

ZMOD4xxx-API Documentation

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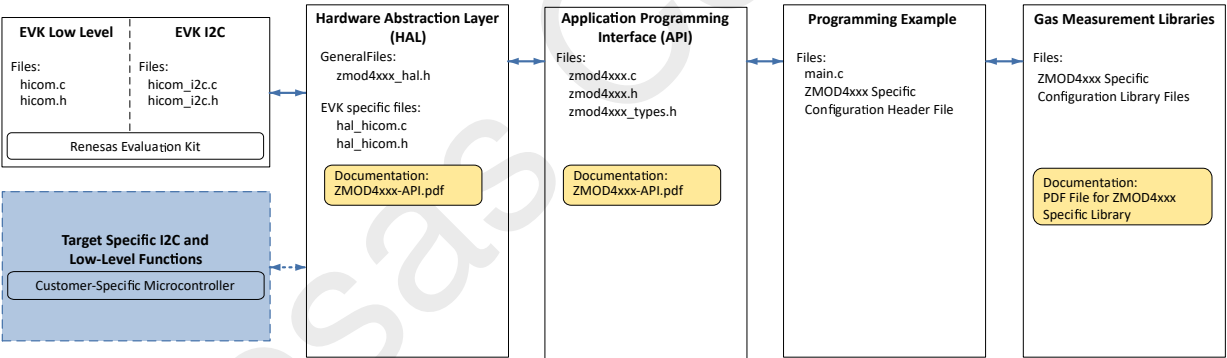
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Chapter 1

ZMOD4xxx Application Programming Interface Overview

This document refers to the Renesas document *ZMOD4xxx Programming Manual - Read Me*. Custom microcontrollers can be used to establish I2C communication. Using the user's own microcontroller requires implementing the user's own target-specific I2C and low-level functions. The following describes in detail the Application Programming Interface (API) of the ZMOD4xxx.



Chapter 2

Data Structure Index

2.1 Data Structures

Here are the data structures with brief descriptions:

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| zmod4xxx_dev_t | Device structure ZMOD4xxx | 5 |

Chapter 3

File Index

3.1 File List

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

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Chapter 4

Data Structure Documentation

4.1 zmod4xxx_conf Struct Reference

Structure to hold the gas sensor module configuration.

```
#include <zmod4xxx_types.h>
```

Data Fields

- `uint8_t start`
- [zmod4xxx_conf_str h](#)
- [zmod4xxx_conf_str d](#)
- [zmod4xxx_conf_str m](#)
- [zmod4xxx_conf_str s](#)
- [zmod4xxx_conf_str r](#)
- `uint8_t prod_data_len`

4.1.1 Detailed Description

Structure to hold the gas sensor module configuration.

The documentation for this struct was generated from the following file:

- [zmod4xxx_types.h](#)

4.2 zmod4xxx_conf_str Struct Reference

A single data set for the configuration.

```
#include <zmod4xxx_types.h>
```

Data Fields

- `uint8_t addr`
- `uint8_t len`
- `uint8_t * data_buf`

4.2.1 Detailed Description

A single data set for the configuration.

The documentation for this struct was generated from the following file:

- [zmod4xxx_types.h](#)

4.3 zmod4xxx_dev_t Struct Reference

Device structure ZMOD4xxx.

```
#include <zmod4xxx_types.h>
```

Data Fields

- `uint8_t i2c_addr`
- `uint8_t config [6]`
- `uint16_t mox_er`
- `uint16_t mox_lr`
- `uint16_t pid`
- `uint8_t * prod_data`
- `zmod4xxx_i2c_ptr_t read`
- `zmod4xxx_i2c_ptr_t write`
- `zmod4xxx_delay_ptr_p delay_ms`
- `zmod4xxx_conf * init_conf`
- `zmod4xxx_conf * meas_conf`

4.3.1 Detailed Description

Device structure ZMOD4xxx.

