AX-AQM-3-M

CO, NO2 and PM Transmitter - Modbus RTU

Product overview

The AX-AQM-3-M is an ideal solution for detecting harmful emissions in parking garages, loading docks, warehouses etc. It offers the detection of carbon monoxide, nitrogen dioxide gases and Particulate matter in the same enclosure. The NO2 and CO sensor modules use plug-in connectors, making easy in -the-field replacement easy. PM2.5/10 sensor uses the laser light scattering principle to measure particles of sizes less than 10µm. The unique data acquisition and calibration techniques used in the product ensure high accuracy and long term reliability.

Products Features

- CO, NO2, PM all in one enclosure
- Easy installation with plug-in connections
- Field replaceable sensors
- 2 year warranty

Product Specifications

Power Supply:	24Vac ±10%, 150mA maximum or 24Vdc ± 10%, 100mA maximum
Sensor Type	CO/NO2 :Electrochemical 3-electrode, PM2.5/10: Laser scattering
Sensing Range:	CO: 0-300ppm, NO2:0-10ppm, PM2.5/10:0-1000µg/m^3
Accuracy:	CO: ±5ppm or ±5% of reading, NO2:±0.2ppm or ±5% of reading , PM2.5/10:± 10%
Response time(t_{90}):	CO, NO2: <35 Seconds , PM2.5/10: <10 Seconds
Typical Coverage Area:	700m^2 or 15m radius
Settling Time:	3 minutes after power up
Life Expectancy:	NO2: >2 years, CO: >5 years, PM2.5/10: >3years. *dependant on environment
Communication:	
Protocol:	Modbus RTU protocol over RS485 2W-Cabling
Address range:	1-63 (settable using dipswitch), 1-247 (settable using configuration register)
Baud rates supported:	9600bps,19200bps,38400bps,57600bps,115200bps
Parity:	None (default), Odd, Even (odd, even selectable via configuration register)
Number of stop bits:	1(default),2 (2 is selectable via configuration register)
Isolation:	1500VDC (60sec, <1mA leakage current) between Power and Output
120Ohms termination :	Available on board. Enabled using jumper
Recommended cable:	24AWG twisted pair shielded cable (1 pair for data and 1 conductor for common)
Maximum devices on a network:	32
Cable Entry:	M20 Compression gland for top entry and M20 membrane spout for rear entry
Ambient Temperature & Humidity:	0-50˚C, 15-90% RH non-condensing
Housing:	IP65
Dimensions & Weight:	
Terminals:	Rising clamp for 0.5-1.5mm^2 , 2 Part Pluggable
Warranty:	2 years for sensors, 5 years for the unit.
Country of origin:	UK

Product Order codes

Order code	Description
AX-AQM-3-M	CO, NO2, PM Transmitter , RS485 Modbus RTU
AX-AQM-3-M-L	CO, NO2, PM Transmitter , RS485 Modbus RTU, LCD Display

