IQ Home Sensor Protocol Documentation

Revision: 18.10
Date: 2018-10-25

www.iqhome.org

Contents

1 Compatible device list

The sensor is a battery powered measurement tool designed to use in sensor networks controlled by Fast Response Commands (FRC). The protocol is based on major DPA version 3.

RF Network	IQRF DPA
HWPID	0x1A5F
HWPIDver	2.0.xx (0x20xx)
IQRF OS	4.02D
IQRF DPA	3.02
IQRF RF Mode	LP (Low Power)
Default RF Channel	52 (868.35 MHz)

1.1 Compatible devices

Next table shows the devices which implement protocol described in this document. The table contains the Product code, the product name and the measurable values.

Code	Product name	T [°C]	rH [%]	CO_2 [ppm]
SN-T-02	Temperature sensor	✔		
SN-TH-02	Temperature and Relative Humidity Sensor	✔	✔	
SN-THC-02	CO2 + Temperature and Relative Humidity Sensor	✔	✔	✔
SI-T-02	Industrial Temperature Sensor	✔		
SI-TH-02	Industrial Temperature and Relative Humidity Sensor	✔	✔	

1.2 Measurement procedure

The temperature, relative humidity and CO_2 concentration measurements are made in background. The measurement starts after reset or after module wakes up from sleep and automatically repeats the measurements in every 12 seconds in background. The measurement do not blocks the RF communication process. The sensor response immediately to peripheral request and to fast response commands, does not need additional conversion time.

If the node get a data request before the first measurement is finished the node response with sensor error. Recommended minimum waiting time between module wake up and the first data request 1 sec.

2 Read measured values

PNUM	PCMD
0x30	0x00

The command is usable to collect 16 bit wide representable physical measurable ambient quantities like ambient temperature in °C, Relative Humidity in %, CO_2 concentration in ppm, VOC concentration in ppm, air pressure, etc....

2.1 Request

The request does not contain any PDATA information.

Request			
NADR [2B]	**PNUM [1B]**	**PCMD [1B]**	**HWPID [2B]**
NADR	0x30	0x00	0x15AF or 0xFFFF

2.2 Response

The addressed node response with all measured ambient data information in PDATA.

Response						
NADR [2B]	**PNUM [1B]**	**PCMD [1B]**	**HWPID [2B]**	**ErrN [1B]**	**DpaValue [1B]**	**PDATA [4, 7 or 10B]**
NADR	0x30	0x80	0x15AF	0x00	?	Measured values

2.2.1 PDATA structure of the response

Response PDATA array contains 1 byte long status register and set of 3 byte long measured value entries.

PDATA										
1. byte	**2. byte**	**3. byte**	**4. byte**	**5. byte**	**6. byte**	**7. byte**	**8. byte**	**9. byte**	**10. byte**	***11. … 46. byte***
Status reg.	Type	Value		Type	Value		Type	Value		*More Type and Value pairs*

Example:

- If sensor can measure only one quantity (for example: temperature value), than the sensor response with 1 byte status register and 3 byte long measured value entry in PDATA array.
- If sensor can measure one Temperature and on Relative Humidity value, than the sensor response with 1 byte status register and 6 byte long measured value entry list in PDATA array.

2.2.2 Structure of status register (1 byte)

Next table shows the **bit** structure of Status register byte.

Status Register Byte							
7. bit	**6. bit**	**5. bit**	**4. bit**	**3. bit**	**2. bit**	**1. bit**	**0. bit**
Battery Low	F.U.	F.U.	F.U.	Number of measured values			

Meanings of bit fields:

- Battery Low
  - 0 = Appropriate battery state
  - 1 = The battery starts to run out
- F.U.
  - Unimplemented, reserved for future use.
- Number of measured values
  - Number of upcoming measured values entries.

