DESC_CONFIGURATION_SIZE 9U

Configuration Descriptor size.

#### 7.51.4.7 #define USB_DESC_CONFIGURATION( *wTotalLength,* *bNumInterfaces,* *bConfigurationValue,* *iConfiguration,* *bmAttributes,* *bMaxPower* )

**Value:**

```
USB_DESC_BYTE(USB_DESC_CONFIGURATION_SIZE),
             \
  USB_DESC_BYTE(USB_DESCRIPTOR_CONFIGURATION),
      \
  USB_DESC_WORD(wTotalLength),
      \
  USB_DESC_BYTE(bNumInterfaces),
      \
  USB_DESC_BYTE(bConfigurationValue),
      \
  USB_DESC_INDEX(iConfiguration),
      \
  USB_DESC_BYTE(bmAttributes),
      \
  USB_DESC_BYTE(bMaxPower)
```

Configuration Descriptor helper macro.

#### 7.51.4.8 #define USB_DESC_INTERFACE_SIZE 9U

Interface Descriptor size.

#### 7.51.4.9 #define USB_DESC_INTERFACE( *bInterfaceNumber,* *bAlternateSetting,* *bNumEndpoints,* *bInterfaceClass,* *bInterfaceSubClass,* *bInterfaceProtocol,* *iInterface* )

**Value:**

```
USB_DESC_BYTE(USB_DESC_INTERFACE_SIZE),
         \
  USB_DESC_BYTE(USB_DESCRIPTOR_INTERFACE),
      \
  USB_DESC_BYTE(bInterfaceNumber),
      \
  USB_DESC_BYTE(bAlternateSetting),
      \
  USB_DESC_BYTE(bNumEndpoints),
      \
  USB_DESC_BYTE(bInterfaceClass),
      \
  USB_DESC_BYTE(bInterfaceSubClass),
      \
  USB_DESC_BYTE(bInterfaceProtocol),
      \
  USB_DESC_INDEX(iInterface)
```

Interface Descriptor helper macro.

#### 7.51.4.10 #define USB_DESC_INTERFACE_ASSOCIATION_SIZE 8U

Interface Association Descriptor size.

#### 7.51.4.11 #define USB_DESC_INTERFACE_ASSOCIATION( *bFirstInterface,* *bInterfaceCount,* *bFunctionClass,* *bFunctionSubClass,* *bFunctionProcotol,* *iInterface* )

**Value:**

```
USB_DESC_BYTE(USB_DESC_INTERFACE_ASSOCIATION_SIZE),
                     \
  USB_DESC_BYTE(USB_DESCRIPTOR_INTERFACE_ASSOCIATION),
      \
  USB_DESC_BYTE(bFirstInterface),
      \
  USB_DESC_BYTE(bInterfaceCount),
      \
  USB_DESC_BYTE(bFunctionClass),
      \
  USB_DESC_BYTE(bFunctionSubClass),
      \
  USB_DESC_BYTE(bFunctionProcotol),
      \
  USB_DESC_INDEX(iInterface)
```

Interface Association Descriptor helper macro.

#### 7.51.4.12 #define USB_DESC_ENDPOINT_SIZE 7U

Endpoint Descriptor size.

#### 7.51.4.13 #define USB_DESC_ENDPOINT( *bEndpointAddress, bmAttributes, wMaxPacketSize, bInterval* )

**Value:**

```
USB_DESC_BYTE(USB_DESC_ENDPOINT_SIZE),
        \
  USB_DESC_BYTE(USB_DESCRIPTOR_ENDPOINT),
      \
  USB_DESC_BYTE(bEndpointAddress),
      \
  USB_DESC_BYTE(bmAttributes),
      \
  USB_DESC_WORD(wMaxPacketSize),
      \
  USB_DESC_BYTE(bInterval)
```

Endpoint Descriptor helper macro.

#### 7.51.4.14 #define USB_EP_MODE_TYPE 0x0003U

Endpoint type mask.

#### 7.51.4.15 #define USB_EP_MODE_TYPE_CTRL 0x0000U

Control endpoint.

#### 7.51.4.16 #define USB_EP_MODE_TYPE_ISOC 0x0001U

Isochronous endpoint.

#### 7.51.4.17 #define USB_EP_MODE_TYPE_BULK 0x0002U

Bulk endpoint.

#### 7.51.4.18 #define USB_EP_MODE_TYPE_INTR 0x0003U

Interrupt endpoint.

#### 7.51.4.19 #define USB_USE_WAIT FALSE

Enables synchronous APIs.

**Note**

Disabling this option saves both code and data space.

#### 7.51.4.20 #define usbGetDriverStateI( *usbp* ) ((usbp)->state)

Returns the driver state.

**Parameters**

| | | |
|---|---|---|
| in | *usbp* | pointer to the `USBDriver` object |

**Returns**

The driver state.

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

#### 7.51.4.21 #define usbConnectBus( *usbp* ) usb_lld_connect_bus(usbp)

Connects the USB device.

**Parameters**

| | | |
|---|---|---|
| in | *usbp* | pointer to the `USBDriver` object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.51.4.22 #define usbDisconnectBus( *usbp* ) usb_lld_disconnect_bus(usbp)

Disconnect the USB device.

**Parameters**

| | | |
|---|---|---|
| in | *usbp* | pointer to the `USBDriver` object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.51.4.23 #define usbGetFrameNumberX( *usbp* ) usb_lld_get_frame_number(usbp)

Returns the current frame number.

**Parameters**

| | | |
|---|---|---|
| in | *usbp* | pointer to the USBDriver object |

**Returns**

The current frame number.

**Function Class:**

This is an **X-Class** API, this function can be invoked from any context.

#### 7.51.4.24 #define usbGetTransmitStatusI( *usbp*, *ep* ) (((usbp)->transmitting & (uint16_t)((unsigned)1U << (unsigned)(ep))) != 0U)

Returns the status of an IN endpoint.

**Parameters**

| | | |
|---|---|---|
| in | *usbp* | pointer to the USBDriver object |
| in | *ep* | endpoint number |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *false* | Endpoint ready. |
| *true* | Endpoint transmitting. |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

#### 7.51.4.25 #define usbGetReceiveStatusI( *usbp*, *ep* ) (((usbp)->receiving & (uint16_t)((unsigned)1U << (unsigned)(ep))) != 0U)

Returns the status of an OUT endpoint.

**Parameters**

| | | |
|---|---|---|
| in | *usbp* | pointer to the USBDriver object |
| in | *ep* | endpoint number |

**Returns**

The operation status.

**Return values**

| | |
|---|---|
| *false* | Endpoint ready. |
| *true* | Endpoint receiving. |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

### 7.51.4.26 #define usbGetReceiveTransactionSizeX( *usbp,* *ep* ) usb_lld_get_transaction_size(usbp, ep)

Returns the exact size of a receive transaction.

The received size can be different from the size specified in `usbStartReceiveI()` because the last packet could have a size different from the expected one.

**Parameters**

| | | |
|---|---|---|
| in | *usbp* | pointer to the `USBDriver` object |
| in | *ep* | endpoint number |

**Returns**

Received data size.

**Function Class:**

This is an **X-Class** API, this function can be invoked from any context.

### 7.51.4.27 #define usbSetupTransfer( *usbp,* *buf,* *n,* *endcb* )

**Value:**

```
{                          \
  (usbp)->ep0next   = (buf);                                        \
  (usbp)->ep0n      = (n);                                          \
  (usbp)->ep0endcb = (endcb);                                       \
}
```

Request transfer setup.

This macro is used by the request handling callbacks in order to prepare a transaction over the endpoint zero.

**Parameters**

| | | |
|---|---|---|
| in | *usbp* | pointer to the `USBDriver` object |
| in | *buf* | pointer to a buffer for the transaction data |
| in | *n* | number of bytes to be transferred |
| in | *endcb* | callback to be invoked after the transfer or `NULL` |

**Function Class:**

Special function, this function has special requirements see the notes.

#### 7.51.4.28 #define usbReadSetup( *usbp,* *ep,* *buf* ) usb_lld_read_setup(usbp, ep, buf)

Reads a setup packet from the dedicated packet buffer.

This function must be invoked in the context of the `setup_cb` callback in order to read the received setup packet.

**Precondition**

In order to use this function the endpoint must have been initialized as a control endpoint.

**Note**

This function can be invoked both in thread and IRQ context.

**Parameters**

| | | |
|---|---|---|
| `in` | *usbp* | pointer to the `USBDriver` object |
| `in` | *ep* | endpoint number |
| `out` | *buf* | buffer where to copy the packet data |

**Function Class:**

Special function, this function has special requirements see the notes.

#### 7.51.4.29 #define _usb_isr_invoke_event_cb( *usbp,* *evt* )

**Value:**

```
{                               \
  if (((usbp)->config->event_cb) != NULL) {                                 \
    (usbp)->config->event_cb(usbp, evt);                                    \
  }                                                                         \
}
```

Common ISR code, usb event callback.

**Parameters**

| | | |
|---|---|---|
| `in` | *usbp* | pointer to the `USBDriver` object |
| `in` | *evt* | USB event code |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.51.4.30 #define _usb_isr_invoke_sof_cb( *usbp* )

**Value:**

```
{                                      \
  if (((usbp)->config->sof_cb) != NULL) {                                   \
    (usbp)->config->sof_cb(usbp);                                           \
  }                                                                         \
}
```

Common ISR code, SOF callback.

**Parameters**

|  |  |  |
|---|---|---|
| in | *usbp* | pointer to the USBDriver object |

**Function Class:**

Not an API, this function is for internal use only.

### 7.51.4.31 #define _usb_isr_invoke_setup_cb( *usbp, ep* )

**Value:**

```
{                                 \
  (usbp)->epc[ep]->setup_cb(usbp, ep);                                      \
}
```

Common ISR code, setup packet callback.

**Parameters**

|  |  |  |
|---|---|---|
| in | *usbp* | pointer to the USBDriver object |
| in | *ep* | endpoint number |

**Function Class:**

Not an API, this function is for internal use only.

### 7.51.4.32 #define _usb_isr_invoke_in_cb( *usbp, ep* )

**Value:**

```
{                                    \
  (usbp)->transmitting &= ~(1 << (ep));                                      \
  if ((usbp)->epc[ep]->in_cb != NULL) {                                       \
    (usbp)->epc[ep]->in_cb(usbp, ep);                                         \
  }                                                                           \
  osalSysLockFromISR();
      \
  osalThreadResumeI(&(usbp)->epc[ep]->in_state->thread, MSG_OK);
      \
  osalSysUnlockFromISR();                                                     \
}
```

Common ISR code, IN endpoint callback.

**Parameters**

|  |  |  |
|---|---|---|
| in | *usbp* | pointer to the USBDriver object |
| in | *ep* | endpoint number |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.51.4.33 #define _usb_isr_invoke_out_cb( *usbp, ep* )

**Value:**

```
{                                  \
  (usbp)->receiving &= ~(1 << (ep));                                       \
  if ((usbp)->epc[ep]->out_cb != NULL) {                                   \
    (usbp)->epc[ep]->out_cb(usbp, ep);                                     \
  }                                                                        \
  osalSysLockFromISR();
      \
  osalThreadResumeI(&(usbp)->epc[ep]->out_state->thread,                   \
                    usbGetReceiveTransactionSizeX(usbp, ep));
      \
  osalSysUnlockFromISR();                                                  \
}
```

Common ISR code, OUT endpoint event.

**Parameters**

| | | |
|---|---|---|
| `in` | *usbp* | pointer to the `USBDriver` object |
| `in` | *ep* | endpoint number |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.51.4.34 #define USB_MAX_ENDPOINTS 4

Maximum endpoint address.

#### 7.51.4.35 #define USB_EP0_STATUS_STAGE USB_EP0_STATUS_STAGE_SW

Status stage handling method.

#### 7.51.4.36 #define USB_SET_ADDRESS_MODE USB_LATE_SET_ADDRESS

The address can be changed immediately upon packet reception.

#### 7.51.4.37 #define USB_SET_ADDRESS_ACK_HANDLING USB_SET_ADDRESS_ACK_SW

Method for set address acknowledge.

#### 7.51.4.38 #define PLATFORM_USB_USE_USB1 FALSE

USB driver enable switch.

If set to `TRUE` the support for USB1 is included.

**Note**

The default is `FALSE`.

#### 7.51.4.39 #define usb_lld_get_frame_number( *usbp* ) 0

Returns the current frame number.

**Parameters**

| | | |
|---|---|---|
| in | *usbp* | pointer to the USBDriver object |

**Returns**

The current frame number.

**Function Class:**

Not an API, this function is for internal use only.

#### 7.51.4.40 #define usb_lld_get_transaction_size( *usbp,* *ep* ) ((usbp)->epc[ep]->out_state->rxcnt)

Returns the exact size of a receive transaction.

The received size can be different from the size specified in `usbStartReceiveI()` because the last packet could have a size different from the expected one.

**Precondition**

The OUT endpoint must have been configured in transaction mode in order to use this function.

**Parameters**

| | | |
|---|---|---|
| in | *usbp* | pointer to the USBDriver object |
| in | *ep* | endpoint number |

**Returns**

Received data size.

**Function Class:**

Not an API, this function is for internal use only.

#### 7.51.4.41 #define usb_lld_connect_bus( *usbp* )

Connects the USB device.

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.51.4.42 #define usb_lld_disconnect_bus( *usbp* )

Disconnect the USB device.

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.51.4.43 #define usb_lld_wakeup_host( *usbp* )

Start of host wake-up procedure.

**Function Class:**

Not an API, this function is for internal use only.

### 7.51.5 Typedef Documentation

#### 7.51.5.1 typedef struct USBDriver USBDriver

Type of a structure representing an USB driver.

#### 7.51.5.2 typedef uint8_t usbep_t

Type of an endpoint identifier.

#### 7.51.5.3 typedef void(∗ usbcallback_t) (USBDriver ∗usbp)

Type of an USB generic notification callback.

**Parameters**

| | | |
|---|---|---|
| in | *usbp* | pointer to the `USBDriver` object triggering the callback |

#### 7.51.5.4 typedef void(∗ usbepcallback_t) (USBDriver ∗usbp, usbep_t ep)

Type of an USB endpoint callback.

**Parameters**

| | | |
|---|---|---|
| in | *usbp* | pointer to the `USBDriver` object triggering the callback |
| in | *ep* | endpoint number |

#### 7.51.5.5 typedef void(∗ usbeventcb_t) (USBDriver ∗usbp, usbevent_t event)

Type of an USB event notification callback.

**Parameters**

| | | |
|---|---|---|
| in | *usbp* | pointer to the `USBDriver` object triggering the callback |
| in | *event* | event type |

#### 7.51.5.6 typedef bool(∗ usbreqhandler_t) (USBDriver ∗usbp)

Type of a requests handler callback.

The request is encoded in the `usb_setup` buffer.

**Parameters**

| | | |
|---|---|---|
| in | *usbp* | pointer to the USBDriver object triggering the callback |

**Returns**

The request handling exit code.

**Return values**

| | |
|---|---|
| *false* | Request not recognized by the handler. |
| *true* | Request handled. |

#### 7.51.5.7 typedef const USBDescriptor∗(∗ usbgetdescriptor_t) (USBDriver ∗usbp, uint8_t dtype, uint8_t dindex, uint16_t lang)

Type of an USB descriptor-retrieving callback.

### 7.51.6 Enumeration Type Documentation

#### 7.51.6.1 enum usbstate_t

Type of a driver state machine possible states.

**Enumerator**

***USB_UNINIT*** Not initialized.

***USB_STOP*** Stopped.

***USB_READY*** Ready, after bus reset.

***USB_SELECTED*** Address assigned.

***USB_ACTIVE*** Active, configuration selected.

***USB_SUSPENDED*** Suspended, low power mode.

#### 7.51.6.2 enum usbepstatus_t

Type of an endpoint status.

**Enumerator**

***EP_STATUS_DISABLED*** Endpoint not active.

***EP_STATUS_STALLED*** Endpoint opened but stalled.

***EP_STATUS_ACTIVE*** Active endpoint.

#### 7.51.6.3 enum usbep0state_t

Type of an endpoint zero state machine states.

**Enumerator**

***USB_EP0_STP_WAITING*** Waiting for SETUP data.

***USB_EP0_IN_TX*** Transmitting.

***USB_EP0_IN_WAITING_TX0*** Waiting transmit 0.

***USB_EP0_IN_SENDING_STS*** Sending status.

***USB_EP0_OUT_WAITING_STS*** Waiting status.

***USB_EP0_OUT_RX*** Receiving.

***USB_EP0_ERROR*** Error, EP0 stalled.

#### 7.51.6.4 enum usbevent_t

Type of an enumeration of the possible USB events.

**Enumerator**

***USB_EVENT_RESET*** Driver has been reset by host.

***USB_EVENT_ADDRESS*** Address assigned.

***USB_EVENT_CONFIGURED*** Configuration selected.

***USB_EVENT_UNCONFIGURED*** Configuration removed.

***USB_EVENT_SUSPEND*** Entering suspend mode.

***USB_EVENT_WAKEUP*** Leaving suspend mode.

***USB_EVENT_STALLED*** Endpoint 0 error, stalled.

### 7.51.7 Function Documentation

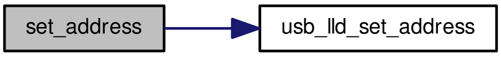
#### 7.51.7.1 static void set_address ( USBDriver * *usbp* ) [static]

SET ADDRESS transaction callback.

**Parameters**

| | | |
|---|---|---|
| in | *usbp* | pointer to the USBDriver object |

Here is the call graph for this function:



#### 7.51.7.2 static bool default_handler ( USBDriver * *usbp* ) [static]

Standard requests handler.

This is the standard requests default handler, most standard requests are handled here, the user can override the standard handling using the `requests_hook_cb` hook in the USBConfig structure.

**Parameters**

| | | |
|---|---|---|
| in | *usbp* | pointer to the USBDriver object |

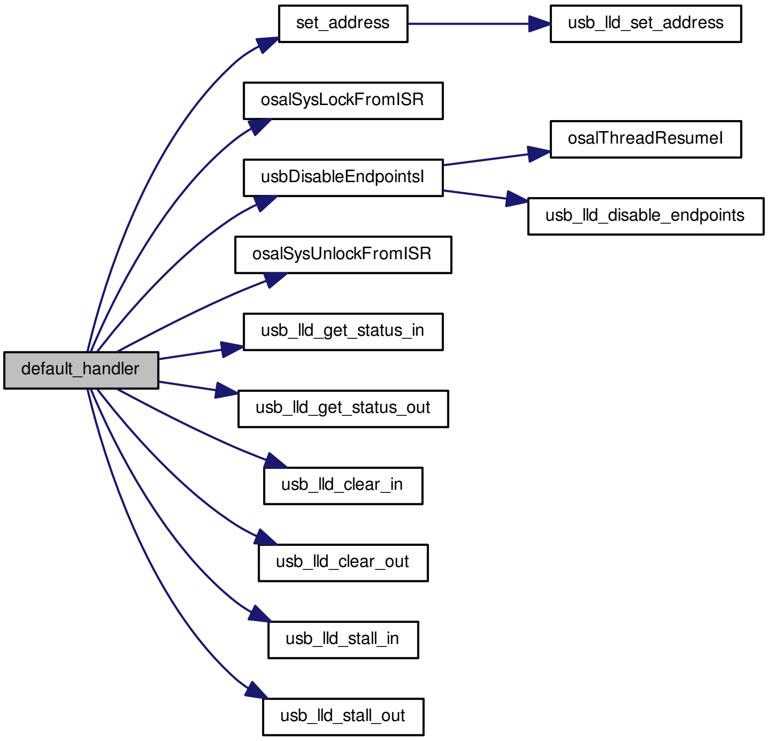
**Returns**

The request handling exit code.

**Return values**

| | |
|---|---|
| *false* | Request not recognized by the handler or error. |
| *true* | Request handled. |

Here is the call graph for this function:



### 7.51.7.3 void usbInit ( void )

USB Driver initialization.

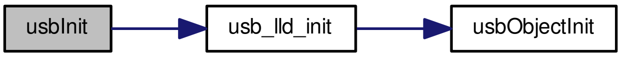
**Note**

This function is implicitly invoked by halInit(), there is no need to explicitly initialize the driver.

**Function Class:**

Initializer, this function just initializes an object and can be invoked before the kernel is initialized.

Here is the call graph for this function:



### 7.51.7.4 void usbObjectInit ( USBDriver ∗ *usbp* )

Initializes the standard part of a USBDriver structure.

**Parameters**

| | | |
|---|---|---|
| out | *usbp* | pointer to the USBDriver object |

**Function Class:**

Initializer, this function just initializes an object and can be invoked before the kernel is initialized.

### 7.51.7.5 void usbStart ( USBDriver ∗ *usbp*, const USBConfig ∗ *config* )

Configures and activates the USB peripheral.

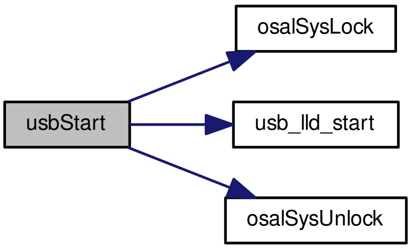
**Parameters**

| | | |
|---|---|---|
| in | *usbp* | pointer to the USBDriver object |
| in | *config* | pointer to the USBConfig object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.51.7.6 void usbStop ( **USBDriver** ∗ *usbp* )

Deactivates the USB peripheral.

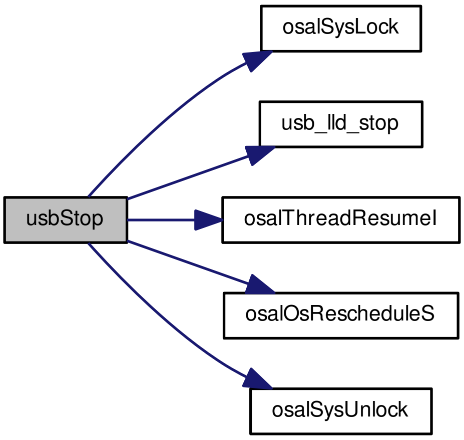
**Parameters**

| | | |
|---|---|---|
| `in` | *usbp* | pointer to the `USBDriver` object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.51.7.7 void usbInitEndpointI ( USBDriver ∗ *usbp,* usbep_t *ep,* const USBEndpointConfig ∗ *epcp* )

Enables an endpoint.

This function enables an endpoint, both IN and/or OUT directions depending on the configuration structure.

**Note**

This function must be invoked in response of a SET_CONFIGURATION or SET_INTERFACE message.

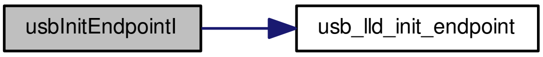
**Parameters**

| | | |
|---|---|---|
| `in` | *usbp* | pointer to the `USBDriver` object |
| `in` | *ep* | endpoint number |
| `in` | *epcp* | the endpoint configuration |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

Here is the call graph for this function:



#### 7.51.7.8 void usbDisableEndpointsI ( USBDriver ∗ *usbp* )

Disables all the active endpoints.

This function disables all the active endpoints except the endpoint zero.

**Note**

This function must be invoked in response of a SET_CONFIGURATION message with configuration number zero.

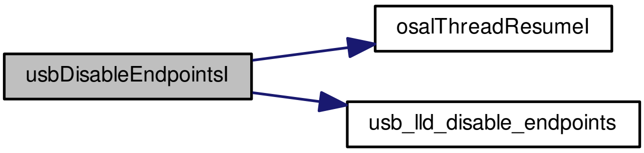
**Parameters**

| | | |
|---|---|---|
| `in` | *usbp* | pointer to the `USBDriver` object |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

Here is the call graph for this function:



#### 7.51.7.9 void usbStartReceiveI ( USBDriver ∗ *usbp,* usbep_t *ep,* uint8_t ∗ *buf,* size_t *n* )

Starts a receive transaction on an OUT endpoint.

**Note**

This function is meant to be called from ISR context outside critical zones because there is a potentially slow operation inside.

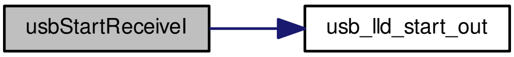
**Parameters**

| | | |
|---|---|---|
| in | *usbp* | pointer to the USBDriver object |
| in | *ep* | endpoint number |
| out | *buf* | buffer where to copy the received data |
| in | *n* | transaction size. It is recommended a multiple of the packet size because the excess is discarded. |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

Here is the call graph for this function:



#### 7.51.7.10 void usbStartTransmitI ( USBDriver ∗ *usbp,* usbep_t *ep,* const uint8_t ∗ *buf,* size_t *n* )

Starts a transmit transaction on an IN endpoint.

**Note**

This function is meant to be called from ISR context outside critical zones because there is a potentially slow operation inside.

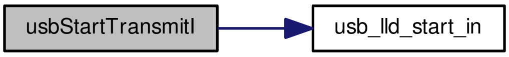
**Parameters**

| | | |
|---|---|---|
| in | *usbp* | pointer to the USBDriver object |
| in | *ep* | endpoint number |
| in | *buf* | buffer where to fetch the data to be transmitted |
| in | *n* | transaction size |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

Here is the call graph for this function:



#### 7.51.7.11 msg_t usbReceive ( USBDriver ∗ *usbp*, usbep_t *ep*, uint8_t ∗ *buf*, size_t *n* )

Performs a receive transaction on an OUT endpoint.

**Parameters**

| | | |
|---|---|---|
| in | *usbp* | pointer to the USBDriver object |
| in | *ep* | endpoint number |
| out | *buf* | buffer where to copy the received data |
| in | *n* | transaction size. It is recommended a multiple of the packet size because the excess is discarded. |

**Returns**

The received effective data size, it can be less than the amount specified.

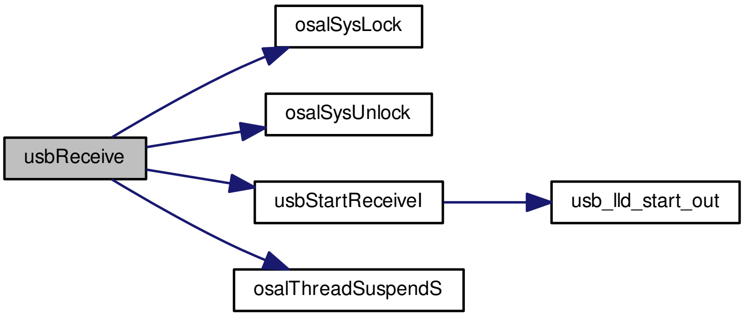
**Return values**

| | |
|---|---|
| *MSG_RESET* | driver not in USB_ACTIVE state or the operation has been aborted by an USB reset or a transition to the USB_SUSPENDED state. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



### 7.51.7.12 msg_t usbTransmit ( USBDriver ∗ *usbp,* usbep_t *ep,* const uint8_t ∗ *buf,* size_t *n* )

Performs a transmit transaction on an IN endpoint.

**Parameters**

| | | |
|---|---|---|
| in | *usbp* | pointer to the USBDriver object |
| in | *ep* | endpoint number |
| in | *buf* | buffer where to fetch the data to be transmitted |
| in | *n* | transaction size |

**Returns**

The operation status.

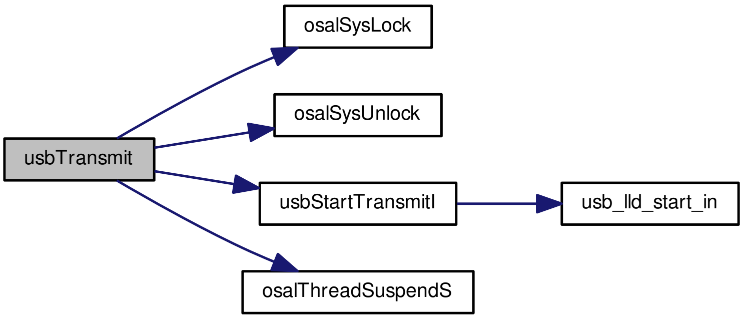
**Return values**

| | |
|---|---|
| *MSG_OK* | operation performed successfully. |
| *MSG_RESET* | driver not in USB_ACTIVE state or the operation has been aborted by an USB reset or a transition to the USB_SUSPENDED state. |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



### 7.51.7.13 bool usbStallReceiveI ( USBDriver * *usbp*, usbep_t *ep* )

Stalls an OUT endpoint.

**Parameters**

| | | |
|---|---|---|
| in | *usbp* | pointer to the `USBDriver` object |
| in | *ep* | endpoint number |

**Returns**

The operation status.

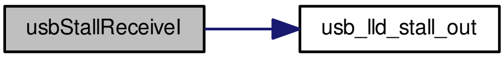
**Return values**

| | |
|---|---|
| *false* | Endpoint stalled. |
| *true* | Endpoint busy, not stalled. |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

Here is the call graph for this function:



#### 7.51.7.14 bool usbStallTransmitI ( USBDriver ∗ *usbp*, usbep_t *ep* )

Stalls an IN endpoint.

**Parameters**

| | | |
|---|---|---|
| in | *usbp* | pointer to the USBDriver object |
| in | *ep* | endpoint number |

**Returns**

The operation status.

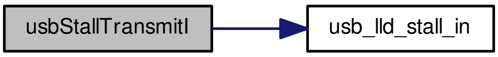
**Return values**

| | |
|---|---|
| *false* | Endpoint stalled. |
| *true* | Endpoint busy, not stalled. |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

Here is the call graph for this function:



#### 7.51.7.15 void usbWakeupHost ( USBDriver ∗ *usbp* )

Host wake-up procedure.

**Note**

It is silently ignored if the USB device is not in the `USB_SUSPENDED` state.

**Parameters**

| | | |
|---|---|---|
| in | *usbp* | pointer to the USBDriver object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

#### 7.51.7.16 void _usb_reset ( USBDriver ∗ *usbp* )

USB reset routine.

This function must be invoked when an USB bus reset condition is detected.

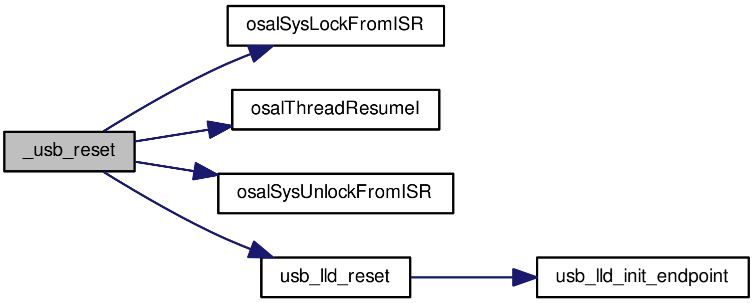
**Parameters**

| | | |
|---|---|---|
| in | *usbp* | pointer to the USBDriver object |

**Function Class:**

Not an API, this function is for internal use only.

Here is the call graph for this function:



#### 7.51.7.17 void _usb_suspend ( USBDriver ∗ *usbp* )

USB suspend routine.

This function must be invoked when an USB bus suspend condition is detected.

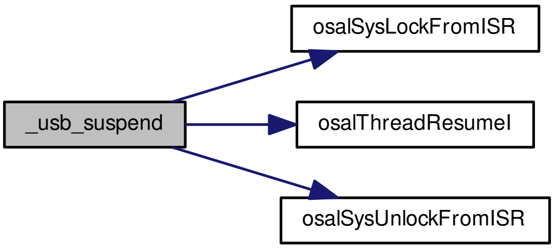
**Parameters**

| | | |
|---|---|---|
| in | *usbp* | pointer to the USBDriver object |

**Function Class:**

Not an API, this function is for internal use only.

Here is the call graph for this function:



#### 7.51.7.18 void _usb_wakeup ( **USBDriver** ∗ *usbp* )

USB wake-up routine.

This function must be invoked when an USB bus wake-up condition is detected.

**Parameters**

| | | |
|---|---|---|
| in | *usbp* | pointer to the `USBDriver` object |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.51.7.19 void _usb_ep0setup ( **USBDriver** ∗ *usbp,* **usbep_t** *ep* )

Default EP0 SETUP callback.

This function is used by the low level driver as default handler for EP0 SETUP events.

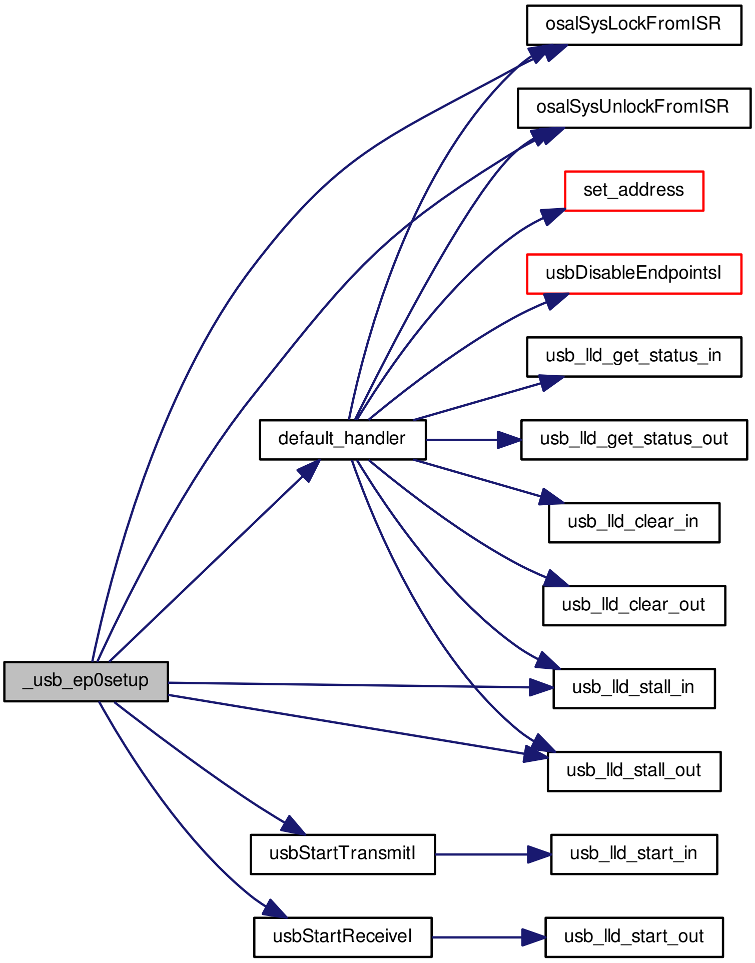
**Parameters**

| | | |
|---|---|---|
| in | *usbp* | pointer to the `USBDriver` object |
| in | *ep* | endpoint number, always zero |

**Function Class:**

Not an API, this function is for internal use only.

Here is the call graph for this function:



### 7.51.7.20 void _usb_ep0in ( USBDriver ∗ *usbp,* usbep_t *ep* )

Default EP0 IN callback.

This function is used by the low level driver as default handler for EP0 IN events.

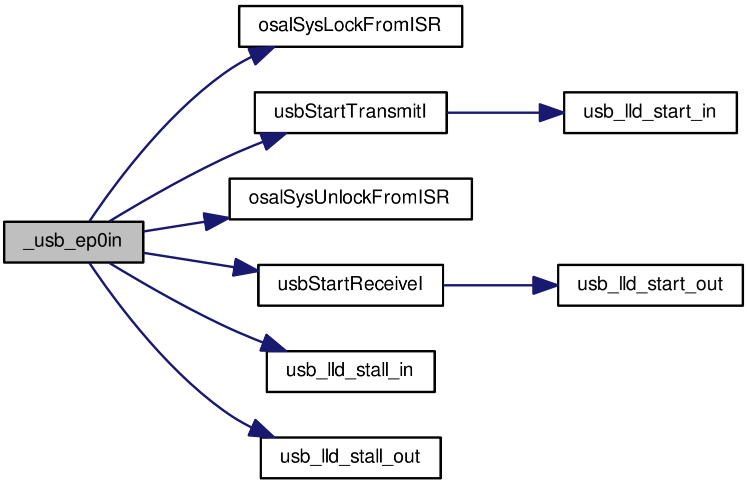
**Parameters**

| | | |
|---|---|---|
| in | *usbp* | pointer to the `USBDriver` object |
| in | *ep* | endpoint number, always zero |

**Function Class:**

Not an API, this function is for internal use only.

Here is the call graph for this function:



#### 7.51.7.21 void _usb_ep0out ( USBDriver ∗ *usbp,* usbep_t *ep* )

Default EP0 OUT callback.

This function is used by the low level driver as default handler for EP0 OUT events.

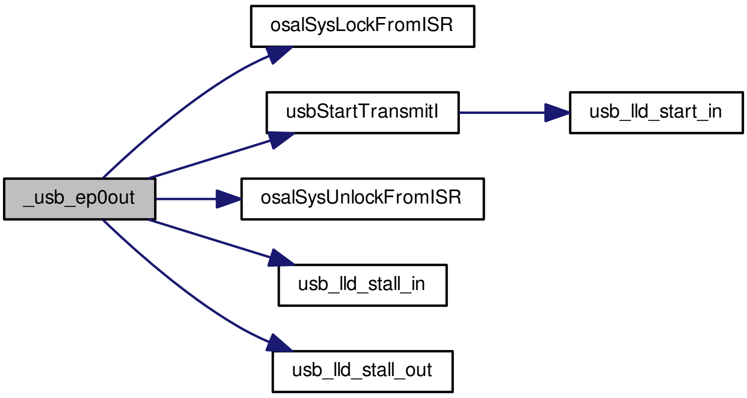
**Parameters**

| | | |
|---|---|---|
| in | *usbp* | pointer to the USBDriver object |
| in | *ep* | endpoint number, always zero |

**Function Class:**

Not an API, this function is for internal use only.

Here is the call graph for this function:



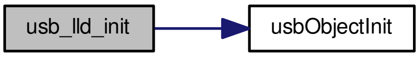
#### 7.51.7.22 void usb_lld_init ( void )

Low level USB driver initialization.

**Function Class:**

Not an API, this function is for internal use only.

Here is the call graph for this function:



#### 7.51.7.23 void usb_lld_start ( USBDriver ∗ *usbp* )

Configures and activates the USB peripheral.

**Parameters**

| | | |
|---|---|---|
| in | *usbp* | pointer to the USBDriver object |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.51.7.24 void usb_lld_stop ( USBDriver * *usbp* )

Deactivates the USB peripheral.

**Parameters**

| | | |
|---|---|---|
| in | *usbp* | pointer to the USBDriver object |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.51.7.25 void usb_lld_reset ( USBDriver * *usbp* )

USB low level reset routine.

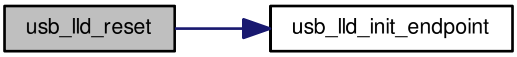
**Parameters**

| | | |
|---|---|---|
| in | *usbp* | pointer to the USBDriver object |

**Function Class:**

Not an API, this function is for internal use only.

Here is the call graph for this function:



#### 7.51.7.26 void usb_lld_set_address ( USBDriver * *usbp* )

Sets the USB address.

**Parameters**

| | | |
|---|---|---|
| in | *usbp* | pointer to the USBDriver object |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.51.7.27 void usb_lld_init_endpoint ( USBDriver * *usbp,* usbep_t *ep* )

Enables an endpoint.

**Parameters**

| | | |
|---|---|---|
| in | *usbp* | pointer to the USBDriver object |
| in | *ep* | endpoint number |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.51.7.28 void usb_lld_disable_endpoints ( USBDriver ∗ *usbp* )

Disables all the active endpoints except the endpoint zero.

**Parameters**

| | | |
|---|---|---|
| in | *usbp* | pointer to the USBDriver object |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.51.7.29 usbepstatus_t usb_lld_get_status_out ( USBDriver ∗ *usbp*, usbep_t *ep* )

Returns the status of an OUT endpoint.

**Parameters**

| | | |
|---|---|---|
| in | *usbp* | pointer to the USBDriver object |
| in | *ep* | endpoint number |

**Returns**

The endpoint status.

**Return values**

| | |
|---|---|
| *EP_STATUS_DISABLED* | The endpoint is not active. |
| *EP_STATUS_STALLED* | The endpoint is stalled. |
| *EP_STATUS_ACTIVE* | The endpoint is active. |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.51.7.30 usbepstatus_t usb_lld_get_status_in ( USBDriver ∗ *usbp*, usbep_t *ep* )

Returns the status of an IN endpoint.

**Parameters**

| | | |
|---|---|---|
| in | *usbp* | pointer to the USBDriver object |
| in | *ep* | endpoint number |

**Returns**

The endpoint status.

**Return values**

| | |
|---|---|
| *EP_STATUS_DISABLED* | The endpoint is not active. |
| *EP_STATUS_STALLED* | The endpoint is stalled. |
| *EP_STATUS_ACTIVE* | The endpoint is active. |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.51.7.31 void usb_lld_read_setup ( USBDriver ∗ *usbp*, usbep_t *ep*, uint8_t ∗ *buf* )

Reads a setup packet from the dedicated packet buffer.

This function must be invoked in the context of the `setup_cb` callback in order to read the received setup packet.

**Precondition**

In order to use this function the endpoint must have been initialized as a control endpoint.

**Postcondition**

The endpoint is ready to accept another packet.

**Parameters**

| | | |
|---|---|---|
| in | *usbp* | pointer to the USBDriver object |
| in | *ep* | endpoint number |
| out | *buf* | buffer where to copy the packet data |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.51.7.32 void usb_lld_prepare_receive ( USBDriver ∗ *usbp*, usbep_t *ep* )

Prepares for a receive operation.

**Parameters**

| | | |
|---|---|---|
| in | *usbp* | pointer to the USBDriver object |
| in | *ep* | endpoint number |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.51.7.33 void usb_lld_prepare_transmit ( USBDriver * *usbp*, usbep_t *ep* )

Prepares for a transmit operation.

**Parameters**

| | | |
|---|---|---|
| in | *usbp* | pointer to the USBDriver object |
| in | *ep* | endpoint number |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.51.7.34 void usb_lld_start_out ( USBDriver * *usbp*, usbep_t *ep* )

Starts a receive operation on an OUT endpoint.

**Parameters**

| | | |
|---|---|---|
| in | *usbp* | pointer to the USBDriver object |
| in | *ep* | endpoint number |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.51.7.35 void usb_lld_start_in ( USBDriver * *usbp*, usbep_t *ep* )

Starts a transmit operation on an IN endpoint.

**Parameters**

| | | |
|---|---|---|
| in | *usbp* | pointer to the USBDriver object |
| in | *ep* | endpoint number |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.51.7.36 void usb_lld_stall_out ( USBDriver * *usbp*, usbep_t *ep* )

Brings an OUT endpoint in the stalled state.

**Parameters**

| | | |
|---|---|---|
| in | *usbp* | pointer to the USBDriver object |
| in | *ep* | endpoint number |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.51.7.37 void usb_lld_stall_in ( USBDriver ∗ *usbp,* usbep_t *ep* )

Brings an IN endpoint in the stalled state.

**Parameters**

| | | |
|---|---|---|
| in | *usbp* | pointer to the USBDriver object |
| in | *ep* | endpoint number |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.51.7.38 void usb_lld_clear_out ( USBDriver ∗ *usbp,* usbep_t *ep* )

Brings an OUT endpoint in the active state.

**Parameters**

| | | |
|---|---|---|
| in | *usbp* | pointer to the USBDriver object |
| in | *ep* | endpoint number |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.51.7.39 void usb_lld_clear_in ( USBDriver ∗ *usbp,* usbep_t *ep* )

Brings an IN endpoint in the active state.

**Parameters**

| | | |
|---|---|---|
| in | *usbp* | pointer to the USBDriver object |
| in | *ep* | endpoint number |

**Function Class:**

Not an API, this function is for internal use only.

### 7.51.8 Variable Documentation

#### 7.51.8.1 USBDriver USBD1

USB1 driver identifier.

#### 7.51.8.2 union { ... } ep0_state [static]

EP0 state.

**Note**

It is an union because IN and OUT endpoints are never used at the same time for EP0.

#### 7.51.8.3 USBInEndpointState { ... } in

IN EP0 state.

#### 7.51.8.4 USBOutEndpointState { ... } out

OUT EP0 state.

#### 7.51.8.5 const USBEndpointConfig ep0config [static]

**Initial value:**

```
= {
  USB_EP_MODE_TYPE_CTRL,
  _usb_ep0setup,
  _usb_ep0in,
  _usb_ep0out,
  0x40,
  0x40,
  &ep0_state.in,
  &ep0_state.out
}
```

EP0 initialization structure.

## 7.52 USB CDC Header

USB CDC Support Header.

### 7.52.1 Detailed Description

USB CDC Support Header.

This header contains definitions and types related to USB CDC.

#### CDC specific messages.

- #define **CDC_SEND_ENCAPSULATED_COMMAND** 0x00U
- #define **CDC_GET_ENCAPSULATED_RESPONSE** 0x01U
- #define **CDC_SET_COMM_FEATURE** 0x02U
- #define **CDC_GET_COMM_FEATURE** 0x03U
- #define **CDC_CLEAR_COMM_FEATURE** 0x04U
- #define **CDC_SET_AUX_LINE_STATE** 0x10U
- #define **CDC_SET_HOOK_STATE** 0x11U
- #define **CDC_PULSE_SETUP** 0x12U
- #define **CDC_SEND_PULSE** 0x13U
- #define **CDC_SET_PULSE_TIME** 0x14U
- #define **CDC_RING_AUX_JACK** 0x15U
- #define **CDC_SET_LINE_CODING** 0x20U
- #define **CDC_GET_LINE_CODING** 0x21U
- #define **CDC_SET_CONTROL_LINE_STATE** 0x22U
- #define **CDC_SEND_BREAK** 0x23U
- #define **CDC_SET_RINGER_PARMS** 0x30U
- #define **CDC_GET_RINGER_PARMS** 0x31U
- #define **CDC_SET_OPERATION_PARMS** 0x32U
- #define **CDC_GET_OPERATION_PARMS** 0x33U

#### CDC classes

- #define **CDC_COMMUNICATION_INTERFACE_CLASS** 0x02U
- #define **CDC_DATA_INTERFACE_CLASS** 0x0AU

#### CDC subclasses

- #define **CDC_ABSTRACT_CONTROL_MODEL** 0x02U

#### CDC descriptors

- #define **CDC_CS_INTERFACE** 0x24U

#### CDC subdescriptors

- #define **CDC_HEADER** 0x00U
- #define **CDC_CALL_MANAGEMENT** 0x01U
- #define **CDC_ABSTRACT_CONTROL_MANAGEMENT** 0x02U
- #define **CDC_UNION** 0x06U

### Line Control bit definitions.

- #define **LC_STOP_1** 0U
- #define **LC_STOP_1P5** 1U
- #define **LC_STOP_2** 2U
- #define **LC_PARITY_NONE** 0U
- #define **LC_PARITY_ODD** 1U
- #define **LC_PARITY_EVEN** 2U
- #define **LC_PARITY_MARK** 3U
- #define **LC_PARITY_SPACE** 4U

### Data Structures

- struct cdc_linecoding_t

  *Type of Line Coding structure.*

# 7.53 WDG Driver

Generic WDG Driver.

## 7.53.1 Detailed Description

Generic WDG Driver.

This module defines an abstract interface for a watchdog timer.

**Precondition**

In order to use the WDG driver the `HAL_USE_WDG` option must be enabled in `halconf.h`.

### Macros

- #define wdgResetI(wdgp) wdg_lld_reset(wdgp)

  *Resets WDG's counter.*

### Configuration options

- #define PLATFORM_WDG_USE_WDG1 FALSE

  *WDG1 driver enable switch.*

### Typedefs

- typedef struct WDGDriver WDGDriver

  *Type of a structure representing an WDG driver.*

### Data Structures

- struct WDGConfig

  *Driver configuration structure.*
- struct WDGDriver

  *Structure representing an WDG driver.*

### Functions

- void wdgInit (void)

  *WDG Driver initialization.*
- void wdgStart (WDGDriver ∗wdgp, const WDGConfig ∗config)

  *Configures and activates the WDG peripheral.*
- void wdgStop (WDGDriver ∗wdgp)

  *Deactivates the WDG peripheral.*
- void wdgReset (WDGDriver ∗wdgp)

  *Resets WDG's counter.*
- void wdg_lld_init (void)

  *Low level WDG driver initialization.*
- void wdg_lld_start (WDGDriver ∗wdgp)

  *Configures and activates the WDG peripheral.*
- void wdg_lld_stop (WDGDriver ∗wdgp)

*Deactivates the WDG peripheral.*

- void wdg_lld_reset (WDGDriver ∗wdgp)

  *Reloads WDG's counter.*

## Enumerations

## 7.53.2 Macro Definition Documentation

### 7.53.2.1 #define wdgResetI( *wdgp* ) wdg_lld_reset(wdgp)

Resets WDG's counter.

**Parameters**

| | | |
|---|---|---|
| in | *wdgp* | pointer to the `WDGDriver` object |

**Function Class:**

This is an **I-Class** API, this function can be invoked from within a system lock zone by both threads and interrupt handlers.

### 7.53.2.2 #define PLATFORM_WDG_USE_WDG1 FALSE

WDG1 driver enable switch.

**Note**

The default is `FALSE`.

## 7.53.3 Typedef Documentation

### 7.53.3.1 typedef struct WDGDriver WDGDriver

Type of a structure representing an WDG driver.

## 7.53.4 Enumeration Type Documentation

### 7.53.4.1 enum wdgstate_t

Driver state machine possible states.

**Enumerator**

***WDG_UNINIT*** Not initialized.

***WDG_STOP*** Stopped.

***WDG_READY*** Ready.

## 7.53.5 Function Documentation

### 7.53.5.1 void wdgInit ( void )

WDG Driver initialization.

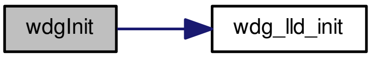
**Note**

This function is implicitly invoked by `halInit()`, there is no need to explicitly initialize the driver.

**Function Class:**

Initializer, this function just initializes an object and can be invoked before the kernel is initialized.

Here is the call graph for this function:



#### 7.53.5.2 void wdgStart ( WDGDriver * *wdgp*, const WDGConfig * *config* )

Configures and activates the WDG peripheral.

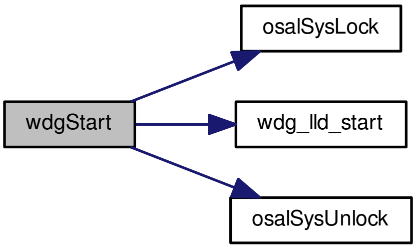
**Parameters**

| | | |
|---|---|---|
| in | *wdgp* | pointer to the `WDGDriver` object |
| in | *config* | pointer to the `WDGConfig` object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.53.5.3 void wdgStop ( WDGDriver * *wdgp* )

Deactivates the WDG peripheral.

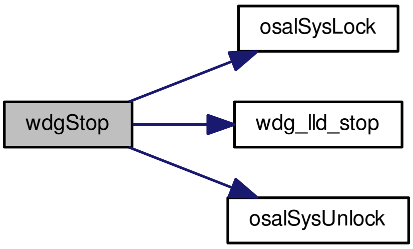
**Parameters**

| | | |
|---|---|---|
| in | *wdgp* | pointer to the WDGDriver object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



### 7.53.5.4 void wdgReset ( WDGDriver ∗ *wdgp* )

Resets WDG's counter.

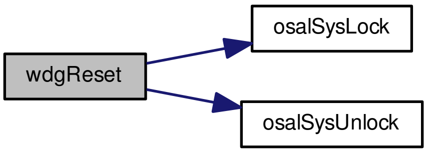
**Parameters**

| | | |
|---|---|---|
| in | *wdgp* | pointer to the WDGDriver object |

**Function Class:**

Normal API, this function can be invoked by regular system threads but not from within a lock zone.

Here is the call graph for this function:



#### 7.53.5.5 void wdg_lld_init ( void )

Low level WDG driver initialization.

**Function Class:**

Not an API, this function is for internal use only.

#### 7.53.5.6 void wdg_lld_start ( WDGDriver * *wdgp* )

Configures and activates the WDG peripheral.

**Parameters**

| | | |
|---|---|---|
| in | *wdgp* | pointer to the WDGDriver object |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.53.5.7 void wdg_lld_stop ( WDGDriver * *wdgp* )

Deactivates the WDG peripheral.

**Parameters**

| | | |
|---|---|---|
| in | *wdgp* | pointer to the WDGDriver object |

**Function Class:**

Not an API, this function is for internal use only.

#### 7.53.5.8 void wdg_lld_reset ( WDGDriver * *wdgp* )

Reloads WDG's counter.

**Parameters**

| | | |
|---|---|---|
| in | *wdgp* | pointer to the WDGDriver object |

**Function Class:**

Not an API, this function is for internal use only.

# Chapter 8

# Data Structure Documentation

## 8.1 ADCConfig Struct Reference

Driver configuration structure.

```
#include <hal_adc_lld.h>
```

Collaboration diagram for ADCConfig:

### 8.1.1 Detailed Description

Driver configuration structure.

**Note**

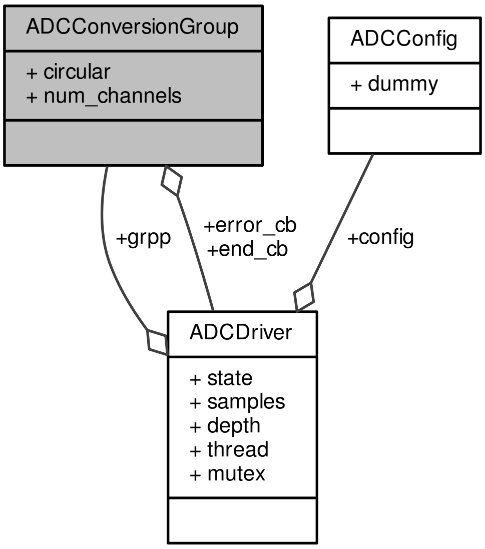
It could be empty on some architectures.

## 8.2 ADCConversionGroup Struct Reference

Conversion group configuration structure.

`#include <hal_adc_lld.h>`

Collaboration diagram for ADCConversionGroup:



### Data Fields

- bool circular

    *Enables the circular buffer mode for the group.*
- adc_channels_num_t num_channels

    *Number of the analog channels belonging to the conversion group.*
- adccallback_t end_cb

    *Callback function associated to the group or `NULL`.*
- adcerrorcallback_t error_cb

    *Error callback or `NULL`.*

### 8.2.1 Detailed Description

Conversion group configuration structure.

This implementation-dependent structure describes a conversion operation.

**Note**

> The use of this configuration structure requires knowledge of PLATFORM ADC cell registers interface, please refer to the PLATFORM reference manual for details.

### 8.2.2 Field Documentation

#### 8.2.2.1 bool ADCConversionGroup::circular

Enables the circular buffer mode for the group.

#### 8.2.2.2 adc_channels_num_t ADCConversionGroup::num_channels

Number of the analog channels belonging to the conversion group.

#### 8.2.2.3 adccallback_t ADCConversionGroup::end_cb

Callback function associated to the group or `NULL`.

#### 8.2.2.4 adcerrorcallback_t ADCConversionGroup::error_cb

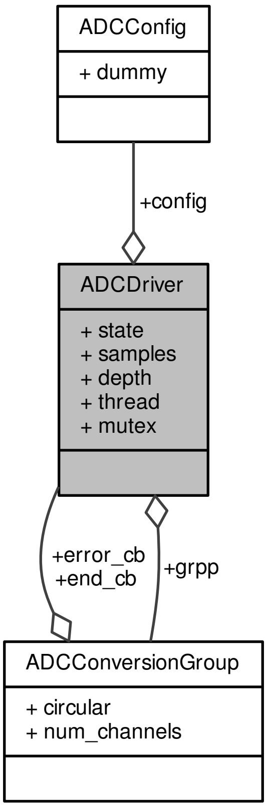
Error callback or `NULL`.

## 8.3 ADCDriver Struct Reference

Structure representing an ADC driver.

```
#include <hal_adc_lld.h>
```

Collaboration diagram for ADCDriver:



## Data Fields

- adcstate_t state

  *Driver state.*
- const ADCConfig ∗ config

  *Current configuration data.*
- adcsample_t ∗ samples

  *Current samples buffer pointer or* `NULL`.
- size_t depth

  *Current samples buffer depth or* `0`.
- const ADCConversionGroup ∗ grpp

  *Current conversion group pointer or* `NULL`.
- thread_reference_t thread

  *Waiting thread.*
- mutex_t mutex

  *Mutex protecting the peripheral.*

### 8.3.1 Detailed Description

Structure representing an ADC driver.

### 8.3.2 Field Documentation

#### 8.3.2.1 adcstate_t ADCDriver::state

Driver state.

#### 8.3.2.2 const ADCConfig* ADCDriver::config

Current configuration data.

#### 8.3.2.3 adcsample_t* ADCDriver::samples

Current samples buffer pointer or `NULL`.

#### 8.3.2.4 size_t ADCDriver::depth

Current samples buffer depth or `0`.

#### 8.3.2.5 const ADCConversionGroup* ADCDriver::grpp

Current conversion group pointer or `NULL`.

#### 8.3.2.6 thread_reference_t ADCDriver::thread

Waiting thread.

#### 8.3.2.7 mutex_t ADCDriver::mutex

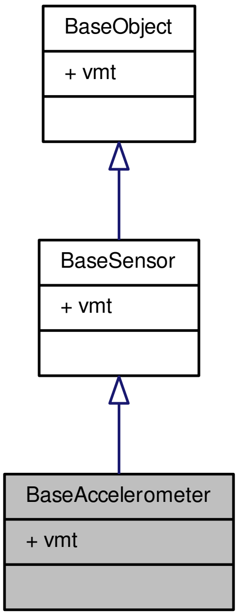
Mutex protecting the peripheral.

## 8.4 BaseAccelerometer Struct Reference

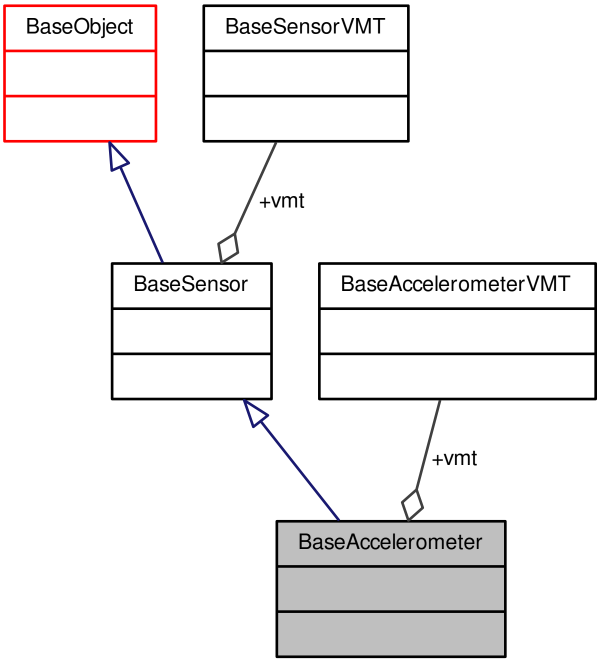
Base accelerometer class.

```
#include <hal_accelerometer.h>
```

Inheritance diagram for BaseAccelerometer:



Collaboration diagram for BaseAccelerometer:



### Data Fields

- const struct BaseAccelerometerVMT ∗ vmt

  *Virtual Methods Table.*

### 8.4.1 Detailed Description

Base accelerometer class.

This class represents a generic a generic accelerometer.

### 8.4.2 Field Documentation

#### 8.4.2.1 const struct BaseAccelerometerVMT∗ BaseAccelerometer::vmt

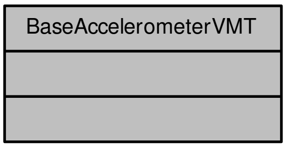
Virtual Methods Table.

## 8.5 BaseAccelerometerVMT Struct Reference

`BaseAccelerometer` virtual methods table.

`#include <hal_accelerometer.h>`

Collaboration diagram for BaseAccelerometerVMT:



### 8.5.1 Detailed Description

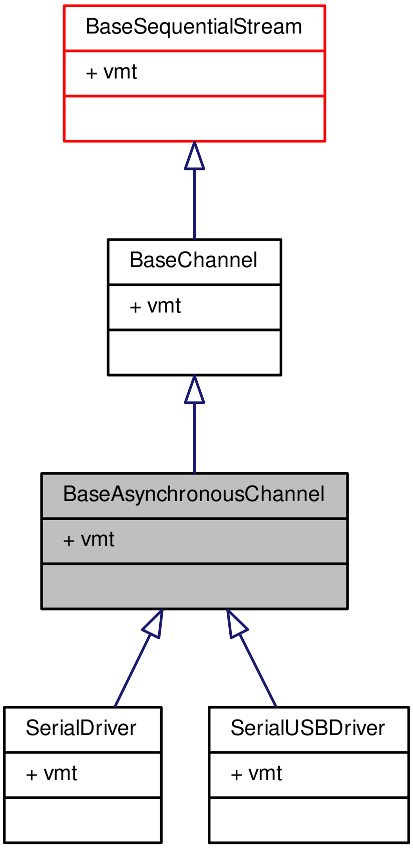
BaseAccelerometer virtual methods table.

## 8.6 BaseAsynchronousChannel Struct Reference

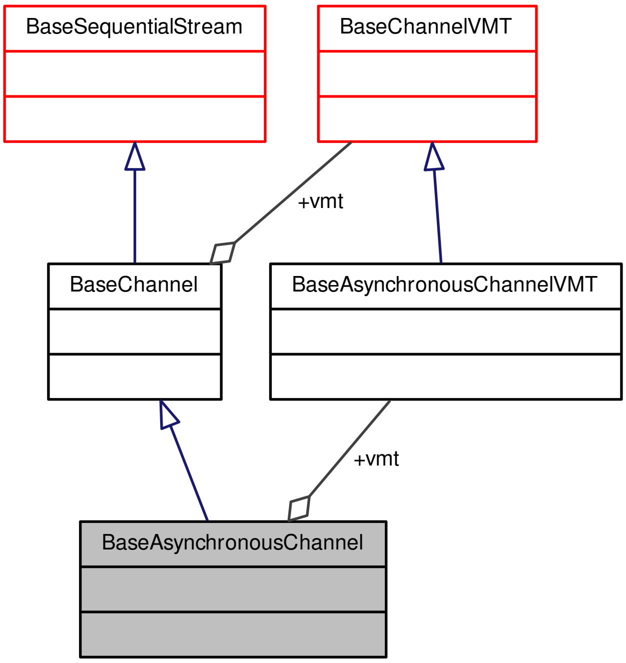
Base asynchronous channel class.

`#include <hal_channels.h>`

Inheritance diagram for BaseAsynchronousChannel:



Collaboration diagram for BaseAsynchronousChannel:



### Data Fields

- const struct BaseAsynchronousChannelVMT ∗ vmt

  *Virtual Methods Table.*

### 8.6.1 Detailed Description

Base asynchronous channel class.

This class extends `BaseChannel` by adding event sources fields for asynchronous I/O for use in an event-driven environment.

### 8.6.2 Field Documentation

#### 8.6.2.1 const struct BaseAsynchronousChannelVMT∗ BaseAsynchronousChannel::vmt

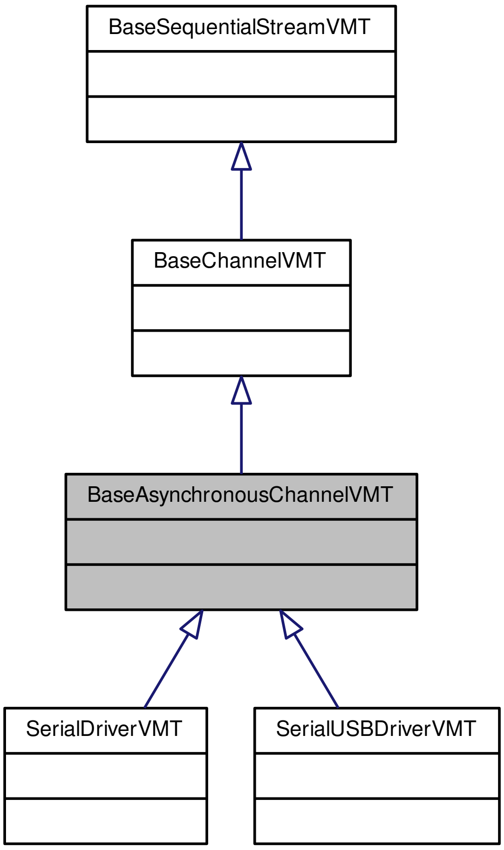
Virtual Methods Table.

