MODEL 302

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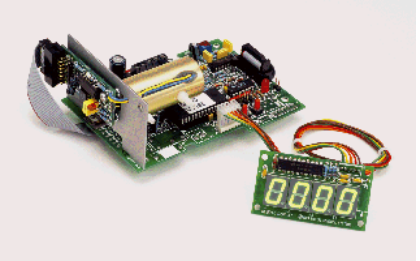

CO_2 Concentration Sensor

Reference Manual

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revision history	
Date	**Change**
3/22/00	Initial release

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INTRODUCTION

The Model 302 is a microprocessor based, non-dispersive infrared CO_2 concentration sensor. The amount of power impinging on the detector is an approximately logarithmic function of the CO_2 concentration in the gas between source and detector. The wavelengths used are absorbed only by CO_2, making the measurement insensitive to other components, such as water vapor, in the gas being measured.

The Model 302, supplied in a "bare board" configuration, is a cost effective measurement component for a variety of scientific and industrial products. Advanced design provides a very stable, drift-free output requiring less frequent calibration.

Its microprocessor based design keeps analog signal processing, with its troublesome limitations to a minimum. Detector linearization is performed with 32 bit digital accuracy. Concentration can be transmitted to another device via a voltage or a 4 to 20 milliamp current loop interface, or directly displayed with the optional LED read-out.

The Model 302 is available in several versions. The detector assembly can be provided in a remote, bulkhead mounted configuration or directly mounted to the control board. Both types can be supplied with hose nipples for pumped sample draw systems or with multiple ports for diffusion applications.

SPECIFICATIONS

Sensing Technique	Non-dispersive infrared (NDIR)
Measurement Range	0 - 5000 ppm CO_2
Maximum Drift (per year)	± 3% of full scale
Accuracy	±5% of reading or 0.1% CO_2, whichever is greater
Repeatability	better than 0.1% CO_2
Measurement Outputs	Linear
voltage	0 - 1 volt is standard, other ranges available
current loop	4 - 20 mA ($R_{loop} \leq 470\Omega$)
digital display	7 segment LED showing CO_2 concentration
Operating Temperature Range	0 - 50^{o} C
Storage Temperature	-20 to +70^{o} C
Power Requirement	10-35 VDC 8 - 28 VAC_{rms} Approx. 1.5W 250 mA max with optional digital display
Optional Digital Display	3 digit LED
Optional Relay	0 to full scale setpoint range
Contact Rating	2A @ 24 VAC

OPERATIONAL DESCRIPTION

The Model 302 CO_2 sensor consists of a control board and a detector assembly connected with a flat ribbon cable. The sensor/control board pairs are factory calibrated as a unit and should not be separated.

Operating Power Requirements

The Model 302 requires approximately 170 mA of peak current at 8 volts DC. The current wave form has an AC component of about 50 mA peak to peak at a frequency of approximately two hertz. At higher voltages the current decreases proportionally.

Low voltage operating power is applied at the "V+" and "V-" screw terminals of J50. **Reversing the input power polarity when the 'COM' terminal is connected to ground will damage the output voltage driver.**

Maintaining adequate input voltage is critical. **Input voltages below 8 volts will result in erroneous readings.**

If the digital display option is connected, the current draw increases to a maximum of 250 mA.

Analog Measurement Output

The measured CO2 concentration is available as either a voltage or current signal whose amplitude is linearly proportional to the measured concentration. While both outputs are always present, they share a single set of calibration parameters; they can not be independently calibrated.

Calibration of the analog outputs is done as described on page 10. Note that this calibration only adjusts the analog signal that is generated in response to the measured concentration level. The concentration measurement itself is calibrated as described in the *Measurement Calibration* section starting on page 9

Voltage Output

The Model 302 CO_2 sensor indicates the CO_2 concentration measured by the sensor as a DC voltage at the "V OUT" (positive) and "COM" terminals of J50. The standard output voltage range is from 0 to 1.0 volts as CO_2 concentration ranges from zero to full scale. Other voltage ranges are available.

The "COM" terminal is the reference potential for the output voltage. For best accuracy the ground of the circuit that receives the output signal should be referenced to the "COM" terminal rather than the negative side of the power supply connected to the "V -" terminal. Because of varying voltage drops caused by the varying IR source current that flows out of the "V -" terminal, the voltage at the "COM" terminal may vary by tens of millivolts relative to the potential at the other end of the wire connected to the "V -" terminal.

Current Output

The Model 302 supplies a current ranging linearly from 4 to 20 milliamps as the CO_2 concentration varies from 0 to full scale. The current flows out of the "I OUT" terminal at J50 and returns through the "COM" terminal. The maximum load resistance through which the full

scale current can be driven increases at higher supply voltages. With a 12 volt input the maximum resistance is about 500 Ohms. Excessive resistance between the "I OUT" and "COM" terminals will result in low reading errors at higher concentrations.