2.2.3 Structure of measured value entry (3 byte)

Measured value entry contains:

- 1st byte: Data type (1st byte)
- 2nd byte: Low byte of measured value
- 3th byte: High byte of measured value

Next table shows the Structure of one measured value entry:

Data block of one Measured value		
1. byte	**2. byte**	**3. byte**
Type	Value (low byte) [0-7 bit]	Value (high byte) [8-15 bit]

2.2.3.1 Structure of Data Type Byte

Data type byte describes the meaning of following data value.
Next table shows the data type **bit** structure.

Data Type Byte							
7. bit	**6. bit**	**5. bit**	**4. bit**	**3. bit**	**2. bit**	**1. bit**	**0. bit**
F.U.				Type of measured quantity			

Meanings of bit fields:

- F.U.
  - Unimplemented, reserved for future use.
- Type of measured quantity
  - like Temperature, Relative Humidity, CO2, etc… Next table shows the exact type of measured quantities

Type of measured quantity

Representation number	Measured quantity
0x00	Reserved (status register response @ FRC)
0x01	Temperature
0x02	Relative Humidity
0x03	CO_2 concentration
0x04 - 0x0F	Reserved

2.2.4 2.2.4. Data value

Data value is a 16 bit wide signed binary data represented in two's complement.

Measured Data Value															
15.	**14.**	**13.**	**12.**	**11.**	**10.**	**9.**	**8.**	**7.**	**6.**	**5.**	**4.**	**3.**	**2.**	**1.**	**0.**
SIGN	2^{14}	2^{13}	2^{12}	2^{11}	2^{10}	2^{9}	2^{8}	2^{7}	2^{6}	2^{5}	2^{4}	2^{3}	2^{2}	2^{1}	2^{0}

- Minimum representable value = -32764 (0x8004)
- Maximum representable value = +32767 (0x7FFF)
- Resolution = 1
- Error code = 0x8000 (Sensor error)
- Restricted values = 0x8001, 0x8002, 0x8003

2.2.5 Exact meaning of data values

Next table shows the exact meaning of data values based on measured quantity.*

Measured quantity	Data representation number	Unit	Response value Calculation	Resolution	Minimum value	Maximum value
Temperature	0x01	°C	T [°C] = Data value / 16	0.0625 °C	-2047.75 °C	+2047.9375 °C
Relative Humidity	0x02	%	rH [%] = Data value / 16	0.0625 %	-2047.75 %	+2047.9375 %
CO_2 concentration	0x03	ppm	CO_2 [ppm] = Data value	1 ppm	-32764 ppm	+32767 ppm

**At sensor error the response value equal with 0x8000.*

2.2.6 PDATA response examples

Example: The sensor can measure temperature only. The measured Temperature is 25.5 °C. Battery state is ok.

PDATA			
1. byte	**2. byte**	**3. byte**	**4. byte**
0x01	**0x01**	0x98	0x01

- 1. byte = 0x01 - Battery state is ok, Number of measured values: 1
- 2. Byte = 0x01 - Next value is temperature value
- 3. - 4. Byte = 0x0198 -> 25.5 °C. (0x0198 = 408 -> 408/16= 25.5)

Example: The sensor can measure temperature only. The sensor detected sensor error.

PDATA			
1. byte	**2. byte**	**3. byte**	**4. byte**
0x01	**0x01**	0x00	0x80

- 1. byte = 0x01 - Battery state is ok, Number of measured values: 1
- 2. Byte = 0x01 - Next value is temperature value
- 3. - 4. Byte = 0x8000 -> Sensor error

Example: The sensor can measure temperature only. The measured Temperature is -12.25 °C. Battery state is low.

PDATA			
1. byte	**2. byte**	**3. byte**	**4. byte**
0x81	**0x01**	0x3C	0xFF

- 1. byte = 0x81 - Battery state is low (MSB bit equal with 1), Number of measured values: 1
- 2. Byte = 0x01 - Next value is temperature value
- 3. - 4. Byte = 0xFF3C -> -12.25 °C. (-(0x10000 - 0xFF3C) = -196 -> -196/16= 12.25)

Example: The sensor can measure temperature, relative humidity and CO_2 concentrate. The measured Temperature is 45 °C, Relative Humidity is 62.25%, the CO_2 concentrate is 925 ppm.

