

Delta Electronics Inc.

UNOnext Modbus/RTU protocol

Revision

Date	Version	Description
2020-07-09	V1.3	First released version
2020-07-28	V1.5	Toggle for ventilation control function
2021-03-24	V1.6	Add setting of rs485 slave parameters
2021-04-14	V1.7	More description for RS485 connection
2021-05-06	V1.8	Add registers for temperature in Fahrenheit
2021-08-18	V1.9	Add section of CO ₂ calibration and temperature calibration
2021-09-22	V1.10	Add IAQ index

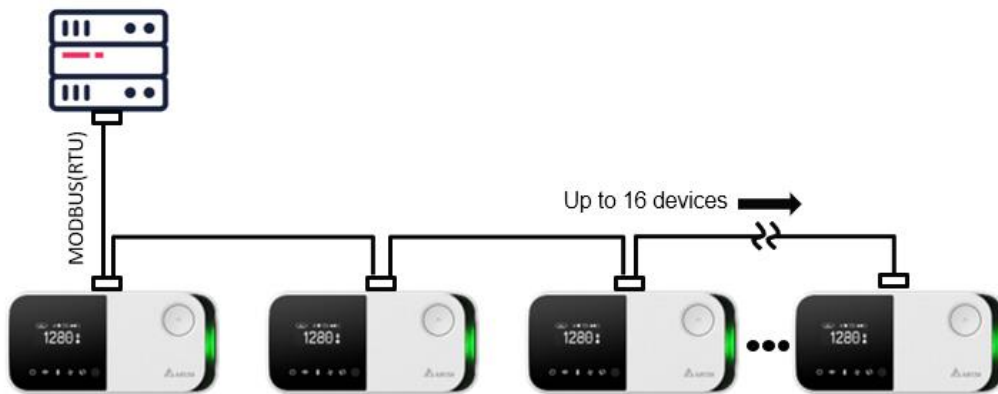
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1. Communication

- UNOnext can directly connect to a controller with RS485 interface, up to 16 devices can be connected to one controller.



Suggestion to use 22AWG shielded twisted pair cable to connect devices in sequence.

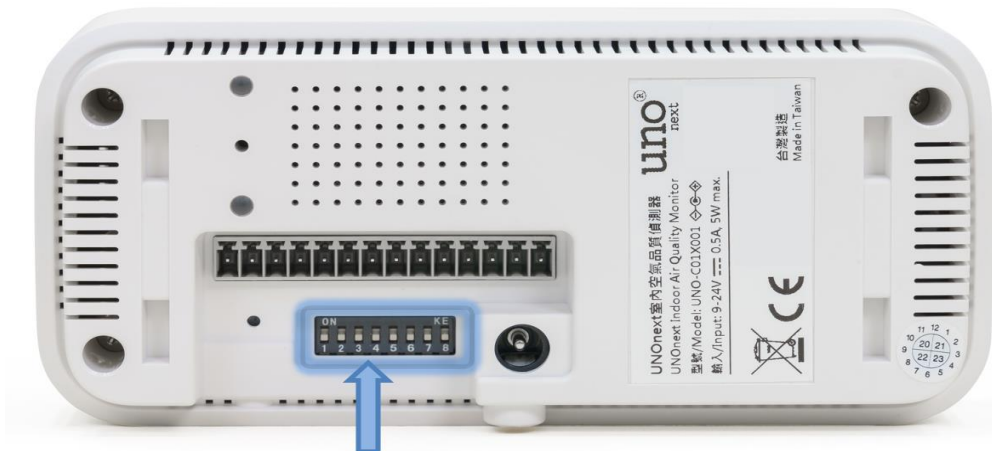
- UART configuration
 Baud: 9600 by default, also supports 38400 / 57600 / 115200 modified by Modbus/RTU protocol.
 Data-bit: 8
 Parity: None
 Stop-bit: 1

- Follow Modbus over serial line specification

A. Format of frame

Application Data Unit (ADU)			
Protocol Data Unit (PDU)			
Address	Function	Data	CRC
8-bits	8-bits	N * 8-bits	16-bits

B. Address



User can use dip switch pin 2-5 to set Modbus slave address

The address starts from 0xD0(208), please refer the address setting table to switch pins.

