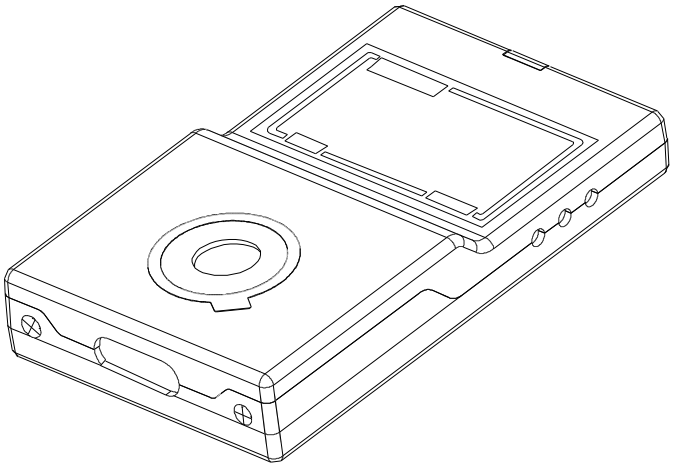
CTS-M1816
CARBON MONOXIDE
TRANSMITTER/SENSOR



INSTALLATION
OPERATION AND MAINTENANCE
MANUAL

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CTS-M1816 Configuration:

Default Settings

			Default Settings	User Settings
1.	Sensor Type/Gas Sensed		TGS-2442/Carbon Monoxide	
2.	Signal	20 mA (10 VDC)	125 ppm	_____
		4 mA (2 VDC)	0 ppm	_____
3.	Password		0017	_____
4.*	Relay 1 Actuation		Enabled	_____
5.	Relay 1 Setpoint (Actuation)		25 ppm	_____
6.	Relay 1 Release Point (De-Actuation)		20 ppm	_____
7.	Relay 1 Actuation Delay		0 Minutes	_____
8.	Relay 1 De-Actuation Delay		0 Minutes	_____
9.*	Relay 2 Actuation		Enabled	_____
10.	Relay 2 Setpoint (Actuation)		50 ppm	_____
11.	Relay 2 Release Point (De-Actuation)		40 ppm	_____
12.	Relay 2 Actuation Delay		0 Minutes	_____
13.	Relay 2 De-Actuation Delay		0 Minutes	_____
14	Calibration Gas (LO)		50 ppm	_____
15	Calibration Gas (HI)		100 ppm	_____
16	Communication Protocol		OptoMux	_____
17.	Digital Address		0001	_____
18	Baudrate		4800bps	_____

* Note: Relay setpoints are standard in software, relays are optional.

