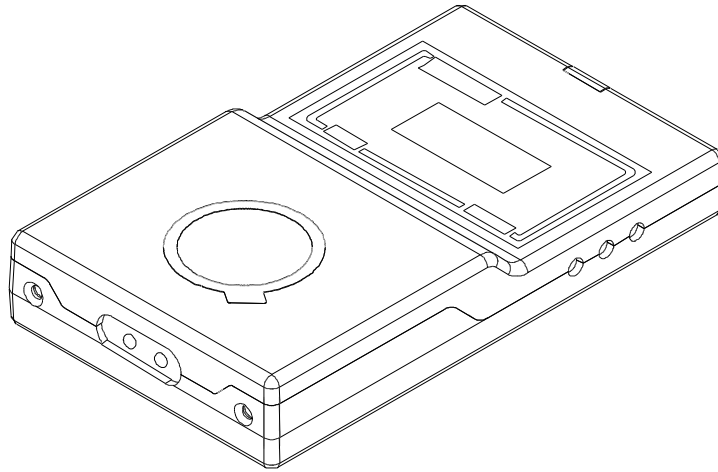


**CTS-M20  
CARBON DIOXIDE  
TRANSMITTER/SENSOR**



**INSTALLATION  
OPERATION AND MAINTENANCE  
MANUAL**

QUATROSENSE ENVIRONMENTAL LTD.  
5935 OTTAWA STREE, PO BOX 749 RICHMOND, ONTARIO CANADA KOA 2Z0  
PHONE: (613) 838-4005 FAX: (613) 838-4018  
Web: [www.QELsafety.com](http://www.QELsafety.com) Email: [QEL@QELsafety.com](mailto:QEL@QELsafety.com)

## Configuration:

(User settings are set to default settings, unless otherwise indicated below)

		Default Setting		User Setting
		J3 to Left	J3 to Right	
1	Gas sensed	Carbon Dioxide (CO <sub>2</sub> )		
2	Signal mode	2-10V Linear	4-20mA Linear	
3	Signal "CO <sub>2</sub> From" point	0ppm		
4	Signal "CO <sub>2</sub> To" point	2500 ppm		
5	Signal "Sig From" at "CO <sub>2</sub> From" point	2.0V	4.0mA	
6	Signal "Sig To" at "CO <sub>2</sub> To" point	10.0V	20.0mA	
7	Output signal clipping	Disabled		
8	Auto Zero	No		
9	Altitude	300 feet		
10	Password	0017		
11	Relay	Enabled		
12	Relay On	1000ppm		
13	Relay Off	950ppm		
14	Relay On Delay	0 minutes		
15	Relay Off Delay	0 minutes		
16	Global Average	360ppm		

## Specifications:

(The manufacturer reserves the right to change these at any time)

Input Power (Nominal)	24 VAC or 24 VDC (Isolated)
Input Power Range	18-40VAC or 18-40VDC
Sensor Type	Non-Dispersive Infra Red (NDIR) Thermo compensated aluminum block
Enclosure Materials	Polycarbonate / ABS blend, Fire Retardant
Output Signal	0 - 20 mA, 4-20mA, 0-10V or 2-10 V or User Range linear.
Temperature	5° C to 40° C
Humidity	0 to 99% RH, non-condensing
Pressure	Atmospheric ±10%
Sensor Response Time	Less than 45 seconds for 90% of step change
Accuracy	±2% of range
Repeatability	± 10 ppm
Range	Default 0 to 2500 ppm (4.0 – 20.0mA) User Programmable 0 to 5000 ppm (0-10V or 0-20mA)
Display	Alphanumeric 2-line X 8-digit LCD
Relay Output	One Single Pole Double Throw (SPDT), Form C, 1 amp dry contact (CSA 1500 V, FCC Part 68)
Relay Time Delays	Actuation – 0 to 60 minutes in 5-minute increments. De-actuation – 0 to 60 minutes in 5-minute increments.
Mounting	Screw mounts to a standard 2" X 4" electrical junction box.
Software	Version 3.00 Revision A (or later)

## M-20 Operation And Maintenance Manual

<b>Special Features</b>	Signal output options include negative slope. Signal end-points: adjustable ppm, 0-10V, 0-20mA. Adjustable relay dead-band. Relay can activate for decreasing ppm. Simulation mode to simulate any ppm value from 0 to 5000. Auto Zero to global average over 8-day period. Password protection for user settings.
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## Table of Contents

<b>1. INTRODUCTION</b> .....	<b>4</b>
1.1 Principle of Operation .....	4
1.2 Display .....	5
1.3 Keypad .....	5
1.4 Output Signal .....	5
1.5 Signal Range .....	5
1.6 Relay .....	7
1.7 Power .....	7
<b>2. OPERATION</b> .....	<b>8</b>
<b>3. FAULT INDICATION</b> .....	<b>8</b>
<b>4. CONFIGURATION</b> .....	<b>9</b>
4.1 User Interface .....	9
4.2 Menu Activation .....	9
4.3 Menu Item Selection .....	10
4.4 Menu Item Alteration .....	10
4.5 Menu Tree.....	10
<b>5. CALIBRATION</b> .....	<b>20</b>
5.1 Equipment Required.....	20
5.2 Gain Check.....	20
5.3 Zero Calibration .....	21
5.4 Span Calibration .....	21
<b>6. TROUBLESHOOTING</b> .....	<b>22</b>
6.1 Troubleshooting Tips .....	22
6.2 Fault Codes .....	24
<b>7. DUCT MOUNT ADAPTER (CTS-M2000X-D00000)</b> .....	<b>25</b>
<b>8. WIRING AND POWER SUPPLY</b> .....	<b>26</b>
<b>WARRANTY STATEMENT</b> .....	<b>28</b>

## Table of Figures

Figure 1 - Internal View and Features .....	4
Figure 2 - Signal Mode Jumper (J3).....	5
Figure 3 - Duct Mount Configuration .....	25
Figure 4 - Duct Cutout.....	25
Figure 5 - 24VAC Floating Supply (4-Wire Installation) .....	26
Figure 6 - 24 VAC with Separate Grounds (4-Wire Installation).....	26
Figure 7 - 24VAC with Common Grounds (3-Wire Installation) .....	26
Figure 8 - 24VDC Supply with Common Ground (3-Wire Installation) .....	27
Figure 9 - 24VDC Supply with Separate Ground (4-Wire Installation) .....	27
Figure 10 - 24VDC Ungrounded Supply (4-Wire Installation) .....	27
Figure 11 - 24VDC Ungrounded Supply (3-Wire Installation) .....	27

## 1. Introduction

This manual applies to M-20 units with software Version 3.01 and later (released 2008-01-03). If you have a product with software Version 1.XX, please contact the factory to obtain a copy of the correct manual.

### 1.1 Principle of Operation

The M-20 is a microprocessor controlled CO<sub>2</sub> Sensor/Transmitter using infrared sensing technology. The concentration of CO<sub>2</sub> is measured by determining the amount of absorption of light in a specific frequency band.

