MaCURCO
GAS DETECTION

MODEL: EX SERIES
NON-INTRUSIVE CALIBRATION
GAS TRANSMITTER/SENSOR

INSTALLATION
OPERATION AND MAINTENANCE
MANUAL

Macurco Gas Detection
PHONE: 877-367-7891 FAX: 512-524-3415
WEBSITE: www.macurco.com EMAIL: info@aerionicsinc.com
Sioux Falls, SD 57104

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READ BEFORE OPERATING

Warning read and understand the contents of this manual. Failure to do so could result in serious injury or death. Users are responsible for correct translations of this manual into their native language. AVERTISSEMENT: Lire attentivement les instructions avant de metre en marche

All individuals who have or will have the responsibility of using, maintaining, or servicing this product must carefully read this manual. The product will perform as designed only if it is used, maintained, and serviced in accordance with the manufacturer's instructions.

The EX Series is a state-of-the-art transmitter that can operate as an independent, stand-alone system or as part of an integrated system. The EX Series communicates with analog and digital signals to virtually any controller, PLC, or DCS. Setup procedures are simplified with user-friendly push buttons and LCD menus.

1. Specifications

1.1 Electrical/Mechanical Specifications

Input Power:	24VDC nominal, range 18 to 30VDC, 0.3A DC Total Max. 24VAC nominal, range 15 to 24VAC, 0.3A AC Total Max. **(AC must not be grounded)**
Fuse:	F2 on Main Board: Polyswitch 750mA Polyswitch device resets after the fault is cleared and power to the circuit is removed
Sensor:	Combustible gases: Catalytic Bead Toxic gases and Oxygen: Electrochemical
Panel Indicators:	5 Status LED's • RS-485 TX Status (Green) • RS-485 RX Status (Green) • Relay 1 Status (Red) • Relay 2 Status (Red) • Relay 3 Status (Red)
Display:	LCD graphic backlight display
Keypad:	3 magnetic switches: F1, F2, F3
Relays:	3 Relays SPDT, Dry contacts • 1.0A maximum at 30 VDC (resistive load) • 0.3A maximum at 125VAC (resistive load)

Output Signal: RS-485 RTU
4-20mA and 2-10VDC Analog Signal Output

Enclosure: Aluminum Pressure Die–Casting
Entries: 2 - ¾" NPT

Certificate: FM 3615, CSA C22.2 No.30
Class I, Groups A, B, C, D
Class II, Groups E, F, G
Class III

Enclosure type: NEMA 4X, Division 1 Division 2
ANSI/ISA 12.22.01
Class I, Zone 1 AEx d II C, IP66 Zone 1
CSA E60079-1 Ex d II C, Class I, Zone 1, IP66

Operating Temperature: -40°C to 70°C, depends on sensor specification

Ambient Humidity: 5% to 95% RH (non-condensing)

Storage Temperature: 0°C to 40°C, depends on sensor specification

Size: 5.7 inches x 7.48 inches x 5.19 inches (145mm X 190mm X 130mm)

Weight: 3.97 lbs. (Less than 1.8kg)

1.2 Sensor Specifications

EX Detector P/N	Sensor P/N	Gas	Symbol	Span
EX-BUTAN-100L-O	70-2900-0228-5	Butanol	$C_4H_{10}O$	0-100% LEL
EX-C2H4-100L-O	70-2900-0229-6	Ethylene	C_2H_4	0-100% LEL
EX-C4H10-100L-O	70-2900-0230-7	Butane	C_4H_{10}	0-100% LEL
EX-C5H12-100L-O	70-2900-0231-8	Pentane	C_5H_{12}	0-100% LEL
EX-C6H6-100L-O	70-2900-0232-9	Benzene	C_6H_6	0-100% LEL
EX-CH3CO-100L-O	70-2900-0233-0	Acetone	CH_3CO	0-100% LEL
EX-CH3OH-100L-O	70-2900-0234-1	Methanol	CH_3OH	0-100% LEL
EX-CL2-5P-O	70-2900-0235-2	Chlorine	CL_2	0-5 PPM
EX-CLO2-2P-O	70-2900-0236-3	Chlorine Dioxide	CLO_2	0-2 PPM
EX-CO-1000P-O	70-2900-0237-4	Carbon Monoxide	CO	0–250 PPM
EX-CO-250P-O	70-2900-0238-5	Carbon Monoxide	CO	0 – 1000 PPM
EX-GENL-100L-O	70-2900-0239-6	General Combustible	-	0-100% LEL
EX-H2-1000P-O	70-2900-0240-7	Hydrogen	H_2	0-1000 PPM
EX-H2-100L-O	70-2900-0241-8	Hydrogen	H_2	0–100% LEL
EX-H2-2000P-O	70-2900-0242-9	Hydrogen	H_2	0-2000 PPM
EX-H2S-100P-O	70-2900-0243-0	Hydrogen Sulfide	H_2S	0–25 PPM
EX-H2S-25P-O	70-2900-0244-1	Hydrogen Sulfide	H_2S	0-100 PPM
EX-HCL-30P-O	70-2900-0245-2	Hydrogen Chloride	HCL	0-30 PPM
EX-HCN-50P-O	70-2900-0246-3	Hydrogen Cyanide	HCN	0-50 PPM
EX-NH3-1000P-O	70-2900-0247-4	Ammonia	NH3	0-100 PPM
EX-NH3-100P-O	70-2900-0248-5	Ammonia	NH3	0-1000 PPM
EX-NO-100P-O	70-2900-0249-6	Nitric Oxide	NO	0-100 PPM
EX-NO2-10P-O	70-2900-0250-7	Nitrogen Dioxide	NO_2	0-10 PPM
EX-O2-25V-O	70-2900-0251-8	Oxygen	O_2	0-25%VOL
EX-O3-1P-O	70-2900-0252-9	Ozone	O_3	0-1 PPM
EX-SO2-6P-O	70-2900-0253-0	Sulphur Dioxide	SO_2	0–6 PPM

1.3 Sensor Mounting Location by Gas

Code	Gas	Symbol	Gas Density	Span	Operating Temperature
1	Carbon Monoxide	CO	Slightly Lighter	0–250 PPM	-4° F to 122°F (-20°C to +50°C)
1	Carbon Monoxide	CO	Slightly Lighter	0 – 1000 PPM	-4° F to 122°F (-20°C to +50°C)
2	Hydrogen Sulfide	H_2S	Heavier	0–25 PPM	-4° F to 122°F (-20°C to +50°C)
2	Hydrogen Sulfide	H_2S	Heavier	0-100 PPM	-4° F to 122°F (-20°C to +50°C)
3	Sulfur Dioxide	SO_2	Heavier	0–6 PPM	-4° F to 122°F (-20°C to +50°C)
5	Nitrogen Dioxide	NO_2	Heavier	0-10 PPM	-4° F to 122°F (-20°C to +50°C)
6	Hydrogen	H_2	Lighter	0-1000 PPM	-4° F to 122°F (-20°C to +50°C)
6	Hydrogen	H_2	Lighter	0-2000 PPM	-4° F to 122°F (-20°C to +50°C)
7	Hydrogen Cyanide	HCN	Lighter	0-50 PPM	-4° F to 122°F (-20°C to +50°C)
9	Ammonia	NH3	Lighter	0-100 PPM	-22° F to 122°F (-30°C to +50°C)
9	Ammonia	NH^3	Lighter	0-1000 PPM	-22° F to 122°F (-30°C to +50°C)
11	Ozone	O_3	Heavier	0-1 PPM	-4° F to 104°F (-20°C to +40°C)
13	Chlorine	CL_2	Heavier	0-5 PPM	-4° F to 122°F (-20°C to +50°C)
14	Chlorine Dioxide	CLO_2	Heavier	0-2 PPM	-4° F to 104°F (-20°C to +40°C)
4	Nitric Oxide	NO	Slightly Lighter	0-100 PPM	-4° F to 122°F (-20°C to +50°C)
8	Hydrogen Chloride	HCL	Heavier	0-30 PPM	-4° F to 104°F (-20°C to +40°C)
12	Ethylene Oxide	ETO	Heavier	0-20 PPM	-4° F to 122°F (-20°C to +50°C)

*NOTE: Mounting Heights   - Low = 9-18 inches (0.25-0.5 meters) from floor
                                         - Mid = 4-6 feet (1.25-1.75 meters) from floor
                                         - High = 9-18 inches (0.25-0.5 meters) from ceiling

2. Installation

Warnings:

EX Series is designed for installation and use in Zone 1 or 2 hazardous areas in many countries including Europe and for Class 1 Division 1 or 2 area applications in North America. Installation must be in accordance with the recognized standards of the appropriate authority in the country concerned.

Access to the interior of the detector, when carrying out any work, must only be conducted by trained personnel.

Before carrying out any work ensure local regulations and site procedures are followed. Appropriate standards must be followed to maintain the overall certification of the detector.