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1. Principles of Operation

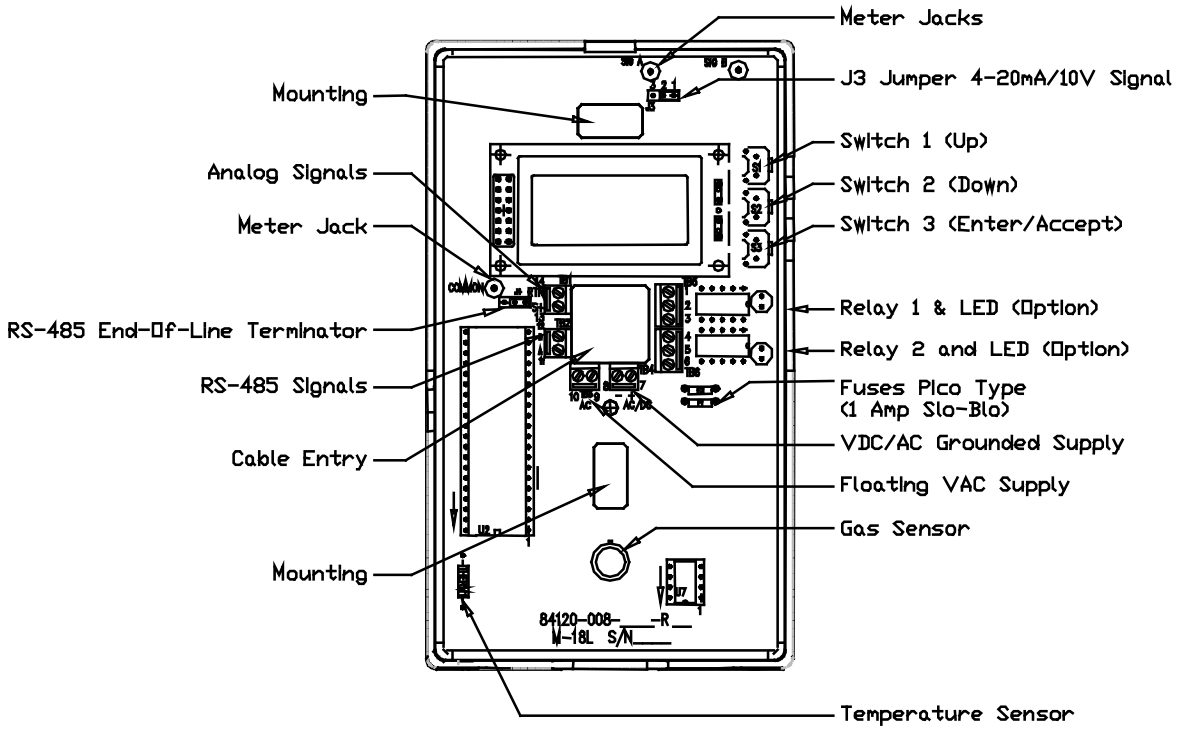

Figure 1 CTS-M1816 Internal View - Features

1.1 Display

The display module is a 2-line by 8-character LCD. Standard reading in operation is

CO ppm
xxxx

1.2 Keypad

The keypad is a set of 3 buttons recessed along the upper right side of the enclosure. It is not necessary to open the cover for use of the keypad. Access to the menus is password restricted. Press any key for 3 seconds to enter the menus. (See below for details)

1.3 Password

Factory preset default password is 0017.

Password can be changed. **RECORD PASSWORD IN A SECURE PLACE**. **<u>If the password is lost, the unit must be returned to QEL to be reset</u>**

1.4 Output Signals

Options are 4-20 milliamp or 2-10 V linear. Choose the option by moving the jumper on J3. On overrange concentrations the signal can exceed the range slightly.

Figure 2 Signal Jumper J3

IMPORTANT: Voltage monitoring should be into a monitor with at least 50 000 ohms imput impedance. Voltage monitoring is not recommended over long distances as these signals are more susceptible to induced noise than current signals

1.5 Meter Jacks

Test pads accepting standard test probes are provided on the circuit card. These are labelled SigA SigB and Common

To test milliamp signals measure:

- SigA to Common shorts to internal ground.
- SigA to SigB without interrupting signal to monitor

To Test voltage signals measure

- SigB to Common.

1.6 Signal Range

Default gas range for the 4-20 mA signal is

CO	0 – 125 ppm	max = 500 ppm

This range is adjustable. Both the 4 mA level and the 20 mA level can be reassigned through the menu system. Note that this adjustment does not change the measurement resolution.

IMPORTANT: The Signal Range is the applied range of the 4-20 milliamp signal. The Display Range is quite independent of the signal range.

1.7 Optional Relay Package

Two relays are supplied; single pole double throw (SPDT; Form C) 1 Amp. Dry contacts only. Configuration allows setpoint adjustment for actuation point, deadband, and delays, increasing or decreasing concentrations. The relay settings have the same range as the display, and are independent of Signal Range.

1.8 Default Conditions

Default conditions are those conditions which occur

- During the one minute wait state on Power On.
- In Fault status
- In menu tree.

In these situations the the following conditions hold:

- Signal set at 4.0 milliamps (2 Volts)
- Relays set non-energized.
- Digital comms show 0 ppm; no alarm status and 4 milliamp equivalent signal.

1.9 Sensing and Calibration

Sensor type: Solid-state semi-conductor.

1.9.1 Calibration

This sensor is highly non-linear in its response, and true zero is difficult to determine, so the microprocessor must be given two non-zero separate gas points in order to decide on the best fit for a gas curve. In addition, for all sensor types except for the TGS-2442 CO sensor, there is some response to humidity and therefore the gas applied must be humidified. See gas-specific notes below.

1.9.2 Implications for Troubleshooting

The microprocessor will detect various component faults and out-of-range conditions, and drop the output signal to 0.0 milliamps. When a fault is detected, both relays will be deactivated as well. However, it cannot detect simple out of calibration conditions, which can only be detected by applying a gas standard.

2. Function and Configuration

2.1 Menu Structure and Use

Note: While the keypad functions are available without opening the case. It is necessary to open the case to apply the calibration gases. The ‘keypad’ switches are located in the upper right side of the enclosure.. See Figure 1 Page 3.

Display: The display is 2 line by 8 character alphanumeric. The top line contains the feature name and the second contains the variable.

Keypad: The keypad consists of three (3) pushbutton switches.

S1	Scroll Up
S2	Scroll down
S3	Enter/Accept

Display at Turn-On:

The display shows the following for about 2 seconds:

QEL M-18
Vx.xx Ry

Where: x.xx = the Software Version
y = the Software Revision

Followed for about 2 seconds by:

TGS-ZZZZ
Vx.xx Ry

Where: ZZZZ = TGS Sensor Type
x.xx = the Sensor Algorithm Version
y = the Sensor Algorithm Revision

Display in Operation: The display shows

GAS ppm
xxxx

Where GAS will show the target gas, and xxxx is concentration of the gas

Note: The unit features a warm-up function to prevent false alarms while the sensor is warming up. Warm-up is activated when the unit is powered up initially. During warm-up, "----" will be shown in the bottom line of the display in place of the gas concentration. It is not possible to enter the menu system during warm-up. Sensor warm-up duration is from one minute to several minutes, depending on sensor type.