4.3.2 Field Documentation

4.3.2.1 config

```
uint8_t config[6]
```

configuration parameter set

4.3.2.2 delay_ms

```
zmod4xxx_delay_ptr_p delay_ms
```

function pointer to delay function

4.3.2.3 i2c_addr

```
uint8_t i2c_addr
```

i2c address of the sensor

4.3.2.4 init_conf

```
zmod4xxx_conf* init_conf
```

pointer to the init configuration

4.3.2.5 meas_conf

```
zmod4xxx_conf* meas_conf
```

pointer to the measurement configuration

4.3.2.6 mox_er

```
uint16_t mox_er
```

sensor specific parameter

4.3.2.7 mox_lr

```
uint16_t mox_lr
```

sensor specific parameter

4.3.2.8 pid

`uint16_t pid`

product id of the sensor

4.3.2.9 prod_data

`uint8_t* prod_data`

production data

4.3.2.10 read

`zmod4xxx_i2c_ptr_t read`

function pointer to i2c read

4.3.2.11 write

`zmod4xxx_i2c_ptr_t write`

function pointer to i2c write

The documentation for this struct was generated from the following file:

- [zmod4xxx_types.h](#)

Chapter 5

File Documentation

5.1 hal_hicom.h File Reference

Hardware abstraction layer for windows.

```
#include "hicom.h"
#include "hicom_i2c.h"
#include "zmod4xxx_types.h"
#include <conio.h>
```

Functions

- `int8_t init_hardware (zmod4xxx_dev_t *dev)`
Initialize the target hardware.
- `int8_t is_key_pressed ()`
Check if any key is pressed.
- `int8_t deinit_hardware ()`
deinitialize target hardware

5.1.1 Detailed Description

Hardware abstraction layer for windows.

Version

2.5.1

Author

Renesas Electronics Corporation

5.1.2 Function Documentation

5.1.2.1 deinit hardware()

```
int8_t deinit_hardware ( )
```

deinitialize target hardware

Returns

error code

Return values

| | |
|------|---------|
| 0 | success |
| != 0 | error |

5.1.2.2 init hardware()

```
int8_t init_hardware (
    zmod4xxx_dev_t * dev )
```

Initialize the target hardware.

< Windows Target >

Parameters

| | | |
|----|------------|-----------------------|
| in | <i>dev</i> | pointer to the device |
|----|------------|-----------------------|

Returns

error code

Return values

| | |
|------|---------|
| 0 | success |
| != 0 | error |

5.1.2.3 is_key_pressed()

```
int8_t is_key_pressed ( )
```

Check if any key is pressed.

Return values

| | |
|---|-------------|
| 1 | pressed |
| 0 | not pressed |

5.2 zmod4xxx.h File Reference

zmod4xxx-API functions

```
#include "zmod4xxx_types.h"
```

Macros

- #define **ZMOD4XXX_ADDR_PID** (0x00)
- #define **ZMOD4XXX_ADDR_CONF** (0x20)
- #define **ZMOD4XXX_ADDR_PROD_DATA** (0x26)
- #define **ZMOD4XXX_ADDR_CMD** (0x93)
- #define **ZMOD4XXX_ADDR_STATUS** (0x94)
- #define **ZMOD4XXX_ADDR_TRACKING** (0x3A)
- #define **ZMOD4XXX_LEN_PID** (2)
- #define **ZMOD4XXX_LEN_CONF** (6)
- #define **ZMOD4XXX_LEN_TRACKING** (6)
- #define **HSP_MAX** (8)
- #define **RSLT_MAX** (32)
- #define **STATUS_SEQUENCER_RUNNING_MASK** (0x80)
- #define **STATUS_SLEEP_TIMER_ENABLED_MASK** (0x40)
- #define **STATUS_ALARM_MASK** (0x20)
- #define **STATUS_LAST_SEQ_STEP_MASK** (0x1F)
- #define **STATUS_POR_EVENT_MASK** (0x80)
- #define **STATUS_ACCESS_CONFLICT_MASK** (0x40)

Functions

- [zmod4xxx_err zmod4xxx_calc_factor](#) ([zmod4xxx_conf](#) *conf, uint8_t *hsp, uint8_t *config)
Calculate measurement settings.
- [zmod4xxx_err zmod4xxx_calc_rmx](#) ([zmod4xxx_dev_t](#) *dev, uint8_t *adc_result, float *rmx)
Calculate mx resistance.
- [zmod4xxx_err zmod4xxx_check_error_event](#) ([zmod4xxx_dev_t](#) *dev)
Check the error event of the device.