Modbus slave address		Pin Number of DIP Switches			
Decimal	Hexadecimal	2	3	4	5
208	0xD0	↓	↓	↓	↓
209	0xD1	↓	↓	↓	↑
210	0xD2	↓	↓	↑	↓
211	0xD3	↓	↓	↑	↑
212	0xD4	↓	↑	↓	↓
213	0xD5	↓	↑	↓	↑
214	0xD6	↓	↑	↑	↓
215	0xD7	↓	↑	↑	↑
216	0xD8	↑	↓	↓	↓
217	0xD9	↑	↓	↓	↑
218	0xDA	↑	↓	↑	↓
219	0xDB	↑	↓	↑	↑
220	0xDC	↑	↑	↓	↓
221	0xDD	↑	↑	↓	↑
222	0xDE	↑	↑	↑	↓
223	0xDF	↑	↑	↑	↑

C. Function code

Following codes are supported:

Code	Description
0x03	Read holding registers <i>as well as input registers</i>
0x04	Read input registers
0x06	Write single holding register
0x10	Write multiple holding registers
0x2B/0x0E	Read Device Identification

D. Cyclic Redundancy check (CRC)

```
// CRC example
uint16_t crc16(uint8_t *buf, uint8_t len) {
    uint16_t crc = 0xFFFF;
    int i;
    for (int pos = 0; pos < len; pos++) {
        crc ^= (uint16_t)buf[pos];
        i = 0;
        for (i = 8; i != 0; i--) {
            if ((crc & 0x0001) != 0) {
                crc >>= 1;
                crc ^= 0xA001;
            }
            else {
                crc >>= 1;
            }
        }
    }
    return crc;
}
```

2. Function and Registers specification

This chapter details the format of data packet for supported function codes

2.1. Read information of UNOnext

1. Function code: 0x03

Request:

Slave Address 1 byte	Function code 1 byte	Register 2 bytes	Length [N] 2 bytes	CRC16 2 bytes
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Response

Slave Address 1 byte	Function code 1 byte	Count [2 * N] 1 byte	Data N * 2 bytes	CRC16 2 bytes
-------------------------	-------------------------	-------------------------	---------------------	------------------

2. Register list (**Read only**):

<i>Sensor Measurement*</i>			
<i>Note: sensors vary by device model</i>			
Register		Name	Description
30001	0x0000	IAQ index	Give an index according to current PM2.5, PM10, and CO2 concentration. The index also be referenced by IAQ LED: GREEN: 0-80 YELLOW: 81-100 RED: 101-400 PURPLE: 400+
30002	0x0001	Concentration of PM2.5	Unit: $\mu\text{g}/\text{m}^3$
30003	0x0002	Concentration of PM10	Unit: $\mu\text{g}/\text{m}^3$
30004	0x0003	Concentration of carbon dioxide (formula CO ₂)	Unit: ppm
30005	0x0004	Concentration of total volatile organic compound (TVOC)	Unit: ppb
30009	0x0008	Humidity	Unit: 0.01 %
30011	0x000A	Temperature in Celsius	Real Temperature = (Value - 4500) Unit: 0.01 °C
30012	0x000B	Delta Temperature	Unit: 0.01 % Real Temperature after compensation = Real Temperature – Delta Temperature

30013	0x000C	Formaldehyde (formula HCHO) concentration	Unit: ppb				
30015	0x000E	Ozone (formula O ₃) concentration	Unit: ppb				
30016	0x000F	Concentration of carbon monoxide (formula CO)	Unit: ppm				
30018	0x0011	Temperature in Fahrenheit	Real Temperature = (Value - 4500) Unit: 0.01 °F				
30019	0x0012	Ambient light intensity	Unit: lux				
30026	0x0019	Temperature in Fahrenheit from negative temperature coefficient (NTC) thermistor	Real Temperature = (Value - 4500) Unit: 0.01 °F <i>Note: 0 if thermistor is not installed</i>				
30029	0x001C	Temperature in Celsius from negative temperature coefficient (NTC) thermistor	Real Temperature = (Value - 4500) Unit: 0.01 °C <i>Note: 0 if thermistor is not installed</i>				
Sensor State							
Register		Name	Description				
30033	0x0020	PM2.5 sensor	0x00 Power off or does not exist 0x01 Ready 0x02 Warming Up 0x03 Busy 0xFE(254) CSERROR 0xFF(255) FAIL				
30034	0x0021	PM10 sensor					
30035	0x0022	CO ₂ sensor					
30036	0x0023	TVOC sensor					
30037	0x0024	Humidity sensor					
30038	0x0025	Temperature sensor					
30039	0x0026	HCHO sensor					
30040	0x0027	O ₃ sensor					
30041	0x0028	CO sensor					
30043	0x002A	Light Sensor					
UNOnext Information							
Register		Name	Description				
30044	0x002B	Button State* <i>Note: works only if control function is disabled</i>	0x00 IAQ LED is off 0x01 IAQ LED is on				
30045	0x002C	OLED display status	Format: <table border="1"> <thead> <tr> <th>Hi Byte</th> <th>Lo Byte</th> </tr> </thead> <tbody> <tr> <td>Temperature unit</td> <td>-</td> </tr> </tbody> </table> Temperature unit: 0x01 Celsius 0x02 Fahrenheit	Hi Byte	Lo Byte	Temperature unit	-
Hi Byte	Lo Byte						
Temperature unit	-						
30145-30160	0x0090-0x009F	Model and Serial Number	An ASCII string consists model name and serial number, separated by a comma. For				