For installations where conduit is used, and the sensor is mounted directly to the EX Series, there must be a "Seal Fitting" installed for each of the cable gland entries within 18 inches of the EX Series. For installations where the smart sensor head assembly will be mounted remotely from EX Series, an additional "Seal Fitting" will be required: One at each of the conduit entries for the power/signal/relay contact outputs and one at the sensor wiring entrance. The total distance of the location of these Seal Fittings is 18 inches. (e.g. If all 3 gland entries are to be used, 3 Seal Fittings should be located, each within 6 inches of the wiring entrance).

If using an anti-seize compound, the threads should be thinly coated with an approved silicone free compound (e.g. petroleum jelly or other).

To reduce the risk of ignition of hazardous atmosphere, de-classify the area or disconnect the equipment from the supply circuit before opening the detector enclosure. Keep assembly tightly closed during operation.

Never attempt to open a junction box/enclosure or replace/refit the sensor in potentially hazardous atmospheres while power is still applied to the transmitter.

The detector must be earthed/grounded for electrical safety and to limit the effects of radio frequency interference. Earth/ground points are provided inside and outside the unit. Ensure that all screens/instrument earth/clean earth wiring is earthed/grounded at a single point (either at the controller or detector - BUT NOT BOTH) to prevent false alarms due to earth/ground loops.

Take care when handling sensors as they may contain corrosive solutions.

This equipment is designed and constructed as to prevent ignition sources arising, even in the event of frequent disturbances or equipment operating faults.

The sensor head must be fitted with the supplied weather protection, and mounted so that the sinter is pointing downward to provide ingress protection IPX6.

2.1 Enclosures Physical Dimensions
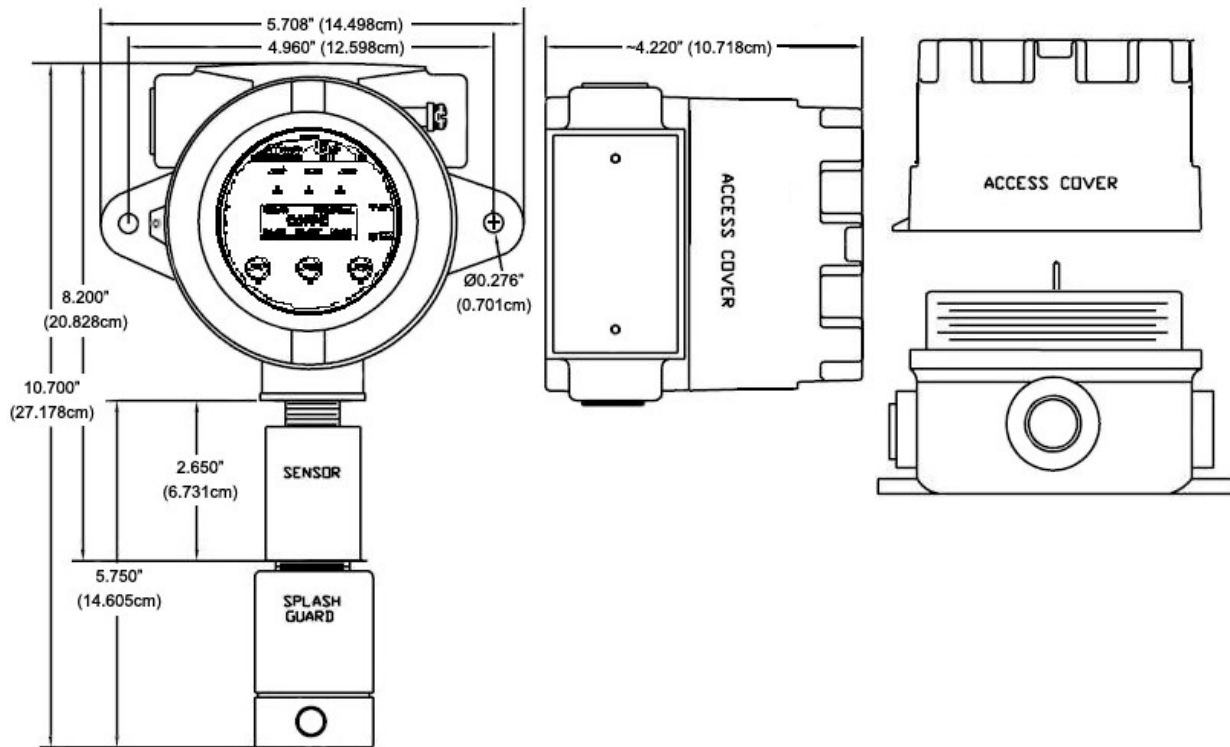
2.2 Mounting the transmitter

The EX Series transmitter has an integral mounting plate consisting of two mounting holes on the transmitter body. The transmitter may be fixed directly to a surface for mounting.

The EX Series Sensor/Transmitter should be mounted where the gas to be measured is most likely to be present. This location will be dependent on the source of the target gas and whether that gas is lighter or heavier than air. Air circulation and mixture should also be taken into account.

3/4" NPT cable/conduit entries on UL/CSA versions.

Where possible, the sensor/transmitter should be mounted where it is accessible for the purposes of routine re-calibration and **periodic** sensor replacement. Sufficient room should be left to allow the enclosure cover to be removed and the connection of the calibration adapter to the sensor assembly. For sensor element replacement, there will need to be enough room to reach into the sensor assembly.

NOTE: Avoid mounting the electronics near 600 VAC switchgear and other sources of radio frequency and/or electromagnetic interference. While RFI/EMI protection is built in to the electronics, excessive levels of interference may cause instability in the output signal.

Warning: GROUNDING - The industrial explosion-proof metal enclosure must be connected to a safety ground, either locally or back at the controller, in order to provide immunity to Electromagnetic Interference.

2.3 Remote Mounting the Smart Sensor Head Assembly
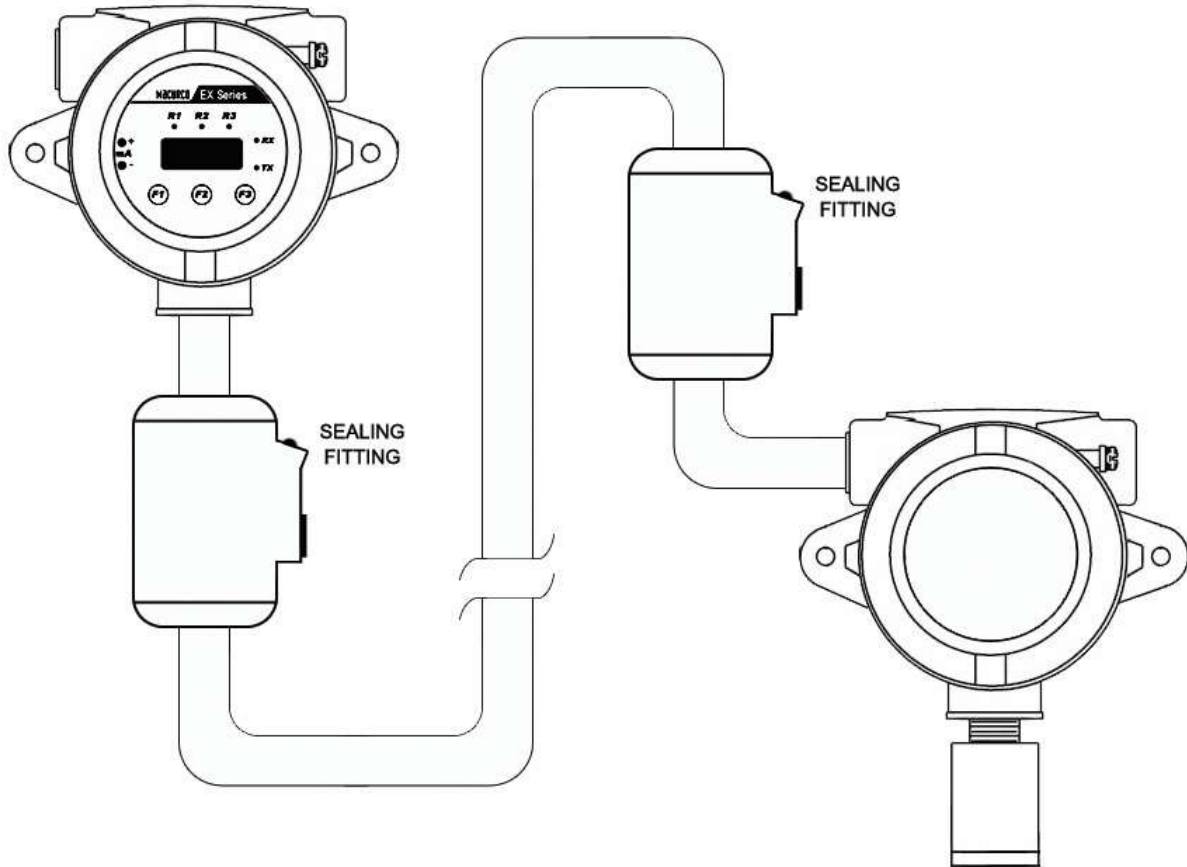
The Smart Sensor Head can be equipped with EX Series locally or remotely. For installations where the smart sensor head assembly will be mounted remotely from EX Series, the max distance between EX Series and Remote Smart Sensor Head is 100 meters. The Remote Smart Sensor Head Assembly is not included in the EX Series standard package, it must be ordered separately.

