Indoor Air Quality 2nd Gen. Library Documentation

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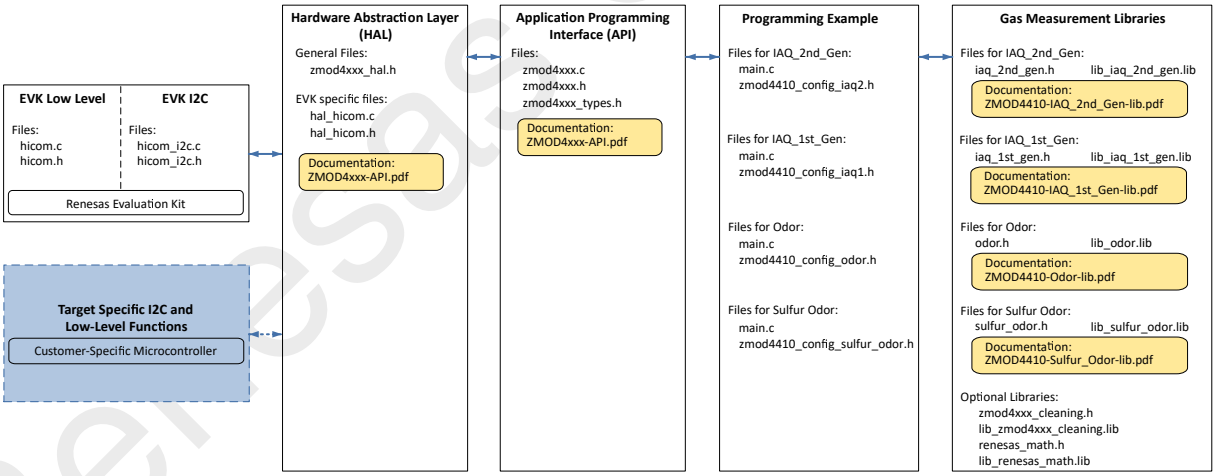
Chapter 1

ZMOD4410 Application Programming Interface Overview

This document describes the libraries for the ZMOD4410 gas sensor module using the second generation algorithms for indoor air quality measurements (IAQ 2nd Gen). This algorithm is the recommended for accurate and consistent TVOC, IAQ and eCO2 measurements. Refer to the *ZMOD4410 Programming Manual - Read Me* for further information regarding sample code. The figure below shows an overview of the ZMOD4xxx API, programming example and libraries. 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 (highlighted in blue). The following sections describe in detail the IAQ 2nd Gen algorithm libraries and an optional cleaning procedure after product assembly.



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Chapter 2

How to Read Library Version

Libraries have library version as variable that can be accessed during run-time.

To access the library version;

```
#include <iaq_2nd_gen.h>

extern algorithm_version iaq_2nd_gen_ver;

int main()
{
    int8_t ret;
    zmod4xxx_dev_t dev;

    /* Sensor target variables */
    uint8_t zmod4xxx_status;
    .
    .

    // Debug library version
    printf("major = %u", iaq_2nd_gen_ver.major);
    printf("minor = %u", iaq_2nd_gen_ver.minor);
    printf("patch = %u", iaq_2nd_gen_ver.patch);
```

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Chapter 3

How to Work with the Renesas Gas Algorithm Libraries

- Include the intended header file in the user's program for gas sensor module control; for example:
  `#include "iaq_2nd_gen.h"`
- Copy the library file into user's project folder
- Call the intended function in the user's program

Example for IAQ:

```
#include "iaq_2nd_gen.h"

int main() {
    int8_t ret;
    iaq_2nd_gen_handle_t iaq_handle;
    iaq_2nd_gen_results_t results;
    zmod4xxx_dev_t dev;

    // User's functionality
    // Hardware initialization

    ret = init_iaq_2nd_gen(&iaq_handle);

    // User's functionality

    while(1) {
        // get sensor results with API
        ret = calc_iaq_2nd_gen(&iaq_handle, &dev, &sensor_results, &results);
    }

    return 0;
}
```

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Chapter 4

Example for zmod4xxx_cleaning:

- Include the intended header file in the user's program for cleaning;
  `#include "zmod4xxx_cleaning.h"`

- Copy the library file into user's project folder
- Call the `zmod4xxx_cleaning_run` function in the user's program
- `IMPORTANT NOTE:` The cleaning procedure can be run only once during the modules lifetime and takes 10 minutes.

```
#include "zmod4xxx_cleaning.h"

int main() {
    // initialization of the device structure(dev)
    zmod4xxx_dev_t dev;

    // User's functionality

    zmod4xxx_cleaning_run(&dev);

    // User's functionality

    return 0;
}
```

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Chapter 5

Module Index

5.1 Modules

Here is a list of all modules:

Return codes of the algorithm functions. 8

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Chapter 6

Data Structure Index

6.1 Data Structures

Here are the data structures with brief descriptions:

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Chapter 7

File Index

7.1 File List

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

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zmod4xxx_cleaning.h
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Chapter 8

Module Documentation

8.1 Return codes of the algorithm functions.

Macros

- #define IAQ_2ND_GEN_OK (0)
- #define IAQ_2ND_GEN_STABILIZATION (1)

8.1.1 Detailed Description

8.1.2 Macro Definition Documentation

8.1.2.1 IAQ_2ND_GEN_OK

```
#define IAQ_2ND_GEN_OK (0)
```

everything okay

8.1.2.2 IAQ_2ND_GEN_STABILIZATION

```
#define IAQ_2ND_GEN_STABILIZATION (1)
```

sensor in stabilization

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Chapter 9

Data Structure Documentation

9.1 algorithm_version Struct Reference

Variables that describe the library version.

```
#include <iaq_2nd_gen.h>
```

Data Fields

- uint8_t **major**
- uint8_t **minor**
- uint8_t **patch**

9.1.1 Detailed Description

Variables that describe the library version.