			example: "UNO-S00FC07X011-A,2039N01F0001"																
30209	0x00D0	Main firmware version	Integer 1 ~ 65535, 0x00 device is initializing																
30210	0x00D1	Current DIP switch settings	<p>While Control function enabled:</p> <table border="1"> <thead> <tr> <th>Hi Byte</th> <th>Lo Byte</th> </tr> </thead> <tbody> <tr> <td>Protocol ID</td> <td>Max fan speed</td> </tr> </tbody> </table> <p>Protocol ID (UNOnext detects what ventilator is connected while setting PIN8 OFF):</p> <p>0x02 PIN8 off, Delta ERV (RS485) 0x03 PIN8 off, Delta Inline fan (RS485) 0x07 PIN8 off, Unknown (RS485) 0x08 PIN8 on, uses normal opened relay</p> <p>Max fan speed:</p> <p>0x01 Low 0x02 Mid 0x03 High</p> <p>While Control function disabled:</p> <table border="1"> <thead> <tr> <th>Hi Byte</th> <th>Lo Byte</th> </tr> </thead> <tbody> <tr> <td>IAQ LED setting</td> <td>-</td> </tr> </tbody> </table> <p>IAQ LED setting:</p> <p>0x00 PIN8 off, disables IAQ LED 0x01 PIN8 on, enables IAQ LED</p>	Hi Byte	Lo Byte	Protocol ID	Max fan speed	Hi Byte	Lo Byte	IAQ LED setting	-								
Hi Byte	Lo Byte																		
Protocol ID	Max fan speed																		
Hi Byte	Lo Byte																		
IAQ LED setting	-																		
30211	0x00D2	Cumulative time of ventilation* <i>Note: control function must be enabled</i>	Unit: 10 minutes Cumulative time = N * 10 minutes																
30214	0x00D5	Filter life* <i>Note: control function must be enabled</i>	Unit: 10 minutes, default is 12960 (3 months) Remaining life (%) = 100 - (100 * cumulative time / filter life)																
<p>Ventilation information*</p> <p><i>Note: control function must be enabled</i></p>																			
Register		Name	Description																
30193	0x00C0	Common status	<p>Format:</p> <table border="1"> <thead> <tr> <th colspan="3">Hi Byte</th> <th>Lo Byte</th> </tr> <tr> <th>Bit 7-4</th> <th>Bit 3-1</th> <th>Bit 0</th> <th></th> </tr> <tr> <th>A</th> <th>B</th> <th>C</th> <th>D</th> </tr> </thead> <tbody> <tr> <td></td> <td></td> <td></td> <td></td> </tr> </tbody> </table> <p>A (connection state):</p> <p>Bit 7 1st ventilation unit, 1 for online Bit 6 2nd ventilation unit, 1 for online Bit 5 3rd ventilation unit, 1 for online Bit 4 4th ventilation unit, 1 for online</p> <p>B (button state):</p>	Hi Byte			Lo Byte	Bit 7-4	Bit 3-1	Bit 0		A	B	C	D				
Hi Byte			Lo Byte																
Bit 7-4	Bit 3-1	Bit 0																	
A	B	C	D																