- `zmod4xxx_err zmod4xxx_init_measurement (zmod4xxx_dev_t *dev)`
Initialize the sensor for corresponding measurement.
- `zmod4xxx_err zmod4xxx_init_sensor (zmod4xxx_dev_t *dev)`
Initialize the sensor after power on.
- `zmod4xxx_err zmod4xxx_null_ptr_check (zmod4xxx_dev_t *dev)`
Check if all function pointers are assigned.
- `zmod4xxx_err zmod4xxx_prepare_sensor (zmod4xxx_dev_t *dev)`
High-level function to prepare sensor.
- `zmod4xxx_err zmod4xxx_read_adc_result (zmod4xxx_dev_t *dev, uint8_t *adc_result)`
Read adc values from the sensor.
- `zmod4xxx_err zmod4xxx_read_rmx (zmod4xxx_dev_t *dev, uint8_t *adc_result, float *rmx)`
High-level function to read rmx.
- `zmod4xxx_err zmod4xxx_read_sensor_info (zmod4xxx_dev_t *dev)`
Read sensor parameter.
- `zmod4xxx_err zmod4xxx_read_status (zmod4xxx_dev_t *dev, uint8_t *status)`
Read the status of the device.
- `zmod4xxx_err zmod4xxx_read_tracking_number (zmod4xxx_dev_t *dev, uint8_t *track_num)`
Read tracking number of sensor.
- `zmod4xxx_err zmod4xxx_start_measurement (zmod4xxx_dev_t *dev)`
Start the measurement.

5.2.1 Detailed Description

zmod4xxx-API functions

Version

2.5.1

Author

Renesas Electronics Corporation

5.2.2 Macro Definition Documentation

5.2.2.1 STATUS_ACCESS_CONFLICT_MASK

```
#define STATUS_ACCESS_CONFLICT_MASK (0x40)
```

AccessConflict

5.2.2.2 STATUS_ALARM_MASK

```
#define STATUS_ALARM_MASK (0x20)
```

Alarm

5.2.2.3 STATUS_LAST_SEQ_STEP_MASK

```
#define STATUS_LAST_SEQ_STEP_MASK (0x1F)
```

Last executed sequencer step

5.2.2.4 STATUS_POR_EVENT_MASK

```
#define STATUS_POR_EVENT_MASK (0x80)
```

POR_event

5.2.2.5 STATUS_SEQUENCER_RUNNING_MASK

```
#define STATUS_SEQUENCER_RUNNING_MASK (0x80)
```

Sequencer is running

5.2.2.6 STATUS_SLEEP_TIMER_ENABLED_MASK

```
#define STATUS_SLEEP_TIMER_ENABLED_MASK (0x40)
```

SleepTimer_enabled

5.2.3 Function Documentation

5.2.3.1 zmod4xxx_calc_factor()

```
zmod4xxx_err zmod4xxx_calc_factor (
    zmod4xxx_conf * conf,
    uint8_t * hsp,
    uint8_t * config )
```

Calculate measurement settings.

Parameters

| | | |
|----|---------------|-----------------------------------|
| in | <i>conf</i> | measurement configuration data |
| in | <i>hsp</i> | heater set point pointer |
| in | <i>config</i> | sensor configuration data pointer |

Returns

error code

Return values

| | |
|---|---------|
| 0 | success |
|---|---------|

5.2.3.2 zmod4xxx_calc_rmx()

```
zmod4xxx_err zmod4xxx_calc_rmx (
    zmod4xxx_dev_t * dev,
    uint8_t * adc_result,
    float * rmx )
```

Calculate rmx resistance.

Note

This is not a generic function. Only use it if indicated in your example program flow.

Parameters

| | | |
|---------|-------------------|----------------------------|
| in | <i>dev</i> | pointer to the device |
| in, out | <i>adc_result</i> | pointer to the adc results |
| in, out | <i>rmx</i> | pointer to the rmx values |

Returns

error code

Return values

| | |
|----------|---------|
| 0 | success |
| $\neq 0$ | error |

5.2.3.3 zmod4xxx_check_error_event()

```
zmod4xxx_err zmod4xxx_check_error_event (
    zmod4xxx_dev_t * dev )
```

Check the error event of the device.

Parameters

| | | |
|----|-----|-----------------------|
| in | dev | pointer to the device |
|----|-----|-----------------------|

Returns

error code

Return values

| | |
|------|---------|
| 0 | success |
| != 0 | error |

5.2.3.4 zmod4xxx_init_measurement()

```
zmod4xxx_err zmod4xxx_init_measurement (
    zmod4xxx_dev_t * dev )
```

Initialize the sensor for corresponding measurement.