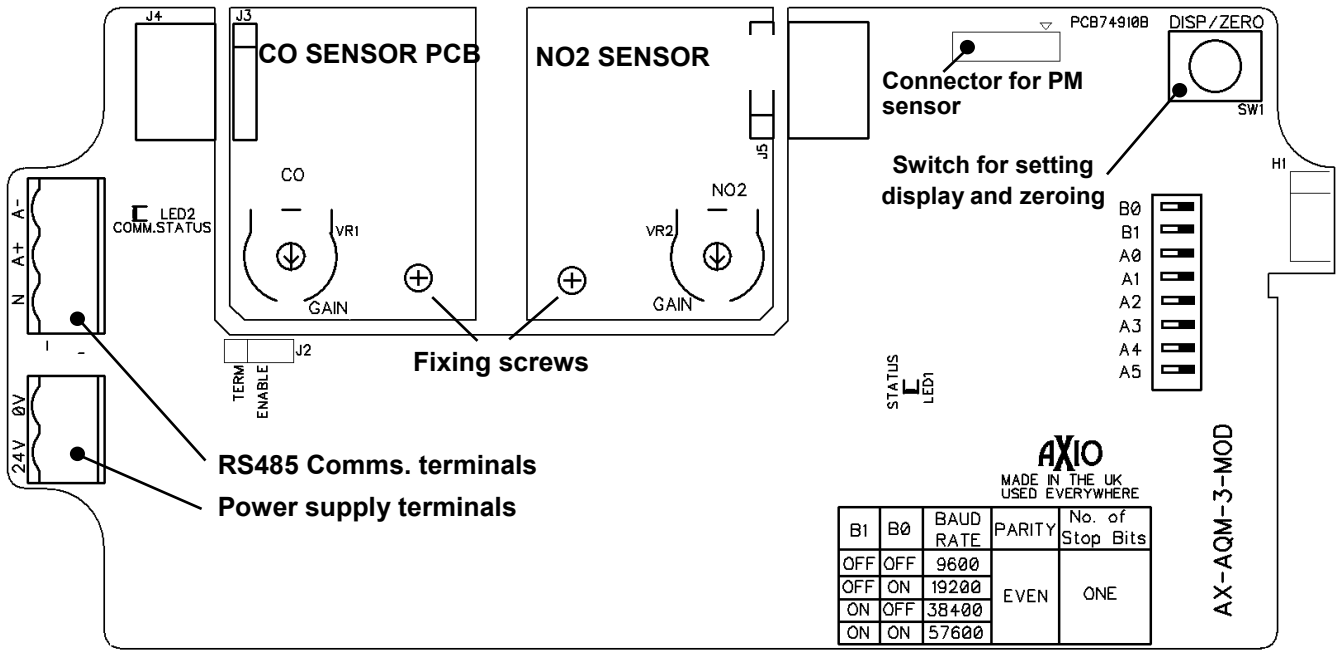
AX-AQM-3-M

CO, NO2 and PM Transmitter - Modbus RTU

Installation

The unit should be installed by a suitably qualified technician in conjunction with any guidelines for the equipment it is to be connected to and any local regulations. Field wiring should be installed to satisfy the requirements set out by the manufacturer of the equipment that the unit is being connected to. Anti-static precautions must be observed when handling. As a general rule screened cable should be used to connect signal to a BMS or other controller. The shield should be connected to the earth at one end only.

Connections



Status LED

This flashes 4 times every 6 seconds. A brighter flash in the sequence indicates a fault, ordered as:

1 - EEPROM 2 - CO Sensor

3 - NO2 Sensor 4 - PM Sensor

Communication status LED

OFF - No valid communication

Short flash - Valid packets received. NOT for this unit.

Long flash - Valid packets received. Replied to the request.

Sensor module replacement

Contact us for sensor module replacements. After replacing the sensors, ensure that the Status LED gives 4 dim flashes every 6 seconds.

DISP/ZERO Tactile switch

Press momentarily and release to change the parameter displayed on the LCD (if fitted).

Press and hold the switch for 10 seconds to zero the CO and NO2 outputs. This should be done in a clean environment or after applying nitrogen/air to the sensors.

Dipswitch

A5:A0 sets the address, and B1:B0 sets the baud rate of the device. When A5:A0 are OFF, the baud rate and address are set by the registers. More information in installation manual.

Termination Impedance

If the slave device is at the end of the network, enable 120Ohms termination resistor by placing TERM in ENABLE Position. This ensures the proper termination of signals travelling in both directions on the bus. Do NOT use more than two termination impedances in a network.

Usage

Suitable for monitoring and ventilation applications. Do NOT use in safety critical or hazardous applications.

Datasheet Contents

Every effort has been taken in the production of this data sheet to ensure accuracy. Annicom do not accept responsibility for any damage, expense, injury, loss or consequential loss resulting from any errors or omissions. Annicom has a policy of continuous improvement and reserves the right to change this specification without notice.

Installation and Operation

The purpose of this document is to provide information on installing and setting up AX-AQM-3-M range of air quality transmitters. The details of the variants of the transmitters are provided in the relevant datasheet. Please download the latest datasheets from our website www.annicom.com. This manual is applicable for the following models.

Air quality transmitters : AX-AQM-3-M, AX-AQM-3-M-L

General

Read this manual carefully before installing and commissioning the transmitter. It is imperative that the installation be carried out by qualified personnel familiar with relevant standards and safety procedures. Failing to do so may result in personal injury and product damage.

> ⚠ ***Do NOT use the product in explosive or hazardous environments, with combustible or flammable gases, or in safety critical systems where the failure of the product could result in loss of life, significant property damage, or damage to the environment.***

Prior to installation ensure that all power sources are disconnected and locked out and remain locked out during Installation and set-up. Follow electrostatic discharge (ESD) precautions while installation to prevent equipment damage.

Detection principle

Carbon monoxide (CO) and nitrogen dioxide (NO2) gases are detected by three-electrode electrochemical sensors. Electrochemical cells exhibit good linearity, are highly selective, and respond quickly to the target gas. Inside an electrochemical cell, three electrodes (sensing, reference, and counter electrodes) are immersed in an electrolyte. The material selected for the electrode determines the target gas. In this case, it is carbon monoxide and nitrogen dioxide. When the target gas comes into contact with the electrodes through diffusion, it undergoes a series of reactions that result in an electrical current flowing between the electrodes. The magnitude of the current is proportional to the concentration of the gas present. The ambient temperature has a small yet significant effect on the electrochemical cells. A built-in temperature sensor mitigates this effect. Data from the electrochemical cell and temperature sensor are digitally processed using a microcontroller.