PDATA									
1. byte	**2. byte**	**3. byte**	**4. byte**	**5. byte**	**6. byte**	**7. byte**	**8. byte**	**9. byte**	**10. byte**
0x03	**0x01**	0xD0	0x02	**0x02**	0xE4	0x03	**0x03**	0x9D	0x03

- 1. byte = 0x03 - Battery state is ok, Number of measured values: 3
- 2. Byte = 0x01 - Next value is temperature value
- 3. - 4. Byte = 0x02D0 -> 45 °C. (0x02D0 = 720 -> 720/16= 45)
- 5. Byte = 0x02 - Next value is relative humidity
- 6. - 7. Byte = 0x03E4 -> 62.25%. (0x03E4 = 996 -> 996/16= 62.25)
- 8. Byte = 0x01 - Next value is temperature value
- 9. - 10. Byte = 0x039D -> 925 ppm. (0x039D = 925)

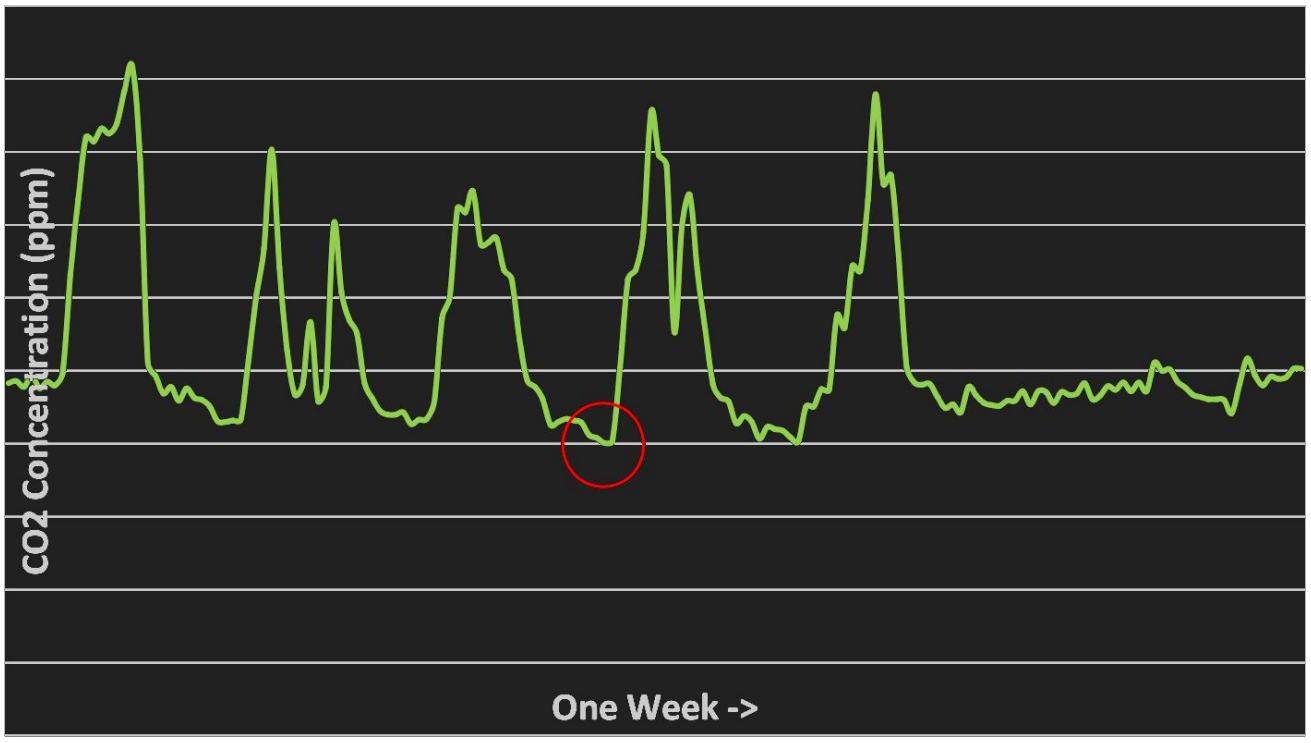
3 Auto calibration - CO2

CO_2 sensor modules are fully calibrated prior to shipping from the factory. Over time, the zero point of the sensor needs to be calibrated to maintain the long term stability of the sensor. In many applications, this can happen automatically using the built in auto-calibration function.