Note: Should the unit be initially not calibrated, or if a fault occurred in the calibration procedure, the unit will flash "CALIBR" on display line 2 after five seconds from completion of warm-up and thereafter every 4 minutes.

Menu Activation: Press and hold any key for 3 seconds to enter the menu tree.

Menu Scrolling: Use the scroll buttons to scroll up and down through the menu tree.

Data Entry Mode: Enter the data entry mode by pressing S3 (Enter) while displaying any feature. This mode is indicated by an ***** (asterisk) at the right of the variable, and indicates that the variable may be changed by scrolling. Press S3 (Accept) to save result and return to menu tree. While in data entry mode, the Up and Down keys perform an automatic key repeat while the key is held in.

Password: The first item on entering the menu tree is a Password request. The display is 0000, the default password is 0017. The * appears, indicating that a number can be entered and accepted. This number can be changed by the user (see below).

Fault: In case of faults, the display will read FAULT and a fault code in the bottom LCD line (see below). Signal will drop to 0 milliamps.

See section 3 below for more information on faults.

2.2 Configuration and Calibration

Note: The user has control of all variables, including calibration gas concentrations, alarm settings and signal range (both 4 milliamp and 20 milliamp) assignments. It is important to note that these must be chosen carefully with regard to calibration. As noted elsewhere, the unconditioned sensor is non-linear in it's response. The microprocessor performs an algorithm to linearize the final signal, compensating for temperature effects, and where appropriate, for humidity. These items may be more or less accurate depending upon a number of factors, and the non-linear response of the sensor can have amplifying effects for any error introduced. Errors are amplified for results outside the calibration range (e.g.: with a calibration error of 3 ppm at 100 ppm, then there may be a resultant error of 12 ppm at 300 ppm).

1. Press any key for 3 seconds to enter menu system

2. Password Control

   PASSWORD
   0000 *

Select password and accept

3. Relay 1 Sub-menu Branch

RELAY 1
Settings

Press Enter to proceed to the Relay 1 Settings sub-menu (press down/up to skip Relay 1 Settings and go to next/previous menu item or sub-menu).

3.1 RELAY
Enable

Press Enter to change. * Indicates to use scroll buttons to toggle between Enable and Disable. Press Accept when done.

Note that this disables the physical relay, but not the setpoint. Setpoint actuation status will still be transmitted on the digital communications link if queried.

Enable is the default

Press Down button to continue through Relay 1 Settings branch. Press Up to return to Main Menu (and Relay 1 Settings sub-menu branch).

3.2 Actuation Setpoint

ACTUATE
0025

Choose the concentration of Gas in ppm at which the relay will actuate (energize). Minimum = 15 ppm. Maximum = 500 ppm in 5 ppm increments.
Default = 25 ppm

Up/Down scrolls up/down in the Relay 1 Settings branch.

3.3. De-Actuation Setpoint

DEACT
0020

Choose the concentration of the gas in ppm at which the relay will de-actuate (de-energize). Minimum = 10 ppm. Maximum = 500 ppm Actuation point in 5 ppm increments.
Default = 20 ppm.

Note: If the De Actuation Setpoint is set at a higher concentration than the Actuation setpoint, then the setpoint function reverses and actuates on decreasing concentrations.

Note: The software will not allow the user to set Actuation = Deactuation.

3.4 Actuation Delay.

ACT-TIME
0000

Adjust the amount of time delayed before the relay is actuated after the Actuation Setpoint is reached. A maximum of 60 minutes is possible, adjustable in 5-minute increments.
Default is 0000.

3.5 De-Actuation Delay.

DEACTIME
0000

Adjust the amount of time delayed before the relay is released after the De-Actuation setpoint is reached. A maximum of 60 minutes is possible, adjustable in 5-minute increments. Default is 0000.

The Up key scrolls back up the Relay 1 Settings sub-menu branch. The Down key leaves the Relay 1 Settings sub-menu branch and returns to the Relay 1 Settings main menu item.

4. Relay 2 Sub-menu Branch

RELAY 2
Settings

Press Enter to access the settings. The sub-menu structure is the same as for Relay 1 Settings. Defaults are as follows:

4.2 Actuation Setpoint

Minimum = 15 ppm. Maximum = 500 ppm in 5 ppm increments.
Default = 50 ppm

4.3. De-Actuation Setpoint

Minimum = 10 ppm. Maximum = 500 ppm in 5 ppm increments.