Parameters

| | | |
|----|-----|-----------------------|
| in | dev | pointer to the device |
|----|-----|-----------------------|

Returns

error code

Return values

| | |
|------|---------|
| 0 | success |
| != 0 | error |

Note

Before calling function, measurement data set has to be passed the dev->meas_conf

5.2.3.5 zmod4xxx_init_sensor()

```
zmod4xxx_err zmod4xxx_init_sensor (
    zmod4xxx_dev_t * dev )
```

Initialize the sensor after power on.

Parameters

| | | |
|----|-----|-----------------------|
| in | dev | pointer to the device |
|----|-----|-----------------------|

Returns

error code

Return values

| | |
|------|---------|
| 0 | success |
| != 0 | error |

Note

Before calling function, initialization data set has to be passed the dev->init_conf

5.2.3.6 zmod4xxx_null_ptr_check()

```
zmod4xxx_err zmod4xxx_null_ptr_check (
    zmod4xxx_dev_t * dev )
```

Check if all function pointers are assigned.

Parameters

| | | |
|----|-----|-----------------------|
| in | dev | pointer to the device |
|----|-----|-----------------------|

Returns

error code

Return values

| | |
|------|---------|
| 0 | success |
| != 0 | error |

5.2.3.7 zmod4xxx_prepare_sensor()

```
zmod4xxx_err zmod4xxx_prepare_sensor (
    zmod4xxx_dev_t * dev )
```

High-level function to prepare sensor.

Parameters

| | | |
|----|------------|-----------------------|
| in | <i>dev</i> | pointer to the device |
|----|------------|-----------------------|

Returns

error code

Return values

| | |
|-----|---------|
| 0 | success |
| !=0 | error |

5.2.3.8 zmod4xxx_read_adc_result()

```
zmod4xxx_err zmod4xxx_read_adc_result (
    zmod4xxx_dev_t * dev,
    uint8_t * adc_result )
```

Read adc values from the sensor.

Parameters

| | | |
|---------|-------------------|----------------------------|
| in | <i>dev</i> | pointer to the device |
| in, out | <i>adc_result</i> | pointer to the adc results |

Returns

error code

Return values

| | |
|------|---------|
| 0 | success |
| != 0 | error |

5.2.3.9 zmod4xxx_read_rmx()

```
zmod4xxx_err zmod4xxx_read_rmx (
    zmod4xxx_dev_t * dev,
    uint8_t * adc_result,
    float * rmx )
```

High-level function to read rmx.

Note

This is not a generic function. Only use it if indicated in your example program flow.

Parameters

| | | |
|---------|-------------------|----------------------------|
| in | <i>dev</i> | pointer to the device |
| in, out | <i>adc_result</i> | pointer to the adc results |
| in, out | <i>rmx</i> | pointer to the rmx values |

Returns

error code

Return values

| | |
|------|---------|
| 0 | success |
| != 0 | error |

5.2.3.10 zmod4xxx_read_sensor_info()

```
zmod4xxx_err zmod4xxx_read_sensor_info (
    zmod4xxx_dev_t * dev )
```

Read sensor parameter.

Parameters

| | | |
|----|------------|-----------------------|
| in | <i>dev</i> | pointer to the device |
|----|------------|-----------------------|

Returns

error code

Return values

| | |
|------|---------|
| 0 | success |
| != 0 | error |

Note

This function must be called once before running other sensor functions.

5.2.3.11 zmod4xxx_read_status()

```
zmod4xxx_err zmod4xxx_read_status (
    zmod4xxx_dev_t * dev,
    uint8_t * status )
```

Read the status of the device.

Parameters

| | | |
|---------|---------------|--------------------------------|
| in | <i>dev</i> | pointer to the device |
| in, out | <i>status</i> | pointer to the status variable |

Returns

error code

Return values

| | |
|------|---------|
| 0 | success |
| != 0 | error |

5.2.3.12 zmod4xxx_read_tracking_number()

```
zmod4xxx_err zmod4xxx_read_tracking_number (
    zmod4xxx_dev_t * dev,
    uint8_t * track_num )
```

Read tracking number of sensor.

This function needs a pointer as a parameter and return tracking number. The tracking number is uint8_t type and 6 dimension array. Ex: uint8_t track_number[6]; zmod_read_tracking_number(dev, track_number); If function return success, the variable is filled with tracking number of sensor

Parameters

| | | |
|----------------|------------------|-----------------------|
| <i>in</i> | <i>dev</i> | pointer to the device |
| <i>in, out</i> | <i>track_num</i> | number pointer |

Returns

error code

Return values

| | |
|-------------|---------|
| <i>0</i> | success |
| <i>!= 0</i> | error |

5.2.3.13 zmod4xxx_start_measurement()

```
zmod4xxx_err zmod4xxx_start_measurement (
    zmod4xxx_dev_t * dev )
```

Start the measurement.