Full Scale Turn-down

The full scale concentration of the unit can be decreased from the factory calibration full scale value. For example a Model 300 factory calibrated as a 5000 ppm full scale unit can be adjusted so that any concentration below 5000 ppm becomes the new top of scale..

Changing the full scale calibration value has two effects. The digital display clips at the selected concentration value, and the analog output scaling is changed so that the selected maximum concentration value corresponds to the full scale analog output.

A Model 302 factory calibrated for 0 to 5000 ppm that is turned down to 2000 ppm full scale can never indicate more than 2000 ppm CO_2 on the display, and its analog outputs will be at full scale when the indicated concentration reaches 2000 ppm.

To turn down the full scale value of a Model 302 proceed as follows:

1) Note whether the shorting block at JP5 is covering one or both pins, then remove it and use it to close jumper JP4.
2) While JP4 is closed, use another shorting block to close jumper JP3.
3) If the optional display is connected it will show the full scale value.

   The analog output value will be the same fraction of its full scale value as the turn down ratio. For example if a 5000 ppm unit is turned down to 2000 ppm full scale, the analog output will be at 2/5 of its maximum value (i.e. the voltage will be at .4 V and the current will be 10.4 mA).
4) Use the ‘UP’ and ‘DOWN’ buttons to set the desired full scale value.
5) Remove the shorting block from JP3 and store it over only a single pin of JP3. Remove the shorting block from JP4 and replace it at its original position over one or both pins of jumper JP5.

Options

This section describes operational features that may not be present on all units.

Digital Display

The CO_2 concentration can be directly displayed on an optional LED display. The display cable is connected to the 5 pin locking header marked "DISPLAY" at the lower left edge of the control board.

The displayed concentration is calibrated with the measurement calibration procedure (see page 9). Analog calibration has no effect on the displayed value.

High Limit Contact Closure

The optional contact closure provides a dry (i.e. unpowered) contact at the two terminals of J3. The set point is adjustable over the full range of the unit by closing jumper JP3 and using the buttons to select the desired value. If the optional display is installed, the setpoint value is displayed while jumper JP3 is closed. If the display is not present the voltage or current output will indicate the set point while jumper JP3 is closed.

Jumper JP5 sets the polarity of the contact.

Jumper JP5 ON	Contact **closed above** set point
Jumper JP5 OFF	Contact **open above** set point

Relay contacts are rated at 2A/24V.

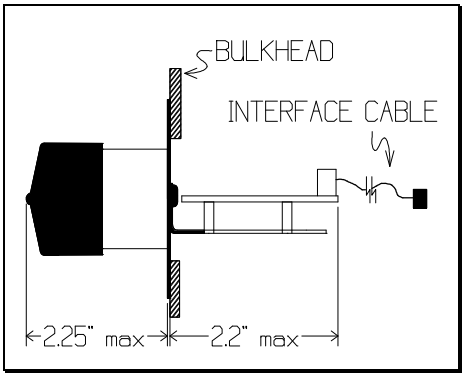


Figure 1: Typical Bulkhead Style Detector Mounting

INSTALLATION

Detector Mounting

The remote and attached detector versions differ only in the mechanical configuration of the electronics module. Detectors should be placed so that they are not subject to excessive vibration or shock which could alter their calibration or decrease their operating life.

The remote detector is intended primarily for monitoring the CO_2 concentration through a bulkhead in enclosed spaces. Figure 1 shows a typical installation. A hole pattern similar to Figure 2 is provided in the wall, and the sensor assembly is installed from inside the area to be monitored, with its mounting plate fastened to the inside of the wall.

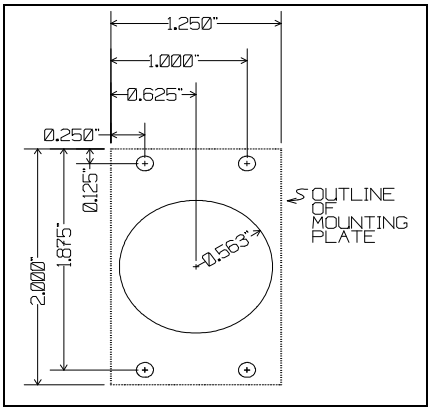


Figure 2: Bulkhead Detector Mounting Pattern

The board mounted detector is intended for pumped sample draw applications where the detector location is not critical. The detector is mounted to the control board with a bracket. The control board requires an additional 1/2" of clearance at the edge of the board opposite the detector connector to accommodate the detector electronics (see control board layout diagram on page 7.).

Pumped Sample Draw Considerations

To avoid excessive pressure build-up in the detector, place filters or other flow restricting devices upstream of the sample cell.