Default = 40 ppm.

5. Range Adjustments

CONC4MA
0000

This feature allows adjustment of the 4 milliamp point to non-zero gas concentrations. The display will always read as low as 0000 ppm, but the concentration corresponding to 4 milliamps changes.

Maximum: 500 ppm
Minimum: 0 ppm

Note: An inverted response at the signal output can be achieved by setting CONC4MA higher than CONC20MA.

Note: Changing the range in this fashion does not enhance the gas measurement accuracy. e.g.: If there is an error of 1 ppm, it will still be an error of 1 ppm even if the range is reduced.

IMPORTANT: Do NOT set CONC4MA and CONC20MA points closer than 10 ppm! If the unit finds these points closer than 10ppm on menu system exit, the higher point will be automatically adjusted until a minimum difference of 10ppm is present.

6. Range Adjustments

CONC20MA
0125

This feature allows adjustment of the 20 milliamp point to different gas concentrations. The display will always read as low as the maximum for that gas but the concentration corresponding to 20 milliamps changes.

Maximum: 500 ppm
Minimum: 0 ppm

Note: An inverted response at the signal output can be achieved by setting CONC4MA higher than CONC20MA.

Note: changing the range in this fashion does not enhance the gas measurement accuracy. e.g.: If there is an error of 1 ppm, it will still be an error of 1 ppm even if the range is reduced.

IMPORTANT: Do NOT set to CONC4MA and CONC20MA points closer than 10 ppm! If the unit finds these points closer than 10ppm on menu system exit, the higher point will be automatically adjusted until a minimum difference of 10ppm is present.

7. Calibration:

This sensor is highly non-linear in its response, and so the microprocessor must be given two separate gas points in order to decide on the best fit for a gas curve. Zero is a problematic number for solid state sensors and so both of the gases must be non-zero concentrations.

Low Concentration Calibration Setting

CAL LO
0050

Entering this menu item displays the default or last calibration gas concentration. Press Enter to start the calibration process or Up/Down to continue through the menu tree.

7.1 Enter Calibration concentration
CAL LO
0050*

Change the concentration by Up/Down or press Enter to accept (the unit now enters Calibration Mode).

7.2 Apply Gas

CAL LO
Open Gas (Flashing)

Waiting for gas to be applied. The microprocessor monitors to see if the gas has been applied before proceeding. Press Enter at any time to abort Calibration Mode.

7.3 Reading Gas

CAL LO
Wait (Flashing)

The microprocessor has detected an increasing signal and now monitors the signal from the sensor, waiting for stability. Press Enter at any time to abort Calibration Mode.

7.4 Calibration Complete

CAL LO
XXXX (Flashing)

Where:

XXXX is a verification ppm value close to the ppm value of the calibration gas.

Calibration to this gas type and concentration is complete.

Note: The hands and attention-free calibration feature works by detecting an increase in gas concentration over period of 15 seconds, and subequently waits until the increased reading is sufficiently stable. It will therefore not detect a gas application if you are going quickly from a high gas concentration to a low concentration. It is always best to wait a few moments for the gas concentrations to clear out of the sensor before applying a second concentration.

Press Enter to accept and **exit** Calibration Mode. The non-flashing value now indicates the selected calibration gas ppm (and not the measured ppm value). The non-flashing value also indicates the unit is back in the menu tree and out of calibration mode.

Repeat as needed or press Up/Down to go to the next/previous menu item.

8. High Concentration Calibration Setting

CAL HI
100

This shows the present reading. Follow the same procedure as described for the low concentration above.

Maximum: 500 ppm

9. Communications Protocol

PROTOCOL
Optomux

The B4000 protocol communicates with QEL’s QDC-4000 monitor.
The Optomux protocol (default) communicates with QEL's M-Controller monitor or any other systems with this protocol capability.

Press Enter and Up/Down to select the desired protocol.

10 Digital Address

ADDRESS
0001

Allows changes to the digital communications address for the M-18 transmitter.

Note: The new address is available **immediately it is accepted at this point**, and the unit will respond to only this address when queried even though you are still inside the main menu tree. If you abort the main menu tree (see below) then the address will revert to the previous address.

Maximum: 256

Note: If the B4000 protocol was selected (above), all communications addresses higher than 16 will be folded back to address 16.

11 Baud Rate

BAUDRATE
4800

Default is 4800 baud.

Options: 600, 1200, 2400, 4800 and 9600

12. Change Password

PASSWORD
0000

Press Enter and scroll up and down to choose a new password. **RECORD PASSWORD IN A SECURE PLACE**.

Note: This item displays the current password, so it is important to keep security in mind when passing this item in the presence of bystanders.

If the password is lost, the unit must be returned to QEL to be reset.

