uno®
lite

Modbus User Guide

VER 0.5

【Revision】

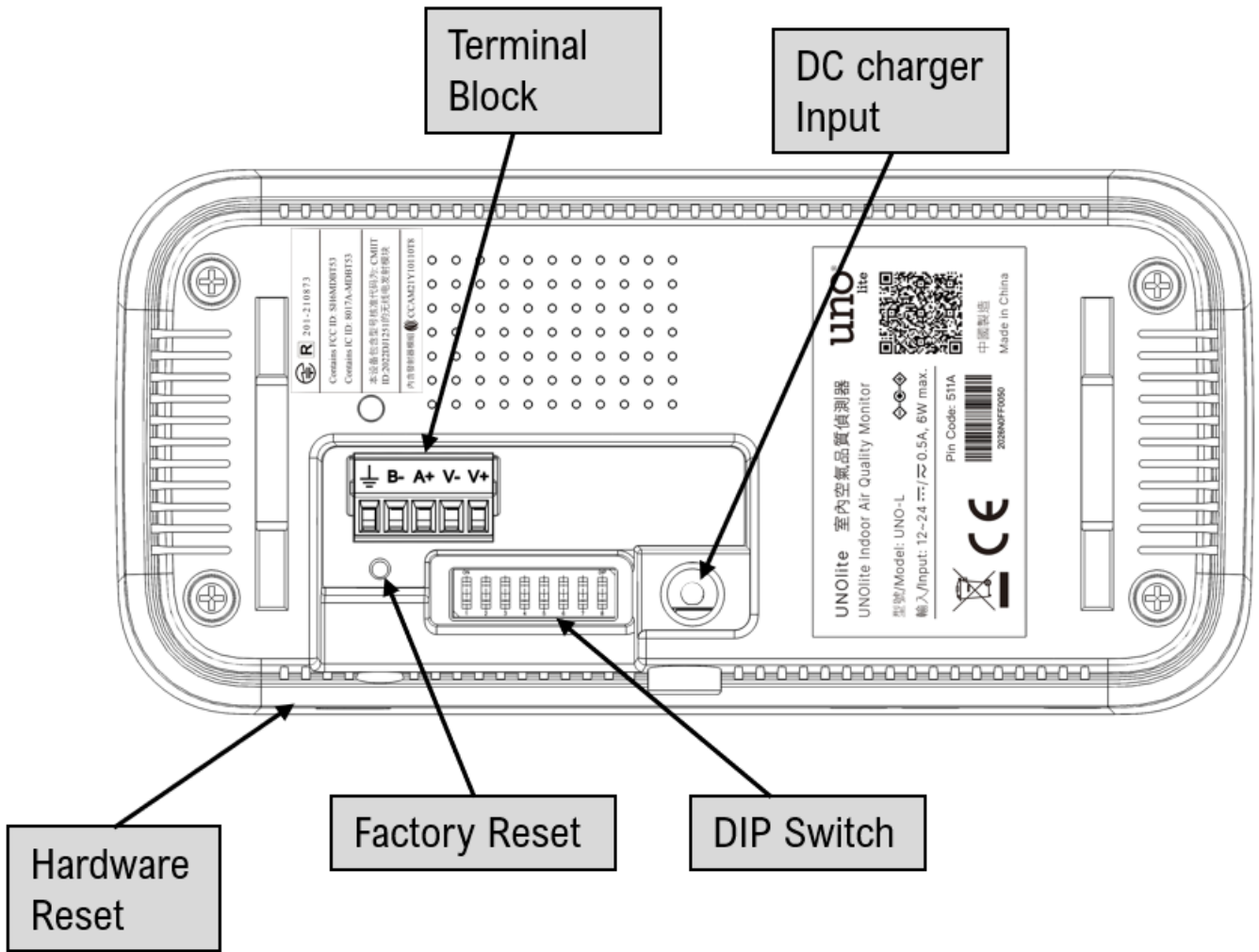| Date	Version	Description
2022/ 11 / 11	0.1	Initial Version
2022/ 11 / 16	0.2	Add CO2, PM calibration registers
2022/ 12 / 07	0.3	Update calibration registers New feature for custom IAQ indicator
2023/ 05 / 11	0.4	Update description of DIP switches Add ventilation control command Add TVOC reset register
2023/ 12 / 05	0.5	** Require FW. above version 0.3.01 ** Update calibration registers Add a temperature unit switch for display Add dim mode switch

【Overview】

UNOlite is an indoor air quality monitor to measure the space temperature / humidity / CO2 / PM2.5 / PM10 / PM1 / TVOC and expose the measurements directly onto a BACnet MS/TP or Modbus RTU network. Moreover, the measurements are also accessible with UNO apps through BLE or UNO web through Wi-Fi (Wi-Fi model). Please refer to UNOlite official website for more product information.

https://isdweb.deltaww.com/resources/#unolite

This document is primarily concerned how to add UNOlite to Modbus/RTU network.