			0x0 force stop ventilation 0x1 auto/remote mode 0x2 low fan speed (manual mode) 0x3 mid fan speed (manual mode) 0x4 high fan speed (manual mode) C (control lock): 0x0 free to use app/button 0x1 app/button is prohibited D (UNOnext error code): 0x80(128) need to replace filter																
30194-30195	0x00C1-0x00C2	1 st ventilation unit	Format: <table border="1"> <thead> <tr> <th colspan="2">1st word</th> <th colspan="2">2nd word</th> </tr> <tr> <th></th> <th></th> <th>Hi byte</th> <th>Lo byte</th> </tr> <tr> <th colspan="2">Bit 15-0</th> <th>Bit 3-0</th> <th>Bit1 Bit0</th> </tr> </thead> <tbody> <tr> <td colspan="2">A</td> <td>B</td> <td>C D</td> </tr> </tbody> </table> A (error flag): The values vary by each ventilation unit, please refer to respective specifications B (fan speed): 0x01 ~ 0x03 low-mid-high C (bypass mode): 0x0 off 0x1 on D (power): 0x0 off 0x1 on	1 st word		2 nd word				Hi byte	Lo byte	Bit 15-0		Bit 3-0	Bit1 Bit0	A		B	C D
1 st word		2 nd word																	
		Hi byte		Lo byte															
Bit 15-0		Bit 3-0		Bit1 Bit0															
A		B	C D																
30196-30197	0x00C3-0x00C4	2 nd ventilation unit																	
30198-30199	0x00C5-0x00C6	3 rd ventilation unit																	
30200-30201	0x00C7-0x00C8	4 th ventilation unit																	
30202	0x00C9	Control mode	Lo Byte: 0x00 Turbo mode 0x01 Manual mode (App or Button) 0x02 Smart mode 0x03 Remote mode 0x04 Force stop ventilation																
30203	0x00CA	Control command	Format: <table border="1"> <thead> <tr> <th>Hi byte</th> <th colspan="2">Lo byte</th> </tr> <tr> <th>Bit 3-0</th> <th>Bit 1</th> <th>Bit 0</th> </tr> </thead> <tbody> <tr> <td>A</td> <td>B</td> <td>C</td> </tr> </tbody> </table> A (fan speed): 0x00 power off 0x01 ~ 0x03 low-mid-high B (bypass mode): 0x00 off 0x01 on C (power): 0x00 off	Hi byte	Lo byte		Bit 3-0	Bit 1	Bit 0	A	B	C							
Hi byte	Lo byte																		
Bit 3-0	Bit 1	Bit 0																	
A	B	C																	

			0x01 on
Thresholds (for Turbo/Smart mode)*			
<i>Note: control function must be enabled</i>			
Register		Name	Description
30243	0x00F2	Threshold of carbon dioxide	Unit: ppm, default is 1000
30244	0x00F3	Threshold of PM10	Unit: $\mu\text{g}/\text{m}^3$, default is 75
30245	0x00F4	Threshold of PM2.5	Unit: $\mu\text{g}/\text{m}^3$, default is 35
30246	0x00F5	Threshold of TVOC	Unit: ppb, default is 560
30247	0x00F6	Threshold of formaldehyde	Unit: ppb, default is 80
30248	0x00F7	Threshold for ozone	Unit: ppb, default is 60
30250	0x00F9	Threshold for carbon monoxide	Unit: ppm, default is 9

2.2. Write Commands

1. Function code: 0x06

Request:

Address 1 byte	Function code 1 byte	Register 2 bytes	Data 2 bytes	CRC16 2 bytes
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Response:

Address 1 byte	Function code 1 byte	Register 2 bytes	Data 2 bytes	CRC16 2 bytes
-------------------	-------------------------	---------------------	-----------------	------------------

2. Function code: 0x10

Request:

Address 1 byte	FC 1 byte	Register 2 bytes	Length [N] 2 bytes	Count [2 * N] 1 byte	Data N * 2 bytes	CRC16 2 bytes
-------------------	--------------	---------------------	-----------------------	-------------------------	---------------------	------------------

Response:

Address 1 byte	Function code 1 byte	Register 2 bytes	Length [N] 2 bytes	CRC16 2 bytes
-------------------	-------------------------	---------------------	-----------------------	------------------