13. Exit Menu Tree

EXIT
Save

Press Enter, an * will appear beside Save. Press Up/Down to choose Save or Abort. Press Enter/Accept to exit.

Note: Choosing Abort will discard all changes made since last entering the menu system, including calibration values.

2.3 Hardware Configuration

2.3.1 Output Signals

Options are 4-20 milliamp or 2-10 VDC linear. Choose the option by moving the jumper on J3. On over-range concentrations the signal can exceed the range slightly.

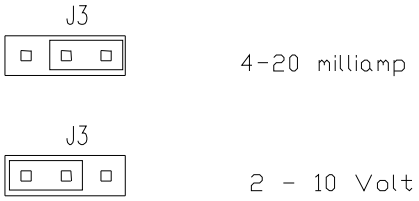

Figure 3 Signal Configuration

2.3.2 RS-485 End-of-Line Wiring and Termination

RS-485 installations require specialized wiring. A number of manufacturers make cable especially for this wiring standard (EIA-485), (e.g. Belden 9841). This is a twisted, shielded, balanced pair, 24 awg, 120 ohm. In order to prevent signal bounce-back and other distortions, it is necessary to provide a balancing resistor across both ends of the wire. The M-18 supplies this resistor on board, and it is chosen using a jumper at J4.

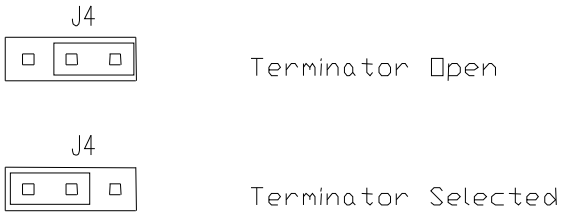

Figure 4 RS-485 End-of-Line Termination

2.4 Gas Calibration

Calibration should not vary significantly over a period of years; however, it is best to perform a verification calibration after installation, and at one-year intervals thereafter. All units are factory calibrated.

The sensor is quite slow in response. Allow about **6 minutes** gas application time at 0.4 to 0.6 liters/minute to perform a calibration for each gas concentration. The unit has been designed to be as easy to work with as possible, and the microprocessor handles all stages

of the calibration. The calibration adapter is a bayonet style fitting, and the microprocessor handles all calculations, enabling hands-free, and to some degree attention-free calibration.

ATTENTION: During Calibration the microprocessor monitors the reading from the sensor to detect when the gas has been applied, and then watches to determine when the signal has stabilized. IT IS POSSIBLE TO CONFUSE THE MICROPROCESSOR UNDER CERTAIN CONDITIONS!

The gas sensor elements vary a great deal from one element to another in both absolute values and in the type and amount of response to the gas; some sensors are inherently more difficult to work with. The microprocessor is watching for an initial significant change in reading. False positives or false negatives can be generated in this by ongoing variations in the background environment. In the field you may be trying to calibrate while the sensor is operating where there is a background concentration of CO; worse, this background may be shifting. In addition, a "jumpy" application of the calibration gas may produce a plateau reading prematurely which leads the microprocessor to conclude that calibration is complete.

Points to watch for:

- **When the unit is waiting for gas to be applied it displays "OPEN GAS". If this goes to WAIT before or immediately after application of the gas, then assume that the calibration has been compromised.**
- **Stabilization (XXXX = flashing complete) should take at least two (2) minutes but definitely less than eight (8) minutes.**
- **An erroneous calibration will produce either a stabilization (goes to WAIT then to XXXX = flashing complete) within about 30 seconds or will WAIT forever.**
- **Do not hold the gas source near to the sensor until you intend to connect. Place the calibration adaptor smoothly over the sensor and connect. If this is your first time doing this, practice a couple of times using the bayonet adapter only.**
- **Allow plenty of time for the sensor to return to zero between gas applications.**

2.4.1 Equipment Required:

- Two distinct concentrations of Carbon Monoxide with Balance Air.
  - LO Default: CO 50 ppm Balance Air
  - HI Default: CO 100 ppm Balance Air
- Pressure and Flow Limiting Regulator(s) **0.4 to 0.8 lpm (0.8 to 1.6 scfh)**
- Tubing and bayonet adapter.