NOTE:

- **Conduit or Approved Hazardous Location Cable connecting the remote sensor and Transmitter must have Sealing Fittings at both ends within total distance 18"(350mm).**
- **Hazardous Location Cable and Sealing Fittings must be approved for Class 1. Div. 1 Group B, C, D Hazardous Locations.**

2.4 Terminals
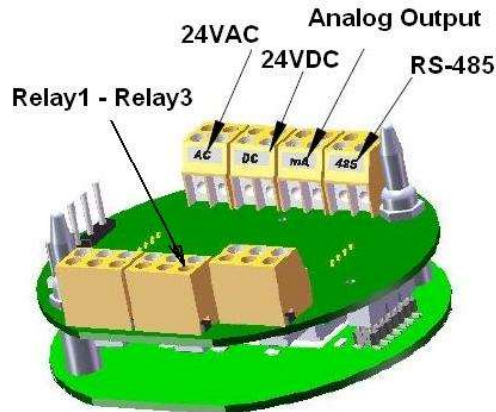
2.4.1 Wire and Cable

Terminal blocks TB1 to TB8 accept 12 AWG to 24 AWG wire. Use 16 AWG or 18 AWG wire for the Power Supply in long wiring runs, which can be up to 3,280 feet (1,000 meters) long.

We recommend using BELDEN 9841 for communications. This wire has 120 ohm input impedance, which will reduce RS-485 communication problems.

2.4.2 Digital Connection
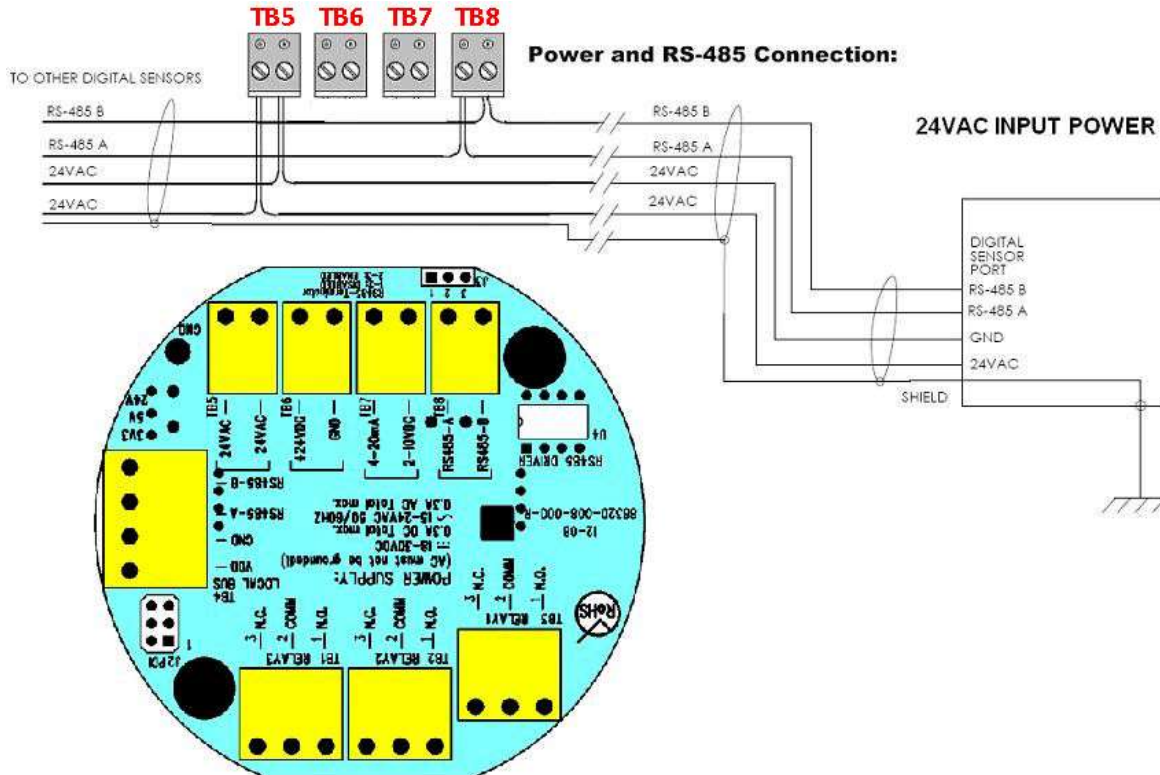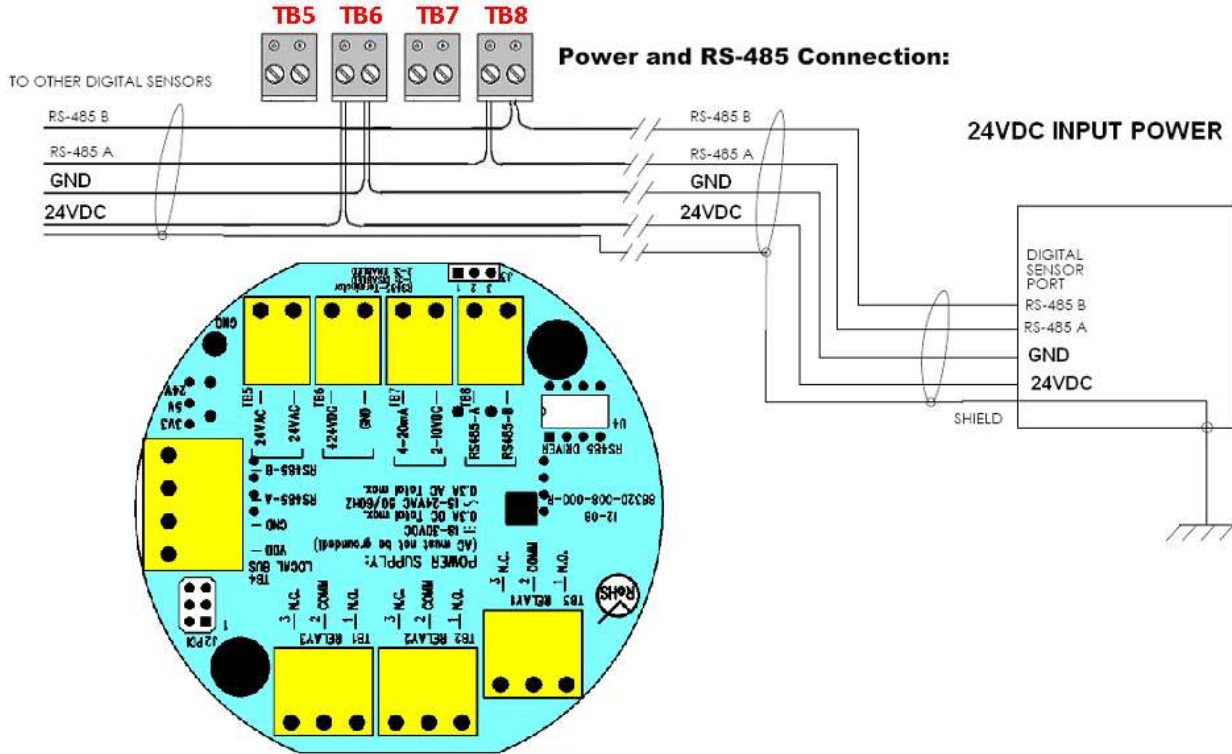
2.4.3 Remote Smart Sensor Connection
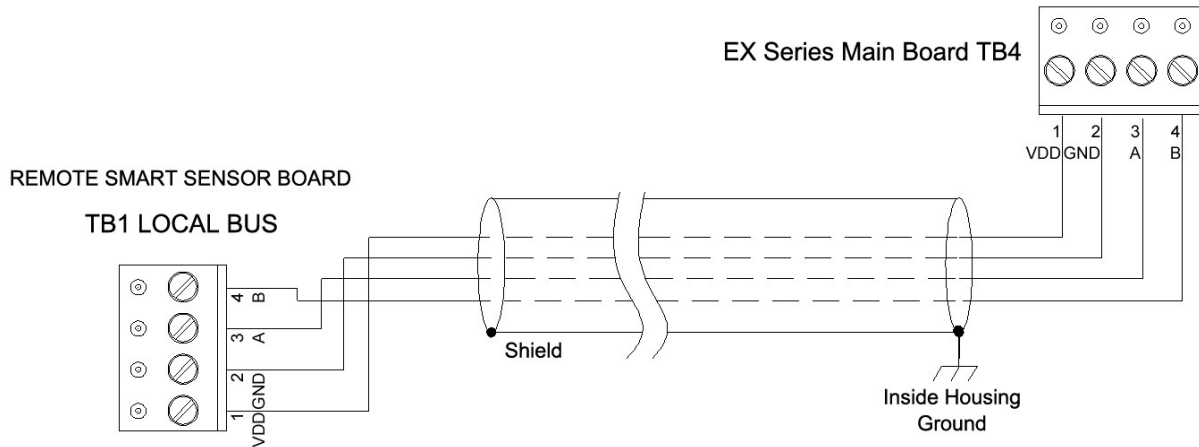
2.4.4 RS-485 Terminator and Driver Replacement

The terminator on each end of the RS-485 run is designed to match the electrical impedance characteristic of the twisted pair wire, and will prevent signal echoes from corrupting the data on the line. The terminator should be enabled on BOTH ends of the RS-485 run. Short and medium length Modbus/485 runs can operate without the terminating resistor. Longer runs may require the terminating resistors; adding terminating resistors dramatically increases power consumption. **Factory default setting is disabled terminating resistors**.