## 8.7 BaseAsynchronousChannelVMT Struct Reference

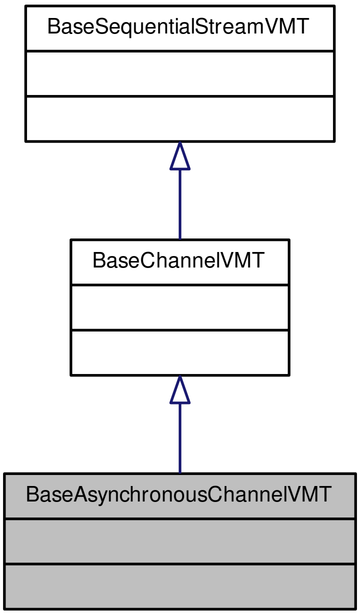
`BaseAsynchronousChannel` virtual methods table.

```
#include <hal_channels.h>
```

Inheritance diagram for BaseAsynchronousChannelVMT:



Collaboration diagram for BaseAsynchronousChannelVMT:



### 8.7.1 Detailed Description

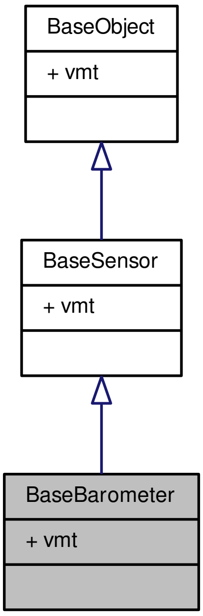
BaseAsynchronousChannel virtual methods table.

## 8.8 BaseBarometer Struct Reference

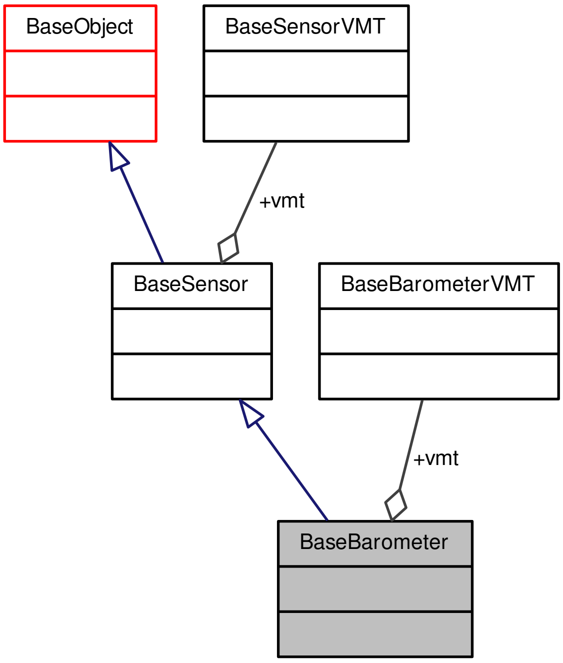
Base barometer class.

```
#include <hal_barometer.h>
```

Inheritance diagram for BaseBarometer:



Collaboration diagram for BaseBarometer:



## Data Fields

- const struct BaseBarometerVMT ∗ vmt

  *Virtual Methods Table.*

### 8.8.1 Detailed Description

Base barometer class.

This class represents a generic barometer.

### 8.8.2 Field Documentation

#### 8.8.2.1 const struct BaseBarometerVMT∗ BaseBarometer::vmt

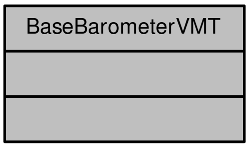
Virtual Methods Table.

## 8.9 BaseBarometerVMT Struct Reference

`BaseBarometer` virtual methods table.

`#include <hal_barometer.h>`

Collaboration diagram for BaseBarometerVMT:



### 8.9.1 Detailed Description

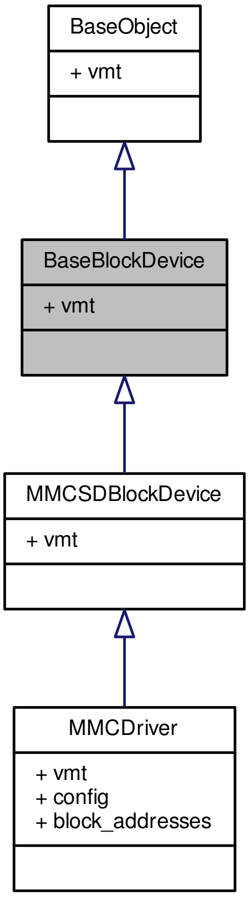
BaseBarometer virtual methods table.

## 8.10 BaseBlockDevice Struct Reference

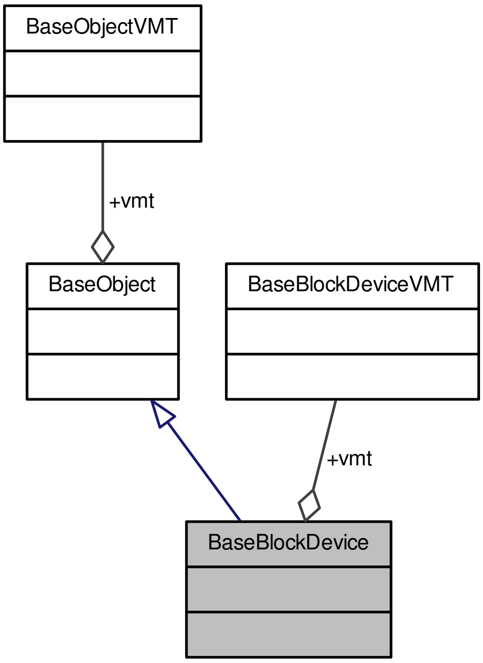
Base block device class.

```
#include <hal_ioblock.h>
```

Inheritance diagram for BaseBlockDevice:



Collaboration diagram for BaseBlockDevice:



## Data Fields

- const struct BaseBlockDeviceVMT ∗ vmt

  *Virtual Methods Table.*

### 8.10.1 Detailed Description

Base block device class.

This class represents a generic, block-accessible, device.

### 8.10.2 Field Documentation

#### 8.10.2.1 const struct BaseBlockDeviceVMT∗ BaseBlockDevice::vmt

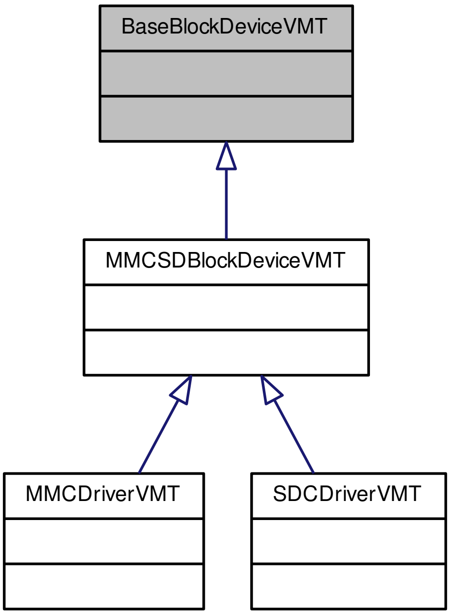
Virtual Methods Table.

## 8.11 BaseBlockDeviceVMT Struct Reference

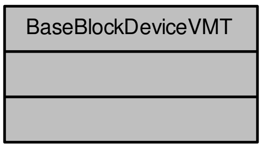
`BaseBlockDevice` virtual methods table.

`#include <hal_ioblock.h>`

Inheritance diagram for BaseBlockDeviceVMT:



Collaboration diagram for BaseBlockDeviceVMT:



### 8.11.1 Detailed Description

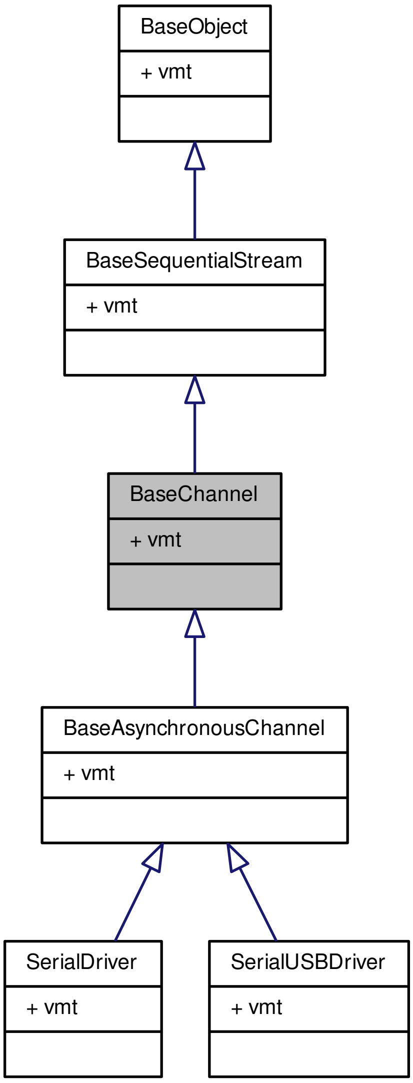
`BaseBlockDevice` virtual methods table.

## 8.12 BaseChannel Struct Reference

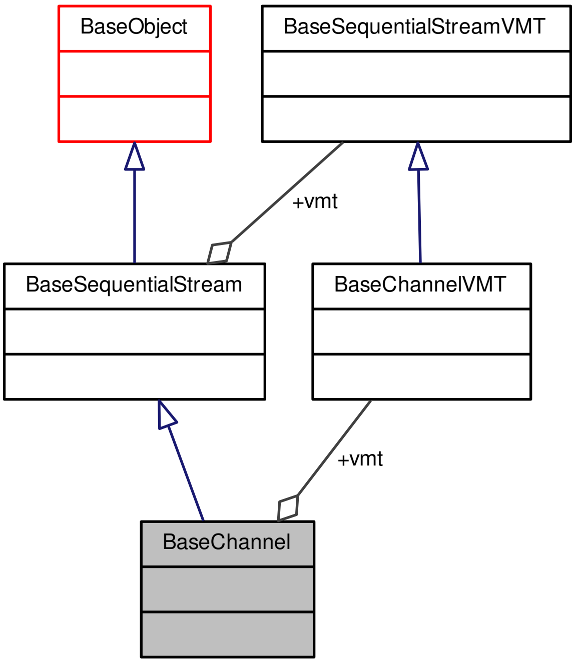
Base channel class.

```
#include <hal_channels.h>
```

Inheritance diagram for BaseChannel:



Collaboration diagram for BaseChannel:



### Data Fields

- const struct BaseChannelVMT ∗ vmt

  *Virtual Methods Table.*

### 8.12.1 Detailed Description

Base channel class.

This class represents a generic, byte-wide, I/O channel. This class introduces generic I/O primitives with timeout specification.

### 8.12.2 Field Documentation

#### 8.12.2.1 const struct BaseChannelVMT∗ BaseChannel::vmt

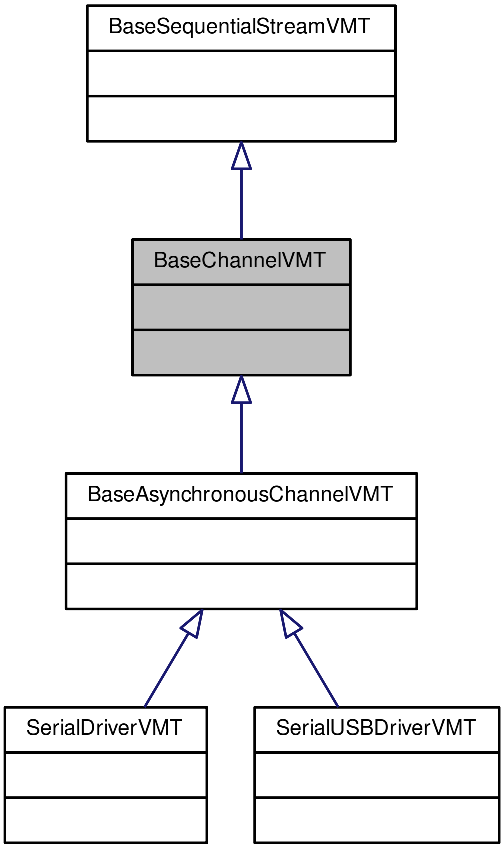
Virtual Methods Table.

## 8.13 BaseChannelVMT Struct Reference

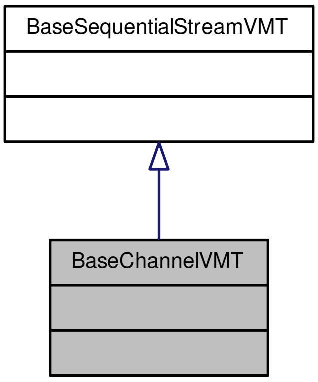
`BaseChannel` virtual methods table.

```
#include <hal_channels.h>
```

Inheritance diagram for BaseChannelVMT:



Collaboration diagram for BaseChannelVMT:



### 8.13.1 Detailed Description

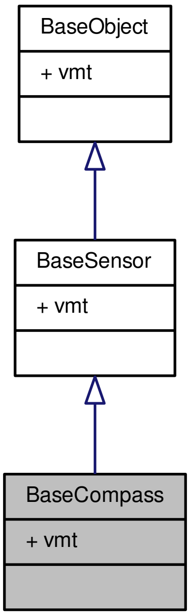
BaseChannel virtual methods table.

## 8.14 BaseCompass Struct Reference

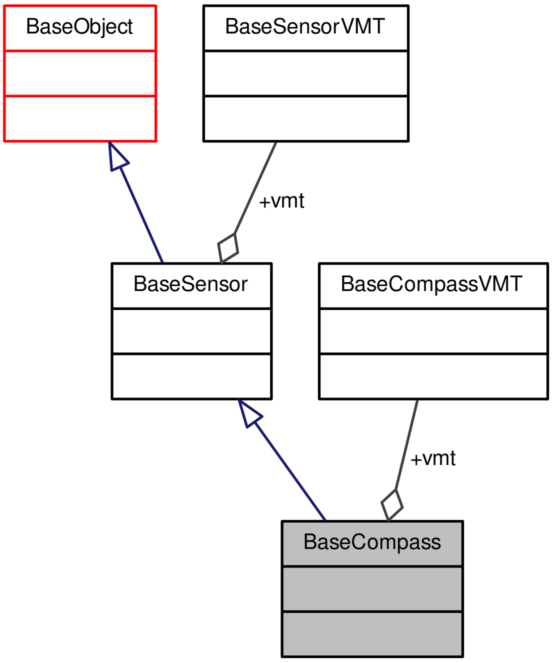
Base compass class.

```
#include <hal_compass.h>
```

Inheritance diagram for BaseCompass:



Collaboration diagram for BaseCompass:



## Data Fields

- const struct BaseCompassVMT ∗ vmt

  *Virtual Methods Table.*

### 8.14.1 Detailed Description

Base compass class.

This class represents a generic compass.

### 8.14.2 Field Documentation

#### 8.14.2.1 const struct BaseCompassVMT∗ BaseCompass::vmt

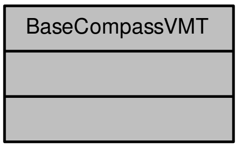
Virtual Methods Table.

## 8.15 BaseCompassVMT Struct Reference

`BaseCompass` virtual methods table.

`#include <hal_compass.h>`

Collaboration diagram for BaseCompassVMT:



### 8.15.1 Detailed Description

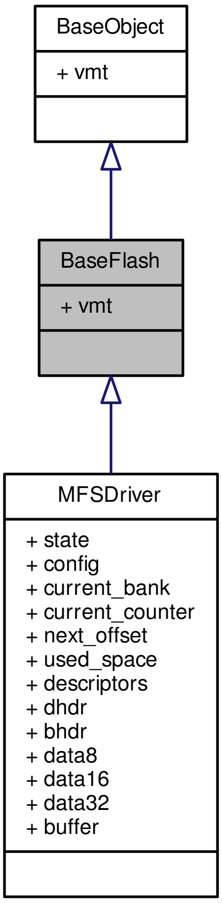
BaseCompass virtual methods table.

## 8.16 BaseFlash Struct Reference

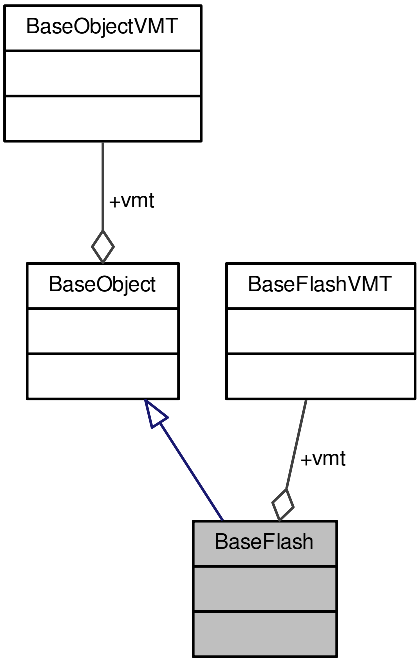
Base flash class.

`#include <hal_flash.h>`

Inheritance diagram for BaseFlash:



Collaboration diagram for BaseFlash:



### Data Fields

- const struct BaseFlashVMT ∗ vmt

  *Virtual Methods Table.*

### 8.16.1 Detailed Description

Base flash class.

### 8.16.2 Field Documentation

#### 8.16.2.1 const struct BaseFlashVMT∗ BaseFlash::vmt

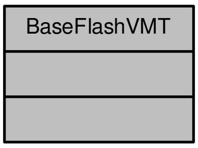
Virtual Methods Table.

## 8.17 BaseFlashVMT Struct Reference

`BaseFlash` virtual methods table.

`#include <hal_flash.h>`

Collaboration diagram for BaseFlashVMT:



### 8.17.1 Detailed Description

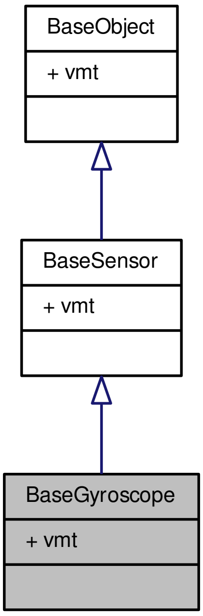
BaseFlash virtual methods table.

## 8.18 BaseGyroscope Struct Reference

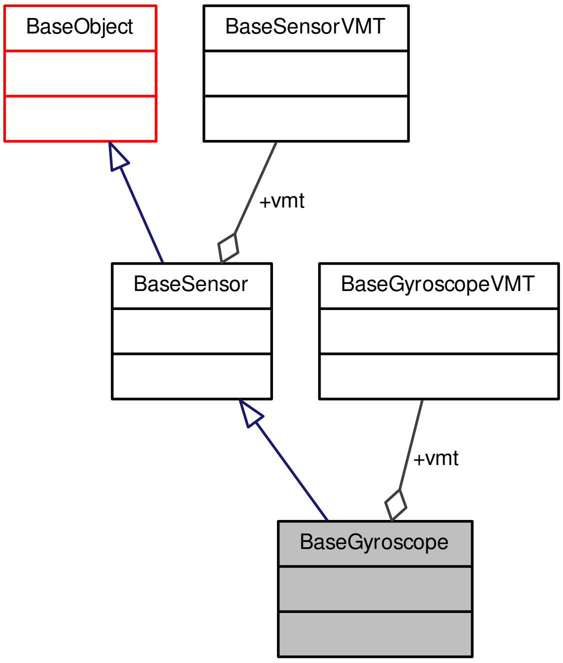
Base gyroscope class.

`#include <hal_gyroscope.h>`

Inheritance diagram for BaseGyroscope:



Collaboration diagram for BaseGyroscope:



## Data Fields

- const struct BaseGyroscopeVMT ∗ vmt

  *Virtual Methods Table.*

### 8.18.1 Detailed Description

Base gyroscope class.

This class represents a generic gyroscope.

### 8.18.2 Field Documentation

#### 8.18.2.1 const struct BaseGyroscopeVMT∗ BaseGyroscope::vmt

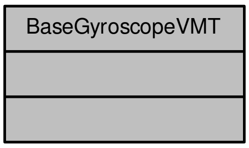
Virtual Methods Table.

## 8.19 BaseGyroscopeVMT Struct Reference

`BaseGyroscope` virtual methods table.

`#include <hal_gyroscope.h>`

Collaboration diagram for BaseGyroscopeVMT:



### 8.19.1 Detailed Description

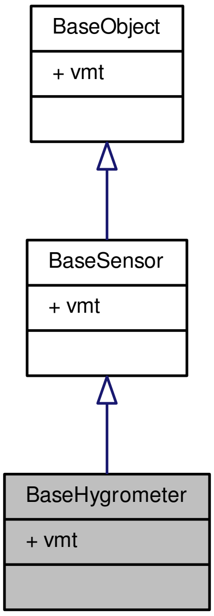
BaseGyroscope virtual methods table.

## 8.20 BaseHygrometer Struct Reference

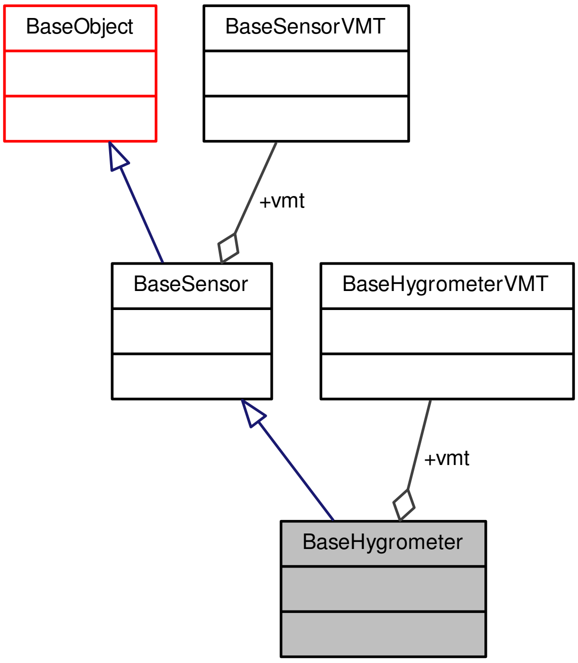
Base hygrometer class.

`#include <hal_hygrometer.h>`

Inheritance diagram for BaseHygrometer:



Collaboration diagram for BaseHygrometer:



### Data Fields

- const struct BaseHygrometerVMT ∗ vmt

  *Virtual Methods Table.*

### 8.20.1 Detailed Description

Base hygrometer class.

This class represents a generic hygrometer.

### 8.20.2 Field Documentation

#### 8.20.2.1 const struct BaseHygrometerVMT∗ BaseHygrometer::vmt

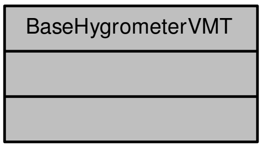
Virtual Methods Table.

## 8.21 BaseHygrometerVMT Struct Reference

`BaseHygrometer` virtual methods table.

`#include <hal_hygrometer.h>`

Collaboration diagram for BaseHygrometerVMT:



### 8.21.1 Detailed Description

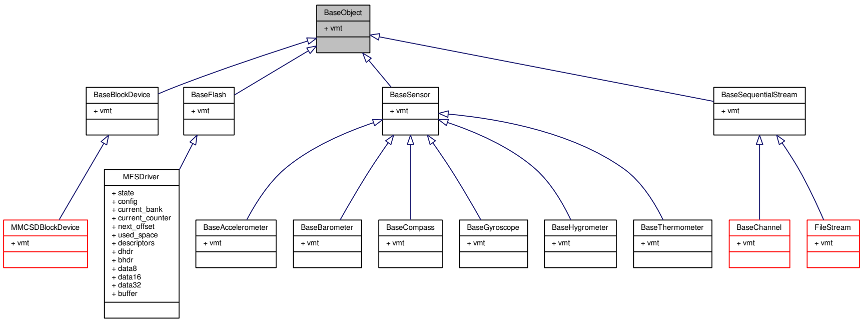
BaseHygrometer virtual methods table.

## 8.22 BaseObject Struct Reference

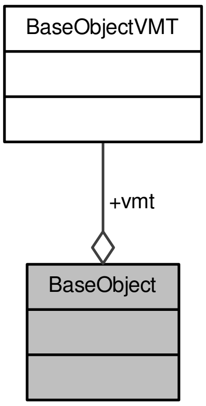
Base stream class.

`#include <hal_objects.h>`

Inheritance diagram for BaseObject:



Collaboration diagram for BaseObject:



### Data Fields

- const struct BaseObjectVMT ∗ vmt

  *Virtual Methods Table.*

### 8.22.1 Detailed Description

Base stream class.

This class represents a generic blocking unbuffered sequential data stream.

### 8.22.2 Field Documentation

#### 8.22.2.1 const struct **BaseObjectVMT**∗ BaseObject::vmt

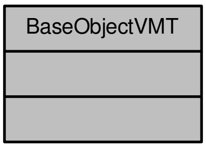
Virtual Methods Table.

## 8.23 BaseObjectVMT Struct Reference

`BaseObject` virtual methods table.

`#include <hal_objects.h>`

Collaboration diagram for BaseObjectVMT:



### 8.23.1 Detailed Description

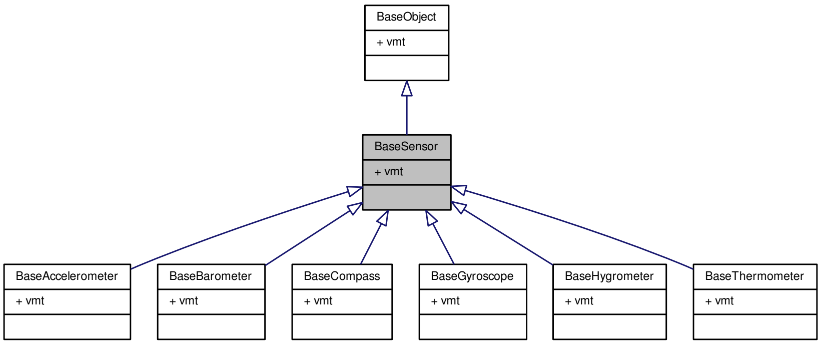
BaseObject virtual methods table.

## 8.24 BaseSensor Struct Reference

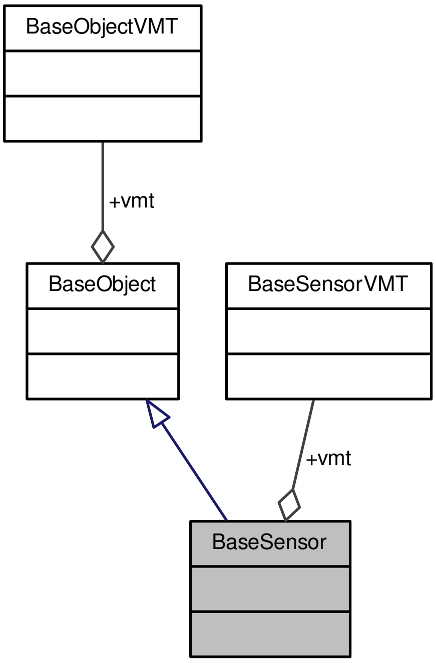
Base stream class.

`#include <hal_sensors.h>`

Inheritance diagram for BaseSensor:



Collaboration diagram for BaseSensor:



## Data Fields

- const struct BaseSensorVMT ∗ vmt

  *Virtual Methods Table.*

### 8.24.1 Detailed Description

Base stream class.

This class represents a generic blocking unbuffered sequential data stream.

### 8.24.2 Field Documentation

#### 8.24.2.1 const struct BaseSensorVMT∗ BaseSensor::vmt

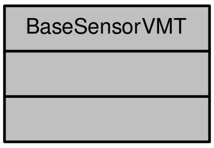
Virtual Methods Table.

## 8.25 BaseSensorVMT Struct Reference

`BaseSensor` virtual methods table.

`#include <hal_sensors.h>`

Collaboration diagram for BaseSensorVMT:



### 8.25.1 Detailed Description

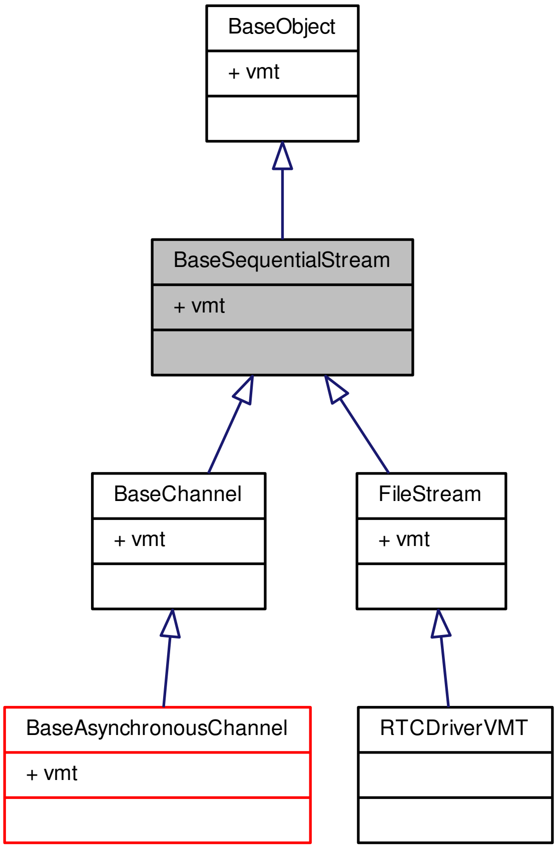
BaseSensor virtual methods table.

## 8.26 BaseSequentialStream Struct Reference

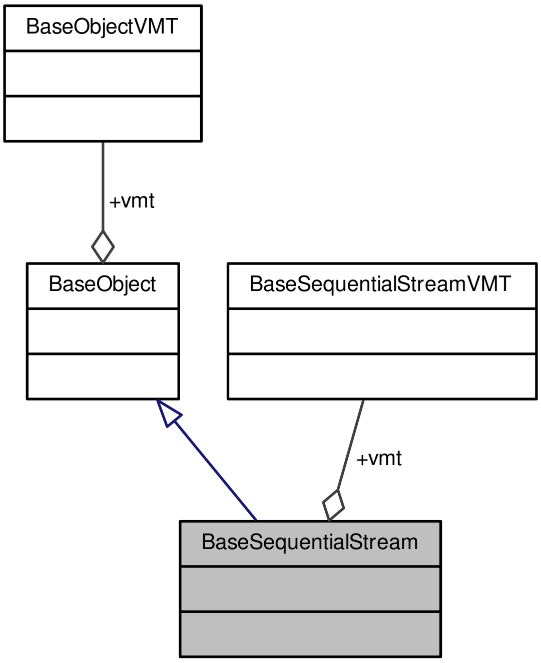
Base stream class.

```
#include <hal_streams.h>
```

Inheritance diagram for BaseSequentialStream:



Collaboration diagram for BaseSequentialStream:



## Data Fields

- const struct BaseSequentialStreamVMT ∗ vmt

    *Virtual Methods Table.*

### 8.26.1 Detailed Description

Base stream class.

This class represents a generic blocking unbuffered sequential data stream.

### 8.26.2 Field Documentation

#### 8.26.2.1 const struct **BaseSequentialStreamVMT**∗ BaseSequentialStream::vmt

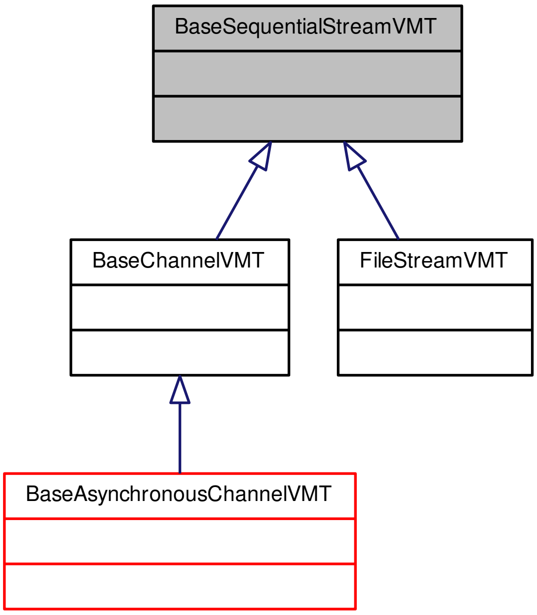
Virtual Methods Table.

## 8.27 BaseSequentialStreamVMT Struct Reference

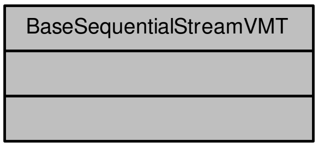
`BaseSequentialStream` virtual methods table.

`#include <hal_streams.h>`

Inheritance diagram for BaseSequentialStreamVMT:



Collaboration diagram for BaseSequentialStreamVMT:



### 8.27.1 Detailed Description

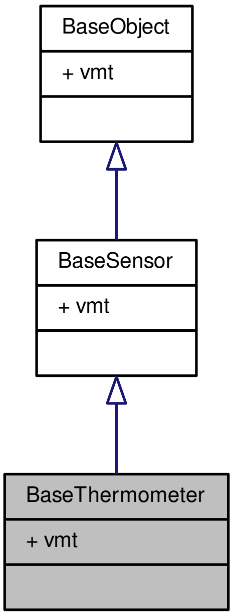
BaseSequentialStream virtual methods table.

## 8.28 BaseThermometer Struct Reference

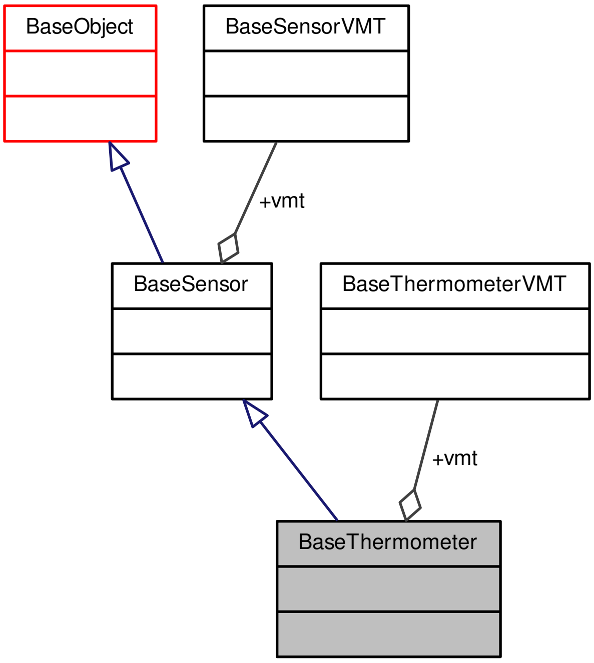
Base thermometer class.

```
#include <hal_thermometer.h>
```

Inheritance diagram for BaseThermometer:



Collaboration diagram for BaseThermometer:



## Data Fields

- const struct BaseThermometerVMT ∗ vmt

  *Virtual Methods Table.*

### 8.28.1 Detailed Description

Base thermometer class.

This class represents a generic thermometer.

### 8.28.2 Field Documentation

#### 8.28.2.1 const struct BaseThermometerVMT∗ BaseThermometer::vmt

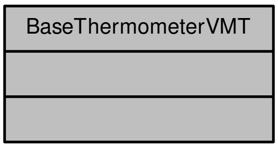
Virtual Methods Table.

## 8.29 BaseThermometerVMT Struct Reference

`BaseThermometer` virtual methods table.

```
#include <hal_thermometer.h>
```

Collaboration diagram for BaseThermometerVMT:



### 8.29.1 Detailed Description

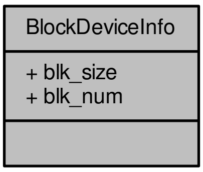
`BaseThermometer` virtual methods table.

## 8.30 BlockDeviceInfo Struct Reference

Block device info.

```
#include <hal_ioblock.h>
```

Collaboration diagram for BlockDeviceInfo:



### Data Fields

- uint32_t blk_size

  *Block size in bytes.*
- uint32_t blk_num

  *Total number of blocks.*

### 8.30.1 Detailed Description

Block device info.

### 8.30.2 Field Documentation

#### 8.30.2.1 uint32_t BlockDeviceInfo::blk_size

Block size in bytes.

#### 8.30.2.2 uint32_t BlockDeviceInfo::blk_num

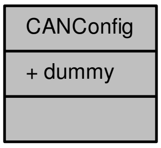
Total number of blocks.

## 8.31 CANConfig Struct Reference

Driver configuration structure.

```
#include <hal_can_lld.h>
```

Collaboration diagram for CANConfig:



### 8.31.1 Detailed Description

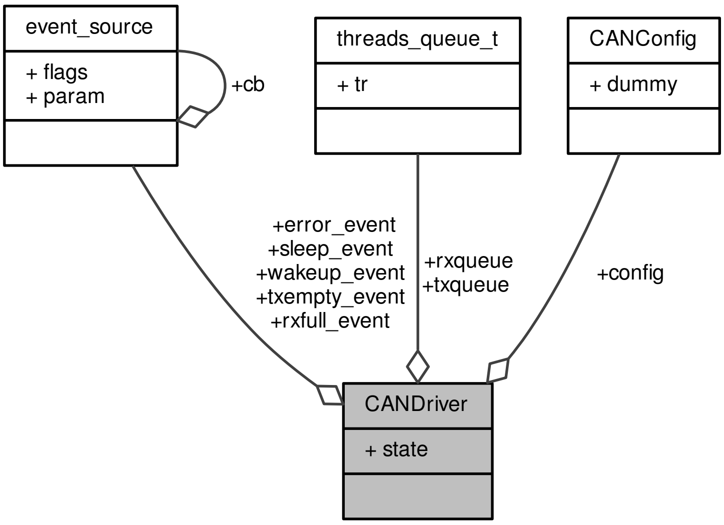
Driver configuration structure.

## 8.32 CANDriver Struct Reference

Structure representing an CAN driver.

```
#include <hal_can_lld.h>
```

Collaboration diagram for CANDriver:



## Data Fields

- canstate_t state

  *Driver state.*
- const CANConfig ∗ config

  *Current configuration data.*
- threads_queue_t txqueue

  *Transmission threads queue.*
- threads_queue_t rxqueue

  *Receive threads queue.*
- event_source_t rxfull_event

  *One or more frames become available.*
- event_source_t txempty_event

  *One or more transmission mailbox become available.*
- event_source_t error_event

  *A CAN bus error happened.*
- event_source_t sleep_event

  *Entering sleep state event.*
- event_source_t wakeup_event

  *Exiting sleep state event.*

### 8.32.1 Detailed Description

Structure representing an CAN driver.

## 8.32.2 Field Documentation

### 8.32.2.1 canstate_t CANDriver::state

Driver state.

### 8.32.2.2 const CANConfig* CANDriver::config

Current configuration data.

### 8.32.2.3 threads_queue_t CANDriver::txqueue

Transmission threads queue.

### 8.32.2.4 threads_queue_t CANDriver::rxqueue

Receive threads queue.

### 8.32.2.5 event_source_t CANDriver::rxfull_event

One or more frames become available.

**Note**

> After broadcasting this event it will not be broadcasted again until the received frames queue has been completely emptied. It is **not** broadcasted for each received frame. It is responsibility of the application to empty the queue by repeatedly invoking `chReceive()` when listening to this event. This behavior minimizes the interrupt served by the system because CAN traffic.
> The flags associated to the listeners will indicate which receive mailboxes become non-empty.

### 8.32.2.6 event_source_t CANDriver::txempty_event

One or more transmission mailbox become available.

**Note**

> The flags associated to the listeners will indicate which transmit mailboxes become empty.

### 8.32.2.7 event_source_t CANDriver::error_event

A CAN bus error happened.

**Note**

> The flags associated to the listeners will indicate the error(s) that have occurred.

### 8.32.2.8 event_source_t CANDriver::sleep_event

Entering sleep state event.

### 8.32.2.9 event_source_t CANDriver::wakeup_event

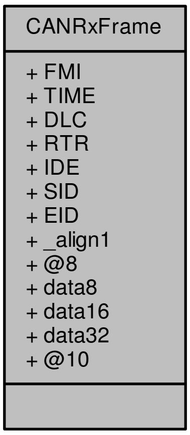
Exiting sleep state event.

## 8.33 CANRxFrame Struct Reference

CAN received frame.

```
#include <hal_can_lld.h>
```

Collaboration diagram for CANRxFrame:



### Data Fields

- uint8_t FMI

  *Filter id.*
- uint16_t TIME

  *Time stamp.*
- uint8_t DLC:4

  *Data length.*
- uint8_t RTR:1

  *Frame type.*
- uint8_t IDE:1

  *Identifier type.*
- uint32_t SID:11

  *Standard identifier.*
- uint32_t EID:29

  *Extended identifier.*
- uint8_t data8 [8]

  *Frame data.*
- uint16_t data16 [4]

  *Frame data.*
- uint32_t data32 [2]

  *Frame data.*

### 8.33.1 Detailed Description

CAN received frame.

**Note**

> Accessing the frame data as word16 or word32 is not portable because machine data endianness, it can be still useful for a quick filling.

### 8.33.2 Field Documentation

#### 8.33.2.1 uint8_t CANRxFrame::FMI

Filter id.

#### 8.33.2.2 uint16_t CANRxFrame::TIME

Time stamp.

#### 8.33.2.3 uint8_t CANRxFrame::DLC

Data length.

#### 8.33.2.4 uint8_t CANRxFrame::RTR

Frame type.

#### 8.33.2.5 uint8_t CANRxFrame::IDE

Identifier type.

#### 8.33.2.6 uint32_t CANRxFrame::SID

Standard identifier.

#### 8.33.2.7 uint32_t CANRxFrame::EID

Extended identifier.

#### 8.33.2.8 uint8_t CANRxFrame::data8[8]

Frame data.

#### 8.33.2.9 uint16_t CANRxFrame::data16[4]

Frame data.

#### 8.33.2.10 uint32_t CANRxFrame::data32[2]

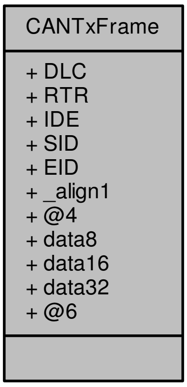
Frame data.

## 8.34 CANTxFrame Struct Reference

CAN transmission frame.

`#include <hal_can_lld.h>`

Collaboration diagram for CANTxFrame:



### Data Fields

- uint8_t DLC:4

  *Data length.*
- uint8_t RTR:1

  *Frame type.*
- uint8_t IDE:1

  *Identifier type.*
- uint32_t SID:11

  *Standard identifier.*
- uint32_t EID:29

  *Extended identifier.*
- uint8_t data8 [8]

  *Frame data.*
- uint16_t data16 [4]

  *Frame data.*
- uint32_t data32 [2]

  *Frame data.*

### 8.34.1 Detailed Description

CAN transmission frame.

**Note**

> Accessing the frame data as word16 or word32 is not portable because machine data endianness, it can be still useful for a quick filling.

## 8.34.2 Field Documentation

### 8.34.2.1 uint8_t CANTxFrame::DLC

Data length.

### 8.34.2.2 uint8_t CANTxFrame::RTR

Frame type.

### 8.34.2.3 uint8_t CANTxFrame::IDE

Identifier type.

### 8.34.2.4 uint32_t CANTxFrame::SID

Standard identifier.

### 8.34.2.5 uint32_t CANTxFrame::EID

Extended identifier.

### 8.34.2.6 uint8_t CANTxFrame::data8[8]

Frame data.

### 8.34.2.7 uint16_t CANTxFrame::data16[4]

Frame data.

### 8.34.2.8 uint32_t CANTxFrame::data32[2]

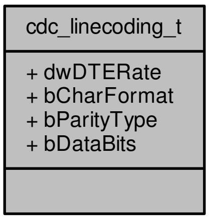
Frame data.

## 8.35 cdc_linecoding_t Struct Reference

Type of Line Coding structure.

```
#include <hal_usb_cdc.h>
```

Collaboration diagram for cdc_linecoding_t:



### 8.35.1 Detailed Description

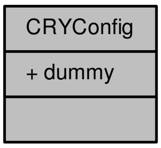
Type of Line Coding structure.

## 8.36 CRYConfig Struct Reference

Driver configuration structure.

```
#include <hal_crypto_lld.h>
```

Collaboration diagram for CRYConfig:



### 8.36.1 Detailed Description

Driver configuration structure.

**Note**

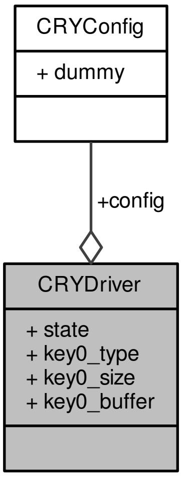
It could be empty on some architectures.

## 8.37 CRYDriver Struct Reference

Structure representing an CRY driver.

```
#include <hal_crypto_lld.h>
```

Collaboration diagram for CRYDriver:



## Data Fields

- crystate_t state

  *Driver state.*
- const CRYConfig ∗ config

  *Current configuration data.*
- cryalgorithm_t key0_type

  *Algorithm type of transient key.*
- size_t key0_size

  *Size of transient key.*
- uint8_t key0_buffer [HAL_CRY_MAX_KEY_SIZE]

  *Key buffer for the fall-back implementation.*

## 8.37.1 Detailed Description

Structure representing an CRY driver.

## 8.37.2 Field Documentation

### 8.37.2.1 crystate_t CRYDriver::state

Driver state.

### 8.37.2.2 const CRYConfig∗ CRYDriver::config

Current configuration data.

#### 8.37.2.3 cryalgorithm_t CRYDriver::key0_type

Algorithm type of transient key.

#### 8.37.2.4 size_t CRYDriver::key0_size

Size of transient key.

#### 8.37.2.5 uint8_t CRYDriver::key0_buffer[HAL_CRY_MAX_KEY_SIZE]

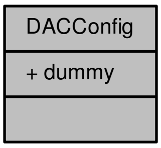
Key buffer for the fall-back implementation.

## 8.38 DACConfig Struct Reference

Driver configuration structure.

`#include <hal_dac_lld.h>`

Collaboration diagram for DACConfig:



### 8.38.1 Detailed Description

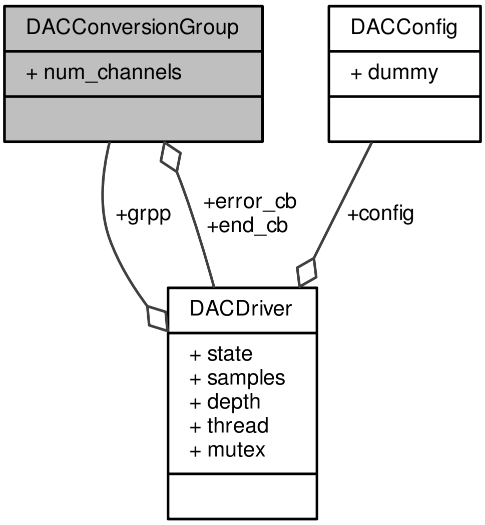
Driver configuration structure.

## 8.39 DACConversionGroup Struct Reference

DAC Conversion group structure.

`#include <hal_dac_lld.h>`

Collaboration diagram for DACConversionGroup:



## Data Fields

- uint32_t num_channels

    *Number of DAC channels.*
- daccallback_t end_cb

    *Operation complete callback or* `NULL`*.*
- dacerrorcallback_t error_cb

    *Error handling callback or* `NULL`*.*

## 8.39.1 Detailed Description

DAC Conversion group structure.

## 8.39.2 Field Documentation

### 8.39.2.1 uint32_t DACConversionGroup::num_channels

Number of DAC channels.

### 8.39.2.2 daccallback_t DACConversionGroup::end_cb

Operation complete callback or `NULL`.

### 8.39.2.3 dacerrorcallback_t DACConversionGroup::error_cb

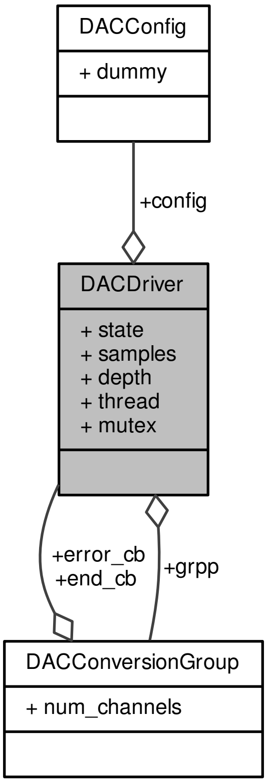
Error handling callback or `NULL`.

## 8.40 DACDriver Struct Reference

Structure representing a DAC driver.

```
#include <hal_dac_lld.h>
```

Collaboration diagram for DACDriver:



### Data Fields

- dacstate_t state

  *Driver state.*
- const DACConversionGroup ∗ grpp

  *Conversion group.*
- dacsample_t ∗ samples

  *Samples buffer pointer.*
- uint16_t depth

  *Samples buffer size.*
- const DACConfig ∗ config

  *Current configuration data.*
- thread_reference_t thread

  *Waiting thread.*
- mutex_t mutex

  *Mutex protecting the bus.*

### 8.40.1 Detailed Description

Structure representing a DAC driver.

### 8.40.2 Field Documentation

#### 8.40.2.1 dacstate_t DACDriver::state

Driver state.

#### 8.40.2.2 const DACConversionGroup* DACDriver::grpp

Conversion group.

#### 8.40.2.3 dacsample_t* DACDriver::samples

Samples buffer pointer.

#### 8.40.2.4 uint16_t DACDriver::depth

Samples buffer size.

#### 8.40.2.5 const DACConfig* DACDriver::config

Current configuration data.

#### 8.40.2.6 thread_reference_t DACDriver::thread

Waiting thread.

#### 8.40.2.7 mutex_t DACDriver::mutex

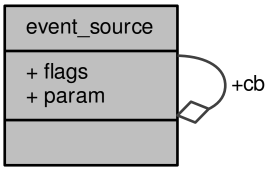
Mutex protecting the bus.

## 8.41 event_source Struct Reference

Events source object.

```
#include <osal.h>
```

Collaboration diagram for event_source:



### Data Fields

- volatile eventflags_t flags

  *Stored event flags.*
- eventcallback_t cb

  *Event source callback.*
- void ∗ param

  *User defined field.*

## 8.41.1 Detailed Description

Events source object.

**Note**

The content of this structure is not part of the API and should not be relied upon. Implementers may define this structure in an entirely different way.
Retrieval and clearing of the flags are not defined in this API and are implementation-dependent.

## 8.41.2 Field Documentation

### 8.41.2.1 volatile **eventflags_t** event_source::flags

Stored event flags.

### 8.41.2.2 **eventcallback_t** event_source::cb

Event source callback.

### 8.41.2.3 void∗ event_source::param

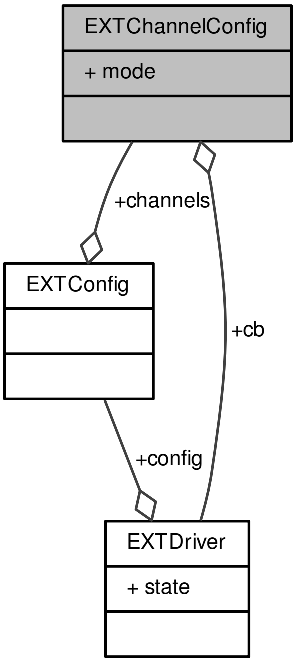
User defined field.

# 8.42 EXTChannelConfig Struct Reference

Channel configuration structure.

```
#include <hal_ext_lld.h>
```

Collaboration diagram for EXTChannelConfig:



### Data Fields

- uint32_t mode

  *Channel mode.*
- extcallback_t cb

  *Channel callback.*

## 8.42.1 Detailed Description

Channel configuration structure.

## 8.42.2 Field Documentation

### 8.42.2.1 uint32_t EXTChannelConfig::mode

Channel mode.

### 8.42.2.2 extcallback_t EXTChannelConfig::cb

Channel callback.

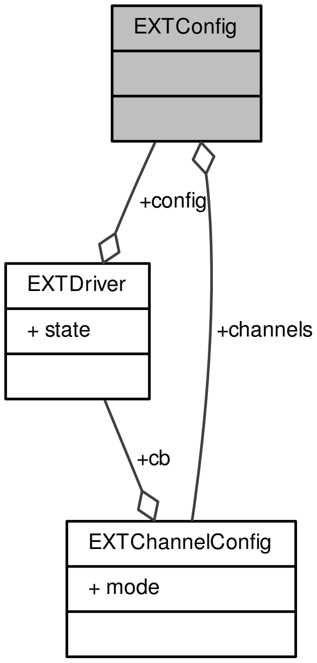
In the STM32 implementation a `NULL` callback pointer is valid and configures the channel as an event sources instead of an interrupt source.

## 8.43 EXTConfig Struct Reference

Driver configuration structure.

`#include <hal_ext_lld.h>`

Collaboration diagram for EXTConfig:



### Data Fields

- EXTChannelConfig channels [EXT_MAX_CHANNELS]

  *Channel configurations.*

### 8.43.1 Detailed Description

Driver configuration structure.

**Note**

It could be empty on some architectures.

### 8.43.2 Field Documentation

#### 8.43.2.1 EXTChannelConfig EXTConfig::channels[EXT_MAX_CHANNELS]

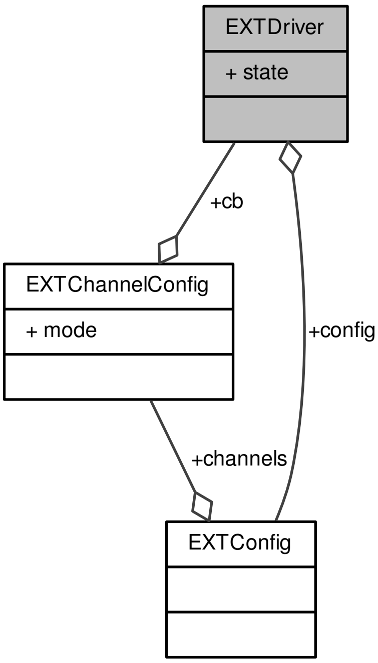
Channel configurations.

## 8.44 EXTDriver Struct Reference

Structure representing an EXT driver.

`#include <hal_ext_lld.h>`

Collaboration diagram for EXTDriver:



### Data Fields

- extstate_t state

  *Driver state.*
- const EXTConfig ∗ config

  *Current configuration data.*

### 8.44.1 Detailed Description

Structure representing an EXT driver.

### 8.44.2 Field Documentation

#### 8.44.2.1 extstate_t EXTDriver::state

Driver state.

#### 8.44.2.2 const EXTConfig∗ EXTDriver::config

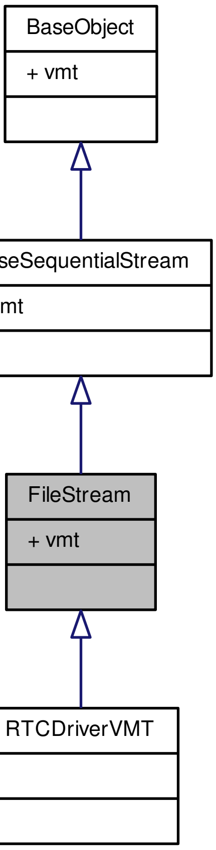
Current configuration data.

## 8.45 FileStream Struct Reference

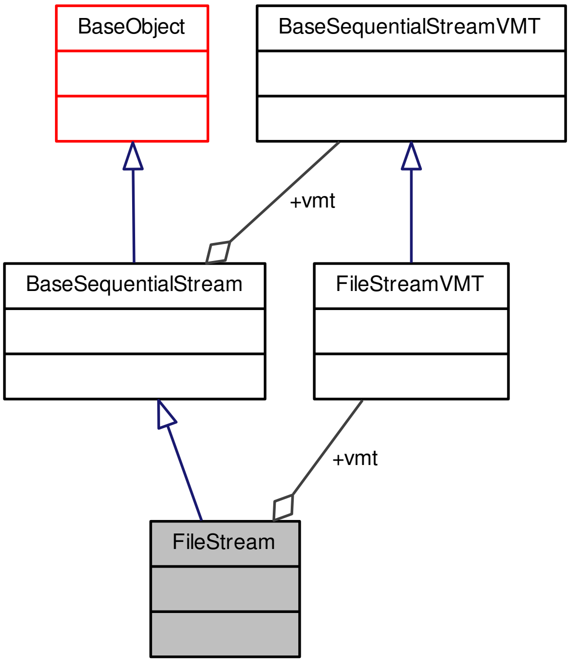
Base file stream class.

`#include <hal_files.h>`

Inheritance diagram for FileStream:



Collaboration diagram for FileStream:



### Data Fields

- const struct FileStreamVMT ∗ vmt

  *Virtual Methods Table.*

### 8.45.1 Detailed Description

Base file stream class.

This class represents a generic file data stream.

### 8.45.2 Field Documentation

#### 8.45.2.1 const struct **FileStreamVMT**∗ FileStream::vmt

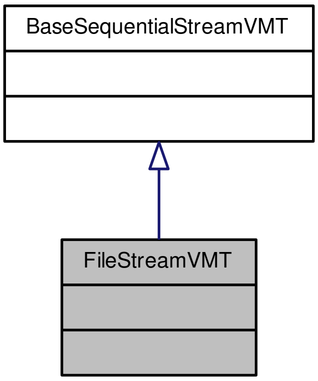
Virtual Methods Table.

## 8.46 FileStreamVMT Struct Reference

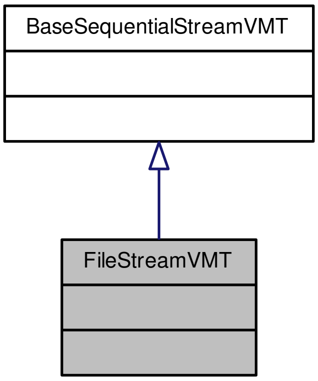
`FileStream` virtual methods table.

`#include <hal_files.h>`

Inheritance diagram for FileStreamVMT:



Collaboration diagram for FileStreamVMT:



### 8.46.1 Detailed Description

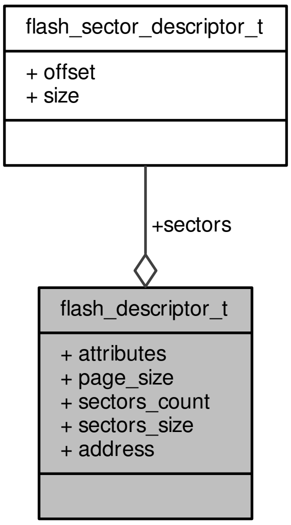
FileStream virtual methods table.

## 8.47 flash_descriptor_t Struct Reference

Type of a flash device descriptor.

`#include <hal_flash.h>`

Collaboration diagram for flash_descriptor_t:



## Data Fields

- uint32_t attributes

  *Device_attributes.*
- uint32_t page_size

  *Size of write page.*
- flash_sector_t sectors_count

  *Number of sectors in the device.*
- const flash_sector_descriptor_t ∗ sectors

  *List of sectors for devices with non-uniform sector sizes.*
- uint32_t sectors_size

  *Size of sectors for devices with uniform sector size.*
- flash_offset_t address

  *Flash address if memory mapped or zero.*

## 8.47.1 Detailed Description

Type of a flash device descriptor.

## 8.47.2 Field Documentation

### 8.47.2.1 uint32_t flash_descriptor_t::attributes

Device_attributes.

#### 8.47.2.2 uint32_t flash_descriptor_t::page_size

Size of write page.

#### 8.47.2.3 flash_sector_t flash_descriptor_t::sectors_count

Number of sectors in the device.

#### 8.47.2.4 const flash_sector_descriptor_t* flash_descriptor_t::sectors

List of sectors for devices with non-uniform sector sizes.

**Note**

If `NULL` then the device has uniform sectors size equal to `sector_size`.

#### 8.47.2.5 uint32_t flash_descriptor_t::sectors_size

Size of sectors for devices with uniform sector size.

**Note**

If zero then the device has non uniform sectors described by the `sectors` array.

#### 8.47.2.6 flash_offset_t flash_descriptor_t::address

Flash address if memory mapped or zero.

**Note**

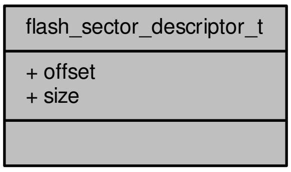
Conventionally, non memory mapped devices have address zero.

## 8.48 flash_sector_descriptor_t Struct Reference

Flash sector descriptor.

`#include <hal_flash.h>`

Collaboration diagram for flash_sector_descriptor_t:



## Data Fields

- flash_offset_t offset

  *Sector offset.*
- uint32_t size

  *Sector size.*

### 8.48.1 Detailed Description

Flash sector descriptor.

### 8.48.2 Field Documentation

#### 8.48.2.1 flash_offset_t flash_sector_descriptor_t::offset

Sector offset.

#### 8.48.2.2 uint32_t flash_sector_descriptor_t::size

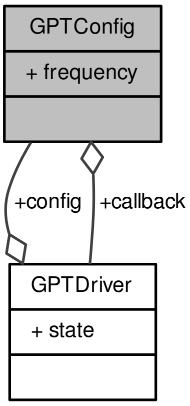
Sector size.

## 8.49 GPTConfig Struct Reference

Driver configuration structure.

```
#include <hal_gpt_lld.h>
```

Collaboration diagram for GPTConfig:



## Data Fields

- gptfreq_t frequency

*Timer clock in Hz.*

- gptcallback_t callback

  *Timer callback pointer.*

### 8.49.1 Detailed Description

Driver configuration structure.

**Note**

It could be empty on some architectures.

### 8.49.2 Field Documentation

#### 8.49.2.1 gptfreq_t GPTConfig::frequency

Timer clock in Hz.

**Note**

The low level can use assertions in order to catch invalid frequency specifications.

#### 8.49.2.2 gptcallback_t GPTConfig::callback

Timer callback pointer.

**Note**

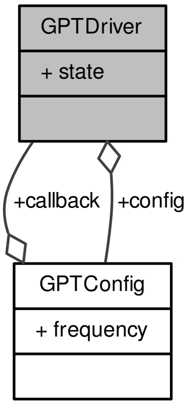
This callback is invoked on GPT counter events.

## 8.50 GPTDriver Struct Reference

Structure representing a GPT driver.

```
#include <hal_gpt_lld.h>
```

Collaboration diagram for GPTDriver:



## Data Fields

- gptstate_t state

  *Driver state.*
- const GPTConfig ∗ config

  *Current configuration data.*

### 8.50.1 Detailed Description

Structure representing a GPT driver.

### 8.50.2 Field Documentation

#### 8.50.2.1 gptstate_t GPTDriver::state

Driver state.

#### 8.50.2.2 const GPTConfig∗ GPTDriver::config

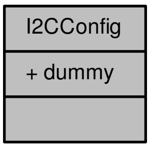
Current configuration data.

## 8.51 I2CConfig Struct Reference

Type of I2C driver configuration structure.

```
#include <hal_i2c_lld.h>
```

Collaboration diagram for I2CConfig:



### 8.51.1 Detailed Description

Type of I2C driver configuration structure.

**Note**

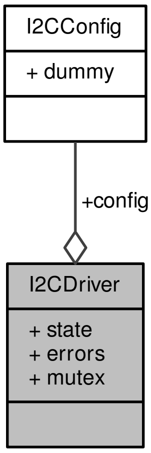
Implementations may extend this structure to contain more, architecture dependent, fields.

## 8.52 I2CDriver Struct Reference

Structure representing an I2C driver.

`#include <hal_i2c_lld.h>`

Collaboration diagram for I2CDriver:



### Data Fields

- i2cstate_t state

*Driver state.*

- const I2CConfig ∗ config

  *Current configuration data.*
- i2cflags_t errors

  *Error flags.*

### 8.52.1 Detailed Description

Structure representing an I2C driver.

### 8.52.2 Field Documentation

#### 8.52.2.1 i2cstate_t I2CDriver::state

Driver state.

#### 8.52.2.2 const I2CConfig∗ I2CDriver::config

Current configuration data.