【Hardware Interface】

Buttons

Key	Description
Hardware reset	Push this button will trigger a power cycle.
Factory reset	After booting, press this button three times within 2 seconds will trigger factory reset. The settings below will be restored to default: ♦ User's sensors calibration data ♦ Ventilation configuration ♦ Serial port configuration ♦ BACnet saved mac address ♦ Wi-Fi MQTT broker setting (Wi-Fi model) ♦ BLE mesh network configuration ♦ IAQ breathing LED customization

NOTE: It's recommended to use a paper clip to press the keys.

Terminal block

Terminal	Description
V+	Power input. For more information, please refer to production specification.
V-	Power input. For more information, please refer to production specification.
A+	RS485(+) data pin. For Modbus/BACnet network.
B-	RS485(-) data pin. For Modbus/BACnet network.
GND	Ground terminal *Note: Each RS485 driver in an installation is recommended to connect to the same ground to get a common reference.*

DIP switch

Number	Description	ON	OFF
1 - 6	Refer to the later sections for the definition of each pin		

7	BACnet mode switch.
	   ON : BACnet mode
	   OFF : Modbus mode
		BACnet	**Modbus**

8	120 ohm terminator resistor for RS485 wiring.	Enable	Disable

NOTE: *The switches should be adjusted to proper position in power off state.* **Adjust the switches, then power on device.**

【Modbus Mode】

UNOlite follows Modbus over serial line specification and will run on Modbus/RTU mode if **the 6ᵗʰ and the 7ᵗʰ switches** are set to OFF state.

The definition of the switches in Modbus mode as listed below:

Number	Description	ON	OFF
1	Modbus slave address *(check address table)*		
2	Modbus slave address *(check address table)*		
3	Modbus slave address *(check address table)*		
4	Modbus slave address *(check address table)*		
5	Modbus slave address *(check address table)*		
6	Ventilation control	Enable	**Disable**

NOTE: The above definitions of DIP switch are different from BACnet mode.

NOTE: If ventilation control is selected, device will stop Modbus server and RS485 pins are used to control ventilation units.

Serial Configuration

UNOlite can directly connect to a controller with RS485 interface, up to 32 UNOlite devices can be joined to a Modbus serial bus. Suggestion to use **22AWG shielded twisted pair cable** to connect devices in sequence
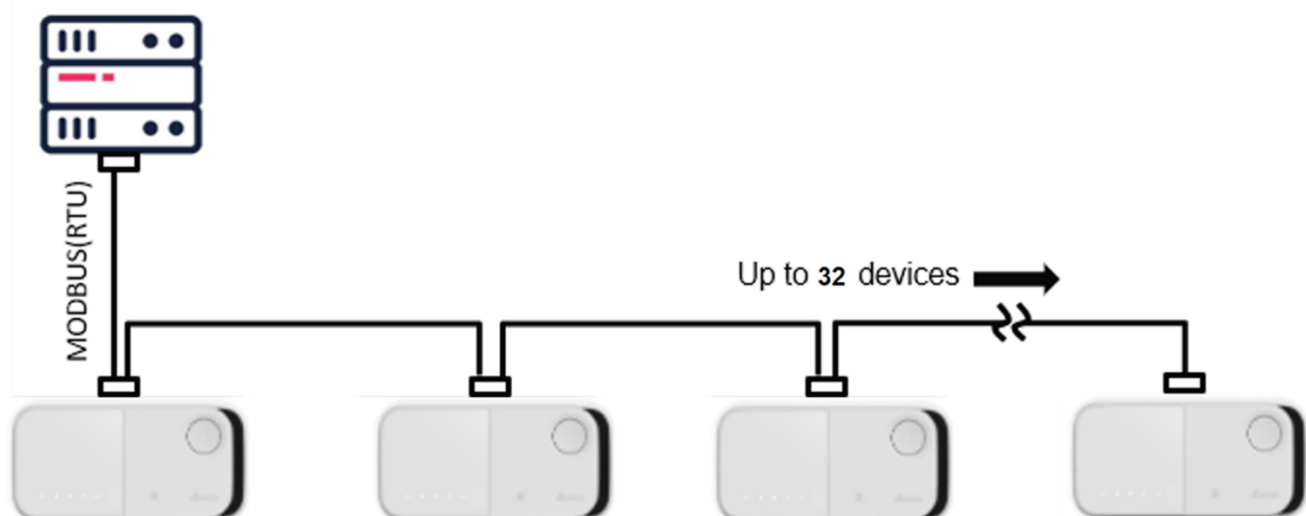
Default parameters:

- Baud: 9600
- Data-Bit: 8
- Parity: None
- Stop-Bit: 1

Note: Perform factory reset to restore default value if custom configuration is missing

Polling Interval

It is recommend to set **50ms** time interval between requests sent from a Modbus master.