An analog signal output is provided, as well as a relay with adjustable set points. New features for Version 3.01 software are; extension of the signal output range down to 0V (or 0mA) and a Simulation Mode to assist in testing the installation before commissioning. The field calibration features of the unit are extended as well.

The unit operates from nominal 24VAC or 24VDC and incorporates an isolated switching power supply.

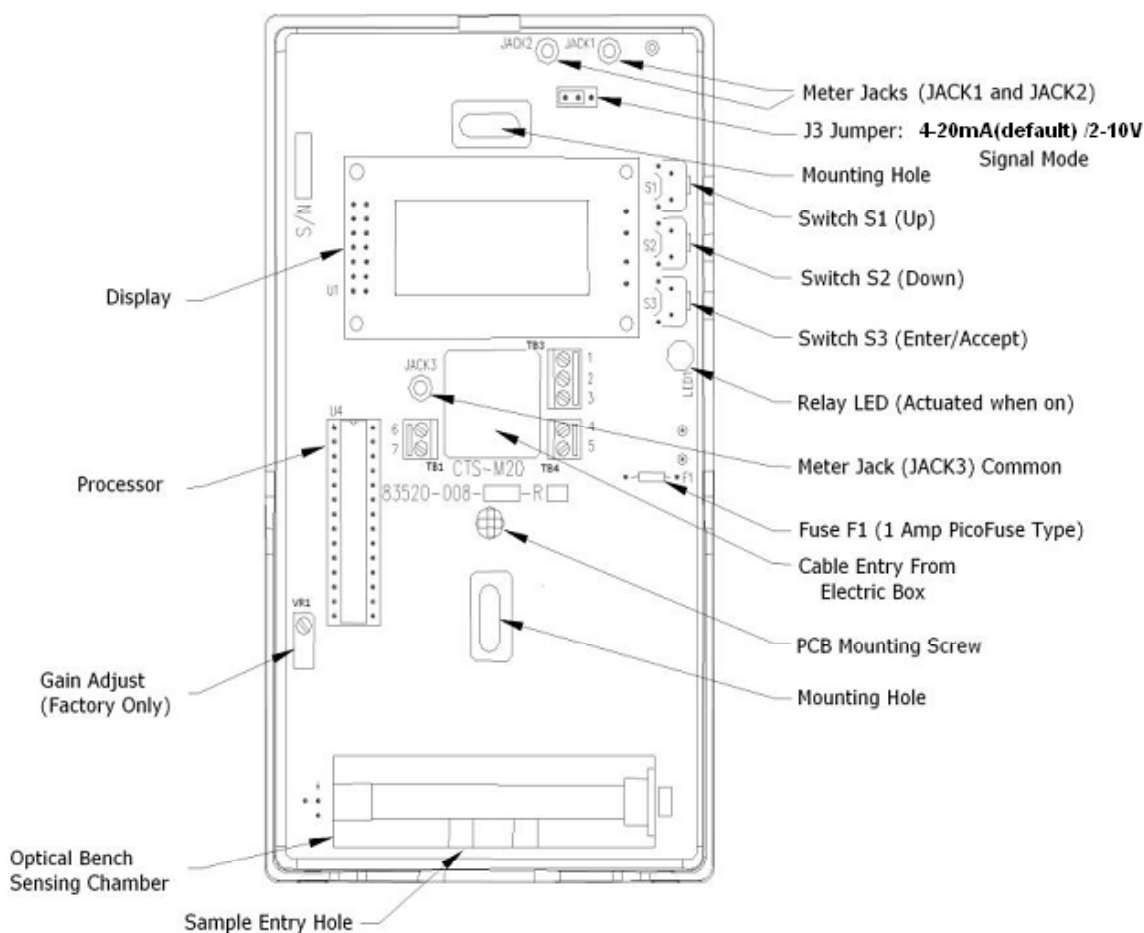


Figure 1 - Internal View and Features

### 1.2 Display

The display module is a 2-line by 8-character LCD. The gas concentration display format in measurement mode is as follows:

**CO2 ppm**  
**XXXX**

Where xxxx is concentration of CO<sub>2</sub>, shown from -999 to 9999. The displayed number includes leading zeros if below 1000. Negative concentrations indicate that the unit requires calibration. The concentration is updated every 10 seconds.

**NOTE:** The display range is not the same as the analog output signal range. If the signal range is set to 2500 ppm, the concentration will be displayed above the signal range, even though the signal has already stopped at 20 mA or 10V. The concentration display is linear up to 5000 ppm. Above 5000ppm, the measurement becomes non-linear. The display has a maximum reading of 9999 ppm, in which case the actual concentration may be above 9999ppm.

### 1.3 Keypad

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

### 1.4 Output Signal

Options for the analog output signal are: 4-20 mA linear (default) or 2-10V linear. The output mode can be chosen moving the J3 jumper. For over range concentrations the signal can exceed the range slightly (above 20mA or 10V) if clipping is disabled (see below for details). Jumper 3 (J3) is located in the top-right hand corner of the circuit card.

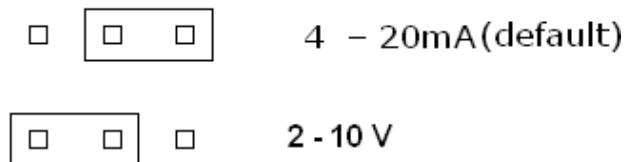


Figure 2 - Signal Mode Jumper (J3)

### 1.5 Signal Range

Signal range assignments allow the user to choose how the analog output signal is calculated from the gas concentration. This allows direct operation of louvers and fan speeds.

The default settings are 0ppm CO<sub>2</sub> = 4.0mA and 2500 ppm CO<sub>2</sub> = 20.0mA, with linear signal between the two points. These settings will cover 90% or more of applications for indoor air quality control.

The user may assign any gas concentration between 0 and 5000 ppm to each range point in steps of 50 ppm. The lower concentration point is called the "CO2 From" point and the upper concentration point is called the "CO2 To" point. The software will limit the minimum range (difference between the two points) to 500ppm.

**NOTE:** The "CO2 To" point cannot be set smaller than the "CO2 From" point.

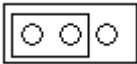



The corresponding Voltage or Current points can be adjusted between 0V and 10V (for voltage output mode) or 0mA to 20mA (for current output mode).

The current (or Voltage) points can be set to any relation, meaning the "Sig From" point and "Sig To" point can be swapped to obtain an output response with a negative slope. For a negative slope the output Voltage (or current) will decrease as the concentration increases.




**NOTE:** Always set the "JumperJ3" setting to match J3 on the unit. It is advisable to maintain at least 4V or (8mA) between the two "Sig" points. The software does not perform checking on these settings. While in the menu system, or before the first measurement, the signal is set to "Sig From".


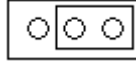

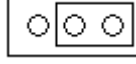
When "Clipping" is enabled, the signal output will not go beyond either of the two current (or Voltage) end-points. When "Clipping" is disabled, the signal output will go to 0V or 0mA minimum to about 10.75V (21.5mA) maximum.