#### 8.52.2.3 i2cflags_t I2CDriver::errors

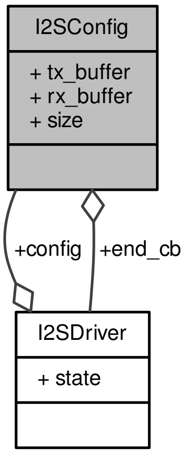
Error flags.

## 8.53 I2SConfig Struct Reference

Driver configuration structure.

```
#include <hal_i2s_lld.h>
```

Collaboration diagram for I2SConfig:



### Data Fields

- const void ∗ tx_buffer

  *Transmission buffer pointer.*
- void ∗ rx_buffer

  *Receive buffer pointer.*
- size_t size

  *TX and RX buffers size as number of samples.*
- i2scallback_t end_cb

  *Callback function called during streaming.*

## 8.53.1 Detailed Description

Driver configuration structure.

**Note**

It could be empty on some architectures.

## 8.53.2 Field Documentation

### 8.53.2.1 const void∗ I2SConfig::tx_buffer

Transmission buffer pointer.

**Note**

Can be `NULL` if TX is not required.

### 8.53.2.2 void∗ I2SConfig::rx_buffer

Receive buffer pointer.

**Note**

Can be `NULL` if RX is not required.

### 8.53.2.3 size_t I2SConfig::size

TX and RX buffers size as number of samples.

### 8.53.2.4 i2scallback_t I2SConfig::end_cb

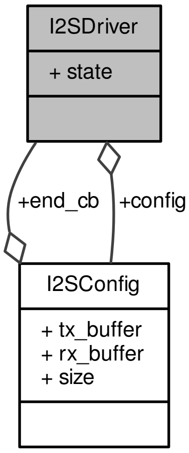
Callback function called during streaming.

# 8.54 I2SDriver Struct Reference

Structure representing an I2S driver.

```
#include <hal_i2s_lld.h>
```

Collaboration diagram for I2SDriver:



## Data Fields

- i2sstate_t state

  *Driver state.*
- const I2SConfig ∗ config

  *Current configuration data.*

### 8.54.1 Detailed Description

Structure representing an I2S driver.

### 8.54.2 Field Documentation

#### 8.54.2.1 i2sstate_t I2SDriver::state

Driver state.

#### 8.54.2.2 const I2SConfig∗ I2SDriver::config

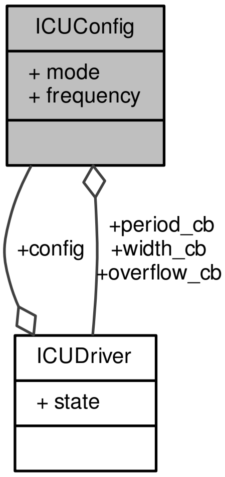
Current configuration data.

## 8.55 ICUConfig Struct Reference

Driver configuration structure.

```
#include <hal_icu_lld.h>
```

Collaboration diagram for ICUConfig:



## Data Fields

- icumode_t mode

  *Driver mode.*
- icufreq_t frequency

  *Timer clock in Hz.*
- icucallback_t width_cb

  *Callback for pulse width measurement.*
- icucallback_t period_cb

  *Callback for cycle period measurement.*
- icucallback_t overflow_cb

  *Callback for timer overflow.*

### 8.55.1 Detailed Description

Driver configuration structure.

**Note**

It could be empty on some architectures.

### 8.55.2 Field Documentation

#### 8.55.2.1 icumode_t ICUConfig::mode

Driver mode.

#### 8.55.2.2 icufreq_t ICUConfig::frequency

Timer clock in Hz.

**Note**

The low level can use assertions in order to catch invalid frequency specifications.

#### 8.55.2.3 icucallback_t ICUConfig::width_cb

Callback for pulse width measurement.

#### 8.55.2.4 icucallback_t ICUConfig::period_cb

Callback for cycle period measurement.

#### 8.55.2.5 icucallback_t ICUConfig::overflow_cb

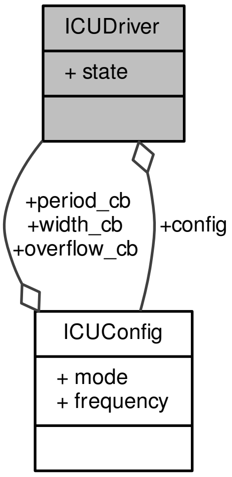
Callback for timer overflow.

## 8.56 ICUDriver Struct Reference

Structure representing an ICU driver.

```
#include <hal_icu_lld.h>
```

Collaboration diagram for ICUDriver:



### Data Fields

- icustate_t state

*Driver state.*

- const ICUConfig ∗ config

  *Current configuration data.*

### 8.56.1 Detailed Description

Structure representing an ICU driver.

### 8.56.2 Field Documentation

#### 8.56.2.1 icustate_t ICUDriver::state

Driver state.

#### 8.56.2.2 const ICUConfig∗ ICUDriver::config

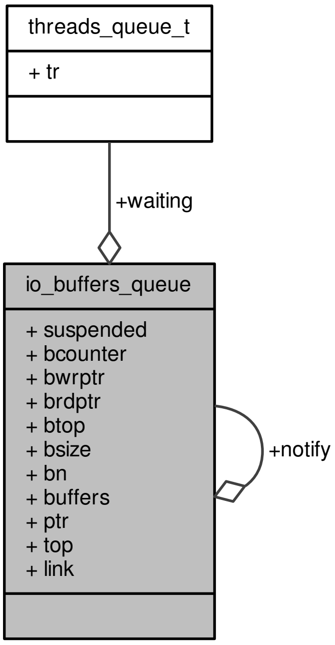
Current configuration data.

## 8.57 io_buffers_queue Struct Reference

Structure of a generic buffers queue.

```
#include <hal_buffers.h>
```

Collaboration diagram for io_buffers_queue:



## Data Fields

- threads_queue_t waiting

  *Queue of waiting threads.*
- bool suspended

  *Queue suspended state flag.*
- volatile size_t bcounter

  *Active buffers counter.*
- uint8_t ∗ bwrptr

  *Buffer write pointer.*
- uint8_t ∗ brdptr

  *Buffer read pointer.*
- uint8_t ∗ btop

  *Pointer to the buffers boundary.*
- size_t bsize

  *Size of buffers.*
- size_t bn

  *Number of buffers.*
- uint8_t ∗ buffers

  *Queue of buffer objects.*
- uint8_t ∗ ptr

  *Pointer for R/W sequential access.*
- uint8_t ∗ top

  *Boundary for R/W sequential access.*
- bqnotify_t notify

  *Data notification callback.*
- void ∗ link

  *Application defined field.*

## 8.57.1 Detailed Description

Structure of a generic buffers queue.

## 8.57.2 Field Documentation

### 8.57.2.1 threads_queue_t io_buffers_queue::waiting

Queue of waiting threads.

### 8.57.2.2 bool io_buffers_queue::suspended

Queue suspended state flag.

### 8.57.2.3 volatile size_t io_buffers_queue::bcounter

Active buffers counter.

### 8.57.2.4 uint8_t∗ io_buffers_queue::bwrptr

Buffer write pointer.

#### 8.57.2.5 uint8_t* io_buffers_queue::brdptr

Buffer read pointer.

#### 8.57.2.6 uint8_t* io_buffers_queue::btop

Pointer to the buffers boundary.

#### 8.57.2.7 size_t io_buffers_queue::bsize

Size of buffers.

**Note**

> The buffer size must be not lower than `sizeof(size_t) + 2` because the first bytes are used to store the used size of the buffer.

#### 8.57.2.8 size_t io_buffers_queue::bn

Number of buffers.

#### 8.57.2.9 uint8_t* io_buffers_queue::buffers

Queue of buffer objects.

#### 8.57.2.10 uint8_t* io_buffers_queue::ptr

Pointer for R/W sequential access.

**Note**

> It is `NULL` if a new buffer must be fetched from the queue.

#### 8.57.2.11 uint8_t* io_buffers_queue::top

Boundary for R/W sequential access.

#### 8.57.2.12 bqnotify_t io_buffers_queue::notify

Data notification callback.

#### 8.57.2.13 void* io_buffers_queue::link

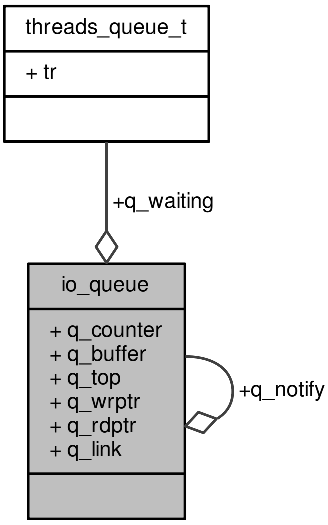
Application defined field.

## 8.58 io_queue Struct Reference

Generic I/O queue structure.

```
#include <hal_queues.h>
```

Collaboration diagram for io_queue:



## Data Fields

- threads_queue_t q_waiting

  *Queue of waiting threads.*
- volatile size_t q_counter

  *Resources counter.*
- uint8_t ∗ q_buffer

  *Pointer to the queue buffer.*
- uint8_t ∗ q_top

  *Pointer to the first location after the buffer.*
- uint8_t ∗ q_wrptr

  *Write pointer.*
- uint8_t ∗ q_rdptr

  *Read pointer.*
- qnotify_t q_notify

  *Data notification callback.*
- void ∗ q_link

  *Application defined field.*

### 8.58.1 Detailed Description

Generic I/O queue structure.

This structure represents a generic Input or Output asymmetrical queue. The queue is asymmetrical because one end is meant to be accessed from a thread context, and thus can be blocking, the other end is accessible from interrupt handlers or from within a kernel lock zone and is non-blocking.

### 8.58.2 Field Documentation

#### 8.58.2.1 threads_queue_t io_queue::q_waiting

Queue of waiting threads.

#### 8.58.2.2 volatile size_t io_queue::q_counter

Resources counter.

#### 8.58.2.3 uint8_t∗ io_queue::q_buffer

Pointer to the queue buffer.

#### 8.58.2.4 uint8_t∗ io_queue::q_top

Pointer to the first location after the buffer.

#### 8.58.2.5 uint8_t∗ io_queue::q_wrptr

Write pointer.

#### 8.58.2.6 uint8_t∗ io_queue::q_rdptr

Read pointer.

#### 8.58.2.7 qnotify_t io_queue::q_notify

Data notification callback.

#### 8.58.2.8 void∗ io_queue::q_link

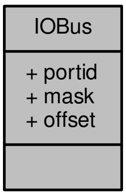
Application defined field.

## 8.59 IOBus Struct Reference

I/O bus descriptor.

```
#include <hal_pal.h>
```

Collaboration diagram for IOBus:



## Data Fields

- ioportid_t portid

  *Port identifier.*
- ioportmask_t mask

  *Bus mask aligned to port bit 0.*
- uint_fast8_t offset

  *Offset, within the port, of the least significant bit of the bus.*

### 8.59.1 Detailed Description

I/O bus descriptor.

This structure describes a group of contiguous digital I/O lines that have to be handled as bus.

**Note**

I/O operations on a bus do not affect I/O lines on the same port but not belonging to the bus.

### 8.59.2 Field Documentation

#### 8.59.2.1 ioportid_t IOBus::portid

Port identifier.

#### 8.59.2.2 ioportmask_t IOBus::mask

Bus mask aligned to port bit 0.

**Note**

The bus mask implicitly define the bus width. A logic AND is performed on the bus data.

#### 8.59.2.3 uint_fast8_t IOBus::offset

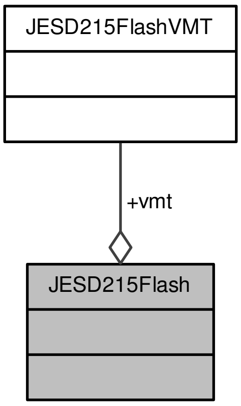
Offset, within the port, of the least significant bit of the bus.

## 8.60 JESD215Flash Struct Reference

Base flash class.

`#include <hal_jesd216_flash.h>`

Collaboration diagram for JESD215Flash:



### Data Fields

- const struct JESD215FlashVMT ∗ vmt

  *Virtual Methods Table.*

### 8.60.1 Detailed Description

Base flash class.

### 8.60.2 Field Documentation

#### 8.60.2.1 const struct JESD215FlashVMT∗ JESD215Flash::vmt

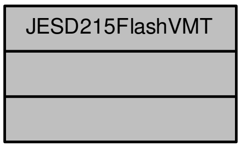
Virtual Methods Table.

## 8.61 JESD215FlashVMT Struct Reference

`JESD215Flash` virtual methods table.

`#include <hal_jesd216_flash.h>`

Collaboration diagram for JESD215FlashVMT:



### 8.61.1 Detailed Description

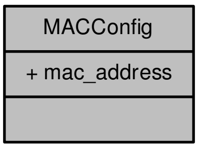
JESD215Flash virtual methods table.

## 8.62 MACConfig Struct Reference

Driver configuration structure.

`#include <hal_mac_lld.h>`

Collaboration diagram for MACConfig:



### Data Fields

- uint8_t ∗ mac_address

  *MAC address.*

### 8.62.1 Detailed Description

Driver configuration structure.

### 8.62.2 Field Documentation

#### 8.62.2.1 uint8_t∗ MACConfig::mac_address

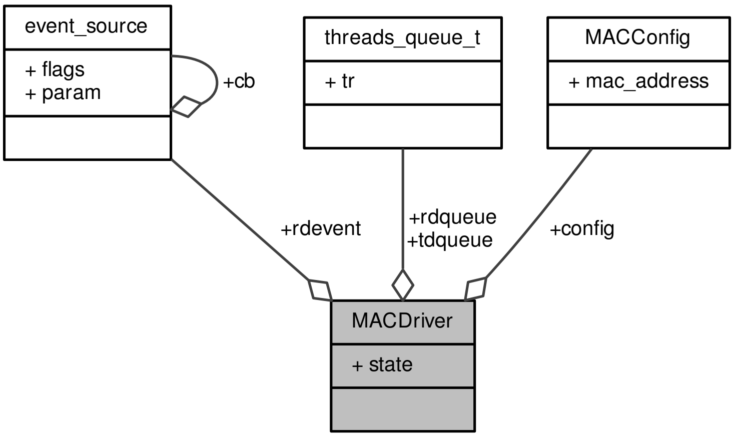
MAC address.

## 8.63 MACDriver Struct Reference

Structure representing a MAC driver.

```
#include <hal_mac_lld.h>
```

Collaboration diagram for MACDriver:



### Data Fields

- macstate_t state

  *Driver state.*
- const MACConfig ∗ config

  *Current configuration data.*
- threads_queue_t tdqueue

  *Transmit semaphore.*
- threads_queue_t rdqueue

  *Receive semaphore.*
- event_source_t rdevent

  *Receive event.*

### 8.63.1 Detailed Description

Structure representing a MAC driver.

### 8.63.2 Field Documentation

#### 8.63.2.1 macstate_t MACDriver::state

Driver state.

#### 8.63.2.2 const MACConfig∗ MACDriver::config

Current configuration data.

#### 8.63.2.3 threads_queue_t MACDriver::tdqueue

Transmit semaphore.

#### 8.63.2.4 threads_queue_t MACDriver::rdqueue

Receive semaphore.

#### 8.63.2.5 event_source_t MACDriver::rdevent

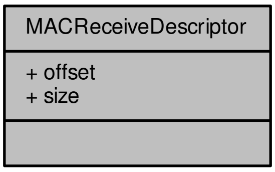
Receive event.

## 8.64 MACReceiveDescriptor Struct Reference

Structure representing a receive descriptor.

```
#include <hal_mac_lld.h>
```

Collaboration diagram for MACReceiveDescriptor:



### Data Fields

- size_t offset

  *Current read offset.*
- size_t size

  *Available data size.*

### 8.64.1 Detailed Description

Structure representing a receive descriptor.

### 8.64.2 Field Documentation

#### 8.64.2.1 size_t MACReceiveDescriptor::offset

Current read offset.

#### 8.64.2.2 size_t MACReceiveDescriptor::size

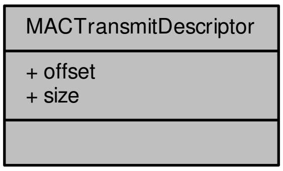
Available data size.

## 8.65 MACTransmitDescriptor Struct Reference

Structure representing a transmit descriptor.

```
#include <hal_mac_lld.h>
```

Collaboration diagram for MACTransmitDescriptor:



### Data Fields

- size_t offset

  *Current write offset.*
- size_t size

  *Available space size.*

### 8.65.1 Detailed Description

Structure representing a transmit descriptor.

### 8.65.2 Field Documentation

#### 8.65.2.1 size_t MACTransmitDescriptor::offset

Current write offset.

#### 8.65.2.2 size_t MACTransmitDescriptor::size

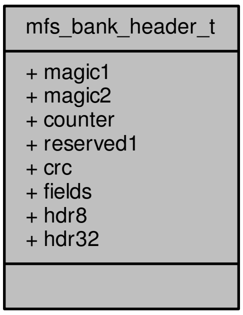
Available space size.

## 8.66 mfs_bank_header_t Union Reference

Type of a bank header.

`#include <mfs.h>`

Collaboration diagram for mfs_bank_header_t:



### 8.66.1 Detailed Description

Type of a bank header.

**Note**

The header resides in the first 16 bytes of a bank.

### 8.66.2 Field Documentation

#### 8.66.2.1 uint32_t mfs_bank_header_t::magic1

Bank magic 1.

#### 8.66.2.2 uint32_t mfs_bank_header_t::magic2

Bank magic 2.

#### 8.66.2.3 uint32_t mfs_bank_header_t::counter

Usage counter of the bank.

This value is increased each time a bank swap is performed. It indicates how much wearing the flash has already endured.

#### 8.66.2.4 uint16_t mfs_bank_header_t::reserved1

Reserved field.

#### 8.66.2.5 uint16_t mfs_bank_header_t::crc

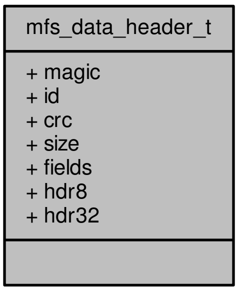
Header CRC.

## 8.67 mfs_data_header_t Union Reference

Type of a data block header.

`#include <mfs.h>`

Collaboration diagram for mfs_data_header_t:



### 8.67.1 Detailed Description

Type of a data block header.

This structure is placed before each written data block.

### 8.67.2 Field Documentation

#### 8.67.2.1 uint32_t mfs_data_header_t::magic

Data header magic.

#### 8.67.2.2 uint16_t mfs_data_header_t::id

Data identifier.

#### 8.67.2.3 uint16_t mfs_data_header_t::crc

Data CRC.

#### 8.67.2.4 uint32_t mfs_data_header_t::size

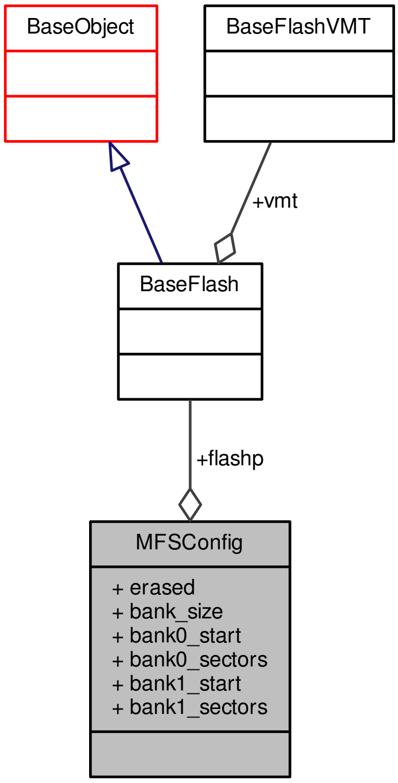
Data size.

## 8.68 MFSConfig Struct Reference

Type of a MFS configuration structure.

```
#include <mfs.h>
```

Collaboration diagram for MFSConfig:



### Data Fields

- BaseFlash ∗ flashp

  *Flash driver associated to this MFS instance.*
- uint32_t erased

  *Erased value.*
- flash_offset_t bank_size

  *Banks size.*
- flash_sector_t bank0_start

  *Base sector index for bank 0.*
- flash_sector_t bank0_sectors

  *Number of sectors for bank 0.*
- flash_sector_t bank1_start

  *Base sector index for bank 1.*
- flash_sector_t bank1_sectors

  *Number of sectors for bank 1.*

### 8.68.1 Detailed Description

Type of a MFS configuration structure.

### 8.68.2 Field Documentation

#### 8.68.2.1 BaseFlash* MFSConfig::flashp

Flash driver associated to this MFS instance.

#### 8.68.2.2 uint32_t MFSConfig::erased

Erased value.

#### 8.68.2.3 flash_offset_t MFSConfig::bank_size

Banks size.

#### 8.68.2.4 flash_sector_t MFSConfig::bank0_start

Base sector index for bank 0.

#### 8.68.2.5 flash_sector_t MFSConfig::bank0_sectors

Number of sectors for bank 0.

**Note**

> The total size of bank0 sectors must be greater or equal to `bank_size`.

#### 8.68.2.6 flash_sector_t MFSConfig::bank1_start

Base sector index for bank 1.

#### 8.68.2.7 flash_sector_t MFSConfig::bank1_sectors

Number of sectors for bank 1.

**Note**

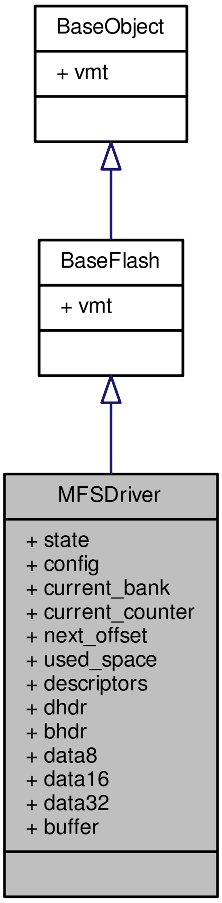
> The total size of bank1 sectors must be greater or equal to `bank_size`.

## 8.69 MFSDriver Struct Reference

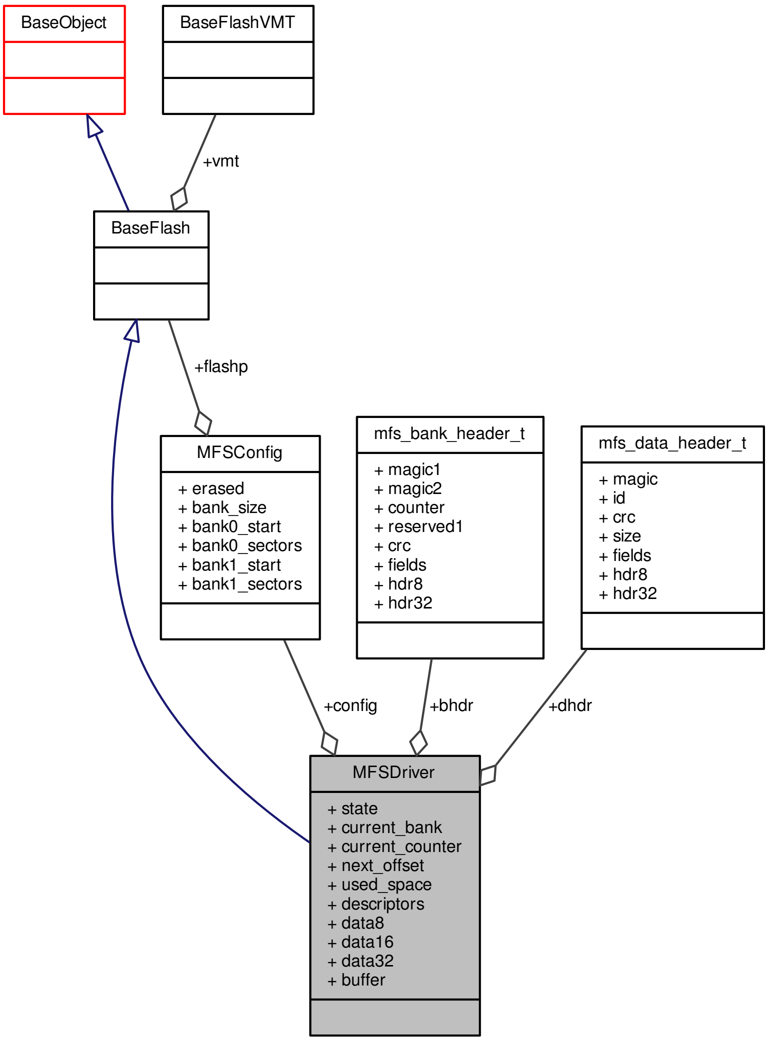
Type of an MFS instance.

```
#include <mfs.h>
```

Inheritance diagram for MFSDriver:



Collaboration diagram for MFSDriver:



## Data Fields

- mfs_state_t state

  *Driver state.*
- const MFSConfig ∗ config

  *Current configuration data.*
- mfs_bank_t current_bank

  *Bank currently in use.*
- uint32_t current_counter

  *Usage counter of the current bank.*
- flash_offset_t next_offset

  *Pointer to the next free position in the current bank.*
- flash_offset_t used_space

  *Used space in the current bank without considering erased records.*

- mfs_record_descriptor_t descriptors [MFS_CFG_MAX_RECORDS]

  *Offsets of the most recent instance of the records.*
- union {
  } buffer

  *Transient buffer.*

## 8.69.1 Detailed Description

Type of an MFS instance.

## 8.69.2 Field Documentation

### 8.69.2.1 mfs_state_t MFSDriver::state

Driver state.

### 8.69.2.2 const MFSConfig∗ MFSDriver::config

Current configuration data.

### 8.69.2.3 mfs_bank_t MFSDriver::current_bank

Bank currently in use.

### 8.69.2.4 uint32_t MFSDriver::current_counter

Usage counter of the current bank.

### 8.69.2.5 flash_offset_t MFSDriver::next_offset

Pointer to the next free position in the current bank.

### 8.69.2.6 flash_offset_t MFSDriver::used_space

Used space in the current bank without considering erased records.

### 8.69.2.7 mfs_record_descriptor_t MFSDriver::descriptors[MFS_CFG_MAX_RECORDS]

Offsets of the most recent instance of the records.

**Note**

> Zero means that there is not a record with that id.

### 8.69.2.8 union { ... } MFSDriver::buffer

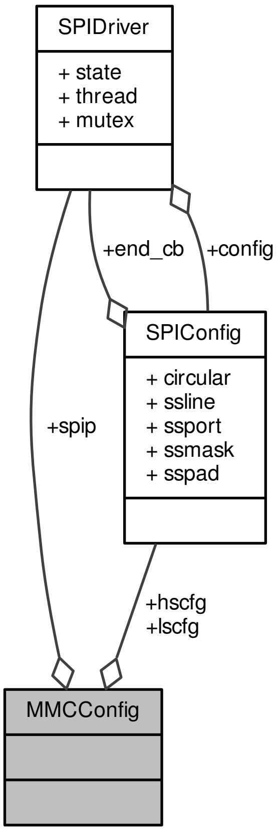
Transient buffer.

## 8.70 MMCConfig Struct Reference

MMC/SD over SPI driver configuration structure.

`#include <hal_mmc_spi.h>`

Collaboration diagram for MMCConfig:



### Data Fields

- SPIDriver ∗ spip

    *SPI driver associated to this MMC driver.*
- const SPIConfig ∗ lscfg

    *SPI low speed configuration used during initialization.*
- const SPIConfig ∗ hscfg

    *SPI high speed configuration used during transfers.*

### 8.70.1 Detailed Description

MMC/SD over SPI driver configuration structure.

## 8.70.2 Field Documentation

### 8.70.2.1 SPIDriver∗ MMCConfig::spip

SPI driver associated to this MMC driver.

### 8.70.2.2 const SPIConfig∗ MMCConfig::lscfg

SPI low speed configuration used during initialization.

### 8.70.2.3 const SPIConfig∗ MMCConfig::hscfg

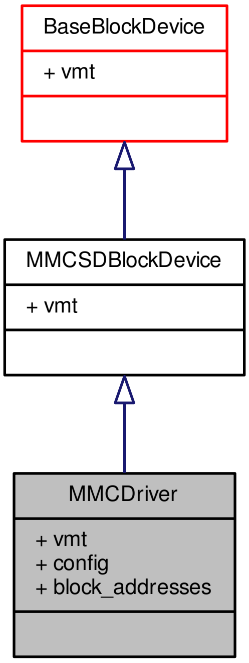
SPI high speed configuration used during transfers.

## 8.71 MMCDriver Struct Reference

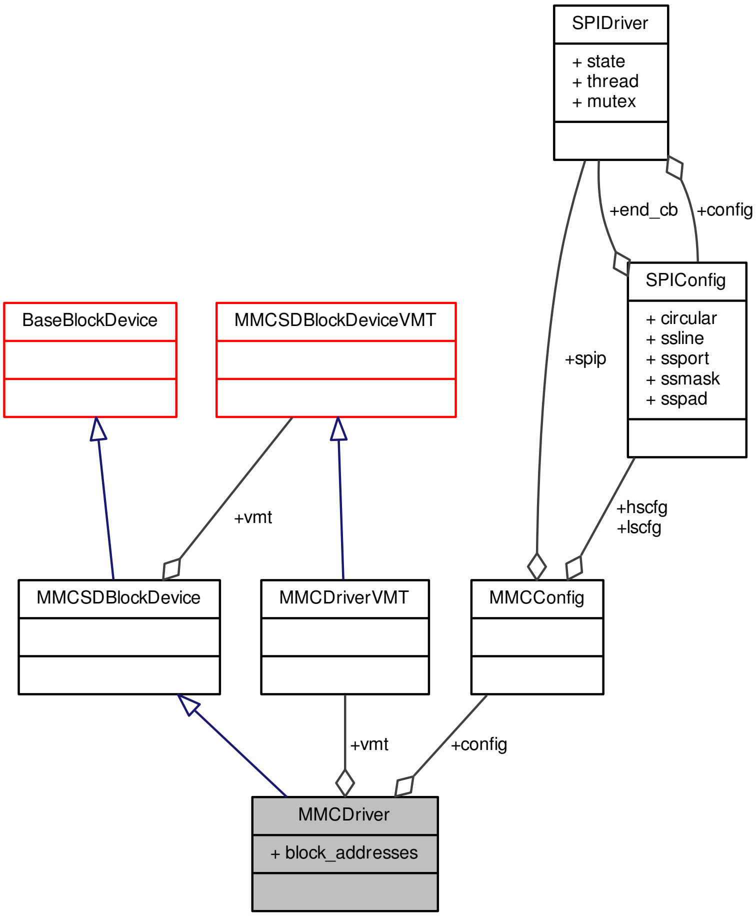
Structure representing a MMC/SD over SPI driver.

```
#include <hal_mmc_spi.h>
```

Inheritance diagram for MMCDriver:



Collaboration diagram for MMCDriver:



## Data Fields

- const struct MMCDriverVMT ∗ vmt

  *Virtual Methods Table.*
- _mmcsd_block_device_data const MMCConfig ∗ config

  *Current configuration data.*

## 8.71.1 Detailed Description

Structure representing a MMC/SD over SPI driver.

## 8.71.2 Field Documentation

### 8.71.2.1 const struct **MMCDriverVMT**∗ MMCDriver::vmt

Virtual Methods Table.

#### 8.71.2.2 _mmcsd_block_device_data const MMCConfig∗ MMCDriver::config

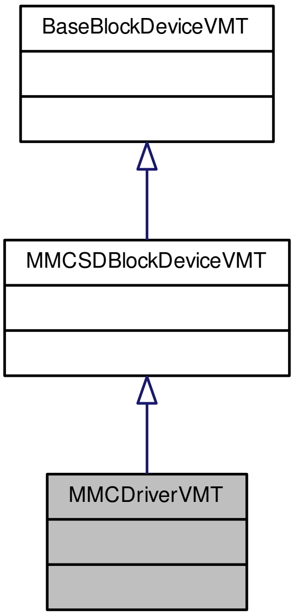
Current configuration data.

## 8.72 MMCDriverVMT Struct Reference

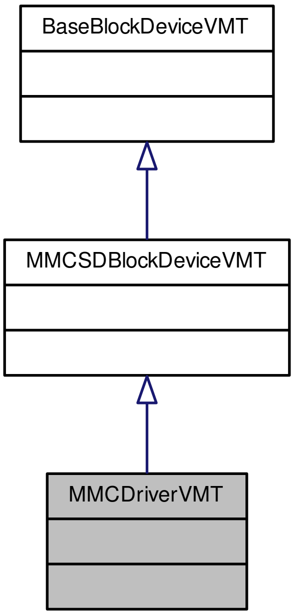
MMCDriver virtual methods table.

`#include <hal_mmc_spi.h>`

Inheritance diagram for MMCDriverVMT:



Collaboration diagram for MMCDriverVMT:



### 8.72.1 Detailed Description

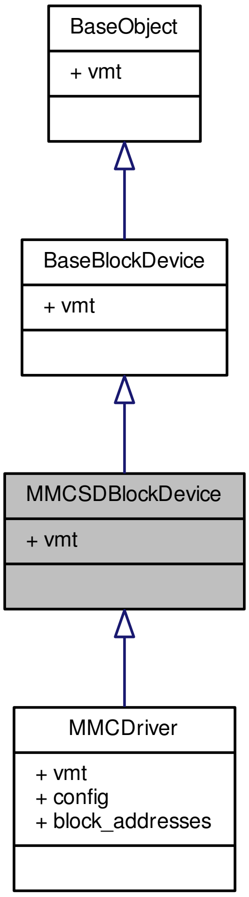
MMCDriver virtual methods table.

## 8.73 MMCSDBlockDevice Struct Reference

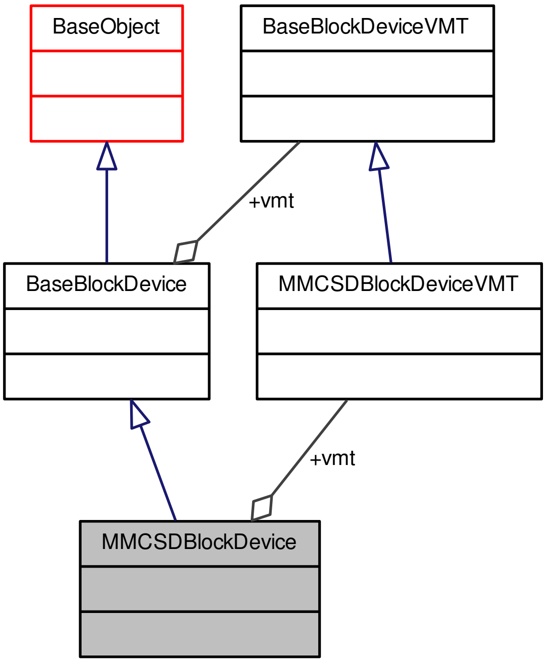
MCC/SD block device class.

`#include <hal_mmcsd.h>`

Inheritance diagram for MMCSDBlockDevice:



Collaboration diagram for MMCSDBlockDevice:



## Data Fields

- const struct MMCSDBlockDeviceVMT ∗ vmt

    *Virtual Methods Table.*

### 8.73.1 Detailed Description

MCC/SD block device class.

This class represents a, block-accessible, MMC/SD device.

### 8.73.2 Field Documentation

#### 8.73.2.1 const struct MMCSDBlockDeviceVMT∗ MMCSDBlockDevice::vmt

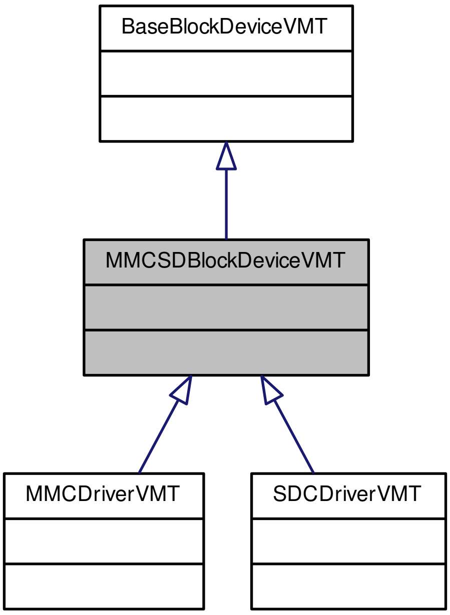
Virtual Methods Table.

## 8.74 MMCSDBlockDeviceVMT Struct Reference

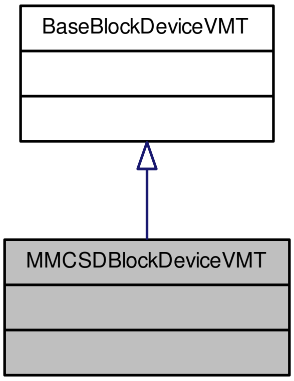
`MMCSDBlockDevice` virtual methods table.

`#include <hal_mmcsd.h>`

Inheritance diagram for MMCSDBlockDeviceVMT:



Collaboration diagram for MMCSDBlockDeviceVMT:



### 8.74.1 Detailed Description

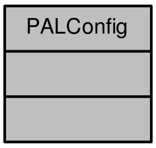
MMCSDBlockDevice virtual methods table.

## 8.75 PALConfig Struct Reference

Generic I/O ports static initializer.

`#include <hal_pal_lld.h>`

Collaboration diagram for PALConfig:



### 8.75.1 Detailed Description

Generic I/O ports static initializer.

An instance of this structure must be passed to `palInit()` at system startup time in order to initialized the digital I/O subsystem. This represents only the initial setup, specific pads or whole ports can be reprogrammed at later time.

**Note**

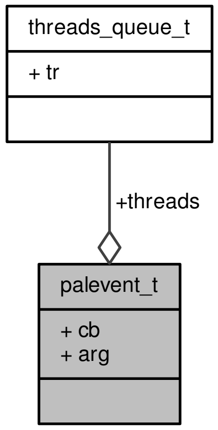
Implementations may extend this structure to contain more, architecture dependent, fields.

## 8.76 palevent_t Struct Reference

Type of a PAL event record.

`#include <hal_pal.h>`

Collaboration diagram for palevent_t:



## Data Fields

- threads_queue_t threads

  *Threads queued for an event.*
- palcallback_t cb

  *Event callback.*
- void ∗ arg

  *Event callback argument.*

## 8.76.1 Detailed Description

Type of a PAL event record.

## 8.76.2 Field Documentation

### 8.76.2.1 threads_queue_t palevent_t::threads

Threads queued for an event.

### 8.76.2.2 palcallback_t palevent_t::cb

Event callback.

### 8.76.2.3 void∗ palevent_t::arg

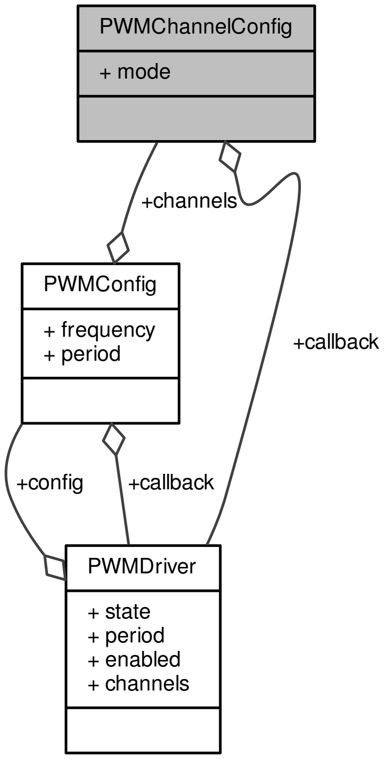
Event callback argument.

## 8.77 PWMChannelConfig Struct Reference

Type of a PWM driver channel configuration structure.

`#include <hal_pwm_lld.h>`

Collaboration diagram for PWMChannelConfig:



### Data Fields

- pwmmode_t mode

    *Channel active logic level.*
- pwmcallback_t callback

    *Channel callback pointer.*

### 8.77.1 Detailed Description

Type of a PWM driver channel configuration structure.

### 8.77.2 Field Documentation

#### 8.77.2.1 pwmmode_t PWMChannelConfig::mode

Channel active logic level.

#### 8.77.2.2 pwmcallback_t PWMChannelConfig::callback

Channel callback pointer.

**Note**

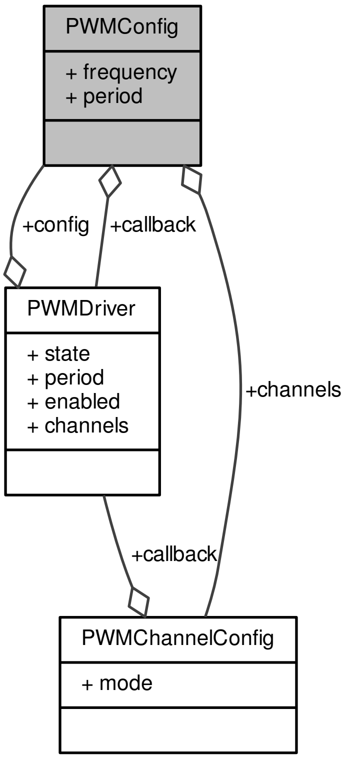
This callback is invoked on the channel compare event. If set to `NULL` then the callback is disabled.

## 8.78 PWMConfig Struct Reference

Type of a PWM driver configuration structure.

`#include <hal_pwm_lld.h>`

Collaboration diagram for PWMConfig:



### Data Fields

- uint32_t frequency

  *Timer clock in Hz.*
- pwmcnt_t period

  *PWM period in ticks.*
- pwmcallback_t callback

  *Periodic callback pointer.*

- PWMChannelConfig channels [PWM_CHANNELS]

  *Channels configurations.*

## 8.78.1 Detailed Description

Type of a PWM driver configuration structure.

## 8.78.2 Field Documentation

### 8.78.2.1 uint32_t PWMConfig::frequency

Timer clock in Hz.

**Note**

The low level can use assertions in order to catch invalid frequency specifications.

### 8.78.2.2 pwmcnt_t PWMConfig::period

PWM period in ticks.

**Note**

The low level can use assertions in order to catch invalid period specifications.

### 8.78.2.3 pwmcallback_t PWMConfig::callback

Periodic callback pointer.

**Note**

This callback is invoked on PWM counter reset. If set to `NULL` then the callback is disabled.

### 8.78.2.4 PWMChannelConfig PWMConfig::channels[PWM_CHANNELS]

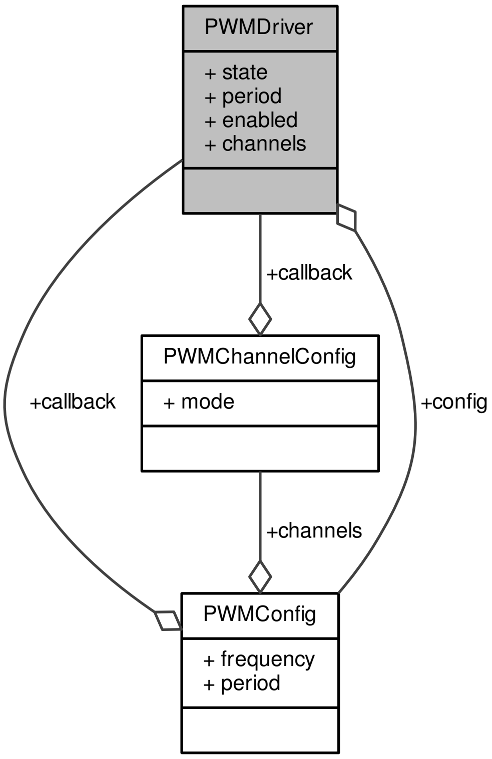
Channels configurations.

## 8.79 PWMDriver Struct Reference

Structure representing a PWM driver.

```
#include <hal_pwm_lld.h>
```

Collaboration diagram for PWMDriver:



## Data Fields

- pwmstate_t state

  *Driver state.*
- const PWMConfig ∗ config

  *Current driver configuration data.*
- pwmcnt_t period

  *Current PWM period in ticks.*
- pwmchnmsk_t enabled

  *Mask of the enabled channels.*
- pwmchannel_t channels

  *Number of channels in this instance.*

### 8.79.1 Detailed Description

Structure representing a PWM driver.

### 8.79.2 Field Documentation

#### 8.79.2.1 pwmstate_t PWMDriver::state

Driver state.

#### 8.79.2.2 const PWMConfig∗ PWMDriver::config

Current driver configuration data.

#### 8.79.2.3 pwmcnt_t PWMDriver::period

Current PWM period in ticks.

#### 8.79.2.4 pwmchnmsk_t PWMDriver::enabled

Mask of the enabled channels.

#### 8.79.2.5 pwmchannel_t PWMDriver::channels

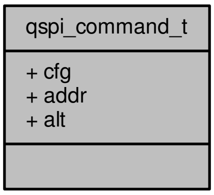
Number of channels in this instance.

## 8.80 qspi_command_t Struct Reference

Type of a QSPI command descriptor.

`#include <hal_qspi.h>`

Collaboration diagram for qspi_command_t:



### 8.80.1 Detailed Description

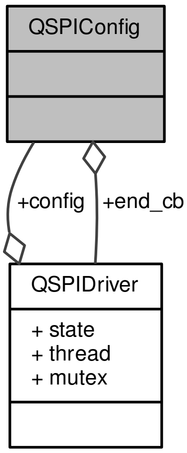
Type of a QSPI command descriptor.

## 8.81 QSPIConfig Struct Reference

Driver configuration structure.

`#include <hal_qspi_lld.h>`

Collaboration diagram for QSPIConfig:



## Data Fields

- qspicallback_t end_cb

  *Operation complete callback or* `NULL`*.*

### 8.81.1 Detailed Description

Driver configuration structure.

### 8.81.2 Field Documentation

#### 8.81.2.1 qspicallback_t QSPIConfig::end_cb

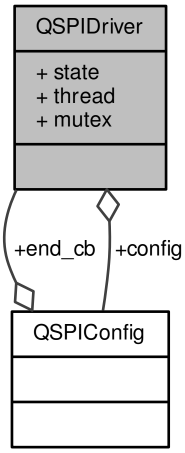
Operation complete callback or `NULL`.

## 8.82 QSPIDriver Struct Reference

Structure representing an QSPI driver.

```
#include <hal_qspi_lld.h>
```

Collaboration diagram for QSPIDriver:



## Data Fields

- qspistate_t state

  *Driver state.*
- const QSPIConfig ∗ config

  *Current configuration data.*
- thread_reference_t thread

  *Waiting thread.*
- mutex_t mutex

  *Mutex protecting the peripheral.*

### 8.82.1 Detailed Description

Structure representing an QSPI driver.

### 8.82.2 Field Documentation

#### 8.82.2.1 qspistate_t QSPIDriver::state

Driver state.

#### 8.82.2.2 const QSPIConfig∗ QSPIDriver::config

Current configuration data.

#### 8.82.2.3 thread_reference_t QSPIDriver::thread

Waiting thread.

#### 8.82.2.4 mutex_t QSPIDriver::mutex

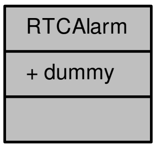
Mutex protecting the peripheral.

## 8.83 RTCAlarm Struct Reference

Type of a structure representing an RTC alarm time stamp.

```
#include <hal_rtc_lld.h>
```

Collaboration diagram for RTCAlarm:



### 8.83.1 Detailed Description

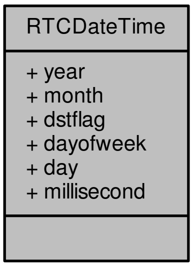
Type of a structure representing an RTC alarm time stamp.

## 8.84 RTCDateTime Struct Reference

Type of a structure representing an RTC date/time stamp.

```
#include <hal_rtc.h>
```

Collaboration diagram for RTCDateTime:



## Data Fields

- uint32_t year: 8

  *Years since 1980.*
- uint32_t month: 4

  *Months 1..12.*
- uint32_t dstflag: 1

  *DST correction flag.*
- uint32_t dayofweek: 3

  *Day of week 1..7.*
- uint32_t day: 5

  *Day of the month 1..31.*
- uint32_t millisecond: 27

  *Milliseconds since midnight.*

## 8.84.1 Detailed Description

Type of a structure representing an RTC date/time stamp.

## 8.84.2 Field Documentation

### 8.84.2.1 uint32_t RTCDateTime::year

Years since 1980.

### 8.84.2.2 uint32_t RTCDateTime::month

Months 1..12.

### 8.84.2.3 uint32_t RTCDateTime::dstflag

DST correction flag.

### 8.84.2.4 uint32_t RTCDateTime::dayofweek

Day of week 1..7.

### 8.84.2.5 uint32_t RTCDateTime::day

Day of the month 1..31.

### 8.84.2.6 uint32_t RTCDateTime::millisecond

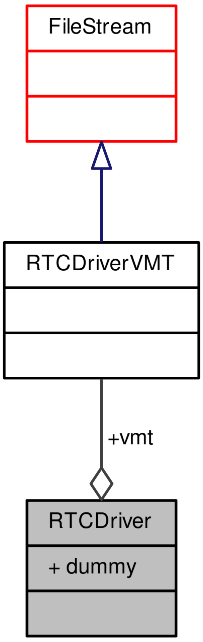
Milliseconds since midnight.

## 8.85 RTCDriver Struct Reference

Structure representing an RTC driver.

```
#include <hal_rtc_lld.h>
```

Collaboration diagram for RTCDriver:



### Data Fields

- const struct RTCDriverVMT ∗ vmt

    *Virtual Methods Table.*

### 8.85.1 Detailed Description

Structure representing an RTC driver.

### 8.85.2 Field Documentation

#### 8.85.2.1 const struct RTCDriverVMT∗ RTCDriver::vmt

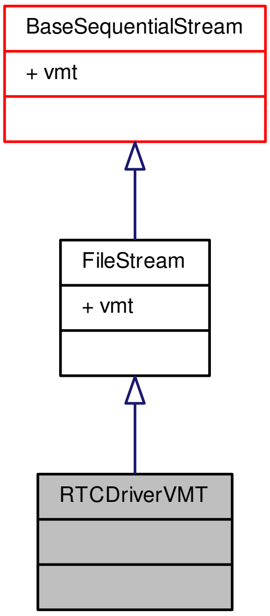
Virtual Methods Table.

## 8.86 RTCDriverVMT Struct Reference

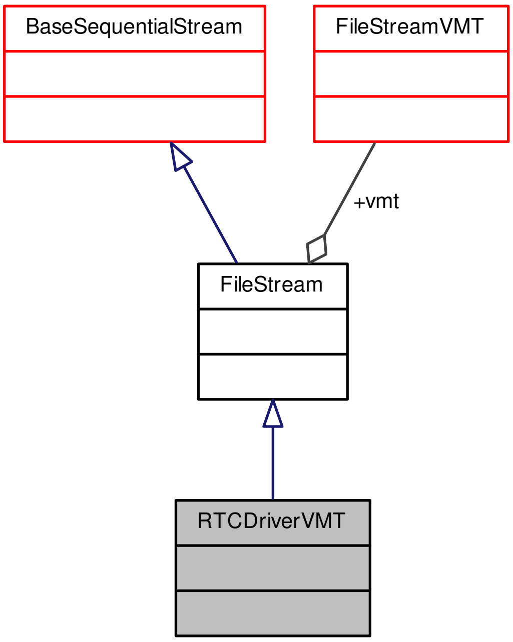
`RTCDriver` virtual methods table.

```
#include <hal_rtc_lld.h>
```

Inheritance diagram for RTCDriverVMT:



Collaboration diagram for RTCDriverVMT:



### Additional Inherited Members

### 8.86.1 Detailed Description

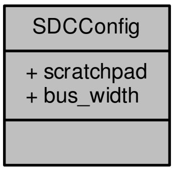
RTCDriver virtual methods table.

## 8.87 SDCConfig Struct Reference

Driver configuration structure.

`#include <hal_sdc_lld.h>`

Collaboration diagram for SDCConfig:



### Data Fields

- uint8_t ∗ scratchpad

  *Working area for memory consuming operations.*
- sdcbusmode_t bus_width

  *Bus width.*

### 8.87.1 Detailed Description

Driver configuration structure.

**Note**

It could be empty on some architectures.

### 8.87.2 Field Documentation

#### 8.87.2.1 uint8_t∗ SDCConfig::scratchpad

Working area for memory consuming operations.

**Note**

It is mandatory for detecting MMC cards bigger than 2GB else it can be `NULL`.
Memory pointed by this buffer is only used by `sdcConnect()`, afterward it can be reused for other purposes.

#### 8.87.2.2 sdcbusmode_t SDCConfig::bus_width

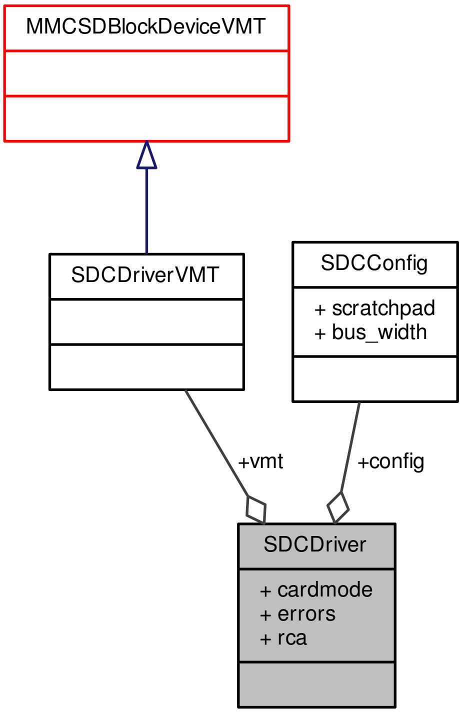
Bus width.

## 8.88 SDCDriver Struct Reference

Structure representing an SDC driver.

```
#include <hal_sdc_lld.h>
```

Collaboration diagram for SDCDriver:



## Data Fields

- const struct SDCDriverVMT ∗ vmt

  *Virtual Methods Table.*
- _mmcsd_block_device_data const SDCConfig ∗ config

  *Current configuration data.*
- sdcmode_t cardmode

  *Various flags regarding the mounted card.*
- sdcflags_t errors

  *Errors flags.*
- uint32_t rca

  *Card RCA.*

### 8.88.1 Detailed Description

Structure representing an SDC driver.

### 8.88.2 Field Documentation

#### 8.88.2.1 const struct SDCDriverVMT∗ SDCDriver::vmt

Virtual Methods Table.

#### 8.88.2.2 _mmcsd_block_device_data const SDCConfig∗ SDCDriver::config

Current configuration data.

#### 8.88.2.3 sdcmode_t SDCDriver::cardmode

Various flags regarding the mounted card.

#### 8.88.2.4 sdcflags_t SDCDriver::errors

Errors flags.

#### 8.88.2.5 uint32_t SDCDriver::rca

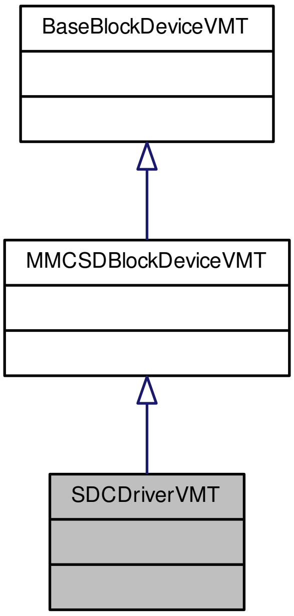
Card RCA.

## 8.89 SDCDriverVMT Struct Reference

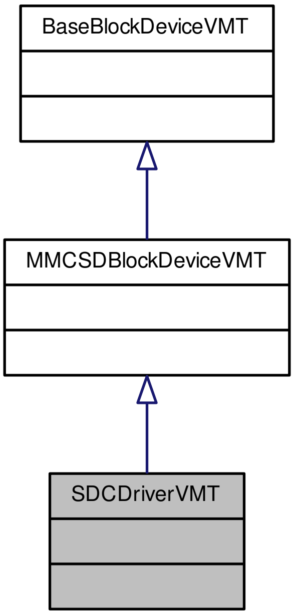
`SDCDriver` virtual methods table.

`#include <hal_sdc_lld.h>`

Inheritance diagram for SDCDriverVMT:



Collaboration diagram for SDCDriverVMT:



### 8.89.1 Detailed Description

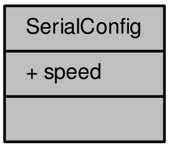
SDCDriver virtual methods table.

## 8.90 SerialConfig Struct Reference

PLATFORM Serial Driver configuration structure.

```
#include <hal_serial_lld.h>
```

Collaboration diagram for SerialConfig:



## Data Fields

- uint32_t speed

  *Bit rate.*

### 8.90.1 Detailed Description

PLATFORM Serial Driver configuration structure.

An instance of this structure must be passed to `sdStart()` in order to configure and start a serial driver operations.

**Note**

> This structure content is architecture dependent, each driver implementation defines its own version and the custom static initializers.

### 8.90.2 Field Documentation

#### 8.90.2.1 uint32_t SerialConfig::speed

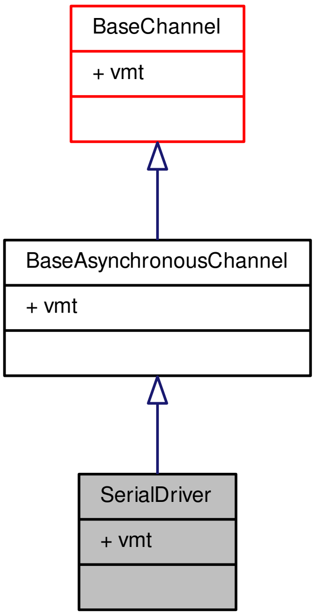
Bit rate.

## 8.91 SerialDriver Struct Reference

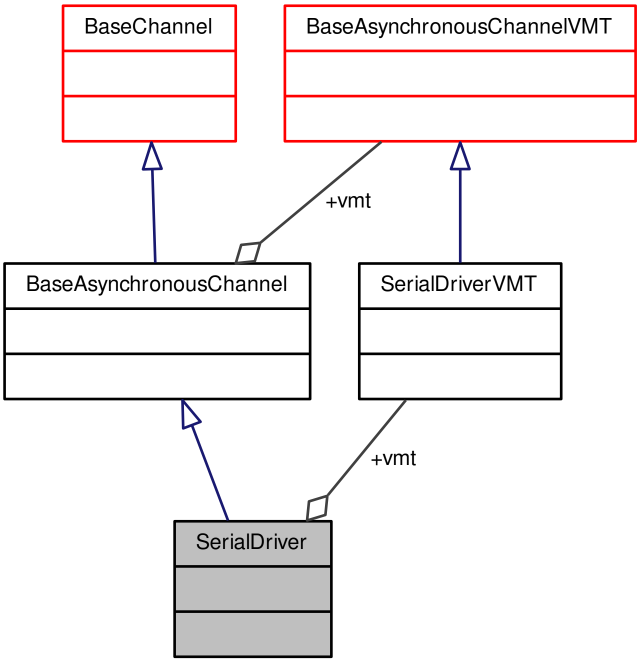
Full duplex serial driver class.

`#include <hal_serial.h>`

Inheritance diagram for SerialDriver:



Collaboration diagram for SerialDriver:



### Data Fields

- const struct SerialDriverVMT ∗ vmt

  *Virtual Methods Table.*

### 8.91.1 Detailed Description

Full duplex serial driver class.

This class extends `BaseAsynchronousChannel` by adding physical I/O queues.

### 8.91.2 Field Documentation

#### 8.91.2.1 const struct SerialDriverVMT∗ SerialDriver::vmt

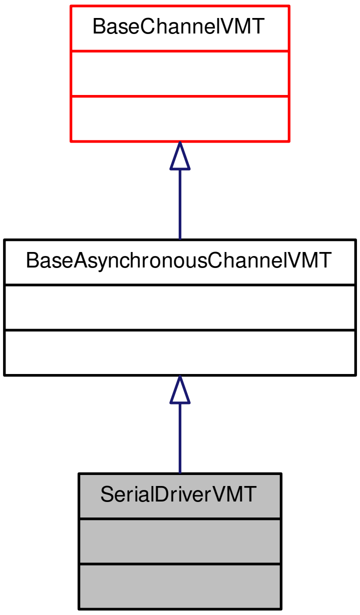
Virtual Methods Table.

## 8.92 SerialDriverVMT Struct Reference

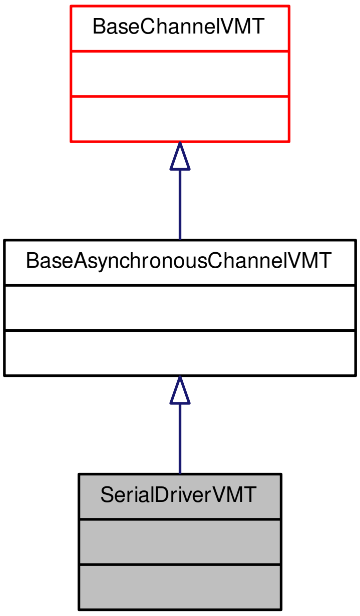
`SerialDriver` virtual methods table.

```
#include <hal_serial.h>
```

Inheritance diagram for SerialDriverVMT:



Collaboration diagram for SerialDriverVMT:



### 8.92.1 Detailed Description

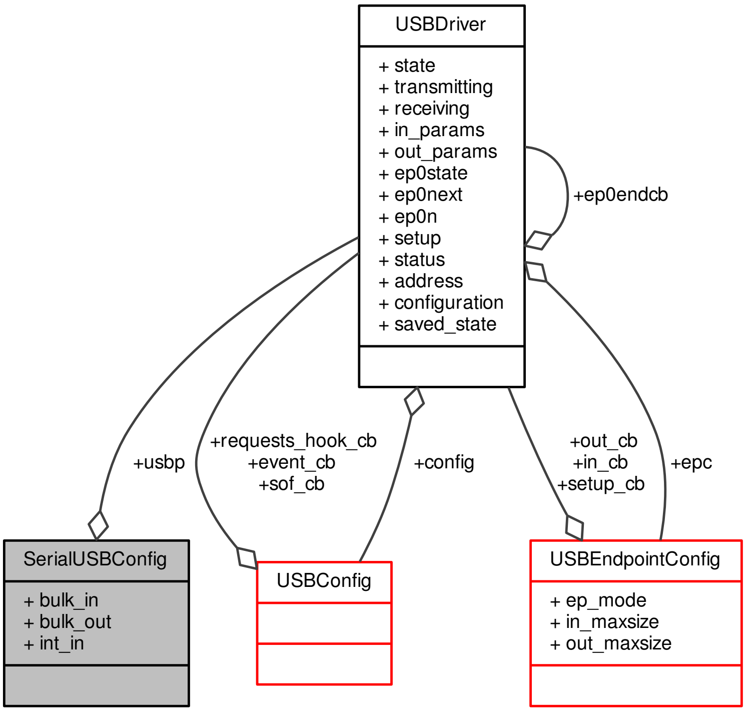
SerialDriver virtual methods table.

## 8.93 SerialUSBConfig Struct Reference

Serial over USB Driver configuration structure.

```
#include <hal_serial_usb.h>
```

Collaboration diagram for SerialUSBConfig:



### Data Fields

- USBDriver ∗ usbp

  *USB driver to use.*
- usbep_t bulk_in

  *Bulk IN endpoint used for outgoing data transfer.*
- usbep_t bulk_out

  *Bulk OUT endpoint used for incoming data transfer.*
- usbep_t int_in

  *Interrupt IN endpoint used for notifications.*

### 8.93.1 Detailed Description

Serial over USB Driver configuration structure.

An instance of this structure must be passed to `sduStart()` in order to configure and start the driver operations.

### 8.93.2 Field Documentation

#### 8.93.2.1 USBDriver* SerialUSBConfig::usbp

USB driver to use.

#### 8.93.2.2 usbep_t SerialUSBConfig::bulk_in

Bulk IN endpoint used for outgoing data transfer.

#### 8.93.2.3 usbep_t SerialUSBConfig::bulk_out

Bulk OUT endpoint used for incoming data transfer.

#### 8.93.2.4 usbep_t SerialUSBConfig::int_in

Interrupt IN endpoint used for notifications.