The EX Series supplies this resistor on the main board, and it is chosen using a jumper at J3.

- J3 1-2: Terminator Disabled / OFF (default)

- J3 2-3: Terminator Enabled / ON

RS-485 lines in heavy industrial environments are sometimes subjected to magnetic disturbances causing sufficient inducted power surges to damage the driver integrated circuit (IC). This IC (U4) has a socket on the circuit card for ease of replacement in the field.

2.4.5 4-20mA and 1-5VDC / 2-10VDC Analog Output

The EX Series provides one-channel 4-20 milliamp analog outputs and programmable 1-5VDC / 2-10VDC analog output at the same time. The maximum output impedance is 600 ohms for the 4-20mA output. The maximum output current is 10 mA for the 1-5VDC/2-10VDC output.
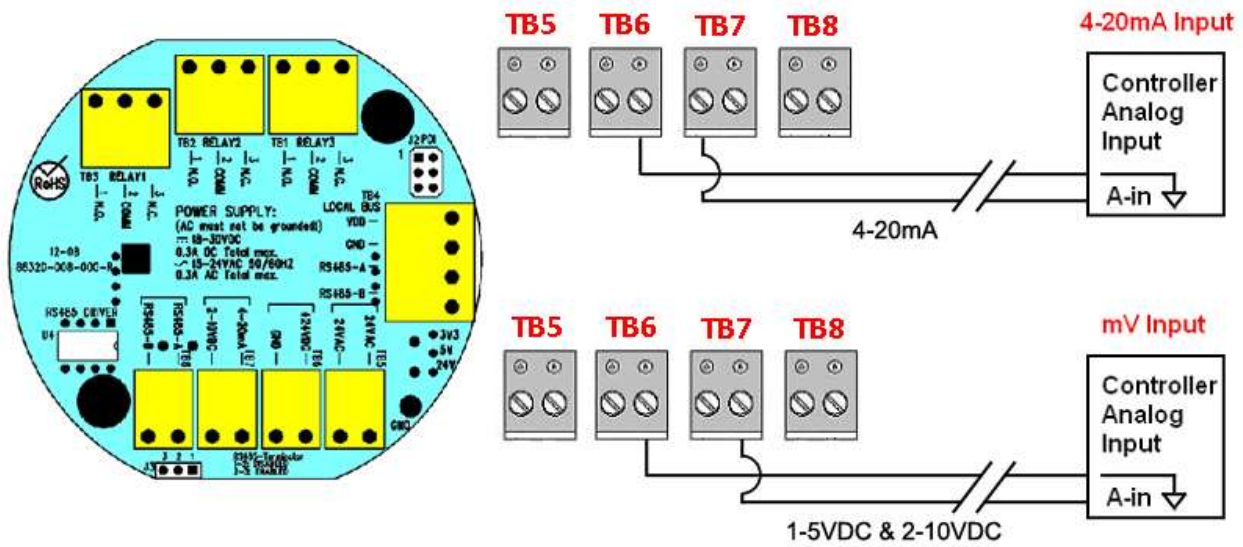
Test point mA+ and mA- on top plate board are used to measure the 4-20mA output current inline when the EX Series is working in the field.

The 1-5VDC/2-10VDC output can be selected through the menu. Default setting is 1-5VDC output.

The analog output may be defined in complex ways allowing assignment of different values to both 4 milliamps and 20 milliamps. You may even assign a gas concentration to 4 mA, which is higher than the concentration assigned to 20 milliamps. The EX Series will draw a straight line between them. There is no need to assign gas concentration to 1V-5VDC/2V-10VDC. When the EX Series outputs 4mA, it also outputs 1VDC or 2VDC. When the EX Series outputs 20mA, it also outputs 5VDC or 10VDC, which follows the 4-20mA output.

If there is any fault found in the EX Series, it will output 2.5mA and 1VDC at 2-10V output or 0.5VDC at 1-5VDC output to indicate the fault.

2.4.6 Relays Outputs

The EX Series has three onboard, programmable, Single-Pole Double-Throw (SPDT) relays. These relays can be used to control other equipment, such as fans, lights, horns, etc. eliminating the need for a separate controller.

Three terminal blocks (TB1, TB2, and TB3) are located on the main board. Each relay can be programmed individually.

Switching capability of each relay is:

- 1.0 A maximum resistive load at 30 VDC

- 0.3A maximum resistive load at 125 VAC

2.5 Note for EX Series:

Avoid running communication wires or sensor input wires next to AC power wires or the relay output wires. These can be sources of noise that can affect signal quality.

When the EX Series input power is AC, the 24VAC must not be grounded. A dedicated floating 24VAC may be needed if other nodes on the network are grounded, otherwise a DC power supply is recommended.

3. Function and Configuration

3.1 *Indicators*

The indicators consist of five LED's – two to indicate RS-485 digital communication, three to indicate the status of Relay 1, Relay 2, and Relay 3.
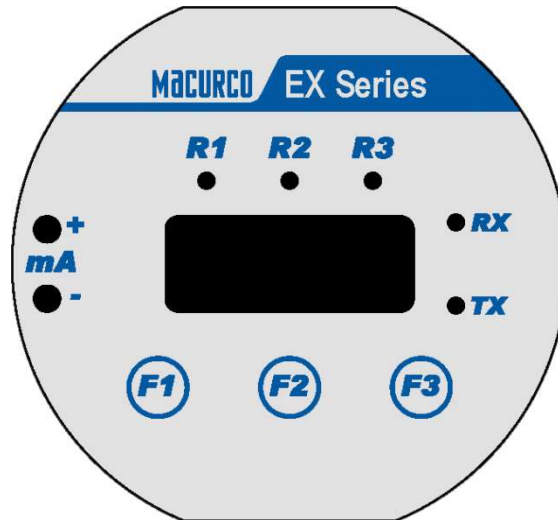
- **RS-485-TX/RX**

When the EX Series is connected to a controller system via RS-485, the traffic of the communication can be monitored visually through the two RS-485 indicators. One is RX LED, which indicates the data stream received in from the controller. The other is TX LED, which indicates the data stream out of the EX Series.

Note: If the TX LED or the RX LED is always ON, is indicative of a communication problem. See Troubleshooting for RS-485.

- **Relay 1 – Relay 3 LED**

Indicate the status of each relay. When the relay is actuated/closed, the relay LED is ON. When the relay is de-actuated/open, the relay LED is OFF.

Note: If you set the relay to be Normally Energized (Fail Safe), the relay LED will turn ON at non-alarm state and turn OFF at alarm state, because the LED reflects the relay coil status.

3.2 Tool Function

Press Key [F3] to enter Tool Function that might be used frequently in the field.
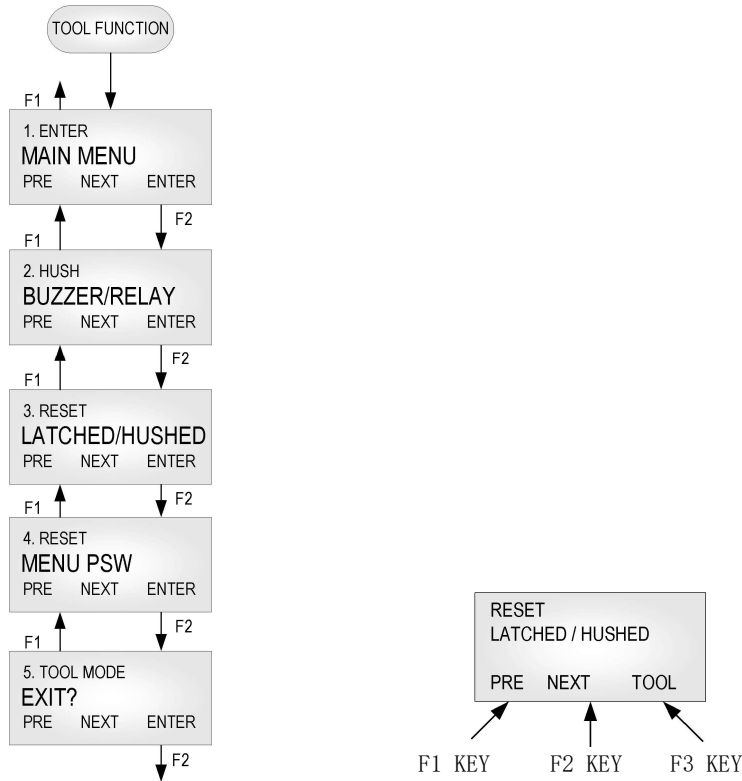
3.2.1 Enter Main Menu

Press key [F1] to browse previous item of the current menu.
Press key [F2] to browse next item of the current menu.
Press key [F3] to enter the main menu for more configuration and settings.