This technique can be used in situations in which sensors will be exposed to typical background levels (400-450ppm) at least once during the auto-calibration period. For example, many buildings will drop quickly to background CO_2 levels when unoccupied overnight or at weekends. The auto-calibration function uses the information gathered at these periods to recalibrate.

The sensor has a zero calibration option designed to allow users to implement an network centralized autocalibration routine.

This recording from a sensor shows a typical one week recording in an office environment. The auto-calibration function uses the low point (circled) and uses it to recalibrate the zero point.



3.1 Environmental Requirements for Auto-calibration

Exposure to Fresh Air
The sensor must 'see' fresh air at least once during the auto-calibration period. You do not need to know when the fresh air will be sensed, just that it will be sensed at some point during the period.

Continuously Powered
The auto-calibration information is deleted when the sensor is switched off. This ensures that each installation is unaffected by any previous history of the sensor. For auto-calibration to function, it must be power on for the whole of the auto-calibration period.

Autocalibration Interval
Autocalibration is depend from current sensor usage. The minimum recommended autocalibration interval is one or two week at generally usage.

3.2 Implementing auto-calibration

The sensor has a zero calibration option designed to allow users to implement network centralized autocalibration routine. To implement auto-calibration the user have to implement these steps:

- First, select a calibration period. The choice of period should be long enough to ensure exposure to fresh air, so should usually be no less than one week.
- Next, select the value of background CO_2 expected. The recommended default minimum value is 400ppm, but it could be different based on current usage.
- The sensor automatically records the lowest CO_2 value from power-up or from last auto-calibration command. The user don't need to care about it.
- Finally, send the auto-calibration DPA command after after a period of time to correct the minimum measured CO_2 value to value sent in command parameter. The command can be sent
    - Directly with direct node addressing;
    - With broadcast addressing (Node address = 0xFF);
    - With acknowledged broadcast FRC command (More information: IQRF DPA Framework - Technical Guide).
      Note that this command can only be used once on a set of historic readings. The command automatically erases the recorded minimum value stored in the sensor. The next calibration command have to be sent at end of the new calibration period.

3.3 Auto-Calibration Command

PNUM	PCMD
0x30	0x0F

3.3.1 3.3.1. Request

The request contains 3 byte PDATA information.

Request						
NADR [2B]	**PNUM [1B]**	**PCMD [1B]**	**HWPID [2B]**	**PDATA 1. byte**	**PDATA 2. byte**	**PDATA 3. byte**
NADR	0x30	0x0F	0x15AF or 0xFFFF	Type (0x03)	Calibration value (low byte) [0-7 bit]	Calibration value (high byte) [8-15 bit]

- First byte is the type of the calibration value. Current protocol implements only CO_2 calibration (Type have to be equal with 0x03)
- Second and third byte is the new calibration (minimum) value. The numerical representation of the calibration value is equal with data value representation described in chapter Data value.

3.3.2 Response

The addressed node response with minimum measured CO_2 value from last calibration command or from last power-up.

Response								
NADR [2B]	**PNUM [1B]**	**PCMD [1B]**	**HWPID [2B]**	**ErrN [1B]**	**DpaValue [1B]**	**PDATA 1. byte**	**PDATA 2. byte**	**PDATA 3. byte**
NADR	0x30	0x8F	0x15AF	0x00	?	Type (0x03)	Min. Value (low byte) [0-7 bit]	Min. Value (high byte) [8-15 bit]

- First byte is the type of the minimum value. Current protocol implements only CO_2 calibration (Type will equal with 0x03)
- Second and third byte is the minimum measured CO_2 value from last calibration command or from last power-up. The numerical representation of the minimum measured CO_2 value is equal with data value representation described in chapter Data value.