Modbus Slave Address

The DIP switches 1~5 represent for binary number 0~31, switch 1 is most significant bit (MSB) and switch 5 is least significant bit (LSB). Notice that **Modbus slave address starts from 208**, therefore, UNOlite can be configured address from 208 to 239.

Modbus Slave Address Table

Number					Modbus Slave Addr		Number					Modbus Slave Addr
1	2	3	4	5			1	2	3	4	5	
↓	↓	↓	↓	↓	208 (0xD0)		↑	↓	↓	↓	↓	224 (0xE0)
↓	↓	↓	↓	↑	209 (0xD1)		↑	↓	↓	↓	↑	225 (0xE1)
↓	↓	↓	↑	↓	210 (0xD2)		↑	↓	↓	↑	↓	226 (0xE2)
↓	↓	↓	↑	↑	211 (0xD3)		↑	↓	↓	↑	↑	227 (0xE3)
↓	↓	↑	↓	↓	212 (0xD4)		↑	↓	↑	↓	↓	228 (0xE4)
↓	↓	↑	↓	↑	213 (0xD5)		↑	↓	↑	↓	↑	229 (0xE5)
↓	↓	↑	↑	↓	214 (0xD6)		↑	↓	↑	↑	↓	230 (0xE6)
↓	↓	↑	↑	↑	215 (0xD7)		↑	↓	↑	↑	↑	231 (0xE7)
↓	↑	↓	↓	↓	216 (0xD8)		↑	↑	↓	↓	↓	232 (0xE8)
↓	↑	↓	↓	↑	217 (0xD9)		↑	↑	↓	↓	↑	233 (0xE9)
↓	↑	↓	↑	↓	218 (0xDA)		↑	↑	↓	↑	↓	234 (0xEA)
↓	↑	↓	↑	↑	219 (0xDB)		↑	↑	↓	↑	↑	235 (0xEB)
↓	↑	↑	↓	↓	220 (0xDC)		↑	↑	↑	↓	↓	236 (0xEC)
↓	↑	↑	↓	↑	221 (0xDD)		↑	↑	↑	↓	↑	237 (0xED)
↓	↑	↑	↑	↓	222 (0xDE)		↑	↑	↑	↑	↓	238 (0xED)
↓	↑	↑	↑	↑	223 (0xDF)		↑	↑	↑	↑	↑	239 (0xEF)

【Modbus Read Data】

UNOlite supports function code both 0×03 and 0×04 to read following registers
  0×03: read holding registers
  0×04: read input registers

Modbus Application Data Unit (ADU)

Request				
Slave Address 1 byte	Function code 1 byte	Register 2 bytes	Length [N] 2 bytes	CRC16 2 bytes
Response				
Slave Address 1 byte	Function code 1 byte	Count [2*N] 1 byte	Data N * 2 bytes	CRC16 2 bytes

Register List

Sensor Measurement			
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 light: 0 - 80 YELLOW light : 81 - 100 RED light: 101 - 400 PURPLE light: 401 –
30002	0x0001	Concentration of PM2.5	Unit: $\mu g/m^3$
30003	0x0002	Concentration of PM10	Unit: $\mu g/m^3$
30004	0x0003	Concentration of carbon dioxide (formula CO_2)	Unit: ppm
30005	0x0004	Concentration of total volatile organic compound (TVOC)	Unit: ppb
30006	0x0005	Concentration of total volatile organic compound (TVOC)	Unit: $\mu g/m^3$ (factor 1 ppb = 4.5 $\mu g/m^3$)
30009	0x0008	Humidity	Unit: 0.01%

30011	0x000A	Celsius temperature	Real Temp = (Value - 4500) * 0.01 Unit: °C
30018	0x0011	Fahrenheit temperature	Real Temp = (Value - 4500) * 0.01 Unit: °F
30020	0x0013	Concentration of PM1	Unit: µg/m^3