**Note**

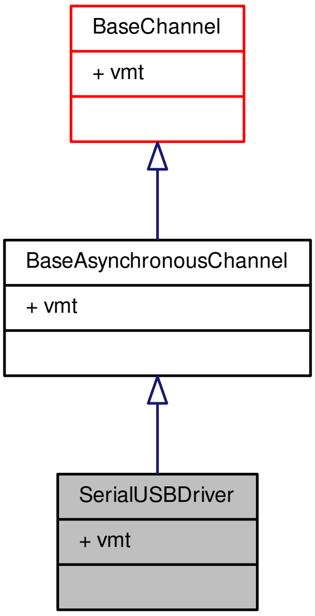
> If set to zero then the INT endpoint is assumed to be not present, USB descriptors must be changed accordingly.

## 8.94 SerialUSBDriver Struct Reference

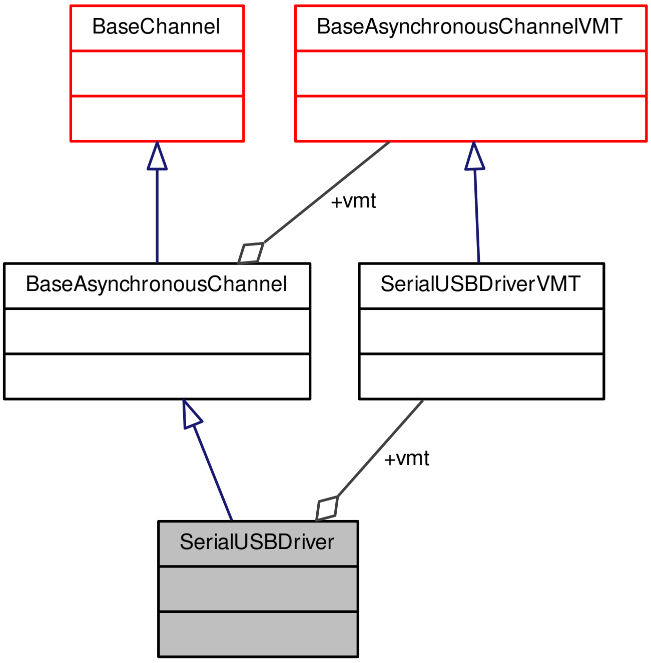
Full duplex serial driver class.

```
#include <hal_serial_usb.h>
```

Inheritance diagram for SerialUSBDriver:



Collaboration diagram for SerialUSBDriver:



### Data Fields

- const struct SerialUSBDriverVMT ∗ vmt

    *Virtual Methods Table.*

### 8.94.1 Detailed Description

Full duplex serial driver class.

This class extends `BaseAsynchronousChannel` by adding physical I/O queues.

### 8.94.2 Field Documentation

#### 8.94.2.1 const struct SerialUSBDriverVMT∗ SerialUSBDriver::vmt

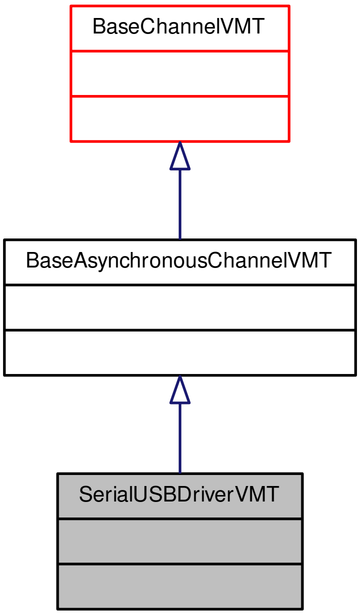
Virtual Methods Table.

## 8.95 SerialUSBDriverVMT Struct Reference

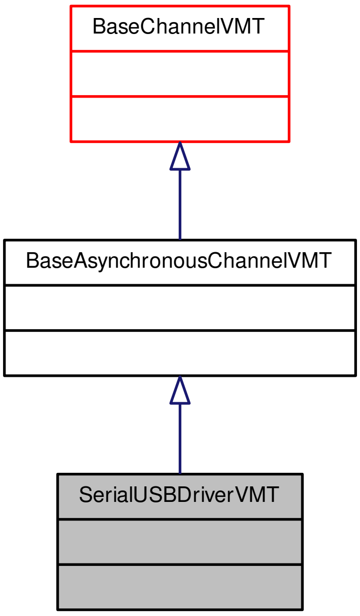
`SerialDriver` virtual methods table.

`#include <hal_serial_usb.h>`

Inheritance diagram for SerialUSBDriverVMT:



Collaboration diagram for SerialUSBDriverVMT:



### 8.95.1 Detailed Description

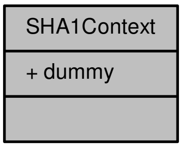
SerialDriver virtual methods table.

## 8.96 SHA1Context Struct Reference

Type of a SHA1 context.

```
#include <hal_crypto_lld.h>
```

Collaboration diagram for SHA1Context:



### 8.96.1 Detailed Description

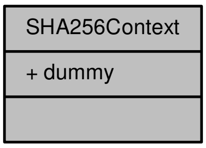
Type of a SHA1 context.

## 8.97 SHA256Context Struct Reference

Type of a SHA256 context.

```
#include <hal_crypto_lld.h>
```

Collaboration diagram for SHA256Context:



### 8.97.1 Detailed Description

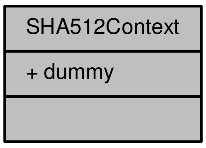
Type of a SHA256 context.

## 8.98 SHA512Context Struct Reference

Type of a SHA512 context.

`#include <hal_crypto_lld.h>`

Collaboration diagram for SHA512Context:



### 8.98.1 Detailed Description

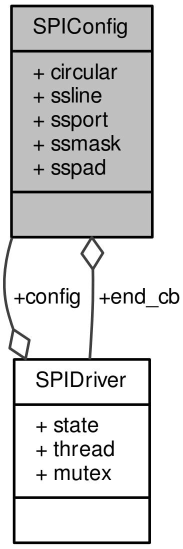
Type of a SHA512 context.

## 8.99 SPIConfig Struct Reference

Driver configuration structure.

`#include <hal_spi_lld.h>`

Collaboration diagram for SPIConfig:



## Data Fields

- bool circular

  *Enables the circular buffer mode.*
- spicallback_t end_cb

  *Operation complete callback or `NULL`.*
- ioline_t ssline

  *The chip select line.*
- ioportid_t ssport

  *The chip select port.*
- ioportmask_t ssmask

  *The chip select port mask.*
- uint_fast8_t sspad

  *The chip select pad number.*

### 8.99.1 Detailed Description

Driver configuration structure.

**Note**

Implementations may extend this structure to contain more, architecture dependent, fields.

### 8.99.2 Field Documentation

#### 8.99.2.1 bool SPIConfig::circular

Enables the circular buffer mode.

#### 8.99.2.2 spicallback_t SPIConfig::end_cb

Operation complete callback or `NULL`.

#### 8.99.2.3 ioline_t SPIConfig::ssline

The chip select line.

#### 8.99.2.4 ioportid_t SPIConfig::ssport

The chip select port.

#### 8.99.2.5 ioportmask_t SPIConfig::ssmask

The chip select port mask.

#### 8.99.2.6 uint_fast8_t SPIConfig::sspad

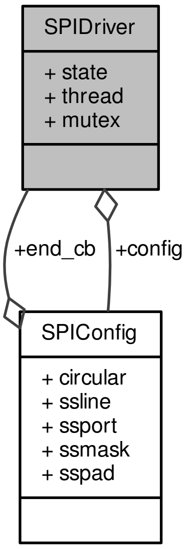
The chip select pad number.

## 8.100 SPIDriver Struct Reference

Structure representing an SPI driver.

`#include <hal_spi_lld.h>`

Collaboration diagram for SPIDriver:



### Data Fields

- spistate_t state

  *Driver state.*
- const SPIConfig ∗ config

  *Current configuration data.*
- thread_reference_t thread

  *Waiting thread.*
- mutex_t mutex

  *Mutex protecting the peripheral.*

### 8.100.1 Detailed Description

Structure representing an SPI driver.

**Note**

Implementations may extend this structure to contain more, architecture dependent, fields.

### 8.100.2 Field Documentation

#### 8.100.2.1 spistate_t SPIDriver::state

Driver state.

#### 8.100.2.2 const SPIConfig∗ SPIDriver::config

Current configuration data.

#### 8.100.2.3 thread_reference_t SPIDriver::thread

Waiting thread.

#### 8.100.2.4 mutex_t SPIDriver::mutex

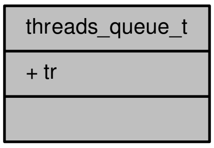
Mutex protecting the peripheral.

## 8.101 threads_queue_t Struct Reference

Type of a thread queue.

`#include <osal.h>`

Collaboration diagram for threads_queue_t:



### 8.101.1 Detailed Description

Type of a thread queue.

A thread queue is a queue of sleeping threads, queued threads can be dequeued one at time or all together.

**Note**

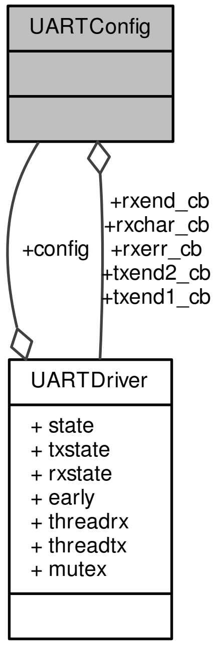
> If the OSAL is implemented on a bare metal machine without RTOS then the queue can be implemented as a single thread reference.

## 8.102 UARTConfig Struct Reference

Driver configuration structure.

`#include <hal_uart_lld.h>`

Collaboration diagram for UARTConfig:



### Data Fields

- uartcb_t txend1_cb

    *End of transmission buffer callback.*
- uartcb_t txend2_cb

    *Physical end of transmission callback.*
- uartcb_t rxend_cb

    *Receive buffer filled callback.*
- uartccb_t rxchar_cb

    *Character received while out if the `UART_RECEIVE` state.*
- uartecb_t rxerr_cb

    *Receive error callback.*

## 8.102.1 Detailed Description

Driver configuration structure.

**Note**

Implementations may extend this structure to contain more, architecture dependent, fields.

## 8.102.2 Field Documentation

#### 8.102.2.1 uartcb_t UARTConfig::txend1_cb

End of transmission buffer callback.

#### 8.102.2.2 uartcb_t UARTConfig::txend2_cb

Physical end of transmission callback.

#### 8.102.2.3 uartcb_t UARTConfig::rxend_cb

Receive buffer filled callback.

#### 8.102.2.4 uartccb_t UARTConfig::rxchar_cb

Character received while out if the `UART_RECEIVE` state.

#### 8.102.2.5 uartecb_t UARTConfig::rxerr_cb

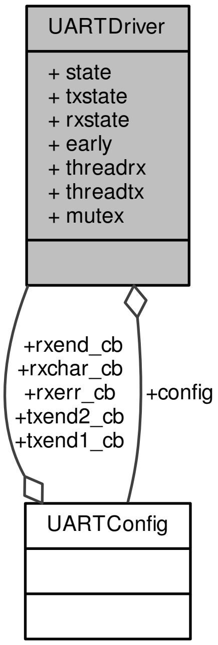
Receive error callback.

## 8.103 UARTDriver Struct Reference

Structure representing an UART driver.

`#include <hal_uart_lld.h>`

Collaboration diagram for UARTDriver:



## Data Fields

- uartstate_t state

  *Driver state.*
- uarttxstate_t txstate

  *Transmitter state.*
- uartrxstate_t rxstate

  *Receiver state.*
- const UARTConfig ∗ config

  *Current configuration data.*
- bool early

  *Synchronization flag for transmit operations.*
- thread_reference_t threadrx

  *Waiting thread on RX.*
- thread_reference_t threadtx

  *Waiting thread on TX.*
- mutex_t mutex

  *Mutex protecting the peripheral.*

### 8.103.1 Detailed Description

Structure representing an UART driver.

**Note**

Implementations may extend this structure to contain more, architecture dependent, fields.

## 8.103.2 Field Documentation

### 8.103.2.1 uartstate_t UARTDriver::state

Driver state.

### 8.103.2.2 uarttxstate_t UARTDriver::txstate

Transmitter state.

### 8.103.2.3 uartrxstate_t UARTDriver::rxstate

Receiver state.

### 8.103.2.4 const UARTConfig∗ UARTDriver::config

Current configuration data.

### 8.103.2.5 bool UARTDriver::early

Synchronization flag for transmit operations.

### 8.103.2.6 thread_reference_t UARTDriver::threadrx

Waiting thread on RX.

### 8.103.2.7 thread_reference_t UARTDriver::threadtx

Waiting thread on TX.

### 8.103.2.8 mutex_t UARTDriver::mutex

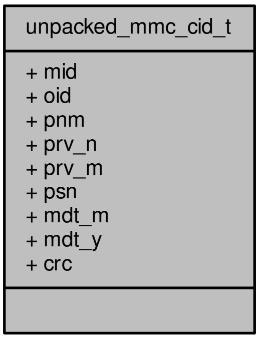
Mutex protecting the peripheral.

# 8.104 unpacked_mmc_cid_t Struct Reference

Unpacked CID register from MMC.

```
#include <hal_mmcsd.h>
```

Collaboration diagram for unpacked_mmc_cid_t:



### 8.104.1 Detailed Description

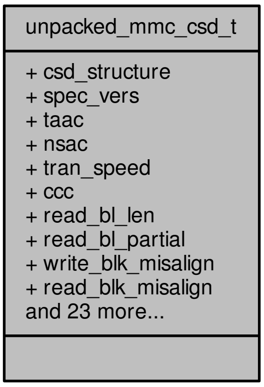
Unpacked CID register from MMC.

## 8.105 unpacked_mmc_csd_t Struct Reference

Unpacked CSD register from MMC.

```
#include <hal_mmcsd.h>
```

Collaboration diagram for unpacked_mmc_csd_t:



### 8.105.1 Detailed Description

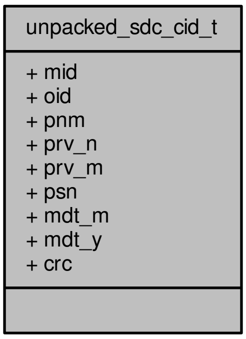
Unpacked CSD register from MMC.

## 8.106 unpacked_sdc_cid_t Struct Reference

Unpacked CID register from SDC.

`#include <hal_mmcsd.h>`

Collaboration diagram for unpacked_sdc_cid_t:



### 8.106.1 Detailed Description

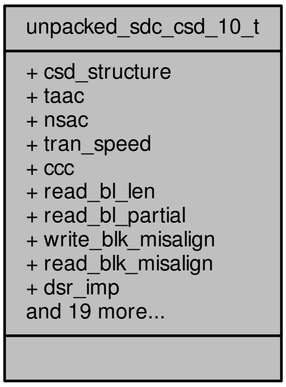
Unpacked CID register from SDC.

## 8.107 unpacked_sdc_csd_10_t Struct Reference

Unpacked CSD v1.0 register from SDC.

`#include <hal_mmcsd.h>`

Collaboration diagram for unpacked_sdc_csd_10_t:



### 8.107.1 Detailed Description

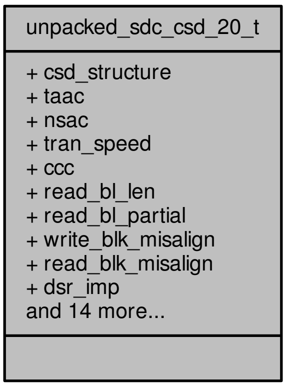
Unpacked CSD v1.0 register from SDC.

## 8.108 unpacked_sdc_csd_20_t Struct Reference

Unpacked CSD v2.0 register from SDC.

```
#include <hal_mmcsd.h>
```

Collaboration diagram for unpacked_sdc_csd_20_t:



### 8.108.1 Detailed Description

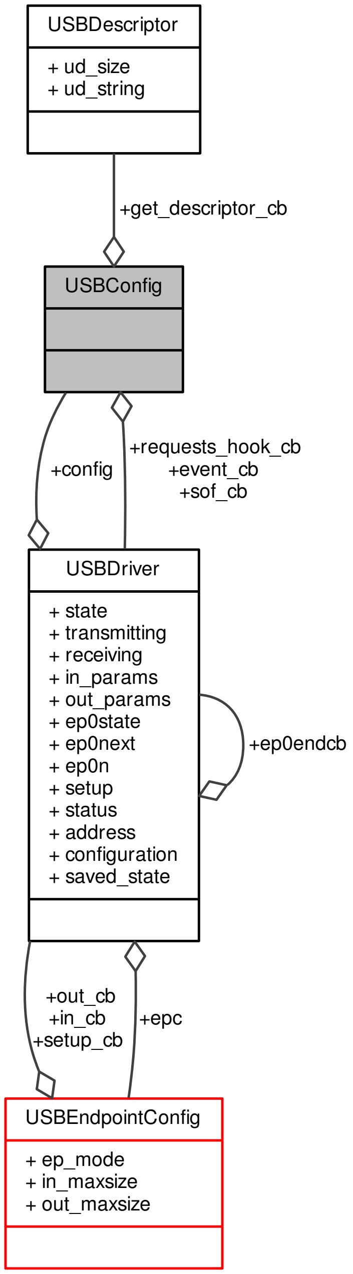
Unpacked CSD v2.0 register from SDC.

## 8.109 USBConfig Struct Reference

Type of an USB driver configuration structure.

```
#include <hal_usb_lld.h>
```

Collaboration diagram for USBConfig:



## Data Fields

- usbeventcb_t event_cb

  *USB events callback.*
- usbgetdescriptor_t get_descriptor_cb

  *Device GET_DESCRIPTOR request callback.*
- usbreqhandler_t requests_hook_cb

*Requests hook callback.*

- usbcallback_t sof_cb

  *Start Of Frame callback.*

### 8.109.1 Detailed Description

Type of an USB driver configuration structure.

### 8.109.2 Field Documentation

#### 8.109.2.1 usbeventcb_t USBConfig::event_cb

USB events callback.

This callback is invoked when an USB driver event is registered.

#### 8.109.2.2 usbgetdescriptor_t USBConfig::get_descriptor_cb

Device GET_DESCRIPTOR request callback.

**Note**

This callback is mandatory and cannot be set to `NULL`.

#### 8.109.2.3 usbreqhandler_t USBConfig::requests_hook_cb

Requests hook callback.

This hook allows to be notified of standard requests or to handle non standard requests.

#### 8.109.2.4 usbcallback_t USBConfig::sof_cb

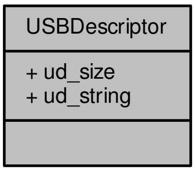
Start Of Frame callback.

## 8.110 USBDescriptor Struct Reference

Type of an USB descriptor.

`#include <hal_usb.h>`

Collaboration diagram for USBDescriptor:



## Data Fields

- size_t ud_size

  *Descriptor size in unicode characters.*
- const uint8_t ∗ ud_string

  *Pointer to the descriptor.*

### 8.110.1 Detailed Description

Type of an USB descriptor.

### 8.110.2 Field Documentation

#### 8.110.2.1 size_t USBDescriptor::ud_size

Descriptor size in unicode characters.

#### 8.110.2.2 const uint8_t∗ USBDescriptor::ud_string

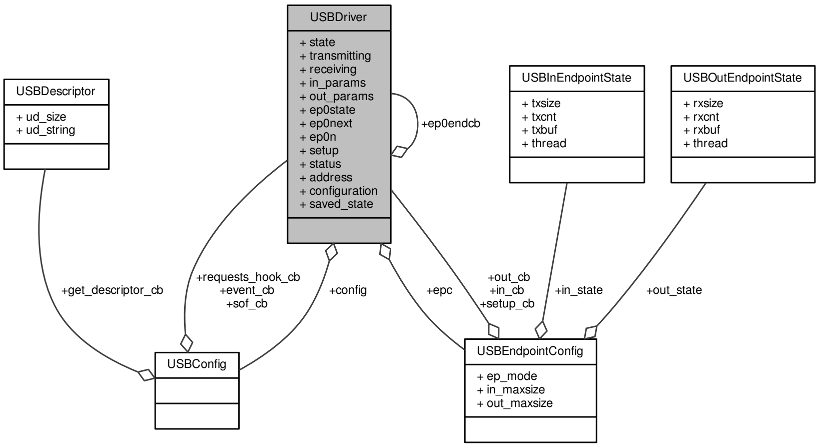
Pointer to the descriptor.

## 8.111 USBDriver Struct Reference

Structure representing an USB driver.

```
#include <hal_usb_lld.h>
```

Collaboration diagram for USBDriver:



## Data Fields

- usbstate_t state

  *Driver state.*
- const USBConfig ∗ config

*Current configuration data.*
- uint16_t transmitting

  *Bit map of the transmitting IN endpoints.*
- uint16_t receiving

  *Bit map of the receiving OUT endpoints.*
- const USBEndpointConfig ∗ epc [USB_MAX_ENDPOINTS+1]

  *Active endpoints configurations.*
- void ∗ in_params [USB_MAX_ENDPOINTS]

  *Fields available to user, it can be used to associate an application-defined handler to an IN endpoint.*
- void ∗ out_params [USB_MAX_ENDPOINTS]

  *Fields available to user, it can be used to associate an application-defined handler to an OUT endpoint.*
- usbep0state_t ep0state

  *Endpoint 0 state.*
- uint8_t ∗ ep0next

  *Next position in the buffer to be transferred through endpoint 0.*
- size_t ep0n

  *Number of bytes yet to be transferred through endpoint 0.*
- usbcallback_t ep0endcb

  *Endpoint 0 end transaction callback.*
- uint8_t setup [8]

  *Setup packet buffer.*
- uint16_t status

  *Current USB device status.*
- uint8_t address

  *Assigned USB address.*
- uint8_t configuration

  *Current USB device configuration.*
- usbstate_t saved_state

  *State of the driver when a suspend happened.*

## 8.111.1 Detailed Description

Structure representing an USB driver.

## 8.111.2 Field Documentation

### 8.111.2.1 usbstate_t USBDriver::state

Driver state.

### 8.111.2.2 const USBConfig∗ USBDriver::config

Current configuration data.

### 8.111.2.3 uint16_t USBDriver::transmitting

Bit map of the transmitting IN endpoints.

### 8.111.2.4 uint16_t USBDriver::receiving

Bit map of the receiving OUT endpoints.

#### 8.111.2.5 const USBEndpointConfig∗ USBDriver::epc[USB_MAX_ENDPOINTS+1]

Active endpoints configurations.

#### 8.111.2.6 void∗ USBDriver::in_params[USB_MAX_ENDPOINTS]

Fields available to user, it can be used to associate an application-defined handler to an IN endpoint.

**Note**

The base index is one, the endpoint zero does not have a reserved element in this array.

#### 8.111.2.7 void∗ USBDriver::out_params[USB_MAX_ENDPOINTS]

Fields available to user, it can be used to associate an application-defined handler to an OUT endpoint.

**Note**

The base index is one, the endpoint zero does not have a reserved element in this array.

#### 8.111.2.8 usbep0state_t USBDriver::ep0state

Endpoint 0 state.

#### 8.111.2.9 uint8_t∗ USBDriver::ep0next

Next position in the buffer to be transferred through endpoint 0.

#### 8.111.2.10 size_t USBDriver::ep0n

Number of bytes yet to be transferred through endpoint 0.

#### 8.111.2.11 usbcallback_t USBDriver::ep0endcb

Endpoint 0 end transaction callback.

#### 8.111.2.12 uint8_t USBDriver::setup[8]

Setup packet buffer.

#### 8.111.2.13 uint16_t USBDriver::status

Current USB device status.

#### 8.111.2.14 uint8_t USBDriver::address

Assigned USB address.

#### 8.111.2.15 uint8_t USBDriver::configuration

Current USB device configuration.

#### 8.111.2.16 usbstate_t USBDriver::saved_state

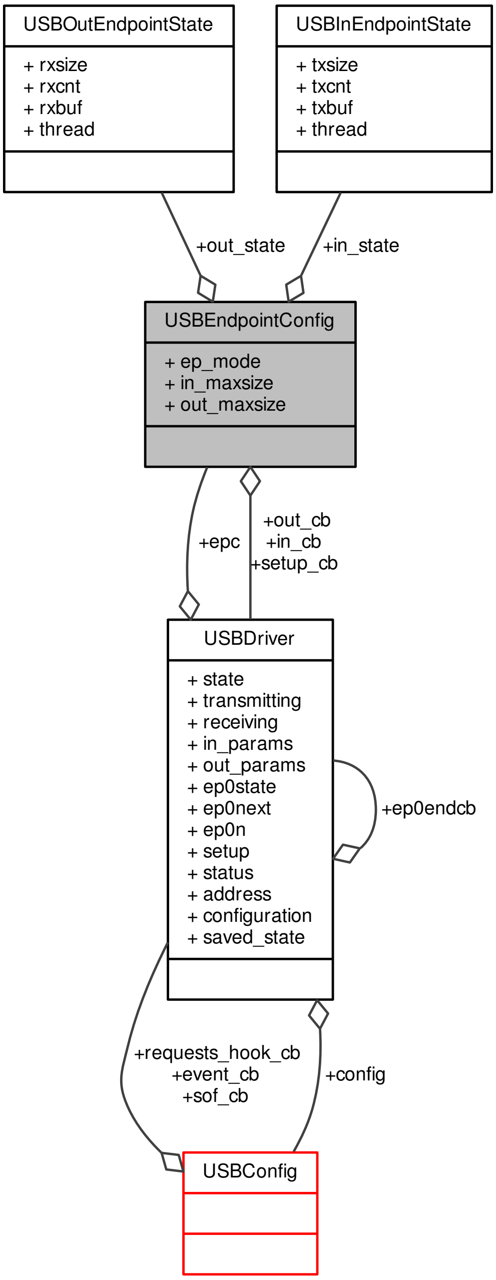
State of the driver when a suspend happened.

## 8.112 USBEndpointConfig Struct Reference

Type of an USB endpoint configuration structure.

```
#include <hal_usb_lld.h>
```

Collaboration diagram for USBEndpointConfig:



## Data Fields

- uint32_t ep_mode

  *Type and mode of the endpoint.*
- usbepcallback_t setup_cb

  *Setup packet notification callback.*
- usbepcallback_t in_cb

*IN endpoint notification callback.*

- usbepcallback_t out_cb

  *OUT endpoint notification callback.*

- uint16_t in_maxsize

  *IN endpoint maximum packet size.*

- uint16_t out_maxsize

  *OUT endpoint maximum packet size.*

- USBInEndpointState ∗ in_state

  *`USBEndpointState` associated to the IN endpoint.*

- USBOutEndpointState ∗ out_state

  *`USBEndpointState` associated to the OUT endpoint.*

## 8.112.1 Detailed Description

Type of an USB endpoint configuration structure.

**Note**

Platform specific restrictions may apply to endpoints.

## 8.112.2 Field Documentation

### 8.112.2.1 uint32_t USBEndpointConfig::ep_mode

Type and mode of the endpoint.

### 8.112.2.2 usbepcallback_t USBEndpointConfig::setup_cb

Setup packet notification callback.

This callback is invoked when a setup packet has been received.

**Postcondition**

The application must immediately call `usbReadPacket()` in order to access the received packet.

**Note**

This field is only valid for `USB_EP_MODE_TYPE_CTRL` endpoints, it should be set to `NULL` for other endpoint types.

### 8.112.2.3 usbepcallback_t USBEndpointConfig::in_cb

IN endpoint notification callback.

This field must be set to `NULL` if the IN endpoint is not used.

### 8.112.2.4 usbepcallback_t USBEndpointConfig::out_cb

OUT endpoint notification callback.

This field must be set to `NULL` if the OUT endpoint is not used.

#### 8.112.2.5 uint16_t USBEndpointConfig::in_maxsize

IN endpoint maximum packet size.

This field must be set to zero if the IN endpoint is not used.

#### 8.112.2.6 uint16_t USBEndpointConfig::out_maxsize

OUT endpoint maximum packet size.

This field must be set to zero if the OUT endpoint is not used.

#### 8.112.2.7 USBInEndpointState∗ USBEndpointConfig::in_state

`USBEndpointState` associated to the IN endpoint.

This structure maintains the state of the IN endpoint.

#### 8.112.2.8 USBOutEndpointState∗ USBEndpointConfig::out_state

`USBEndpointState` associated to the OUT endpoint.

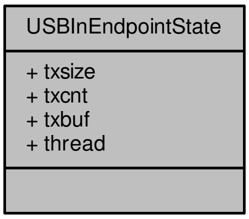
This structure maintains the state of the OUT endpoint.

## 8.113 USBInEndpointState Struct Reference

Type of an IN endpoint state structure.

`#include <hal_usb_lld.h>`

Collaboration diagram for USBInEndpointState:



### Data Fields

- size_t txsize

  *Requested transmit transfer size.*
- size_t txcnt

  *Transmitted bytes so far.*
- const uint8_t ∗ txbuf

  *Pointer to the transmission linear buffer.*

- thread_reference_t thread

  *Waiting thread.*

### 8.113.1 Detailed Description

Type of an IN endpoint state structure.

### 8.113.2 Field Documentation

#### 8.113.2.1 size_t USBInEndpointState::txsize

Requested transmit transfer size.

#### 8.113.2.2 size_t USBInEndpointState::txcnt

Transmitted bytes so far.

#### 8.113.2.3 const uint8_t∗ USBInEndpointState::txbuf

Pointer to the transmission linear buffer.

#### 8.113.2.4 thread_reference_t USBInEndpointState::thread

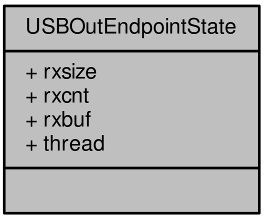
Waiting thread.

## 8.114 USBOutEndpointState Struct Reference

Type of an OUT endpoint state structure.

```
#include <hal_usb_lld.h>
```

Collaboration diagram for USBOutEndpointState:



### Data Fields

- size_t rxsize

  *Requested receive transfer size.*

- size_t rxcnt

  *Received bytes so far.*
- uint8_t ∗ rxbuf

  *Pointer to the receive linear buffer.*
- thread_reference_t thread

  *Waiting thread.*

### 8.114.1 Detailed Description

Type of an OUT endpoint state structure.

### 8.114.2 Field Documentation

#### 8.114.2.1 size_t USBOutEndpointState::rxsize

Requested receive transfer size.

#### 8.114.2.2 size_t USBOutEndpointState::rxcnt

Received bytes so far.

#### 8.114.2.3 uint8_t∗ USBOutEndpointState::rxbuf

Pointer to the receive linear buffer.

#### 8.114.2.4 thread_reference_t USBOutEndpointState::thread

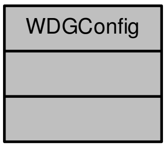
Waiting thread.

## 8.115 WDGConfig Struct Reference

Driver configuration structure.

```
#include <hal_wdg_lld.h>
```

Collaboration diagram for WDGConfig:



### 8.115.1 Detailed Description

Driver configuration structure.

**Note**

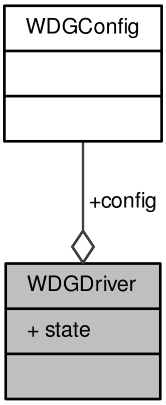
It could be empty on some architectures.

## 8.116 WDGDriver Struct Reference

Structure representing an WDG driver.

```
#include <hal_wdg_lld.h>
```

Collaboration diagram for WDGDriver:



### Data Fields

- wdgstate_t state

  *Driver state.*
- const WDGConfig ∗ config

  *Current configuration data.*

### 8.116.1 Detailed Description

Structure representing an WDG driver.

### 8.116.2 Field Documentation

#### 8.116.2.1 wdgstate_t WDGDriver::state

Driver state.

#### 8.116.2.2 const WDGConfig∗ WDGDriver::config

Current configuration data.

# Chapter 9

# File Documentation

## 9.1 hal.c File Reference

HAL subsystem code.

```
#include "hal.h"
```

### Functions

- void halInit (void)

  *HAL initialization.*

### 9.1.1 Detailed Description

HAL subsystem code.

## 9.2 hal.h File Reference

HAL subsystem header.

```
#include "osal.h"
#include "board.h"
#include "halconf.h"
#include "hal_lld.h"
#include "hal_objects.h"
#include "hal_streams.h"
#include "hal_channels.h"
#include "hal_files.h"
#include "hal_ioblock.h"
#include "hal_mmcsd.h"
#include "hal_buffers.h"
#include "hal_queues.h"
#include "hal_pal.h"
#include "hal_adc.h"
#include "hal_can.h"
#include "hal_crypto.h"
#include "hal_dac.h"
#include "hal_ext.h"
#include "hal_gpt.h"
#include "hal_i2c.h"
#include "hal_i2s.h"
#include "hal_icu.h"
#include "hal_mac.h"
#include "hal_pwm.h"
#include "hal_qspi.h"
#include "hal_rtc.h"
#include "hal_serial.h"
#include "hal_sdc.h"
#include "hal_spi.h"
#include "hal_uart.h"
#include "hal_usb.h"
#include "hal_wdg.h"
#include "hal_mmc_spi.h"
#include "hal_serial_usb.h"
#include "hal_community.h"
```

## Macros

- #define _CHIBIOS_HAL_

  *ChibiOS/HAL identification macro.*
- #define CH_HAL_STABLE 1

  *Stable release flag.*

### ChibiOS/HAL version identification

- #define HAL_VERSION "6.0.1"

  *HAL version string.*
- #define CH_HAL_MAJOR 6

  *HAL version major number.*
- #define CH_HAL_MINOR 0

  *HAL version minor number.*
- #define CH_HAL_PATCH 1

  *HAL version patch number.*

### Return codes

- #define **HAL_SUCCESS** false
- #define **HAL_FAILED** true

## Functions

- void halInit (void)

  *HAL initialization.*

### 9.2.1 Detailed Description

HAL subsystem header.

## 9.3 hal_accelerometer.h File Reference

Generic accelerometer interface header.

```
#include "hal_sensors.h"
```

## Data Structures

- struct BaseAccelerometerVMT

  *`BaseAccelerometer` virtual methods table.*
- struct BaseAccelerometer

  *Base accelerometer class.*

## Macros

- #define _base_accelerometer_methods_alone

  *BaseAccelerometer specific methods.*
- #define _base_accelerometer_methods

  *BaseAccelerometer specific methods with inherited ones.*
- #define _base_accelerometer_data _base_sensor_data

  *`BaseAccelerometer` specific data.*

**Macro Functions (BaseAccelerometer)**

- #define accelerometerGetAxesNumber(ip) (ip)->vmt->get_channels_number(ip)

  *Accelerometer get axes number.*
- #define accelerometerReadRaw(ip, dp) (ip)->vmt->read_raw(ip, dp)

  *Accelerometer read raw data.*
- #define accelerometerReadCooked(ip, dp) (ip)->vmt->read_cooked(ip, dp)

  *Accelerometer read cooked data.*
- #define accelerometerSetBias(ip, bp) (ip)->vmt->set_bias(ip, bp)

  *Updates accelerometer bias data from received buffer.*
- #define accelerometerResetBias(ip) (ip)->vmt->reset_bias(ip)

  *Reset accelerometer bias data restoring it to zero.*
- #define accelerometerSetSensitivity(ip, sp) (ip)->vmt->set_sensitivity(ip, sp)

  *Updates accelerometer sensitivity data from received buffer.*
- #define accelerometerResetSensitivity(ip) (ip)->vmt->reset_sensitivity(ip)

  *Reset accelerometer sensitivity data restoring it to its typical value.*

### 9.3.1 Detailed Description

Generic accelerometer interface header.

## 9.4 hal_adc.c File Reference

ADC Driver code.

```
#include "hal.h"
```

### Functions

- void adcInit (void)

  *ADC Driver initialization.*
- void adcObjectInit (ADCDriver ∗adcp)

  *Initializes the standard part of a `ADCDriver` structure.*
- void adcStart (ADCDriver ∗adcp, const ADCConfig ∗config)

  *Configures and activates the ADC peripheral.*
- void adcStop (ADCDriver ∗adcp)

  *Deactivates the ADC peripheral.*
- void adcStartConversion (ADCDriver ∗adcp, const ADCConversionGroup ∗grpp, adcsample_t ∗samples, size_t depth)

  *Starts an ADC conversion.*
- void adcStartConversionI (ADCDriver ∗adcp, const ADCConversionGroup ∗grpp, adcsample_t ∗samples, size_t depth)

  *Starts an ADC conversion.*
- void adcStopConversion (ADCDriver ∗adcp)

  *Stops an ongoing conversion.*
- void adcStopConversionI (ADCDriver ∗adcp)

  *Stops an ongoing conversion.*
- msg_t adcConvert (ADCDriver ∗adcp, const ADCConversionGroup ∗grpp, adcsample_t ∗samples, size_t depth)

  *Performs an ADC conversion.*
- void adcAcquireBus (ADCDriver ∗adcp)

  *Gains exclusive access to the ADC peripheral.*
- void adcReleaseBus (ADCDriver ∗adcp)

  *Releases exclusive access to the ADC peripheral.*

### 9.4.1 Detailed Description

ADC Driver code.

## 9.5 hal_adc.h File Reference

ADC Driver macros and structures.

```
#include "hal_adc_lld.h"
```

### Macros

**ADC configuration options**

- #define ADC_USE_WAIT TRUE

*Enables synchronous APIs.*
- #define ADC_USE_MUTUAL_EXCLUSION TRUE

    *Enables the `adcAcquireBus()` and `adcReleaseBus()` APIs.*

**Low level driver helper macros**

- #define _adc_reset_i(adcp) osalThreadResumeI(&(adcp)->thread, MSG_RESET)

    *Resumes a thread waiting for a conversion completion.*
- #define _adc_reset_s(adcp) osalThreadResumeS(&(adcp)->thread, MSG_RESET)

    *Resumes a thread waiting for a conversion completion.*
- #define _adc_wakeup_isr(adcp)

    *Wakes up the waiting thread.*
- #define _adc_timeout_isr(adcp)

    *Wakes up the waiting thread with a timeout message.*
- #define _adc_isr_half_code(adcp)

    *Common ISR code, half buffer event.*
- #define _adc_isr_full_code(adcp)

    *Common ISR code, full buffer event.*
- #define _adc_isr_error_code(adcp, err)

    *Common ISR code, error event.*

## Enumerations

## Functions

- void adcInit (void)

    *ADC Driver initialization.*
- void adcObjectInit (ADCDriver ∗adcp)

    *Initializes the standard part of a `ADCDriver` structure.*
- void adcStart (ADCDriver ∗adcp, const ADCConfig ∗config)

    *Configures and activates the ADC peripheral.*
- void adcStop (ADCDriver ∗adcp)

    *Deactivates the ADC peripheral.*
- void adcStartConversion (ADCDriver ∗adcp, const ADCConversionGroup ∗grpp, adcsample_t ∗samples, size_t depth)

    *Starts an ADC conversion.*
- void adcStartConversionI (ADCDriver ∗adcp, const ADCConversionGroup ∗grpp, adcsample_t ∗samples, size_t depth)

    *Starts an ADC conversion.*
- void adcStopConversion (ADCDriver ∗adcp)

    *Stops an ongoing conversion.*
- void adcStopConversionI (ADCDriver ∗adcp)

    *Stops an ongoing conversion.*
- msg_t adcConvert (ADCDriver ∗adcp, const ADCConversionGroup ∗grpp, adcsample_t ∗samples, size_t depth)

    *Performs an ADC conversion.*
- void adcAcquireBus (ADCDriver ∗adcp)

    *Gains exclusive access to the ADC peripheral.*
- void adcReleaseBus (ADCDriver ∗adcp)

    *Releases exclusive access to the ADC peripheral.*

### 9.5.1 Detailed Description

ADC Driver macros and structures.

## 9.6 hal_adc_lld.c File Reference

PLATFORM ADC subsystem low level driver source.

```
#include "hal.h"
```

### Functions

- void adc_lld_init (void)

  *Low level ADC driver initialization.*
- void adc_lld_start (ADCDriver ∗adcp)

  *Configures and activates the ADC peripheral.*
- void adc_lld_stop (ADCDriver ∗adcp)

  *Deactivates the ADC peripheral.*
- void adc_lld_start_conversion (ADCDriver ∗adcp)

  *Starts an ADC conversion.*
- void adc_lld_stop_conversion (ADCDriver ∗adcp)

  *Stops an ongoing conversion.*

### Variables

- ADCDriver ADCD1

  *ADC1 driver identifier.*

### 9.6.1 Detailed Description

PLATFORM ADC subsystem low level driver source.

## 9.7 hal_adc_lld.h File Reference

PLATFORM ADC subsystem low level driver header.

### Data Structures

- struct ADCConversionGroup

  *Conversion group configuration structure.*
- struct ADCConfig

  *Driver configuration structure.*
- struct ADCDriver

  *Structure representing an ADC driver.*

### Macros

**PLATFORM configuration options**

- #define PLATFORM_ADC_USE_ADC1 FALSE

  *ADC1 driver enable switch.*

### Typedefs

- typedef uint16_t adcsample_t

  *ADC sample data type.*
- typedef uint16_t adc_channels_num_t

  *Channels number in a conversion group.*
- typedef struct ADCDriver ADCDriver

  *Type of a structure representing an ADC driver.*
- typedef void(∗ adccallback_t) (ADCDriver ∗adcp, adcsample_t ∗buffer, size_t n)

  *ADC notification callback type.*
- typedef void(∗ adcerrorcallback_t) (ADCDriver ∗adcp, adcerror_t err)

  *ADC error callback type.*

### Enumerations

### Functions

- void adc_lld_init (void)

  *Low level ADC driver initialization.*
- void adc_lld_start (ADCDriver ∗adcp)

  *Configures and activates the ADC peripheral.*
- void adc_lld_stop (ADCDriver ∗adcp)

  *Deactivates the ADC peripheral.*
- void adc_lld_start_conversion (ADCDriver ∗adcp)

  *Starts an ADC conversion.*
- void adc_lld_stop_conversion (ADCDriver ∗adcp)

  *Stops an ongoing conversion.*

### 9.7.1 Detailed Description

PLATFORM ADC subsystem low level driver header.

## 9.8 hal_barometer.h File Reference

Generic barometer interface header.

```
#include "hal_sensors.h"
```

### Data Structures

- struct BaseBarometerVMT

  `BaseBarometer` *virtual methods table.*
- struct BaseBarometer

  *Base barometer class.*

### Macros

- #define _base_barometer_methods_alone

  *BaseBarometer specific methods.*
- #define _base_barometer_methods

  *BaseBarometer specific methods with inherited ones.*
- #define _base_barometer_data _base_sensor_data

  *`BaseBarometer` specific data.*

**Macro Functions (BaseBarometer)**

- #define barometerGetChannelsNumber(ip) (ip)->vmt->get_channels_number(ip)

  *Barometer get channels number.*
- #define barometerReadRaw(ip, dp) (ip)->vmt->read_raw(ip, dp)

  *Barometer read raw data.*
- #define barometerReadCooked(ip, dp) (ip)->vmt->read_cooked(ip, dp)

  *Barometer read cooked data.*
- #define barometerSetBias(ip, bp) (ip)->vmt->set_bias(ip, bp)

  *Updates barometer bias data from received buffer.*
- #define barometerResetBias(ip) (ip)->vmt->reset_bias(ip)

  *Reset barometer bias data restoring it to zero.*
- #define barometerSetSensitivity(ip, sp) (ip)->vmt->set_sensitivity(ip, sp)

  *Updates barometer sensitivity data from received buffer.*
- #define barometerResetSensitivity(ip) (ip)->vmt->reset_sensitivity(ip)

  *Reset barometer sensitivity data restoring it to its typical value.*

### 9.8.1 Detailed Description

Generic barometer interface header.

## 9.9 hal_buffers.c File Reference

I/O Buffers code.

```
#include <string.h>
#include "hal.h"
```

### Functions

- void ibqObjectInit (input_buffers_queue_t ∗ibqp, bool suspended, uint8_t ∗bp, size_t size, size_t n, bqnotify_t infy, void ∗link)

  *Initializes an input buffers queue object.*
- void ibqResetI (input_buffers_queue_t ∗ibqp)

  *Resets an input buffers queue.*
- uint8_t ∗ ibqGetEmptyBufferI (input_buffers_queue_t ∗ibqp)

  *Gets the next empty buffer from the queue.*
- void ibqPostFullBufferI (input_buffers_queue_t ∗ibqp, size_t size)

  *Posts a new filled buffer to the queue.*
- msg_t ibqGetFullBufferTimeout (input_buffers_queue_t ∗ibqp, sysinterval_t timeout)

  *Gets the next filled buffer from the queue.*
- msg_t ibqGetFullBufferTimeoutS (input_buffers_queue_t ∗ibqp, sysinterval_t timeout)

  *Gets the next filled buffer from the queue.*

- void ibqReleaseEmptyBuffer (input_buffers_queue_t ∗ibqp)

  *Releases the buffer back in the queue.*
- void ibqReleaseEmptyBufferS (input_buffers_queue_t ∗ibqp)

  *Releases the buffer back in the queue.*
- msg_t ibqGetTimeout (input_buffers_queue_t ∗ibqp, sysinterval_t timeout)

  *Input queue read with timeout.*
- size_t ibqReadTimeout (input_buffers_queue_t ∗ibqp, uint8_t ∗bp, size_t n, sysinterval_t timeout)

  *Input queue read with timeout.*
- void obqObjectInit (output_buffers_queue_t ∗obqp, bool suspended, uint8_t ∗bp, size_t size, size_t n, bqnotify_t onfy, void ∗link)

  *Initializes an output buffers queue object.*
- void obqResetI (output_buffers_queue_t ∗obqp)

  *Resets an output buffers queue.*
- uint8_t ∗ obqGetFullBufferI (output_buffers_queue_t ∗obqp, size_t ∗sizep)

  *Gets the next filled buffer from the queue.*
- void obqReleaseEmptyBufferI (output_buffers_queue_t ∗obqp)

  *Releases the next filled buffer back in the queue.*
- msg_t obqGetEmptyBufferTimeout (output_buffers_queue_t ∗obqp, sysinterval_t timeout)

  *Gets the next empty buffer from the queue.*
- msg_t obqGetEmptyBufferTimeoutS (output_buffers_queue_t ∗obqp, sysinterval_t timeout)

  *Gets the next empty buffer from the queue.*
- void obqPostFullBuffer (output_buffers_queue_t ∗obqp, size_t size)

  *Posts a new filled buffer to the queue.*
- void obqPostFullBufferS (output_buffers_queue_t ∗obqp, size_t size)

  *Posts a new filled buffer to the queue.*
- msg_t obqPutTimeout (output_buffers_queue_t ∗obqp, uint8_t b, sysinterval_t timeout)

  *Output queue write with timeout.*
- size_t obqWriteTimeout (output_buffers_queue_t ∗obqp, const uint8_t ∗bp, size_t n, sysinterval_t timeout)

  *Output queue write with timeout.*
- bool obqTryFlushI (output_buffers_queue_t ∗obqp)

  *Flushes the current, partially filled, buffer to the queue.*
- void obqFlush (output_buffers_queue_t ∗obqp)

  *Flushes the current, partially filled, buffer to the queue.*

### 9.9.1 Detailed Description

I/O Buffers code.

## 9.10 hal_buffers.h File Reference

I/O Buffers macros and structures.

### Data Structures

- struct io_buffers_queue

  *Structure of a generic buffers queue.*

## Macros

- #define BQ_BUFFER_SIZE(n, size) (((size_t)(size) + sizeof (size_t)) ∗ (size_t)(n))

  *Computes the size of a buffers queue buffer size.*

### Macro Functions

- #define bqSizeX(bqp) ((bqp)->bn)

  *Returns the queue's number of buffers.*
- #define bqSpaceI(bqp) ((bqp)->bcounter)

  *Return the ready buffers number.*
- #define bqGetLinkX(bqp) ((bqp)->link)

  *Returns the queue application-defined link.*
- #define bqIsSuspendedX(bqp) ((bqp)->suspended)

  *Return the suspended state of the queue.*
- #define bqSuspendI(bqp)

  *Puts the queue in suspended state.*
- #define bqResumeX(bqp)

  *Resumes normal queue operations.*
- #define ibqIsEmptyI(ibqp) ((bool)(bqSpaceI(ibqp) == 0U))

  *Evaluates to `true` if the specified input buffers queue is empty.*
- #define ibqIsFullI(ibqp)

  *Evaluates to `true` if the specified input buffers queue is full.*
- #define obqIsEmptyI(obqp)

  *Evaluates to `true` if the specified output buffers queue is empty.*
- #define obqIsFullI(obqp) ((bool)(bqSpaceI(obqp) == 0U))

  *Evaluates to `true` if the specified output buffers queue is full.*

## Typedefs

- typedef struct io_buffers_queue io_buffers_queue_t

  *Type of a generic queue of buffers.*
- typedef void(∗ bqnotify_t) (io_buffers_queue_t ∗bqp)

  *Double buffer notification callback type.*
- typedef io_buffers_queue_t input_buffers_queue_t

  *Type of an input buffers queue.*
- typedef io_buffers_queue_t output_buffers_queue_t

  *Type of an output buffers queue.*

## Functions

- void ibqObjectInit (input_buffers_queue_t ∗ibqp, bool suspended, uint8_t ∗bp, size_t size, size_t n, bqnotify_t infy, void ∗link)

  *Initializes an input buffers queue object.*
- void ibqResetI (input_buffers_queue_t ∗ibqp)

  *Resets an input buffers queue.*
- uint8_t ∗ ibqGetEmptyBufferI (input_buffers_queue_t ∗ibqp)

  *Gets the next empty buffer from the queue.*
- void ibqPostFullBufferI (input_buffers_queue_t ∗ibqp, size_t size)

  *Posts a new filled buffer to the queue.*
- msg_t ibqGetFullBufferTimeout (input_buffers_queue_t ∗ibqp, sysinterval_t timeout)

  *Gets the next filled buffer from the queue.*
- msg_t ibqGetFullBufferTimeoutS (input_buffers_queue_t ∗ibqp, sysinterval_t timeout)

  *Gets the next filled buffer from the queue.*

- void ibqReleaseEmptyBuffer (input_buffers_queue_t ∗ibqp)

  *Releases the buffer back in the queue.*
- void ibqReleaseEmptyBufferS (input_buffers_queue_t ∗ibqp)

  *Releases the buffer back in the queue.*
- msg_t ibqGetTimeout (input_buffers_queue_t ∗ibqp, sysinterval_t timeout)

  *Input queue read with timeout.*
- size_t ibqReadTimeout (input_buffers_queue_t ∗ibqp, uint8_t ∗bp, size_t n, sysinterval_t timeout)

  *Input queue read with timeout.*
- void obqObjectInit (output_buffers_queue_t ∗obqp, bool suspended, uint8_t ∗bp, size_t size, size_t n, bqnotify_t onfy, void ∗link)

  *Initializes an output buffers queue object.*
- void obqResetI (output_buffers_queue_t ∗obqp)

  *Resets an output buffers queue.*
- uint8_t ∗ obqGetFullBufferI (output_buffers_queue_t ∗obqp, size_t ∗sizep)

  *Gets the next filled buffer from the queue.*
- void obqReleaseEmptyBufferI (output_buffers_queue_t ∗obqp)

  *Releases the next filled buffer back in the queue.*
- msg_t obqGetEmptyBufferTimeout (output_buffers_queue_t ∗obqp, sysinterval_t timeout)

  *Gets the next empty buffer from the queue.*
- msg_t obqGetEmptyBufferTimeoutS (output_buffers_queue_t ∗obqp, sysinterval_t timeout)

  *Gets the next empty buffer from the queue.*
- void obqPostFullBuffer (output_buffers_queue_t ∗obqp, size_t size)

  *Posts a new filled buffer to the queue.*
- void obqPostFullBufferS (output_buffers_queue_t ∗obqp, size_t size)

  *Posts a new filled buffer to the queue.*
- msg_t obqPutTimeout (output_buffers_queue_t ∗obqp, uint8_t b, sysinterval_t timeout)

  *Output queue write with timeout.*
- size_t obqWriteTimeout (output_buffers_queue_t ∗obqp, const uint8_t ∗bp, size_t n, sysinterval_t timeout)

  *Output queue write with timeout.*
- bool obqTryFlushI (output_buffers_queue_t ∗obqp)

  *Flushes the current, partially filled, buffer to the queue.*
- void obqFlush (output_buffers_queue_t ∗obqp)

  *Flushes the current, partially filled, buffer to the queue.*

### 9.10.1 Detailed Description

I/O Buffers macros and structures.

## 9.11 hal_can.c File Reference

CAN Driver code.

```
#include "hal.h"
```

## Functions

- void canInit (void)

  *CAN Driver initialization.*
- void canObjectInit (CANDriver ∗canp)

  *Initializes the standard part of a `CANDriver` structure.*
- void canStart (CANDriver ∗canp, const CANConfig ∗config)

  *Configures and activates the CAN peripheral.*
- void canStop (CANDriver ∗canp)

  *Deactivates the CAN peripheral.*
- bool canTryTransmitI (CANDriver ∗canp, canmbx_t mailbox, const CANTxFrame ∗ctfp)

  *Can frame transmission attempt.*
- bool canTryReceiveI (CANDriver ∗canp, canmbx_t mailbox, CANRxFrame ∗crfp)

  *Can frame receive attempt.*
- msg_t canTransmitTimeout (CANDriver ∗canp, canmbx_t mailbox, const CANTxFrame ∗ctfp, sysinterval_t timeout)

  *Can frame transmission.*
- msg_t canReceiveTimeout (CANDriver ∗canp, canmbx_t mailbox, CANRxFrame ∗crfp, sysinterval_t timeout)

  *Can frame receive.*
- void canSleep (CANDriver ∗canp)

  *Enters the sleep mode.*
- void canWakeup (CANDriver ∗canp)

  *Enforces leaving the sleep mode.*

### 9.11.1 Detailed Description

CAN Driver code.

## 9.12 hal_can.h File Reference

CAN Driver macros and structures.

```
#include "hal_can_lld.h"
```

## Macros

- #define CAN_ANY_MAILBOX 0U

  *Special mailbox identifier.*

### CAN status flags

- #define CAN_LIMIT_WARNING 1U

  *Errors rate warning.*
- #define CAN_LIMIT_ERROR 2U

  *Errors rate error.*
- #define CAN_BUS_OFF_ERROR 4U

  *Bus off condition reached.*
- #define CAN_FRAMING_ERROR 8U

  *Framing error of some kind on the CAN bus.*
- #define CAN_OVERFLOW_ERROR 16U

  *Overflow in receive queue.*

### CAN configuration options

- #define CAN_USE_SLEEP_MODE TRUE

  *Sleep mode related APIs inclusion switch.*
- #define CAN_ENFORCE_USE_CALLBACKS FALSE

  *Enforces the driver to use direct callbacks rather than OSAL events.*

### Macro Functions

- #define CAN_MAILBOX_TO_MASK(mbx) (1U << ((mbx) - 1U))

  *Converts a mailbox index to a bit mask.*
- #define canTransmit(canp, mailbox, ctfp, timeout) canTransmitTimeout(canp, mailbox, ctfp, timeout)

  *Legacy name for `canTransmitTimeout()`.*
- #define canReceive(canp, mailbox, crfp, timeout) canReceiveTimeout(canp, mailbox, crfp, timeout)

  *Legacy name for `canReceiveTimeout()`.*

### Low level driver helper macros

- #define _can_tx_empty_isr(canp, flags)

  *TX mailbox empty event.*
- #define _can_rx_full_isr(canp, flags)

  *RX mailbox empty full event.*
- #define _can_wakeup_isr(canp)

  *Error event.*
- #define _can_error_isr(canp, flags)

  *Error event.*

## Enumerations

## Functions

- void canInit (void)

  *CAN Driver initialization.*
- void canObjectInit (CANDriver ∗canp)

  *Initializes the standard part of a `CANDriver` structure.*
- void canStart (CANDriver ∗canp, const CANConfig ∗config)

  *Configures and activates the CAN peripheral.*
- void canStop (CANDriver ∗canp)

  *Deactivates the CAN peripheral.*
- bool canTryTransmitI (CANDriver ∗canp, canmbx_t mailbox, const CANTxFrame ∗ctfp)

  *Can frame transmission attempt.*
- bool canTryReceiveI (CANDriver ∗canp, canmbx_t mailbox, CANRxFrame ∗crfp)

  *Can frame receive attempt.*
- msg_t canTransmitTimeout (CANDriver ∗canp, canmbx_t mailbox, const CANTxFrame ∗ctfp, sysinterval_t timeout)

  *Can frame transmission.*
- msg_t canReceiveTimeout (CANDriver ∗canp, canmbx_t mailbox, CANRxFrame ∗crfp, sysinterval_t timeout)

  *Can frame receive.*

## 9.12.1 Detailed Description

CAN Driver macros and structures.

## 9.13 hal_can_lld.c File Reference

PLATFORM CAN subsystem low level driver source.

```
#include "hal.h"
```

### Functions

- void can_lld_init (void)

  *Low level CAN driver initialization.*
- void can_lld_start (CANDriver ∗canp)

  *Configures and activates the CAN peripheral.*
- void can_lld_stop (CANDriver ∗canp)

  *Deactivates the CAN peripheral.*
- bool can_lld_is_tx_empty (CANDriver ∗canp, canmbx_t mailbox)

  *Determines whether a frame can be transmitted.*
- void can_lld_transmit (CANDriver ∗canp, canmbx_t mailbox, const CANTxFrame ∗ctfp)

  *Inserts a frame into the transmit queue.*
- bool can_lld_is_rx_nonempty (CANDriver ∗canp, canmbx_t mailbox)

  *Determines whether a frame has been received.*
- void can_lld_receive (CANDriver ∗canp, canmbx_t mailbox, CANRxFrame ∗crfp)

  *Receives a frame from the input queue.*
- void can_lld_sleep (CANDriver ∗canp)

  *Enters the sleep mode.*
- void can_lld_wakeup (CANDriver ∗canp)

  *Enforces leaving the sleep mode.*

### Variables

- CANDriver CAND1

  *CAN1 driver identifier.*

### 9.13.1 Detailed Description

PLATFORM CAN subsystem low level driver source.

## 9.14 hal_can_lld.h File Reference

PLATFORM CAN subsystem low level driver header.

### Data Structures

- struct CANTxFrame

  *CAN transmission frame.*
- struct CANRxFrame

  *CAN received frame.*
- struct CANConfig

  *Driver configuration structure.*
- struct CANDriver

  *Structure representing an CAN driver.*

## Macros

- #define CAN_TX_MAILBOXES 1

  *Number of transmit mailboxes.*
- #define CAN_RX_MAILBOXES 1

  *Number of receive mailboxes.*

### PLATFORM configuration options

- #define PLATFORM_CAN_USE_CAN1 FALSE

  *CAN1 driver enable switch.*

## Typedefs

- typedef struct CANDriver CANDriver

  *Type of a structure representing an CAN driver.*
- typedef uint32_t canmbx_t

  *Type of a transmission mailbox index.*
- typedef void(∗ can_callback_t) (CANDriver ∗canp, uint32_t flags)

  *Type of a CAN notification callback.*

## Functions

- void can_lld_init (void)

  *Low level CAN driver initialization.*
- void can_lld_start (CANDriver ∗canp)

  *Configures and activates the CAN peripheral.*
- void can_lld_stop (CANDriver ∗canp)

  *Deactivates the CAN peripheral.*
- bool can_lld_is_tx_empty (CANDriver ∗canp, canmbx_t mailbox)

  *Determines whether a frame can be transmitted.*
- void can_lld_transmit (CANDriver ∗canp, canmbx_t mailbox, const CANTxFrame ∗ctfp)

  *Inserts a frame into the transmit queue.*
- bool can_lld_is_rx_nonempty (CANDriver ∗canp, canmbx_t mailbox)

  *Determines whether a frame has been received.*
- void can_lld_receive (CANDriver ∗canp, canmbx_t mailbox, CANRxFrame ∗crfp)

  *Receives a frame from the input queue.*
- void can_lld_sleep (CANDriver ∗canp)

  *Enters the sleep mode.*
- void can_lld_wakeup (CANDriver ∗canp)

  *Enforces leaving the sleep mode.*

### 9.14.1 Detailed Description

PLATFORM CAN subsystem low level driver header.

## 9.15 hal_channels.h File Reference

I/O channels access.

## Data Structures

- struct BaseChannelVMT

  *`BaseChannel` virtual methods table.*
- struct BaseChannel

  *Base channel class.*
- struct BaseAsynchronousChannelVMT

  *`BaseAsynchronousChannel` virtual methods table.*
- struct BaseAsynchronousChannel

  *Base asynchronous channel class.*

## Macros

- #define _base_channel_methods

  *`BaseChannel` specific methods.*
- #define _base_channel_data _base_sequential_stream_data

  *`BaseChannel` specific data.*
- #define _base_asynchronous_channel_methods _base_channel_methods \

  *`BaseAsynchronousChannel` specific methods.*
- #define _base_asynchronous_channel_data

  *`BaseAsynchronousChannel` specific data.*

### Default control operation codes.

- #define **CHN_CTL_INVALID** 0 /∗∗ @brief Invalid operation code. ∗/
- #define **CHN_CTL_NOP** 1 /∗∗ @brief Does nothing. ∗/
- #define **CHN_CTL_TX_WAIT** 2 /∗∗ @brief Wait for TX completion. ∗/

### Macro Functions (BaseChannel)

- #define chnPutTimeout(ip, b, time) ((ip)->vmt->putt(ip, b, time))

  *Channel blocking byte write with timeout.*
- #define chnGetTimeout(ip, time) ((ip)->vmt->gett(ip, time))

  *Channel blocking byte read with timeout.*
- #define chnWrite(ip, bp, n) streamWrite(ip, bp, n)

  *Channel blocking write.*
- #define chnWriteTimeout(ip, bp, n, time) ((ip)->vmt->writet(ip, bp, n, time))

  *Channel blocking write with timeout.*
- #define chnRead(ip, bp, n) streamRead(ip, bp, n)

  *Channel blocking read.*
- #define chnReadTimeout(ip, bp, n, time) ((ip)->vmt->readt(ip, bp, n, time))

  *Channel blocking read with timeout.*
- #define chnControl(ip, operation, arg) ((ip)->vmt->ctl(ip, operation, arg))

  *Control operation on a channel.*

### I/O status flags added to the event listener

- #define CHN_NO_ERROR (eventflags_t)0

  *No pending conditions.*
- #define CHN_CONNECTED (eventflags_t)1

  *Connection happened.*
- #define CHN_DISCONNECTED (eventflags_t)2

  *Disconnection happened.*
- #define CHN_INPUT_AVAILABLE (eventflags_t)4

  *Data available in the input queue.*
- #define CHN_OUTPUT_EMPTY (eventflags_t)8

*Output queue empty.*
- #define CHN_TRANSMISSION_END (eventflags_t)16

  *Transmission end.*

**Macro Functions (BaseAsynchronousChannel)**

- #define chnGetEventSource(ip) (&((ip)->event))

  *Returns the I/O condition event source.*
- #define chnAddFlagsI(ip, flags)

  *Adds status flags to the listeners's flags mask.*

### 9.15.1 Detailed Description

I/O channels access.

This header defines an abstract interface useful to access generic I/O serial devices in a standardized way.

## 9.16 hal_compass.h File Reference

Generic compass interface header.

```
#include "hal_sensors.h"
```

### Data Structures

- struct BaseCompassVMT

  `BaseCompass` *virtual methods table.*
- struct BaseCompass

  *Base compass class.*

### Macros

- #define _base_compass_methods_alone

  *BaseCompass specific methods.*
- #define _base_compass_methods

  *BaseCompass specific methods with inherited ones.*
- #define _base_compass_data _base_sensor_data

  `BaseCompass` *specific data.*

**Macro Functions (BaseCompass)**

- #define compassGetAxesNumber(ip) (ip)->vmt->get_channels_number(ip)

  *Compass get axes number.*
- #define compassReadRaw(ip, dp) (ip)->vmt->read_raw(ip, dp)

  *Compass read raw data.*
- #define compassReadCooked(ip, dp) (ip)->vmt->read_cooked(ip, dp)

  *Compass read cooked data.*
- #define compassSetBias(ip, bp) (ip)->vmt->set_bias(ip, bp)

  *Updates compass bias data from received buffer.*
- #define compassResetBias(ip) (ip)->vmt->reset_bias(ip)

  *Reset compass bias data restoring it to zero.*
- #define compassSetSensitivity(ip, sp) (ip)->vmt->set_sensitivity(ip, sp)

  *Updates compass sensitivity data from received buffer.*
- #define compassResetSensitivity(ip) (ip)->vmt->reset_sensitivity(ip)

  *Reset compass sensitivity data restoring it to its typical value.*

### 9.16.1 Detailed Description

Generic compass interface header.