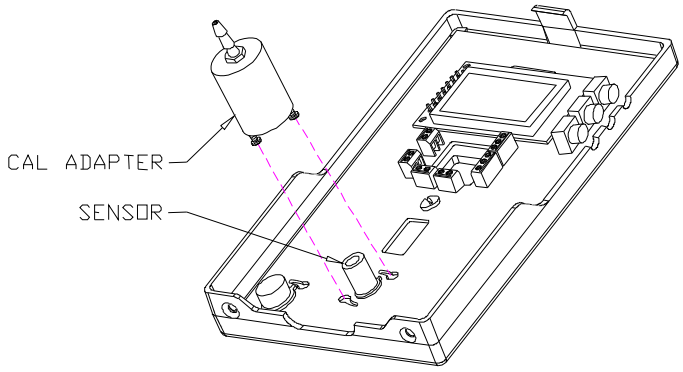

Figure 5 Calibration Gas Bayonet Adapter

2.4.2 Procedure

- Scroll through the menus and enter the calibration mode, either CAL LO or CAL HI. The display shows a default gas concentration, either factory default or the last gas concentration used.
- The user may change these values to match the actual concentration of gas to be used.
- Accept the concentration (the unit enters Calibration Mode). The display flashes "Open gas". The unit is waiting to detect a change in signal indicating that gas has been applied.
- On detecting gas applied, the display will flash "*Wait*". The microprocessor is then waiting for a stable reading.
- On reaching a stable reading, the display will start flashing the gas concentration as calculated, which should be close to the actual gas concentration, especially if the unit has been previously calibrated.
- Press Enter to exit Calibration Mode. The display stops flashing and displays the selected ppm value of the calibration gas (and not the measured gas ppm).
- You may redo the calibration (by pressing Enter/Accept) or continue to the next menu item (by pressing Up/Down).

2.4.3 Calibration Errors

If the gas flow was not sufficient, or the bayonet adapter was too loosely applied, the gas concentration in the sensor will stabilize at an incorrect low value. One symptom of this is that in clean air, the sensor will not zero well, and will read, say, 10 ppm in clean air.

Note: The hands and attention-free calibration feature works by detecting an increase in gas concentration over period of 15 seconds, and subequently waits until the increased reading is sufficiently stable. It will therefore not detect a gas application if you are going quickly from a high gas concentration to a low concentration. It is always best to wait a few moments for the gas concentrations to clear out of the sensor before applying a second concentration.

3. Faults

3.1 Self-check Faults

The microprocessor monitors a number of operational values for faults, and will display each occurrence for two seconds as follows:

FAULT
XXX

Where XXX is a fault code.

The unit will automatically restart and continue normal operation if the fault occurred due to a temporary intrusion (e.g.: Radio frequency interference or water condensation formed due to fast temperature change).

A fault shown repeatedly indicates malfunction of the unit. In such cases the fault code should be recorded and the unit returned for repair.

When a fault is detected, the output is dropped to 0.0 mA and both relays are deactivated.

The only Self Check Faults which can be field addressed are those which refer to problems with the sensor (fault codes 040 through 043):

- Check that the sensor is socketed correctly.
- Replace sensor. If the fault is removed, then re-calibrate.
- Return unit to Factory.

Fault Codes:

Fault Code	Description	Action
EEPROM		
008	Read time-out.	Return unit to factory for repair if fault persists.
009	Write time-out.	
010	Too many retries.	
011	Verify error when writing.	
012	Bus level fault.	
MCOP		
016	No acknowledge or reply received.	Return unit to factory for repair if fault persists.
017	Checksum error with receive.	
018	NACK received, bad command sent.	
019	Bad checksum received by slave.	
020	Attempted transmit overrun.	
System		
024	Out of ms timers.	Return unit to factory for repair if fault persists.
025	Out of second timers.	
026	Message queue overflow.	
Sensor		
040	Gas sensing element trouble detected.	Check sensor. Replace sensor and calibrate. Return unit to factory for repair if fault persists.
041	Heater current too high.	
042	Heater current too low.	
043	Heater off current high/or no sensor.	
Calibration		

048	**Concentration too far negative.**	**Calibrate.**
049	**Concentration range.**	**Return unit to factory for repair if fault persists.**
050	**New unit, not calibrated yet.**	
Floating Point Mathematics		
056	**Stack overflow.**	**Calibrate.**
057	**Stack underflow.**	**Return unit to factory for repair if fault persists.**
058	**Number overflow.**	
059	**Number underflow.**	
060	**Divide by zero.**	
062	**Domain error.**	
Thermistor		
064	**Stuck low.**	**Return unit to factory for repair if fault persists.**
065	**Stuck high.**	

3.2 Hardware Faults

Screen Blank, no Signal	Check Wiring, check fuses.
Distorted Milliamp Signal	Output jumper set to voltage.
Voltage signal pinned high	Output jumper set to milliamps
No milliamp Signal on AC floating power supply	Check for signal common line. Check for signal operation by using on-board test points
Bad RS-485 Communications for this unit.	Check wiring polarity for A & B lines Check for correct line terminations. Check for correct address.
Bad RS-485 Communications for a multi-drop group.	Check wiring polarity for A & B lines Check for correct line terminations. It is possible for one failed device on a multidrop line to pull communication down for the whole line. Check for correct addresses.