Sensor State			
Register		Name	Description
30033	0x0020	PM2.5 sensor	State of sensor hardware module 0x0000: Power off or does not exist 0x0001: Sensor ready 0x0002: Warming up 0x0003: Busy 0x00FE: CSERROR 0x00FF: FAIL
30034	0x0021	PM10 sensor	
30035	0x0022	CO$_2$ sensor	
30036	0x0023	TVOC sensor	
30037	0x0024	Humidity sensor	
30038	0x0025	Temperature sensor	
30042	0x0029	PM1 sensor	
30044	0x002B	IAQ LED state	0x0000: LED off 0x0001: LED on

Device Information			
Register		Name	Description
30145-30160	0x0090-0x009F	Model and Product Serial Number	An ASCII string consists model name and serial number, separated by a comma. For example: "UNO-L,2250L01F9999"

30203	0×00CA	Ventilation Control Command	UNOLite can give ventilation control suggestion includes power and speed to another controller unit in building management system. Data format | Hi byte		Lo byte	
H7-H4	H3-H0	L7-L1	L0

-	Speed	-	Power |
			
			Control command
			  [H3-H4] Speed, 0~3 (off, low, mid, high)
			  [L7] Power, 0~1
			
			The UNOeco algorithm, serving as the control logic, continuously computes new commands influenced by the IAQ (Indoor Air Quality) and ventilation system, with internal data storage capabilities. When the UNOlite has been operational in the field without ventilation for a period of time, it is recommended to perform a factory reset in order to clear internal data before beginning to adopt the command.

30209	0x00D0	Main firmware version	Number 1 to 65535 0x0000: device is initializing
30216	0x00D7	Software configuration	Data format 	Hi byte	Lo byte
---	---

Configuration	SW build	
		
		Configuration
		  The value is composed of bit flags:
		    [H7] Custom IAQ indicator
		    [H6] IAQ LED
		    [H5] Display
		    [H4] Control Mode
		    [H3] Front LEDs
		    [H2] BLE function
		    [H1] WIFI functions
		    [H0] Reserved
		  Each bit is 0 for enabled, 1 for disabled, furthermore, IAQ LED, Display, and Front LEDs are disabled while dim mode activated.
		SW build
		  0x2 build for UNOlite

30225-30227	0x00E0-0x00E2	IAQ Indicator customization	Threshold registers and its unit:
			  [E0] PM2.5 ($\mu g/m^3$)
			  [E1] PM10 ($\mu g/m^3$)
			  [E2] CO2 (ppm)
			0: ignore the sensor
			1-65535: set new threshold for yellow-to-red color
			
			For each sensor, the IAQ LED is able to show 4 colors, green yellow, red, and purple by 3 thresholds. Besides the threshold read from register, it will automatic generate other 2 thresholds according to register value:
			  Yellow light threshold: 80% * register value
			  Red light threshold: register value
			  Purple light threshold: 400% * register value

30257-30259	0x0100-0x0102	BT MAC address	6 groups of two hexadecimal digits, e.g. F2:11:8F:36:F6:93
30260-30262	0x0103-0x0105	WIFI MAC address	6 groups of two hexadecimal digits

【Modbus Write Command】

UNOlite supports function code 0×06 and 0×10 to write request
  0×06: write single register
  0×10: write multiple registers

Modbus Application Data Unit (ADU) for fn. 0×06

Request				
Address	Function code (6)	Register	Data	CRC16
1 byte	1 byte	2 bytes	2 bytes	2 bytes
Response				
Address	Function code	Register	Data	CRC16
1 byte	1 byte	2 bytes	2 bytes	2 bytes

Modbus Application Data Unit (ADU) for fn. 0×10

Request						
Address	Fn. Code (16)	Register	Length[N]	Count[2*N]	Data	CRC16
1 byte	1 byte	2 bytes	2 bytes	1 byte	N * 2 bytes	2 bytes

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

Register List

Calibration			
Notes before performing calibration:			

- It's recommended to operate in an environment with good air quality and ensure the sensor reading is stable.
- For temperature, it's recommended to allow device to reach thermal equialibrium after power-on one hour. (typically 1 minutes for other sensors)
- Approximately 30 seconds for changes to take effect after calibration.
- The device will compute new internal parameters and apply them. However the parameters has reasonable limits. If the new readings still significantly differ from the given value, consider replacing or repairing the sensor.