3.2.2 Hush Buzzer and Relay

Press key [F3] to silence the buzzer and buzzer-style relays.

3.2.3 Reset Latched/Hushed

To acknowledge a latched condition or a hushed condition, press key [F3] to reset latched relays and hushed buzzer if equipped for which the alarm condition has been removed. If the alarm condition (e.g. high gas concentration) is still present, the relay(s) will not reset.

3.2.4 Reset MENU Password

If you forgot the main menu password, you can reset the menu password to default password "4321" by entering a correct active code. For the active code, contact Macurco.

3.2.5 Exit Tool Mode

Press key [F3] to return to monitoring mode.

3.3 Main Menu Tree

The main menu is password protected. Once the password is accepted, you are allowed into the main menu tree.

Factory default password is 4321.

Note: While in the Menu Tree, all normal monitoring operations stop. The alarm status does not change.

```
                    F2        ↑
                    ↓         F1
          ┌─────────────────────┐
          │ MENU:               │  F3
          │ 1_ SYSTEM SETUP     │ ───→
          │ PRE    NEXT   ENTER │
          └─────────────────────┘
                    F2        F1
                    ↓         ↑
          ┌─────────────────────┐
          │ MENU:               │  F3
          │ 2_ ZERO CAL         │ ───→
          │ PRE    NEXT   ENTER │
          └─────────────────────┘
                    F2        F1
                    ↓         ↑
          ┌─────────────────────┐
          │ MENU:               │  F3
          │ 3_ SPAN CAL         │ ───→
          │ PRE    NEXT   ENTER │
          └─────────────────────┘
                    F2        F1
                    ↓         ↑
          ┌─────────────────────┐
          │ MENU:               │  F3
          │ 4_ OUTPUT TEST      │ ───→
          │ PRE    NEXT   ENTER │
          └─────────────────────┘
                    F2        F1
                    ↓         ↑
          ┌─────────────────────┐
          │ MENU:               │  F3
          │ 5_ VIEW SETTING     │ ───→
          │ PRE    NEXT   ENTER │
          └─────────────────────┘
                    F2        F1
                    ↓         ↑
          ┌─────────────────────┐                              F2        ↑
          │ MENU:               │  F3                          ↓         F1
          │ 6_ ALARM SETUP      │ ───→             ┌─────────────────────┐
          │ PRE    NEXT   ENTER │                  │ MENU:               │ F1/F3
          └─────────────────────┘                  │ B_ SIMULATION       │ ───→
                    F2        F1                    │ PRE    NEXT   ENTER │ ←───
                    ↓         ↑                     └─────────────────────┘
          ┌─────────────────────┐                            F2        F1
          │ MENU:               │  F3                         ↓         ↑
          │ 7_ RELAY  STYLE     │ ───→             ┌─────────────────────┐
          │ PRE    NEXT   ENTER │                  │ MENU:               │  F3
          └─────────────────────┘                  │ C_ SITE SERVICE     │ ───→
                    F2        F1                    │ PRE    NEXT   ENTER │
                    ↓         ↑                     └─────────────────────┘
          ┌─────────────────────┐                            F2        F1
          │ MENU:               │  F3                         ↓         ↑
          │ 8_ BUZZER  STYLE    │ ───→             ┌─────────────────────┐
          │ PRE    NEXT   ENTER │                  │ MENU:               │  F3
          └─────────────────────┘                  │ D_ FACTORY SET      │ ───→
                    F2        F1                    │ PRE    NEXT   ENTER │
                    ↓         ↑                     └─────────────────────┘
          ┌─────────────────────┐                            F2        F1
          │ MENU:               │  F3                         ↓         ↑
          │ 9_ A-OUT SETUP      │ ───→             ┌─────────────────────┐
          │ PRE    NEXT   ENTER │                  │ MENU:               │  F3
          └─────────────────────┘                  │ E_ EXIT MENU        │ ───→
                    F2        F1                    │ PRE    NEXT   ENTER │
                    ↓         ↑    F3               └─────────────────────┘
          ┌─────────────────────┐                            F2        F1
          │ MENU:               │ ───→                        ↓         ↑
          │ A_ ALL DISABLE      │ F1/2
          │ PRE    NEXT   ENTER │ ←───
          └─────────────────────┘
                    F2        ↑
```

3.4 Menu "1_SYSTEM SETUP"

The system setup subdivision contains general settings for monitor operations, communications and 4-20mA calibrations.

System Settings

Password:	Default password is 4321.
Address:	The EX Series RS-485 address can be defined from 0 to 255. Default is 3. Note: In Modbus protocol, the address 0 is for broadcast.
Baud rate:	Define baud rate for RS-485 communication with Macurco controller protocol, Modbus protocol, or BACnet protocol. EX Series default baud rate is 4800 bps.
Scroll Rate:	In normal operation, the sensor and relay status information scrolls automatically. Set the number of seconds for each item to be displayed. Default value is 3 seconds.
Backlight:	The LCD backlight can be set to Always Off, Always On and Auto Power Saving mode. In Auto Power Saving mode, the backlight will turn on for 10 seconds after any key has been pressed. Default setting is Auto mode.
4mA Cal **20mA Cal** **1V Cal** **2V Cal** **5V Cal** **10V Cal:**	These values are established during factory calibration for the 4-20mA analog output and should not require recalibration in the field. Do not attempt to modify these settings in the field. Changing these values will change the analog output signal scale. **Warning: This procedure is part of the factory setup. In most circumstances, it will not be necessary to perform this procedure in the field. These functions require the use of precision reference instrumentation.**
New Password:	The new password can be any combination of up to four digits. Default password is 4321. **Warning: Be sure that you record the new password in a safe and secure location!**

Protocol:	The EX Series supports Modbus protocol, responds as a Modbus Slave using RTU protocol. When it's set to Modbus, the parity bit can be defined as EVEN, ODD, and No Parity.

Display Mode:	• Display Instant: displays instantaneous gas concentration
	
	• Display Average:
	
	    ○ Displays STEL (15 min average reading)
	
	    ○ Displays TWA (8 hour average reading)
	
	    ○ Displays daily peak
	
	• Display Alarm: displays alarm 1-8 status
	
	• Display Relay: displays relay 1-3 status
	
	• Display Buzzer: displays buzzer 1-3 status (if equipped)
	
	• Display A-Out mA: displays current 4-20mA output
	
	• Display A-Out VDC: displays current VDC output
	
	• Display Clock: displays real time clock
	
	If there is nothing to display, the unit will display "Running…"

Auto Zero:	When AutoZero is set to ON, the unit will gather the lowest reading in 7-day period and set the unit into Zeroing Calibration mode so that the lowest reading goes to zero. When AutoZero is set to OFF, the unit will not adjust its own zero and work off the last manual or factory calibration. Default value is OFF. **NOTE: AutoZero works best in situations where the building will purge at night (or over a weekend) to a zero concentration of target gas.**
RESERVED:	TBD.
Restore Default:	**Note: Don't do this if you don't have calibration gas and precision reference instrumentation to calibrate the unit** To load defaults to factory settings, or to restore the unit to correct operation. The settings below will be restored to default values:

	-Password, -Baud rate, -Scroll rate, -Backlight, -Display mode, -LCD contrast, **-Gas type on the Sensor Board, -**Alarm settings, -Relay/Buzzer settings, and 4-20mA/1-5VDC settings. The unit needs to change the gas type if the sensor on the sensor board is not the default gas type: CO, CH4, or O2. Contact Macurco for instructions. The analog output 4-20mA/1-5VDC may need to be calibrated. Zero and span calibrations are needed.
ADJ Clock:	Adjust real time clock.
ADJ Contrast:	Adjust the LCD contrast. Valid values are between 10 (light) and 50 (dark). Default is 21.
RESERVED:	TBD.

3.5 Menu "2_ZERO CAL"

The EX Series is calibrated using a two-point calibration process. First, use a "Zero Gas", then use a "CAL Gas" containing a known concentration of a standard reference gas to set the second point of reference.

Equipment Required

- A cylinder of Zero Gas (clean air or nitrogen)
- A cylinder of Cal Gas
- Flow Limiting Regulator(s) **0.2 to 1.0 LPM**
- Tubing
- Cal Adapter
  - Toxic Cal Adapter for use with Toxic gases
  - LEL Cal Adapter for use with all other gases

Zeroing Calibration Procedure

- "2_ ZERO CAL:"

```
┌─────────────────────────────┐
│                             │
│        2_ ZERO CAL          │
│                             │
└─────────────────────────────┘
```

- Press key [F3] and the device will show the calibration notice and then ask if you want to continue. The middle line will display the current concentration.

```
┌─────────────────────────────┐
│   CONTINUE?                 │
│             XXPPM           │
│                             │
└─────────────────────────────┘
```

- Apply the Zero Gas.