4. Wiring and Power Supplies

The CTS-M1816 Power Supply input is not isolated internally from the electronics and thus the signal common. Therefore, while the power supplied may be AC or DC, care must be taken to avoid the creation of multiple grounds (or a ground loop).

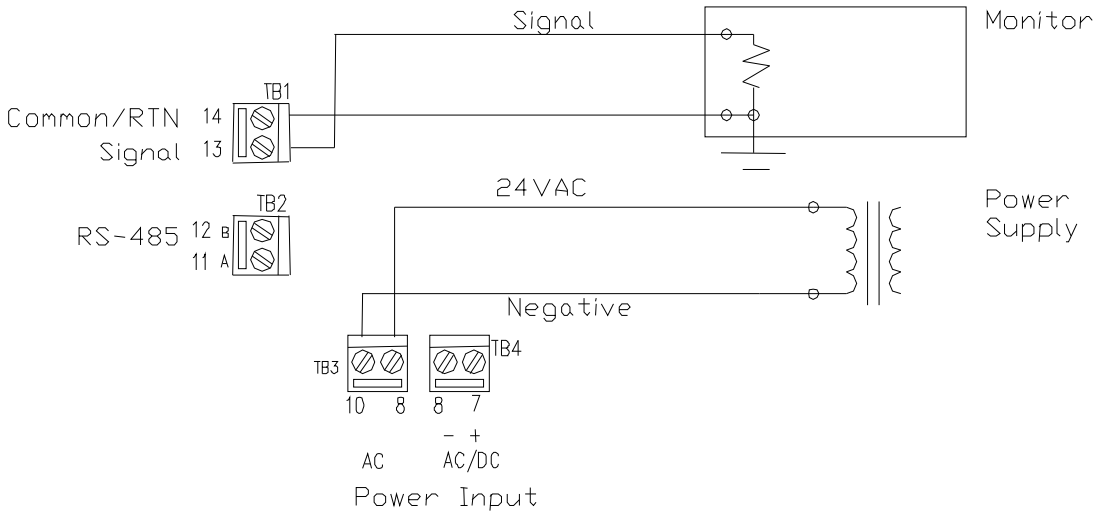

Figure 6 24VAC Floating Supply 4-Wire Installation

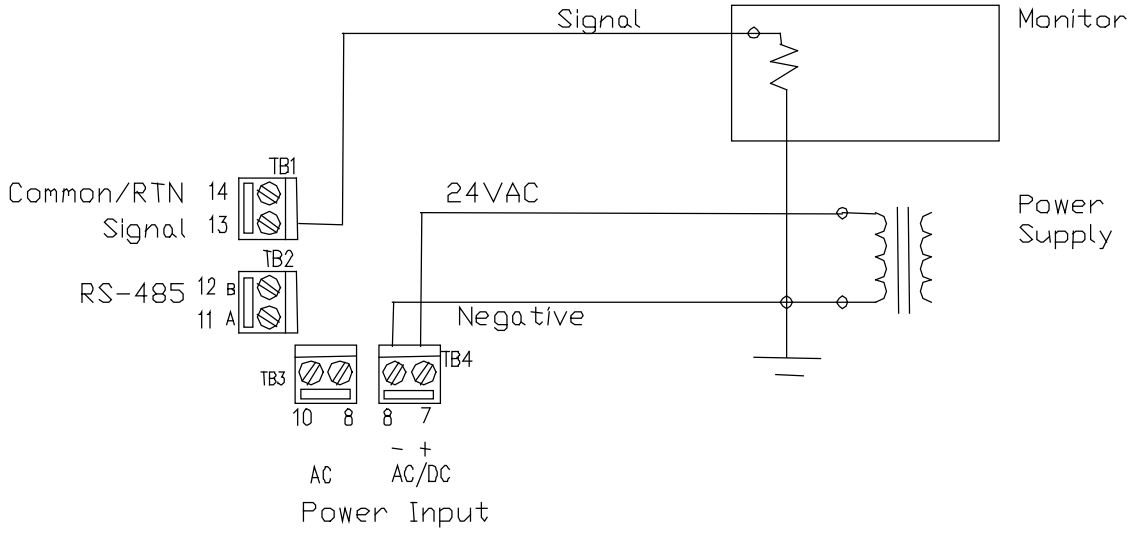

Figure 7 24VAC with Common Grounds - 3-Wire Installation

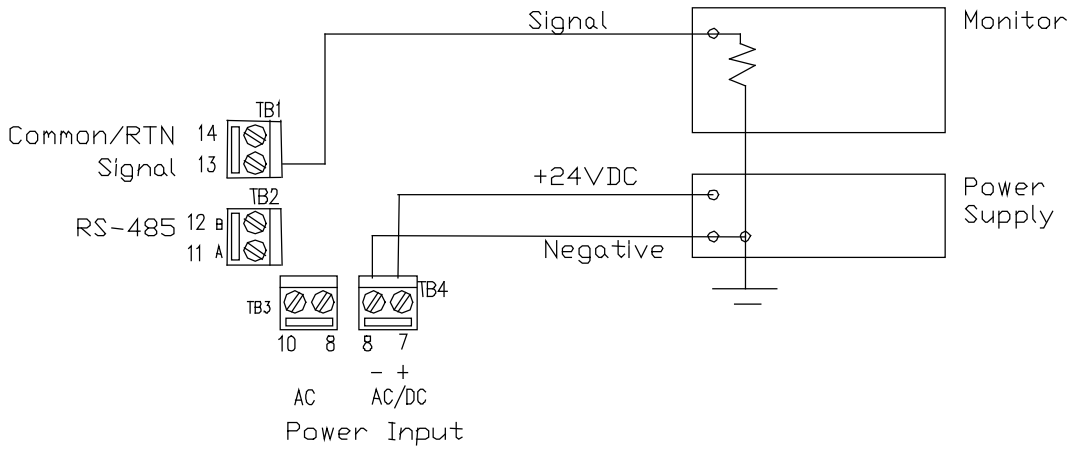

Figure 8 24VDC Supply with Common Ground - 3-Wire Installation

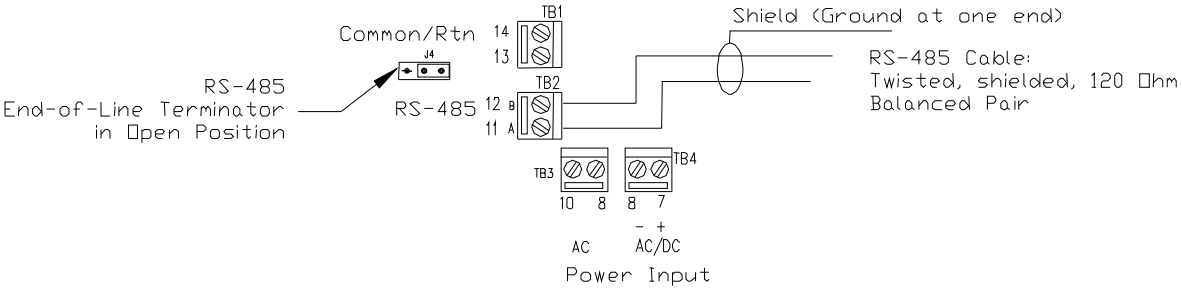

Figure 9 RS-485 Connection

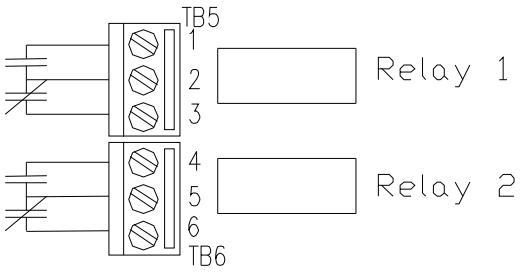

Figure 10 Relay Connections

WARRANTY STATEMENT

The information contained in this manual is based upon data considered accurate; however, no warranty is expressed or implied regarding the accuracy of this data. All QEL equipment is warranted against defects in material and workmanship for a period of two years from date of shipment with the following exceptions:

Electrochemical Sensors (Toxic)	Six Months
Catalytic Sensors (Combustible)	One Year

During the warranty period we will repair or replace, at our discretion, any components or complete units that prove, in our opinion, to be defective. We are not liable for consequential or incidental damage to auxiliary interfaced equipment.

A returned material authorization number should be obtained from the factory prior to returning any goods. All return shipments must be shipped freight prepaid and a copy of the maintenance records should accompany the unit concerned.

Warranty should be considered F.O.B. the factory. Labour and travel time are chargeable for any field site visits required for warranty work.

LIMITED LIABILITY

All QEL systems shall be installed by a qualified technician/electrician and maintained in strict accordance with data provided for individual systems in the form of installation/maintenance manuals. QEL assumes no responsibility for improper installation, maintenance, etc., and stresses the importance of reading all manuals. QEL shall not be responsible for any liability arising from auxiliary interfaced equipment nor any damage resulting from the installation or operation of this equipment.

QEL's total liability is contained as above with no other liability expressed or implied as the purchaser is entirely responsible for installation and maintenance of systems.

This warranty is in lieu of all other warranties, expressed or implied, and no representative or person is authorized to represent or assume for QEL any liability in connection with the sales of our products other than that set forth herein.

NOTE: Due to on-going product development, QEL reserves the right to change specifications without notice and will assume no responsibility for any costs as a result of modifications.

For further information or assistance, contact:

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