**Signal Output Options**

"JumperJ3" Setting	"Clipping" Setting	Jumper J3	Analog Output Signal Range
"LeftVDC"	"Disable"		0.0V – 10.75V (default)
"LeftVDC"	"Enable"		"Sig From" – "Sig To" in Volt
"RightMA"	"Disable"		0.0mA – 21.5mA
"RightMA"	"Enable"		"Sig From" – "Sig To" in mA

**Signal Setting Examples**

Example	Settings	Jumper J3	Analog Output Signal Range
500-1500ppm 2.5V – 8.5V	"JumperJ3" = "LeftVDC" "CO2 From" = "0500ppm" "CO2 To" = "1500ppm" "Sig From" = "02.50V" "Sig To" = "08.50V" "Clipping" = "Disable"		0.0V – 10.75V
500-1500ppm 2.5V – 8.5V	"JumperJ3" = "LeftVDC" "CO2 From" = "0500ppm" "CO2 To" = "1500ppm" "Sig From" = "02.50V" "Sig To" = "08.50V" "Clipping" = "Enable"		2.5V – 8.5V
0-2500ppm 1.0V – 5.0V	"JumperJ3" = "LeftVDC" "CO2 From" = "0000ppm" "CO2 To" = "2500ppm" "Sig From" = "01.00V" "Sig To" = "05.00V" "Clipping" = "Disable"		1.0V – 10.0V

Example	Settings	Jumper J3	Analog Output Signal Range
0-2500ppm 1.0V – 5.0V	"JumperJ3" = "LeftVDC" "CO2 From" = "0000ppm" "CO2 To" = "2500ppm" "Sig From" = "01.00V" "Sig To" = "05.00V" "Clipping" = "Enable"		1.0V – 5.0V
0-2500ppm 4.0mA – 20.0mA (default)	"JumperJ3" = "RightMA" "CO2 From" = "0000ppm" "CO2 To" = "2500ppm" "Sig From" = "04.00mA" "Sig To" = "20.00mA" "Clipping" = "Disable"		4.0mA – 21.5mA
0-2500ppm 4.0mA – 20.0mA (default with clipping enabled by user)	"JumperJ3" = "RightMA" "CO2 From" = "0000ppm" "CO2 To" = "2500ppm" "Sig From" = "04.00mA" "Sig To" = "20.00mA" "Clipping" = "Enable"		4.0mA – 20.0mA
0-5000ppm 0.0mA – 20.0mA	"JumperJ3" = "RightMA" "CO2 From" = "0000ppm" "CO2 To" = "5000ppm" "Sig From" = "00.00mA" "Sig To" = "20.00mA" "Clipping" = "Enable"		0.0mA – 20.0mA

**IMPORTANT:** The Signal Range is the applied range of the analog output signal. The Display Range is independent of the signal range and is defined from Oppm to 5000 ppm. It is non-linear above 5000 ppm to a maximum of 9999ppm. Negative concentrations may be shown, but indicate that the unit needs calibration. The global average for CO<sub>2</sub> is in the order of 360ppm and should be the lowest concentration measured under most conditions.

### 1.6 Relay

One single pole double throw (SPDT; Form C, Dry contacts) with 1 Ampere rating is standard. Configuration allows adjustment for actuation point, dead band, and delays. The relay settings have the same range as the display (0-5000ppm), and are independent of the analog output signal range.

**NOTE:** The relay set points may be set to operate on declining gas concentrations simply by setting the de-actuation set point ("RelayOff") to a greater concentration than the actuation set point ("Relay On").

### 1.7 Power

The M-20 can be powered from an AC or DC power source with nominal voltage of 24V. The power supply is isolated and therefore few restrictions exist in the number of wiring configurations.

**NOTE:** The power input is isolated from the internal power of the unit, but the analog signal output is not isolated from the internal power of the unit. For installations where isolation is required for the signal, the power supply isolation will be sufficient. The user needs to bear in mind that the analog output signal is referenced to the secondary side of the isolated power supply.



## 2. Operation

When the unit is powered up, it displays a software revision string, followed by the gas identification string as shown below:

The display shows the software revision for 3 seconds:

**QEL M-20  
V3.01 RA**

Where "V3.01" indicates the software Version and "RA" the software Revision number.

The revision string is followed by:

**CO2 ppm  
----**

Where "----" indicate that the first measurement is in process.

After 10 seconds, the bottom display line will show the concentration of CO<sub>2</sub> in ppm. The measurement is updated every 10 seconds.

## 3. Fault Indication

Should an internal fault occur, the unit will display:

**FAULT OX**

Where X is a fault code, ranging from 0 to 9. Please refer to the *Troubleshooting* section for a list of fault codes.

**NOTE:** Please refer to the troubleshooting section if you notice any unexpected message indications (e.g.: Defaults Loaded). A fault code will be displayed for 10 seconds, after which the unit will restart and attempt to resume normal operation.

## 4. Configuration

All configuration of the unit, except the signal output mode (set with J3) is done through a software user menu system. The menu system is protected by a password. To provide protection to certain sensitive parameters, some menu items are hidden and need to be enabled before they can be accessed.

The M-20 enters its measurement mode automatically after power up. The first concentration reading is available after 10 seconds. If the default configuration matches the requirements of the installation, the power and analog output signal can be connected, after which the unit will enter service when powered up.

If the installation requires any of the default settings to be altered, it can be done through a user-friendly menu system. The user settings are saved in non-volatile RAM and will be preserved, should power be removed during operation.

**NOTE:** It is not necessary to open the enclosure to perform calibration or to change the default settings. The 'keypad' switches are located in the upper right side of the enclosure, and the gas ports are located at the bottom (see Figure 1).

### 4.1 User Interface

The M-20 user interface consists of a 2-line by 8-character alphanumeric LCD and a three-button keypad.

The top LCD line is used to indicate the setting and the second LCD line contains the value for the setting. Most settings use a numeric value (e.g.: 0500ppm) and some use a toggle string (e.g.: "Disable" or "Enable").

The keypad consists of three pushbutton switches. The pushbutton switches are marked S1, S2 and S3. Each button performs a specific function as follows:

- S1 = Scroll Up or Increment value (top button)
- S2 = Scroll down or Decrement value (middle button)
- S3 = Enter Alteration Mode or Accept value (bottom button)

The three switches will be referred to as Up (Top), Dn (Middle) and Enter (Bottom).

**NOTE:** The pushbutton switches are recessed to discourage tampering with the unit. A small screwdriver, pen or similar object is required to reach the switches.

**TIP:** Two levels of key repeat is provided for the Up and Dn keys. A slow repeat activates after about half a second of holding the key in. After a few seconds, the key will go to fast repeat to enable quick setting of a value with large difference.

### 4.2 Menu Activation

Press and hold any key for 3 seconds to activate the password request sequence. Select the password by scrolling to the user password (which is actually a number from 0000 to 0255) using the Up and Dn keys. When the password is reached, press the Enter key.

If the correct password was entered, the first item in the menu tree will be shown (see Menu Tree below). An incorrect password will be rejected and followed by a restart of the unit, similar to the power up sequence. Entering numerous incorrect passwords cannot cause harm to the unit, or cause it to lock out a subsequent valid password.