The transmitter utilize a particulate matter sensor that employs a laser light scattering technique to accurately measure particle concentration. This technique involves illuminating suspended particles with a coherent and intense laser beam, enabling precise measurements. The transmitter's two probes serve as an inlet and outlet for the sampled air, ensuring the sensor's protection from water splashes. Air is drawn into the inlet port, passes through a cavity within the sensor where particle analysis occurs, and exits through the outlet. As the laser encounters particles, they scatter light in various directions, with the scattering patterns dependent on the particles' size, shape, and refractive index. The microcontroller then determines the particle sizes based on the data collected by the detector.

The processed data from the transmitter can be accessed by a BMS controller using the Modbus RTU protocol over a 2-wire RS485 communication line.

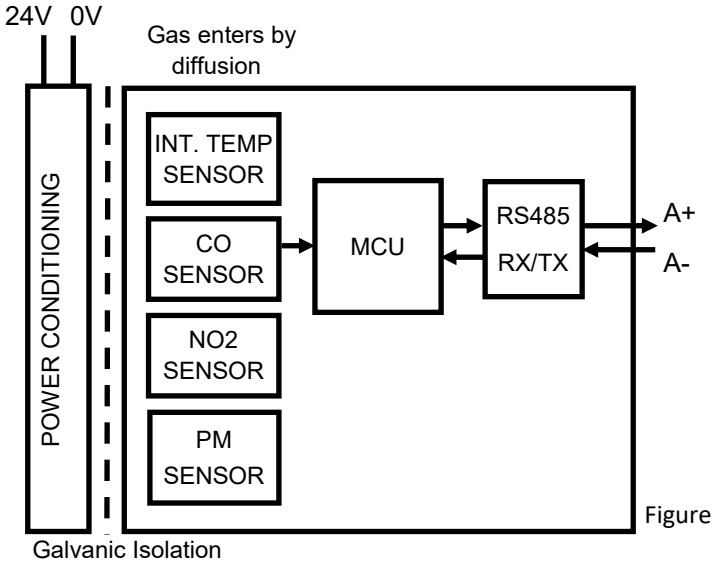


Figure 1

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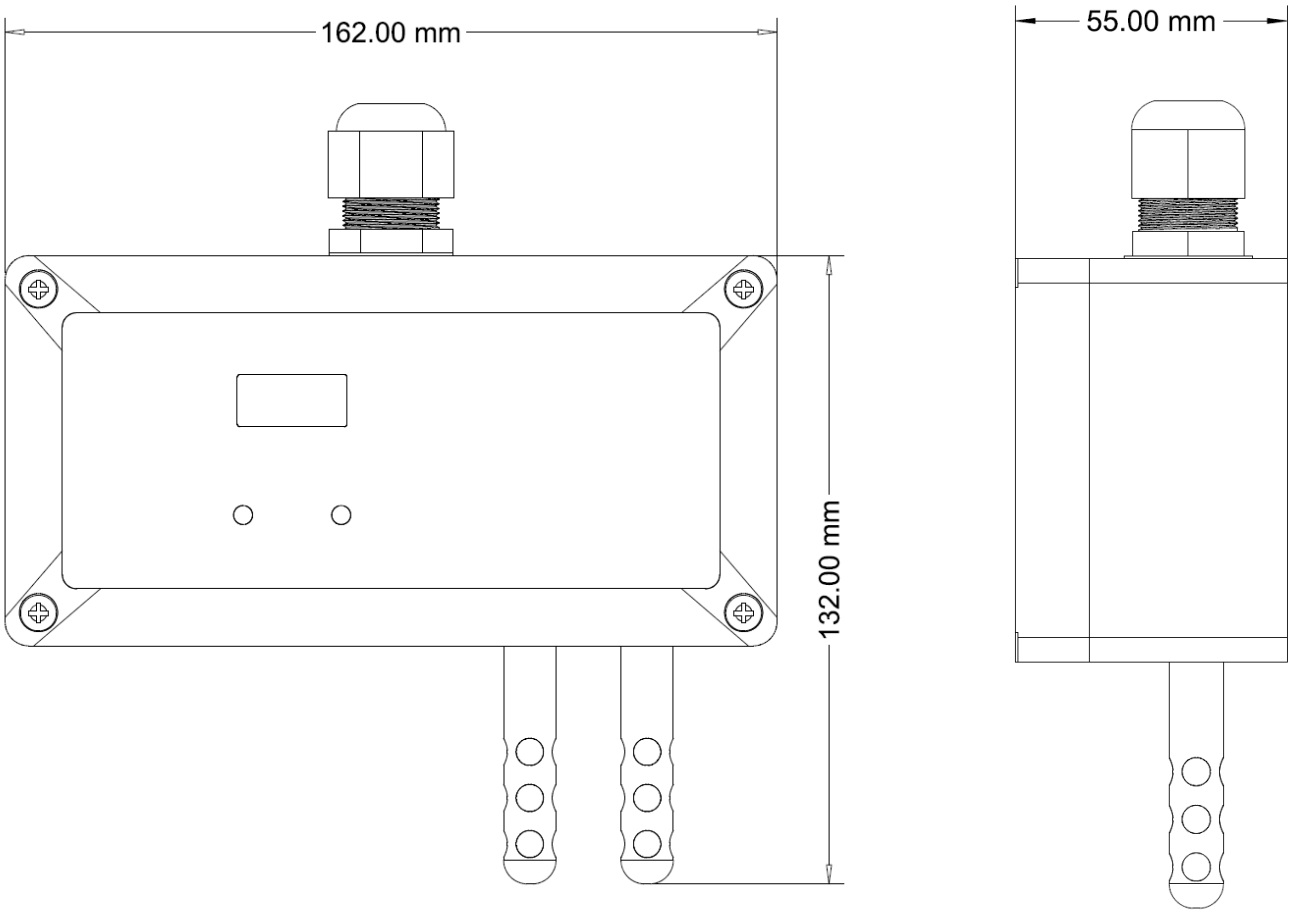
Tel: +44 (0)1420 487788 Fax: +44(0)1420 477799 Email: sales@annicom.com Website: www.annicom.com