3. Register list (**Write only**):

Operation			
Register		Name	Description
40014	0x000D	Set display temperature unit	0x01 Celsius 0x02 Fahrenheit
40215	0x00D6	UNOnext operation	0x01

			reset cumulative power-on time (equivalent to long-press the function key) 0x08 save threshold changes 0x10(16) do factory reset (equivalent to press function key 3 times) 0x80(128) toggle control function																						
40097	0x0060- 0x0062	RS485 slave parameters* <i>Note: need to manually restart UNOnext after configuration</i>	Format: <table border="1" style="margin-left: 20px;"> <tr> <td style="width: 33%;">1st word</td> <td style="width: 33%;">2nd word</td> <td style="width: 33%;">3rd word</td> </tr> <tr> <td colspan="2" style="text-align: center;">A</td> <td></td> </tr> </table> <table border="1" style="margin-left: 20px;"> <tr> <td colspan="4" style="text-align: center;">3rd word</td> </tr> <tr> <td colspan="2" style="text-align: center;">Hi byte</td> <td colspan="2" style="text-align: center;">Lo byte</td> </tr> <tr> <td style="text-align: center;">Bit7-4</td> <td style="text-align: center;">Bit3-0</td> <td style="text-align: center;">Bit7-4</td> <td style="text-align: center;">Bit3-0</td> </tr> <tr> <td style="text-align: center;">B</td> <td style="text-align: center;">C</td> <td style="text-align: center;">D</td> <td></td> </tr> </table> A (baud): 32 bits for baud rate, default 9600, user can set 38400, 57600, or 115200 bps B (char length): 0x8 (default) C (parity bit): 0x00 Even 0x01 Odd 0x04 None (default) D (stop bit): 0x00 1 bit (default) 0x02 2 bits	1 st word	2 nd word	3 rd word	A			3 rd word				Hi byte		Lo byte		Bit7-4	Bit3-0	Bit7-4	Bit3-0	B	C	D	
1 st word	2 nd word	3 rd word																							
A																									
3 rd word																									
Hi byte		Lo byte																							
Bit7-4	Bit3-0	Bit7-4	Bit3-0																						
B	C	D																							
Thresholds (Turbo/Smart mode)* <i>Note: write 0x0008 to 0x00D6 (40215) register to save changes</i>																									
Register		Name	Description																						
40243	0x00F2	Threshold of carbon dioxide	Unit: ppm, default is 1000																						
40244	0x00F3	Threshold of PM10	Unit: µg/m3, default is 75																						
40245	0x00F4	Threshold of PM2.5	Unit: µg/m3, default is 35																						
40246	0x00F5	Threshold of TVOC	Unit: ppb, default is 560																						
40247	0x00F6	Threshold of formaldehyde	Unit: ppb, default is 80																						
40248	0x00F7	Threshold for ozone	Unit: ppb, default is 60																						
40250	0x00F9	Threshold for carbon monoxide	Unit: ppm, default is 9																						

Remote control																			
Register		Name	Description																
40203	0x00CA	Control command	Format: <table border="1" style="margin-left: 20px;"> <thead> <tr> <th colspan="3">Hi Byte</th> <th colspan="2">Lo Byte</th> </tr> <tr> <th>Bit7</th> <th>Bit6-4</th> <th>Bit3-0</th> <th></th> <th>Bit 0</th> </tr> </thead> <tbody> <tr> <td>A</td> <td>B</td> <td>C</td> <td></td> <td>D</td> </tr> </tbody> </table> <p>A (control flag): Set flag to 1 if command is changed</p> <p>B (control mode): 0x04 remote 0x06 turbo 0x07 smart</p> <p>C (remote mode - fan speed): Not used in turbo / smart mode 0x00 off 0x01-0x03 low-mid-high</p> <p>D (remote mode - power): Not used in turbo / smart mode 0x00 off 0x01 on</p>		Hi Byte			Lo Byte		Bit7	Bit6-4	Bit3-0		Bit 0	A	B	C		D
Hi Byte			Lo Byte																
Bit7	Bit6-4	Bit3-0		Bit 0															
A	B	C		D															
Calibration																			
Register		Name	Description																
40003	0x0002	Calibration of CO ₂	To set current measurement of CO ₂ sensor Range: 400-2000 ppm																
40007	0x0006	Set delta temperature	To set temperature compensation <i>Real Temperature after compensation = Real Temperature – Delta Temperature.</i> Unit: 0.01 °C For example, the delta temp is 440 (4.4°C), current measured temp is 28°C, hence the temp on display of UNOnext will be 23.6°C																

2.3. Modbus Encapsulated Interface (EMI)

1. Function code: 0x2B/0x0E

Read device identification and additional information about UNOnext

Request:

Function code	1 byte	0x2B
---------------	--------	------

MEI	1 byte	0x0E
Read Device ID code	1 byte	0x01 read basic device identification <i>Note: 0x02 / 0x03 / 0x04 are not supported</i>
Object ID	1 byte	0x00

Response:

Function code	1 byte	0x2B
MEI	1 byte	0x0E
Read Device ID code	1 byte	0x01
Conformity level	1 byte	0x01
More follow	1 byte	0x00
Next Object Id	1 byte	0x00
Number of objects	1 byte	0x04
List of		
Object ID	1 byte	0x00 – 0x03
Object Length	1 byte	N
Object Value	N bytes	string with length N bytes

2. Object ID list

Object ID	Object Name	Type	Category
0x00	Vendor "DELTA"	ASCII	Basic
0x01	Product Code "UNO-005"	ASCII	Basic
0x02	Version Name	ASCII	Basic
0x03	An ASCII string consists model name and serial number, separated by a comma. For example, "UNO-S00FC07X011-A,2017N01F0001"	ASCII	Basic

2.4. Modbus/RTU examples

1. Read all sensor measurement from device 208 (0xD0)

Request	D0 03 00 00 00 1F 16 43
Response	D0 03 3E 00 67 00 0A 00 0B 04 81 00 23 02 38 33 50 49 3D 16 38 38 D6 1C 30 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 F0 00 00 00 00 02 F9 03 67 03 6B 03 6B 00 00 90 38 8C 78 00 00 00 00 00 60 32 C0

2. Read all sensor status from device 208 (0xD0)

Request	D0 03 00 20 00 0B 17 86
---------	-------------------------

Response	D0 03 16 00 01 00 01 00 01 00 01 00 01 00 01 00 FE 00 FE 00 FF 00 00 00 01 60 8F
----------	---

3. Read firmware version from device 208 (0xD0)

Request	D0 03 00 D0 00 01 97 B2
Response	D0 03 02 00 04 45 95

4. Read ventilation information from device 208 (0xD0)

Request	D0 03 00 C0 00 0A D7 B0
Response	D0 03 14 03 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 03 FB 90

5. Read all thresholds from device 208 (0xD0)

Request	D0 03 00 F0 00 0A D7 BF
Response	D0 03 14 00 00 00 00 03 F2 00 24 00 4C 00 4C 00 50 00 3D 00 00 00 0A 0F 67

6. Reset cumulative power-on time of ventilation

Request	D0 06 00 D6 00 01 BB B3
Response	D0 06 00 D6 00 01 BB B3

7. Remote command to power off ventilation

Request	D0 06 00 CA C0 00 EB B5
Response	D0 06 00 CA C0 00 EB B5

8. Remote command to set LOW fan speed

Request	D0 06 00 CA C1 01 2B E5
Response	D0 06 00 CA C1 01 2B E5

9. Remote command to set MID fan speed

Request	D0 06 00 CA C2 01 2B 15
Response	D0 06 00 CA C2 01 2B 15

10. Remote command to set HIGH fan speed

Request	D0 06 00 CA C3 01 2A 85
Response	D0 06 00 CA C3 01 2A 85

11. Switch control mode to smart mode

Request	D0 06 00 CA E0 00 F2 75
Response	D0 06 00 CA E0 00 F2 75

12. Set rs485 slave parameters, 115200-8-N-1

Request	D0 10 00 60 00 03 06 00 01 C2 00 84 00 BB 56
Response	D0 10 00 60 00 03 92 57

2.5. Modbus exception responses

If device receives a request message without a communication error, but cannot handle the query

1. Format:

Device replies with requested function code plus 0x80. Example, function code 3 becomes 0x83

Address	Function	Code	CRC16
1 byte	1 byte	1 bytes	2 bytes

2. Code list:

Please refer to "Modbus_Application_Protocol_V1_1b3" from www.modbus.org

Code	Name
0x01	ILLEGAL FUNCTION
0x02	ILLEGAL DATA ADDRESS
0x03	ILLEGAL DATA VALUE
0x04	SERVER DEVICE FAILURE
0x05	ACKNOWLEDGE
0x06	SERVER DEVICE BUSY
0x08	MEMORY PARITY ERROR
0x0A	GATEWAY PATH UNAVAILABLE
0x0B	GATEWAY TARGET DEVICE FAILED TO RESPOND