Place the detector in the high pressure side of the system, so that any leaks discharge sample gas rather than drawing in ambient air and altering the concentration of the sample stream.

When sampling high humidity gas, the detector chamber must be kept above the dew point of the sample stream to avoid condensation. Any moisture on the detector window will cause calibration errors.

In very high flow systems a shunt tube should be provided, to avoid turbulence in the sample chamber that may cause unstable readings when the flow rate exceeds .25 l/min.

Control Board Mounting

The control board has four .125" diameter mounting holes, and can be mounted in any orientation. Overall board size and mounting hole locations are shown in Figure 3 below. The board must be mounted a minimum .5" above any conducting surface, and should be positioned so that there is easy access to its lower right hand corner where the jumpers and buttons used for calibration are located. The required clearance above the board is 2.5". If the detector is mounted to the control board, an additional 1/2" of clearance is required on the side of the board opposite the detector connector.

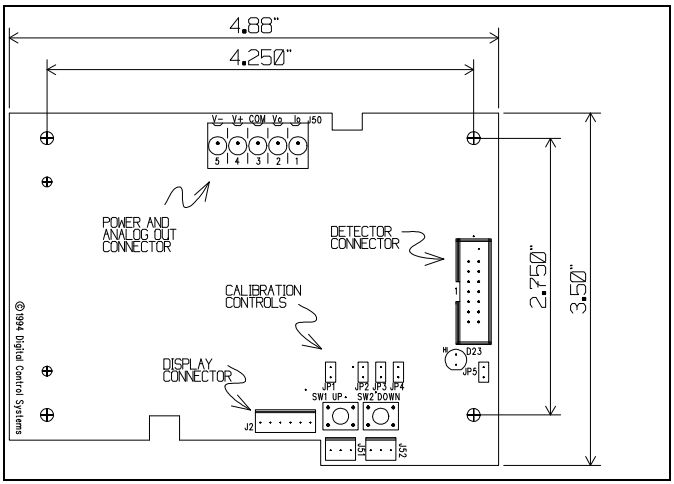


Figure 3: Control Board Layout

Cable Connections

All power and signal connections to the Model 302 are summarized in Table 1 below.

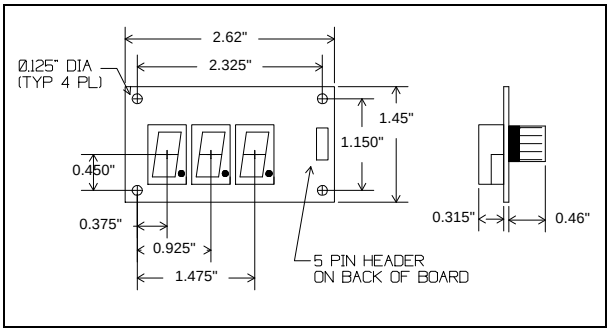
For best noise immunity, the signal output wires should be twisted together and not routed for long distances close to power carrying conductors.

Terminal Number	Contact Name	Signal Description	Comments
J1	none	The detector assembly ribbon cable is connected here.	Detector assembly should not be connected while the control board is under power.
J2	DISPLAY	The optional digital LED display is connected here.	.
J50	V-	Negative side of supply voltage.	#16 AWG or larger wire should be used to supply the operating power.
	V+	Positive side of supply voltage Must be at least 8 volts DC relative to 'V-' terminal.	
	I OUT	Source terminal for current loop analog output.	The current loop is connected between this terminal and "COM".
	V OUT	Voltage proportional to CO_2 concentration is present at this terminal.	
	COM	Reference potential for output signal voltage, and return for current signal.	When the voltage output is used, the receiving circuit should use this pin rather than "V-" as the reference potential.

TABLE 1: Control Board Connector Summary

Display Board Mounting

The display board dimensions are shown in the figure below. The most straightforward installation technique is to mount the display board behind a panel using 3/8" standoffs, with a 1.6" by .75" cutout centered on the middle LED digit. A translucent window the same color as the LEDs will greatly enhance the viewing contrast.



POWER UP SELF-TEST

Whenever power is applied the software version number is displayed on the LED read out, and the calibration data stored in the EEPROM in the detector assembly is read and verified. If an error is detected the analog outputs will continue to indicate maximum CO_2 concentration and the digital display will continue to show the software revision number.

MEASUREMENT CALIBRATION

The non-linear gas measurement calibration parameters for each detector assembly are established during factory calibration and stored in the EEPROM on the detector electronics module.

Sensors are calibrated during manufacture at 20°C and atmospheric pressure of approximately 1000 millibars. When placed in service at significantly different temperatures and/or pressures, the measurement should be calibrated at the actual operating conditions. This is especially important in pumped sample systems, where the ambient pressure seen by the detector may vary significantly from the factory calibration conditions.