External Dimensions



Locating

- Choose a location with good air circulation and representative of the monitored area.
- Mount the transmitter on a flat surface 1 to 1.5 metres from the floor of the area to be monitored.
- For best operation do not mount the sensor near doors, opening windows, supply air diffusers or other known air disturbances .
- Avoid areas where the transmitter would be exposed to rapid temperature and relative humidity changes.
- Avoid direct sunlight entering the sensor
- Do not position the sensor on a vibrating surface
- Do not position the sensor where other objects will block or impede airflow to the inlet and outlet ports.

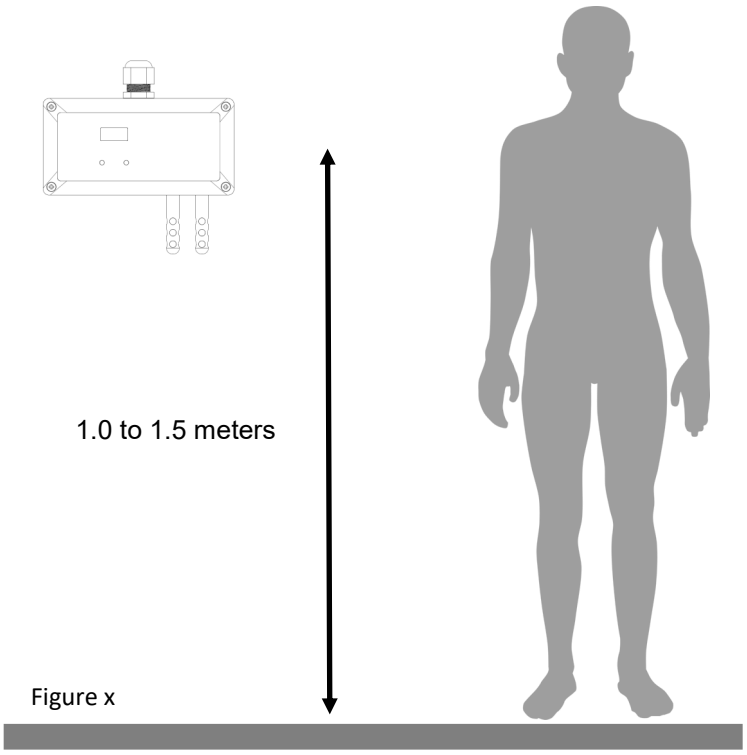


Figure x

Mounting

- Drill 4x holes for mounting the transmitter on a flat surface. Refer to Figure 3 for mounting dimensions.
- For rear entry, puncture the membrane using a sharp object and push the cable into the enclosure.
- Secure the enclosure onto the wall using #8 screws (not supplied).
- The unit should be mounted with the Particulate matter sensor's probes facing down.
- Follow the instructions to complete the wiring and tighten the cable gland (if used) to protect the unit from dust and water ingress.
- Fix the lid using four spring-loaded screws that come with the enclosure. Use a screwdriver to push the screws inside and rotate to lock it in place.

