

## ZMOD4xxx-API Documentation

# Contents

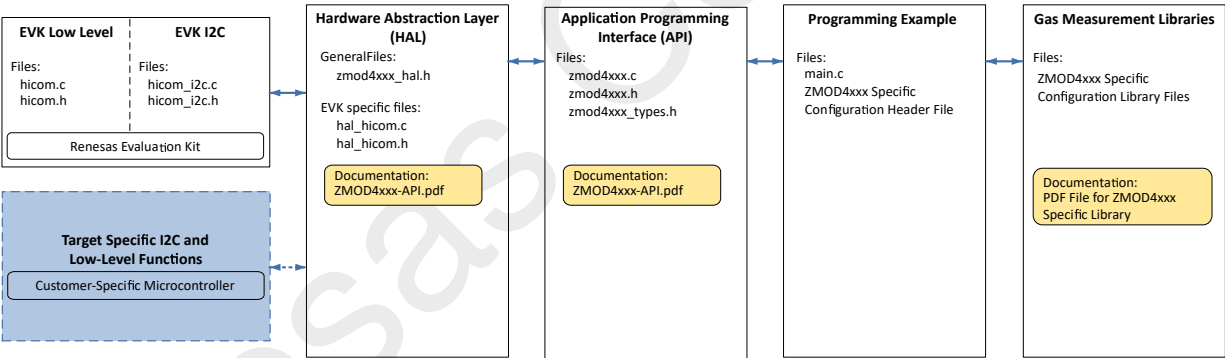
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Chapter 1

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:

<a href="#">zmod4xxx_conf</a>	Structure to hold the gas sensor module configuration . . . . .	4
<a href="#">zmod4xxx_conf_str</a>	A single data set for the configuration . . . . .	4
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## Chapter 3

# File Index

### 3.1 File List

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

<a href="#">hal_hicom.h</a>	Hardware abstraction layer for windows	8
<a href="#">zmod4xxx.h</a>	Zmod4xxx-API functions	10
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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

2.5.2

#### 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	dev	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 rmx 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

2.5.2

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
!= 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 assinged.

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	dev	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	dev	pointer to the device
in, out	adc_result	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	dev	pointer to the device
in, out	status	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.

Note

The buffer pointed to by track\_num must be at least 6 bytes long

Parameters

<i>in</i>	<i>dev</i>	pointer to the device
<i>in, out</i>	<i>track_num</i>	pointer to buffer to store the tracking number

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

2.5.2

## 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  
2.5.2

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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