**NOTE:** The default password is 0017, but it can be changed by the user to any value between 0000 and 0255.

**WARNING:** Please keep proper record of the password, should it be changed from the default. Call the factory for support if it was lost.

### 4.3 Menu Item Selection

Use the scroll buttons (Up or Dn) to scroll up and down through the menu tree.

**TIP:** When the bottom of the menu tree is reached, further downward scrolling will roll over to the top. To reach the bottom of the menu tree in quick fashion, press Up to roll over to the bottom of the menu tree.

### 4.4 Menu Item Alteration

Activate the Menu Item Alteration mode by pressing Enter while displaying any menu item. The data alteration mode is indicated by an asterisk (\*) in the right-hand side of the bottom LCD display line. This indicates that the variable may be changed by scrolling (using Up or Dn).

To accept the selected value, press Enter. The \* will disappear, meaning that subsequent use of Up and Dn will select the previous or next item in the menu tree.

### 4.5 Menu Tree

The menu tree is explained in the table below. The order of items in the table is as they appear from the first item down to the last.

The "JumperJ3" item is the first (or top) item in the menu tree (or menu item list). To go to the next item, press the Dn key. To go to the last item in the list from the "JumperJ3" item, press the Up key to roll over to the last item.

Please note that, depending on certain selections, the length of the menu item list is altered. The "Calibr.." item adds the calibration items to the tree when "Enable" is selected. The "Factory." item adds the factory setup items to the tree when "Enable" is selected.

To return to the measure mode and exit from the menu tree, scroll up or down to the "Exit" menu item.

#### Menu Item List

Item Name	Item Range	Default	Description/Function
"JumperJ3"	"LeftVDC" or "RightMA"	"RightMA"	When using the analog signal output in Voltage mode (J3 set to the left), select "LeftVDC".  When using the 0-20mA analog signal mode (J3 set to the right), select "RightMA"  <b>NOTE:</b> This setting does not change the output mode, but selects the units and values to be used when setting the analog signal end-points.

M-20 Operation And Maintenance Manual

Item Name	Item Range	Default	Description/Function
"CO2 From"	Oppm to "CO2 To" - 500ppm.	Oppm	Adjust the lower ppm point for the analog signal output in steps of 50ppm.  <b>NOTE:</b> This setting is limited to "CO2 To" minus 500ppm. If you want to set it to a certain value and scrolling up "gets stuck", go to the "CO2 To" setting and set it higher first.
"CO2 To"	"CO2From"+500ppm to 5000ppm	2500ppm	Adjust the upper ppm point for the analog signal output in steps of 50ppm.  <b>NOTE:</b> This setting has a lower limit of "CO2 From" plus 500ppm. If you want to set it to a certain value and scrolling down "gets stuck", go back to the "CO2 From" setting and set it lower first.
"Sig From"	0.00V to 10.00V or 0.00mA to 20.0mA  <b>NOTE:</b> "Sig From" may be set higher or lower than "Sig To".	4.0mA	Adjust the signal output level at "CO2 From" ppm in steps of 0.05V or 0.10mA.  <b>NOTE:</b> The units depend on the setting of "JumperJ3" above.  <b>NOTE:</b> Please maintain at least 4.00V or 8.00mA between "Sig To" and "Sig From" for proper operation of the output signal.
"Sig To"	0.00V to 10.00V or 0.00mA to 20.0mA  <b>NOTE:</b> "Sig To" may be set higher or lower than "Sig From".	20.0mA	Adjust the signal output level at "CO2 To" ppm in steps of 0.05V or 0.10mA.  <b>NOTE:</b> The units depend on the setting of "JumperJ3" above.  <b>NOTE:</b> Please maintain at least 4.00V or 8.00mA between "Sig From" and "Sig To" for proper operation of the output signal.
"Clipping"	"Enable" or "Disable"	"Disable"	With clipping set to "Enabled", the analog output signal will be limited to "Sig From" to "Sig To". If the concentration drops below "CO2 From", the output signal will be clipped to "Sig From". If the concentration rises above "Sig To" the signal output will not rise above "Sig To".  With clipping set to "Disabled", the signal output will range from 0.00V to just over 10.00V (or 0.0mA to just over 20.0mA). The output will therefore have a range beyond "Sig From" and "Sig To".

M-20 Operation And Maintenance Manual

Item Name	Item Range	Default	Description/Function
"AutoZero"	"Yes" or "No"	"No"	<p>When "AutoZero" is set to "Yes", the unit will gather the lowest ppm reading in an 8-day period and set the unit calibration so that the lowest reading indicate the global average of around 360ppm.</p> <p>When "AutoZero" is set to "No", the unit will not adjust its own calibration and work off the last manual or factory calibration.</p> <p><b>NOTE:</b> "AutoZero" works best in situations where the building will purge at night (or over a weekend) to the global average CO<sub>2</sub> concentration.</p>
"Altitude"	0 to 9999 feet (ft)	300 ft	The altitude of the installed unit above sea level in feet. Can be set in steps of 50 ft.
"PassWord"	0000 to 0255	0017	<p>User password, required for entering the menu system.</p> <p><b>NOTE:</b> Please make sure you keep a record of the password if changed.</p>
"Relay"	"Enable" or "Disable"	"Enable"	<p>Select "Enable" to update the relay status from the measured concentration.</p> <p>When "Disable" is selected, the relay is passive and remains non-energized.</p>
"Relay On"	0 – 5000ppm	1000ppm	<p>The concentration at which the relay will be energized.</p> <p><b>NOTE:</b> If "Relay On" is set lower than "Relay Off", the relay will energize when the concentration drops below the concentration set for "Relay On". This causes and inverted relay action.</p>
"RelayOff"	<p>0 – 5000ppm</p> <p><b>NOTE:</b> Do not set the dead band to be lower than 50ppm to allow proper operation of the relay.</p>	950ppm	<p>The concentration at which the relay will be de-energized.</p> <p><b>NOTE:</b> The dead band is the difference between "Relay On" and "Relay Off". The default dead band is therefore 50ppm.</p>
"Delay On"	0 – 60 minutes	0 min	<p>"Delay On" is the time delay in minutes after the concentration passed the "Relay On" concentration until the relay is energized.</p> <p>This delay can be used to eliminate nuisance fan start-ups. The delay can be set in increments of 5 minutes.</p>