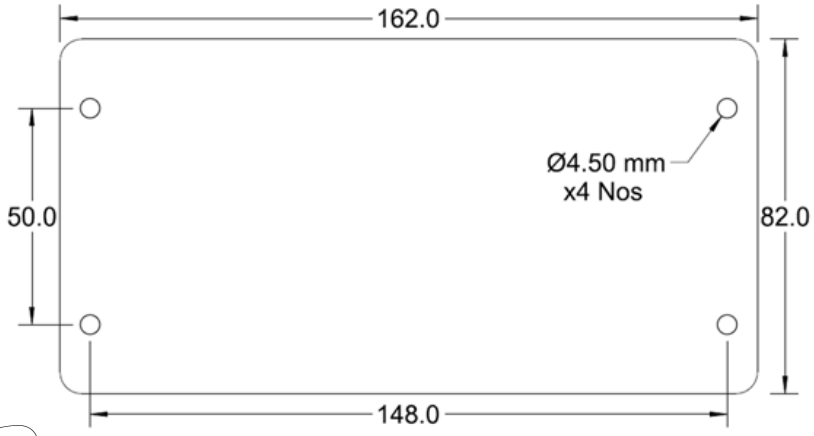


Figure 3

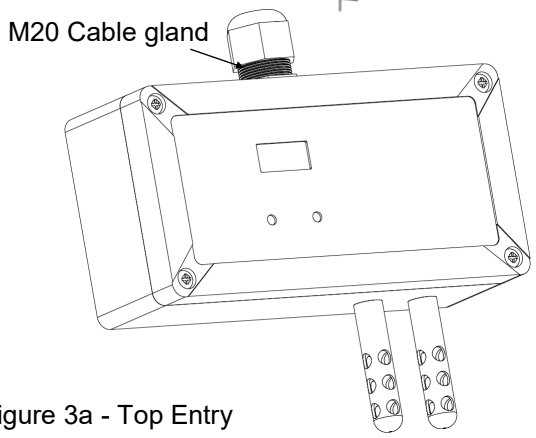


Figure 3a - Top Entry

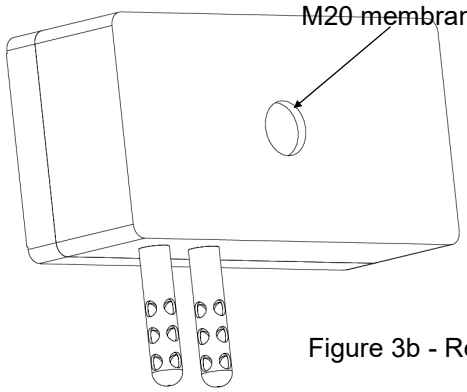
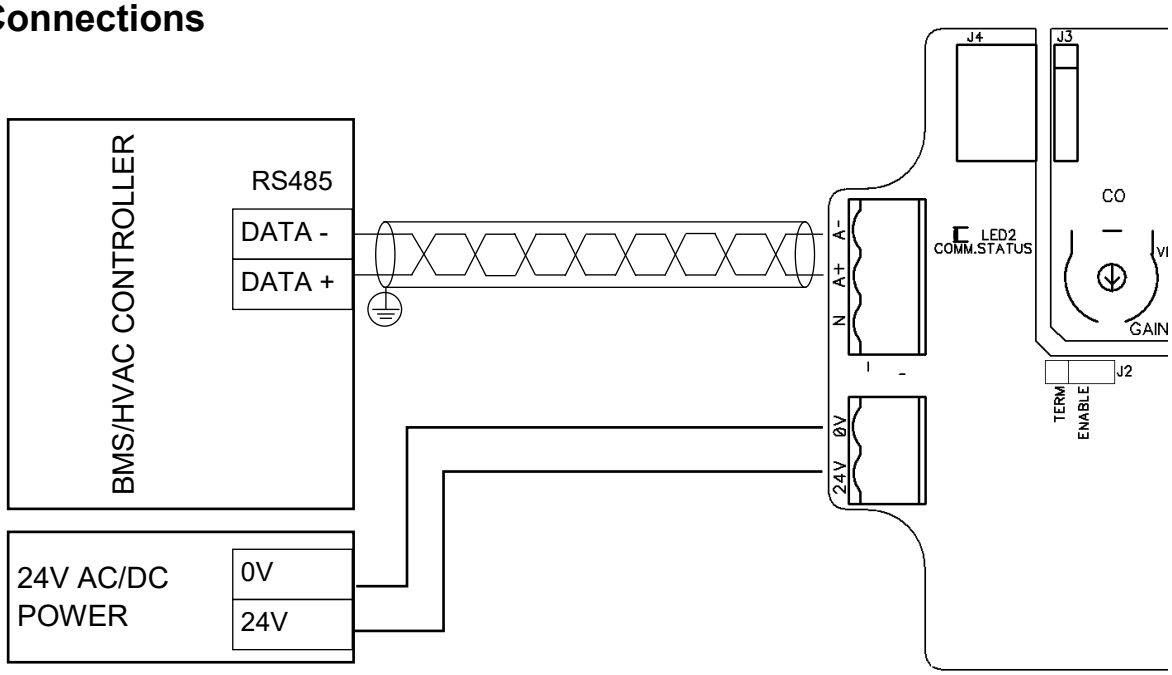