- Wait for about 3 minutes or until the reading is stable.

- Press key [F3] to confirm Zeroing Cal.

- When the device is in Zeroing CAL, it will take 3 seconds to 20 seconds to complete.

- When the zeroing CAL operation is over, the device will display "Accepted" and return to "2_ZERO CAL".

- Make sure there is no Cal Error displayed. If Cal Error is reported, repeat the procedures above. If the Cal Error is still showing up, the sensor may be expired.

- Remove the gas.

- Exit the menu to Monitoring Mode.

3.6 Menu "3_SPAN CAL"

- "3_ SPAN CAL"

```
┌─────────────────────────────────┐
│                                 │
│          3_ SPAN CAL            │
│                                 │
└─────────────────────────────────┘
```

- Press key [F3] and the device will ask for the CAL GAS. Input the concentration of the calibration gas.

```
┌─────────────────────────────────┐
│  CAL GAS:                       │
│  >                    XXX       │
└─────────────────────────────────┘
```

- Press key [F3] and the device will show the calibration notice and then show the flow rate for the span calibration. Press any key to continue, and then the device will ask you if you want to continue. The middle line will display the current concentration.

```
┌─────────────────────────────┐
│  CONTINUE?                  │
│              XXPPM          │
└─────────────────────────────┘
```

- Apply the calibration gas.

- Wait for about 3 minutes or until the reading is stable.

- Press key [F3] to confirm SPAN CAL.

- When the device is in span cal, it will take 10 seconds to 1 minute to complete.

- When the span cal operation is over, the device will display "Accepted" and return to "3_SPAN CAL".

- Make sure there is no Cal Error displayed. If Cal Error is reported, repeat the procedures above. If the Cal Error is still showed up, the sensor maybe expired.

- Remove the gas.

- Exit menu to Monitoring Mode.

3.7 Menu "4_OUT TEST"

During system installation and testing, it may be necessary to force relays and buzzers on and off.

The Relay Testing feature allows the user to force the actuation of each relay. This function forces an Actuate vs. De-actuate action, not an energized vs. non-energized action. Therefore, the user must be aware of these relays, which have been defined as normally energized or not normally energized.
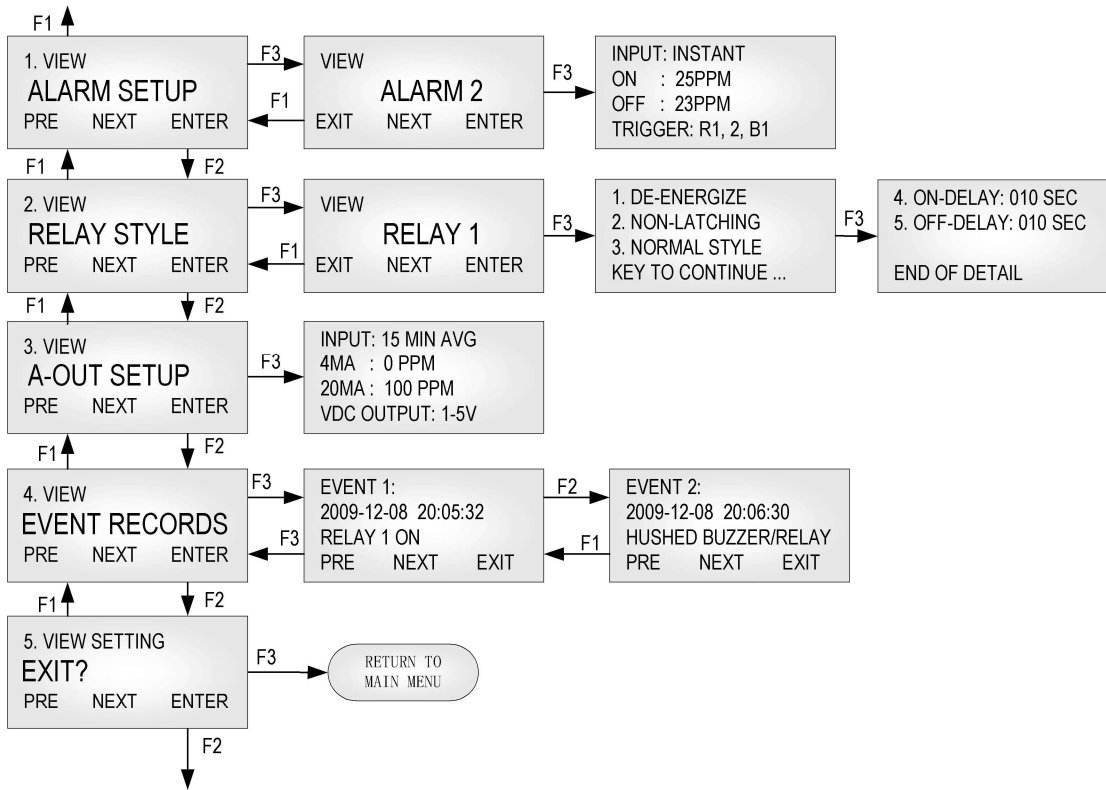
The 4mA (1VDC/2VDC) and 20mA (5VDC/10VDC) outputs can be tested too.
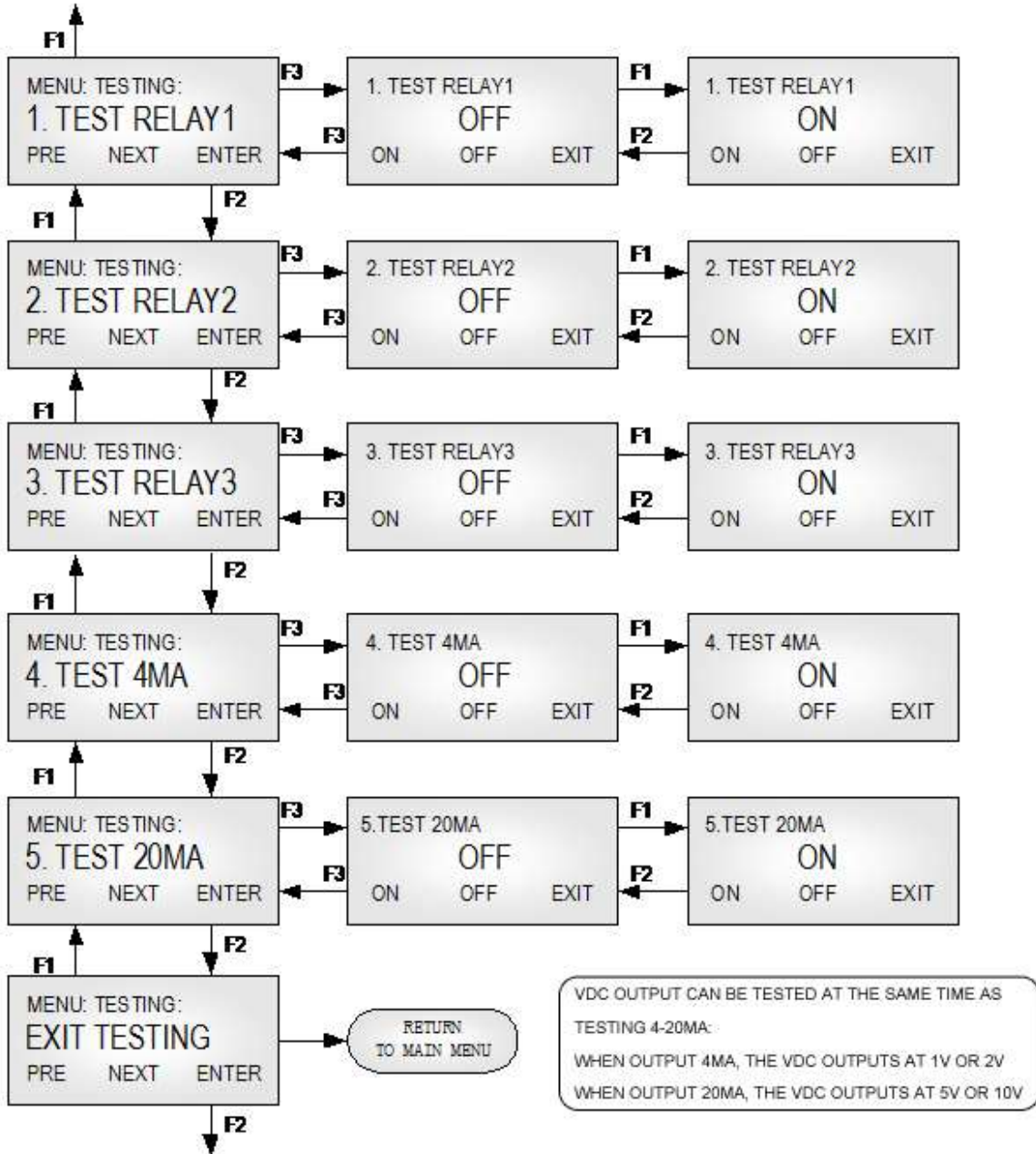
3.8 Menu "5_VIEW SETTING"