M-20 Operation And Maintenance Manual

Item Name	Item Range	Default	Description/Function
"DelayOff"	0 – 60 minutes	0 min	<p>"Delay Off" is the time delay in minutes after the concentration passed the "RelayOff" concentration until the relay is de-energized.</p> <p>This delay can be used to extend the fan running time after the concentration has dropped below "RelayOff". The delay can be set in increments of 5 minutes.</p>
"Simulate"	0-5000ppm	500ppm	<p>Any CO<sub>2</sub> concentration from 0ppm to 5000ppm can be simulated by pressing Enter at this item. While the * is shown the simulated concentration can be set with the Up or Dn keys.</p> <p>This feature is available for evaluating the user settings and testing the installation (e.g.: the travel of the valve, fan speed, relay set points, etc. can be verified.)</p>
"Exit"	"Save" or "KeepOld"	"Save"	<p>This is the menu exit point, which returns the unit to the measurement mode.</p> <p><b>TO SAVE YOUR CHANGES:</b></p> <ol style="list-style-type: none"> <li>1) Press Enter (* appears).</li> <li>2) Choose "Save" with Up or Dn.</li> <li>3) Press Enter to save your changes in non-volatile RAM.</li> <li>4) A confirmation string "Data Saved" will be displayed for a few seconds.</li> <li>5) The unit returns to measure mode.</li> </ol> <p><b>TO UNDO YOUR CHANGES:</b></p> <ol style="list-style-type: none"> <li>1) Press Enter (* appears).</li> <li>2) Choose "KeepOld" with Up or Dn, which will restore the last settings from non-volatile RAM and <i>not</i> save the new settings.</li> <li>3) Press Enter to dump your changes and restore the values in non-volatile RAM.</li> <li>4) The unit returns to measure mode.</li> </ol>

Item Name	Item Range	Default	Description/Function
"Calibr.."	"Enable" or "Disable"	"Disable"	<p><b>CAUTION:</b> Do not choose "Enable" if you do not intend to calibrate the unit and have calibration gas available.</p> <p>If "Disable" is selected, this item is the end of the menu list. Pressing Dn will roll over to the top menu item.</p> <p>If "Enable" is selected, the menu list is extended to include the calibration menu items.</p> <p>Choose "Enable" if you want to calibrate the unit.</p> <p><b>NOTE:</b> This item will be defaulted to "Disable" when returning to measure mode.</p>
"Zero Cal"	Oppm $\pm$ 50ppm	Oppm	<p><b>NOTE:</b> Please refer to the <i>Calibration</i> section in the text below for more information.</p> <p><b>PROCEDURE:</b></p> <ol style="list-style-type: none"> <li>1) Apply 100% pure Nitrogen gas to the unit, using an M-20 calibration kit.</li> <li>2) Press Enter and see the * appear on the bottom LCD line.</li> <li>3) Wait for the concentration to stabilize, it should be low and not too far from Oppm.</li> <li>4) Press Dn (or Up) to set the indicated concentration to Oppm. The Zero ppm point is now calibrated.</li> <li>5) If the concentration changes and re-stabilize more than 50ppm from zero, press Up (or Dn) again.</li> <li>6) Repeat step 5) until the concentration shows a stable pattern between Oppm and 50ppm. Try not to accept a negative concentration, unless it is small (-10ppm to -1ppm).</li> <li>7) Press Enter to accept (* disappears).</li> </ol>

Item Name	Item Range	Default	Description/Function
"Span Cal"	2500ppm ± 50ppm	2500ppm	<p><b>NOTE:</b> Please refer to the <i>Calibration</i> section in the text below for more information.</p> <p><b>EXCEPTION:</b> It is also possible to calibrate the span with a different span gas concentration than 2500ppm. In such cases, replace 2500ppm in this procedure with the chosen span gas concentration (e.g.: 5000ppm). The unit will have non-linear response for span calibration above 5000ppm.</p> <p><b>PROCEDURE:</b></p> <ol style="list-style-type: none"> <li>1) Apply 2500ppm CO<sub>2</sub> (balance Nitrogen) to the unit, using an M-20 calibration kit.</li> <li>2) Press Enter and see the * appear on the bottom LCD line.</li> <li>3) Wait for the concentration to stabilize, it should be 2500ppm ± 1000ppm.</li> <li>4) Press Dn (or Up) to set the indicated concentration to 2500ppm ± 50ppm. As you get closer to 2500ppm, reduce the number of Up or Dn key presses between measurements.</li> <li>5) If the concentration changes and re-stabilize more than 50ppm from 2500ppm, press Up or Dn to trim the concentration.</li> <li>6) Repeat step 5) until the concentration shows a stable pattern between 2450pm and 2550ppm.</li> <li>7) Press Enter to accept (* disappears).</li> </ol>



Item Name	Item Range	Default	Description/Function
"Factory."	"Enable" or "Disable"	"Disable"	<p><b>CAUTION:</b> Do not choose "Enable" if you are not familiar with technical procedures. Some of the items in the Factory Menu Require Zero Gas, and some require a calibrated DMM.</p> <p>If "Disable" is selected, this item is the end of the menu list. Pressing Dn will roll over to the top menu item.</p> <p>If "Enable" is selected, the menu list is extended to include the factory setup menu items.</p> <p>Choose "Enable" if you want to update the factory settings of the unit.</p> <p><b>NOTE:</b> This item will be defaulted to "Disable" when returning to measure mode.</p>

Item Name	Item Range	Default	Description/Function
"Sig Cal"	<p>0800 – 1023</p> <p><b>NOTE:</b> The indicated value is a proportion of 1023, which results in a desired output voltage or current.</p> <p>21.5mA = 1023/1023 20mA = 951/1023</p>	951	<p><b>NOTE:</b> Calibrating this setting in the mode required for the specific application will deliver better accuracy for the signal level.</p> <p><b>TIP 1:</b> If you are using the 0-20mA output mode and want to perform an "in-circuit" calibration, do not disconnect the signal output lines from the target system and connect the DMM positive probe to "JACK1" and the negative probe to "JACK2". Proceed as described below, but keep the DMM probes connected as described here.</p> <p><b>TIP 2:</b> When using the 0-10V mode, the signal connections can be left in place, resulting in a calibration that includes the input impedance of the target system.</p> <p><b>REQUIRED:</b></p> <ol style="list-style-type: none"> <li>1) Calibrated DMM (3½ or 4½ digit).</li> <li>2) Philips screwdriver to open cover.</li> </ol> <p><b>POCEDURE:</b></p> <ol style="list-style-type: none"> <li>1) Disconnect the "SIG" line on "TB1" if you are not performing a 0-20mA "in-circuit" calibration (see TIP 1 and TIP 2 above).</li> <li>2) Decide if you want to calibrate the signal output for 0-10V or 0-20mA. Set J3 to match your preference.</li> <li>3) Select the scale on the DMM to your preference (0-40mA scale for 0-20mA, and 0 – 10V scale for 0-10V mode).</li> <li>4) Insert the negative lead of the DMM into the "JACK3" test point on the circuit card (see TIP 1 above).</li> <li>5) Insert the positive lead of the DMM into the "JACK2" test point on the circuit card (see TIP 1 above).</li> <li>6) Press Enter (* appears). The signal output will rise to 20mA or 10V.</li> <li>7) Use Up or Dn to trim the signal output to 10.01V or 20.01mA.</li> <li>8) Press Enter (* disappears).</li> </ol> <p><b>TIP 3:</b> You may need to find a compromise between the lower and upper parts of the range. When not in edit mode (* is off), the "Sig From" level will be at the signal output. Trim the adjustment if necessary to have a closer match for "Sig From".</p>