Figure 3b - Rear Entry

Connections



RS-485 output wiring

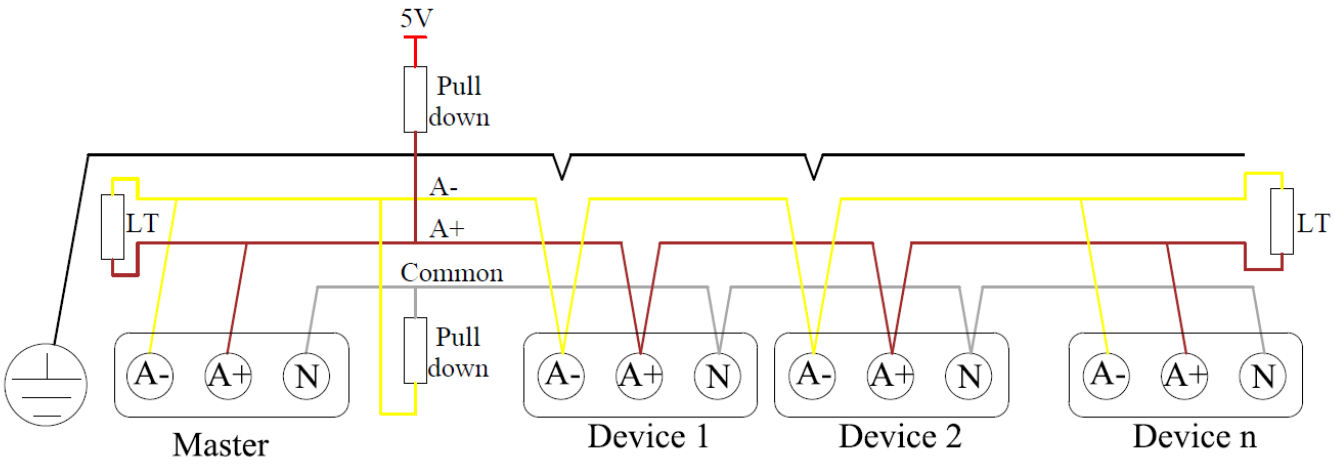


Figure 5

Use twisted pair shielded cables with a characteristic impedance of approximately 120 ohms. A balanced pair must be used for data lines (A+,A-) and a third conductor for the net common (N). The shield should be connected to the earth at one end only, preferably at the master control panel.

The RS485 standard suggests a daisy chain topology. A long trunk with short derivation cables is also acceptable.

A maximum of 32 devices may be connected to the network without using a repeater. This is subject to changes depending on the Unit Load used by other devices on the network and line polarization.

Either end of the network should be terminated with 120 Ohms to avoid signal reflections. Do not use line termination on a derivation cable. For convenience, unit has the Line Termination (LT) built-in, which may be enabled using the jumper.

Line polarisation might be needed in applications involving noisy environments. A pull-up is connected to a 5V source on A+ circuit. A pull-down resistor to the common is connected on A– circuit. The value of the resistors is chosen between 450 ohms and 650 ohms. Line polarisation will reduce the maximum number of devices that may be connected to a network.

Modbus RTU is a serial protocol. As the number of devices in a network increases, there will be potential delays in updating data from each device. The system designer determines the number of devices connected in a network depending on the required data refresh interval.

Network Configuration

The communication parameters can be set using the Dipswitches or can be programmed over the network.

If any switches are ON, switches A5 to A0 sets the device address and B1 and B0 sets the baud rate. The Parity will be Even, and the Number of Stop bits will be 1 in this mode.

If the dipswitches A5 to A0 are set to OFF, the communication parameters will be loaded from the internal configuration registers. When these registers are modified, the updated values will not be stored until a Non Volatile Memory Update command has been executed and will not be used until either a Force Reset command or a re-power of the unit.

A unique address for each device is essential for the proper operation of the serial bus. If two devices have the same address, the Master will not be able to communicate with any slave on the bus, causing a malfunction. The address assignment must be checked carefully before the procedure.

Dipswitch configuration

A5	A4	A3	A2	A1	A0	
OFF	OFF	OFF	OFF	OFF	OFF	Comms. set by Modbus registers
						Address
OFF	OFF	OFF	OFF	OFF	ON	1
OFF	OFF	OFF	OFF	ON	OFF	2
↓	↓	↓	↓	↓	↓	↓
ON	ON	ON	ON	ON	ON	63

B1	B0	Baud Rate	Parity	No of Stop Bits
OFF	OFF	9600	Even	One
OFF	ON	19200		
ON	OFF	38400		
ON	ON	57600		

Supported Function Codes

03	READ HOLDING REGISTERS (4XXXX BANK)
04	READ INPUT REGISTERS (3XXXX BANK)
06	WRITE SINGLE REGISTER(4XXXX BANK)
16	WRITE MULTIPLE REGISTERS(4XXXX BANK)