3.4 Auto-Calibration examples

Example #1:
For example, if the lowest reading measured of Node #1 over 3 weeks was 415ppm, and the user wants to correct that to read 400ppm, the user have to send DPA command with value: 400ppm. 400 ppm = 0x0190

Request						
NADR [2B]	**PNUM [1B]**	**PCMD [1B]**	**HWPID [2B]**	**PDATA 1. byte**	**PDATA 2. byte**	**PDATA 3. byte**
0x0001 (NADR)	0x30	0x0F	0x15AF	0x03 (Type)	0x90 (low byte of the calibration value)	0x01 (high byte of the calibration value)

The response contains the measured minimum value. Minimum measured value was 415 ppm. 415 ppm = 0x019F

Response								
NADR [2B]	**PNUM [1B]**	**PCMD [1B]**	**HWPID [2B]**	**ErrN [1B]**	**DpaValue [1B]**	**PDATA 1. byte**	**PDATA 2. byte**	**PDATA 3. byte**
0x0001 (NADR)	0x30	0x8F	0x15AF	0x00	?	0x03 (Type)	0x9F Min. Value (low byte) [0-7 bit]	0x01 Min. Value (high byte) [8-15 bit]

Example #2:
To make half a month periodic whole network auto-calibration the user have to send auto-calibration broadcast message in every 14 days. For example, if user wants to correct the minimum measured value to 400ppm, the user have to send broadcast DPA message with value: 435ppm. 435 ppm = 0x01B3

Request						
NADR [2B]	**PNUM [1B]**	**PCMD [1B]**	**HWPID [2B]**	**PDATA 1. byte**	**PDATA 2. byte**	**PDATA 3. byte**
0x00FF Broadcast	0x30	0x0F	0x15AF	0x03 (Type)	0xB3 (low byte of the calibration value)	0x01 (high byte of the calibration value)

The broadcast DPA message does not have any response message.

4 Read product information

PNUM	PCMD
0x3E	0x00

The command is usable to get basic information about the product.

4.1 Request

The request does not contains any PDATA information.

Request			
NADR [2B]	**PNUM [1B]**	**PCMD [1B]**	**HWPID [2B]**
NADR	0x3E	0x00	0x15AF or 0xFFFF

4.2 Response

The addressed node response with all basic product information.

Response						
NADR [2B]	**PNUM [1B]**	**PCMD [1B]**	**HWPID [2B]**	**ErrN [1B]**	**DpaValue [1B]**	**PDATA [16B]**
NADR	0x3E	0x80	0x15AF	0x00	?	Product information

4.2.1 PDATA structure of the response

Response PDATA array contains 16 byte long product information string.

PDATA															
1. byte	2. byte	3. byte	4. byte	5. byte	6. byte	7. byte	8. byte	9. byte	10. byte	11. byte	12. byte	13. byte	14. byte	15. byte	16. byte
Product Code											Hardware revision				

- Product Code = Main product code of the product stored in ASCII characters.
- Hardware revision = Internal information about the hardware revision.

5 FRC - 1 Byte long sensor data collection

PNUM	PCMD	FRC command
0x0D	0x00 or 0x02	0xDF

This FRC command is used to collect measured sensor values in 1 byte wide representation format. All measured quantities have to have 1 byte wide FRC representation format. The data collection can be done

- with normal FRC (PCMD=0x00) command
- and with selective FRC (PCMD=0x02) command.

More information about the FRC command can be found in IQRF DPA Framework - Technical Guide.

5.1 Request

Next table shows the structure of the request FRC command.