Item Name	Item Range	Default	Description/Function
"Glob Ave"	0000 – 5000ppm	360ppm	<p>This item is used by the AutoZero function. Change it only if the global average changes (guaranteed over time to change) or if you want to use a different value for the AutoZero function.</p> <p><b>TIP:</b> If you have statistical data showing that the building purges to, say 400ppm, over an 8-day period, you can change "Glob Ave" to a pseudo global average of 400ppm to obtain more accurate auto zeroing.</p>
"NitroRef"	3850mV – 3950mV	3800mV	<p><b>CAUTION:</b> This item adjusts the gain of the front-end amplifier and its zero reference.</p> <p>Adjustment is required during production, or if the lamp brightness has drifted over time.</p> <p><b>REQUIRED:</b></p> <ol style="list-style-type: none"> <li>1) 100% Nitrogen used for Zero Cal.</li> <li>2) 2500ppm CO<sub>2</sub> span gas.</li> <li>3) M-20 Calibration Kit.</li> <li>4) Small flat screwdriver.</li> </ol> <p><b>PROCEDURE:</b></p> <ol style="list-style-type: none"> <li>1) Hook up the calibration kit as when performing a Zero Cal.</li> <li>2) Press Enter (* appears). The mV reading will start updating as the lamp cycles on and off at an 1 second rate.</li> <li>3) Check the indicated mV reading after it stabilizes. If the reading is stable between 3850mV and 3950mV, proceed to item 5).</li> <li>4) Adjust VR1 until the reading is stable between 3850mV and 3950mV. The preferred target reading is 3900mV.</li> <li>5) Press Enter (* disappears).</li> <li>6) Perform a Zero Cal and Span Cal (required) as described above.</li> </ol>

Item Name	Item Range	Default	Description/Function
"Defaults"	"User" or "All"	"User"	<p><b>WARNING:</b> Choosing "All" will restore defaults to all items in the menu tree, including the factory settings.</p> <p><b>User Settings:</b> To load defaults to all user items, press Enter (* appears) choose "User" with Up or Dn, and press Enter to accept. A confirmation string "Defaults Restored" will be shown for a few seconds. The calibration settings will <i>not</i> be changed.</p> <p><b>All Settings (includes calibration):</b> To load defaults to all items, press Enter (* appears) choose "All" with Up or Dn, and press Enter to accept. A confirmation string "Defaults Restored" will be shown for a few seconds. <b>Perform a full factory and gas calibration to restore the unit to correct operation.</b></p> <p><b>TIP:</b> If you changed your mind after restoring "All" defaults, do the following:</p> <ol style="list-style-type: none"> <li>1) Go straight to the "Exit" menu item by pressing up (while * is not shown).</li> <li>2) Press Enter at the "Exit" menu item (* appears).</li> <li>3) Choose "KeepOld".</li> <li>4) Press Enter to accept.</li> <li>5) The restored defaults will not be saved to non-volatile RAM. All other changes will also be lost.</li> <li>6) The unit returns to the measure mode.</li> </ol>

## 5. Calibration

This section is complemented by the detailed procedures outlined in the menu tree table above. Refer to the menu tree table when performing a calibration.

In general, calibration should be performed at an ambient temperature close to the temperature to which the unit will be exposed during operation. When matching the calibration and operational temperature a more accurate calibration is obtained.

The recommended gas flow rate is approximately 0.2 to 0.4 liters/minute for all the procedures in this section.

### 5.1 Equipment Required

The easiest way to obtain the equipment below is by means of a M-20 calibration kit. The list of items required is as follows:

- 1) Zero Calibration Gas, which is Nitrogen (100% pure, normally >99.99% is available).
- 2) Span Calibration Gas, which is 2500ppm Carbon Dioxide, balanced with Nitrogen.
- 3) Pressure and Flow Limiting Regulator(s) 0.2 to 0.4 lpm (0.4 to 0.8 scfh).
- 4) Tubing and hose barb adaptors with 10-32 male threads.

**NOTE:** 2500ppm CO<sub>2</sub> span gas is recommended for building air quality management applications. Higher concentration span gas can be used up to 5000ppm CO<sub>2</sub> for other applications. The span gas must be balanced with Nitrogen.

**NOTE:** The measurement cycle for Zero and Span Calibration is every 10 seconds. The concentration is updated at the end of the light period. For the Gain Check, the cycle is two seconds long.

### 5.2 Gain Check

The front-end amplifier gain check only need to be done in cases that are more exceptional:

- 1) When the lamp has drifted due to ageing.
- 2) Dirt particles accumulated in the sensing chamber.
- 3) Difficulty is experienced when performing a Zero or Span Calibration as described below.

This procedure is similar to and requires the same setup as for a Zero Calibration. Follow the procedure below (do not continue if you do not have Nitrogen available):

- 1) Complete the calibration setup using a M-20 calibration kit.
- 2) Scroll through the menu (as described in the previous chapter) to the "NitroRef" item.
- 3) Make a note of the value for "NitroRef" before pressing Enter. The value should be between 3700mV and 4050mV.
- 4) Press Enter (\* appears next to the value)
- 5) Apply zero gas (Nitrogen) and wait until the reading stabilizes (at least within five minutes).
- 6) If you obtain a similar reading to the original value for "NitroRef" continue with step 8). Check that the value is within the prescribed limits in step 3).
- 7) If the stabilized value is significantly lower than 3700mV, adjust the gain potentiometer (VR1) clockwise to increase the gain. The ideal value to obtain is 3900mV (3850-3950mV). The range from 3700mV to 4050mV is acceptable if the end of the range for VR1 is reached in either direction and it is not possible to set to 3900mV. The value must never be above 4050mV. If you see the value 4095mV, it means the gain is too high and the value is in an unknown region. Turn VR1 anti-clockwise to reduce the gain.

- 8) When you are satisfied that the gain is good and the value is stable, press Enter (the \* will go off and the value will stop changing). It is normal for the value to fluctuate up or down by up to 5mV.
- 9) Repeat if required, but keep the gas flowing throughout. Afterwards, perform a Zero and Span Calibration, which is mandatory after doing a Gain Check. You can keep the Nitrogen gas flowing to perform the Zero Calibration.

### **5.3 Zero Calibration**

Follow the procedure below to perform a Zero Calibration:

- 1) Complete the calibration setup using a M-20 calibration kit.
- 2) Scroll through the menu (as described in the previous chapter) to the "Zero Cal" item.
- 3) Apply zero gas (100% Nitrogen) and wait until the reading stabilizes (to be within five minutes).
- 4) If the indicated concentration is  $0\text{ppm} \pm 25\text{ppm}$ , the Zero Calibration is fine and no adjustment is necessary, proceed in such a case to the Span Calibration.
- 5) Press Enter (\* appears next to value).
- 6) Press Up or Dn, the display will immediately adjust to 0000.
- 7) Repeat as necessary, preferably with the concentration between 0ppm and 50ppm. Small negative concentrations are acceptable from -10ppm to -1ppm.
- 8) Press Enter to exit (\* disappears).
- 9) Proceed to the Span Calibration.