Modbus Registers

ADDRESS	DESCRIPTION	DATA TYPE	DATA	ACCESS	NVM
3XXXX REGISTER BANK					
30001	CO_CONCENTRATION (0.0-300.0) (ppm)	UINT16	0-3000	R	
30002	NO2_CONCENTRATION (0.0 0- 10.00)(ppm)	UINT16	0-1000	R	
30003	PM2.5_CONCENTRATION (µg/m^3)	UINT16	0-1000	R	
30004	PM10_CONCENTRATION (µg/m^3)	UINT16	0-1000	R	
30005	FAULT (0: NO_FAULT, 1: FAULT)	UINT16	BIT15-6: RESERVED BIT6: INT_TEMP_SENSOR BIT5: PM SENSOR BIT4: NO2 GAIN BIT3: NO2 SENSOR BIT2: CO GAIN BIT1: CO SENSOR BIT0: EEPROM	R	
30006:10	RESERVED	UINT16		R	
4XXXX REGISTER BANK					
40001	MODBUS ADDRESS (NETWORK)	UINT16	1-247(DEFAULT:1)	R/W	*
40002	BAUD RATE (NETWORK)	UINT16	0: 9600 1:19200(DEFAULT) 2:38400 3:57600 4:115200	R/W	*
40003	PARITY (NETWORK)	UINT16	0:NONE 1:ODD 2:EVEN(DEFAULT)	R/W	*
40004	NO OF STOP BITS (NETWORK)	UINT16	0:1 STOP BIT (DEFAULT) 1:2 STOP BITS	R/W	*
40005	DISPLAY	UINT16	DEFAULT: 0x0AFF(CYCLE THROUGH , MAX BRIGHT-NESS) BIT15:8 :BACKLIGHT BRIGHTNESS (0-10) BIT7: STOP_BITS BIT6: PARITY BIT5: BAUD BIT4: ADDRESS BIT3: PM10 (µg/m^3) BIT2: PM2.5 (µg/m^3) BIT1: NO2(PPM)	R/W	*
40006	FORCE_RESET	UINT16	1:RESET	R/W	
40007	NON_VOLATILE_MEMORY_UPDATE	UINT16	1:UPDATE	R/W	
40008	FORCE_FACTORY_DEFAULTS	UINT16	1:FORCE DEFAULTS	R/W	
40009	CALIBRATE_ZERO	UINT16	0x5A : ZERO	R/W	

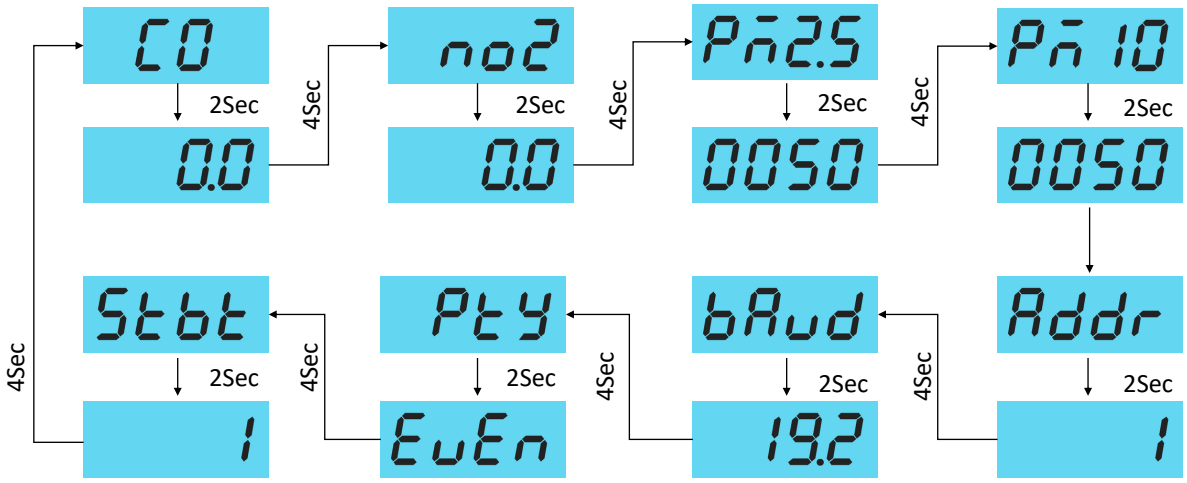
Common Exceptions

- Exception code :01 - ILLEGAL FUNCTION — Function code in the query is not supported by this device.
- Exception code : 02 ILLEGAL DATA ADDRESS — Starting address or starting address+ number of registers is out of range.
- Exception code : 03 ILLEGAL DATA VALUE — The value in the request data field is not an authorized value for the slave.