This function is to check the settings for Alarms, Relays, Buzzers and Analog Output.

```
      F1
   1. VIEW              F3      VIEW                F3    INPUT: INSTANT
   ALARM SETUP                  ALARM 2                   ON    : 25PPM
                         F1                               OFF   : 23PPM
   PRE    NEXT   ENTER          EXIT    NEXT   ENTER      TRIGGER: R1, 2, B1

      F1           F2
   2. VIEW              F3      VIEW                F3    1. DE-ENERGIZE        F3    4. ON-DELAY: 010 SEC
   RELAY STYLE                  RELAY 1                   2. NON-LATCHING             5. OFF-DELAY: 010 SEC
                         F1                               3. NORMAL STYLE
   PRE    NEXT   ENTER          EXIT    NEXT   ENTER      KEY TO CONTINUE ...         END OF DETAIL

      F1           F2
   3. VIEW                      INPUT: 15 MIN AVG
   A-OUT SETUP           F3     4MA  : 0 PPM
                               20MA :  100 PPM
   PRE    NEXT   ENTER          VDC OUTPUT: 1-5V

      F1           F2
   4. VIEW              F3      EVENT 1:             F2    EVENT 2:
   EVENT RECORDS                2009-12-08  20:05:32       2009-12-08  20:06:30
                        F3      RELAY 1 ON           F1    HUSHED BUZZER/RELAY
   PRE    NEXT   ENTER          PRE     NEXT    EXIT       PRE      NEXT     EXIT

      F1           F2
   5. VIEW SETTING      F3           RETURN  TO
   EXIT?                             MAIN  MENU
   PRE    NEXT   ENTER

                    F2
```

3.9 Menu "6_ALARM SETUP"

The EX Series supports alarm 1 to alarm 8.

Alarm is a programmable condition that can receive a selectable input and trigger relays and buzzers.

Disabled or Enabled:	Each alarm may be individually set to be enabled or disabled. If the alarm is disabled, the alarm will not be used to calculate or trigger anything. **Default: Alarm 1 to Alarm 4 is enabled. Alarm 5 to Alarm 8 is disabled.**
Input:	One of five inputs is selected to calculate the alarm condition status to trigger the selected outputs: • **INSTANT**: instantaneous gas reading. • **15 MIN AVG** (STEL): Short Term Exposure Limit, average reading over 15 minutes. • **8 HOURS AVG** (TWA): 8-hour Time Weighted Average, average reading over 8 hours. • **DAILY PEAK**: daily peak reading. • **FAULT**: If the unit reports any faults, no matter the gas concentration, it will trigger the selected outputs.
Alarm On and Alarm Off Reading:	*If Alarm On is greater than or equal to Alarm Off:* Alarm On: Sets the concentration at or above which the relay will actuate. Alarm Off: Sets the concentration at or below which the relay will de-actuate. *If Action On is less than Action Off:* Action On: Sets the concentration below that the relay will actuate. Action Off: Sets the concentration above that the relay will de-actuate.
Trigger:	Trigger Outputs: Relay 1, Relay 2, Relay 3, Buzzer 1*, Buzzer 2*, Buzzer 3* *if equipped

3.10 Menu "7_RELAY STYLE"

Enabled:	Each relay may be individually set to be enabled or disabled. If it's disabled, the relay will always de-actuate no matter what the current gas concentration. **Default is Enabled.**
Normally Open:	Each relay may be individually set to be normally open or normally closed. **Default is normally open.**
Latching:	Each relay may be set to latch in actuate status until acknowledged by a front-panel action. **Default is Non-Latching.**
ON Delay:	"Delay on Actuation" or "Delay on Make". For each relay a separate time delay may be set from 0 to 990 seconds before an alarm condition will cause the relay to actuate. **Default is 5 seconds.**
OFF Delay:	"Delay on De-Actuation" or "Delay on Break". For each relay a separate time delay may be set from 0 to 990 seconds before a return to a non-alarming signal condition will cause the relay to de-actuate. **Default is 5 seconds.**
Style:	Normal Relay Style: Work as normal relay. Buzzer Style Relay: When the relay is used to control a buzzer or horn. Working as a buzzer style will make the relay have the same function as the buzzer. It will be switched off when performing the Hush Buzzer/Relay function in the Tool Menu. **Default is OFF.**

3.11 Menu "8_BUZZER STYLE"

Function not available in the EX Series.

3.12 Menu "9_A-OUT SETUP"

The EX Series will compare the concentration at 4mA and the concentration at 20mA. You may assign a larger concentration for 4mA than for 20 mA; the EX Series will still stretch a straight-line signal between the two points and then convert the selected gas reading to analog output.

Input:	One of four inputs is selected to calculate the analog outputs: • **INSTANT**: instantaneous gas reading. • **15 MIN AVG** (STEL): Short Term Exposure Limit, average reading over 15 minutes. • **8 HOURS AVG** (TWA): 8-hour Time Weighted Averages, average reading over 8 hours. • **DAILY PEAK**: daily peak reading.
Out 4mA at **Conc:**	Input the gas concentration at which 4mA is output.
Out 20mA at **Conc:**	Input the gas concentration at which 20mA is output.
VDC Output:	VDC Output can be selected from: • 1-5VDC or 2-10VDC

Note: The analog output cannot be disabled.

Note: When the sensor has a fault, the output will be 2.5mA to indicate fault status.

3.13 Menu "A_ALL DISABLE"

This function is for calibration, system testing etc. When All Disable is ON, the status of the relay, buzzer and analog output, etc. will freeze in their current state.

Default is OFF.

3.14 Menu "B_SIMULATION"

Simulation mode is used to assist in testing the installation before commissioning. When simulation is enabled, the unit will not detect gas concentrations; it will display the simulated value and use it to calculate the status of relays and buzzers, as well as the 4-20mA analog output. This feature is available for evaluating the user settings and testing the installation (e.g.: the activation of the valve, fan speed, relay set points, etc. can be verified.)

Any concentration between 0ppm and 9999ppm can be simulated.

3.15 Menu "C_SITE SERVICE" and "D_FACTORY SET"

C_SITE SERVICE and D_FACTORY SET are for use by trained technicians in the manufacturing facility.

4. Modbus Protocol Supported by EX Series

4.1 Serial Transmission Mode
- Modbus RTU Slave Mode
- Baud Rate: 1200 to 57.6k, selectable from Baud Rate Setting in System Setting Menu.
- Byte parity: Odd, Even or None parity, selectable in Menu (Default is Even Parity).
- Data format: One start bit, 8 data bit, (one parity bit), one stop bit, LSB first.
- Frame Check: CRC check.

4.2 Function Code Supported by Ex-Series

• #03 Read Holding Registers
Function in EX Series: Read inputs and outputs statuses and readings, such as
- Sensor readings and statuses
- Analog output current (mA x 10)
- Relay Statuses and Settings
- Buzzer Statuses and Settings
- Alarm Statuses and Settings
- Real Time Clock
- Events Records

Attribute: Read Only.
Broadcast is not supported.
EX Series only supports the reading that number points is not more than 100 in one query.
Query:
      Slave Address: xx (Default 0x01, check Address in Ex Series)
      Function code: 03
      Starting addr. Hi: 000
      Starting addr. Lo: xxx
      No. of points Hi: 000
      No. of points Lo: xxx
      CRC check: xxxxH
Example: to read all holding registers in Ex Series (Address: 0x01)
Query: [001] [003] [000] [000] [000] [004] [068] [009] in unsigned decimal.