## 9.17 hal_crypto.c File Reference

Cryptographic Driver code.

```
#include "hal.h"
```

### Functions

- void cryInit (void)

  *Cryptographic Driver initialization.*
- void cryObjectInit (CRYDriver ∗cryp)

  *Initializes the standard part of a `CRYDriver` structure.*
- void cryStart (CRYDriver ∗cryp, const CRYConfig ∗config)

  *Configures and activates the cryptographic peripheral.*
- void cryStop (CRYDriver ∗cryp)

  *Deactivates the cryptographic peripheral.*
- cryerror_t cryLoadTransientKey (CRYDriver ∗cryp, cryalgorithm_t algorithm, size_t size, const uint8_t ∗keyp)

  *Initializes the transient key for a specific algorithm.*
- cryerror_t cryEncryptAES (CRYDriver ∗cryp, crykey_t key_id, const uint8_t ∗in, uint8_t ∗out)

  *Encryption of a single block using AES.*
- cryerror_t cryDecryptAES (CRYDriver ∗cryp, crykey_t key_id, const uint8_t ∗in, uint8_t ∗out)

  *Decryption of a single block using AES.*
- cryerror_t cryEncryptAES_ECB (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out)

  *Encryption operation using AES-ECB.*
- cryerror_t cryDecryptAES_ECB (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out)

  *Decryption operation using AES-ECB.*
- cryerror_t cryEncryptAES_CBC (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out, const uint8_t ∗iv)

  *Encryption operation using AES-CBC.*
- cryerror_t cryDecryptAES_CBC (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out, const uint8_t ∗iv)

  *Decryption operation using AES-CBC.*
- cryerror_t cryEncryptAES_CFB (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out, const uint8_t ∗iv)

  *Encryption operation using AES-CFB.*
- cryerror_t cryDecryptAES_CFB (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out, const uint8_t ∗iv)

  *Decryption operation using AES-CFB.*
- cryerror_t cryEncryptAES_CTR (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out, const uint8_t ∗iv)

  *Encryption operation using AES-CTR.*
- cryerror_t cryDecryptAES_CTR (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out, const uint8_t ∗iv)

  *Decryption operation using AES-CTR.*

- cryerror_t cryEncryptAES_GCM (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out, const uint8_t ∗iv, size_t aadsize, const uint8_t ∗aad, uint8_t ∗authtag)

    *Encryption operation using AES-GCM.*
- cryerror_t cryDecryptAES_GCM (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out, const uint8_t ∗iv, size_t aadsize, const uint8_t ∗aad, uint8_t ∗authtag)

    *Decryption operation using AES-GCM.*
- cryerror_t cryEncryptDES (CRYDriver ∗cryp, crykey_t key_id, const uint8_t ∗in, uint8_t ∗out)

    *Encryption of a single block using (T)DES.*
- cryerror_t cryDecryptDES (CRYDriver ∗cryp, crykey_t key_id, const uint8_t ∗in, uint8_t ∗out)

    *Decryption of a single block using (T)DES.*
- cryerror_t cryEncryptDES_ECB (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out)

    *Encryption operation using (T)DES-ECB.*
- cryerror_t cryDecryptDES_ECB (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out)

    *Decryption operation using (T)DES-ECB.*
- cryerror_t cryEncryptDES_CBC (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out, const uint8_t ∗iv)

    *Encryption operation using (T)DES-CBC.*
- cryerror_t cryDecryptDES_CBC (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out, const uint8_t ∗iv)

    *Decryption operation using (T)DES-CBC.*
- cryerror_t crySHA1Init (CRYDriver ∗cryp, SHA1Context ∗sha1ctxp)

    *Hash initialization using SHA1.*
- cryerror_t crySHA1Update (CRYDriver ∗cryp, SHA1Context ∗sha1ctxp, size_t size, const uint8_t ∗in)

    *Hash update using SHA1.*
- cryerror_t crySHA1Final (CRYDriver ∗cryp, SHA1Context ∗sha1ctxp, uint8_t ∗out)

    *Hash finalization using SHA1.*
- cryerror_t crySHA256Init (CRYDriver ∗cryp, SHA256Context ∗sha256ctxp)

    *Hash initialization using SHA256.*
- cryerror_t crySHA256Update (CRYDriver ∗cryp, SHA256Context ∗sha256ctxp, size_t size, const uint8_t ∗in)

    *Hash update using SHA256.*
- cryerror_t crySHA256Final (CRYDriver ∗cryp, SHA256Context ∗sha256ctxp, uint8_t ∗out)

    *Hash finalization using SHA256.*
- cryerror_t crySHA512Init (CRYDriver ∗cryp, SHA512Context ∗sha512ctxp)

    *Hash initialization using SHA512.*
- cryerror_t crySHA512Update (CRYDriver ∗cryp, SHA512Context ∗sha512ctxp, size_t size, const uint8_t ∗in)

    *Hash update using SHA512.*
- cryerror_t crySHA512Final (CRYDriver ∗cryp, SHA512Context ∗sha512ctxp, uint8_t ∗out)

    *Hash finalization using SHA512.*
- cryerror_t cryTRNG (CRYDriver ∗cryp, uint8_t ∗out)

    *True random numbers generator.*

### 9.17.1 Detailed Description

Cryptographic Driver code.

## 9.18 hal_crypto.h File Reference

Cryptographic Driver macros and structures.

```
#include "hal_crypto_lld.h"
#include "hal_crypto_fallback.h"
```

### Data Structures

- struct SHA1Context

  *Type of a SHA1 context.*
- struct SHA256Context

  *Type of a SHA256 context.*
- struct SHA512Context

  *Type of a SHA512 context.*

### Macros

- #define HAL_CRY_MAX_KEY_SIZE 32

  *Maximum size of a key for all supported algorithms.*
- #define HAL_CRY_USE_FALLBACK FALSE

  *Enables the SW fall-back of the cryptographic driver.*
- #define HAL_CRY_ENFORCE_FALLBACK FALSE

  *Makes the driver forcibly use the fall-back implementations.*
- #define HAL_CRY_USE_FALLBACK TRUE

  *Enables the SW fall-back of the cryptographic driver.*

### Typedefs

- typedef size_t bitsize_t

  *Size, in bits, of a crypto field or message.*

### Enumerations

### Functions

- void cryInit (void)

  *Cryptographic Driver initialization.*
- void cryObjectInit (CRYDriver ∗cryp)

  *Initializes the standard part of a `CRYDriver` structure.*
- void cryStart (CRYDriver ∗cryp, const CRYConfig ∗config)

  *Configures and activates the cryptographic peripheral.*
- void cryStop (CRYDriver ∗cryp)

  *Deactivates the cryptographic peripheral.*
- cryerror_t cryLoadTransientKey (CRYDriver ∗cryp, cryalgorithm_t algorithm, size_t size, const uint8_t ∗keyp)

  *Initializes the transient key for a specific algorithm.*
- cryerror_t cryEncryptAES (CRYDriver ∗cryp, crykey_t key_id, const uint8_t ∗in, uint8_t ∗out)

  *Encryption of a single block using AES.*
- cryerror_t cryDecryptAES (CRYDriver ∗cryp, crykey_t key_id, const uint8_t ∗in, uint8_t ∗out)

  *Decryption of a single block using AES.*

- cryerror_t cryEncryptAES_ECB (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out)

  *Encryption operation using AES-ECB.*
- cryerror_t cryDecryptAES_ECB (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out)

  *Decryption operation using AES-ECB.*
- cryerror_t cryEncryptAES_CBC (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out, const uint8_t ∗iv)

  *Encryption operation using AES-CBC.*
- cryerror_t cryDecryptAES_CBC (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out, const uint8_t ∗iv)

  *Decryption operation using AES-CBC.*
- cryerror_t cryEncryptAES_CFB (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out, const uint8_t ∗iv)

  *Encryption operation using AES-CFB.*
- cryerror_t cryDecryptAES_CFB (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out, const uint8_t ∗iv)

  *Decryption operation using AES-CFB.*
- cryerror_t cryEncryptAES_CTR (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out, const uint8_t ∗iv)

  *Encryption operation using AES-CTR.*
- cryerror_t cryDecryptAES_CTR (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out, const uint8_t ∗iv)

  *Decryption operation using AES-CTR.*
- cryerror_t cryEncryptAES_GCM (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out, const uint8_t ∗iv, size_t aadsize, const uint8_t ∗aad, uint8_t ∗authtag)

  *Encryption operation using AES-GCM.*
- cryerror_t cryDecryptAES_GCM (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out, const uint8_t ∗iv, size_t aadsize, const uint8_t ∗aad, uint8_t ∗authtag)

  *Decryption operation using AES-GCM.*
- cryerror_t cryEncryptDES (CRYDriver ∗cryp, crykey_t key_id, const uint8_t ∗in, uint8_t ∗out)

  *Encryption of a single block using (T)DES.*
- cryerror_t cryDecryptDES (CRYDriver ∗cryp, crykey_t key_id, const uint8_t ∗in, uint8_t ∗out)

  *Decryption of a single block using (T)DES.*
- cryerror_t cryEncryptDES_ECB (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out)

  *Encryption operation using (T)DES-ECB.*
- cryerror_t cryDecryptDES_ECB (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out)

  *Decryption operation using (T)DES-ECB.*
- cryerror_t cryEncryptDES_CBC (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out, const uint8_t ∗iv)

  *Encryption operation using (T)DES-CBC.*
- cryerror_t cryDecryptDES_CBC (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out, const uint8_t ∗iv)

  *Decryption operation using (T)DES-CBC.*
- cryerror_t crySHA1Init (CRYDriver ∗cryp, SHA1Context ∗sha1ctxp)

  *Hash initialization using SHA1.*
- cryerror_t crySHA1Update (CRYDriver ∗cryp, SHA1Context ∗sha1ctxp, size_t size, const uint8_t ∗in)

  *Hash update using SHA1.*
- cryerror_t crySHA1Final (CRYDriver ∗cryp, SHA1Context ∗sha1ctxp, uint8_t ∗out)

  *Hash finalization using SHA1.*

- cryerror_t crySHA256Init (CRYDriver ∗cryp, SHA256Context ∗sha256ctxp)

  *Hash initialization using SHA256.*
- cryerror_t crySHA256Update (CRYDriver ∗cryp, SHA256Context ∗sha256ctxp, size_t size, const uint8_t ∗in)

  *Hash update using SHA256.*
- cryerror_t crySHA256Final (CRYDriver ∗cryp, SHA256Context ∗sha256ctxp, uint8_t ∗out)

  *Hash finalization using SHA256.*
- cryerror_t crySHA512Init (CRYDriver ∗cryp, SHA512Context ∗sha512ctxp)

  *Hash initialization using SHA512.*
- cryerror_t crySHA512Update (CRYDriver ∗cryp, SHA512Context ∗sha512ctxp, size_t size, const uint8_t ∗in)

  *Hash update using SHA512.*
- cryerror_t crySHA512Final (CRYDriver ∗cryp, SHA512Context ∗sha512ctxp, uint8_t ∗out)

  *Hash finalization using SHA512.*
- cryerror_t cryTRNG (CRYDriver ∗cryp, uint8_t ∗out)

  *True random numbers generator.*

### 9.18.1 Detailed Description

Cryptographic Driver macros and structures.

## 9.19 hal_crypto_lld.c File Reference

PLATFORM cryptographic subsystem low level driver source.

```
#include "hal.h"
```

### Functions

- void cry_lld_init (void)

  *Low level crypto driver initialization.*
- void cry_lld_start (CRYDriver ∗cryp)

  *Configures and activates the crypto peripheral.*
- void cry_lld_stop (CRYDriver ∗cryp)

  *Deactivates the crypto peripheral.*
- cryerror_t cry_lld_loadkey (CRYDriver ∗cryp, cryalgorithm_t algorithm, size_t size, const uint8_t ∗keyp)

  *Initializes the transient key for a specific algorithm.*
- cryerror_t cry_lld_encrypt_AES (CRYDriver ∗cryp, crykey_t key_id, const uint8_t ∗in, uint8_t ∗out)

  *Encryption of a single block using AES.*
- cryerror_t cry_lld_decrypt_AES (CRYDriver ∗cryp, crykey_t key_id, const uint8_t ∗in, uint8_t ∗out)

  *Decryption of a single block using AES.*
- cryerror_t cry_lld_encrypt_AES_ECB (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out)

  *Encryption operation using AES-ECB.*
- cryerror_t cry_lld_decrypt_AES_ECB (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out)

  *Decryption operation using AES-ECB.*
- cryerror_t cry_lld_encrypt_AES_CBC (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out, const uint8_t ∗iv)

  *Encryption operation using AES-CBC.*
- cryerror_t cry_lld_decrypt_AES_CBC (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out, const uint8_t ∗iv)

*Decryption operation using AES-CBC.*

- cryerror_t cry_lld_encrypt_AES_CFB (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out, const uint8_t ∗iv)

  *Encryption operation using AES-CFB.*
- cryerror_t cry_lld_decrypt_AES_CFB (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out, const uint8_t ∗iv)

  *Decryption operation using AES-CFB.*
- cryerror_t cry_lld_encrypt_AES_CTR (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out, const uint8_t ∗iv)

  *Encryption operation using AES-CTR.*
- cryerror_t cry_lld_decrypt_AES_CTR (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out, const uint8_t ∗iv)

  *Decryption operation using AES-CTR.*
- cryerror_t cry_lld_encrypt_AES_GCM (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out, const uint8_t ∗iv, size_t aadsize, const uint8_t ∗aad, uint8_t ∗authtag)

  *Encryption operation using AES-GCM.*
- cryerror_t cry_lld_decrypt_AES_GCM (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out, const uint8_t ∗iv, size_t aadsize, const uint8_t ∗aad, uint8_t ∗authtag)

  *Decryption operation using AES-GCM.*
- cryerror_t cry_lld_encrypt_DES (CRYDriver ∗cryp, crykey_t key_id, const uint8_t ∗in, uint8_t ∗out)

  *Encryption of a single block using (T)DES.*
- cryerror_t cry_lld_decrypt_DES (CRYDriver ∗cryp, crykey_t key_id, const uint8_t ∗in, uint8_t ∗out)

  *Decryption of a single block using (T)DES.*
- cryerror_t cry_lld_encrypt_DES_ECB (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out)

  *Encryption operation using (T)DES-ECB.*
- cryerror_t cry_lld_decrypt_DES_ECB (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out)

  *Decryption operation using (T)DES-ECB.*
- cryerror_t cry_lld_encrypt_DES_CBC (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out, const uint8_t ∗iv)

  *Encryption operation using (T)DES-CBC.*
- cryerror_t cry_lld_decrypt_DES_CBC (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out, const uint8_t ∗iv)

  *Decryption operation using (T)DES-CBC.*
- cryerror_t cry_lld_SHA1_init (CRYDriver ∗cryp, SHA1Context ∗sha1ctxp)

  *Hash initialization using SHA1.*
- cryerror_t cry_lld_SHA1_update (CRYDriver ∗cryp, SHA1Context ∗sha1ctxp, size_t size, const uint8_t ∗in)

  *Hash update using SHA1.*
- cryerror_t cry_lld_SHA1_final (CRYDriver ∗cryp, SHA1Context ∗sha1ctxp, uint8_t ∗out)

  *Hash finalization using SHA1.*
- cryerror_t cry_lld_SHA256_init (CRYDriver ∗cryp, SHA256Context ∗sha256ctxp)

  *Hash initialization using SHA256.*
- cryerror_t cry_lld_SHA256_update (CRYDriver ∗cryp, SHA256Context ∗sha256ctxp, size_t size, const uint8_t ∗in)

  *Hash update using SHA256.*
- cryerror_t cry_lld_SHA256_final (CRYDriver ∗cryp, SHA256Context ∗sha256ctxp, uint8_t ∗out)

  *Hash finalization using SHA256.*
- cryerror_t cry_lld_SHA512_init (CRYDriver ∗cryp, SHA512Context ∗sha512ctxp)

  *Hash initialization using SHA512.*
- cryerror_t cry_lld_SHA512_update (CRYDriver ∗cryp, SHA512Context ∗sha512ctxp, size_t size, const uint8_t ∗in)

*Hash update using SHA512.*
- cryerror_t cry_lld_SHA512_final (CRYDriver ∗cryp, SHA512Context ∗sha512ctxp, uint8_t ∗out)

  *Hash finalization using SHA512.*
- cryerror_t cry_lld_TRNG (CRYDriver ∗cryp, uint8_t ∗out)

  *True random numbers generator.*

### Variables

- CRYDriver CRYD1

  *CRY1 driver identifier.*

### 9.19.1 Detailed Description

PLATFORM cryptographic subsystem low level driver source.

## 9.20 hal_crypto_lld.h File Reference

PLATFORM cryptographic subsystem low level driver header.

### Data Structures

- struct CRYConfig

  *Driver configuration structure.*
- struct CRYDriver

  *Structure representing an CRY driver.*
- struct SHA1Context

  *Type of a SHA1 context.*
- struct SHA256Context

  *Type of a SHA256 context.*
- struct SHA512Context

  *Type of a SHA512 context.*

### Macros

**Driver capability switches**

- #define **CRY_LLD_SUPPORTS_AES** TRUE
- #define **CRY_LLD_SUPPORTS_AES_ECB** TRUE
- #define **CRY_LLD_SUPPORTS_AES_CBC** TRUE
- #define **CRY_LLD_SUPPORTS_AES_CFB** TRUE
- #define **CRY_LLD_SUPPORTS_AES_CTR** TRUE
- #define **CRY_LLD_SUPPORTS_AES_GCM** TRUE
- #define **CRY_LLD_SUPPORTS_DES** TRUE
- #define **CRY_LLD_SUPPORTS_DES_ECB** TRUE
- #define **CRY_LLD_SUPPORTS_DES_CBC** TRUE
- #define **CRY_LLD_SUPPORTS_SHA1** TRUE
- #define **CRY_LLD_SUPPORTS_SHA256** TRUE
- #define **CRY_LLD_SUPPORTS_SHA512** TRUE
- #define **CRY_LLD_SUPPORTS_TRNG** TRUE

**PLATFORM configuration options**

- #define PLATFORM_CRY_USE_CRY1 FALSE

  *CRY1 driver enable switch.*

## Typedefs

- typedef uint32_t crykey_t

  *CRY key identifier type.*
- typedef struct CRYDriver CRYDriver

  *Type of a structure representing an CRY driver.*

## Functions

- void cry_lld_init (void)

  *Low level crypto driver initialization.*
- void cry_lld_start (CRYDriver ∗cryp)

  *Configures and activates the crypto peripheral.*
- void cry_lld_stop (CRYDriver ∗cryp)

  *Deactivates the crypto peripheral.*
- cryerror_t cry_lld_loadkey (CRYDriver ∗cryp, cryalgorithm_t algorithm, size_t size, const uint8_t ∗keyp)

  *Initializes the transient key for a specific algorithm.*
- cryerror_t cry_lld_encrypt_AES (CRYDriver ∗cryp, crykey_t key_id, const uint8_t ∗in, uint8_t ∗out)

  *Encryption of a single block using AES.*
- cryerror_t cry_lld_decrypt_AES (CRYDriver ∗cryp, crykey_t key_id, const uint8_t ∗in, uint8_t ∗out)

  *Decryption of a single block using AES.*
- cryerror_t cry_lld_encrypt_AES_ECB (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out)

  *Encryption operation using AES-ECB.*
- cryerror_t cry_lld_decrypt_AES_ECB (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out)

  *Decryption operation using AES-ECB.*
- cryerror_t cry_lld_encrypt_AES_CBC (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out, const uint8_t ∗iv)

  *Encryption operation using AES-CBC.*
- cryerror_t cry_lld_decrypt_AES_CBC (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out, const uint8_t ∗iv)

  *Decryption operation using AES-CBC.*
- cryerror_t cry_lld_encrypt_AES_CFB (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out, const uint8_t ∗iv)

  *Encryption operation using AES-CFB.*
- cryerror_t cry_lld_decrypt_AES_CFB (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out, const uint8_t ∗iv)

  *Decryption operation using AES-CFB.*
- cryerror_t cry_lld_encrypt_AES_CTR (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out, const uint8_t ∗iv)

  *Encryption operation using AES-CTR.*
- cryerror_t cry_lld_decrypt_AES_CTR (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out, const uint8_t ∗iv)

  *Decryption operation using AES-CTR.*
- cryerror_t cry_lld_encrypt_AES_GCM (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out, const uint8_t ∗iv, size_t aadsize, const uint8_t ∗aad, uint8_t ∗authtag)

  *Encryption operation using AES-GCM.*
- cryerror_t cry_lld_decrypt_AES_GCM (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out, const uint8_t ∗iv, size_t aadsize, const uint8_t ∗aad, uint8_t ∗authtag)

  *Decryption operation using AES-GCM.*
- cryerror_t cry_lld_encrypt_DES (CRYDriver ∗cryp, crykey_t key_id, const uint8_t ∗in, uint8_t ∗out)

*Encryption of a single block using (T)DES.*

- cryerror_t cry_lld_decrypt_DES (CRYDriver ∗cryp, crykey_t key_id, const uint8_t ∗in, uint8_t ∗out)

  *Decryption of a single block using (T)DES.*
- cryerror_t cry_lld_encrypt_DES_ECB (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out)

  *Encryption operation using (T)DES-ECB.*
- cryerror_t cry_lld_decrypt_DES_ECB (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out)

  *Decryption operation using (T)DES-ECB.*
- cryerror_t cry_lld_encrypt_DES_CBC (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out, const uint8_t ∗iv)

  *Encryption operation using (T)DES-CBC.*
- cryerror_t cry_lld_decrypt_DES_CBC (CRYDriver ∗cryp, crykey_t key_id, size_t size, const uint8_t ∗in, uint8_t ∗out, const uint8_t ∗iv)

  *Decryption operation using (T)DES-CBC.*
- cryerror_t cry_lld_SHA1_init (CRYDriver ∗cryp, SHA1Context ∗sha1ctxp)

  *Hash initialization using SHA1.*
- cryerror_t cry_lld_SHA1_update (CRYDriver ∗cryp, SHA1Context ∗sha1ctxp, size_t size, const uint8_t ∗in)

  *Hash update using SHA1.*
- cryerror_t cry_lld_SHA1_final (CRYDriver ∗cryp, SHA1Context ∗sha1ctxp, uint8_t ∗out)

  *Hash finalization using SHA1.*
- cryerror_t cry_lld_SHA256_init (CRYDriver ∗cryp, SHA256Context ∗sha256ctxp)

  *Hash initialization using SHA256.*
- cryerror_t cry_lld_SHA256_update (CRYDriver ∗cryp, SHA256Context ∗sha256ctxp, size_t size, const uint8_t ∗in)

  *Hash update using SHA256.*
- cryerror_t cry_lld_SHA256_final (CRYDriver ∗cryp, SHA256Context ∗sha256ctxp, uint8_t ∗out)

  *Hash finalization using SHA256.*
- cryerror_t cry_lld_SHA512_init (CRYDriver ∗cryp, SHA512Context ∗sha512ctxp)

  *Hash initialization using SHA512.*
- cryerror_t cry_lld_SHA512_update (CRYDriver ∗cryp, SHA512Context ∗sha512ctxp, size_t size, const uint8_t ∗in)

  *Hash update using SHA512.*
- cryerror_t cry_lld_SHA512_final (CRYDriver ∗cryp, SHA512Context ∗sha512ctxp, uint8_t ∗out)

  *Hash finalization using SHA512.*
- cryerror_t cry_lld_TRNG (CRYDriver ∗cryp, uint8_t ∗out)

  *True random numbers generator.*

### 9.20.1 Detailed Description

PLATFORM cryptographic subsystem low level driver header.

## 9.21 hal_dac.c File Reference

DAC Driver code.

```
#include "hal.h"
```

### Functions

- void dacInit (void)

  *DAC Driver initialization.*
- void dacObjectInit (DACDriver ∗dacp)

  *Initializes the standard part of a `DACDriver` structure.*
- void dacStart (DACDriver ∗dacp, const DACConfig ∗config)

  *Configures and activates the DAC peripheral.*
- void dacStop (DACDriver ∗dacp)

  *Deactivates the DAC peripheral.*
- void dacPutChannelX (DACDriver ∗dacp, dacchannel_t channel, dacsample_t sample)

  *Outputs a value directly on a DAC channel.*
- void dacStartConversion (DACDriver ∗dacp, const DACConversionGroup ∗grpp, dacsample_t ∗samples, size_t depth)

  *Starts a DAC conversion.*
- void dacStartConversionI (DACDriver ∗dacp, const DACConversionGroup ∗grpp, dacsample_t ∗samples, size_t depth)

  *Starts a DAC conversion.*
- void dacStopConversion (DACDriver ∗dacp)

  *Stops an ongoing conversion.*
- void dacStopConversionI (DACDriver ∗dacp)

  *Stops an ongoing conversion.*
- msg_t dacConvert (DACDriver ∗dacp, const DACConversionGroup ∗grpp, dacsample_t ∗samples, size_t depth)

  *Performs a DAC conversion.*
- void dacAcquireBus (DACDriver ∗dacp)

  *Gains exclusive access to the DAC bus.*
- void dacReleaseBus (DACDriver ∗dacp)

  *Releases exclusive access to the DAC bus.*

### 9.21.1 Detailed Description

DAC Driver code.

## 9.22 hal_dac.h File Reference

DAC Driver macros and structures.

```
#include "hal_dac_lld.h"
```

### Macros

**DAC configuration options**

- #define DAC_USE_WAIT TRUE

  *Enables synchronous APIs.*
- #define DAC_USE_MUTUAL_EXCLUSION TRUE

  *Enables the `dacAcquireBus()` and `dacReleaseBus()` APIs.*

**Low level driver helper macros**

- #define _dac_wait_s(dacp) osalThreadSuspendS(&(dacp)->thread)

  *Waits for operation completion.*
- #define _dac_reset_i(dacp) osalThreadResumeI(&(dacp)->thread, MSG_RESET)

  *Resumes a thread waiting for a conversion completion.*
- #define _dac_reset_s(dacp) osalThreadResumeS(&(dacp)->thread, MSG_RESET)

  *Resumes a thread waiting for a conversion completion.*
- #define _dac_wakeup_isr(dacp)

  *Wakes up the waiting thread.*
- #define _dac_timeout_isr(dacp)

  *Wakes up the waiting thread with a timeout message.*
- #define _dac_isr_half_code(dacp)

  *Common ISR code, half buffer event.*
- #define _dac_isr_full_code(dacp)

  *Common ISR code, full buffer event.*
- #define _dac_isr_error_code(dacp, err)

  *Common ISR code, error event.*

### Enumerations

### Functions

- void dacInit (void)

  *DAC Driver initialization.*
- void dacObjectInit (DACDriver ∗dacp)

  *Initializes the standard part of a `DACDriver` structure.*
- void dacStart (DACDriver ∗dacp, const DACConfig ∗config)

  *Configures and activates the DAC peripheral.*
- void dacStop (DACDriver ∗dacp)

  *Deactivates the DAC peripheral.*
- void dacPutChannelX (DACDriver ∗dacp, dacchannel_t channel, dacsample_t sample)

  *Outputs a value directly on a DAC channel.*
- void dacStartConversion (DACDriver ∗dacp, const DACConversionGroup ∗grpp, dacsample_t ∗samples, size_t depth)

  *Starts a DAC conversion.*
- void dacStartConversionI (DACDriver ∗dacp, const DACConversionGroup ∗grpp, dacsample_t ∗samples, size_t depth)

  *Starts a DAC conversion.*
- void dacStopConversion (DACDriver ∗dacp)

  *Stops an ongoing conversion.*
- void dacStopConversionI (DACDriver ∗dacp)

  *Stops an ongoing conversion.*

### 9.22.1 Detailed Description

DAC Driver macros and structures.

## 9.23 hal_dac_lld.c File Reference

PLATFORM DAC subsystem low level driver source.

```
#include "hal.h"
```

## Functions

- void dac_lld_init (void)

  *Low level DAC driver initialization.*
- void dac_lld_start (DACDriver ∗dacp)

  *Configures and activates the DAC peripheral.*
- void dac_lld_stop (DACDriver ∗dacp)

  *Deactivates the DAC peripheral.*
- void dac_lld_put_channel (DACDriver ∗dacp, dacchannel_t channel, dacsample_t sample)

  *Outputs a value directly on a DAC channel.*
- void dac_lld_start_conversion (DACDriver ∗dacp)

  *Starts a DAC conversion.*
- void dac_lld_stop_conversion (DACDriver ∗dacp)

  *Stops an ongoing conversion.*

## Variables

- DACDriver DACD1

  *DAC1 driver identifier.*

### 9.23.1 Detailed Description

PLATFORM DAC subsystem low level driver source.

## 9.24 hal_dac_lld.h File Reference

PLATFORM DAC subsystem low level driver header.

## Data Structures

- struct DACConversionGroup

  *DAC Conversion group structure.*
- struct DACConfig

  *Driver configuration structure.*
- struct DACDriver

  *Structure representing a DAC driver.*

## Macros

- #define DAC_MAX_CHANNELS 2

  *Maximum number of DAC channels per unit.*

### Configuration options

- #define PLATFORM_DAC_USE_DAC1 FALSE

  *DAC1 CH1 driver enable switch.*

### Typedefs

- typedef uint32_t dacchannel_t

  *Type of a DAC channel index.*
- typedef struct DACDriver DACDriver

  *Type of a structure representing an DAC driver.*
- typedef uint16_t dacsample_t

  *Type representing a DAC sample.*
- typedef void(∗ daccallback_t) (DACDriver ∗dacp, dacsample_t ∗buffer, size_t n)

  *DAC notification callback type.*
- typedef void(∗ dacerrorcallback_t) (DACDriver ∗dacp, dacerror_t err)

  *DAC error callback type.*

### Enumerations

### Functions

- void dac_lld_init (void)

  *Low level DAC driver initialization.*
- void dac_lld_start (DACDriver ∗dacp)

  *Configures and activates the DAC peripheral.*
- void dac_lld_stop (DACDriver ∗dacp)

  *Deactivates the DAC peripheral.*
- void dac_lld_put_channel (DACDriver ∗dacp, dacchannel_t channel, dacsample_t sample)

  *Outputs a value directly on a DAC channel.*
- void dac_lld_start_conversion (DACDriver ∗dacp)

  *Starts a DAC conversion.*
- void dac_lld_stop_conversion (DACDriver ∗dacp)

  *Stops an ongoing conversion.*

### 9.24.1 Detailed Description

PLATFORM DAC subsystem low level driver header.

## 9.25 hal_ext.c File Reference

EXT Driver code.

```
#include "hal.h"
```

### Functions

- void extInit (void)

  *EXT Driver initialization.*
- void extObjectInit (EXTDriver ∗extp)

  *Initializes the standard part of a `EXTDriver` structure.*
- void extStart (EXTDriver ∗extp, const EXTConfig ∗config)

  *Configures and activates the EXT peripheral.*
- void extStop (EXTDriver ∗extp)

*Deactivates the EXT peripheral.*

- void extChannelEnable (EXTDriver ∗extp, expchannel_t channel)

  *Enables an EXT channel.*
- void extChannelDisable (EXTDriver ∗extp, expchannel_t channel)

  *Disables an EXT channel.*
- void extSetChannelModeI (EXTDriver ∗extp, expchannel_t channel, const EXTChannelConfig ∗extcp)

  *Changes the operation mode of a channel.*

### 9.25.1 Detailed Description

EXT Driver code.

## 9.26 hal_ext.h File Reference

EXT Driver macros and structures.

```
#include "hal_ext_lld.h"
```

### Macros

**EXT channel modes**

- #define EXT_CH_MODE_EDGES_MASK 3U

  *Mask of edges field.*
- #define EXT_CH_MODE_DISABLED 0U

  *Channel disabled.*
- #define EXT_CH_MODE_RISING_EDGE 1U

  *Rising edge callback.*
- #define EXT_CH_MODE_FALLING_EDGE 2U

  *Falling edge callback.*
- #define EXT_CH_MODE_BOTH_EDGES 3U

  *Both edges callback.*
- #define EXT_CH_MODE_LOW_LEVEL 5U

  *low level callback.*
- #define EXT_CH_MODE_AUTOSTART 4U

  *Channel started automatically on driver start.*

**Macro Functions**

- #define extChannelEnableI(extp, channel) ext_lld_channel_enable(extp, channel)

  *Enables an EXT channel.*
- #define extChannelDisableI(extp, channel) ext_lld_channel_disable(extp, channel)

  *Disables an EXT channel.*
- #define extSetChannelMode(extp, channel, extcp)

  *Changes the operation mode of a channel.*

### Typedefs

- typedef struct EXTDriver EXTDriver

  *Type of a structure representing a EXT driver.*

### Enumerations

### Functions

- void extInit (void)

  *EXT Driver initialization.*
- void extObjectInit (EXTDriver ∗extp)

  *Initializes the standard part of a `EXTDriver` structure.*
- void extStart (EXTDriver ∗extp, const EXTConfig ∗config)

  *Configures and activates the EXT peripheral.*
- void extStop (EXTDriver ∗extp)

  *Deactivates the EXT peripheral.*
- void extChannelEnable (EXTDriver ∗extp, expchannel_t channel)

  *Enables an EXT channel.*
- void extChannelDisable (EXTDriver ∗extp, expchannel_t channel)

  *Disables an EXT channel.*
- void extSetChannelModeI (EXTDriver ∗extp, expchannel_t channel, const EXTChannelConfig ∗extcp)

  *Changes the operation mode of a channel.*

### 9.26.1 Detailed Description

EXT Driver macros and structures.

## 9.27 hal_ext_lld.c File Reference

PLATFORM EXT subsystem low level driver source.

```
#include "hal.h"
```

### Functions

- void ext_lld_init (void)

  *Low level EXT driver initialization.*
- void ext_lld_start (EXTDriver ∗extp)

  *Configures and activates the EXT peripheral.*
- void ext_lld_stop (EXTDriver ∗extp)

  *Deactivates the EXT peripheral.*
- void ext_lld_channel_enable (EXTDriver ∗extp, expchannel_t channel)

  *Enables an EXT channel.*
- void ext_lld_channel_disable (EXTDriver ∗extp, expchannel_t channel)

  *Disables an EXT channel.*

### Variables

- EXTDriver EXTD1

  *EXT1 driver identifier.*

### 9.27.1 Detailed Description

PLATFORM EXT subsystem low level driver source.

## 9.28 hal_ext_lld.h File Reference

PLATFORM EXT subsystem low level driver header.

### Data Structures

- struct EXTChannelConfig

  *Channel configuration structure.*
- struct EXTConfig

  *Driver configuration structure.*
- struct EXTDriver

  *Structure representing an EXT driver.*

### Macros

- #define EXT_MAX_CHANNELS 20

  *Available number of EXT channels.*

#### PLATFORM configuration options

- #define PLATFORM_EXT_USE_EXT1 FALSE

  *EXT driver enable switch.*

### Typedefs

- typedef uint32_t expchannel_t

  *EXT channel identifier.*
- typedef void(∗ extcallback_t) (EXTDriver ∗extp, expchannel_t channel)

  *Type of an EXT generic notification callback.*

### Functions

- void ext_lld_init (void)

  *Low level EXT driver initialization.*
- void ext_lld_start (EXTDriver ∗extp)

  *Configures and activates the EXT peripheral.*
- void ext_lld_stop (EXTDriver ∗extp)

  *Deactivates the EXT peripheral.*
- void ext_lld_channel_enable (EXTDriver ∗extp, expchannel_t channel)

  *Enables an EXT channel.*
- void ext_lld_channel_disable (EXTDriver ∗extp, expchannel_t channel)

  *Disables an EXT channel.*

### 9.28.1 Detailed Description

PLATFORM EXT subsystem low level driver header.

## 9.29 hal_files.h File Reference

Data files.

## Data Structures

- struct FileStreamVMT

  *FileStream virtual methods table.*
- struct FileStream

  *Base file stream class.*

## Macros

- #define _file_stream_methods

  *FileStream specific methods.*
- #define _file_stream_data _base_sequential_stream_data

  *FileStream specific data.*

### Files return codes

- #define FILE_OK STM_OK

  *No error return code.*
- #define FILE_ERROR STM_TIMEOUT

  *Error code from the file stream methods.*
- #define FILE_EOF STM_RESET

  *End-of-file condition for file get/put methods.*

### Macro Functions (FileStream)

- #define fileStreamWrite(ip, bp, n) streamWrite(ip, bp, n)

  *File stream write.*
- #define fileStreamRead(ip, bp, n) streamRead(ip, bp, n)

  *File stream read.*
- #define fileStreamPut(ip, b) streamPut(ip, b)

  *File stream blocking byte write.*
- #define fileStreamGet(ip) streamGet(ip)

  *File stream blocking byte read.*
- #define fileStreamClose(ip) ((ip)->vmt->close(ip))

  *File Stream close.*
- #define fileStreamGetError(ip) ((ip)->vmt->geterror(ip))

  *Returns an implementation dependent error code.*
- #define fileStreamGetSize(ip) ((ip)->vmt->getsize(ip))

  *Returns the current file size.*
- #define fileStreamGetPosition(ip) ((ip)->vmt->getposition(ip))

  *Returns the current file pointer position.*
- #define fileStreamSeek(ip, offset) ((ip)->vmt->lseek(ip, offset))

  *Moves the file current pointer to an absolute position.*

## Typedefs

- typedef uint32_t fileoffset_t

  *File offset type.*

## 9.29.1 Detailed Description

Data files.

This header defines abstract interfaces useful to access generic data files in a standardized way.

## 9.30 hal_flash.c File Reference

Generic flash driver class code.

```
#include "hal.h"
#include "hal_flash.h"
```

### Functions

- flash_error_t flashWaitErase (BaseFlash ∗devp)

  *Waits until the current erase operation is finished.*
- flash_offset_t flashGetSectorOffset (BaseFlash ∗devp, flash_sector_t sector)

  *Returns the offset of a sector.*
- uint32_t flashGetSectorSize (BaseFlash ∗devp, flash_sector_t sector)

  *Returns the size of a sector.*

### 9.30.1 Detailed Description

Generic flash driver class code.

## 9.31 hal_flash.h File Reference

Generic flash driver class header.

### Data Structures

- struct flash_sector_descriptor_t

  *Flash sector descriptor.*
- struct flash_descriptor_t

  *Type of a flash device descriptor.*
- struct BaseFlashVMT

  *`BaseFlash` virtual methods table.*
- struct BaseFlash

  *Base flash class.*

### Macros

- #define _base_flash_methods_alone

  *`BaseFlash` specific methods.*
- #define _base_flash_methods

  *`BaseFlash` specific methods with inherited ones.*
- #define _base_flash_data

  *`BaseFlash` specific data.*

#### Flash attributes

- #define **FLASH_ATTR_ERASED_IS_ONE** 0x00000001
- #define **FLASH_ATTR_MEMORY_MAPPED** 0x00000002
- #define **FLASH_ATTR_REWRITABLE** 0x00000004
- #define **FLASH_ATTR_READ_ECC_CAPABLE** 0x00000008

- #define **FLASH_ATTR_SUSPEND_ERASE_CAPABLE** 0x00000010

**Macro Functions (BaseFlash)**

- #define getBaseFlash(ip) ((BaseFlash ∗)&(ip)->vmt)
  *Instance getter.*
- #define flashGetDescriptor(ip) (ip)->vmt->get_descriptor(ip)
  *Sensors get axes number.*
- #define flashRead(ip, offset, n, rp) (ip)->vmt->read(ip, offset, n, rp)
  *Read operation.*
- #define flashProgram(ip, offset, n, pp) (ip)->vmt->program(ip, offset, n, pp)
  *Program operation.*
- #define flashStartEraseAll(ip) (ip)->vmt->start_erase_all(ip)
  *Starts a whole-device erase operation.*
- #define flashStartEraseSector(ip, sector) (ip)->vmt->start_erase_sector(ip, sector)
  *Starts an sector erase operation.*
- #define flashQueryErase(ip, msec) (ip)->vmt->query_erase(ip, msec)
  *Queries the driver for erase operation progress.*
- #define flashVerifyErase(ip, sector) (ip)->vmt->verify_erase(ip, sector)
  *Returns the erase state of a sector.*

## Typedefs

- typedef uint32_t flash_offset_t
  *Type of a flash offset.*
- typedef uint32_t flash_sector_t
  *Type of a flash sector number.*

## Enumerations

## Functions

- flash_error_t flashWaitErase (BaseFlash ∗devp)
  *Waits until the current erase operation is finished.*
- flash_offset_t flashGetSectorOffset (BaseFlash ∗devp, flash_sector_t sector)
  *Returns the offset of a sector.*
- uint32_t flashGetSectorSize (BaseFlash ∗devp, flash_sector_t sector)
  *Returns the size of a sector.*

### 9.31.1 Detailed Description

Generic flash driver class header.

## 9.32 hal_gpt.c File Reference

GPT Driver code.

```
#include "hal.h"
```

## Functions

- void gptInit (void)

    *GPT Driver initialization.*
- void gptObjectInit (GPTDriver ∗gptp)

    *Initializes the standard part of a `GPTDriver` structure.*
- void gptStart (GPTDriver ∗gptp, const GPTConfig ∗config)

    *Configures and activates the GPT peripheral.*
- void gptStop (GPTDriver ∗gptp)

    *Deactivates the GPT peripheral.*
- void gptChangeInterval (GPTDriver ∗gptp, gptcnt_t interval)

    *Changes the interval of GPT peripheral.*
- void gptStartContinuous (GPTDriver ∗gptp, gptcnt_t interval)

    *Starts the timer in continuous mode.*
- void gptStartContinuousI (GPTDriver ∗gptp, gptcnt_t interval)

    *Starts the timer in continuous mode.*
- void gptStartOneShot (GPTDriver ∗gptp, gptcnt_t interval)

    *Starts the timer in one shot mode.*
- void gptStartOneShotI (GPTDriver ∗gptp, gptcnt_t interval)

    *Starts the timer in one shot mode.*
- void gptStopTimer (GPTDriver ∗gptp)

    *Stops the timer.*
- void gptStopTimerI (GPTDriver ∗gptp)

    *Stops the timer.*
- void gptPolledDelay (GPTDriver ∗gptp, gptcnt_t interval)

    *Starts the timer in one shot mode and waits for completion.*

### 9.32.1 Detailed Description

GPT Driver code.

## 9.33 hal_gpt.h File Reference

GPT Driver macros and structures.

```
#include "hal_gpt_lld.h"
```

## Macros

- #define gptChangeIntervalI(gptp, interval)

    *Changes the interval of GPT peripheral.*
- #define gptGetIntervalX(gptp) gpt_lld_get_interval(gptp)

    *Returns the interval of GPT peripheral.*
- #define gptGetCounterX(gptp) gpt_lld_get_counter(gptp)

    *Returns the counter value of GPT peripheral.*

### Typedefs

- typedef struct GPTDriver GPTDriver

  *Type of a structure representing a GPT driver.*
- typedef void(∗ gptcallback_t) (GPTDriver ∗gptp)

  *GPT notification callback type.*

### Enumerations

### Functions

- void gptInit (void)

  *GPT Driver initialization.*
- void gptObjectInit (GPTDriver ∗gptp)

  *Initializes the standard part of a `GPTDriver` structure.*
- void gptStart (GPTDriver ∗gptp, const GPTConfig ∗config)

  *Configures and activates the GPT peripheral.*
- void gptStop (GPTDriver ∗gptp)

  *Deactivates the GPT peripheral.*
- void gptStartContinuous (GPTDriver ∗gptp, gptcnt_t interval)

  *Starts the timer in continuous mode.*
- void gptStartContinuousI (GPTDriver ∗gptp, gptcnt_t interval)

  *Starts the timer in continuous mode.*
- void gptChangeInterval (GPTDriver ∗gptp, gptcnt_t interval)

  *Changes the interval of GPT peripheral.*
- void gptStartOneShot (GPTDriver ∗gptp, gptcnt_t interval)

  *Starts the timer in one shot mode.*
- void gptStartOneShotI (GPTDriver ∗gptp, gptcnt_t interval)

  *Starts the timer in one shot mode.*
- void gptStopTimer (GPTDriver ∗gptp)

  *Stops the timer.*
- void gptStopTimerI (GPTDriver ∗gptp)

  *Stops the timer.*
- void gptPolledDelay (GPTDriver ∗gptp, gptcnt_t interval)

  *Starts the timer in one shot mode and waits for completion.*

### 9.33.1 Detailed Description

GPT Driver macros and structures.

## 9.34 hal_gpt_lld.c File Reference

PLATFORM GPT subsystem low level driver source.

```
#include "hal.h"
```

## Functions

- void gpt_lld_init (void)

  *Low level GPT driver initialization.*
- void gpt_lld_start (GPTDriver ∗gptp)

  *Configures and activates the GPT peripheral.*
- void gpt_lld_stop (GPTDriver ∗gptp)

  *Deactivates the GPT peripheral.*
- void gpt_lld_start_timer (GPTDriver ∗gptp, gptcnt_t interval)

  *Starts the timer in continuous mode.*
- void gpt_lld_stop_timer (GPTDriver ∗gptp)

  *Stops the timer.*
- void gpt_lld_polled_delay (GPTDriver ∗gptp, gptcnt_t interval)

  *Starts the timer in one shot mode and waits for completion.*

## Variables

- GPTDriver GPTD1

  *GPTD1 driver identifier.*

### 9.34.1 Detailed Description

PLATFORM GPT subsystem low level driver source.

## 9.35 hal_gpt_lld.h File Reference

PLATFORM GPT subsystem low level driver header.

## Data Structures

- struct GPTConfig

  *Driver configuration structure.*
- struct GPTDriver

  *Structure representing a GPT driver.*

## Macros

- #define gpt_lld_change_interval(gptp, interval)

  *Changes the interval of GPT peripheral.*

**PLATFORM configuration options**

- #define PLATFORM_GPT_USE_GPT1 FALSE

  *GPTD1 driver enable switch.*

## Typedefs

- typedef uint32_t gptfreq_t

  *GPT frequency type.*
- typedef uint16_t gptcnt_t

  *GPT counter type.*

### Functions

- void gpt_lld_init (void)

  *Low level GPT driver initialization.*
- void gpt_lld_start (GPTDriver ∗gptp)

  *Configures and activates the GPT peripheral.*
- void gpt_lld_stop (GPTDriver ∗gptp)

  *Deactivates the GPT peripheral.*
- void gpt_lld_start_timer (GPTDriver ∗gptp, gptcnt_t interval)

  *Starts the timer in continuous mode.*
- void gpt_lld_stop_timer (GPTDriver ∗gptp)

  *Stops the timer.*
- void gpt_lld_polled_delay (GPTDriver ∗gptp, gptcnt_t interval)

  *Starts the timer in one shot mode and waits for completion.*

### 9.35.1 Detailed Description

PLATFORM GPT subsystem low level driver header.

## 9.36 hal_gyroscope.h File Reference

Generic gyroscope interface header.

`#include "hal_sensors.h"`

### Data Structures

- struct BaseGyroscopeVMT

  *`BaseGyroscope` virtual methods table.*
- struct BaseGyroscope

  *Base gyroscope class.*

### Macros

- #define _base_gyroscope_methods_alone

  *BaseGyroscope specific methods.*
- #define _base_gyroscope_methods

  *BaseGyroscope specific methods with inherited ones.*
- #define _base_gyroscope_data _base_sensor_data

  *`BaseGyroscope` specific data.*

**Macro Functions (BaseGyroscope)**

- #define gyroscopeGetAxesNumber(ip) (ip)->vmt->get_channels_number(ip)

  *Gyroscope get axes number.*
- #define gyroscopeReadRaw(ip, dp) (ip)->vmt->read_raw(ip, dp)

  *Gyroscope read raw data.*
- #define gyroscopeReadCooked(ip, dp) (ip)->vmt->read_cooked(ip, dp)

  *Gyroscope read cooked data.*
- #define gyroscopeSampleBias(ip) (ip)->vmt->sample_bias(ip)

*Gyroscope bias sampling procedure.*

- #define gyroscopeSetBias(ip, bp) (ip)->vmt->set_bias(ip, bp)

  *Updates gyroscope bias data from received buffer.*
- #define gyroscopeResetBias(ip) (ip)->vmt->reset_bias(ip)

  *Reset gyroscope bias data restoring it to zero.*
- #define gyroscopeSetSensitivity(ip, sp) (ip)->vmt->set_sensitivity(ip, sp)

  *Updates gyroscope sensitivity data from received buffer.*
- #define gyroscopeResetSensitivity(ip) (ip)->vmt->reset_sensitivity(ip)

  *Reset gyroscope sensitivity data restoring it to its typical value.*

### 9.36.1 Detailed Description

Generic gyroscope interface header.

## 9.37 hal_hygrometer.h File Reference

Generic hygrometer interface header.

```
#include "hal_sensors.h"
```

### Data Structures

- struct BaseHygrometerVMT

  `BaseHygrometer` *virtual methods table.*
- struct BaseHygrometer

  *Base hygrometer class.*

### Macros

- #define _base_hygrometer_methods_alone

  *BaseHygrometer specific methods.*
- #define _base_hygrometer_methods

  *BaseHygrometer specific methods with inherited ones.*
- #define _base_hygrometer_data _base_sensor_data

  `BaseHygrometer` *specific data.*

#### Macro Functions (BaseHygrometer)

- #define hygrometerGetChannelsNumber(ip) (ip)->vmt->get_channels_number(ip)

  *Hygrometer get channels number.*
- #define hygrometerReadRaw(ip, dp) (ip)->vmt->read_raw(ip, dp)

  *Hygrometer read raw data.*
- #define hygrometerReadCooked(ip, dp) (ip)->vmt->read_cooked(ip, dp)

  *Hygrometer read cooked data.*
- #define hygrometerSetBias(ip, bp) (ip)->vmt->set_bias(ip, bp)

  *Updates hygrometer bias data from received buffer.*
- #define hygrometerResetBias(ip) (ip)->vmt->reset_bias(ip)

  *Reset hygrometer bias data restoring it to zero.*
- #define hygrometerSetSensitivity(ip, sp) (ip)->vmt->set_sensitivity(ip, sp)

  *Updates hygrometer sensitivity data from received buffer.*
- #define hygrometerResetSensitivity(ip) (ip)->vmt->reset_sensitivity(ip)

  *Reset hygrometer sensitivity data restoring it to its typical value.*

### 9.37.1 Detailed Description

Generic hygrometer interface header.

## 9.38 hal_i2c.c File Reference

I2C Driver code.

```
#include "hal.h"
```

### Functions

- void i2cInit (void)

  *I2C Driver initialization.*
- void i2cObjectInit (I2CDriver ∗i2cp)

  *Initializes the standard part of a `I2CDriver` structure.*
- void i2cStart (I2CDriver ∗i2cp, const I2CConfig ∗config)

  *Configures and activates the I2C peripheral.*
- void i2cStop (I2CDriver ∗i2cp)

  *Deactivates the I2C peripheral.*
- i2cflags_t i2cGetErrors (I2CDriver ∗i2cp)

  *Returns the errors mask associated to the previous operation.*
- msg_t i2cMasterTransmitTimeout (I2CDriver ∗i2cp, i2caddr_t addr, const uint8_t ∗txbuf, size_t txbytes, uint8_t ∗rxbuf, size_t rxbytes, sysinterval_t timeout)

  *Sends data via the I2C bus.*
- msg_t i2cMasterReceiveTimeout (I2CDriver ∗i2cp, i2caddr_t addr, uint8_t ∗rxbuf, size_t rxbytes, sysinterval↩ _t timeout)

  *Receives data from the I2C bus.*
- void i2cAcquireBus (I2CDriver ∗i2cp)

  *Gains exclusive access to the I2C bus.*
- void i2cReleaseBus (I2CDriver ∗i2cp)

  *Releases exclusive access to the I2C bus.*

### 9.38.1 Detailed Description

I2C Driver code.

## 9.39 hal_i2c.h File Reference

I2C Driver macros and structures.

```
#include "hal_i2c_lld.h"
```

### Macros

- #define I2C_USE_MUTUAL_EXCLUSION TRUE

  *Enables the mutual exclusion APIs on the I2C bus.*
- #define _i2c_wakeup_isr(i2cp)

*Wakes up the waiting thread notifying no errors.*

- #define _i2c_wakeup_error_isr(i2cp)

  *Wakes up the waiting thread notifying errors.*
- #define i2cMasterTransmit(i2cp, addr, txbuf, txbytes, rxbuf, rxbytes)

  *Wrap i2cMasterTransmitTimeout function with TIME_INFINITE timeout.*
- #define i2cMasterReceive(i2cp, addr, rxbuf, rxbytes) (i2cMasterReceiveTimeout(i2cp, addr, rxbuf, rxbytes, TIME_INFINITE))

  *Wrap i2cMasterReceiveTimeout function with TIME_INFINITE timeout.*

### I2C bus error conditions

- #define I2C_NO_ERROR 0x00

  *No error.*
- #define I2C_BUS_ERROR 0x01

  *Bus Error.*
- #define I2C_ARBITRATION_LOST 0x02

  *Arbitration Lost.*
- #define I2C_ACK_FAILURE 0x04

  *Acknowledge Failure.*
- #define I2C_OVERRUN 0x08

  *Overrun/Underrun.*
- #define I2C_PEC_ERROR 0x10

  *PEC Error in reception.*
- #define I2C_TIMEOUT 0x20

  *Hardware timeout.*
- #define I2C_SMB_ALERT 0x40

  *SMBus Alert.*

## Enumerations

## Functions

- void i2cInit (void)

  *I2C Driver initialization.*
- void i2cObjectInit (I2CDriver ∗i2cp)

  *Initializes the standard part of a `I2CDriver` structure.*
- void i2cStart (I2CDriver ∗i2cp, const I2CConfig ∗config)

  *Configures and activates the I2C peripheral.*
- void i2cStop (I2CDriver ∗i2cp)

  *Deactivates the I2C peripheral.*
- i2cflags_t i2cGetErrors (I2CDriver ∗i2cp)

  *Returns the errors mask associated to the previous operation.*
- msg_t i2cMasterTransmitTimeout (I2CDriver ∗i2cp, i2caddr_t addr, const uint8_t ∗txbuf, size_t txbytes, uint8_t ∗rxbuf, size_t rxbytes, sysinterval_t timeout)

  *Sends data via the I2C bus.*
- msg_t i2cMasterReceiveTimeout (I2CDriver ∗i2cp, i2caddr_t addr, uint8_t ∗rxbuf, size_t rxbytes, sysinterval↩_t timeout)

  *Receives data from the I2C bus.*
- void i2cAcquireBus (I2CDriver ∗i2cp)

  *Gains exclusive access to the I2C bus.*
- void i2cReleaseBus (I2CDriver ∗i2cp)

  *Releases exclusive access to the I2C bus.*

### 9.39.1 Detailed Description

I2C Driver macros and structures.

## 9.40 hal_i2c_lld.c File Reference

PLATFORM I2C subsystem low level driver source.

```
#include "hal.h"
```

### Functions

- void i2c_lld_init (void)

  *Low level I2C driver initialization.*
- void i2c_lld_start (I2CDriver ∗i2cp)

  *Configures and activates the I2C peripheral.*
- void i2c_lld_stop (I2CDriver ∗i2cp)

  *Deactivates the I2C peripheral.*
- msg_t i2c_lld_master_receive_timeout (I2CDriver ∗i2cp, i2caddr_t addr, uint8_t ∗rxbuf, size_t rxbytes, sysinterval_t timeout)

  *Receives data via the I2C bus as master.*
- msg_t i2c_lld_master_transmit_timeout (I2CDriver ∗i2cp, i2caddr_t addr, const uint8_t ∗txbuf, size_t txbytes, uint8_t ∗rxbuf, size_t rxbytes, sysinterval_t timeout)

  *Transmits data via the I2C bus as master.*

### Variables

- I2CDriver I2CD1

  *I2C1 driver identifier.*

### 9.40.1 Detailed Description

PLATFORM I2C subsystem low level driver source.

## 9.41 hal_i2c_lld.h File Reference

PLATFORM I2C subsystem low level driver header.

### Data Structures

- struct I2CConfig

  *Type of I2C driver configuration structure.*
- struct I2CDriver

  *Structure representing an I2C driver.*

## Macros

- #define i2c_lld_get_errors(i2cp) ((i2cp)->errors)

  *Get errors from I2C driver.*

### PLATFORM configuration options

- #define PLATFORM_I2C_USE_I2C1 FALSE

  *I2C1 driver enable switch.*

## Typedefs

- typedef uint16_t i2caddr_t

  *Type representing an I2C address.*
- typedef uint32_t i2cflags_t

  *Type of I2C Driver condition flags.*
- typedef struct I2CDriver I2CDriver

  *Type of a structure representing an I2C driver.*

## Functions

- void i2c_lld_init (void)

  *Low level I2C driver initialization.*
- void i2c_lld_start (I2CDriver ∗i2cp)

  *Configures and activates the I2C peripheral.*
- void i2c_lld_stop (I2CDriver ∗i2cp)

  *Deactivates the I2C peripheral.*
- msg_t i2c_lld_master_transmit_timeout (I2CDriver ∗i2cp, i2caddr_t addr, const uint8_t ∗txbuf, size_t txbytes, uint8_t ∗rxbuf, size_t rxbytes, sysinterval_t timeout)

  *Transmits data via the I2C bus as master.*
- msg_t i2c_lld_master_receive_timeout (I2CDriver ∗i2cp, i2caddr_t addr, uint8_t ∗rxbuf, size_t rxbytes, sysinterval_t timeout)

  *Receives data via the I2C bus as master.*

### 9.41.1 Detailed Description

PLATFORM I2C subsystem low level driver header.

## 9.42 hal_i2s.c File Reference

I2S Driver code.

```
#include "hal.h"
```

## Functions

- void i2sInit (void)

  *I2S Driver initialization.*
- void i2sObjectInit (I2SDriver ∗i2sp)

  *Initializes the standard part of a `I2SDriver` structure.*

- void i2sStart (I2SDriver ∗i2sp, const I2SConfig ∗config)

    *Configures and activates the I2S peripheral.*
- void i2sStop (I2SDriver ∗i2sp)

    *Deactivates the I2S peripheral.*
- void i2sStartExchange (I2SDriver ∗i2sp)

    *Starts a I2S data exchange.*
- void i2sStopExchange (I2SDriver ∗i2sp)

    *Stops the ongoing data exchange.*

### 9.42.1 Detailed Description

I2S Driver code.

## 9.43 hal_i2s.h File Reference

I2S Driver macros and structures.

```
#include "hal_i2s_lld.h"
```

### Macros

#### I2S modes

- #define **I2S_MODE_SLAVE** 0
- #define **I2S_MODE_MASTER** 1

#### Macro Functions

- #define i2sStartExchangeI(i2sp)

    *Starts a I2S data exchange.*
- #define i2sStopExchangeI(i2sp)

    *Stops the ongoing data exchange.*
- #define _i2s_isr_half_code(i2sp)

    *Common ISR code, half buffer event.*
- #define _i2s_isr_full_code(i2sp)

    *Common ISR code.*

### Enumerations

### Functions

- void i2sInit (void)

    *I2S Driver initialization.*
- void i2sObjectInit (I2SDriver ∗i2sp)

    *Initializes the standard part of a `I2SDriver` structure.*
- void i2sStart (I2SDriver ∗i2sp, const I2SConfig ∗config)

    *Configures and activates the I2S peripheral.*
- void i2sStop (I2SDriver ∗i2sp)

    *Deactivates the I2S peripheral.*
- void i2sStartExchange (I2SDriver ∗i2sp)

    *Starts a I2S data exchange.*
- void i2sStopExchange (I2SDriver ∗i2sp)

    *Stops the ongoing data exchange.*

### 9.43.1 Detailed Description

I2S Driver macros and structures.

## 9.44 hal_i2s_lld.c File Reference

PLATFORM I2S subsystem low level driver source.

```
#include "hal.h"
```

### Functions

- void i2s_lld_init (void)

  *Low level I2S driver initialization.*
- void i2s_lld_start (I2SDriver ∗i2sp)

  *Configures and activates the I2S peripheral.*
- void i2s_lld_stop (I2SDriver ∗i2sp)

  *Deactivates the I2S peripheral.*
- void i2s_lld_start_exchange (I2SDriver ∗i2sp)

  *Starts a I2S data exchange.*
- void i2s_lld_stop_exchange (I2SDriver ∗i2sp)

  *Stops the ongoing data exchange.*

### Variables

- I2SDriver I2SD1

  *I2S2 driver identifier.*

### 9.44.1 Detailed Description

PLATFORM I2S subsystem low level driver source.

## 9.45 hal_i2s_lld.h File Reference

PLATFORM I2S subsystem low level driver header.

### Data Structures

- struct I2SConfig

  *Driver configuration structure.*
- struct I2SDriver

  *Structure representing an I2S driver.*

### Macros

**PLATFORM configuration options**

- #define PLATFORM_I2S_USE_I2S1 FALSE

  *I2SD1 driver enable switch.*

### Typedefs

- typedef struct I2SDriver I2SDriver

  *Type of a structure representing an I2S driver.*
- typedef void(∗ i2scallback_t) (I2SDriver ∗i2sp, size_t offset, size_t n)

  *I2S notification callback type.*

### Functions

- void i2s_lld_init (void)

  *Low level I2S driver initialization.*
- void i2s_lld_start (I2SDriver ∗i2sp)

  *Configures and activates the I2S peripheral.*
- void i2s_lld_stop (I2SDriver ∗i2sp)

  *Deactivates the I2S peripheral.*
- void i2s_lld_start_exchange (I2SDriver ∗i2sp)

  *Starts a I2S data exchange.*
- void i2s_lld_stop_exchange (I2SDriver ∗i2sp)

  *Stops the ongoing data exchange.*

### 9.45.1 Detailed Description

PLATFORM I2S subsystem low level driver header.

## 9.46 hal_icu.c File Reference

ICU Driver code.

```
#include "hal.h"
```

### Functions

- void icuInit (void)

  *ICU Driver initialization.*
- void icuObjectInit (ICUDriver ∗icup)

  *Initializes the standard part of a `ICUDriver` structure.*
- void icuStart (ICUDriver ∗icup, const ICUConfig ∗config)

  *Configures and activates the ICU peripheral.*
- void icuStop (ICUDriver ∗icup)

  *Deactivates the ICU peripheral.*
- void icuStartCapture (ICUDriver ∗icup)

  *Starts the input capture.*
- bool icuWaitCapture (ICUDriver ∗icup)

  *Waits for a completed capture.*
- void icuStopCapture (ICUDriver ∗icup)

  *Stops the input capture.*
- void icuEnableNotifications (ICUDriver ∗icup)

  *Enables notifications.*
- void icuDisableNotifications (ICUDriver ∗icup)

  *Disables notifications.*

### 9.46.1 Detailed Description

ICU Driver code.