### **5.4 Span Calibration**

Follow the procedure below to perform a Span Calibration:

- 1) Complete the calibration setup using a M-20 calibration kit.
- 2) Scroll through the menu (as described in the previous chapter) to the "Span Cal" item.
- 3) Apply span gas (2500ppm CO<sub>2</sub>, balance Nitrogen) and wait until the reading stabilizes (to be within five minutes).
- 4) If the indicated concentration is  $2500\text{ppm} \pm 25\text{ppm}$ , the Span Calibration is fine and no adjustment is necessary, proceed in such a case to the "Exit" menu item and save your changes.
- 5) Press Enter (\* appears next to value).
- 6) Press Up or Dn, the displayed concentration will adjust with each key press to a higher or lower value.
- 7) Repeat as necessary, preferably until the concentration is between 2450ppm and 2550ppm. As you reach 2500ppm, reduce the number of key presses to one per measurement cycle (every 10 seconds). When the displayed concentration is stable (ideally  $2500\text{ppm} \pm 25\text{ppm}$ ) proceed to step 8) below.
- 8) Press Enter to exit (\* disappears).
- 9) Proceed to the "Exit" menu item and save your changes.

## 6. Troubleshooting

The microprocessor will detect various component faults and out-of-range conditions, should they occur during normal operation.

When a fault is detected, the output signal is dropped to 0.0 mA (or 0.0V) and the fault indicated on the LCD.

Most gradually developing conditions such as a failing IR source lamp, dirt in the sample chamber, etc., cause gradually rising readings; these mimic light absorption by CO<sub>2</sub>. Periodic calibration checks are therefore required to ensure that the unit operates properly. The frequency of calibration checks depends on the amount of dirt and dust in the environment and can be determined by trial of one or more units in a new installation.

The typical life cycle of the IR source may see a gradually rising signal over a few months. In ordinary service, one should expect many years of operation. For duct mount units, the filter should be inspected periodically, depending on the amount of dust in the duct system.

**NOTE:** When the menu system is entered, the signal output defaults to the signal setting for "Sig From". The relay will be defaulted to off.

### 6.1 Troubleshooting Tips

Problem	Suggested Course Of Action
LCD blank, Relay LED off.	Check power availability. Check fuse F1. Check for proper connection to TB4.
After power-up, the unit displayed "Defaults Loaded".	The microprocessor detected invalid parameters in the EEPROM and reverted to default settings. If equipment and a calibration kit is available, perform these calibration operations: "NitroRef", "Zero Cal", "Span Cal" and "Sig Cal". Alternatively, return the unit to the factory for factory calibration.
LCD shows row of blocks. Unit freezes, or restarts all the time.	Microprocessor failure. Check for moisture on circuit card. Check for power voltage within specification.
I am watching the unit and the concentration keeps jumping around.	Humans exhale several thousand ppm CO <sub>2</sub> , keep a distance from the unit.
Not possible to perform an accurate span calibration.	The sensor chamber is most likely contaminated or the IR lamp aged too much. Return the unit to the factory for a replacement block. Attempt to clear the sensing chamber with canned air if lint or particles can be seen through the gas ports. Consider cleaning a temporary solution. Find a solution to prevent contamination.
Unit lost its sensitivity to gas.	Check for contamination of the measuring chamber by dust or lint particles. Do a calibration check.
Relay does not want to operate.	Check if relay enabled in the menu system. Check relay set points, time delays and dead band.
Relay keeps switching on and off all the time.	Check dead band (difference between "Relay On" and "Relay Off") to be more than 50ppm. Increase dead band. Increase "Delay On" or "Delay Off", or both.
Signal goes the wrong way.	The "Sig From" and "Sig To" settings are swapped.

M-20 Operation And Maintenance Manual

<b>Problem</b>	<b>Suggested Course Of Action</b>
Signal not showing the correct amount of mA.	Check if J3 not set for voltage output. Check if burden resistor not too high.
Signal supposed to give 2-10V, but is pinned high above 10V.	Check if J3 not set for current output.
Signal output gives weird response. Signal output jumpy.	Check to "Sig From" and "Sig To" settings. Increase the difference between the two points. Increase difference between "From ppm" and "To ppm".
Signal output does not respond enough.	Check to "Sig From" and "Sig To" settings. Decrease the difference between the two points. Change the difference between "From ppm" and "To ppm".
Current output jumper set correctly but output is pinned high.	Check the burden resistor of the monitor. Check cable to the monitor.
The signal output is dropping below 2mA and I am getting a fault indication from the monitor.	The 0-10V or 0-20mA mode is enabled. Go to the "JumperJ3" menu item and select "RightMA". Check the signal end-point settings. Check to see if the unit is not showing a fault condition.



## 6.2 Fault Codes

Should the unit detect an internal fault, it is categorized and the fault is indicated by a fault code. A fault code will be shown for five seconds, after which the unit will attempt to recover to normal operation. A unit experiencing a fault can be identified by the fault indication on the LCD display or by the signal output line dropping to 0.0mA (or 0.0V) periodically.

Should any fault occur, check the circuit card for moisture condensation or for water dripping into the enclosure. Check the supply voltage to be within specification over an 11 second period.

If the fault cannot be repaired by the suggested remedy, please contact the factory or distributor.

Fault Code	Description	Remedy
01	Lamp Failure	Check for excessive dust in chamber. Return unit to factory for replacement block.
02	Software Error	Remove power for 10 seconds to reset microprocessor. Please notify factory and provide the software version and revision number, as well as unit serial number.
03	Lamp State Error	As for Fault 02.
04	Math Overflow	Check Zero and Span Calibration. Check signal output settings, especially "Sig From" and "Sig To". If calibration and signal settings are fine, notify factory.
05	Thermopile Failure	Check for moisture on the circuit card. Return unit to factory for replacement block.
06	Thermistor Stuck Low	Check for moisture on the circuit card. Check if ambient operating temperature falls within specification. Return unit to factory repair.
07	Thermistor Stuck High	Check for moisture on the circuit card. Check if ambient operating temperature falls within specification. Return unit to factory repair.
08	EEPROM Communication Fault	Check for moisture on the circuit card. Return unit to factory for repair.
09	EEPROM Verify Fault	Verify settings and calibration, save on Exit. Return to factory for repair if fault persists.

## 7. Duct Mount Adapter (CTS-M2000X-D00000)

The Duct Adapter enables the M-20 to be used for monitoring moving air inside ducting. Screw in the two hose barbs supplied with the Duct Adapter and mount the adapter as shown.

**NOTE:** Check the required direction of the airflow. Error in mounting will cause dust to be forced into the sensing chamber. The inlet air must pass through the particulate filter before entering the unit.