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

- iaq_2nd_gen.h

9.2 iaq_2nd_gen_handle_t Struct Reference

Variables that describe the sensor or the algorithm state.

```
#include <iaq_2nd_gen.h>
```

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Data Fields

- float log_rcda [9]
- uint8_t stabilization_sample
- uint8_t **need_filter_init**
- float **tvoc_smooth**
- float **tvoc_deltafilter**
- float **acchw**
- float **accow**
- float **etoh**
- float **tvoc**
- float **eco2**
- float **iaq**

9.2.1 Detailed Description

Variables that describe the sensor or the algorithm state.

9.2.2 Field Documentation

9.2.2.1 log_rcda

```
float log_rcda[9]
```

log10 of CDA resistances.

9.2.2.2 stabilization_sample

```
uint8_t stabilization_sample
```

Number of remaining stabilization samples.

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

- iaq_2nd_gen.h

9.3 iaq_2nd_gen_results_t Struct Reference

Variables that receive the algorithm outputs.

```
#include <iaq_2nd_gen.h>
```

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Data Fields

- float rmox [13]
- float log_rcda
- float iaq
- float tvoc
- float etoh
- float eco2

9.3.1 Detailed Description

Variables that receive the algorithm outputs.

9.3.2 Field Documentation

9.3.2.1 eco2

```
float eco2
```

eCO2 concentration (ppm).

9.3.2.2 etoh

```
float etoh
```

EtOH concentration (ppm).

9.3.2.3 iaq

```
float iaq
```

IAQ index.

9.3.2.4 log_rcda

```
float log_rcda
```

log10 of CDA resistance.

9.3.2.5 rmox

```
float rmox[13]
```

MOx resistance.

9.3.2.6 tvoc

```
float tvoc
```

TVOC concentration (mg/m^3).

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

- iaq_2nd_gen.h

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Chapter 10

File Documentation

10.1 iaq_2nd_gen.h File Reference

This file contains the data structure definitions and the function definitions for the 2nd generation IAQ algorithm.

```
#include <stdint.h>
#include <math.h>
#include "zmod4xxx_types.h"
```

Data Structures

- struct algorithm_version

  Variables that describe the library version.
- struct iaq_2nd_gen_handle_t

  Variables that describe the sensor or the algorithm state.
- struct iaq_2nd_gen_results_t

  Variables that receive the algorithm outputs.

Macros

- #define IAQ_2ND_GEN_OK (0)
- #define IAQ_2ND_GEN_STABILIZATION (1)

Functions

- int8_t calc_iaq_2nd_gen (iaq_2nd_gen_handle_t *handle, zmod4xxx_dev_t *dev, const uint8_t *sensor_↩ results_table, iaq_2nd_gen_results_t *results)

  calculates IAQ results from present sample.
- int8_t init_iaq_2nd_gen (iaq_2nd_gen_handle_t *handle)

  Initializes the IAQ algorithm.

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10.1.1 Detailed Description

This file contains the data structure definitions and the function definitions for the 2nd generation IAQ algorithm.

Author

Renesas Electronics Corporation

Version

2.2.0

The library contains an algorithm to calculate an EtOH, TVOC and IAQ index from ZMOD4410 measurements. The implementation is made to allow more than one sensor.

10.1.2 Function Documentation

10.1.2.1 calc_iaq_2nd_gen()

```
int8_t calc_iaq_2nd_gen (
            iaq_2nd_gen_handle_t * handle,
            zmod4xxx_dev_t * dev,
            const uint8_t * sensor_results_table,
            iaq_2nd_gen_results_t * results )
```

calculates IAQ results from present sample.

Parameters

in	*handle*	Pointer to algorithm state variable.
in	*dev*	Pointer to the device.
in	*sensor_results_table*	Array of 32 bytes with the values from the sensor results table.
out	*results*	Pointer for storing the algorithm results.

Returns

error code.

10.1.2.2 init_iaq_2nd_gen()

```
int8_t init_iaq_2nd_gen (
            iaq_2nd_gen_handle_t * handle )
```

Initializes the IAQ algorithm.

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Parameters

out	*handle*	Pointer to algorithm state variable.

Returns

error code.

10.2 zmod4xxx_cleaning.h File Reference

This file contains the cleaning function definition for ZMOD4xxx.

```
#include "zmod4xxx.h"
```

Functions

- int8_t zmod4xxx_cleaning_run (zmod4xxx_dev_t *dev)
  Start a cleaning procedure.

10.2.1 Detailed Description

This file contains the cleaning function definition for ZMOD4xxx.

Version

2.4.2

Author

Renesas Electronics Corporation

The library contains the function that starts the cleaning procedure. **The procedure takes 10 minutes.** After successful cleaning, the function returns 0. **The procedure can be run only once.**

10.2.2 Function Documentation

10.2.2.1 zmod4xxx_cleaning_run()

```
int8_t zmod4xxx_cleaning_run (
            zmod4xxx_dev_t * dev )
```

Start a cleaning procedure.

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Parameters

in	*dev*	pointer to the device

Returns

Error code

Return values

0	Success
!= 0	Error

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