## 9.47 hal_icu.h File Reference

ICU Driver macros and structures.

```
#include "hal_icu_lld.h"
```

### Macros

#### Macro Functions

- #define icuStartCaptureI(icup)
  *Starts the input capture.*
- #define icuStopCaptureI(icup)
  *Stops the input capture.*
- #define icuEnableNotificationsI(icup) icu_lld_enable_notifications(icup)
  *Enables notifications.*
- #define icuDisableNotificationsI(icup) icu_lld_disable_notifications(icup)
  *Disables notifications.*
- #define icuAreNotificationsEnabledX(icup) icu_lld_are_notifications_enabled(icup)
  *Check on notifications status.*
- #define icuGetWidthX(icup) icu_lld_get_width(icup)
  *Returns the width of the latest pulse.*
- #define icuGetPeriodX(icup) icu_lld_get_period(icup)
  *Returns the width of the latest cycle.*

#### Low level driver helper macros

- #define _icu_isr_invoke_width_cb(icup)
  *Common ISR code, ICU width event.*
- #define _icu_isr_invoke_period_cb(icup)
  *Common ISR code, ICU period event.*
- #define _icu_isr_invoke_overflow_cb(icup)
  *Common ISR code, ICU timer overflow event.*

### Typedefs

- typedef struct ICUDriver ICUDriver
  *Type of a structure representing an ICU driver.*
- typedef void(∗ icucallback_t) (ICUDriver ∗icup)
  *ICU notification callback type.*

### Enumerations

### Functions

- void icuInit (void)
  *ICU Driver initialization.*
- void icuObjectInit (ICUDriver ∗icup)
  *Initializes the standard part of a `ICUDriver` structure.*

- void icuStart (ICUDriver ∗icup, const ICUConfig ∗config)

  *Configures and activates the ICU peripheral.*
- void icuStop (ICUDriver ∗icup)

  *Deactivates the ICU peripheral.*
- void icuStartCapture (ICUDriver ∗icup)

  *Starts the input capture.*
- bool icuWaitCapture (ICUDriver ∗icup)

  *Waits for a completed capture.*
- void icuStopCapture (ICUDriver ∗icup)

  *Stops the input capture.*
- void icuEnableNotifications (ICUDriver ∗icup)

  *Enables notifications.*
- void icuDisableNotifications (ICUDriver ∗icup)

  *Disables notifications.*

### 9.47.1 Detailed Description

ICU Driver macros and structures.

## 9.48 hal_icu_lld.c File Reference

PLATFORM ADC subsystem low level driver source.

```
#include "hal.h"
```

### Functions

- void icu_lld_init (void)

  *Low level ICU driver initialization.*
- void icu_lld_start (ICUDriver ∗icup)

  *Configures and activates the ICU peripheral.*
- void icu_lld_stop (ICUDriver ∗icup)

  *Deactivates the ICU peripheral.*
- void icu_lld_start_capture (ICUDriver ∗icup)

  *Starts the input capture.*
- bool icu_lld_wait_capture (ICUDriver ∗icup)

  *Waits for a completed capture.*
- void icu_lld_stop_capture (ICUDriver ∗icup)

  *Stops the input capture.*
- void icu_lld_enable_notifications (ICUDriver ∗icup)

  *Enables notifications.*
- void icu_lld_disable_notifications (ICUDriver ∗icup)

  *Disables notifications.*

### Variables

- ICUDriver ICUD1

  *ICUD1 driver identifier.*

### 9.48.1 Detailed Description

PLATFORM ADC subsystem low level driver source.

## 9.49 hal_icu_lld.h File Reference

PLATFORM ICU subsystem low level driver header.

### Data Structures

- struct ICUConfig

  *Driver configuration structure.*
- struct ICUDriver

  *Structure representing an ICU driver.*

### Macros

- #define icu_lld_get_width(icup) 0

  *Returns the width of the latest pulse.*
- #define icu_lld_get_period(icup) 0

  *Returns the width of the latest cycle.*
- #define icu_lld_are_notifications_enabled(icup) false

  *Check on notifications status.*

**PLATFORM configuration options**

- #define PLATFORM_ICU_USE_ICU1 FALSE

  *ICUD1 driver enable switch.*

### Typedefs

- typedef uint32_t icufreq_t

  *ICU frequency type.*
- typedef uint32_t icucnt_t

  *ICU counter type.*

### Enumerations

### Functions

- void icu_lld_init (void)

  *Low level ICU driver initialization.*
- void icu_lld_start (ICUDriver ∗icup)

  *Configures and activates the ICU peripheral.*
- void icu_lld_stop (ICUDriver ∗icup)

  *Deactivates the ICU peripheral.*
- void icu_lld_start_capture (ICUDriver ∗icup)

  *Starts the input capture.*
- bool icu_lld_wait_capture (ICUDriver ∗icup)

  *Waits for a completed capture.*

- void icu_lld_stop_capture (ICUDriver ∗icup)

  *Stops the input capture.*
- void icu_lld_enable_notifications (ICUDriver ∗icup)

  *Enables notifications.*
- void icu_lld_disable_notifications (ICUDriver ∗icup)

  *Disables notifications.*

### 9.49.1 Detailed Description

PLATFORM ICU subsystem low level driver header.

## 9.50 hal_ioblock.h File Reference

I/O block devices access.

### Data Structures

- struct BlockDeviceInfo

  *Block device info.*
- struct BaseBlockDeviceVMT

  `BaseBlockDevice` *virtual methods table.*
- struct BaseBlockDevice

  *Base block device class.*

### Macros

- #define _base_block_device_methods

  `BaseBlockDevice` *specific methods.*
- #define _base_block_device_data

  `BaseBlockDevice` *specific data.*

#### Macro Functions (BaseBlockDevice)

- #define blkGetDriverState(ip) ((ip)->state)

  *Returns the driver state.*
- #define blkIsTransferring(ip)

  *Determines if the device is transferring data.*
- #define blkIsInserted(ip) ((ip)->vmt->is_inserted(ip))

  *Returns the media insertion status.*
- #define blkIsWriteProtected(ip) ((ip)->vmt->is_protected(ip))

  *Returns the media write protection status.*
- #define blkConnect(ip) ((ip)->vmt->connect(ip))

  *Performs the initialization procedure on the block device.*
- #define blkDisconnect(ip) ((ip)->vmt->disconnect(ip))

  *Terminates operations on the block device.*
- #define blkRead(ip, startblk, buf, n) ((ip)->vmt->read(ip, startblk, buf, n))

  *Reads one or more blocks.*
- #define blkWrite(ip, startblk, buf, n) ((ip)->vmt->write(ip, startblk, buf, n))

  *Writes one or more blocks.*
- #define blkSync(ip) ((ip)->vmt->sync(ip))

  *Ensures write synchronization.*
- #define blkGetInfo(ip, bdip) ((ip)->vmt->get_info(ip, bdip))

  *Returns a media information structure.*

### Enumerations

### 9.50.1 Detailed Description

I/O block devices access.

This header defines an abstract interface useful to access generic I/O block devices in a standardized way.

## 9.51 hal_jesd216_flash.c File Reference

JESD216 compliant flash driver class code.

```
#include "hal.h"
#include "hal_jesd216_flash.h"
```

### 9.51.1 Detailed Description

JESD216 compliant flash driver class code.

## 9.52 hal_jesd216_flash.h File Reference

JESD216 compliant flash driver class header.

```
#include "hal_flash.h"
```

### Data Structures

- struct JESD215FlashVMT

  *`JESD215Flash` virtual methods table.*
- struct JESD215Flash

  *Base flash class.*

### Macros

- #define _jesd216_flash_methods_alone

  *`JESD215Flash` specific methods.*
- #define _jesd216_flash_methods

  *`JESD215Flash` specific methods with inherited ones.*
- #define _jesd216_flash_data _base_flash_data

  *`JESD215Flash` specific data.*

**Common command codes**

- #define **JESD216_CMD_READ_ID** 0x9FU
- #define **JESD216_CMD_READ** 0x03U
- #define **JESD216_CMD_WRITE_ENABLE** 0x06U
- #define **JESD216_CMD_WRITE_DISABLE** 0x04U
- #define **JESD216_CMD_READ_STATUS_REGISTER** 0x05U
- #define **JESD216_CMD_WRITE_STATUS_REGISTER** 0x01U
- #define **JESD216_CMD_PAGE_PROGRAM** 0x02U
- #define **JESD216_CMD_ERASE_4K** 0x20U

- #define **JESD216_CMD_ERASE_BULK** 0xC7U
- #define **JESD216_CMD_PROGRAM_ERASE_RESUME** 0x7AU
- #define **JESD216_CMD_PROGRAM_ERASE_SUSPEND** 0x75U
- #define **JESD216_CMD_READ_OTP_ARRAY** 0x4BU
- #define **JESD216_CMD_PROGRAM_OTP_ARRAY** 0x42U

**Command options**

- #define **JESD216_CMD_EXTENDED_ADDRESSING** 0x80000000U

**Bus interface.**

- #define **JESD216_BUS_MODE_SPI** 0U
- #define **JESD216_BUS_MODE_QSPI1L** 1U
- #define **JESD216_BUS_MODE_QSPI2L** 2U
- #define **JESD216_BUS_MODE_QSPI4L** 4U

**Configuration options**

- #define JESD216_BUS_MODE JESD216_BUS_MODE_QSPI4L

  *Physical transport interface.*
- #define JESD216_SHARED_BUS TRUE

  *Shared bus switch.*

### 9.52.1 Detailed Description

JESD216 compliant flash driver class header.

## 9.53 hal_lld.c File Reference

PLATFORM HAL subsystem low level driver source.

```
#include "hal.h"
```

### Functions

- void hal_lld_init (void)

  *Low level HAL driver initialization.*

### 9.53.1 Detailed Description

PLATFORM HAL subsystem low level driver source.

## 9.54 hal_lld.h File Reference

PLATFORM HAL subsystem low level driver header.

### Macros

**Platform identification macros**

- #define **PLATFORM_NAME** "templates"

## Functions

- void hal_lld_init (void)

  *Low level HAL driver initialization.*

### 9.54.1 Detailed Description

PLATFORM HAL subsystem low level driver header.

## 9.55 hal_mac.c File Reference

MAC Driver code.

```
#include "hal.h"
```

## Functions

- void macInit (void)

  *MAC Driver initialization.*
- void macObjectInit (MACDriver ∗macp)

  *Initialize the standard part of a `MACDriver` structure.*
- void macStart (MACDriver ∗macp, const MACConfig ∗config)

  *Configures and activates the MAC peripheral.*
- void macStop (MACDriver ∗macp)

  *Deactivates the MAC peripheral.*
- msg_t macWaitTransmitDescriptor (MACDriver ∗macp, MACTransmitDescriptor ∗tdp, sysinterval_t timeout)

  *Allocates a transmission descriptor.*
- void macReleaseTransmitDescriptor (MACTransmitDescriptor ∗tdp)

  *Releases a transmit descriptor and starts the transmission of the enqueued data as a single frame.*
- msg_t macWaitReceiveDescriptor (MACDriver ∗macp, MACReceiveDescriptor ∗rdp, sysinterval_t timeout)

  *Waits for a received frame.*
- void macReleaseReceiveDescriptor (MACReceiveDescriptor ∗rdp)

  *Releases a receive descriptor.*
- bool macPollLinkStatus (MACDriver ∗macp)

  *Updates and returns the link status.*

### 9.55.1 Detailed Description

MAC Driver code.

## 9.56 hal_mac.h File Reference

MAC Driver macros and structures.

```
#include "hal_mac_lld.h"
```

## Macros

### MAC configuration options

- #define MAC_USE_ZERO_COPY FALSE

  *Enables an event sources for incoming packets.*
- #define MAC_USE_EVENTS TRUE

  *Enables an event sources for incoming packets.*

### Macro Functions

- #define macGetReceiveEventSource(macp) (&(macp)->rdevent)

  *Enables the zero-copy API.*
- #define macWriteTransmitDescriptor(tdp, buf, size) mac_lld_write_transmit_descriptor(tdp, buf, size)

  *Writes to a transmit descriptor's stream.*
- #define macReadReceiveDescriptor(rdp, buf, size) mac_lld_read_receive_descriptor(rdp, buf, size)

  *Reads from a receive descriptor's stream.*
- #define macGetNextTransmitBuffer(tdp, size, sizep) mac_lld_get_next_transmit_buffer(tdp, size, sizep)

  *Returns a pointer to the next transmit buffer in the descriptor chain.*
- #define macGetNextReceiveBuffer(rdp, sizep) mac_lld_get_next_receive_buffer(rdp, sizep)

  *Returns a pointer to the next receive buffer in the descriptor chain.*

## Typedefs

- typedef struct MACDriver MACDriver

  *Type of a structure representing a MAC driver.*

## Enumerations

## Functions

- void macInit (void)

  *MAC Driver initialization.*
- void macObjectInit (MACDriver ∗macp)

  *Initialize the standard part of a `MACDriver` structure.*
- void macStart (MACDriver ∗macp, const MACConfig ∗config)

  *Configures and activates the MAC peripheral.*
- void macStop (MACDriver ∗macp)

  *Deactivates the MAC peripheral.*
- msg_t macWaitTransmitDescriptor (MACDriver ∗macp, MACTransmitDescriptor ∗tdp, sysinterval_t timeout)

  *Allocates a transmission descriptor.*
- void macReleaseTransmitDescriptor (MACTransmitDescriptor ∗tdp)

  *Releases a transmit descriptor and starts the transmission of the enqueued data as a single frame.*
- msg_t macWaitReceiveDescriptor (MACDriver ∗macp, MACReceiveDescriptor ∗rdp, sysinterval_t timeout)

  *Waits for a received frame.*
- void macReleaseReceiveDescriptor (MACReceiveDescriptor ∗rdp)

  *Releases a receive descriptor.*
- bool macPollLinkStatus (MACDriver ∗macp)

  *Updates and returns the link status.*

## 9.56.1 Detailed Description

MAC Driver macros and structures.

## 9.57 hal_mac_lld.c File Reference

PLATFORM MAC subsystem low level driver source.

```
#include <string.h>
#include "hal.h"
#include "hal_mii.h"
```

### Functions

- void mac_lld_init (void)

  *Low level MAC initialization.*
- void mac_lld_start (MACDriver ∗macp)

  *Configures and activates the MAC peripheral.*
- void mac_lld_stop (MACDriver ∗macp)

  *Deactivates the MAC peripheral.*
- msg_t mac_lld_get_transmit_descriptor (MACDriver ∗macp, MACTransmitDescriptor ∗tdp)

  *Returns a transmission descriptor.*
- void mac_lld_release_transmit_descriptor (MACTransmitDescriptor ∗tdp)

  *Releases a transmit descriptor and starts the transmission of the enqueued data as a single frame.*
- msg_t mac_lld_get_receive_descriptor (MACDriver ∗macp, MACReceiveDescriptor ∗rdp)

  *Returns a receive descriptor.*
- void mac_lld_release_receive_descriptor (MACReceiveDescriptor ∗rdp)

  *Releases a receive descriptor.*
- bool mac_lld_poll_link_status (MACDriver ∗macp)

  *Updates and returns the link status.*
- size_t mac_lld_write_transmit_descriptor (MACTransmitDescriptor ∗tdp, uint8_t ∗buf, size_t size)

  *Writes to a transmit descriptor's stream.*
- size_t mac_lld_read_receive_descriptor (MACReceiveDescriptor ∗rdp, uint8_t ∗buf, size_t size)

  *Reads from a receive descriptor's stream.*
- uint8_t ∗ mac_lld_get_next_transmit_buffer (MACTransmitDescriptor ∗tdp, size_t size, size_t ∗sizep)

  *Returns a pointer to the next transmit buffer in the descriptor chain.*
- const uint8_t ∗ mac_lld_get_next_receive_buffer (MACReceiveDescriptor ∗rdp, size_t ∗sizep)

  *Returns a pointer to the next receive buffer in the descriptor chain.*

### Variables

- MACDriver ETHD1

  *MAC1 driver identifier.*

### 9.57.1 Detailed Description

PLATFORM MAC subsystem low level driver source.

## 9.58 hal_mac_lld.h File Reference

PLATFORM MAC subsystem low level driver header.

## Data Structures

- struct MACConfig

  *Driver configuration structure.*
- struct MACDriver

  *Structure representing a MAC driver.*
- struct MACTransmitDescriptor

  *Structure representing a transmit descriptor.*
- struct MACReceiveDescriptor

  *Structure representing a receive descriptor.*

## Macros

- #define MAC_SUPPORTS_ZERO_COPY TRUE

  *This implementation supports the zero-copy mode API.*

### PLATFORM configuration options

- #define PLATFORM_MAC_USE_MAC1 FALSE

  *MAC driver enable switch.*

## Functions

- void mac_lld_init (void)

  *Low level MAC initialization.*
- void mac_lld_start (MACDriver ∗macp)

  *Configures and activates the MAC peripheral.*
- void mac_lld_stop (MACDriver ∗macp)

  *Deactivates the MAC peripheral.*
- msg_t mac_lld_get_transmit_descriptor (MACDriver ∗macp, MACTransmitDescriptor ∗tdp)

  *Returns a transmission descriptor.*
- void mac_lld_release_transmit_descriptor (MACTransmitDescriptor ∗tdp)

  *Releases a transmit descriptor and starts the transmission of the enqueued data as a single frame.*
- msg_t mac_lld_get_receive_descriptor (MACDriver ∗macp, MACReceiveDescriptor ∗rdp)

  *Returns a receive descriptor.*
- void mac_lld_release_receive_descriptor (MACReceiveDescriptor ∗rdp)

  *Releases a receive descriptor.*
- bool mac_lld_poll_link_status (MACDriver ∗macp)

  *Updates and returns the link status.*
- size_t mac_lld_write_transmit_descriptor (MACTransmitDescriptor ∗tdp, uint8_t ∗buf, size_t size)

  *Writes to a transmit descriptor's stream.*
- size_t mac_lld_read_receive_descriptor (MACReceiveDescriptor ∗rdp, uint8_t ∗buf, size_t size)

  *Reads from a receive descriptor's stream.*
- uint8_t ∗ mac_lld_get_next_transmit_buffer (MACTransmitDescriptor ∗tdp, size_t size, size_t ∗sizep)

  *Returns a pointer to the next transmit buffer in the descriptor chain.*
- const uint8_t ∗ mac_lld_get_next_receive_buffer (MACReceiveDescriptor ∗rdp, size_t ∗sizep)

  *Returns a pointer to the next receive buffer in the descriptor chain.*

### 9.58.1 Detailed Description

PLATFORM MAC subsystem low level driver header.

## 9.59 hal_mii.h File Reference

MII macros and structures.

### Macros

#### Generic MII registers

- #define MII_BMCR 0x00
- #define MII_BMSR 0x01
- #define MII_PHYSID1 0x02
- #define MII_PHYSID2 0x03
- #define MII_ADVERTISE 0x04
- #define MII_LPA 0x05
- #define MII_EXPANSION 0x06
- #define MII_ANNPTR 0x07
- #define MII_CTRL1000 0x09
- #define MII_STAT1000 0x0a
- #define MII_ESTATUS 0x0f
- #define MII_PHYSTS 0x10
- #define MII_MICR 0x11
- #define MII_DCOUNTER 0x12
- #define MII_FCSCOUNTER 0x13
- #define MII_NWAYTEST 0x14
- #define MII_RERRCOUNTER 0x15
- #define MII_SREVISION 0x16
- #define MII_RESV1 0x17
- #define MII_LBRERROR 0x18
- #define MII_PHYADDR 0x19
- #define MII_RESV2 0x1a
- #define MII_TPISTATUS 0x1b
- #define MII_NCONFIG 0x1c

#### Basic mode control register

- #define BMCR_RESV 0x007f
- #define BMCR_CTST 0x0080
- #define BMCR_FULLDPLX 0x0100
- #define BMCR_ANRESTART 0x0200
- #define BMCR_ISOLATE 0x0400
- #define BMCR_PDOWN 0x0800
- #define BMCR_ANENABLE 0x1000
- #define BMCR_SPEED100 0x2000
- #define BMCR_LOOPBACK 0x4000
- #define BMCR_RESET 0x8000

#### Basic mode status register

- #define BMSR_ERCAP 0x0001
- #define BMSR_JCD 0x0002
- #define BMSR_LSTATUS 0x0004
- #define BMSR_ANEGCAPABLE 0x0008
- #define BMSR_RFAULT 0x0010
- #define BMSR_ANEGCOMPLETE 0x0020
- #define BMSR_MFPRESUPPCAP 0x0040
- #define BMSR_RESV 0x0780
- #define BMSR_10HALF 0x0800
- #define BMSR_10FULL 0x1000
- #define BMSR_100HALF 0x2000
- #define BMSR_100FULL 0x4000
- #define BMSR_100BASE4 0x8000

### Advertisement control register

- #define ADVERTISE_SLCT 0x001f
- #define ADVERTISE_CSMA 0x0001
- #define ADVERTISE_10HALF 0x0020
- #define ADVERTISE_10FULL 0x0040
- #define ADVERTISE_100HALF 0x0080
- #define ADVERTISE_100FULL 0x0100
- #define ADVERTISE_100BASE4 0x0200
- #define ADVERTISE_PAUSE_CAP 0x0400
- #define ADVERTISE_PAUSE_ASYM 0x0800
- #define ADVERTISE_RESV 0x1000
- #define ADVERTISE_RFAULT 0x2000
- #define ADVERTISE_LPACK 0x4000
- #define ADVERTISE_NPAGE 0x8000
- #define **ADVERTISE_FULL**
- #define **ADVERTISE_ALL**

### Link partner ability register

- #define LPA_SLCT 0x001f
- #define LPA_10HALF 0x0020
- #define LPA_10FULL 0x0040
- #define LPA_100HALF 0x0080
- #define LPA_100FULL 0x0100
- #define LPA_100BASE4 0x0200
- #define LPA_PAUSE_CAP 0x0400
- #define LPA_PAUSE_ASYM 0x0800
- #define LPA_RESV 0x1000
- #define LPA_RFAULT 0x2000
- #define LPA_LPACK 0x4000
- #define LPA_NPAGE 0x8000
- #define **LPA_DUPLEX** (LPA_10FULL | LPA_100FULL)
- #define **LPA_100** (LPA_100FULL | LPA_100HALF | LPA_100BASE4)

### Expansion register for auto-negotiation

- #define EXPANSION_NWAY 0x0001
- #define EXPANSION_LCWP 0x0002
- #define EXPANSION_ENABLENPAGE 0x0004
- #define EXPANSION_NPCAPABLE 0x0008
- #define EXPANSION_MFAULTS 0x0010
- #define EXPANSION_RESV 0xffe0

### N-way test register

- #define NWAYTEST_RESV1 0x00ff
- #define NWAYTEST_LOOPBACK 0x0100
- #define NWAYTEST_RESV2 0xfe00

### PHY identifiers

- #define **MII_DM9161_ID** 0x0181b8a0
- #define **MII_AM79C875_ID** 0x00225540
- #define **MII_KSZ8081_ID** 0x00221560
- #define **MII_KS8721_ID** 0x00221610
- #define **MII_STE101P_ID** 0x00061C50
- #define **MII_DP83848I_ID** 0x20005C90
- #define **MII_LAN8710A_ID** 0x0007C0F1
- #define **MII_LAN8720_ID** 0x0007C0F0
- #define **MII_LAN8742A_ID** 0x0007C130

### 9.59.1 Detailed Description

MII macros and structures.

## 9.60 hal_mmc_spi.c File Reference

MMC over SPI driver code.

```
#include <string.h>
#include "hal.h"
```

### Functions

- static uint8_t crc7 (uint8_t crc, const uint8_t ∗buffer, size_t len)

  *Calculate the MMC standard CRC-7 based on a lookup table.*
- static void wait (MMCDriver ∗mmcp)

  *Waits an idle condition.*
- static void send_hdr (MMCDriver ∗mmcp, uint8_t cmd, uint32_t arg)

  *Sends a command header.*
- static uint8_t recvr1 (MMCDriver ∗mmcp)

  *Receives a single byte response.*
- static uint8_t recvr3 (MMCDriver ∗mmcp, uint8_t ∗buffer)

  *Receives a three byte response.*
- static uint8_t send_command_R1 (MMCDriver ∗mmcp, uint8_t cmd, uint32_t arg)

  *Sends a command an returns a single byte response.*
- static uint8_t send_command_R3 (MMCDriver ∗mmcp, uint8_t cmd, uint32_t arg, uint8_t ∗response)

  *Sends a command which returns a five bytes response (R3).*
- static bool read_CxD (MMCDriver ∗mmcp, uint8_t cmd, uint32_t cxd[4])

  *Reads the CSD.*
- static void sync (MMCDriver ∗mmcp)

  *Waits that the card reaches an idle state.*
- void mmcInit (void)

  *MMC over SPI driver initialization.*
- void mmcObjectInit (MMCDriver ∗mmcp)

  *Initializes an instance.*
- void mmcStart (MMCDriver ∗mmcp, const MMCConfig ∗config)

  *Configures and activates the MMC peripheral.*
- void mmcStop (MMCDriver ∗mmcp)

  *Disables the MMC peripheral.*
- bool mmcConnect (MMCDriver ∗mmcp)

  *Performs the initialization procedure on the inserted card.*
- bool mmcDisconnect (MMCDriver ∗mmcp)

  *Brings the driver in a state safe for card removal.*
- bool mmcStartSequentialRead (MMCDriver ∗mmcp, uint32_t startblk)

  *Starts a sequential read.*
- bool mmcSequentialRead (MMCDriver ∗mmcp, uint8_t ∗buffer)

  *Reads a block within a sequential read operation.*
- bool mmcStopSequentialRead (MMCDriver ∗mmcp)

  *Stops a sequential read gracefully.*
- bool mmcStartSequentialWrite (MMCDriver ∗mmcp, uint32_t startblk)

*Starts a sequential write.*
- bool mmcSequentialWrite (MMCDriver ∗mmcp, const uint8_t ∗buffer)

  *Writes a block within a sequential write operation.*
- bool mmcStopSequentialWrite (MMCDriver ∗mmcp)

  *Stops a sequential write gracefully.*
- bool mmcSync (MMCDriver ∗mmcp)

  *Waits for card idle condition.*
- bool mmcGetInfo (MMCDriver ∗mmcp, BlockDeviceInfo ∗bdip)

  *Returns the media info.*
- bool mmcErase (MMCDriver ∗mmcp, uint32_t startblk, uint32_t endblk)

  *Erases blocks.*

## Variables

- static const struct MMCDriverVMT mmc_vmt

  *Virtual methods table.*
- static const uint8_t crc7_lookup_table [256]

  *Lookup table for CRC-7 ( based on polynomial x^ 7 + x^ 3 + 1).*

### 9.60.1 Detailed Description

MMC over SPI driver code.

## 9.61 hal_mmc_spi.h File Reference

MMC over SPI driver header.

## Data Structures

- struct MMCConfig

  *MMC/SD over SPI driver configuration structure.*
- struct MMCDriverVMT

  `MMCDriver` *virtual methods table.*
- struct MMCDriver

  *Structure representing a MMC/SD over SPI driver.*

## Macros

- #define _mmc_driver_methods _mmcsd_block_device_methods

  `MMCDriver` *specific methods.*

### MMC_SPI configuration options

- #define MMC_NICE_WAITING TRUE

  *Delays insertions.*

### Macro Functions

- #define mmcIsCardInserted(mmcp) mmc_lld_is_card_inserted(mmcp)

  *Returns the card insertion status.*
- #define mmcIsWriteProtected(mmcp) mmc_lld_is_write_protected(mmcp)

  *Returns the write protect status.*

### Functions

- void mmcInit (void)

  *MMC over SPI driver initialization.*
- void mmcObjectInit (MMCDriver ∗mmcp)

  *Initializes an instance.*
- void mmcStart (MMCDriver ∗mmcp, const MMCConfig ∗config)

  *Configures and activates the MMC peripheral.*
- void mmcStop (MMCDriver ∗mmcp)

  *Disables the MMC peripheral.*
- bool mmcConnect (MMCDriver ∗mmcp)

  *Performs the initialization procedure on the inserted card.*
- bool mmcDisconnect (MMCDriver ∗mmcp)

  *Brings the driver in a state safe for card removal.*
- bool mmcStartSequentialRead (MMCDriver ∗mmcp, uint32_t startblk)

  *Starts a sequential read.*
- bool mmcSequentialRead (MMCDriver ∗mmcp, uint8_t ∗buffer)

  *Reads a block within a sequential read operation.*
- bool mmcStopSequentialRead (MMCDriver ∗mmcp)

  *Stops a sequential read gracefully.*
- bool mmcStartSequentialWrite (MMCDriver ∗mmcp, uint32_t startblk)

  *Starts a sequential write.*
- bool mmcSequentialWrite (MMCDriver ∗mmcp, const uint8_t ∗buffer)

  *Writes a block within a sequential write operation.*
- bool mmcStopSequentialWrite (MMCDriver ∗mmcp)

  *Stops a sequential write gracefully.*
- bool mmcSync (MMCDriver ∗mmcp)

  *Waits for card idle condition.*
- bool mmcGetInfo (MMCDriver ∗mmcp, BlockDeviceInfo ∗bdip)

  *Returns the media info.*
- bool mmcErase (MMCDriver ∗mmcp, uint32_t startblk, uint32_t endblk)

  *Erases blocks.*

### 9.61.1 Detailed Description

MMC over SPI driver header.

## 9.62 hal_mmcsd.c File Reference

MMC/SD cards common code.

```
#include "hal.h"
```

### Functions

- uint32_t _mmcsd_get_slice (const uint32_t ∗data, uint32_t end, uint32_t start)

  *Gets a bit field from a words array.*
- uint32_t _mmcsd_get_capacity (const uint32_t ∗csd)

  *Extract card capacity from a CSD.*

- uint32_t _mmcsd_get_capacity_ext (const uint8_t ∗ext_csd)

  *Extract MMC card capacity from EXT_CSD.*
- void _mmcsd_unpack_sdc_cid (const MMCSDBlockDevice ∗sdcp, unpacked_sdc_cid_t ∗cidsdc)

  *Unpacks SDC CID array in structure.*
- void _mmcsd_unpack_mmc_cid (const MMCSDBlockDevice ∗sdcp, unpacked_mmc_cid_t ∗cidmmc)

  *Unpacks MMC CID array in structure.*
- void _mmcsd_unpack_csd_mmc (const MMCSDBlockDevice ∗sdcp, unpacked_mmc_csd_t ∗csdmmc)

  *Unpacks MMC CSD array in structure.*
- void _mmcsd_unpack_csd_v10 (const MMCSDBlockDevice ∗sdcp, unpacked_sdc_csd_10_t ∗csd10)

  *Unpacks SDC CSD v1.0 array in structure.*
- void _mmcsd_unpack_csd_v20 (const MMCSDBlockDevice ∗sdcp, unpacked_sdc_csd_20_t ∗csd20)

  *Unpacks SDC CSD v2.0 array in structure.*

### 9.62.1 Detailed Description

MMC/SD cards common code.

## 9.63 hal_mmcsd.h File Reference

MMC/SD cards common header.

### Data Structures

- struct MMCSDBlockDeviceVMT

  *`MMCSDBlockDevice` virtual methods table.*
- struct MMCSDBlockDevice

  *MCC/SD block device class.*
- struct unpacked_sdc_cid_t

  *Unpacked CID register from SDC.*
- struct unpacked_mmc_cid_t

  *Unpacked CID register from MMC.*
- struct unpacked_sdc_csd_10_t

  *Unpacked CSD v1.0 register from SDC.*
- struct unpacked_sdc_csd_20_t

  *Unpacked CSD v2.0 register from SDC.*
- struct unpacked_mmc_csd_t

  *Unpacked CSD register from MMC.*

### Macros

- #define MMCSD_BLOCK_SIZE 512U

  *Fixed block size for MMC/SD block devices.*
- #define MMCSD_R1_ERROR_MASK 0xFDFFE008U

  *Mask of error bits in R1 responses.*
- #define MMCSD_CMD8_PATTERN 0x000001AAU

  *Fixed pattern for CMD8.*
- #define _mmcsd_block_device_methods _base_block_device_methods

  *`MMCSDBlockDevice` specific methods.*
- #define _mmcsd_block_device_data

*MMCSDBlockDevice specific data.*

### SD/MMC status conditions

- #define **MMCSD_STS_IDLE** 0U
- #define **MMCSD_STS_READY** 1U
- #define **MMCSD_STS_IDENT** 2U
- #define **MMCSD_STS_STBY** 3U
- #define **MMCSD_STS_TRAN** 4U
- #define **MMCSD_STS_DATA** 5U
- #define **MMCSD_STS_RCV** 6U
- #define **MMCSD_STS_PRG** 7U
- #define **MMCSD_STS_DIS** 8U

### SD/MMC commands

- #define **MMCSD_CMD_GO_IDLE_STATE** 0U
- #define **MMCSD_CMD_INIT** 1U
- #define **MMCSD_CMD_ALL_SEND_CID** 2U
- #define **MMCSD_CMD_SEND_RELATIVE_ADDR** 3U
- #define **MMCSD_CMD_SET_BUS_WIDTH** 6U
- #define **MMCSD_CMD_SWITCH** MMCSD_CMD_SET_BUS_WIDTH
- #define **MMCSD_CMD_SEL_DESEL_CARD** 7U
- #define **MMCSD_CMD_SEND_IF_COND** 8U
- #define **MMCSD_CMD_SEND_EXT_CSD** MMCSD_CMD_SEND_IF_COND
- #define **MMCSD_CMD_SEND_CSD** 9U
- #define **MMCSD_CMD_SEND_CID** 10U
- #define **MMCSD_CMD_STOP_TRANSMISSION** 12U
- #define **MMCSD_CMD_SEND_STATUS** 13U
- #define **MMCSD_CMD_SET_BLOCKLEN** 16U
- #define **MMCSD_CMD_READ_SINGLE_BLOCK** 17U
- #define **MMCSD_CMD_READ_MULTIPLE_BLOCK** 18U
- #define **MMCSD_CMD_SET_BLOCK_COUNT** 23U
- #define **MMCSD_CMD_WRITE_BLOCK** 24U
- #define **MMCSD_CMD_WRITE_MULTIPLE_BLOCK** 25U
- #define **MMCSD_CMD_ERASE_RW_BLK_START** 32U
- #define **MMCSD_CMD_ERASE_RW_BLK_END** 33U
- #define **MMCSD_CMD_ERASE** 38U
- #define **MMCSD_CMD_APP_OP_COND** 41U
- #define **MMCSD_CMD_LOCK_UNLOCK** 42U
- #define **MMCSD_CMD_APP_CMD** 55U
- #define **MMCSD_CMD_READ_OCR** 58U

### CSD record offsets

- #define MMCSD_CSD_MMC_CSD_STRUCTURE_SLICE 127U,126U

  *Slice position of values in CSD register.*
- #define **MMCSD_CSD_MMC_SPEC_VERS_SLICE** 125U,122U
- #define **MMCSD_CSD_MMC_TAAC_SLICE** 119U,112U
- #define **MMCSD_CSD_MMC_NSAC_SLICE** 111U,104U
- #define **MMCSD_CSD_MMC_TRAN_SPEED_SLICE** 103U,96U
- #define **MMCSD_CSD_MMC_CCC_SLICE** 95U,84U
- #define **MMCSD_CSD_MMC_READ_BL_LEN_SLICE** 83U,80U
- #define **MMCSD_CSD_MMC_READ_BL_PARTIAL_SLICE** 79U,79U
- #define **MMCSD_CSD_MMC_WRITE_BLK_MISALIGN_SLICE** 78U,78U
- #define **MMCSD_CSD_MMC_READ_BLK_MISALIGN_SLICE** 77U,77U
- #define **MMCSD_CSD_MMC_DSR_IMP_SLICE** 76U,76U
- #define **MMCSD_CSD_MMC_C_SIZE_SLICE** 73U,62U
- #define **MMCSD_CSD_MMC_VDD_R_CURR_MIN_SLICE** 61U,59U
- #define **MMCSD_CSD_MMC_VDD_R_CURR_MAX_SLICE** 58U,56U
- #define **MMCSD_CSD_MMC_VDD_W_CURR_MIN_SLICE** 55U,53U
- #define **MMCSD_CSD_MMC_VDD_W_CURR_MAX_SLICE** 52U,50U
- #define **MMCSD_CSD_MMC_C_SIZE_MULT_SLICE** 49U,47U

- #define **MMCSD_CSD_MMC_ERASE_GRP_SIZE_SLICE** 46U,42U
- #define **MMCSD_CSD_MMC_ERASE_GRP_MULT_SLICE** 41U,37U
- #define **MMCSD_CSD_MMC_WP_GRP_SIZE_SLICE** 36U,32U
- #define **MMCSD_CSD_MMC_WP_GRP_ENABLE_SLICE** 31U,31U
- #define **MMCSD_CSD_MMC_DEFAULT_ECC_SLICE** 30U,29U
- #define **MMCSD_CSD_MMC_R2W_FACTOR_SLICE** 28U,26U
- #define **MMCSD_CSD_MMC_WRITE_BL_LEN_SLICE** 25U,22U
- #define **MMCSD_CSD_MMC_WRITE_BL_PARTIAL_SLICE** 21U,21U
- #define **MMCSD_CSD_MMC_CONTENT_PROT_APP_SLICE** 16U,16U
- #define **MMCSD_CSD_MMC_FILE_FORMAT_GRP_SLICE** 15U,15U
- #define **MMCSD_CSD_MMC_COPY_SLICE** 14U,14U
- #define **MMCSD_CSD_MMC_PERM_WRITE_PROTECT_SLICE** 13U,13U
- #define **MMCSD_CSD_MMC_TMP_WRITE_PROTECT_SLICE** 12U,12U
- #define **MMCSD_CSD_MMC_FILE_FORMAT_SLICE** 11U,10U
- #define **MMCSD_CSD_MMC_ECC_SLICE** 9U,8U
- #define **MMCSD_CSD_MMC_CRC_SLICE** 7U,1U
- #define **MMCSD_CSD_20_CRC_SLICE** 7U,1U
- #define **MMCSD_CSD_20_FILE_FORMAT_SLICE** 11U,10U
- #define **MMCSD_CSD_20_TMP_WRITE_PROTECT_SLICE** 12U,12U
- #define **MMCSD_CSD_20_PERM_WRITE_PROTECT_SLICE** 13U,13U
- #define **MMCSD_CSD_20_COPY_SLICE** 14U,14U
- #define **MMCSD_CSD_20_FILE_FORMAT_GRP_SLICE** 15U,15U
- #define **MMCSD_CSD_20_WRITE_BL_PARTIAL_SLICE** 21U,21U
- #define **MMCSD_CSD_20_WRITE_BL_LEN_SLICE** 25U,12U
- #define **MMCSD_CSD_20_R2W_FACTOR_SLICE** 28U,26U
- #define **MMCSD_CSD_20_WP_GRP_ENABLE_SLICE** 31U,31U
- #define **MMCSD_CSD_20_WP_GRP_SIZE_SLICE** 38U,32U
- #define **MMCSD_CSD_20_ERASE_SECTOR_SIZE_SLICE** 45U,39U
- #define **MMCSD_CSD_20_ERASE_BLK_EN_SLICE** 46U,46U
- #define **MMCSD_CSD_20_C_SIZE_SLICE** 69U,48U
- #define **MMCSD_CSD_20_DSR_IMP_SLICE** 76U,76U
- #define **MMCSD_CSD_20_READ_BLK_MISALIGN_SLICE** 77U,77U
- #define **MMCSD_CSD_20_WRITE_BLK_MISALIGN_SLICE** 78U,78U
- #define **MMCSD_CSD_20_READ_BL_PARTIAL_SLICE** 79U,79U
- #define **MMCSD_CSD_20_READ_BL_LEN_SLICE** 83U,80U
- #define **MMCSD_CSD_20_CCC_SLICE** 95U,84U
- #define **MMCSD_CSD_20_TRANS_SPEED_SLICE** 103U,96U
- #define **MMCSD_CSD_20_NSAC_SLICE** 111U,104U
- #define **MMCSD_CSD_20_TAAC_SLICE** 119U,112U
- #define **MMCSD_CSD_20_CSD_STRUCTURE_SLICE** 127U,126U
- #define **MMCSD_CSD_10_CRC_SLICE** MMCSD_CSD_20_CRC_SLICE
- #define **MMCSD_CSD_10_FILE_FORMAT_SLICE** MMCSD_CSD_20_FILE_FORMAT_SLICE
- #define **MMCSD_CSD_10_TMP_WRITE_PROTECT_SLICE** MMCSD_CSD_20_TMP_WRITE_PROTECT_SLICE
- #define **MMCSD_CSD_10_PERM_WRITE_PROTECT_SLICE** MMCSD_CSD_20_PERM_WRITE_PROTECT_SLICE
- #define **MMCSD_CSD_10_COPY_SLICE** MMCSD_CSD_20_COPY_SLICE
- #define **MMCSD_CSD_10_FILE_FORMAT_GRP_SLICE** MMCSD_CSD_20_FILE_FORMAT_GRP_SLICE
- #define **MMCSD_CSD_10_WRITE_BL_PARTIAL_SLICE** MMCSD_CSD_20_WRITE_BL_PARTIAL_SLICE
- #define **MMCSD_CSD_10_WRITE_BL_LEN_SLICE** MMCSD_CSD_20_WRITE_BL_LEN_SLICE
- #define **MMCSD_CSD_10_R2W_FACTOR_SLICE** MMCSD_CSD_20_R2W_FACTOR_SLICE
- #define **MMCSD_CSD_10_WP_GRP_ENABLE_SLICE** MMCSD_CSD_20_WP_GRP_ENABLE_SLICE
- #define **MMCSD_CSD_10_WP_GRP_SIZE_SLICE** MMCSD_CSD_20_WP_GRP_SIZE_SLICE
- #define **MMCSD_CSD_10_ERASE_SECTOR_SIZE_SLICE** MMCSD_CSD_20_ERASE_SECTOR_SIZE_SLICE
- #define **MMCSD_CSD_10_ERASE_BLK_EN_SLICE** MMCSD_CSD_20_ERASE_BLK_EN_SLICE
- #define **MMCSD_CSD_10_C_SIZE_MULT_SLICE** 49U,47U
- #define **MMCSD_CSD_10_VDD_W_CURR_MAX_SLICE** 52U,50U
- #define **MMCSD_CSD_10_VDD_W_CURR_MIN_SLICE** 55U,53U
- #define **MMCSD_CSD_10_VDD_R_CURR_MAX_SLICE** 58U,56U
- #define **MMCSD_CSD_10_VDD_R_CURR_MIX_SLICE** 61U,59U
- #define **MMCSD_CSD_10_C_SIZE_SLICE** 73U,62U

- #define **MMCSD_CSD_10_DSR_IMP_SLICE** MMCSD_CSD_20_DSR_IMP_SLICE
- #define **MMCSD_CSD_10_READ_BLK_MISALIGN_SLICE** MMCSD_CSD_20_READ_BLK_MISALIGN_SLICE
- #define **MMCSD_CSD_10_WRITE_BLK_MISALIGN_SLICE** MMCSD_CSD_20_WRITE_BLK_MISALIGN_SLICE
- #define **MMCSD_CSD_10_READ_BL_PARTIAL_SLICE** MMCSD_CSD_20_READ_BL_PARTIAL_SLICE
- #define **MMCSD_CSD_10_READ_BL_LEN_SLICE** 83U,80U
- #define **MMCSD_CSD_10_CCC_SLICE** MMCSD_CSD_20_CCC_SLICE
- #define **MMCSD_CSD_10_TRANS_SPEED_SLICE** MMCSD_CSD_20_TRANS_SPEED_SLICE
- #define **MMCSD_CSD_10_NSAC_SLICE** MMCSD_CSD_20_NSAC_SLICE
- #define **MMCSD_CSD_10_TAAC_SLICE** MMCSD_CSD_20_TAAC_SLICE
- #define **MMCSD_CSD_10_CSD_STRUCTURE_SLICE** MMCSD_CSD_20_CSD_STRUCTURE_SLICE

### CID record offsets

- #define MMCSD_CID_SDC_CRC_SLICE 7U,1U

  *Slice position of values in CID register.*
- #define **MMCSD_CID_SDC_MDT_M_SLICE** 11U,8U
- #define **MMCSD_CID_SDC_MDT_Y_SLICE** 19U,12U
- #define **MMCSD_CID_SDC_PSN_SLICE** 55U,24U
- #define **MMCSD_CID_SDC_PRV_M_SLICE** 59U,56U
- #define **MMCSD_CID_SDC_PRV_N_SLICE** 63U,60U
- #define **MMCSD_CID_SDC_PNM0_SLICE** 71U,64U
- #define **MMCSD_CID_SDC_PNM1_SLICE** 79U,72U
- #define **MMCSD_CID_SDC_PNM2_SLICE** 87U,80U
- #define **MMCSD_CID_SDC_PNM3_SLICE** 95U,88U
- #define **MMCSD_CID_SDC_PNM4_SLICE** 103U,96U
- #define **MMCSD_CID_SDC_OID_SLICE** 119U,104U
- #define **MMCSD_CID_SDC_MID_SLICE** 127U,120U
- #define **MMCSD_CID_MMC_CRC_SLICE** 7U,1U
- #define **MMCSD_CID_MMC_MDT_Y_SLICE** 11U,8U
- #define **MMCSD_CID_MMC_MDT_M_SLICE** 15U,12U
- #define **MMCSD_CID_MMC_PSN_SLICE** 47U,16U
- #define **MMCSD_CID_MMC_PRV_M_SLICE** 51U,48U
- #define **MMCSD_CID_MMC_PRV_N_SLICE** 55U,52U
- #define **MMCSD_CID_MMC_PNM0_SLICE** 63U,56U
- #define **MMCSD_CID_MMC_PNM1_SLICE** 71U,64U
- #define **MMCSD_CID_MMC_PNM2_SLICE** 79U,72U
- #define **MMCSD_CID_MMC_PNM3_SLICE** 87U,80U
- #define **MMCSD_CID_MMC_PNM4_SLICE** 95U,88U
- #define **MMCSD_CID_MMC_PNM5_SLICE** 103U,96U
- #define **MMCSD_CID_MMC_OID_SLICE** 119U,104U
- #define **MMCSD_CID_MMC_MID_SLICE** 127U,120U

### R1 response utilities

- #define MMCSD_R1_ERROR(r1) (((r1) & MMCSD_R1_ERROR_MASK) != 0U)

  *Evaluates to `true` if the R1 response contains error flags.*
- #define MMCSD_R1_STS(r1) (((r1) >> 9U) & 15U)

  *Returns the status field of an R1 response.*
- #define MMCSD_R1_IS_CARD_LOCKED(r1) ((((r1) >> 21U) & 1U) != 0U)

  *Evaluates to `true` if the R1 response indicates a locked card.*

### Macro Functions

- #define mmcsdGetCardCapacity(ip) ((ip)->capacity)

  *Returns the card capacity in blocks.*

### Functions

- uint32_t _mmcsd_get_slice (const uint32_t ∗data, uint32_t end, uint32_t start)

  *Gets a bit field from a words array.*
- uint32_t _mmcsd_get_capacity (const uint32_t ∗csd)

  *Extract card capacity from a CSD.*
- uint32_t _mmcsd_get_capacity_ext (const uint8_t ∗ext_csd)

  *Extract MMC card capacity from EXT_CSD.*
- void _mmcsd_unpack_sdc_cid (const MMCSDBlockDevice ∗sdcp, unpacked_sdc_cid_t ∗cidsdc)

  *Unpacks SDC CID array in structure.*
- void _mmcsd_unpack_mmc_cid (const MMCSDBlockDevice ∗sdcp, unpacked_mmc_cid_t ∗cidmmc)

  *Unpacks MMC CID array in structure.*
- void _mmcsd_unpack_csd_mmc (const MMCSDBlockDevice ∗sdcp, unpacked_mmc_csd_t ∗csdmmc)

  *Unpacks MMC CSD array in structure.*
- void _mmcsd_unpack_csd_v10 (const MMCSDBlockDevice ∗sdcp, unpacked_sdc_csd_10_t ∗csd10)

  *Unpacks SDC CSD v1.0 array in structure.*
- void _mmcsd_unpack_csd_v20 (const MMCSDBlockDevice ∗sdcp, unpacked_sdc_csd_20_t ∗csd20)

  *Unpacks SDC CSD v2.0 array in structure.*

### 9.63.1 Detailed Description

MMC/SD cards common header.

This header defines an abstract interface useful to access MMC/SD I/O block devices in a standardized way.

## 9.64 hal_objects.h File Reference

Base object.

### Data Structures

- struct BaseObjectVMT

  `BaseObject` *virtual methods table.*
- struct BaseObject

  *Base stream class.*

### Macros

- #define _base_object_methods

  `BaseObject` *specific methods.*
- #define _base_object_data

  `BaseObject` *specific data.*

#### Macro Functions (BaseObject)

- #define objGetInstance(type, ip) (type)(((size_t)(ip)) - (ip)->vmt->instance_offset)

  *Returns the instance pointer starting from an interface pointer.*

### 9.64.1 Detailed Description

Base object.

This header defines a base object that is the root for the inheritance system.

## 9.65 hal_pal.c File Reference

I/O Ports Abstraction Layer code.

```
#include "hal.h"
```

### Functions

- ioportmask_t palReadBus (const IOBus ∗bus)

    *Read from an I/O bus.*
- void palWriteBus (const IOBus ∗bus, ioportmask_t bits)

    *Write to an I/O bus.*
- void palSetBusMode (const IOBus ∗bus, iomode_t mode)

    *Programs a bus with the specified mode.*
- void palSetPadCallbackI (ioportid_t port, iopadid_t pad, palcallback_t cb, void ∗arg)

    *Associates a callback to a port/pad.*
- void palSetLineCallbackI (ioline_t line, palcallback_t cb, void ∗arg)

    *Associates a callback to a line.*
- msg_t palWaitPadTimeoutS (ioportid_t port, iopadid_t pad, sysinterval_t timeout)

    *Waits for an edge on the specified port/pad.*
- msg_t palWaitPadTimeout (ioportid_t port, iopadid_t pad, sysinterval_t timeout)

    *Waits for an edge on the specified port/pad.*
- msg_t palWaitLineTimeoutS (ioline_t line, sysinterval_t timeout)

    *Waits for an edge on the specified line.*
- msg_t palWaitLineTimeout (ioline_t line, sysinterval_t timeout)

    *Waits for an edge on the specified line.*

### 9.65.1 Detailed Description

I/O Ports Abstraction Layer code.

## 9.66 hal_pal.h File Reference

I/O Ports Abstraction Layer macros, types and structures.

```
#include "hal_pal_lld.h"
```

### Data Structures

- struct palevent_t

    *Type of a PAL event record.*
- struct IOBus

    *I/O bus descriptor.*

## Macros

- #define PAL_PORT_BIT(n) ((ioportmask_t)(1U << (n)))

  *Port bit helper macro.*
- #define PAL_GROUP_MASK(width) ((ioportmask_t)(1U << (width)) - 1U)

  *Bits group mask helper.*
- #define _IOBUS_DATA(name, port, width, offset) {port, PAL_GROUP_MASK(width), offset}

  *Data part of a static I/O bus initializer.*
- #define IOBUS_DECL(name, port, width, offset) IOBus name = _IOBUS_DATA(name, port, width, offset)

  *Static I/O bus initializer.*

### Pads mode constants

- #define PAL_MODE_RESET 0U

  *After reset state.*
- #define PAL_MODE_UNCONNECTED 1U

  *Safe state for **unconnected** pads.*
- #define PAL_MODE_INPUT 2U

  *Regular input high-Z pad.*
- #define PAL_MODE_INPUT_PULLUP 3U

  *Input pad with weak pull up resistor.*
- #define PAL_MODE_INPUT_PULLDOWN 4U

  *Input pad with weak pull down resistor.*
- #define PAL_MODE_INPUT_ANALOG 5U

  *Analog input mode.*
- #define PAL_MODE_OUTPUT_PUSHPULL 6U

  *Push-pull output pad.*
- #define PAL_MODE_OUTPUT_OPENDRAIN 7U

  *Open-drain output pad.*

### Logic level constants

- #define PAL_LOW 0U

  *Logical low state.*
- #define PAL_HIGH 1U

  *Logical high state.*

### PAL event modes

- #define PAL_EVENT_MODE_EDGES_MASK 3U

  *Mask of edges field.*
- #define PAL_EVENT_MODE_DISABLED 0U

  *Channel disabled.*
- #define PAL_EVENT_MODE_RISING_EDGE 1U

  *Rising edge callback.*
- #define PAL_EVENT_MODE_FALLING_EDGE 2U

  *Falling edge callback.*
- #define PAL_EVENT_MODE_BOTH_EDGES 3U

  *Both edges callback.*

### PAL configuration options

- #define PAL_USE_CALLBACKS TRUE

  *Enables synchronous APIs.*
- #define PAL_USE_WAIT TRUE

  *Enables synchronous APIs.*

### Low level driver helper macros

- #define _pal_init_event(e)
  *Initializes a PAL event object.*
- #define _pal_init_event(e)
  *Initializes a PAL event object.*
- #define _pal_init_event(e)
  *Initializes a PAL event object.*
- #define _pal_clear_event(e)
  *Clears a PAL event object.*
- #define _pal_clear_event(e)
  *Clears a PAL event object.*
- #define _pal_clear_event(e)
  *Clears a PAL event object.*
- #define _pal_isr_code(e)
  *Common ISR code.*
- #define _pal_isr_code(e)
  *Common ISR code.*
- #define _pal_isr_code(e)
  *Common ISR code.*

### Macro Functions

- #define palInit() pal_lld_init()
  *PAL subsystem initialization.*
- #define palReadPort(port) ((void)(port), 0U)
  *Reads the physical I/O port states.*
- #define palReadLatch(port) ((void)(port), 0U)
  *Reads the output latch.*
- #define palWritePort(port, bits) ((void)(port), (void)(bits))
  *Writes a bits mask on a I/O port.*
- #define palSetPort(port, bits) palWritePort(port, palReadLatch(port) | (bits))
  *Sets a bits mask on a I/O port.*
- #define palClearPort(port, bits) palWritePort(port, palReadLatch(port) & ∼(bits))
  *Clears a bits mask on a I/O port.*
- #define palTogglePort(port, bits) palWritePort(port, palReadLatch(port) ^ (bits))
  *Toggles a bits mask on a I/O port.*
- #define palReadGroup(port, mask, offset) ((palReadPort(port) >> (offset)) & (mask))
  *Reads a group of bits.*
- #define palWriteGroup(port, mask, offset, bits)
  *Writes a group of bits.*
- #define palSetGroupMode(port, mask, offset, mode)
  *Pads group mode setup.*
- #define palReadPad(port, pad) ((palReadPort(port) >> (pad)) & 1U)
  *Reads an input pad logic state.*
- #define palWritePad(port, pad, bit)
  *Writes a logic state on an output pad.*
- #define palSetPad(port, pad) palSetPort(port, PAL_PORT_BIT(pad))
  *Sets a pad logic state to `PAL_HIGH`.*
- #define palClearPad(port, pad) palClearPort(port, PAL_PORT_BIT(pad))
  *Clears a pad logic state to `PAL_LOW`.*
- #define palTogglePad(port, pad) palTogglePort(port, PAL_PORT_BIT(pad))
  *Toggles a pad logic state.*
- #define palSetPadMode(port, pad, mode) palSetGroupMode(port, PAL_PORT_BIT(pad), 0U, mode)
  *Pad mode setup.*
- #define palReadLine(line) palReadPad(PAL_PORT(line), PAL_PAD(line))
  *Reads an input line logic state.*
- #define palWriteLine(line, bit) palWritePad(PAL_PORT(line), PAL_PAD(line), bit)
  *Writes a logic state on an output line.*

- #define palSetLine(line) palSetPad(PAL_PORT(line), PAL_PAD(line))

  *Sets a line logic state to `PAL_HIGH`.*
- #define palClearLine(line) palClearPad(PAL_PORT(line), PAL_PAD(line))

  *Clears a line logic state to `PAL_LOW`.*
- #define palToggleLine(line) palTogglePad(PAL_PORT(line), PAL_PAD(line))

  *Toggles a line logic state.*
- #define palSetLineMode(line, mode) palSetPadMode(PAL_PORT(line), PAL_PAD(line), mode)

  *Line mode setup.*
- #define palEnablePadEventI(port, pad, mode)

  *Pad event enable.*
- #define palDisablePadEventI(port, pad)

  *Pad event disable.*
- #define palEnablePadEvent(port, pad, mode)

  *Pad event enable.*
- #define palDisablePadEvent(port, pad)

  *Pad event disable.*
- #define palEnableLineEventI(line, mode) palEnablePadEventI(PAL_PORT(line), PAL_PAD(line), mode)

  *Line event enable.*
- #define palDisableLineEventI(line) palDisablePadEventI(PAL_PORT(line), PAL_PAD(line))

  *Line event disable.*
- #define palEnableLineEvent(line, mode)

  *Line event enable.*
- #define palDisableLineEvent(line)

  *Line event disable.*
- #define palSetPadCallback(port, pad, cb, arg)

  *Associates a callback to a pad.*
- #define palSetLineCallback(line, cb, arg)

  *Associates a callback to a line.*

## Typedefs

- typedef void(∗ palcallback_t) (void ∗arg)

  *Type of a PAL event callback.*

## Functions

- ioportmask_t palReadBus (const IOBus ∗bus)

  *Read from an I/O bus.*
- void palWriteBus (const IOBus ∗bus, ioportmask_t bits)

  *Write to an I/O bus.*
- void palSetBusMode (const IOBus ∗bus, iomode_t mode)

  *Programs a bus with the specified mode.*
- void palSetPadCallbackI (ioportid_t port, iopadid_t pad, palcallback_t cb, void ∗arg)

  *Associates a callback to a port/pad.*
- void palSetLineCallbackI (ioline_t line, palcallback_t cb, void ∗arg)

  *Associates a callback to a line.*
- msg_t palWaitPadTimeoutS (ioportid_t port, iopadid_t pad, sysinterval_t timeout)

  *Waits for an edge on the specified port/pad.*
- msg_t palWaitPadTimeout (ioportid_t port, iopadid_t pad, sysinterval_t timeout)

  *Waits for an edge on the specified port/pad.*
- msg_t palWaitLineTimeoutS (ioline_t line, sysinterval_t timeout)

  *Waits for an edge on the specified line.*
- msg_t palWaitLineTimeout (ioline_t line, sysinterval_t timeout)

  *Waits for an edge on the specified line.*

### 9.66.1 Detailed Description

I/O Ports Abstraction Layer macros, types and structures.

## 9.67 hal_pal_lld.c File Reference

PLATFORM PAL subsystem low level driver source.

```
#include "hal.h"
```

### Functions

- void _pal_lld_init (const PALConfig ∗config)

  *STM32 I/O ports configuration.*
- void _pal_lld_setgroupmode (ioportid_t port, ioportmask_t mask, iomode_t mode)

  *Pads mode setup.*

### 9.67.1 Detailed Description

PLATFORM PAL subsystem low level driver source.

## 9.68 hal_pal_lld.h File Reference

PLATFORM PAL subsystem low level driver header.

### Data Structures

- struct PALConfig

  *Generic I/O ports static initializer.*

### Macros

- #define IOPORT1 0

  *First I/O port identifier.*
- #define pal_lld_init(config) _pal_lld_init(config)

  *Low level PAL subsystem initialization.*
- #define pal_lld_readport(port) 0U

  *Reads the physical I/O port states.*
- #define pal_lld_readlatch(port) 0U

  *Reads the output latch.*
- #define pal_lld_writeport(port, bits)

  *Writes a bits mask on a I/O port.*
- #define pal_lld_setport(port, bits)

  *Sets a bits mask on a I/O port.*
- #define pal_lld_clearport(port, bits)

  *Clears a bits mask on a I/O port.*
- #define pal_lld_toggleport(port, bits)

  *Toggles a bits mask on a I/O port.*

- #define pal_lld_readgroup(port, mask, offset) 0U

  *Reads a group of bits.*
- #define pal_lld_writegroup(port, mask, offset, bits)

  *Writes a group of bits.*
- #define pal_lld_setgroupmode(port, mask, offset, mode) _pal_lld_setgroupmode(port, mask << offset, mode)

  *Pads group mode setup.*
- #define pal_lld_readpad(port, pad) PAL_LOW

  *Reads a logical state from an I/O pad.*
- #define pal_lld_writepad(port, pad, bit)

  *Writes a logical state on an output pad.*
- #define pal_lld_setpad(port, pad)

  *Sets a pad logical state to `PAL_HIGH`.*
- #define pal_lld_clearpad(port, pad)

  *Clears a pad logical state to `PAL_LOW`.*
- #define pal_lld_togglepad(port, pad)

  *Toggles a pad logical state.*
- #define pal_lld_setpadmode(port, pad, mode)

  *Pad mode setup.*
- #define pal_lld_get_pad_event(port, pad) &_pal_events[0]; (void)(port); (void)pad

  *Returns a PAL event structure associated to a pad.*
- #define pal_lld_get_line_event(line) &_pal_events[0]; (void)line

  *Returns a PAL event structure associated to a line.*

### Port related definitions

- #define PAL_IOPORTS_WIDTH 16U

  *Width, in bits, of an I/O port.*
- #define PAL_WHOLE_PORT ((ioportmask_t)0xFFFFU)

  *Whole port mask.*

### Line handling macros

- #define PAL_LINE(port, pad) ((ioline_t)((uint32_t)(port)) | ((uint32_t)(pad)))

  *Forms a line identifier.*
- #define PAL_PORT(line) ((stm32_gpio_t *)(((uint32_t)(line)) & 0xFFFFFFF0U))

  *Decodes a port identifier from a line identifier.*
- #define PAL_PAD(line) ((uint32_t)((uint32_t)(line) & 0x0000000FU))

  *Decodes a pad identifier from a line identifier.*
- #define PAL_NOLINE 0U

  *Value identifying an invalid line.*

## Typedefs

- typedef uint32_t ioportmask_t

  *Digital I/O port sized unsigned type.*
- typedef uint32_t iomode_t

  *Digital I/O modes.*
- typedef uint32_t ioline_t

  *Type of an I/O line.*
- typedef uint32_t ioportid_t

  *Port Identifier.*
- typedef uint32_t iopadid_t

  *Type of an pad identifier.*

### Functions

- void _pal_lld_init (const PALConfig ∗config)

  *STM32 I/O ports configuration.*
- void _pal_lld_setgroupmode (ioportid_t port, ioportmask_t mask, iomode_t mode)

  *Pads mode setup.*

### 9.68.1 Detailed Description

PLATFORM PAL subsystem low level driver header.

## 9.69 hal_pwm.c File Reference

PWM Driver code.

```
#include "hal.h"
```

### Functions

- void pwmInit (void)

  *PWM Driver initialization.*
- void pwmObjectInit (PWMDriver ∗pwmp)

  *Initializes the standard part of a `PWMDriver` structure.*
- void pwmStart (PWMDriver ∗pwmp, const PWMConfig ∗config)

  *Configures and activates the PWM peripheral.*
- void pwmStop (PWMDriver ∗pwmp)

  *Deactivates the PWM peripheral.*
- void pwmChangePeriod (PWMDriver ∗pwmp, pwmcnt_t period)

  *Changes the period the PWM peripheral.*
- void pwmEnableChannel (PWMDriver ∗pwmp, pwmchannel_t channel, pwmcnt_t width)

  *Enables a PWM channel.*
- void pwmDisableChannel (PWMDriver ∗pwmp, pwmchannel_t channel)

  *Disables a PWM channel and its notification.*
- void pwmEnablePeriodicNotification (PWMDriver ∗pwmp)

  *Enables the periodic activation edge notification.*
- void pwmDisablePeriodicNotification (PWMDriver ∗pwmp)

  *Disables the periodic activation edge notification.*
- void pwmEnableChannelNotification (PWMDriver ∗pwmp, pwmchannel_t channel)

  *Enables a channel de-activation edge notification.*
- void pwmDisableChannelNotification (PWMDriver ∗pwmp, pwmchannel_t channel)

  *Disables a channel de-activation edge notification.*

### 9.69.1 Detailed Description

PWM Driver code.