Request								
NADR [2B]	**PNUM [1B]**	**PCMD [1B]**	**HWPID [2B]**	**FRC Command**	**User data 1. byte**	**User data 2. byte**	**User data 3. byte**	**User data 4. byte**
0x0000 Coordi-nator	0x0D	0x00	0xFFFF	0xDF	0x30 Ambient sensor	Data type identifier	Sleep time (low byte)	Sleep time (high byte)

- At FRC Commands the addressable node have to be coordinator (0x00).
- 1st byte of PDATA = FRC Command.
  0xDF: 1 Byte wide sensor data collection.
- 2nd byte of PDATA = 1st user data byte.
  0x30: Ambient sensor mode
- 3th byte of PDATA = 2nd user data byte.
  Data type byte: equals with data type described in chapter Structure of Data Type Byte.
- 4th and 5th byte of PDATA = 3th and 4th user data byte.
  Sleep time: If this parameter is bigger than zero and less than 0x8000 the nodes entries to deep sleep mode after FRC command. Sleep time = sleep value * 2.097 sec.
  Minimum sleep time is: 2.097 sec
  Maximum sleep time is: 32767 * 2.097 sec = 68712 sec (19 hour)
  If Sleep time equal with zero or the MSB bit of sleep value is true then the device remains awake.
  The sleep command is executed regardless the FRC command sub-parameter (1st user data byte) or the requested data type (2nd user data byte) is not implemented in sensor.

5.2 Response

Response							
NADR [2B]	**PNUM [1B]**	**PCMD [1B]**	**HWPID [2B]**	**ErrN [1B]**	**DpaValue [1B]**	**PDATA 1. byte**	**PDATA 2… n. byte**
0x0000 Coordi-nato	0x0D	0x80	?	0x00	?	Status	FRC Data

- Status:
  Return code of the sendFRC IQRF OS function. See IQRF OS documentation for more information.
- FRC data:
  Data collected from the nodes. Because the current version of DPA cannot transfer the whole FRC output buffer at once (currently only up to 55 bytes), the remaining bytes of the buffer can be read by the next described Extra result command. (More information: IQRF DPA Framework - Technical Guide.)

5.2.1 Response values

All of the addressed node response with one byte response value. Collected bytes from each node (1-63) are stored in bytes 1-63 of the output buffer. Addressing of the output buffer is starting from zero. Zero as a node number is reserved for the coordinator, therefore the first byte of the output buffer is always zero.

The response value is equal with measured sensor information or contains status information.

5.2.1.1 Reserved FRC response values (status information)

- 0x00 => No response from node
- 0x01 => FRC command or sensor data type is not implemented
- 0x02 => Sensor error
- 0x03 => Reserved (default response value at status register query)

5.2.1.2 Normal FRC response values (measured sensor values)

Response value from 0x04 to 0xFF represents measured sensor value. Exact meaning of sensor value depends on the measured quantity requested by Data type byte in FRC request parameter.

Next table show the value calculation of 1 byte long FRC response sensor values.

Measured quantity	Data representation number	Unit	Response value Calculation	Resolution	Minimum value	Maximum value
Status Register	0x00	-	Upper four bit of Status register + 0x03	-	-	-
Temperature	0x01	°C	T [°C] = (Data value / 2) - 42	0.5 °C	-40 °C	+85.5 °C
Relative Humidity	0x02	%	rH [%] = (Data value / 2) - 2	0.5 %	0 %	+125.5 %
CO_2 concentration	0x03	ppm	CO_2 [ppm] = (10 * Data value) + 350	10 ppm	390 ppm*	2900 ppm

** The minimum level of atmospheric carbon dioxide is higher than 400 ppm. (More info)*

6 FRC - 2 Byte long sensor data collection

PNUM	PCMD	FRC command
0x0D	0x00 or 0x02	0xFF

This FRC command is used to collect measured sensor values in 2 byte wide representation format. All measured quantities have to have 2 byte wide FRC representation format. The data collection can be done

- with normal FRC (PCMD=0x00) command
- and with selective FRC (PCMD=0x02) command.

More information about FRC command can be found in IQRF DPA Framework - Technical Guide.