Holding Register for Running Data Address Table

Modbus	Name	Description
40001	Instantaneous Gas_Concentration Without Decimal	The concentration is 16 bits signed integer. The Actual Value is the value divided by Decimal Position Decimal Position see 40010
40002	STEL	16 bits signed integer. 15 minutes averaging concentration without decimal The actual value is the value divided by Decimal Position Decimal Position see 40010
40003	TWA	16 bits signed integer 8 Hours Averaging Concentration without decimal The actual value is the value divided by Decimal Position Decimal Position see 40010
40004	Daily Peak	16 bits signed integer Peak reading during a day The actual value is the value divided by Decimal Position Decimal Position see 40010
40005	100 x mA Output	16 bits unsigned integer 4-20mA analog output, 100X mA value. The actual value is the value divided by 100. Unit is mA
40006	mV Output	16 bits unsigned integer 1-5VDC or 2-10VDC analog output, Unit is mV
40007	Board Temperature	16 bits signed integer EX Series Sensor Board Temperature, 10X value. The actual value is the value divided by 10. Unit is °C
40008	Working Status Register and Error Register	Working status register in high 8 bits. 0x00: Monitoring_Mode 0x10: Zeroing_Cal_Mode 0x20: Span_Cal_Mode 0x30: T0_Cal_Mode 0x40: T1_Cal_Mode 0x50: Warmup_Mode 0x60: Restore_Factory_Mode 0x70: Programming_Mode 0x80: Menu_Mode Error Register is in low 8 bits. Bit0 = 1 : Thermistor Error Bit1 = 1 : 3.3VDC Low

		Bit2 = 1 : Sensor Board is offline Bit3 = 1 : Signal Low or Error Bit4 = 1 : Battery Low Bit5 = 1 : Calibration Error Bit6 = 1 : Concentration Overflow
40009	Alarm Status Register and Relay Status Register	Alarm status register in high 8 bits. 0: OFF, 1: ON Bit0 : Alarm 1 status Bit1 : Alarm 2 status Bit2 : Alarm 3 status Bit3 : Alarm 4 status Bit4 : Alarm 5 status Bit5 : Alarm 6 status Bit6 : Alarm 7 status Bit7 : Alarm 8 status Relay stauts register is in low 8 bits. 0: OFF, 1: ON Bit0 : Relay1 status Bit1 : Relay2 status Bit2 : Relay3 status
40010	Buzzer Status Register and Decimal Position	Buzzer status register in high 8 bits. 0: OFF, 1: ON Bit0 : Buzzer1 status Bit1 : Buzzer2 status Bit2 : Buzzer3 status Decimal Position in low 8 bits. If the byte = 0: The actual reading is Reading / 1 If the byte = 1: The actual reading is Reading / 10 If the byte = 2: The actual reading is Reading / 100 If the byte = 3: The actual reading is Reading / 1000 Others: N/A
40011	EX Series Real Time Clock in Seconds	Real Time Clock Seconds is a 32bit Long Integer. The register contains high 16 bits EX Series Real Time Clock is based on the number of seconds elapsed since 00:00:00 on Jan. 1, 2000.
40012	EX Series Real Time Clock in Seconds,	Real Time Clock Seconds is a 32bit Long Integer. The register contains low 16 bits
40013	Transmitter Software Version	Software version major Number register in high 8 bits Software version minor number register in low 8 bits
40014	Transmitter Measure Span	16 bits unsigned integer

		The actual value is the value divided by Decimal Position Decimal Position see 40010
40015	Last Time CAL	Last Time Calibration is a 32bit Long Integer. The time in seconds when the last calibration was performed. The register contains high 16 bits Last Time CAL is based on the number of seconds elapsed since 00:00:00 on Jan. 1, 2000.
40016	Last Time CAL	Last Time Calibration is a 32bit Long Integer. The time in seconds when the last calibration was performed. The register contains low 16 bits
40017	Digital Pot Position	Zeroing CAL Pot Position is in high 8 bits Span CAL Pot Position is in low 8 bits
40018	D/A Value at 4mA	16 bits unsigned integer D/A data output register value at 4mA output
40019	D/A Value at 20mA	16 bits unsigned integer D/A data output register value at 20mA output
40020	D/A Value at 1V	16 bits unsigned integer D/A data output register value at 1VDC output
40021	D/A Value at 5V	16 bits unsigned integer D/A data output register value at 5VDC output
40022	D/A Value at 2V	16 bits unsigned integer D/A data output register value at 2VDC output
40023	D/A Value at 10V	16 bits unsigned integer D/A data output register value at 10VDC output
40024	Detected Gas Name Max. 6 Characters	First Character in high 8 bits Second Character in low 8 bits
40025	Detected Gas Name	Third Character in high 8 bits Fourth Character in low 8 bits
40026	Detected Gas Name	Fifth Character in high 8 bits Sixth Character in low 8 bits
40027	Gas Unit Name Max. 6 Characters	First Character in high 8 bits Second Character in low 8 bits
40028	Gas Unit Name	Third Character in high 8 bits Fourth Character in low 8 bits
40029	Gas Unit Name	Fifth Character in high 8 bits Sixth Character in low 8 bits

5. Maintenance

5.1 DVM connection for 4-20mA measurement

- Interrupt the 4-20mA signal going from the EX Series to the controller (causing a fault):

    o Switch the DVM to measure DC current. On the main board plug the negative probe into GND and plug the positive probe into mA-.

- Monitor the 4-20mA signal going from the EX Series to the controller (not causing a fault):

    o Switch the DVM to measure DC current. On the main board plug the negative probe into mA- and plug the positive probe into mA+.

5.2 4mA and 20mA Output Calibration

These values are established during the factory 4-20mA output calibrations and should not require recalibration in the field. Do not attempt to modify these settings in the field.

Changing these values will change the analog output signal scale.

- Entry [Menu]--> [System Setting]

- Choose [Out 4mA CAL]:

    1. Press key [F3] to output the 4mA signal.

    2. Connect the DVM to the unit as described above.

    3. Press key [F1] or key [F2] to adjust the current to 4.00mA to 4.05mA.

    4. Press key [F3], then the settings will be accepted and saved.

- Choose [Out 20mA CAL]:

    1. Press key [F3] to output the 20mA signal.

    2. Connect the DVM to the unit as described above.

    3. Press key [F1] or key [F2] to adjust the current to 20.00 to 20.05mA.

    4. Press key [F3], then the settings will be accepted and saved

5.3 Smart Sensor Assembly Replacement

Disassembling

Observe all safety and electrical codes and regulations before removing enclosure lid.

Important: Calibrate the transmitter whenever a component is replaced. But if you replace a smart sensor assembly with a sensor onboard from Macurco, you don't need to recalibrate the transmitter, as all the calibration information has been stored in the smart sensor board in factory process.

Replacement Procedure

To replace the entire smart sensor assembly, complete the following steps:

1. Power down the transmitter.

2. Unscrew the enclosure lid assembly from the base enclosure

3. Unplug the Main Board CCA

4. Disconnect the sensor cable from the Sensor Board CCA

5. Unscrew the two rods to release the smart sensor board from the base enclosure

6. Unscrew the sensor head from the base enclosure if the sensor head needs to be replaced.

7. If only replacing the electrochemical sensor cell from the sensor head, unscrew the lid of the sensor head to unplug the sensor cell from the socket

8. Plug in the new sensor or replace new sensor head

9. Screw new smart sensor assembly onto the enclosure and secure with two rods. Ensure that the connectors correctly match each other.

    Note: Incorrect connection may damage the sensor assembly and/or the Main Board.

10. Plug the Main Board to the two rods

11. Reinstall the lid enclosure

Replacement Parts

See table 1.2 for replacement sensor assembly

Troubleshooting

This troubleshooting guide is intended as an aid in identifying the cause of unexpected behavior and determining whether the behavior is due to normal operation or an internal or external problem.

SYMPTOMS	PROBABLE CAUSE	SUGGESTED SOLUTION
RS-485 RX LED or TX LED constantly ON	• RS-485 bus connection has problem • RS-485 Driver U4 is damaged • Controller side RS-485 Driver has problem	• Disconnect the Cable to isolate the problem • Replace U4 IC on main board • Replace RS-485 Driver in Controller
No response to gas	• Sensor screen dirty • Sensor is expired	• Clean sensor opening • Replace smart sensor assembly, see Replacement Parts
Apparent false alarm	• Puff of gas • Not properly calibrated • Solvent fumes or interference from high levels of interfering gas • Radio frequency interference	• Monitor is functioning • Recalibrate • Remove source • Check grounds and shielding are correct
No signal at controller	• Maximum distance reached • Controller does not operate	• Verify loop resistance, change wire AWG • Troubleshoot controller

6. MACURCO EX SERIES FIXED GAS DETECTION PRODUCTS LIMITED WARRANTY

Macurco warrants the EX Series Transmitter and components will be free from defective materials and workmanship for a period of two (2) years from date of shipment provided it is used in accordance with Macurco instructions and/or recommendations. (Sensors excluded, see Sensor Warranty Statement) If any component becomes defective during this warranty period, it will be replaced or repaired free of charge, if the unit is returned in accordance with the instructions below. This warranty does not apply to units that have been altered or had repair attempted, or that have been subject to abuse, accidental or otherwise. The above warranty is in lieu of all other express warranties, obligations or liabilities. Macurco shall not be liable for any incidental or consequential damages for breach of this or any other warranty, express or implied, arising out of or related to the use of said gas detector. Manufacturer or its agent's liability shall be limited to replacement or repair as set forth above. Buyer's sole and exclusive remedies are return of the goods and repayment of the price, or repair and replacement of non-conforming goods or parts.

EX Series Sensors shall be warranted for a period of eighteen (18) months from date of manufacture or twelve (12) months from installation.

For warranty shipments, please contact Macurco for shipment instruction.

For further information or assistance, contact:

Macurco Gas Detection
Sioux Falls, SD
Email: info@aerionicsinc.com
Email: support@aerionicsinc.com
Phone: 1-877-367-7891
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