Register		Name	Description
40012	0x000B	Temperature calibration	0~5000: give a reference value in units of 0.01 degrees Celsius 9999: reset to default
40013	0x000C	Humidity calibration	1000-9000: give a reference value in units of 0.01%RH 9999: reset to default **Temperature can impact the measured values of relative humidity, it's better to perform temperature calibration first.**
40050	0x0031	Automatic self-calibration (ASC) mode of carbon dioxide sensor	0: disable ASC 1: enable ASC (default) Typically the sensor drift per year, ASC helps generate a reference value by analyzing CO_2 levels to keep accuracy every time period
40051	0x0032	Reset TVOC baseline	9999: reset to default
40052	0x0033	TVOC calibration	1-500: give a reference value of TVOC levels in ppb. 9999: reset to default

40054	0x0035	Particulate matter calibration	1-500: give a reference value of PM2.5 levels in µg/m^3. The calibration also applies to PM1 and PM10 measurement. 9999: reset to default
40081	0x0050	Force recalibration (FRC) of carbon dioxide sensor	400~1500: give a reference value of CO_2 levels in ppm to calibrate sensor. It will also **DISABLE** ASC mode

Device Information		
Register	**Name**	**Description**
40014 0x000D	Temperature unit on display	0x0: Celsius 0x1: Fahrenheit

40097-40099 0x0060-0x0062	Serial configuration	Data format
		
		First 4 bytes are **Baud**
		  1200 2400 4800 9600
		  19200 38400 57600 115200 (bps)
		0x62 format
		
		Data bit
		  0x8 (RTU)
		Parity
		  0x0 (Even) 0x1 (Odd) 0x4 (None)
		Stop bit
		  0x0(1 bit) 0x1(2 bits)
		Preset
		  previous parameters are ignored if preset bits are assigned a value larger than 0.
		  0x0: custom configuration
		  0x1: 9600 8-N-1 (default)
		  0x2: 9600 8-N-2
		  0x3. 9600 8-E-1
		  0x4. 19200 8-N-1
		  0x5: 19200 8-N-2
		  0x6: 19200 8–E-1

Data format table:

1st word 0x60	2nd word 0x61	3rd word 0x62
Baud		

0x62 format table:

3rd word			
Hi byte		Lo byte	
Bit7-4	Bit3-0	Bit7-4	Bit3-0
Data bit	Parity	Stop bit	Preset

			Data Examples (hexadecimal): [00 00 25 80 84 10]: set to 9600-8-N-2 [00 00 00 00 00 02]: set to 9600-8-N-2
40215	0x00D6	UNOlite operations	0x0010: perform factory reset (equivalent to press function key 3 times) 0xA100: enable custom IAQ indicator 0xB100: disable custom IAQ indicator 0xA400: enable DIM mode, all lights will be turned off, except power indicator. 0xB400: disable DIM mode 0xC400: enable AUTO-DIM mode, the device will reduce screen brightness and turn off the front LED lights (excluding the power indicator) when idle.

40225-
40235
	0x00E0-
	0x00EA
		IAQ Indicator customization	Each register represents a threshold of a sensor measurement, if any measurement is larger than its threshold, the IAQ LED will turn to red light.
			0: ignore the sensor
			1-65535: set new threshold for yellow-to-red color
			
			Registers and its unit:
			  [E0] PM2.5 ($\mu g/m^3$)
			  [E1] PM10 ($\mu g/m^3$)
			  [E2] CO2 (ppm)
			  [E3-EA] Reserved, should be zero
			
			The IAQ LED is able to show 4 colors, green yellow, red, and purple by 3 thresholds. Besides the given threshold, it will automatic generate other 2 thresholds according to input:
			  Yellow light threshold: 80% * input value
			  Red light threshold: 100% * input value
			  Purple light threshold: 400% * input value
			
			Note that the customization must be written at once from 0xE0~0xEA. An example is shown at next chapter.

【Modbus Examples】

1. 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

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

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

3. Set RS485 serial configuration, 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

4. Set IAQ LED only refer to carbon dioxide sensor, the result will be
   Green: ~ 819 ppm
   Yellow: 820 ~ 1024 ppm
   Red: 1025 ~ 2048 ppm
   Purple: 4097 ~ *max* ppm

Request	D0 10 00 E0 00 0B 16 00 00 00 00 04 00 00 00 00 00 00 00 00 00
	registers:E0~EA *pm2.5* *pm10* *co2* *reserved …*
	00 00 00 00 00 00 00 00 35 ED
Response	D0 10 00 E0 00 0B 92 79

【Modbus Exception Response】

If device receives a request message without a communication error, but cannot handle the query. It will reply with requested function code plus 0×80. Example, function code 0×3 becomes 0×83

Response format

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

Code List

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

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

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