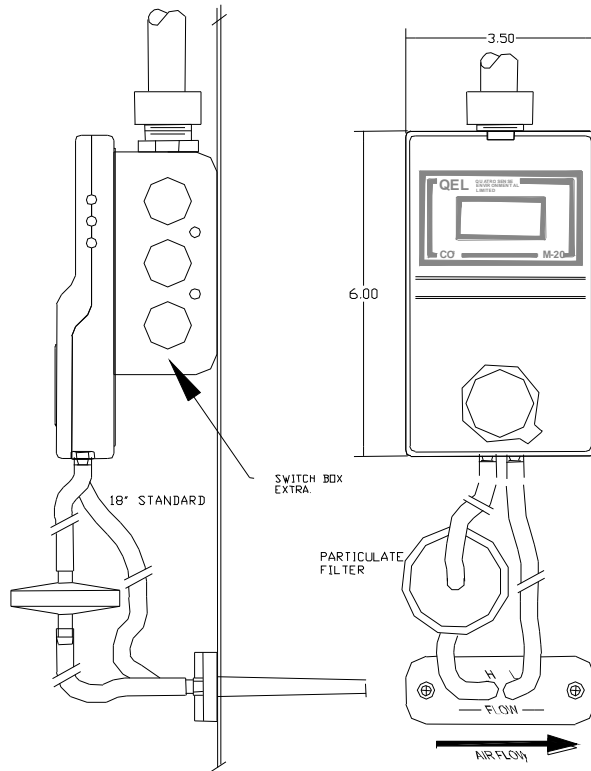


Figure 3 - Duct Mount Configuration

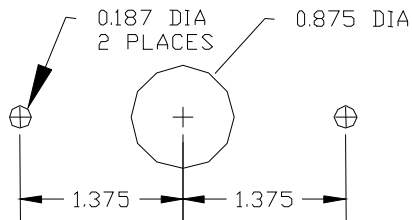
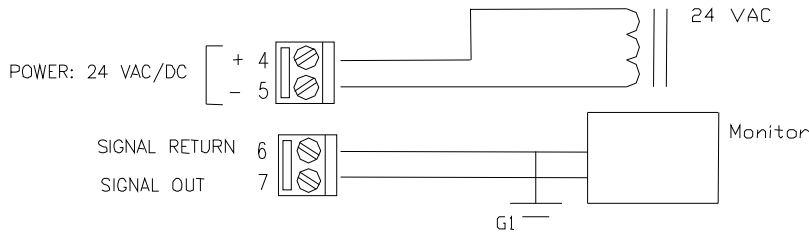


Figure 4 - Duct Cutout

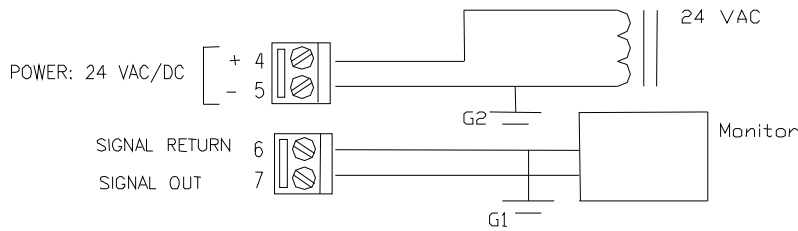
## 8. Wiring and Power Supply

The M-20 Power Supply input is isolated internally from the electronics. This allows it to be connected to all possible power and signal grounding configurations without compromising performance.

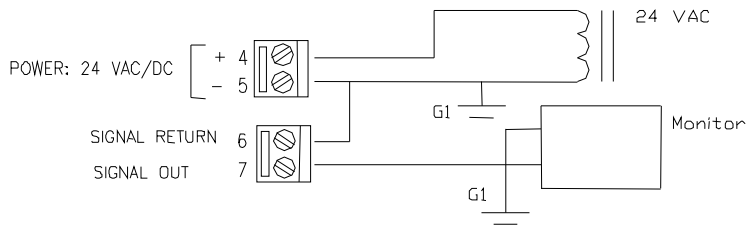
In the following diagrams, G1 is an internal signal ground for the monitor. It may or may not be common with the power supply ground. G2 indicates a ground, which is not common to the monitor, which the installer can leave unconnected to avoid ground loops.



**Figure 5 - 24VAC Floating Supply (4-Wire Installation)**

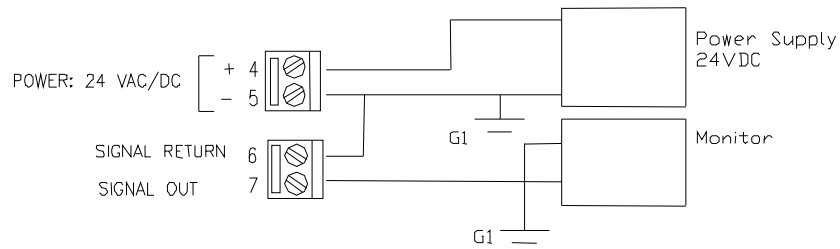


**Figure 6 - 24 VAC with Separate Grounds (4-Wire Installation)**

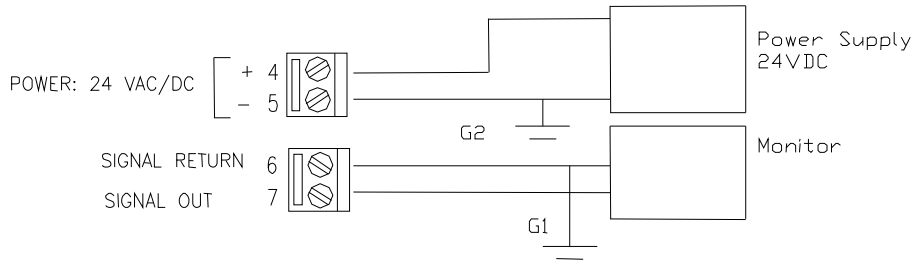


**Figure 7 - 24VAC with Common Grounds (3-Wire Installation)**

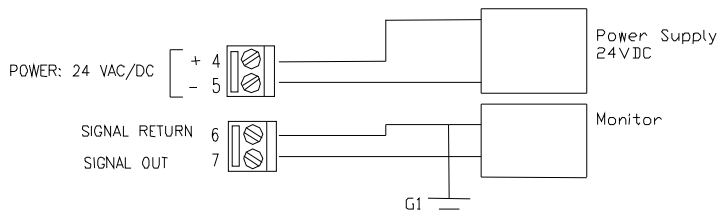
# M-20 Operation And Maintenance Manual



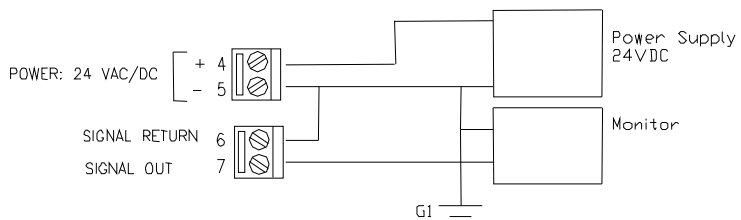
**Figure 8 - 24VDC Supply with Common Ground (3-Wire Installation)**



**Figure 9 - 24VDC Supply with Separate Ground (4-Wire Installation)**



**Figure 10 - 24VDC Ungrounded Supply (4-Wire Installation)**



**Figure 11 - 24VDC Ungrounded Supply (3-Wire Installation)**

## 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:

#### QUATROSENSE ENVIRONMENTAL LTD.

5935 Ottawa Street, PO Box 749

Richmond, Ontario

K0A 2Z0

Tel: (613) 838-4005

Fax: (613) 838-4018

Email: [QEL@QELsafety.com](mailto:QEL@QELsafety.com)

Web: [www.QELsafety.com](http://www.QELsafety.com)