Measurement calibration is used to make the Model 302 accurately report the CO_2 concentration at the prevailing temperature and pressure. If the voltage or current output is used to indicate the measured CO_2 percentage, the analog output span and offset must be correct before the measurement calibration can be accurately established.

To perform a measurement calibration proceed as follows:

Measurement calibration CAN NOT be done at CO_2 concentrations of less than 10% of full scale.

1. Ensure that the detector has stabilized at its normal operating temperature.
2. Establish an accurately known CO_2 concentration between 10% and 100% of full scale at the detector.
3. Note whether the shorting block on jumper JP5 covers both pins or only a single pin. Remove the shorting block and use it to connect the two pins marked 'JP2' on the control board.
4. Use the 'UP' and 'DOWN' buttons to alter the measured CO_2 concentration as indicated by the digital readout or the analog output until it corresponds to the known CO_2 concentration
   A. Because of internal averaging, there will be a several second lag before changes caused by pressing the 'UP' or 'DOWN' buttons are reflected in the display or analog output value.
   B. for changes of more than a few tenths of a percent, hold the appropriate button down until the output is close to the desired value, then make the final adjustment after the output settles.
5. Remove the shorting block from JP2 and replace it in its original position in jumper JP5. The new calibration value is saved in the internal EEPROM.
   A. When jumper JP2 is opened, the output will be erratic for several seconds before returning to the calibrated value.

ANALOG OUTPUT SCALING CORRECTION

The analog voltage or current output generated by the Model 302 in response to the detected CO2 concentration can be adjusted to match the input characteristics of the indicating device. Both the gain and offset of the analog output can be adjusted with the following procedures.

Analog Output Zero Adjustment Check

This adjustment does not calibrate the accuracy of the CO_2 concentration measurement.

This procedure is used to check that the Model 302's analog output (either current or voltage) makes the indicating circuit to which it is connected register correctly at the low end of the scale. This check can be made regardless of the CO_2 concentration at the detector.

To adjust the analog output zero calibration proceed as follows.

1) Connect a volt or current meter to the output terminals.
2) Use a shorting block to connect the two pins of jumper JP4. If installed, the display will read 005.

3) Use the 'UP' and 'DOWN' buttons to adjust the output as shown in the table below.

Output	Zero Cal. Value
4 - 20 mA	4.080mA
0 - 1 Volts	0.005 Volts

4) Remove the shorting block from jumper JP4.

Analog Output Span Adjustment Check

This adjustment does not calibrate the accuracy of the CO_2 concentration measurement.

The analog output span adjusts the amount of change in the analog output signal for a given change in measured CO_2 concentration. It is used only to adjust the gain of the analog output signal to match the input characteristic of the indicating circuit it drives. The span check can be done regardless of the actual concentration at the detector.

To adjust the analog output span proceed as follows.

1) Be sure that jumpers JP4 and JP5 are open
2) Close jumper JP5 with a screwdriver. While JP5 is closed use a shorting block to connect the two pins of jumper JP4. Jumper JP5 can be opened after JP4 is closed. If installed, the display will read 950.
3) Use the 'UP' and 'DOWN' buttons to adjust the output as shown in the table below.

Output	Span Cal. Value
4 - 20 mA	19.20 mA
0 - 10Volts	0.950 Volts

4) Remove the shorting block from jumper JP5

Limited Warranty and Remedies.

DCS warrants to Buyer of the Model 302 that for 2 years from the date of shipment of Products to the Buyer that Products will substantially conform with the product specifications agreed to by DCS. This warranty is not transferable.

This warranty does not cover:

- Defects due to misuse, abuse, or improper or inadequate care, service or repair of Products;
- Defects due to modification of Products, or due to alteration or repair by anyone other than DCS; or
- Problems that arise from lack of compatibility between DCS' Products and other components used with those Products or the design of the product into which Products are incorporated. Buyer is solely responsible for determining whether Products are appropriate for Buyer's purpose, and for ensuring that any product into which Products are incorporated, other components used with DCS' Products, and the purposes for which DCS' Products are used are appropriate and compatible with those Products.

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To obtain service under this warranty, unless DCS agrees otherwise, Buyer must obtain a returned material authorization (RMA) number from the factory, pack any nonconforming Product carefully, and ship it, postpaid or freight prepaid, to the address provided when the RMA number is issued. Buyer must include a brief description of the nonconformity. Any actions for breach of this warranty must be brought within six months of the expiration of this warranty.

If DCS determines that a returned Product does not conform to the warranty in this section, it will either repair or replace that Product, at DCS' discretion, and will ship the Product back to Buyer free of charge. At DCS' option, DCS may choose to refund to Buyer the purchase price for a nonconforming Product instead of repairing or replacing it.

Units returned for service under this warranty and determined on examination to be operating properly are subject to a service charge.