## 9.70 hal_pwm.h File Reference

PWM Driver macros and structures.

```
#include "hal_pwm_lld.h"
```

### Macros

#### PWM output mode macros

- #define PWM_OUTPUT_MASK 0x0FU
  *Standard output modes mask.*
- #define PWM_OUTPUT_DISABLED 0x00U
  *Output not driven, callback only.*
- #define PWM_OUTPUT_ACTIVE_HIGH 0x01U
  *Positive PWM logic, active is logic level one.*
- #define PWM_OUTPUT_ACTIVE_LOW 0x02U
  *Inverse PWM logic, active is logic level zero.*

#### PWM duty cycle conversion

- #define PWM_FRACTION_TO_WIDTH(pwmp, denominator, numerator)
  *Converts from fraction to pulse width.*
- #define PWM_DEGREES_TO_WIDTH(pwmp, degrees) PWM_FRACTION_TO_WIDTH(pwmp, 36000, degrees)
  *Converts from degrees to pulse width.*
- #define PWM_PERCENTAGE_TO_WIDTH(pwmp, percentage) PWM_FRACTION_TO_WIDTH(pwmp, 10000, percentage)
  *Converts from percentage to pulse width.*

#### Macro Functions

- #define pwmChangePeriodI(pwmp, value)
  *Changes the period the PWM peripheral.*
- #define pwmEnableChannelI(pwmp, channel, width)
  *Enables a PWM channel.*
- #define pwmDisableChannelI(pwmp, channel)
  *Disables a PWM channel.*
- #define pwmIsChannelEnabledI(pwmp, channel) (((pwmp)->enabled & ((pwmchnmsk_t)1U << (pwmchnmsk_t)(channel))) != 0U)
  *Returns a PWM channel status.*
- #define pwmEnablePeriodicNotificationI(pwmp) pwm_lld_enable_periodic_notification(pwmp)
  *Enables the periodic activation edge notification.*
- #define pwmDisablePeriodicNotificationI(pwmp) pwm_lld_disable_periodic_notification(pwmp)
  *Disables the periodic activation edge notification.*
- #define pwmEnableChannelNotificationI(pwmp, channel) pwm_lld_enable_channel_notification(pwmp, channel)
  *Enables a channel de-activation edge notification.*
- #define pwmDisableChannelNotificationI(pwmp, channel) pwm_lld_disable_channel_notification(pwmp, channel)
  *Disables a channel de-activation edge notification.*

### Typedefs

- typedef struct PWMDriver PWMDriver
  *Type of a structure representing a PWM driver.*
- typedef void(∗ pwmcallback_t) (PWMDriver ∗pwmp)
  *Type of a PWM notification callback.*

### Enumerations

### Functions

- void pwmInit (void)

  *PWM Driver initialization.*
- void pwmObjectInit (PWMDriver ∗pwmp)

  *Initializes the standard part of a `PWMDriver` structure.*
- void pwmStart (PWMDriver ∗pwmp, const PWMConfig ∗config)

  *Configures and activates the PWM peripheral.*
- void pwmStop (PWMDriver ∗pwmp)

  *Deactivates the PWM peripheral.*
- void pwmChangePeriod (PWMDriver ∗pwmp, pwmcnt_t period)

  *Changes the period the PWM peripheral.*
- void pwmEnableChannel (PWMDriver ∗pwmp, pwmchannel_t channel, pwmcnt_t width)

  *Enables a PWM channel.*
- void pwmDisableChannel (PWMDriver ∗pwmp, pwmchannel_t channel)

  *Disables a PWM channel and its notification.*
- void pwmEnablePeriodicNotification (PWMDriver ∗pwmp)

  *Enables the periodic activation edge notification.*
- void pwmDisablePeriodicNotification (PWMDriver ∗pwmp)

  *Disables the periodic activation edge notification.*
- void pwmEnableChannelNotification (PWMDriver ∗pwmp, pwmchannel_t channel)

  *Enables a channel de-activation edge notification.*
- void pwmDisableChannelNotification (PWMDriver ∗pwmp, pwmchannel_t channel)

  *Disables a channel de-activation edge notification.*

### 9.70.1 Detailed Description

PWM Driver macros and structures.

## 9.71 hal_pwm_lld.c File Reference

PLATFORM PWM subsystem low level driver source.

```
#include "hal.h"
```

### Functions

- void pwm_lld_init (void)

  *Low level PWM driver initialization.*
- void pwm_lld_start (PWMDriver ∗pwmp)

  *Configures and activates the PWM peripheral.*
- void pwm_lld_stop (PWMDriver ∗pwmp)

  *Deactivates the PWM peripheral.*
- void pwm_lld_enable_channel (PWMDriver ∗pwmp, pwmchannel_t channel, pwmcnt_t width)

  *Enables a PWM channel.*
- void pwm_lld_disable_channel (PWMDriver ∗pwmp, pwmchannel_t channel)

  *Disables a PWM channel and its notification.*

- void pwm_lld_enable_periodic_notification (PWMDriver ∗pwmp)

  *Enables the periodic activation edge notification.*
- void pwm_lld_disable_periodic_notification (PWMDriver ∗pwmp)

  *Disables the periodic activation edge notification.*
- void pwm_lld_enable_channel_notification (PWMDriver ∗pwmp, pwmchannel_t channel)

  *Enables a channel de-activation edge notification.*
- void pwm_lld_disable_channel_notification (PWMDriver ∗pwmp, pwmchannel_t channel)

  *Disables a channel de-activation edge notification.*

### Variables

- PWMDriver PWMD1

  *PWMD1 driver identifier.*

### 9.71.1 Detailed Description

PLATFORM PWM subsystem low level driver source.

## 9.72 hal_pwm_lld.h File Reference

PLATFORM PWM subsystem low level driver header.

### Data Structures

- struct PWMChannelConfig

  *Type of a PWM driver channel configuration structure.*
- struct PWMConfig

  *Type of a PWM driver configuration structure.*
- struct PWMDriver

  *Structure representing a PWM driver.*

### Macros

- #define PWM_CHANNELS 4

  *Number of PWM channels per PWM driver.*
- #define pwm_lld_change_period(pwmp, period)

  *Changes the period the PWM peripheral.*

**PLATFORM configuration options**

- #define PLATFORM_PWM_USE_PWM1 FALSE

  *PWMD1 driver enable switch.*

### Typedefs

- typedef uint32_t pwmmode_t

  *Type of a PWM mode.*
- typedef uint8_t pwmchannel_t

  *Type of a PWM channel.*
- typedef uint32_t pwmchnmsk_t

  *Type of a channels mask.*
- typedef uint32_t pwmcnt_t

  *Type of a PWM counter.*

### Functions

- void pwm_lld_init (void)

  *Low level PWM driver initialization.*
- void pwm_lld_start (PWMDriver ∗pwmp)

  *Configures and activates the PWM peripheral.*
- void pwm_lld_stop (PWMDriver ∗pwmp)

  *Deactivates the PWM peripheral.*
- void pwm_lld_enable_channel (PWMDriver ∗pwmp, pwmchannel_t channel, pwmcnt_t width)

  *Enables a PWM channel.*
- void pwm_lld_disable_channel (PWMDriver ∗pwmp, pwmchannel_t channel)

  *Disables a PWM channel and its notification.*
- void pwm_lld_enable_periodic_notification (PWMDriver ∗pwmp)

  *Enables the periodic activation edge notification.*
- void pwm_lld_disable_periodic_notification (PWMDriver ∗pwmp)

  *Disables the periodic activation edge notification.*
- void pwm_lld_enable_channel_notification (PWMDriver ∗pwmp, pwmchannel_t channel)

  *Enables a channel de-activation edge notification.*
- void pwm_lld_disable_channel_notification (PWMDriver ∗pwmp, pwmchannel_t channel)

  *Disables a channel de-activation edge notification.*

### 9.72.1 Detailed Description

PLATFORM PWM subsystem low level driver header.

## 9.73 hal_qspi.c File Reference

QSPI Driver code.

```
#include "hal.h"
```

### Functions

- void qspiInit (void)

  *QSPI Driver initialization.*
- void qspiObjectInit (QSPIDriver ∗qspip)

  *Initializes the standard part of a `QSPIDriver` structure.*
- void qspiStart (QSPIDriver ∗qspip, const QSPIConfig ∗config)

*Configures and activates the QSPI peripheral.*
- void qspiStop (QSPIDriver ∗qspip)

  *Deactivates the QSPI peripheral.*
- void qspiStartCommand (QSPIDriver ∗qspip, const qspi_command_t ∗cmdp)

  *Sends a command without data phase.*
- void qspiStartSend (QSPIDriver ∗qspip, const qspi_command_t ∗cmdp, size_t n, const uint8_t ∗txbuf)

  *Sends a command with data over the QSPI bus.*
- void qspiStartReceive (QSPIDriver ∗qspip, const qspi_command_t ∗cmdp, size_t n, uint8_t ∗rxbuf)

  *Sends a command then receives data over the QSPI bus.*
- void qspiCommand (QSPIDriver ∗qspip, const qspi_command_t ∗cmdp)

  *Sends a command without data phase.*
- void qspiSend (QSPIDriver ∗qspip, const qspi_command_t ∗cmdp, size_t n, const uint8_t ∗txbuf)

  *Sends a command with data over the QSPI bus.*
- void qspiReceive (QSPIDriver ∗qspip, const qspi_command_t ∗cmdp, size_t n, uint8_t ∗rxbuf)

  *Sends a command then receives data over the QSPI bus.*
- void qspiMapFlash (QSPIDriver ∗qspip, const qspi_command_t ∗cmdp, uint8_t ∗∗addrp)

  *Maps in memory space a QSPI flash device.*
- void qspiUnmapFlash (QSPIDriver ∗qspip)

  *Unmaps from memory space a QSPI flash device.*
- void qspiAcquireBus (QSPIDriver ∗qspip)

  *Gains exclusive access to the QSPI bus.*
- void qspiReleaseBus (QSPIDriver ∗qspip)

  *Releases exclusive access to the QSPI bus.*

### 9.73.1 Detailed Description

QSPI Driver code.

## 9.74 hal_qspi.h File Reference

QSPI Driver macros and structures.

```
#include "hal_qspi_lld.h"
```

### Data Structures

- struct qspi_command_t

  *Type of a QSPI command descriptor.*

### Macros

**Transfer options**

- #define **QSPI_CFG_CMD_MASK** (0xFFLU << 0LU)
- #define **QSPI_CFG_CMD**(n) ((n) << 0LU)
- #define **QSPI_CFG_CMD_MODE_MASK** (3LU << 8LU)
- #define **QSPI_CFG_CMD_MODE_NONE** (0LU << 8LU)
- #define **QSPI_CFG_CMD_MODE_ONE_LINE** (1LU << 8LU)
- #define **QSPI_CFG_CMD_MODE_TWO_LINES** (2LU << 8LU)
- #define **QSPI_CFG_CMD_MODE_FOUR_LINES** (3LU << 8LU)
- #define **QSPI_CFG_ADDR_MODE_MASK** (3LU << 10LU)

- #define **QSPI_CFG_ADDR_MODE_NONE** (0LU << 10LU)
- #define **QSPI_CFG_ADDR_MODE_ONE_LINE** (1LU << 10LU)
- #define **QSPI_CFG_ADDR_MODE_TWO_LINES** (2LU << 10LU)
- #define **QSPI_CFG_ADDR_MODE_FOUR_LINES** (3LU << 10LU)
- #define **QSPI_CFG_ADDR_SIZE_MASK** (3LU << 12LU)
- #define **QSPI_CFG_ADDR_SIZE_8** (0LU << 12LU)
- #define **QSPI_CFG_ADDR_SIZE_16** (1LU << 12LU)
- #define **QSPI_CFG_ADDR_SIZE_24** (2LU << 12LU)
- #define **QSPI_CFG_ADDR_SIZE_32** (3LU << 12LU)
- #define **QSPI_CFG_ALT_MODE_MASK** (3LU << 14LU)
- #define **QSPI_CFG_ALT_MODE_NONE** (0LU << 14LU)
- #define **QSPI_CFG_ALT_MODE_ONE_LINE** (1LU << 14LU)
- #define **QSPI_CFG_ALT_MODE_TWO_LINES** (2LU << 14LU)
- #define **QSPI_CFG_ALT_MODE_FOUR_LINES** (3LU << 14LU)
- #define **QSPI_CFG_ALT_SIZE_MASK** (3LU << 16LU)
- #define **QSPI_CFG_ALT_SIZE_8** (0LU << 16LU)
- #define **QSPI_CFG_ALT_SIZE_16** (1LU << 16LU)
- #define **QSPI_CFG_ALT_SIZE_24** (2LU << 16LU)
- #define **QSPI_CFG_ALT_SIZE_32** (3LU << 16LU)
- #define **QSPI_CFG_DUMMY_CYCLES_MASK** (0x1FLU << 18LU)
- #define **QSPI_CFG_DUMMY_CYCLES**(n) ((n) << 18LU)
- #define **QSPI_CFG_DATA_MODE_MASK** (3LU << 24LU)
- #define **QSPI_CFG_DATA_MODE_NONE** (0LU << 24LU)
- #define **QSPI_CFG_DATA_MODE_ONE_LINE** (1LU << 24LU)
- #define **QSPI_CFG_DATA_MODE_TWO_LINES** (2LU << 24LU)
- #define **QSPI_CFG_DATA_MODE_FOUR_LINES** (3LU << 24LU)
- #define **QSPI_CFG_SIOO** (1LU << 28LU)
- #define **QSPI_CFG_DDRM** (1LU << 31LU)

### QSPI configuration options

- #define QSPI_USE_WAIT TRUE

  *Enables synchronous APIs.*
- #define QSPI_USE_MUTUAL_EXCLUSION TRUE

  *Enables the `qspiAcquireBus()` and `qspiReleaseBus()` APIs.*

### Macro Functions

- #define qspiStartCommandI(qspip, cmdp)

  *Sends a command without data phase.*
- #define qspiStartSendI(qspip, cmdp, n, txbuf)

  *Sends data over the QSPI bus.*
- #define qspiStartReceiveI(qspip, cmdp, n, rxbuf)

  *Receives data from the QSPI bus.*
- #define qspiMapFlashI(qspip, cmdp, addrp) qspi_lld_map_flash(qspip, cmdp, addrp)

  *Maps in memory space a QSPI flash device.*
- #define qspiUnmapFlashI(qspip) qspi_lld_unmap_flash(qspip)

  *Maps in memory space a QSPI flash device.*

### Low level driver helper macros

- #define _qspi_wakeup_isr(qspip)

  *Wakes up the waiting thread.*
- #define _qspi_isr_code(qspip)

  *Common ISR code.*

### Enumerations

### Functions

- void qspiInit (void)

  *QSPI Driver initialization.*
- void qspiObjectInit (QSPIDriver ∗qspip)

  *Initializes the standard part of a `QSPIDriver` structure.*
- void qspiStart (QSPIDriver ∗qspip, const QSPIConfig ∗config)

  *Configures and activates the QSPI peripheral.*
- void qspiStop (QSPIDriver ∗qspip)

  *Deactivates the QSPI peripheral.*
- void qspiStartCommand (QSPIDriver ∗qspip, const qspi_command_t ∗cmdp)

  *Sends a command without data phase.*
- void qspiStartSend (QSPIDriver ∗qspip, const qspi_command_t ∗cmdp, size_t n, const uint8_t ∗txbuf)

  *Sends a command with data over the QSPI bus.*
- void qspiStartReceive (QSPIDriver ∗qspip, const qspi_command_t ∗cmdp, size_t n, uint8_t ∗rxbuf)

  *Sends a command then receives data over the QSPI bus.*
- void qspiCommand (QSPIDriver ∗qspip, const qspi_command_t ∗cmdp)

  *Sends a command without data phase.*
- void qspiSend (QSPIDriver ∗qspip, const qspi_command_t ∗cmdp, size_t n, const uint8_t ∗txbuf)

  *Sends a command with data over the QSPI bus.*
- void qspiReceive (QSPIDriver ∗qspip, const qspi_command_t ∗cmdp, size_t n, uint8_t ∗rxbuf)

  *Sends a command then receives data over the QSPI bus.*
- void qspiMapFlash (QSPIDriver ∗qspip, const qspi_command_t ∗cmdp, uint8_t ∗∗addrp)

  *Maps in memory space a QSPI flash device.*
- void qspiUnmapFlash (QSPIDriver ∗qspip)

  *Unmaps from memory space a QSPI flash device.*
- void qspiAcquireBus (QSPIDriver ∗qspip)

  *Gains exclusive access to the QSPI bus.*
- void qspiReleaseBus (QSPIDriver ∗qspip)

  *Releases exclusive access to the QSPI bus.*

### 9.74.1 Detailed Description

QSPI Driver macros and structures.

## 9.75 hal_qspi_lld.c File Reference

PLATFORM QSPI subsystem low level driver source.

```
#include "hal.h"
```

### Functions

- void qspi_lld_init (void)

  *Low level QSPI driver initialization.*
- void qspi_lld_start (QSPIDriver ∗qspip)

  *Configures and activates the QSPI peripheral.*

- void qspi_lld_stop (QSPIDriver ∗qspip)

  *Deactivates the QSPI peripheral.*
- void qspi_lld_command (QSPIDriver ∗qspip, const qspi_command_t ∗cmdp)

  *Sends a command without data phase.*
- void qspi_lld_send (QSPIDriver ∗qspip, const qspi_command_t ∗cmdp, size_t n, const uint8_t ∗txbuf)

  *Sends a command with data over the QSPI bus.*
- void qspi_lld_receive (QSPIDriver ∗qspip, const qspi_command_t ∗cmdp, size_t n, uint8_t ∗rxbuf)

  *Sends a command then receives data over the QSPI bus.*
- void qspi_lld_map_flash (QSPIDriver ∗qspip, const qspi_command_t ∗cmdp, uint8_t ∗∗addrp)

  *Maps in memory space a QSPI flash device.*
- void qspi_lld_unmap_flash (QSPIDriver ∗qspip)

  *Unmaps from memory space a QSPI flash device.*

### Variables

- QSPIDriver QSPID1

  *QSPID1 driver identifier.*

### 9.75.1 Detailed Description

PLATFORM QSPI subsystem low level driver source.

## 9.76 hal_qspi_lld.h File Reference

PLATFORM QSPI subsystem low level driver header.

### Data Structures

- struct QSPIConfig

  *Driver configuration structure.*
- struct QSPIDriver

  *Structure representing an QSPI driver.*

### Macros

#### QSPI capabilities

- #define **QSPI_SUPPORTS_MEMMAP** TRUE

#### Configuration options

- #define PLATFORM_QSPI_USE_QSPI1 FALSE

  *QSPID1 driver enable switch.*

### Typedefs

- typedef struct QSPIDriver QSPIDriver

  *Type of a structure representing an QSPI driver.*
- typedef void(∗ qspicallback_t) (QSPIDriver ∗qspip)

  *Type of a QSPI notification callback.*

### Functions

- void qspi_lld_init (void)

  *Low level QSPI driver initialization.*
- void qspi_lld_start (QSPIDriver ∗qspip)

  *Configures and activates the QSPI peripheral.*
- void qspi_lld_stop (QSPIDriver ∗qspip)

  *Deactivates the QSPI peripheral.*
- void qspi_lld_command (QSPIDriver ∗qspip, const qspi_command_t ∗cmdp)

  *Sends a command without data phase.*
- void qspi_lld_send (QSPIDriver ∗qspip, const qspi_command_t ∗cmdp, size_t n, const uint8_t ∗txbuf)

  *Sends a command with data over the QSPI bus.*
- void qspi_lld_receive (QSPIDriver ∗qspip, const qspi_command_t ∗cmdp, size_t n, uint8_t ∗rxbuf)

  *Sends a command then receives data over the QSPI bus.*
- void qspi_lld_map_flash (QSPIDriver ∗qspip, const qspi_command_t ∗cmdp, uint8_t ∗∗addrp)

  *Maps in memory space a QSPI flash device.*
- void qspi_lld_unmap_flash (QSPIDriver ∗qspip)

  *Unmaps from memory space a QSPI flash device.*

### 9.76.1 Detailed Description

PLATFORM QSPI subsystem low level driver header.

## 9.77 hal_queues.c File Reference

I/O Queues code.

```
#include <string.h>
#include "hal.h"
```

### Functions

- static size_t iq_read (input_queue_t ∗iqp, uint8_t ∗bp, size_t n)

  *Non-blocking input queue read.*
- static size_t oq_write (output_queue_t ∗oqp, const uint8_t ∗bp, size_t n)

  *Non-blocking output queue write.*
- void iqObjectInit (input_queue_t ∗iqp, uint8_t ∗bp, size_t size, qnotify_t infy, void ∗link)

  *Initializes an input queue.*
- void iqResetI (input_queue_t ∗iqp)

  *Resets an input queue.*
- msg_t iqPutI (input_queue_t ∗iqp, uint8_t b)

  *Input queue write.*
- msg_t iqGetI (input_queue_t ∗iqp)

  *Input queue non-blocking read.*
- msg_t iqGetTimeout (input_queue_t ∗iqp, sysinterval_t timeout)

  *Input queue read with timeout.*
- size_t iqReadI (input_queue_t ∗iqp, uint8_t ∗bp, size_t n)

  *Input queue non-blocking read.*
- size_t iqReadTimeout (input_queue_t ∗iqp, uint8_t ∗bp, size_t n, sysinterval_t timeout)

*Input queue read with timeout.*
- void oqObjectInit (output_queue_t ∗oqp, uint8_t ∗bp, size_t size, qnotify_t onfy, void ∗link)

  *Initializes an output queue.*
- void oqResetI (output_queue_t ∗oqp)

  *Resets an output queue.*
- msg_t oqPutI (output_queue_t ∗oqp, uint8_t b)

  *Output queue non-blocking write.*
- msg_t oqPutTimeout (output_queue_t ∗oqp, uint8_t b, sysinterval_t timeout)

  *Output queue write with timeout.*
- msg_t oqGetI (output_queue_t ∗oqp)

  *Output queue read.*
- size_t oqWriteI (output_queue_t ∗oqp, const uint8_t ∗bp, size_t n)

  *Output queue non-blocking write.*
- size_t oqWriteTimeout (output_queue_t ∗oqp, const uint8_t ∗bp, size_t n, sysinterval_t timeout)

  *Output queue write with timeout.*

### 9.77.1 Detailed Description

I/O Queues code.

## 9.78 hal_queues.h File Reference

I/O Queues macros and structures.

### Data Structures

- struct io_queue

  *Generic I/O queue structure.*

### Macros

**Queue functions returned status value**

- #define Q_OK MSG_OK

  *Operation successful.*
- #define Q_TIMEOUT MSG_TIMEOUT

  *Timeout condition.*
- #define Q_RESET MSG_RESET

  *Queue has been reset.*
- #define Q_EMPTY MSG_TIMEOUT

  *Queue empty.*
- #define Q_FULL MSG_TIMEOUT

  *Queue full,.*

**Macro Functions**

- #define qSizeX(qp)

  *Returns the queue's buffer size.*
- #define qSpaceI(qp) ((qp)->q_counter)

  *Queue space.*
- #define qGetLink(qp) ((qp)->q_link)

  *Returns the queue application-defined link.*

- #define iqGetFullI(iqp) qSpaceI(iqp)

  *Returns the filled space into an input queue.*
- #define iqGetEmptyI(iqp) (qSizeX(iqp) - qSpaceI(iqp))

  *Returns the empty space into an input queue.*
- #define iqIsEmptyI(iqp) ((bool)(qSpaceI(iqp) == 0U))

  *Evaluates to `true` if the specified input queue is empty.*
- #define iqIsFullI(iqp)

  *Evaluates to `true` if the specified input queue is full.*
- #define iqGet(iqp) iqGetTimeout(iqp, TIME_INFINITE)

  *Input queue read.*
- #define oqGetFullI(oqp) (qSizeX(oqp) - qSpaceI(oqp))

  *Returns the filled space into an output queue.*
- #define oqGetEmptyI(oqp) qSpaceI(oqp)

  *Returns the empty space into an output queue.*
- #define oqIsEmptyI(oqp)

  *Evaluates to `true` if the specified output queue is empty.*
- #define oqIsFullI(oqp) ((bool)(qSpaceI(oqp) == 0U))

  *Evaluates to `true` if the specified output queue is full.*
- #define oqPut(oqp, b) oqPutTimeout(oqp, b, TIME_INFINITE)

  *Output queue write.*

## Typedefs

- typedef struct io_queue io_queue_t

  *Type of a generic I/O queue structure.*
- typedef void(∗ qnotify_t) (io_queue_t ∗qp)

  *Queue notification callback type.*
- typedef io_queue_t input_queue_t

  *Type of an input queue structure.*
- typedef io_queue_t output_queue_t

  *Type of an output queue structure.*

## Functions

- void iqObjectInit (input_queue_t ∗iqp, uint8_t ∗bp, size_t size, qnotify_t infy, void ∗link)

  *Initializes an input queue.*
- void iqResetI (input_queue_t ∗iqp)

  *Resets an input queue.*
- msg_t iqPutI (input_queue_t ∗iqp, uint8_t b)

  *Input queue write.*
- msg_t iqGetI (input_queue_t ∗iqp)

  *Input queue non-blocking read.*
- msg_t iqGetTimeout (input_queue_t ∗iqp, sysinterval_t timeout)

  *Input queue read with timeout.*
- size_t iqReadI (input_queue_t ∗iqp, uint8_t ∗bp, size_t n)

  *Input queue non-blocking read.*
- size_t iqReadTimeout (input_queue_t ∗iqp, uint8_t ∗bp, size_t n, sysinterval_t timeout)

  *Input queue read with timeout.*
- void oqObjectInit (output_queue_t ∗oqp, uint8_t ∗bp, size_t size, qnotify_t onfy, void ∗link)

  *Initializes an output queue.*
- void oqResetI (output_queue_t ∗oqp)

  *Resets an output queue.*
- msg_t oqPutI (output_queue_t ∗oqp, uint8_t b)

*Output queue non-blocking write.*

- msg_t oqPutTimeout (output_queue_t ∗oqp, uint8_t b, sysinterval_t timeout)

  *Output queue write with timeout.*
- msg_t oqGetI (output_queue_t ∗oqp)

  *Output queue read.*
- size_t oqWriteI (output_queue_t ∗oqp, const uint8_t ∗bp, size_t n)

  *Output queue non-blocking write.*
- size_t oqWriteTimeout (output_queue_t ∗oqp, const uint8_t ∗bp, size_t n, sysinterval_t timeout)

  *Output queue write with timeout.*

### 9.78.1 Detailed Description

I/O Queues macros and structures.

## 9.79 hal_rtc.c File Reference

RTC Driver code.

```
#include "hal.h"
```

### Functions

- void rtcInit (void)

  *RTC Driver initialization.*
- void rtcObjectInit (RTCDriver ∗rtcp)

  *Initializes a generic RTC driver object.*
- void rtcSetTime (RTCDriver ∗rtcp, const RTCDateTime ∗timespec)

  *Set current time.*
- void rtcGetTime (RTCDriver ∗rtcp, RTCDateTime ∗timespec)

  *Get current time.*
- void rtcSetAlarm (RTCDriver ∗rtcp, rtcalarm_t alarm, const RTCAlarm ∗alarmspec)

  *Set alarm time.*
- void rtcGetAlarm (RTCDriver ∗rtcp, rtcalarm_t alarm, RTCAlarm ∗alarmspec)

  *Get current alarm.*
- void rtcSetCallback (RTCDriver ∗rtcp, rtccb_t callback)

  *Enables or disables RTC callbacks.*
- void rtcConvertDateTimeToStructTm (const RTCDateTime ∗timespec, struct tm ∗timp, uint32_t ∗tv_msec)

  *Convert `RTCDateTime` to broken-down time structure.*
- void rtcConvertStructTmToDateTime (const struct tm ∗timp, uint32_t tv_msec, RTCDateTime ∗timespec)

  *Convert broken-down time structure to `RTCDateTime`.*
- uint32_t rtcConvertDateTimeToFAT (const RTCDateTime ∗timespec)

  *Get current time in format suitable for usage in FAT file system.*

### 9.79.1 Detailed Description

RTC Driver code.

## 9.80 hal_rtc.h File Reference

RTC Driver macros and structures.

```
#include <time.h>
#include "hal_rtc_lld.h"
```

### Data Structures

- struct RTCDateTime

  *Type of a structure representing an RTC date/time stamp.*

### Macros

- #define RTC_BASE_YEAR 1980U

  *Base year of the calendar.*

#### Date/Time bit masks for FAT format

- #define **RTC_FAT_TIME_SECONDS_MASK** 0x0000001FU
- #define **RTC_FAT_TIME_MINUTES_MASK** 0x000007E0U
- #define **RTC_FAT_TIME_HOURS_MASK** 0x0000F800U
- #define **RTC_FAT_DATE_DAYS_MASK** 0x001F0000U
- #define **RTC_FAT_DATE_MONTHS_MASK** 0x01E00000U
- #define **RTC_FAT_DATE_YEARS_MASK** 0xFE000000U

#### Day of week encoding

- #define **RTC_DAY_CATURDAY** 0U
- #define **RTC_DAY_MONDAY** 1U
- #define **RTC_DAY_TUESDAY** 2U
- #define **RTC_DAY_WEDNESDAY** 3U
- #define **RTC_DAY_THURSDAY** 4U
- #define **RTC_DAY_FRIDAY** 5U
- #define **RTC_DAY_SATURDAY** 6U
- #define **RTC_DAY_SUNDAY** 7U

### Typedefs

- typedef struct RTCDriver RTCDriver

  *Type of a structure representing an RTC driver.*

### Functions

- void rtcInit (void)

  *RTC Driver initialization.*
- void rtcObjectInit (RTCDriver ∗rtcp)

  *Initializes a generic RTC driver object.*
- void rtcSetTime (RTCDriver ∗rtcp, const RTCDateTime ∗timespec)

  *Set current time.*
- void rtcGetTime (RTCDriver ∗rtcp, RTCDateTime ∗timespec)

  *Get current time.*
- void rtcSetCallback (RTCDriver ∗rtcp, rtccb_t callback)

*Enables or disables RTC callbacks.*

- void rtcConvertDateTimeToStructTm (const RTCDateTime ∗timespec, struct tm ∗timp, uint32_t ∗tv_msec)

  *Convert `RTCDateTime` to broken-down time structure.*
- void rtcConvertStructTmToDateTime (const struct tm ∗timp, uint32_t tv_msec, RTCDateTime ∗timespec)

  *Convert broken-down time structure to `RTCDateTime`.*
- uint32_t rtcConvertDateTimeToFAT (const RTCDateTime ∗timespec)

  *Get current time in format suitable for usage in FAT file system.*

### 9.80.1 Detailed Description

RTC Driver macros and structures.

## 9.81 hal_rtc_lld.c File Reference

PLATFORM RTC subsystem low level driver source.

```
#include "hal.h"
```

### Functions

- void rtc_lld_init (void)

  *RTC driver identifier.*
- void rtc_lld_set_time (RTCDriver ∗rtcp, const RTCDateTime ∗timespec)

  *Set current time.*
- void rtc_lld_get_time (RTCDriver ∗rtcp, RTCDateTime ∗timespec)

  *Get current time.*
- void rtc_lld_set_alarm (RTCDriver ∗rtcp, rtcalarm_t alarm, const RTCAlarm ∗alarmspec)

  *Set alarm time.*
- void rtc_lld_get_alarm (RTCDriver ∗rtcp, rtcalarm_t alarm, RTCAlarm ∗alarmspec)

  *Get alarm time.*

### 9.81.1 Detailed Description

PLATFORM RTC subsystem low level driver source.

## 9.82 hal_rtc_lld.h File Reference

PLATFORM RTC subsystem low level driver header.

### Data Structures

- struct RTCAlarm

  *Type of a structure representing an RTC alarm time stamp.*
- struct RTCDriverVMT

  *`RTCDriver` virtual methods table.*
- struct RTCDriver

  *Structure representing an RTC driver.*

### Macros

- #define _rtc_driver_methods _file_stream_methods

  *FileStream specific methods.*

**Implementation capabilities**

- #define RTC_SUPPORTS_CALLBACKS TRUE

  *Callback support int the driver.*
- #define RTC_ALARMS 2

  *Number of alarms available.*
- #define RTC_HAS_STORAGE FALSE

  *Presence of a local persistent storage.*

**PLATFORM configuration options**

- #define PLATFORM_RTC_USE_RTC1 FALSE

  *RTCD1 driver enable switch.*

### Typedefs

- typedef uint32_t rtcalarm_t

  *Type of an RTC alarm number.*
- typedef void(∗ rtccb_t) (RTCDriver ∗rtcp, rtcevent_t event)

  *Type of a generic RTC callback.*

### Enumerations

### Functions

- void rtc_lld_init (void)

  *RTC driver identifier.*
- void rtc_lld_set_time (RTCDriver ∗rtcp, const RTCDateTime ∗timespec)

  *Set current time.*
- void rtc_lld_get_time (RTCDriver ∗rtcp, RTCDateTime ∗timespec)

  *Get current time.*
- void rtc_lld_set_alarm (RTCDriver ∗rtcp, rtcalarm_t alarm, const RTCAlarm ∗alarmspec)

  *Set alarm time.*
- void rtc_lld_get_alarm (RTCDriver ∗rtcp, rtcalarm_t alarm, RTCAlarm ∗alarmspec)

  *Get alarm time.*

### 9.82.1 Detailed Description

PLATFORM RTC subsystem low level driver header.

## 9.83 hal_sdc.c File Reference

SDC Driver code.

```
#include <string.h>
#include "hal.h"
```

## Enumerations

## Functions

- static bool mode_detect (SDCDriver ∗sdcp)

  *Detects card mode.*
- static bool mmc_init (SDCDriver ∗sdcp)

  *Init procedure for MMC.*
- static bool sdc_init (SDCDriver ∗sdcp)

  *Init procedure for SDC.*
- static uint32_t mmc_cmd6_construct (mmc_switch_t access, uint32_t idx, uint32_t value, uint32_t cmd_set)

  *Constructs CMD6 argument for MMC.*
- static uint32_t sdc_cmd6_construct (sd_switch_t mode, sd_switch_function_t function, uint32_t value)

  *Constructs CMD6 argument for SDC.*
- static uint16_t sdc_cmd6_extract_info (sd_switch_function_t function, const uint8_t ∗buf)

  *Extracts information from CMD6 answer.*
- static bool sdc_cmd6_check_status (sd_switch_function_t function, const uint8_t ∗buf)

  *Checks status after switching using CMD6.*
- static bool sdc_detect_bus_clk (SDCDriver ∗sdcp, sdcbusclk_t ∗clk)

  *Reads supported bus clock and switch SDC to appropriate mode.*
- static bool mmc_detect_bus_clk (SDCDriver ∗sdcp, sdcbusclk_t ∗clk)

  *Reads supported bus clock and switch MMC to appropriate mode.*
- static bool detect_bus_clk (SDCDriver ∗sdcp, sdcbusclk_t ∗clk)

  *Reads supported bus clock and switch card to appropriate mode.*
- static bool sdc_set_bus_width (SDCDriver ∗sdcp)

  *Sets bus width for SDC.*
- static bool mmc_set_bus_width (SDCDriver ∗sdcp)

  *Sets bus width for MMC.*
- bool _sdc_wait_for_transfer_state (SDCDriver ∗sdcp)

  *Wait for the card to complete pending operations.*
- void sdcInit (void)

  *SDC Driver initialization.*
- void sdcObjectInit (SDCDriver ∗sdcp)

  *Initializes the standard part of a `SDCDriver` structure.*
- void sdcStart (SDCDriver ∗sdcp, const SDCConfig ∗config)

  *Configures and activates the SDC peripheral.*
- void sdcStop (SDCDriver ∗sdcp)

  *Deactivates the SDC peripheral.*
- bool sdcConnect (SDCDriver ∗sdcp)

  *Performs the initialization procedure on the inserted card.*
- bool sdcDisconnect (SDCDriver ∗sdcp)

  *Brings the driver in a state safe for card removal.*
- bool sdcRead (SDCDriver ∗sdcp, uint32_t startblk, uint8_t ∗buf, uint32_t n)

  *Reads one or more blocks.*
- bool sdcWrite (SDCDriver ∗sdcp, uint32_t startblk, const uint8_t ∗buf, uint32_t n)

  *Writes one or more blocks.*
- sdcflags_t sdcGetAndClearErrors (SDCDriver ∗sdcp)

  *Returns the errors mask associated to the previous operation.*
- bool sdcSync (SDCDriver ∗sdcp)

  *Waits for card idle condition.*
- bool sdcGetInfo (SDCDriver ∗sdcp, BlockDeviceInfo ∗bdip)

  *Returns the media info.*
- bool sdcErase (SDCDriver ∗sdcp, uint32_t startblk, uint32_t endblk)

  *Erases the supplied blocks.*

## Variables

- static const struct SDCDriverVMT sdc_vmt

  *Virtual methods table.*

### 9.83.1 Detailed Description

SDC Driver code.

## 9.84 hal_sdc.h File Reference

SDC Driver macros and structures.

```
#include "hal_sdc_lld.h"
```

## Macros

**SD card types**

- #define **SDC_MODE_CARDTYPE_MASK** 0xFU
- #define **SDC_MODE_CARDTYPE_SDV11** 0U
- #define **SDC_MODE_CARDTYPE_SDV20** 1U
- #define **SDC_MODE_CARDTYPE_MMC** 2U
- #define **SDC_MODE_HIGH_CAPACITY** 0x10U

**SDC bus error conditions**

- #define **SDC_NO_ERROR** 0U
- #define **SDC_CMD_CRC_ERROR** 1U
- #define **SDC_DATA_CRC_ERROR** 2U
- #define **SDC_DATA_TIMEOUT** 4U
- #define **SDC_COMMAND_TIMEOUT** 8U
- #define **SDC_TX_UNDERRUN** 16U
- #define **SDC_RX_OVERRUN** 32U
- #define **SDC_STARTBIT_ERROR** 64U
- #define **SDC_OVERFLOW_ERROR** 128U
- #define **SDC_UNHANDLED_ERROR** 0xFFFFFFFFU

**SDC configuration options**

- #define SDC_INIT_RETRY 100

  *Number of initialization attempts before rejecting the card.*
- #define SDC_MMC_SUPPORT FALSE

  *Include support for MMC cards.*
- #define SDC_NICE_WAITING TRUE

  *Delays insertions.*
- #define SDC_INIT_OCR_V20 0x50FF8000U

  *OCR initialization constant for V20 cards.*
- #define SDC_INIT_OCR 0x80100000U

  *OCR initialization constant for non-V20 cards.*

**Macro Functions**

- #define sdcIsCardInserted(sdcp) (sdc_lld_is_card_inserted(sdcp))

  *Returns the card insertion status.*
- #define sdcIsWriteProtected(sdcp) (sdc_lld_is_write_protected(sdcp))

  *Returns the write protect status.*

### Enumerations

### Functions

- void sdcInit (void)

  *SDC Driver initialization.*
- void sdcObjectInit (SDCDriver ∗sdcp)

  *Initializes the standard part of a `SDCDriver` structure.*
- void sdcStart (SDCDriver ∗sdcp, const SDCConfig ∗config)

  *Configures and activates the SDC peripheral.*
- void sdcStop (SDCDriver ∗sdcp)

  *Deactivates the SDC peripheral.*
- bool sdcConnect (SDCDriver ∗sdcp)

  *Performs the initialization procedure on the inserted card.*
- bool sdcDisconnect (SDCDriver ∗sdcp)

  *Brings the driver in a state safe for card removal.*
- bool sdcRead (SDCDriver ∗sdcp, uint32_t startblk, uint8_t ∗buf, uint32_t n)

  *Reads one or more blocks.*
- bool sdcWrite (SDCDriver ∗sdcp, uint32_t startblk, const uint8_t ∗buf, uint32_t n)

  *Writes one or more blocks.*
- sdcflags_t sdcGetAndClearErrors (SDCDriver ∗sdcp)

  *Returns the errors mask associated to the previous operation.*
- bool sdcSync (SDCDriver ∗sdcp)

  *Waits for card idle condition.*
- bool sdcGetInfo (SDCDriver ∗sdcp, BlockDeviceInfo ∗bdip)

  *Returns the media info.*
- bool sdcErase (SDCDriver ∗sdcp, uint32_t startblk, uint32_t endblk)

  *Erases the supplied blocks.*
- bool _sdc_wait_for_transfer_state (SDCDriver ∗sdcp)

  *Wait for the card to complete pending operations.*

### 9.84.1 Detailed Description

SDC Driver macros and structures.

## 9.85 hal_sdc_lld.c File Reference

PLATFORM SDC subsystem low level driver source.

```
#include "hal.h"
```

### Functions

- void sdc_lld_init (void)

  *Low level SDC driver initialization.*
- void sdc_lld_start (SDCDriver ∗sdcp)

  *Configures and activates the SDC peripheral.*
- void sdc_lld_stop (SDCDriver ∗sdcp)

  *Deactivates the SDC peripheral.*

- void sdc_lld_start_clk (SDCDriver ∗sdcp)

  *Starts the SDIO clock and sets it to init mode (400kHz or less).*
- void sdc_lld_set_data_clk (SDCDriver ∗sdcp, sdcbusclk_t clk)

  *Sets the SDIO clock to data mode (25MHz or less).*
- void sdc_lld_stop_clk (SDCDriver ∗sdcp)

  *Stops the SDIO clock.*
- void sdc_lld_set_bus_mode (SDCDriver ∗sdcp, sdcbusmode_t mode)

  *Switches the bus to 4 bits mode.*
- void sdc_lld_send_cmd_none (SDCDriver ∗sdcp, uint8_t cmd, uint32_t arg)

  *Sends an SDIO command with no response expected.*
- bool sdc_lld_send_cmd_short (SDCDriver ∗sdcp, uint8_t cmd, uint32_t arg, uint32_t ∗resp)

  *Sends an SDIO command with a short response expected.*
- bool sdc_lld_send_cmd_short_crc (SDCDriver ∗sdcp, uint8_t cmd, uint32_t arg, uint32_t ∗resp)

  *Sends an SDIO command with a short response expected and CRC.*
- bool sdc_lld_send_cmd_long_crc (SDCDriver ∗sdcp, uint8_t cmd, uint32_t arg, uint32_t ∗resp)

  *Sends an SDIO command with a long response expected and CRC.*
- bool sdc_lld_read (SDCDriver ∗sdcp, uint32_t startblk, uint8_t ∗buf, uint32_t n)

  *Reads one or more blocks.*
- bool sdc_lld_write (SDCDriver ∗sdcp, uint32_t startblk, const uint8_t ∗buf, uint32_t n)

  *Writes one or more blocks.*
- bool sdc_lld_sync (SDCDriver ∗sdcp)

  *Waits for card idle condition.*

### Variables

- SDCDriver SDCD1

  *SDCD1 driver identifier.*

### 9.85.1 Detailed Description

PLATFORM SDC subsystem low level driver source.

## 9.86 hal_sdc_lld.h File Reference

PLATFORM SDC subsystem low level driver header.

### Data Structures

- struct SDCConfig

  *Driver configuration structure.*
- struct SDCDriverVMT

  `SDCDriver` *virtual methods table.*
- struct SDCDriver

  *Structure representing an SDC driver.*

## Macros

- #define _sdc_driver_methods _mmcsd_block_device_methods

  *`SDCDriver` specific methods.*

### PLATFORM configuration options

- #define PLATFORM_SDC_USE_SDC1 FALSE

  *PWMD1 driver enable switch.*

## Typedefs

- typedef uint32_t sdcmode_t

  *Type of card flags.*
- typedef uint32_t sdcflags_t

  *SDC Driver condition flags type.*
- typedef struct SDCDriver SDCDriver

  *Type of a structure representing an SDC driver.*

## Functions

- void sdc_lld_init (void)

  *Low level SDC driver initialization.*
- void sdc_lld_start (SDCDriver ∗sdcp)

  *Configures and activates the SDC peripheral.*
- void sdc_lld_stop (SDCDriver ∗sdcp)

  *Deactivates the SDC peripheral.*
- void sdc_lld_start_clk (SDCDriver ∗sdcp)

  *Starts the SDIO clock and sets it to init mode (400kHz or less).*
- void sdc_lld_set_data_clk (SDCDriver ∗sdcp, sdcbusclk_t clk)

  *Sets the SDIO clock to data mode (25MHz or less).*
- void sdc_lld_stop_clk (SDCDriver ∗sdcp)

  *Stops the SDIO clock.*
- void sdc_lld_set_bus_mode (SDCDriver ∗sdcp, sdcbusmode_t mode)

  *Switches the bus to 4 bits mode.*
- void sdc_lld_send_cmd_none (SDCDriver ∗sdcp, uint8_t cmd, uint32_t arg)

  *Sends an SDIO command with no response expected.*
- bool sdc_lld_send_cmd_short (SDCDriver ∗sdcp, uint8_t cmd, uint32_t arg, uint32_t ∗resp)

  *Sends an SDIO command with a short response expected.*
- bool sdc_lld_send_cmd_short_crc (SDCDriver ∗sdcp, uint8_t cmd, uint32_t arg, uint32_t ∗resp)

  *Sends an SDIO command with a short response expected and CRC.*
- bool sdc_lld_send_cmd_long_crc (SDCDriver ∗sdcp, uint8_t cmd, uint32_t arg, uint32_t ∗resp)

  *Sends an SDIO command with a long response expected and CRC.*
- bool sdc_lld_read (SDCDriver ∗sdcp, uint32_t startblk, uint8_t ∗buf, uint32_t n)

  *Reads one or more blocks.*
- bool sdc_lld_write (SDCDriver ∗sdcp, uint32_t startblk, const uint8_t ∗buf, uint32_t n)

  *Writes one or more blocks.*
- bool sdc_lld_sync (SDCDriver ∗sdcp)

  *Waits for card idle condition.*

### 9.86.1 Detailed Description

PLATFORM SDC subsystem low level driver header.

## 9.87 hal_sensors.h File Reference

Generic sensors interface header.

### Data Structures

- struct BaseSensorVMT

  *BaseSensor virtual methods table.*
- struct BaseSensor

  *Base stream class.*

### Macros

- #define _base_sensor_methods_alone

  *BaseSensor specific methods.*
- #define _base_sensor_methods

  *BaseSensor specific methods with inherited ones.*
- #define _base_sensor_data

  *BaseSensor specific data.*

**Macro Functions (BaseSensor)**

- #define sensorGetChannelNumber(ip) (ip)->vmt->get_channels_number(ip)

  *Sensors get channels number.*
- #define sensorReadRaw(ip, dp) (ip)->vmt->read_raw(ip, dp)

  *Sensors read raw data.*
- #define sensorReadCooked(ip, dp) (ip)->vmt->read_cooked(ip, dp)

  *Sensors read cooked data.*

### 9.87.1 Detailed Description

Generic sensors interface header.

## 9.88 hal_serial.c File Reference

Serial Driver code.

```
#include "hal.h"
```

### Functions

- void sdInit (void)

  *Serial Driver initialization.*
- void sdObjectInit (SerialDriver ∗sdp, qnotify_t inotify, qnotify_t onotify)

  *Initializes a generic full duplex driver object.*

- void sdStart (SerialDriver ∗sdp, const SerialConfig ∗config)

    *Configures and starts the driver.*
- void sdStop (SerialDriver ∗sdp)

    *Stops the driver.*
- void sdIncomingDataI (SerialDriver ∗sdp, uint8_t b)

    *Handles incoming data.*
- msg_t sdRequestDataI (SerialDriver ∗sdp)

    *Handles outgoing data.*
- bool sdPutWouldBlock (SerialDriver ∗sdp)

    *Direct output check on a `SerialDriver`.*
- bool sdGetWouldBlock (SerialDriver ∗sdp)

    *Direct input check on a `SerialDriver`.*
- msg_t sdControl (SerialDriver ∗sdp, unsigned int operation, void ∗arg)

    *Control operation on a serial port.*

### 9.88.1 Detailed Description

Serial Driver code.

## 9.89 hal_serial.h File Reference

Serial Driver macros and structures.

```
#include "hal_serial_lld.h"
```

### Data Structures

- struct SerialDriverVMT

    *`SerialDriver` virtual methods table.*
- struct SerialDriver

    *Full duplex serial driver class.*

### Macros

- #define _serial_driver_methods _base_asynchronous_channel_methods

    *`SerialDriver` specific methods.*

**Serial status flags**

- #define SD_PARITY_ERROR (eventflags_t)32

    *Parity.*
- #define SD_FRAMING_ERROR (eventflags_t)64

    *Framing.*
- #define SD_OVERRUN_ERROR (eventflags_t)128

    *Overflow.*
- #define SD_NOISE_ERROR (eventflags_t)256

    *Line noise.*
- #define SD_BREAK_DETECTED (eventflags_t)512

    *LIN Break.*
- #define SD_QUEUE_FULL_ERROR (eventflags_t)1024

    *Queue full.*

### Serial configuration options

- #define SERIAL_DEFAULT_BITRATE 38400

  *Default bit rate.*
- #define SERIAL_BUFFERS_SIZE 16

  *Serial buffers size.*

### Macro Functions

- #define sdPutI(sdp, b) oqPutI(&(sdp)->oqueue, b)

  *Direct write to a `SerialDriver`.*
- #define sdPut(sdp, b) oqPut(&(sdp)->oqueue, b)

  *Direct write to a `SerialDriver`.*
- #define sdPutTimeout(sdp, b, t) oqPutTimeout(&(sdp)->oqueue, b, t)

  *Direct write to a `SerialDriver` with timeout specification.*
- #define sdGetI(sdp) iqGetI(&(sdp)->iqueue)

  *Direct read from a `SerialDriver`.*
- #define sdGet(sdp) iqGet(&(sdp)->iqueue)

  *Direct read from a `SerialDriver`.*
- #define sdGetTimeout(sdp, t) iqGetTimeout(&(sdp)->iqueue, t)

  *Direct read from a `SerialDriver` with timeout specification.*
- #define sdWriteI(sdp, b, n) oqWriteI(&(sdp)->oqueue, b, n)

  *Direct blocking write to a `SerialDriver`.*
- #define sdWrite(sdp, b, n) oqWriteTimeout(&(sdp)->oqueue, b, n, TIME_INFINITE)

  *Direct blocking write to a `SerialDriver`.*
- #define sdWriteTimeout(sdp, b, n, t) oqWriteTimeout(&(sdp)->oqueue, b, n, t)

  *Direct blocking write to a `SerialDriver` with timeout specification.*
- #define sdAsynchronousWrite(sdp, b, n) oqWriteTimeout(&(sdp)->oqueue, b, n, TIME_IMMEDIATE)

  *Direct non-blocking write to a `SerialDriver`.*
- #define sdReadI(sdp, b, n) iqReadI(&(sdp)->iqueue, b, n, TIME_INFINITE)

  *Direct blocking read from a `SerialDriver`.*
- #define sdRead(sdp, b, n) iqReadTimeout(&(sdp)->iqueue, b, n, TIME_INFINITE)

  *Direct blocking read from a `SerialDriver`.*
- #define sdReadTimeout(sdp, b, n, t) iqReadTimeout(&(sdp)->iqueue, b, n, t)

  *Direct blocking read from a `SerialDriver` with timeout specification.*
- #define sdAsynchronousRead(sdp, b, n) iqReadTimeout(&(sdp)->iqueue, b, n, TIME_IMMEDIATE)

  *Direct non-blocking read from a `SerialDriver`.*

## Typedefs

- typedef struct SerialDriver SerialDriver

  *Structure representing a serial driver.*

## Enumerations

## Functions

- void sdInit (void)

  *Serial Driver initialization.*
- void sdObjectInit (SerialDriver ∗sdp, qnotify_t inotify, qnotify_t onotify)

  *Initializes a generic full duplex driver object.*
- void sdStart (SerialDriver ∗sdp, const SerialConfig ∗config)

  *Configures and starts the driver.*
- void sdStop (SerialDriver ∗sdp)

  *Stops the driver.*

- void sdIncomingDataI (SerialDriver ∗sdp, uint8_t b)

  *Handles incoming data.*
- msg_t sdRequestDataI (SerialDriver ∗sdp)

  *Handles outgoing data.*
- bool sdPutWouldBlock (SerialDriver ∗sdp)

  *Direct output check on a `SerialDriver`.*
- bool sdGetWouldBlock (SerialDriver ∗sdp)

  *Direct input check on a `SerialDriver`.*
- msg_t sdControl (SerialDriver ∗sdp, unsigned int operation, void ∗arg)

  *Control operation on a serial port.*

### 9.89.1 Detailed Description

Serial Driver macros and structures.

## 9.90 hal_serial_lld.c File Reference

PLATFORM serial subsystem low level driver source.

```
#include "hal.h"
```

### Functions

- void sd_lld_init (void)

  *Low level serial driver initialization.*
- void sd_lld_start (SerialDriver ∗sdp, const SerialConfig ∗config)

  *Low level serial driver configuration and (re)start.*
- void sd_lld_stop (SerialDriver ∗sdp)

  *Low level serial driver stop.*

### Variables

- SerialDriver SD1

  *USART1 serial driver identifier.*
- static const SerialConfig default_config

  *Driver default configuration.*

### 9.90.1 Detailed Description

PLATFORM serial subsystem low level driver source.

## 9.91 hal_serial_lld.h File Reference

PLATFORM serial subsystem low level driver header.

### Data Structures

- struct SerialConfig

  *PLATFORM Serial Driver configuration structure.*

### Macros

- #define _serial_driver_data

  *`SerialDriver` specific data.*

#### PLATFORM configuration options

- #define PLATFORM_SERIAL_USE_USART1 FALSE

  *USART1 driver enable switch.*

### Functions

- void sd_lld_init (void)

  *Low level serial driver initialization.*
- void sd_lld_start (SerialDriver ∗sdp, const SerialConfig ∗config)

  *Low level serial driver configuration and (re)start.*
- void sd_lld_stop (SerialDriver ∗sdp)

  *Low level serial driver stop.*

### 9.91.1 Detailed Description

PLATFORM serial subsystem low level driver header.

## 9.92 hal_serial_usb.c File Reference

Serial over USB Driver code.

```
#include "hal.h"
```

### Functions

- static void ibnotify (io_buffers_queue_t ∗bqp)

  *Notification of empty buffer released into the input buffers queue.*
- static void obnotify (io_buffers_queue_t ∗bqp)

  *Notification of filled buffer inserted into the output buffers queue.*
- void sduInit (void)

  *Serial Driver initialization.*
- void sduObjectInit (SerialUSBDriver ∗sdup)

  *Initializes a generic full duplex driver object.*
- void sduStart (SerialUSBDriver ∗sdup, const SerialUSBConfig ∗config)

  *Configures and starts the driver.*
- void sduStop (SerialUSBDriver ∗sdup)

  *Stops the driver.*
- void sduSuspendHookI (SerialUSBDriver ∗sdup)

*USB device suspend handler.*
- void sduWakeupHookI (SerialUSBDriver ∗sdup)

  *USB device wakeup handler.*
- void sduConfigureHookI (SerialUSBDriver ∗sdup)

  *USB device configured handler.*
- bool sduRequestsHook (USBDriver ∗usbp)

  *Default requests hook.*
- void sduSOFHookI (SerialUSBDriver ∗sdup)

  *SOF handler.*
- void sduDataTransmitted (USBDriver ∗usbp, usbep_t ep)

  *Default data transmitted callback.*
- void sduDataReceived (USBDriver ∗usbp, usbep_t ep)

  *Default data received callback.*
- void sduInterruptTransmitted (USBDriver ∗usbp, usbep_t ep)

  *Default data received callback.*
- msg_t sduControl (USBDriver ∗usbp, unsigned int operation, void ∗arg)

  *Control operation on a serial USB port.*

### 9.92.1 Detailed Description

Serial over USB Driver code.

## 9.93 hal_serial_usb.h File Reference

Serial over USB Driver macros and structures.

```
#include "hal_usb_cdc.h"
```

### Data Structures

- struct SerialUSBConfig

  *Serial over USB Driver configuration structure.*
- struct SerialUSBDriverVMT

  *`SerialDriver` virtual methods table.*
- struct SerialUSBDriver

  *Full duplex serial driver class.*

### Macros

- #define _serial_usb_driver_data

  *`SerialDriver` specific data.*
- #define _serial_usb_driver_methods _base_asynchronous_channel_methods

  *`SerialUSBDriver` specific methods.*

**SERIAL_USB configuration options**

- #define SERIAL_USB_BUFFERS_SIZE 256

  *Serial over USB buffers size.*
- #define SERIAL_USB_BUFFERS_NUMBER 2

  *Serial over USB number of buffers.*

### Typedefs

- typedef struct SerialUSBDriver SerialUSBDriver

  *Structure representing a serial over USB driver.*

### Enumerations

### Functions

- void sduInit (void)

  *Serial Driver initialization.*
- void sduObjectInit (SerialUSBDriver ∗sdup)

  *Initializes a generic full duplex driver object.*
- void sduStart (SerialUSBDriver ∗sdup, const SerialUSBConfig ∗config)

  *Configures and starts the driver.*
- void sduStop (SerialUSBDriver ∗sdup)

  *Stops the driver.*
- void sduSuspendHookI (SerialUSBDriver ∗sdup)

  *USB device suspend handler.*
- void sduWakeupHookI (SerialUSBDriver ∗sdup)

  *USB device wakeup handler.*
- void sduConfigureHookI (SerialUSBDriver ∗sdup)

  *USB device configured handler.*
- bool sduRequestsHook (USBDriver ∗usbp)

  *Default requests hook.*
- void sduSOFHookI (SerialUSBDriver ∗sdup)

  *SOF handler.*
- void sduDataTransmitted (USBDriver ∗usbp, usbep_t ep)

  *Default data transmitted callback.*
- void sduDataReceived (USBDriver ∗usbp, usbep_t ep)

  *Default data received callback.*
- void sduInterruptTransmitted (USBDriver ∗usbp, usbep_t ep)

  *Default data received callback.*
- msg_t sduControl (USBDriver ∗usbp, unsigned int operation, void ∗arg)

  *Control operation on a serial USB port.*

### 9.93.1 Detailed Description

Serial over USB Driver macros and structures.

## 9.94 hal_spi.c File Reference

SPI Driver code.

```
#include "hal.h"
```

## Functions

- void spiInit (void)

  *SPI Driver initialization.*
- void spiObjectInit (SPIDriver ∗spip)

  *Initializes the standard part of a `SPIDriver` structure.*
- void spiStart (SPIDriver ∗spip, const SPIConfig ∗config)

  *Configures and activates the SPI peripheral.*
- void spiStop (SPIDriver ∗spip)

  *Deactivates the SPI peripheral.*
- void spiSelect (SPIDriver ∗spip)

  *Asserts the slave select signal and prepares for transfers.*
- void spiUnselect (SPIDriver ∗spip)

  *Deasserts the slave select signal.*
- void spiStartIgnore (SPIDriver ∗spip, size_t n)

  *Ignores data on the SPI bus.*
- void spiStartExchange (SPIDriver ∗spip, size_t n, const void ∗txbuf, void ∗rxbuf)

  *Exchanges data on the SPI bus.*
- void spiStartSend (SPIDriver ∗spip, size_t n, const void ∗txbuf)

  *Sends data over the SPI bus.*
- void spiStartReceive (SPIDriver ∗spip, size_t n, void ∗rxbuf)

  *Receives data from the SPI bus.*
- void spiAbortI (SPIDriver ∗spip)

  *Aborts the ongoing SPI operation.*
- void spiAbort (SPIDriver ∗spip)

  *Aborts the ongoing SPI operation, if any.*
- void spiIgnore (SPIDriver ∗spip, size_t n)

  *Ignores data on the SPI bus.*
- void spiExchange (SPIDriver ∗spip, size_t n, const void ∗txbuf, void ∗rxbuf)

  *Exchanges data on the SPI bus.*
- void spiSend (SPIDriver ∗spip, size_t n, const void ∗txbuf)

  *Sends data over the SPI bus.*
- void spiReceive (SPIDriver ∗spip, size_t n, void ∗rxbuf)

  *Receives data from the SPI bus.*
- void spiAcquireBus (SPIDriver ∗spip)

  *Gains exclusive access to the SPI bus.*
- void spiReleaseBus (SPIDriver ∗spip)

  *Releases exclusive access to the SPI bus.*

### 9.94.1 Detailed Description

SPI Driver code.

## 9.95 hal_spi.h File Reference

SPI Driver macros and structures.

```
#include "hal_spi_lld.h"
```

## Macros

### Chip Select modes

- #define **SPI_SELECT_MODE_NONE**
- #define **SPI_SELECT_MODE_PAD** 1 /∗∗ @brief Legacy mode. ∗/
- #define **SPI_SELECT_MODE_PORT** 2 /∗∗ @brief Fastest mode. ∗/
- #define **SPI_SELECT_MODE_LINE** 3 /∗∗ @brief Packed mode. ∗/
- #define **SPI_SELECT_MODE_LLD** 4 /∗∗ @brief LLD-defined mode.∗/

### SPI configuration options

- #define SPI_USE_WAIT TRUE

  *Enables synchronous APIs.*
- #define SPI_USE_CIRCULAR FALSE

  *Enables circular transfers APIs.*
- #define SPI_USE_MUTUAL_EXCLUSION TRUE

  *Enables the `spiAcquireBus()` and `spiReleaseBus()` APIs.*
- #define SPI_SELECT_MODE SPI_SELECT_MODE_PAD

  *Handling method for SPI CS line.*

### Macro Functions

- #define spiSelectI(spip)

  *Asserts the slave select signal and prepares for transfers.*
- #define spiUnselectI(spip)

  *Deasserts the slave select signal.*
- #define spiStartIgnoreI(spip, n)

  *Ignores data on the SPI bus.*
- #define spiStartExchangeI(spip, n, txbuf, rxbuf)

  *Exchanges data on the SPI bus.*
- #define spiStartSendI(spip, n, txbuf)

  *Sends data over the SPI bus.*
- #define spiStartReceiveI(spip, n, rxbuf)

  *Receives data from the SPI bus.*
- #define spiPolledExchange(spip, frame) spi_lld_polled_exchange(spip, frame)

  *Exchanges one frame using a polled wait.*

### Low level driver helper macros

- #define _spi_wakeup_isr(spip)

  *Wakes up the waiting thread.*
- #define _spi_isr_code(spip)

  *Common ISR code.*
- #define _spi_isr_code_half1(spip)

  *Common ISR code in circular mode.*
- #define _spi_isr_code_half2(spip)

  *Common ISR code in circular mode.*

## Enumerations

## Functions

- void spiInit (void)

  *SPI Driver initialization.*
- void spiObjectInit (SPIDriver ∗spip)

  *Initializes the standard part of a `SPIDriver` structure.*

- void spiStart (SPIDriver ∗spip, const SPIConfig ∗config)

  *Configures and activates the SPI peripheral.*
- void spiStop (SPIDriver ∗spip)

  *Deactivates the SPI peripheral.*
- void spiSelect (SPIDriver ∗spip)

  *Asserts the slave select signal and prepares for transfers.*
- void spiUnselect (SPIDriver ∗spip)

  *Deasserts the slave select signal.*
- void spiStartIgnore (SPIDriver ∗spip, size_t n)

  *Ignores data on the SPI bus.*
- void spiStartExchange (SPIDriver ∗spip, size_t n, const void ∗txbuf, void ∗rxbuf)

  *Exchanges data on the SPI bus.*
- void spiStartSend (SPIDriver ∗spip, size_t n, const void ∗txbuf)

  *Sends data over the SPI bus.*
- void spiStartReceive (SPIDriver ∗spip, size_t n, void ∗rxbuf)

  *Receives data from the SPI bus.*
- void spiAbortI (SPIDriver ∗spip)

  *Aborts the ongoing SPI operation.*
- void spiAbort (SPIDriver ∗spip)

  *Aborts the ongoing SPI operation, if any.*
- void spiIgnore (SPIDriver ∗spip, size_t n)

  *Ignores data on the SPI bus.*
- void spiExchange (SPIDriver ∗spip, size_t n, const void ∗txbuf, void ∗rxbuf)

  *Exchanges data on the SPI bus.*
- void spiSend (SPIDriver ∗spip, size_t n, const void ∗txbuf)

  *Sends data over the SPI bus.*
- void spiReceive (SPIDriver ∗spip, size_t n, void ∗rxbuf)

  *Receives data from the SPI bus.*
- void spiAcquireBus (SPIDriver ∗spip)

  *Gains exclusive access to the SPI bus.*
- void spiReleaseBus (SPIDriver ∗spip)

  *Releases exclusive access to the SPI bus.*

### 9.95.1 Detailed Description

SPI Driver macros and structures.