6.1 Request

Next table shows the structure of request FRC command.

Request								
NADR [2B]	**PNUM [1B]**	**PCMD [1B]**	**HWPID [2B]**	**FRC Command**	**User data 1. byte**	**User data 2. byte**	**User data 3. byte**	**User data 4. byte**
0x0000 Coordi-nator	0x0D	0x00	0xFFFF	0xFF	0x30 Ambient sensor	Data type identifier	Sleep time (low byte)	Sleep time (high byte)

The format of 2 byte long FRC request user data equals to 1 byte long FRC request user data format. The exact meaning of user data array described in chapter FRC - 1 Byte long sensor data collection - Request.

6.2 Response

Response							
NADR [2B]	**PNUM [1B]**	**PCMD [1B]**	**HWPID [2B]**	**ErrN [1B]**	**DpaValue [1B]**	**PDATA 1. byte**	**PDATA 2… n. byte**
0x0000 Coordi-nato	0x0D	0x80	?	0x00	?	Status	FRC Data

The basic format of 2 byte long FRC response to 1 byte long FRC response format. The basic information about the Status register and FRC Data is described in chapter FRC - 1 Byte long sensor data collection - Response.

6.2.1 Response values

All of the addressed node response with two byte response value. Collected byte pairs from each node (1-31) are stored in bytes 2-63 of the output buffer. Addressing of the output buffer is starting from zero. Zero as a node number is reserved for the coordinator, therefore the first two byte of the output buffer is always zero. The lower index of the byte pair contains the low significant byte information (low byte), the higher index of the byte pair contains the most significant byte information (high byte).
The response value is equal with measured sensor information or contains status information.

6.2.1.1 Reserved FRC response values (status information)

- 0x0000 => No response from node
- 0x0001 => FRC command or sensor data type is not implemented
- 0x0002 => Sensor error
- 0x0003 => Reserved (default response value at status register query)

6.2.1.2 Normal FRC response values (measured sensor values)

Response value from 0x0004 to 0xFFFF represents measured sensor value. Exact meaning of sensor value depends on the measured quantity requested by Data type byte in FRC request parameter.

The response values are equal with response values described in chapter Exact meaning of data values except if the calculated value is between zero and four. In such cases the FRC response values equal with calculated value + 0x8000.

Next table show the value calculation of 2 byte long FRC response sensor values.

Measured quantity	Data representation number	Unit	Response value Calculation	Resolution	Minimum value	Maximum value
Status Register	0x00	-	Upper four bit of Status register + 0x03	-	-	-
Temperature*	0x01	°C	T [°C] = Data value / 16	0.0625 °C	-2047.75 °C	+2047.9375 °C
Relative Humidity*	0x02	%	rH [%] = Data value / 16	0.0625 %	-2047.75 %	+2047.9375 %
CO_2 concentration*	0x03	ppm	CO_2 [ppm] = Data value	1 ppm	-32764 ppm	+32767 ppm

**The response values of 2 byte wide FRC queries have four representation exception:*

- *If the calculated response value equals with 0x0000 the FRC response value is 0x8000.*
- *If the calculated response value equals with 0x0001 the FRC response value is 0x8001.*
- *If the calculated response value equals with 0x0002 the FRC response value is 0x8002.*
- *If the calculated response value equals with 0x0003 the FRC response value is 0x8003.*

7 Release Notes

Property	Value
Protocol version	2.0.xx
IQRF OS version	4.00D
IQRF DPA version	3.00
Date of release	25/07/2017
Notes	First revision of IQ Home sensor protocol version 2.

Property	Value
Protocol version	2.0.xx
IQRF OS version	4.02D
IQRF DPA version	3.02
Date of release	11/05/2018
Notes	Device list has been modified Bonding documentation moved to product datasheet

Property	Value
Protocol version	2.0.xx
IQRF OS version	4.02D
IQRF DPA version	3.02
Date of release	02/06/2018
Notes	Sleep calculation is modified. - MSB bit check is added.