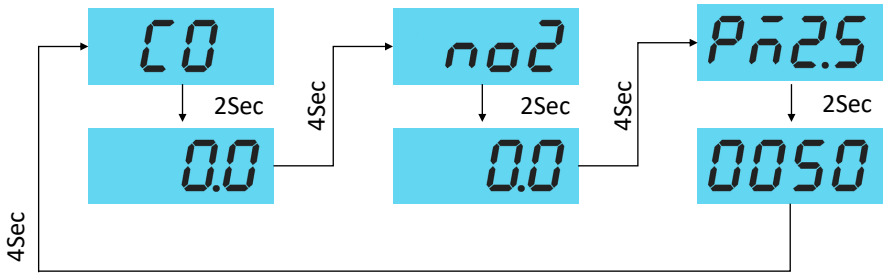
Display (if fitted)

The -L version of the device features a segmented display with a blue backlight for local readout. The switch on the PCB and register 40005(Bits 7:0) control the displayed parameter. By default, the display is programmed to cycle through the available parameters. A few examples are shown below.

40005(Bits 7:0) Register value : 255



40005(Bits 7:0) Register value : 7



40005(Bits 7:0) Register value : 4

Aside from the aforementioned examples, any combination of bits 7:0 of register 40005 written via Modbus can be used. The display will cycle through the parameters whose corresponding bits are set. Pressing the tactile switch will modify the register contents. However, the possible combinations are limited to 1, 2, 4, 8, 16, 32, 64, 128, and 255. Changes are saved in EEPROM to ensure they persist after power loss. When registers are modified via Modbus, an NVM update command must be sent to save the values. If changes are made using the switch, the contents are automatically stored.

Backlight

The brightness is controlled by bits 15:8 of DISPLAY register 40005. 0 is completely off, and 255 is maximum brightness.

Testing

Remove the lid and double-check all connections before applying power. The RS485 connections are polarity-sensitive. Observe the STATUS LED after applying power. The LED should make four dim flashes every 6 seconds. A brighter flash in the sequence indicates an error. If the communication lines are active and a valid request is received, the communication status LED will flash. A shorter flash indicates a request not addressed to the unit, and a long flash indicates that the reply is sent. If it remains off, check the communication parameters in the BMS controller and the device.

Reinstall the lid.

Allow the transmitter to warm up and stabilize for at least 15 minutes.

To perform a bump test, use a calibrated gas source (not supplied). Place the calibration cap (not supplied) over the sensor and allow a steady flow of gas (0.4 to 1 liter/minute) using a regulator. The target gas enters the sensor by diffusion and causes a change in output. The output from the transmitter will be proportional to the concentration of the target gas.

A few things must be taken into consideration while testing the NO2 sensor. NO2 is a very reactive gas. It will adsorb onto any surface it comes into contact with. PTFE tubing is preferred when connecting the regulator to the calibration cap. The gas should flow through the system for at least 15 minutes so that the adsorption/desorption has reached equilibrium.

To test the PM sensor, use a source of smoke (lit candle, a tiny piece of burning paper, cigarette, etc.) to generate particulates. The output of the transmitter should increase. If the reading does not change, the sensor is faulty.

Calibration

The device comes with pre-calibrated CO and NO2 sensors. They may be calibrated if necessary. The PM sensor cannot be field-calibrated. It can only be replaced with a spare. Calibration is recommended only if the transmitter has been shelved for more than six months from the date of manufacture.

Calibration must be done in a clean environment. The presence of CO/NO2 could offset the values. The ambient temperature can be between 20°C and 30°C while calibrating. The transmitter should be powered on for at least 30 minutes before calibration.

Use the display for local readout or observe values on the BMS controller.

Zeroing

Press and hold the DISP/ZERO switch for 10 seconds. The device will restart. Wait 2-3 minutes before continuing with the span calibration.

Adjusting span

There are two trim pots on the board to adjust the gain (span) for CO and NO2 outputs.

The recommended concentrations of calibration gases are:
NO2: 10 ppm with a fixed flow rate of 0.4 liters/minute.
CO: 300 ppm with a flow rate of 0.4 liters/minute.

1. Fix the calibration cap (not supplied).
2. Attach the calibrated target gas source to the calibration cap with PTFE tubing.
3. Turn the knob to let the gas flow through the calibration cap.
4. Maintain the flow for at least 5 minutes for CO and 15 minutes for NO2 to reach equilibrium conditions.
5. Adjust the output (300 ppm CO/10 ppm NO) by rotating the respective GAIN trim-pot on the PCB. If the output is low, rotate the trim-pot in the counterclockwise direction. Rotate clockwise to reduce the output.
6. Close the gas supply and remove the calibration cap. Calibration is complete.

Sensor replacement

When the sensor's lifetime is over, customers can request a spare at a reasonable price. The new sensors will be factory-calibrated. Contact our sales department for more information.