## 9.96 hal_spi_lld.c File Reference

PLATFORM SPI subsystem low level driver source.

```
#include "hal.h"
```

### Functions

- void spi_lld_init (void)

  *Low level SPI driver initialization.*
- void spi_lld_start (SPIDriver ∗spip)

  *Configures and activates the SPI peripheral.*

- void spi_lld_stop (SPIDriver ∗spip)

  *Deactivates the SPI peripheral.*
- void spi_lld_select (SPIDriver ∗spip)

  *Asserts the slave select signal and prepares for transfers.*
- void spi_lld_unselect (SPIDriver ∗spip)

  *Deasserts the slave select signal.*
- void spi_lld_ignore (SPIDriver ∗spip, size_t n)

  *Ignores data on the SPI bus.*
- void spi_lld_exchange (SPIDriver ∗spip, size_t n, const void ∗txbuf, void ∗rxbuf)

  *Exchanges data on the SPI bus.*
- void spi_lld_send (SPIDriver ∗spip, size_t n, const void ∗txbuf)

  *Sends data over the SPI bus.*
- void spi_lld_receive (SPIDriver ∗spip, size_t n, void ∗rxbuf)

  *Receives data from the SPI bus.*
- void spi_lld_abort (SPIDriver ∗spip)

  *Aborts the ongoing SPI operation, if any.*
- uint16_t spi_lld_polled_exchange (SPIDriver ∗spip, uint16_t frame)

  *Exchanges one frame using a polled wait.*

### Variables

- SPIDriver SPID1

  *SPI1 driver identifier.*

### 9.96.1 Detailed Description

PLATFORM SPI subsystem low level driver source.

## 9.97 hal_spi_lld.h File Reference

PLATFORM SPI subsystem low level driver header.

### Data Structures

- struct SPIConfig

  *Driver configuration structure.*
- struct SPIDriver

  *Structure representing an SPI driver.*

### Macros

- #define SPI_SUPPORTS_CIRCULAR TRUE

  *Circular mode support flag.*

**PLATFORM configuration options**

- #define PLATFORM_SPI_USE_SPI1 FALSE

  *SPI1 driver enable switch.*

### Typedefs

- typedef struct SPIDriver SPIDriver

  *Type of a structure representing an SPI driver.*
- typedef void(∗ spicallback_t) (SPIDriver ∗spip)

  *SPI notification callback type.*

### Functions

- void spi_lld_init (void)

  *Low level SPI driver initialization.*
- void spi_lld_start (SPIDriver ∗spip)

  *Configures and activates the SPI peripheral.*
- void spi_lld_stop (SPIDriver ∗spip)

  *Deactivates the SPI peripheral.*
- void spi_lld_select (SPIDriver ∗spip)

  *Asserts the slave select signal and prepares for transfers.*
- void spi_lld_unselect (SPIDriver ∗spip)

  *Deasserts the slave select signal.*
- void spi_lld_ignore (SPIDriver ∗spip, size_t n)

  *Ignores data on the SPI bus.*
- void spi_lld_exchange (SPIDriver ∗spip, size_t n, const void ∗txbuf, void ∗rxbuf)

  *Exchanges data on the SPI bus.*
- void spi_lld_send (SPIDriver ∗spip, size_t n, const void ∗txbuf)

  *Sends data over the SPI bus.*
- void spi_lld_receive (SPIDriver ∗spip, size_t n, void ∗rxbuf)

  *Receives data from the SPI bus.*
- void spi_lld_abort (SPIDriver ∗spip)

  *Aborts the ongoing SPI operation, if any.*
- uint16_t spi_lld_polled_exchange (SPIDriver ∗spip, uint16_t frame)

  *Exchanges one frame using a polled wait.*

### 9.97.1 Detailed Description

PLATFORM SPI subsystem low level driver header.

## 9.98 hal_st.c File Reference

ST Driver code.

```
#include "hal.h"
```

### Functions

- void stInit (void)

  *ST Driver initialization.*
- void stStartAlarm (systime_t abstime)

  *Starts the alarm.*
- void stStopAlarm (void)

*Stops the alarm interrupt.*
- void stSetAlarm (systime_t abstime)

  *Sets the alarm time.*
- systime_t stGetAlarm (void)

  *Returns the current alarm time.*

### 9.98.1 Detailed Description

ST Driver code.

## 9.99 hal_st.h File Reference

ST Driver macros and structures.

```
#include "hal_st_lld.h"
```

### Macros

**Macro Functions**

- #define stGetCounter() st_lld_get_counter()

  *Returns the time counter value.*
- #define stIsAlarmActive() st_lld_is_alarm_active()

  *Determines if the alarm is active.*

### Functions

- void stInit (void)

  *ST Driver initialization.*
- void stStartAlarm (systime_t abstime)

  *Starts the alarm.*
- void stStopAlarm (void)

  *Stops the alarm interrupt.*
- void stSetAlarm (systime_t abstime)

  *Sets the alarm time.*
- systime_t stGetAlarm (void)

  *Returns the current alarm time.*

### 9.99.1 Detailed Description

ST Driver macros and structures.

This header is designed to be include-able without having to include other files from the HAL.

## 9.100 hal_st_lld.c File Reference

PLATFORM ST subsystem low level driver source.

```
#include "hal.h"
```

### Functions

- void st_lld_init (void)

  *Low level ST driver initialization.*

### 9.100.1 Detailed Description

PLATFORM ST subsystem low level driver source.

## 9.101 hal_st_lld.h File Reference

PLATFORM ST subsystem low level driver header.

### Functions

- void st_lld_init (void)

  *Low level ST driver initialization.*
- static systime_t st_lld_get_counter (void)

  *Returns the time counter value.*
- static void st_lld_start_alarm (systime_t abstime)

  *Starts the alarm.*
- static void st_lld_stop_alarm (void)

  *Stops the alarm interrupt.*
- static void st_lld_set_alarm (systime_t abstime)

  *Sets the alarm time.*
- static systime_t st_lld_get_alarm (void)

  *Returns the current alarm time.*
- static bool st_lld_is_alarm_active (void)

  *Determines if the alarm is active.*

### 9.101.1 Detailed Description

PLATFORM ST subsystem low level driver header.

This header is designed to be include-able without having to include other files from the HAL.

## 9.102 hal_streams.h File Reference

Data streams.

### Data Structures

- struct BaseSequentialStreamVMT

  `BaseSequentialStream` *virtual methods table.*
- struct BaseSequentialStream

  *Base stream class.*

## Macros

- #define _base_sequential_stream_methods

  *BaseSequentialStream specific methods.*
- #define _base_sequential_stream_data _base_object_data

  *BaseSequentialStream specific data.*

### Streams return codes

- #define **STM_OK** MSG_OK
- #define **STM_TIMEOUT** MSG_TIMEOUT
- #define **STM_RESET** MSG_RESET

### Macro Functions (BaseSequentialStream)

- #define streamWrite(ip, bp, n) ((ip)->vmt->write(ip, bp, n))

  *Sequential Stream write.*
- #define streamRead(ip, bp, n) ((ip)->vmt->read(ip, bp, n))

  *Sequential Stream read.*
- #define streamPut(ip, b) ((ip)->vmt->put(ip, b))

  *Sequential Stream blocking byte write.*
- #define streamGet(ip) ((ip)->vmt->get(ip))

  *Sequential Stream blocking byte read.*

### 9.102.1 Detailed Description

Data streams.

This header defines abstract interfaces useful to access generic data streams in a standardized way.

## 9.103 hal_thermometer.h File Reference

Generic thermometer interface header.

```
#include "hal_sensors.h"
```

## Data Structures

- struct BaseThermometerVMT

  *BaseThermometer virtual methods table.*
- struct BaseThermometer

  *Base thermometer class.*

## Macros

- #define _base_thermometer_methods_alone

  *BaseThermometer specific methods.*
- #define _base_thermometer_methods

  *BaseThermometer specific methods with inherited ones.*
- #define _base_thermometer_data _base_sensor_data

  *BaseThermometer specific data.*

**Macro Functions (BaseThermometer)**

- #define thermometerGetChannelsNumber(ip) (ip)->vmt->get_channels_number(ip)

  *Thermometer get channels number.*
- #define thermometerReadRaw(ip, dp) (ip)->vmt->read_raw(ip, dp)

  *Thermometer read raw data.*
- #define thermometerReadCooked(ip, dp) (ip)->vmt->read_cooked(ip, dp)

  *Thermometer read cooked data.*
- #define thermometerSetBias(ip, bp) (ip)->vmt->set_bias(ip, bp)

  *Updates thermometer bias data from received buffer.*
- #define thermometerResetBias(ip) (ip)->vmt->reset_bias(ip)

  *Reset thermometer bias data restoring it to zero.*
- #define thermometerSetSensitivity(ip, sp) (ip)->vmt->set_sensitivity(ip, sp)

  *Updates thermometer sensitivity data from received buffer.*
- #define thermometerResetSensitivity(ip) (ip)->vmt->reset_sensitivity(ip)

  *Reset thermometer sensitivity data restoring it to its typical value.*

### 9.103.1 Detailed Description

Generic thermometer interface header.

## 9.104 hal_uart.c File Reference

UART Driver code.

```
#include "hal.h"
```

### Functions

- void uartInit (void)

  *UART Driver initialization.*
- void uartObjectInit (UARTDriver ∗uartp)

  *Initializes the standard part of a `UARTDriver` structure.*
- void uartStart (UARTDriver ∗uartp, const UARTConfig ∗config)

  *Configures and activates the UART peripheral.*
- void uartStop (UARTDriver ∗uartp)

  *Deactivates the UART peripheral.*
- void uartStartSend (UARTDriver ∗uartp, size_t n, const void ∗txbuf)

  *Starts a transmission on the UART peripheral.*
- void uartStartSendI (UARTDriver ∗uartp, size_t n, const void ∗txbuf)

  *Starts a transmission on the UART peripheral.*
- size_t uartStopSend (UARTDriver ∗uartp)

  *Stops any ongoing transmission.*
- size_t uartStopSendI (UARTDriver ∗uartp)

  *Stops any ongoing transmission.*
- void uartStartReceive (UARTDriver ∗uartp, size_t n, void ∗rxbuf)

  *Starts a receive operation on the UART peripheral.*
- void uartStartReceiveI (UARTDriver ∗uartp, size_t n, void ∗rxbuf)

  *Starts a receive operation on the UART peripheral.*
- size_t uartStopReceive (UARTDriver ∗uartp)

  *Stops any ongoing receive operation.*

- size_t uartStopReceiveI (UARTDriver ∗uartp)

  *Stops any ongoing receive operation.*
- msg_t uartSendTimeout (UARTDriver ∗uartp, size_t ∗np, const void ∗txbuf, sysinterval_t timeout)

  *Performs a transmission on the UART peripheral.*
- msg_t uartSendFullTimeout (UARTDriver ∗uartp, size_t ∗np, const void ∗txbuf, sysinterval_t timeout)

  *Performs a transmission on the UART peripheral.*
- msg_t uartReceiveTimeout (UARTDriver ∗uartp, size_t ∗np, void ∗rxbuf, sysinterval_t timeout)

  *Performs a receive operation on the UART peripheral.*
- void uartAcquireBus (UARTDriver ∗uartp)

  *Gains exclusive access to the UART bus.*
- void uartReleaseBus (UARTDriver ∗uartp)

  *Releases exclusive access to the UART bus.*

### 9.104.1 Detailed Description

UART Driver code.

## 9.105 hal_uart.h File Reference

UART Driver macros and structures.

```
#include "hal_uart_lld.h"
```

### Macros

**UART status flags**

- #define UART_NO_ERROR 0

  *No pending conditions.*
- #define UART_PARITY_ERROR 4

  *Parity error happened.*
- #define UART_FRAMING_ERROR 8

  *Framing error happened.*
- #define UART_OVERRUN_ERROR 16

  *Overflow happened.*
- #define UART_NOISE_ERROR 32

  *Noise on the line.*
- #define UART_BREAK_DETECTED 64

  *Break detected.*

**UART error conditions**

- #define **UART_ERR_NOT_ACTIVE** (size_t)-1

**UART configuration options**

- #define UART_USE_WAIT FALSE

  *Enables synchronous APIs.*
- #define UART_USE_MUTUAL_EXCLUSION FALSE

  *Enables the `uartAcquireBus()` and `uartReleaseBus()` APIs.*

**Low level driver helper macros**

- #define _uart_wakeup_tx1_isr(uartp)

  *Wakes up the waiting thread in case of early TX complete.*
- #define _uart_wakeup_tx2_isr(uartp)

  *Wakes up the waiting thread in case of late TX complete.*
- #define _uart_wakeup_rx_complete_isr(uartp)

  *Wakes up the waiting thread in case of RX complete.*
- #define _uart_wakeup_rx_error_isr(uartp)

  *Wakes up the waiting thread in case of RX error.*
- #define _uart_wakeup_rx_timeout_isr(uartp)

  *Wakes up the waiting thread in case of RX timeout.*
- #define _uart_tx1_isr_code(uartp)

  *Common ISR code for early TX.*
- #define _uart_tx2_isr_code(uartp)

  *Common ISR code for late TX.*
- #define _uart_rx_complete_isr_code(uartp)

  *Common ISR code for RX complete.*
- #define _uart_rx_error_isr_code(uartp, errors)

  *Common ISR code for RX error.*
- #define _uart_rx_idle_code(uartp)

  *Common ISR code for RX on idle.*
- #define _uart_timeout_isr_code(uartp)

  *Timeout ISR code for receiver.*

## Enumerations

## Functions

- void uartInit (void)

  *UART Driver initialization.*
- void uartObjectInit (UARTDriver ∗uartp)

  *Initializes the standard part of a `UARTDriver` structure.*
- void uartStart (UARTDriver ∗uartp, const UARTConfig ∗config)

  *Configures and activates the UART peripheral.*
- void uartStop (UARTDriver ∗uartp)

  *Deactivates the UART peripheral.*
- void uartStartSend (UARTDriver ∗uartp, size_t n, const void ∗txbuf)

  *Starts a transmission on the UART peripheral.*
- void uartStartSendI (UARTDriver ∗uartp, size_t n, const void ∗txbuf)

  *Starts a transmission on the UART peripheral.*
- size_t uartStopSend (UARTDriver ∗uartp)

  *Stops any ongoing transmission.*
- size_t uartStopSendI (UARTDriver ∗uartp)

  *Stops any ongoing transmission.*
- void uartStartReceive (UARTDriver ∗uartp, size_t n, void ∗rxbuf)

  *Starts a receive operation on the UART peripheral.*
- void uartStartReceiveI (UARTDriver ∗uartp, size_t n, void ∗rxbuf)

  *Starts a receive operation on the UART peripheral.*
- size_t uartStopReceive (UARTDriver ∗uartp)

  *Stops any ongoing receive operation.*
- size_t uartStopReceiveI (UARTDriver ∗uartp)

  *Stops any ongoing receive operation.*
- msg_t uartSendTimeout (UARTDriver ∗uartp, size_t ∗np, const void ∗txbuf, sysinterval_t timeout)

  *Performs a transmission on the UART peripheral.*

- msg_t uartSendFullTimeout (UARTDriver ∗uartp, size_t ∗np, const void ∗txbuf, sysinterval_t timeout)

  *Performs a transmission on the UART peripheral.*
- msg_t uartReceiveTimeout (UARTDriver ∗uartp, size_t ∗np, void ∗rxbuf, sysinterval_t timeout)

  *Performs a receive operation on the UART peripheral.*
- void uartAcquireBus (UARTDriver ∗uartp)

  *Gains exclusive access to the UART bus.*
- void uartReleaseBus (UARTDriver ∗uartp)

  *Releases exclusive access to the UART bus.*

### 9.105.1 Detailed Description

UART Driver macros and structures.

## 9.106 hal_uart_lld.c File Reference

PLATFORM UART subsystem low level driver source.

```
#include "hal.h"
```

### Functions

- void uart_lld_init (void)

  *Low level UART driver initialization.*
- void uart_lld_start (UARTDriver ∗uartp)

  *Configures and activates the UART peripheral.*
- void uart_lld_stop (UARTDriver ∗uartp)

  *Deactivates the UART peripheral.*
- void uart_lld_start_send (UARTDriver ∗uartp, size_t n, const void ∗txbuf)

  *Starts a transmission on the UART peripheral.*
- size_t uart_lld_stop_send (UARTDriver ∗uartp)

  *Stops any ongoing transmission.*
- void uart_lld_start_receive (UARTDriver ∗uartp, size_t n, void ∗rxbuf)

  *Starts a receive operation on the UART peripheral.*
- size_t uart_lld_stop_receive (UARTDriver ∗uartp)

  *Stops any ongoing receive operation.*

### Variables

- UARTDriver UARTD1

  *UART1 driver identifier.*

### 9.106.1 Detailed Description

PLATFORM UART subsystem low level driver source.

## 9.107 hal_uart_lld.h File Reference

PLATFORM UART subsystem low level driver header.

## Data Structures

- struct UARTConfig

    *Driver configuration structure.*
- struct UARTDriver

    *Structure representing an UART driver.*

## Macros

### PLATFORM configuration options

- #define PLATFORM_UART_USE_UART1 FALSE

    *UART driver enable switch.*

## Typedefs

- typedef uint32_t uartflags_t

    *UART driver condition flags type.*
- typedef struct UARTDriver UARTDriver

    *Type of structure representing an UART driver.*
- typedef void(∗ uartcb_t) (UARTDriver ∗uartp)

    *Generic UART notification callback type.*
- typedef void(∗ uartccb_t) (UARTDriver ∗uartp, uint16_t c)

    *Character received UART notification callback type.*
- typedef void(∗ uartecb_t) (UARTDriver ∗uartp, uartflags_t e)

    *Receive error UART notification callback type.*

## Functions

- void uart_lld_init (void)

    *Low level UART driver initialization.*
- void uart_lld_start (UARTDriver ∗uartp)

    *Configures and activates the UART peripheral.*
- void uart_lld_stop (UARTDriver ∗uartp)

    *Deactivates the UART peripheral.*
- void uart_lld_start_send (UARTDriver ∗uartp, size_t n, const void ∗txbuf)

    *Starts a transmission on the UART peripheral.*
- size_t uart_lld_stop_send (UARTDriver ∗uartp)

    *Stops any ongoing transmission.*
- void uart_lld_start_receive (UARTDriver ∗uartp, size_t n, void ∗rxbuf)

    *Starts a receive operation on the UART peripheral.*
- size_t uart_lld_stop_receive (UARTDriver ∗uartp)

    *Stops any ongoing receive operation.*

### 9.107.1 Detailed Description

PLATFORM UART subsystem low level driver header.

## 9.108 hal_usb.c File Reference

USB Driver code.

```
#include <string.h>
#include "hal.h"
```

### Functions

- static void set_address (USBDriver ∗usbp)

  *SET ADDRESS transaction callback.*
- static bool default_handler (USBDriver ∗usbp)

  *Standard requests handler.*
- void usbInit (void)

  *USB Driver initialization.*
- void usbObjectInit (USBDriver ∗usbp)

  *Initializes the standard part of a `USBDriver` structure.*
- void usbStart (USBDriver ∗usbp, const USBConfig ∗config)

  *Configures and activates the USB peripheral.*
- void usbStop (USBDriver ∗usbp)

  *Deactivates the USB peripheral.*
- void usbInitEndpointI (USBDriver ∗usbp, usbep_t ep, const USBEndpointConfig ∗epcp)

  *Enables an endpoint.*
- void usbDisableEndpointsI (USBDriver ∗usbp)

  *Disables all the active endpoints.*
- void usbStartReceiveI (USBDriver ∗usbp, usbep_t ep, uint8_t ∗buf, size_t n)

  *Starts a receive transaction on an OUT endpoint.*
- void usbStartTransmitI (USBDriver ∗usbp, usbep_t ep, const uint8_t ∗buf, size_t n)

  *Starts a transmit transaction on an IN endpoint.*
- msg_t usbReceive (USBDriver ∗usbp, usbep_t ep, uint8_t ∗buf, size_t n)

  *Performs a receive transaction on an OUT endpoint.*
- msg_t usbTransmit (USBDriver ∗usbp, usbep_t ep, const uint8_t ∗buf, size_t n)

  *Performs a transmit transaction on an IN endpoint.*
- bool usbStallReceiveI (USBDriver ∗usbp, usbep_t ep)

  *Stalls an OUT endpoint.*
- bool usbStallTransmitI (USBDriver ∗usbp, usbep_t ep)

  *Stalls an IN endpoint.*
- void usbWakeupHost (USBDriver ∗usbp)

  *Host wake-up procedure.*
- void _usb_reset (USBDriver ∗usbp)

  *USB reset routine.*
- void _usb_suspend (USBDriver ∗usbp)

  *USB suspend routine.*
- void _usb_wakeup (USBDriver ∗usbp)

  *USB wake-up routine.*
- void _usb_ep0setup (USBDriver ∗usbp, usbep_t ep)

  *Default EP0 SETUP callback.*
- void _usb_ep0in (USBDriver ∗usbp, usbep_t ep)

  *Default EP0 IN callback.*
- void _usb_ep0out (USBDriver ∗usbp, usbep_t ep)

  *Default EP0 OUT callback.*

### 9.108.1 Detailed Description

USB Driver code.

## 9.109 hal_usb.h File Reference

USB Driver macros and structures.

```
#include "hal_usb_lld.h"
```

### Data Structures

- struct USBDescriptor

  *Type of an USB descriptor.*

### Macros

- #define USB_USE_WAIT FALSE

  *Enables synchronous APIs.*

**Helper macros for USB descriptors**

- #define USB_DESC_INDEX(i) ((uint8_t)(i))

  *Helper macro for index values into descriptor strings.*
- #define USB_DESC_BYTE(b) ((uint8_t)(b))

  *Helper macro for byte values into descriptor strings.*
- #define USB_DESC_WORD(w)

  *Helper macro for word values into descriptor strings.*
- #define USB_DESC_BCD(bcd)

  *Helper macro for BCD values into descriptor strings.*
- #define **USB_DESC_DEVICE_SIZE** 18U
- #define USB_DESC_DEVICE(bcdUSB, bDeviceClass, bDeviceSubClass, bDeviceProtocol, b↵ MaxPacketSize, idVendor, idProduct, bcdDevice, iManufacturer, iProduct, iSerialNumber, bNum↵ Configurations)

  *Device Descriptor helper macro.*
- #define USB_DESC_CONFIGURATION_SIZE 9U

  *Configuration Descriptor size.*
- #define USB_DESC_CONFIGURATION(wTotalLength, bNumInterfaces, bConfigurationValue, i↵ Configuration, bmAttributes, bMaxPower)

  *Configuration Descriptor helper macro.*
- #define USB_DESC_INTERFACE_SIZE 9U

  *Interface Descriptor size.*
- #define USB_DESC_INTERFACE(bInterfaceNumber, bAlternateSetting, bNumEndpoints, bInterface↵ Class, bInterfaceSubClass, bInterfaceProtocol, iInterface)

  *Interface Descriptor helper macro.*
- #define USB_DESC_INTERFACE_ASSOCIATION_SIZE 8U

  *Interface Association Descriptor size.*
- #define USB_DESC_INTERFACE_ASSOCIATION(bFirstInterface, bInterfaceCount, bFunctionClass, b↵ FunctionSubClass, bFunctionProcotol, iInterface)

  *Interface Association Descriptor helper macro.*
- #define USB_DESC_ENDPOINT_SIZE 7U

  *Endpoint Descriptor size.*
- #define USB_DESC_ENDPOINT(bEndpointAddress, bmAttributes, wMaxPacketSize, bInterval)

  *Endpoint Descriptor helper macro.*

### Endpoint types and settings

- #define USB_EP_MODE_TYPE 0x0003U
- #define USB_EP_MODE_TYPE_CTRL 0x0000U
- #define USB_EP_MODE_TYPE_ISOC 0x0001U
- #define USB_EP_MODE_TYPE_BULK 0x0002U
- #define USB_EP_MODE_TYPE_INTR 0x0003U

### Macro Functions

- #define usbGetDriverStateI(usbp) ((usbp)->state)

  *Returns the driver state.*
- #define usbConnectBus(usbp) usb_lld_connect_bus(usbp)

  *Connects the USB device.*
- #define usbDisconnectBus(usbp) usb_lld_disconnect_bus(usbp)

  *Disconnect the USB device.*
- #define usbGetFrameNumberX(usbp) usb_lld_get_frame_number(usbp)

  *Returns the current frame number.*
- #define usbGetTransmitStatusI(usbp, ep) (((usbp)->transmitting & (uint16_t)((unsigned)1U << (unsigned)(ep))) != 0U)

  *Returns the status of an IN endpoint.*
- #define usbGetReceiveStatusI(usbp, ep) (((usbp)->receiving & (uint16_t)((unsigned)1U << (unsigned)(ep))) != 0U)

  *Returns the status of an OUT endpoint.*
- #define usbGetReceiveTransactionSizeX(usbp, ep) usb_lld_get_transaction_size(usbp, ep)

  *Returns the exact size of a receive transaction.*
- #define usbSetupTransfer(usbp, buf, n, endcb)

  *Request transfer setup.*
- #define usbReadSetup(usbp, ep, buf) usb_lld_read_setup(usbp, ep, buf)

  *Reads a setup packet from the dedicated packet buffer.*

### Low level driver helper macros

- #define _usb_isr_invoke_event_cb(usbp, evt)

  *Common ISR code, usb event callback.*
- #define _usb_isr_invoke_sof_cb(usbp)

  *Common ISR code, SOF callback.*
- #define _usb_isr_invoke_setup_cb(usbp, ep)

  *Common ISR code, setup packet callback.*
- #define _usb_isr_invoke_in_cb(usbp, ep)

  *Common ISR code, IN endpoint callback.*
- #define _usb_isr_invoke_out_cb(usbp, ep)

  *Common ISR code, OUT endpoint event.*

## Typedefs

- typedef struct USBDriver USBDriver

  *Type of a structure representing an USB driver.*
- typedef uint8_t usbep_t

  *Type of an endpoint identifier.*
- typedef void(∗ usbcallback_t) (USBDriver ∗usbp)

  *Type of an USB generic notification callback.*
- typedef void(∗ usbepcallback_t) (USBDriver ∗usbp, usbep_t ep)

  *Type of an USB endpoint callback.*
- typedef void(∗ usbeventcb_t) (USBDriver ∗usbp, usbevent_t event)

  *Type of an USB event notification callback.*
- typedef bool(∗ usbreqhandler_t) (USBDriver ∗usbp)

*Type of a requests handler callback.*
- typedef const USBDescriptor ∗(∗ usbgetdescriptor_t) (USBDriver ∗usbp, uint8_t dtype, uint8_t dindex, uint16_t lang)

    *Type of an USB descriptor-retrieving callback.*

## Enumerations

## Functions

- void usbInit (void)

    *USB Driver initialization.*
- void usbObjectInit (USBDriver ∗usbp)

    *Initializes the standard part of a `USBDriver` structure.*
- void usbStart (USBDriver ∗usbp, const USBConfig ∗config)

    *Configures and activates the USB peripheral.*
- void usbStop (USBDriver ∗usbp)

    *Deactivates the USB peripheral.*
- void usbInitEndpointI (USBDriver ∗usbp, usbep_t ep, const USBEndpointConfig ∗epcp)

    *Enables an endpoint.*
- void usbDisableEndpointsI (USBDriver ∗usbp)

    *Disables all the active endpoints.*
- void usbStartReceiveI (USBDriver ∗usbp, usbep_t ep, uint8_t ∗buf, size_t n)

    *Starts a receive transaction on an OUT endpoint.*
- void usbStartTransmitI (USBDriver ∗usbp, usbep_t ep, const uint8_t ∗buf, size_t n)

    *Starts a transmit transaction on an IN endpoint.*
- msg_t usbReceive (USBDriver ∗usbp, usbep_t ep, uint8_t ∗buf, size_t n)

    *Performs a receive transaction on an OUT endpoint.*
- msg_t usbTransmit (USBDriver ∗usbp, usbep_t ep, const uint8_t ∗buf, size_t n)

    *Performs a transmit transaction on an IN endpoint.*
- bool usbStallReceiveI (USBDriver ∗usbp, usbep_t ep)

    *Stalls an OUT endpoint.*
- bool usbStallTransmitI (USBDriver ∗usbp, usbep_t ep)

    *Stalls an IN endpoint.*
- void usbWakeupHost (USBDriver ∗usbp)

    *Host wake-up procedure.*
- void _usb_reset (USBDriver ∗usbp)

    *USB reset routine.*
- void _usb_suspend (USBDriver ∗usbp)

    *USB suspend routine.*
- void _usb_wakeup (USBDriver ∗usbp)

    *USB wake-up routine.*
- void _usb_ep0setup (USBDriver ∗usbp, usbep_t ep)

    *Default EP0 SETUP callback.*
- void _usb_ep0in (USBDriver ∗usbp, usbep_t ep)

    *Default EP0 IN callback.*
- void _usb_ep0out (USBDriver ∗usbp, usbep_t ep)

    *Default EP0 OUT callback.*

### 9.109.1 Detailed Description

USB Driver macros and structures.

## 9.110 hal_usb_cdc.h File Reference

USB CDC macros and structures.

### Data Structures

- struct cdc_linecoding_t
  *Type of Line Coding structure.*

### Macros

**CDC specific messages.**

- #define **CDC_SEND_ENCAPSULATED_COMMAND** 0x00U
- #define **CDC_GET_ENCAPSULATED_RESPONSE** 0x01U
- #define **CDC_SET_COMM_FEATURE** 0x02U
- #define **CDC_GET_COMM_FEATURE** 0x03U
- #define **CDC_CLEAR_COMM_FEATURE** 0x04U
- #define **CDC_SET_AUX_LINE_STATE** 0x10U
- #define **CDC_SET_HOOK_STATE** 0x11U
- #define **CDC_PULSE_SETUP** 0x12U
- #define **CDC_SEND_PULSE** 0x13U
- #define **CDC_SET_PULSE_TIME** 0x14U
- #define **CDC_RING_AUX_JACK** 0x15U
- #define **CDC_SET_LINE_CODING** 0x20U
- #define **CDC_GET_LINE_CODING** 0x21U
- #define **CDC_SET_CONTROL_LINE_STATE** 0x22U
- #define **CDC_SEND_BREAK** 0x23U
- #define **CDC_SET_RINGER_PARMS** 0x30U
- #define **CDC_GET_RINGER_PARMS** 0x31U
- #define **CDC_SET_OPERATION_PARMS** 0x32U
- #define **CDC_GET_OPERATION_PARMS** 0x33U

**CDC classes**

- #define **CDC_COMMUNICATION_INTERFACE_CLASS** 0x02U
- #define **CDC_DATA_INTERFACE_CLASS** 0x0AU

**CDC subclasses**

- #define **CDC_ABSTRACT_CONTROL_MODEL** 0x02U

**CDC descriptors**

- #define **CDC_CS_INTERFACE** 0x24U

**CDC subdescriptors**

- #define **CDC_HEADER** 0x00U
- #define **CDC_CALL_MANAGEMENT** 0x01U
- #define **CDC_ABSTRACT_CONTROL_MANAGEMENT** 0x02U
- #define **CDC_UNION** 0x06U

**Line Control bit definitions.**

- #define **LC_STOP_1** 0U
- #define **LC_STOP_1P5** 1U
- #define **LC_STOP_2** 2U
- #define **LC_PARITY_NONE** 0U
- #define **LC_PARITY_ODD** 1U
- #define **LC_PARITY_EVEN** 2U
- #define **LC_PARITY_MARK** 3U
- #define **LC_PARITY_SPACE** 4U

### 9.110.1 Detailed Description

USB CDC macros and structures.

## 9.111 hal_usb_lld.c File Reference

PLATFORM USB subsystem low level driver source.

```
#include "hal.h"
```

### Functions

- void usb_lld_init (void)

  *Low level USB driver initialization.*
- void usb_lld_start (USBDriver ∗usbp)

  *Configures and activates the USB peripheral.*
- void usb_lld_stop (USBDriver ∗usbp)

  *Deactivates the USB peripheral.*
- void usb_lld_reset (USBDriver ∗usbp)

  *USB low level reset routine.*
- void usb_lld_set_address (USBDriver ∗usbp)

  *Sets the USB address.*
- void usb_lld_init_endpoint (USBDriver ∗usbp, usbep_t ep)

  *Enables an endpoint.*
- void usb_lld_disable_endpoints (USBDriver ∗usbp)

  *Disables all the active endpoints except the endpoint zero.*
- usbepstatus_t usb_lld_get_status_out (USBDriver ∗usbp, usbep_t ep)

  *Returns the status of an OUT endpoint.*
- usbepstatus_t usb_lld_get_status_in (USBDriver ∗usbp, usbep_t ep)

  *Returns the status of an IN endpoint.*
- void usb_lld_read_setup (USBDriver ∗usbp, usbep_t ep, uint8_t ∗buf)

  *Reads a setup packet from the dedicated packet buffer.*
- void usb_lld_prepare_receive (USBDriver ∗usbp, usbep_t ep)

  *Prepares for a receive operation.*
- void usb_lld_prepare_transmit (USBDriver ∗usbp, usbep_t ep)

  *Prepares for a transmit operation.*
- void usb_lld_start_out (USBDriver ∗usbp, usbep_t ep)

  *Starts a receive operation on an OUT endpoint.*
- void usb_lld_start_in (USBDriver ∗usbp, usbep_t ep)

  *Starts a transmit operation on an IN endpoint.*
- void usb_lld_stall_out (USBDriver ∗usbp, usbep_t ep)

  *Brings an OUT endpoint in the stalled state.*
- void usb_lld_stall_in (USBDriver ∗usbp, usbep_t ep)

  *Brings an IN endpoint in the stalled state.*
- void usb_lld_clear_out (USBDriver ∗usbp, usbep_t ep)

  *Brings an OUT endpoint in the active state.*
- void usb_lld_clear_in (USBDriver ∗usbp, usbep_t ep)

  *Brings an IN endpoint in the active state.*

### Variables

- USBDriver USBD1

  *USB1 driver identifier.*
- union {
  USBInEndpointState in
  *IN EP0 state.*
  USBOutEndpointState out
  *OUT EP0 state.*
  } ep0_state

  *EP0 state.*
- static const USBEndpointConfig ep0config

  *EP0 initialization structure.*

### 9.111.1 Detailed Description

PLATFORM USB subsystem low level driver source.

### 9.111.2 Variable Documentation

#### 9.111.2.1 USBInEndpointState in

IN EP0 state.

#### 9.111.2.2 USBOutEndpointState out

OUT EP0 state.

## 9.112 hal_usb_lld.h File Reference

PLATFORM USB subsystem low level driver header.

### Data Structures

- struct USBInEndpointState

  *Type of an IN endpoint state structure.*
- struct USBOutEndpointState

  *Type of an OUT endpoint state structure.*
- struct USBEndpointConfig

  *Type of an USB endpoint configuration structure.*
- struct USBConfig

  *Type of an USB driver configuration structure.*
- struct USBDriver

  *Structure representing an USB driver.*

## Macros

- #define USB_MAX_ENDPOINTS 4

  *Maximum endpoint address.*
- #define USB_EP0_STATUS_STAGE USB_EP0_STATUS_STAGE_SW

  *Status stage handling method.*
- #define USB_SET_ADDRESS_MODE USB_LATE_SET_ADDRESS

  *The address can be changed immediately upon packet reception.*
- #define USB_SET_ADDRESS_ACK_HANDLING USB_SET_ADDRESS_ACK_SW

  *Method for set address acknowledge.*
- #define usb_lld_get_frame_number(usbp) 0

  *Returns the current frame number.*
- #define usb_lld_get_transaction_size(usbp, ep) ((usbp)->epc[ep]->out_state->rxcnt)

  *Returns the exact size of a receive transaction.*
- #define usb_lld_connect_bus(usbp)

  *Connects the USB device.*
- #define usb_lld_disconnect_bus(usbp)

  *Disconnect the USB device.*
- #define usb_lld_wakeup_host(usbp)

  *Start of host wake-up procedure.*

### PLATFORM configuration options

- #define PLATFORM_USB_USE_USB1 FALSE

  *USB driver enable switch.*

## Functions

- void usb_lld_init (void)

  *Low level USB driver initialization.*
- void usb_lld_start (USBDriver ∗usbp)

  *Configures and activates the USB peripheral.*
- void usb_lld_stop (USBDriver ∗usbp)

  *Deactivates the USB peripheral.*
- void usb_lld_reset (USBDriver ∗usbp)

  *USB low level reset routine.*
- void usb_lld_set_address (USBDriver ∗usbp)

  *Sets the USB address.*
- void usb_lld_init_endpoint (USBDriver ∗usbp, usbep_t ep)

  *Enables an endpoint.*
- void usb_lld_disable_endpoints (USBDriver ∗usbp)

  *Disables all the active endpoints except the endpoint zero.*
- usbepstatus_t usb_lld_get_status_in (USBDriver ∗usbp, usbep_t ep)

  *Returns the status of an IN endpoint.*
- usbepstatus_t usb_lld_get_status_out (USBDriver ∗usbp, usbep_t ep)

  *Returns the status of an OUT endpoint.*
- void usb_lld_read_setup (USBDriver ∗usbp, usbep_t ep, uint8_t ∗buf)

  *Reads a setup packet from the dedicated packet buffer.*
- void usb_lld_prepare_receive (USBDriver ∗usbp, usbep_t ep)

  *Prepares for a receive operation.*
- void usb_lld_prepare_transmit (USBDriver ∗usbp, usbep_t ep)

*Prepares for a transmit operation.*
- void usb_lld_start_out (USBDriver ∗usbp, usbep_t ep)

  *Starts a receive operation on an OUT endpoint.*
- void usb_lld_start_in (USBDriver ∗usbp, usbep_t ep)

  *Starts a transmit operation on an IN endpoint.*
- void usb_lld_stall_out (USBDriver ∗usbp, usbep_t ep)

  *Brings an OUT endpoint in the stalled state.*
- void usb_lld_stall_in (USBDriver ∗usbp, usbep_t ep)

  *Brings an IN endpoint in the stalled state.*
- void usb_lld_clear_out (USBDriver ∗usbp, usbep_t ep)

  *Brings an OUT endpoint in the active state.*
- void usb_lld_clear_in (USBDriver ∗usbp, usbep_t ep)

  *Brings an IN endpoint in the active state.*

### 9.112.1 Detailed Description

PLATFORM USB subsystem low level driver header.

## 9.113 hal_wdg.c File Reference

WDG Driver code.

```
#include "hal.h"
```

### Functions

- void wdgInit (void)

  *WDG Driver initialization.*
- void wdgStart (WDGDriver ∗wdgp, const WDGConfig ∗config)

  *Configures and activates the WDG peripheral.*
- void wdgStop (WDGDriver ∗wdgp)

  *Deactivates the WDG peripheral.*
- void wdgReset (WDGDriver ∗wdgp)

  *Resets WDG's counter.*

### 9.113.1 Detailed Description

WDG Driver code.

## 9.114 hal_wdg.h File Reference

WDG Driver macros and structures.

```
#include "hal_wdg_lld.h"
```

### Macros

- #define wdgResetI(wdgp) wdg_lld_reset(wdgp)

  *Resets WDG's counter.*

### Enumerations

### Functions

- void wdgInit (void)

  *WDG Driver initialization.*
- void wdgStart (WDGDriver ∗wdgp, const WDGConfig ∗config)

  *Configures and activates the WDG peripheral.*
- void wdgStop (WDGDriver ∗wdgp)

  *Deactivates the WDG peripheral.*
- void wdgReset (WDGDriver ∗wdgp)

  *Resets WDG's counter.*

### 9.114.1 Detailed Description

WDG Driver macros and structures.

## 9.115 hal_wdg_lld.c File Reference

WDG Driver subsystem low level driver source template.

```
#include "hal.h"
```

### Functions

- void wdg_lld_init (void)

  *Low level WDG driver initialization.*
- void wdg_lld_start (WDGDriver ∗wdgp)

  *Configures and activates the WDG peripheral.*
- void wdg_lld_stop (WDGDriver ∗wdgp)

  *Deactivates the WDG peripheral.*
- void wdg_lld_reset (WDGDriver ∗wdgp)

  *Reloads WDG's counter.*

### 9.115.1 Detailed Description

WDG Driver subsystem low level driver source template.

## 9.116 hal_wdg_lld.h File Reference

WDG Driver subsystem low level driver header template.

### Data Structures

- struct WDGConfig

  *Driver configuration structure.*
- struct WDGDriver

  *Structure representing an WDG driver.*

### Macros

#### Configuration options

- #define PLATFORM_WDG_USE_WDG1 FALSE

  *WDG1 driver enable switch.*

### Typedefs

- typedef struct WDGDriver WDGDriver

  *Type of a structure representing an WDG driver.*

### Functions

- void wdg_lld_init (void)

  *Low level WDG driver initialization.*
- void wdg_lld_start (WDGDriver ∗wdgp)

  *Configures and activates the WDG peripheral.*
- void wdg_lld_stop (WDGDriver ∗wdgp)

  *Deactivates the WDG peripheral.*
- void wdg_lld_reset (WDGDriver ∗wdgp)

  *Reloads WDG's counter.*

### 9.116.1 Detailed Description

WDG Driver subsystem low level driver header template.

## 9.117 halconf.h File Reference

HAL configuration header.

```
#include "mcuconf.h"
```

### Macros

- #define HAL_USE_PAL TRUE

  *Enables the PAL subsystem.*
- #define HAL_USE_ADC TRUE

  *Enables the ADC subsystem.*
- #define HAL_USE_CAN TRUE

  *Enables the CAN subsystem.*
- #define HAL_USE_CRY TRUE

*Enables the cryptographic subsystem.*

- #define HAL_USE_DAC TRUE

  *Enables the DAC subsystem.*
- #define HAL_USE_EXT TRUE

  *Enables the EXT subsystem.*
- #define HAL_USE_GPT TRUE

  *Enables the GPT subsystem.*
- #define HAL_USE_I2C TRUE

  *Enables the I2C subsystem.*
- #define HAL_USE_I2S TRUE

  *Enables the I2S subsystem.*
- #define HAL_USE_ICU TRUE

  *Enables the ICU subsystem.*
- #define HAL_USE_MAC TRUE

  *Enables the MAC subsystem.*
- #define HAL_USE_MMC_SPI TRUE

  *Enables the MMC_SPI subsystem.*
- #define HAL_USE_PWM TRUE

  *Enables the PWM subsystem.*
- #define HAL_USE_QSPI TRUE

  *Enables the QSPI subsystem.*
- #define HAL_USE_RTC TRUE

  *Enables the RTC subsystem.*
- #define HAL_USE_SDC TRUE

  *Enables the SDC subsystem.*
- #define HAL_USE_SERIAL TRUE

  *Enables the SERIAL subsystem.*
- #define HAL_USE_SERIAL_USB TRUE

  *Enables the SERIAL over USB subsystem.*
- #define HAL_USE_SPI TRUE

  *Enables the SPI subsystem.*
- #define HAL_USE_UART TRUE

  *Enables the UART subsystem.*
- #define HAL_USE_USB TRUE

  *Enables the USB subsystem.*
- #define HAL_USE_WDG TRUE

  *Enables the WDG subsystem.*
- #define PAL_USE_CALLBACKS FALSE

  *Enables synchronous APIs.*
- #define PAL_USE_WAIT FALSE

  *Enables synchronous APIs.*
- #define ADC_USE_WAIT TRUE

  *Enables synchronous APIs.*
- #define ADC_USE_MUTUAL_EXCLUSION TRUE

  *Enables the `adcAcquireBus()` and `adcReleaseBus()` APIs.*
- #define CAN_USE_SLEEP_MODE TRUE

  *Sleep mode related APIs inclusion switch.*
- #define CAN_ENFORCE_USE_CALLBACKS FALSE

  *Enforces the driver to use direct callbacks rather than OSAL events.*
- #define HAL_CRY_USE_FALLBACK FALSE

  *Enables the SW fall-back of the cryptographic driver.*

- #define HAL_CRY_ENFORCE_FALLBACK FALSE

  *Makes the driver forcibly use the fall-back implementations.*
- #define DAC_USE_WAIT TRUE

  *Enables synchronous APIs.*
- #define DAC_USE_MUTUAL_EXCLUSION TRUE

  *Enables the `dacAcquireBus()` and `dacReleaseBus()` APIs.*
- #define I2C_USE_MUTUAL_EXCLUSION TRUE

  *Enables the mutual exclusion APIs on the I2C bus.*
- #define MAC_USE_ZERO_COPY TRUE

  *Enables the zero-copy API.*
- #define MAC_USE_EVENTS TRUE

  *Enables an event sources for incoming packets.*
- #define MMC_NICE_WAITING TRUE

  *Delays insertions.*
- #define QSPI_USE_WAIT TRUE

  *Enables synchronous APIs.*
- #define QSPI_USE_MUTUAL_EXCLUSION TRUE

  *Enables the `qspiAcquireBus()` and `qspiReleaseBus()` APIs.*
- #define SDC_INIT_RETRY 100

  *Number of initialization attempts before rejecting the card.*
- #define SDC_MMC_SUPPORT TRUE

  *Include support for MMC cards.*
- #define SDC_NICE_WAITING TRUE

  *Delays insertions.*
- #define SDC_INIT_OCR_V20 0x50FF8000U

  *OCR initialization constant for V20 cards.*
- #define SDC_INIT_OCR 0x80100000U

  *OCR initialization constant for non-V20 cards.*
- #define SERIAL_DEFAULT_BITRATE 38400

  *Default bit rate.*
- #define SERIAL_BUFFERS_SIZE 16

  *Serial buffers size.*
- #define SERIAL_USB_BUFFERS_SIZE 256

  *Serial over USB buffers size.*
- #define SERIAL_USB_BUFFERS_NUMBER 2

  *Serial over USB number of buffers.*
- #define SPI_USE_WAIT TRUE

  *Enables synchronous APIs.*
- #define SPI_USE_CIRCULAR FALSE

  *Enables circular transfers APIs.*
- #define SPI_USE_MUTUAL_EXCLUSION TRUE

  *Enables the `spiAcquireBus()` and `spiReleaseBus()` APIs.*
- #define SPI_SELECT_MODE SPI_SELECT_MODE_PAD

  *Handling method for SPI CS line.*
- #define UART_USE_WAIT TRUE

  *Enables synchronous APIs.*
- #define UART_USE_MUTUAL_EXCLUSION TRUE

  *Enables the `uartAcquireBus()` and `uartReleaseBus()` APIs.*
- #define USB_USE_WAIT TRUE

  *Enables synchronous APIs.*

### 9.117.1 Detailed Description

HAL configuration header.

HAL configuration file, this file allows to enable or disable the various device drivers from your application. You may also use this file in order to override the device drivers default settings.

## 9.118 mfs.c File Reference

Managed Flash Storage module code.

```
#include <string.h>
#include "hal.h"
#include "mfs.h"
```

### Macros

- #define RET_ON_ERROR(err)

  *Error check helper.*

### Functions

- static mfs_error_t mfs_flash_read (MFSDriver ∗mfsp, flash_offset_t offset, size_t n, uint8_t ∗rp)

  *Flash read.*
- static mfs_error_t mfs_flash_write (MFSDriver ∗mfsp, flash_offset_t offset, size_t n, const uint8_t ∗wp)

  *Flash write.*
- static mfs_error_t mfs_flash_copy (MFSDriver ∗mfsp, flash_offset_t doffset, flash_offset_t soffset, uint32_t n)

  *Flash copy.*
- static mfs_error_t mfs_record_check (MFSDriver ∗mfsp, mfs_data_header_t ∗dhdrp, flash_offset_t offset, flash_offset_t limit, mfs_record_state_t ∗sts)

  *Verifies integrity of a record.*
- static mfs_error_t mfs_bank_erase (MFSDriver ∗mfsp, mfs_bank_t bank)

  *Erases and verifies all sectors belonging to a bank.*
- static mfs_error_t mfs_bank_verify_erase (MFSDriver ∗mfsp, mfs_bank_t bank)

  *Erases and verifies all sectors belonging to a bank.*
- static mfs_error_t mfs_bank_write_header (MFSDriver ∗mfsp, mfs_bank_t bank, uint32_t cnt)

  *Writes the validation header in a bank.*
- static mfs_error_t mfs_bank_scan_records (MFSDriver ∗mfsp, mfs_bank_t bank, mfs_bank_state_t ∗statep)

  *Scans blocks searching for records.*
- static mfs_error_t mfs_bank_get_state (MFSDriver ∗mfsp, mfs_bank_t bank, mfs_bank_state_t ∗statep, uint32_t ∗cntp)

  *Determines the state of a bank.*
- static mfs_error_t mfs_bank_mount (MFSDriver ∗mfsp, mfs_bank_t bank, mfs_bank_state_t ∗statep)

  *Selects a bank as current.*
- static mfs_error_t mfs_garbage_collect (MFSDriver ∗mfsp)

  *Enforces a garbage collection.*
- static mfs_error_t mfs_try_mount (MFSDriver ∗mfsp)

  *Performs a flash partition mount attempt.*
- mfs_error_t mfs_mount (MFSDriver ∗mfsp)

  *Configures and activates a MFS driver.*
- void mfsObjectInit (MFSDriver ∗mfsp)

*Initializes an instance.*
- mfs_error_t mfsStart (MFSDriver ∗mfsp, const MFSConfig ∗config)

  *Configures and activates a MFS driver.*
- void mfsStop (MFSDriver ∗mfsp)

  *Deactivates a MFS driver.*
- mfs_error_t mfsErase (MFSDriver ∗mfsp)

  *Destroys the state of the managed storage by erasing the flash.*
- mfs_error_t mfsReadRecord (MFSDriver ∗mfsp, mfs_id_t id, size_t ∗np, uint8_t ∗buffer)

  *Retrieves and reads a data record.*
- mfs_error_t mfsWriteRecord (MFSDriver ∗mfsp, mfs_id_t id, size_t n, const uint8_t ∗buffer)

  *Creates or updates a data record.*
- mfs_error_t mfsEraseRecord (MFSDriver ∗mfsp, mfs_id_t id)

  *Erases a data record.*
- mfs_error_t mfsPerformGarbageCollection (MFSDriver ∗mfsp)

  *Enforces a garbage collection operation.*

### 9.118.1 Detailed Description

Managed Flash Storage module code.

This module manages a flash partition as a generic storage where arbitrary data records can be created, updated, deleted and retrieved.
A managed partition is composed of two banks of equal size, a bank is composed of one or more erasable sectors, a sector is divided in writable pages.
The module handles flash wear leveling and recovery of damaged banks (where possible) caused by power loss during operations. Both operations are transparent to the user.

## 9.119 mfs.h File Reference

Managed Flash Storage module header.

```
#include "hal_flash.h"
```

### Data Structures

- union mfs_bank_header_t

  *Type of a bank header.*
- union mfs_data_header_t

  *Type of a data block header.*
- struct MFSConfig

  *Type of a MFS configuration structure.*
- struct MFSDriver

  *Type of an MFS instance.*

### Macros

**Configuration options**

- #define MFS_CFG_MAX_RECORDS 32

  *Maximum number of indexed records in the managed storage.*
- #define MFS_CFG_MAX_REPAIR_ATTEMPTS 3

*Maximum number of repair attempts on partition mount.*
- #define MFS_CFG_WRITE_VERIFY TRUE

  *Verify written data.*
- #define MFS_CFG_STRONG_CHECKING TRUE

  *Enables a stronger and slower check procedure on mount.*
- #define MFS_CFG_BUFFER_SIZE 32

  *Size of the buffer used for data copying.*

**Error codes handling macros**

- #define **MFS_IS_ERROR**(err) ((err) < MFS_NO_ERROR)
- #define **MFS_IS_WARNING**(err) ((err) > MFS_NO_ERROR)

### Typedefs

- typedef uint32_t mfs_id_t

  *Type of a record identifier.*

### Enumerations

### Functions

- void mfsObjectInit (MFSDriver ∗mfsp)

  *Initializes an instance.*
- mfs_error_t mfsStart (MFSDriver ∗mfsp, const MFSConfig ∗config)

  *Configures and activates a MFS driver.*
- void mfsStop (MFSDriver ∗mfsp)

  *Deactivates a MFS driver.*
- mfs_error_t mfsErase (MFSDriver ∗mfsp)

  *Destroys the state of the managed storage by erasing the flash.*
- mfs_error_t mfsReadRecord (MFSDriver ∗mfsp, mfs_id_t id, size_t ∗np, uint8_t ∗buffer)

  *Retrieves and reads a data record.*
- mfs_error_t mfsWriteRecord (MFSDriver ∗mfsp, mfs_id_t id, size_t n, const uint8_t ∗buffer)

  *Creates or updates a data record.*
- mfs_error_t mfsEraseRecord (MFSDriver ∗mfsp, mfs_id_t id)

  *Erases a data record.*
- mfs_error_t mfsPerformGarbageCollection (MFSDriver ∗mfsp)

  *Enforces a garbage collection operation.*

### 9.119.1 Detailed Description

Managed Flash Storage module header.

## 9.120 osal.c File Reference

OSAL module code.

```
#include "osal.h"
```

## Functions

- void osalInit (void)

  *OSAL module initialization.*
- void osalSysHalt (const char ∗reason)

  *System halt with error message.*
- void osalSysPolledDelayX (rtcnt_t cycles)

  *Polled delay.*
- void osalOsTimerHandlerI (void)

  *System timer handler.*
- void osalOsRescheduleS (void)

  *Checks if a reschedule is required and performs it.*
- systime_t osalOsGetSystemTimeX (void)

  *Current system time.*
- void osalThreadSleepS (sysinterval_t time)

  *Suspends the invoking thread for the specified time.*
- void osalThreadSleep (sysinterval_t time)

  *Suspends the invoking thread for the specified time.*
- msg_t osalThreadSuspendS (thread_reference_t ∗trp)

  *Sends the current thread sleeping and sets a reference variable.*
- msg_t osalThreadSuspendTimeoutS (thread_reference_t ∗trp, sysinterval_t timeout)

  *Sends the current thread sleeping and sets a reference variable.*
- void osalThreadResumeI (thread_reference_t ∗trp, msg_t msg)

  *Wakes up a thread waiting on a thread reference object.*
- void osalThreadResumeS (thread_reference_t ∗trp, msg_t msg)

  *Wakes up a thread waiting on a thread reference object.*
- msg_t osalThreadEnqueueTimeoutS (threads_queue_t ∗tqp, sysinterval_t timeout)

  *Enqueues the caller thread.*
- void osalThreadDequeueNextI (threads_queue_t ∗tqp, msg_t msg)

  *Dequeues and wakes up one thread from the queue, if any.*
- void osalThreadDequeueAllI (threads_queue_t ∗tqp, msg_t msg)

  *Dequeues and wakes up all threads from the queue.*
- void osalEventBroadcastFlagsI (event_source_t ∗esp, eventflags_t flags)

  *Add flags to an event source object.*
- void osalEventBroadcastFlags (event_source_t ∗esp, eventflags_t flags)

  *Add flags to an event source object.*
- void osalEventSetCallback (event_source_t ∗esp, eventcallback_t cb, void ∗param)

  *Event callback setup.*
- void osalMutexLock (mutex_t ∗mp)

  *Locks the specified mutex.*
- void osalMutexUnlock (mutex_t ∗mp)

  *Unlocks the specified mutex.*

## Variables

- const char ∗ osal_halt_msg

  *Pointer to a halt error message.*

### 9.120.1 Detailed Description

OSAL module code.

## 9.121 osal.h File Reference

OSAL module header.

```
#include <stddef.h>
#include <stdint.h>
#include <stdbool.h>
```

### Data Structures

- struct event_source

    *Events source object.*
- struct threads_queue_t

    *Type of a thread queue.*

### Macros

- #define OSAL_DBG_ENABLE_ASSERTS FALSE

    *Enables OSAL assertions.*
- #define OSAL_DBG_ENABLE_CHECKS FALSE

    *Enables OSAL functions parameters checks.*

#### Common constants

- #define **FALSE** 0
- #define **TRUE** 1
- #define **OSAL_SUCCESS** false
- #define **OSAL_FAILED** true

#### Messages

- #define **MSG_OK** (msg_t)0
- #define **MSG_TIMEOUT** (msg_t)-1
- #define **MSG_RESET** (msg_t)-2

#### Special time constants

- #define **TIME_IMMEDIATE** ((sysinterval_t)0)
- #define **TIME_INFINITE** ((sysinterval_t)-1)

#### Systick modes.

- #define **OSAL_ST_MODE_NONE** 0
- #define **OSAL_ST_MODE_PERIODIC** 1
- #define **OSAL_ST_MODE_FREERUNNING** 2

#### Systick parameters.

- #define OSAL_ST_RESOLUTION 32

    *Size in bits of the `systick_t` type.*
- #define OSAL_ST_FREQUENCY 1000

    *Required systick frequency or resolution.*
- #define OSAL_ST_MODE OSAL_ST_MODE_PERIODIC

    *Systick mode required by the underlying OS.*

### IRQ-related constants

- #define OSAL_IRQ_PRIORITY_LEVELS 16U

  *Total priority levels.*
- #define OSAL_IRQ_MAXIMUM_PRIORITY 0U

  *Highest IRQ priority for HAL drivers.*

### Debug related macros

- #define osalDbgAssert(c, remark)

  *Condition assertion.*
- #define osalDbgCheck(c)

  *Function parameters check.*
- #define osalDbgCheckClassI()

  *I-Class state check.*
- #define osalDbgCheckClassS()

  *S-Class state check.*

### IRQ service routines wrappers

- #define OSAL_IRQ_IS_VALID_PRIORITY(n) (((n) >= OSAL_IRQ_MAXIMUM_PRIORITY) && ((n) < O↩ SAL_IRQ_PRIORITY_LEVELS))

  *Priority level verification macro.*
- #define OSAL_IRQ_PROLOGUE()

  *IRQ prologue code.*
- #define OSAL_IRQ_EPILOGUE()

  *IRQ epilogue code.*
- #define OSAL_IRQ_HANDLER(id) void id(void)

  *IRQ handler function declaration.*

### Time conversion utilities

- #define OSAL_S2I(secs) ((sysinterval_t)((uint32_t)(secs) ∗ (uint32_t)OSAL_ST_FREQUENCY))

  *Seconds to system ticks.*
- #define OSAL_MS2I(msecs)

  *Milliseconds to system ticks.*
- #define OSAL_US2I(usecs)

  *Microseconds to system ticks.*

### Time conversion utilities for the realtime counter

- #define OSAL_S2RTC(freq, sec) ((freq) ∗ (sec))

  *Seconds to realtime counter.*
- #define OSAL_MS2RTC(freq, msec) (rtcnt_t)((((freq) + 999UL) / 1000UL) ∗ (msec))

  *Milliseconds to realtime counter.*
- #define OSAL_US2RTC(freq, usec) (rtcnt_t)((((freq) + 999999UL) / 1000000UL) ∗ (usec))

  *Microseconds to realtime counter.*

### Sleep macros using absolute time

- #define osalThreadSleepSeconds(secs) osalThreadSleep(OSAL_S2I(secs))

  *Delays the invoking thread for the specified number of seconds.*
- #define osalThreadSleepMilliseconds(msecs) osalThreadSleep(OSAL_MS2I(msecs))

  *Delays the invoking thread for the specified number of milliseconds.*
- #define osalThreadSleepMicroseconds(usecs) osalThreadSleep(OSAL_US2I(usecs))

  *Delays the invoking thread for the specified number of microseconds.*

## Typedefs

- typedef uint32_t syssts_t

  *Type of a system status word.*
- typedef int32_t msg_t

  *Type of a message.*
- typedef uint32_t systime_t

  *Type of system time counter.*
- typedef uint32_t sysinterval_t

  *Type of system time interval.*
- typedef uint32_t rtcnt_t

  *Type of realtime counter.*
- typedef void ∗ thread_reference_t

  *Type of a thread reference.*
- typedef uint32_t eventflags_t

  *Type of an event flags mask.*
- typedef struct event_source event_source_t

  *Type of an event flags object.*
- typedef void(∗ eventcallback_t) (event_source_t ∗esp)

  *Type of an event source callback.*
- typedef uint32_t mutex_t

  *Type of a mutex.*

## Functions

- void osalInit (void)

  *OSAL module initialization.*
- void osalSysHalt (const char ∗reason)

  *System halt with error message.*
- void osalSysPolledDelayX (rtcnt_t cycles)

  *Polled delay.*
- void osalOsTimerHandlerI (void)

  *System timer handler.*
- void osalOsRescheduleS (void)

  *Checks if a reschedule is required and performs it.*
- systime_t osalOsGetSystemTimeX (void)

  *Current system time.*
- void osalThreadSleepS (sysinterval_t time)

  *Suspends the invoking thread for the specified time.*
- void osalThreadSleep (sysinterval_t time)

  *Suspends the invoking thread for the specified time.*
- msg_t osalThreadSuspendS (thread_reference_t ∗trp)

  *Sends the current thread sleeping and sets a reference variable.*
- msg_t osalThreadSuspendTimeoutS (thread_reference_t ∗trp, sysinterval_t timeout)

  *Sends the current thread sleeping and sets a reference variable.*
- void osalThreadResumeI (thread_reference_t ∗trp, msg_t msg)

  *Wakes up a thread waiting on a thread reference object.*
- void osalThreadResumeS (thread_reference_t ∗trp, msg_t msg)

  *Wakes up a thread waiting on a thread reference object.*
- msg_t osalThreadEnqueueTimeoutS (threads_queue_t ∗tqp, sysinterval_t timeout)

  *Enqueues the caller thread.*

- void osalThreadDequeueNextI (threads_queue_t ∗tqp, msg_t msg)

    *Dequeues and wakes up one thread from the queue, if any.*
- void osalThreadDequeueAllI (threads_queue_t ∗tqp, msg_t msg)

    *Dequeues and wakes up all threads from the queue.*
- void osalEventBroadcastFlagsI (event_source_t ∗esp, eventflags_t flags)

    *Add flags to an event source object.*
- void osalEventBroadcastFlags (event_source_t ∗esp, eventflags_t flags)

    *Add flags to an event source object.*
- void osalEventSetCallback (event_source_t ∗esp, eventcallback_t cb, void ∗param)

    *Event callback setup.*
- void osalMutexLock (mutex_t ∗mp)

    *Locks the specified mutex.*
- void osalMutexUnlock (mutex_t ∗mp)

    *Unlocks the specified mutex.*
- static void osalSysDisable (void)

    *Disables interrupts globally.*
- static void osalSysEnable (void)

    *Enables interrupts globally.*
- static void osalSysLock (void)

    *Enters a critical zone from thread context.*
- static void osalSysUnlock (void)

    *Leaves a critical zone from thread context.*
- static void osalSysLockFromISR (void)

    *Enters a critical zone from ISR context.*
- static void osalSysUnlockFromISR (void)

    *Leaves a critical zone from ISR context.*
- static syssts_t osalSysGetStatusAndLockX (void)

    *Returns the execution status and enters a critical zone.*
- static void osalSysRestoreStatusX (syssts_t sts)

    *Restores the specified execution status and leaves a critical zone.*
- static systime_t osalTimeAddX (systime_t systime, sysinterval_t interval)

    *Adds an interval to a system time returning a system time.*
- static sysinterval_t osalTimeDiffX (systime_t start, systime_t end)

    *Subtracts two system times returning an interval.*
- static bool osalTimeIsInRangeX (systime_t time, systime_t start, systime_t end)

    *Checks if the specified time is within the specified time window.*
- static void osalThreadQueueObjectInit (threads_queue_t ∗tqp)

    *Initializes a threads queue object.*
- static void osalEventObjectInit (event_source_t ∗esp)

    *Initializes an event source object.*
- static void osalMutexObjectInit (mutex_t ∗mp)

    *Initializes s `mutex_t` object.*

## Variables

- const char ∗ osal_halt_msg

    *Pointer to a halt error message.*

### 9.121.1 Detailed Description

OSAL module header.

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