Parameters

| | | |
|-----------|------------|-----------------------|
| <i>in</i> | <i>dev</i> | pointer to the device |
|-----------|------------|-----------------------|

Returns

error code

Return values

| | |
|-------------|---------|
| <i>0</i> | success |
| <i>!= 0</i> | error |

5.3 zmod4xxx_hal.h File Reference

zmod4xxx hardware abstraction layer (HAL)

5.3.1 Detailed Description

zmod4xxx hardware abstraction layer (HAL)

Version

2.5.1

Author

Renesas Electronics Corporation

5.4 zmod4xxx_types.h File Reference

zmod4xxx types

```
#include <stdint.h>
#include <stdio.h>
```

Data Structures

- struct [zmod4xxx_conf_str](#)
A single data set for the configuration.
- struct [zmod4xxx_conf](#)
Structure to hold the gas sensor module configuration.
- struct [zmod4xxx_dev_t](#)
Device structure ZMOD4xxx.

Typedefs

- typedef int8_t(* [zmod4xxx_i2c_ptr_t](#)) (uint8_t addr, uint8_t reg_addr, uint8_t *data_buf, uint8_t len)
function pointer type for i2c access
- typedef void(* [zmod4xxx_delay_ptr_p](#)) (uint32_t ms)
function pointer to hardware dependent delay function

Enumerations

- enum [zmod4xxx_err](#) {
 ZMOD4XXX_OK = 0, [ERROR_INIT_OUT_OF_RANGE](#), [ERROR_GAS_TIMEOUT](#), [ERROR_I2C](#) = -3,
 [ERROR_SENSOR_UNSUPPORTED](#), [ERROR_CONFIG_MISSING](#), [ERROR_ACCESS_CONFLICT](#), [ERROR_POR_EVENT](#),
 [ERROR_CLEANING](#), [ERROR_NULL_PTR](#) }
error_codes Error codes

5.4.1 Detailed Description

zmod4xxx types

Version

2.5.1

Author

Renesas Electronics Corporation

5.4.2 Typedef Documentation

5.4.2.1 zmod4xxx_delay_ptr_p

```
typedef void(* zmod4xxx_delay_ptr_p) (uint32_t ms)
```

function pointer to hardware dependent delay function

Parameters

| | | |
|----|--------------|-----------------|
| in | <i>delay</i> | in milliseconds |
|----|--------------|-----------------|

Returns

none

5.4.2.2 zmod4xxx_i2c_ptr_t

```
typedef int8_t(* zmod4xxx_i2c_ptr_t) (uint8_t addr, uint8_t reg_addr, uint8_t *data_buf, uint8_t len)
```

function pointer type for i2c access

Parameters

| | | |
|---------|-----------------|--|
| in | <i>addr</i> | 7-bit I2C slave address of the ZMOD4xxx |
| in | <i>reg_addr</i> | address of internal register to read/write |
| in, out | <i>data</i> | pointer to the read/write data value |
| in | <i>len</i> | number of bytes to read/write |

Returns

error code

Return values

| | |
|------|---------|
| 0 | success |
| != 0 | error |

5.4.3 Enumeration Type Documentation**5.4.3.1 zmod4xxx_err**

enum `zmod4xxx_err`

error_codes Error codes

Enumerator

| | |
|--------------------------|---|
| ERROR_INIT_OUT_OF_RANGE | The initialization value is out of range. |
| ERROR_GAS_TIMEOUT | A previous measurement is running that could not be stopped or sensor does not respond. |
| ERROR_I2C | I2C communication was not successful. |
| ERROR_SENSOR_UNSUPPORTED | The Firmware configuration used does not match the sensor module. |
| ERROR_CONFIG_MISSING | There is no pointer to a valid configuration. |
| ERROR_ACCESS_CONFLICT | Invalid ADC results due to a still running measurement while results readout. |
| ERROR_POR_EVENT | Power-on reset event. Check power supply and reset pin. |
| ERROR_CLEANING | The maximum numbers of cleaning cycles ran on this sensor. Cleaning function has no effect anymore. |
| ERROR_NULL_PTR | The dev structure did not receive the pointers for I2C read, write and/or delay. |

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