

# **MODEL 301A**

**Microprocessor Based, Infra-red  
Environmental CO<sub>2</sub> Concentration Sensor**

## **OPERATOR'S MANUAL**

(5000ppm Full Scale w/ Spline Software)

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## Revision History

| <b>Date</b> | <b>Comments</b>            |
|-------------|----------------------------|
| 12/1/01     | incorporate 5Kppm addendum |

# MODEL 301A OPERATORS MANUAL

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# MODEL 301A OPERATORS MANUAL

## Introduction

The Model 301A is a non-dispersive infra-red analyzer designed for measuring environmental CO<sub>2</sub> concentration in ventilation systems and indoor living spaces. Its measurement range of 0 - 2000 ppm (parts per million; 1000 ppm = 0.1%) covers the range required to monitor compliance with ASHRAE or other ventilation efficiency standards.

Packaged in a compact distinctively styled enclosure, the Model 301A can be discretely installed anywhere from the board room to the boiler room. Standard center wiring access, foolproof power hookup and fully floating outputs make installation a snap.

The Model 301A provides several output alternatives. A Voltage or 4 - 20 mA current output to transmit CO<sub>2</sub> levels to control systems is standard. An optional LED readout is available to display the concentration at the unit. An optional relay output is available that can be configured to open or close above a user adjustable setpoint.

A simple one point calibration procedure and a built-in calibration port (requiring no special fittings or adapters) makes the Model 301A quick and easy to maintain. No computer and only a single cal gas is required.

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## Specifications

|   |  |                   |
|---|--|-------------------|
| Operating Principle                     | Non-dispersive infrared (NDIR)                   |                   |
| Gas sampling method                     | Diffusion or sample draw                         |                   |
| Measurement Range                       | 0 - 5000 ppm CO <sub>2</sub>                     |                   |
| Maximum drift (per year)                | ±150 ppm   |                   |
| Accuracy                                | ±5% of reading or ±175 ppm, whichever is greater |                   |
| Repeatability                           | ±20 ppm  |                   |
| Recommended Calibration Interval        | One Year   |                   |
| Response time                           | Less than 1 minute                               |                   |
| Operating temperature range             | 0 to 50 ° C                                      |                   |
| Operating humidity range                | 0 - 99% RH (non condensing)                      |                   |
| Storage temperature                     | -30 to + 70 ° C                                  |                   |
| Power requirements                      | 20 - 30 V <sub>RMS</sub> AC, 18 - 30 VDC         |                   |
| Power consumption                       | Less than 2.5 W @ 24 VAC                         |                   |
| Calibration adjustments                 | Span only (offset electronically nulled)         |                   |
| Calibration verification procedure time | 10 minutes typical                               |                   |
| Dimensions                              | 4.9" x 2.6" x 1.9"                               |                   |
| Voltage output (linear)                 | 0 - 10 VDC standard                              |                   |
| Current output (linear)                 | 4 - 20 mA  |                   |
| Warm up time                            | 5 minutes  |                   |
| Weight                                  | 12 Oz. (.35 Kg)                                  |                   |
| Optional Digital Display                | 4 digit, .3" LED                                 |                   |
| Optional                                | setpoint range                                   | 0 to 5000 ppm     |
| High Limit                              | contact polarity                                 | jumper selectable |
| Contact                                 | contact rating                                   | 2A @ 24 VAC       |
| Operating life expectancy               | 10 years typical                                 |                   |

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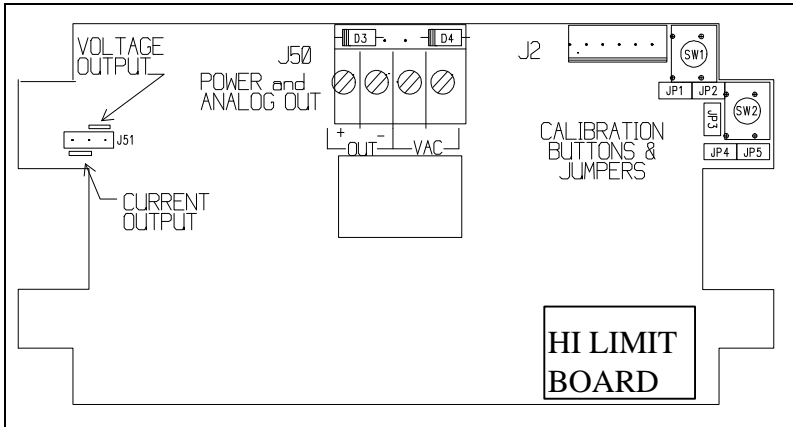
## Installation

This section contains the information and procedures to install the Model 301A and verify its performance.

### Cover Removal

To open the Model 301A insert a coin in the slot on the right hand side to snap open one side. Grasp the front cover and pull firmly away from the base plate to release the snaps at the corners, then lift it from the base plate.

The locations of controls and terminals on the main circuit board are shown in the part location figure on page 3.

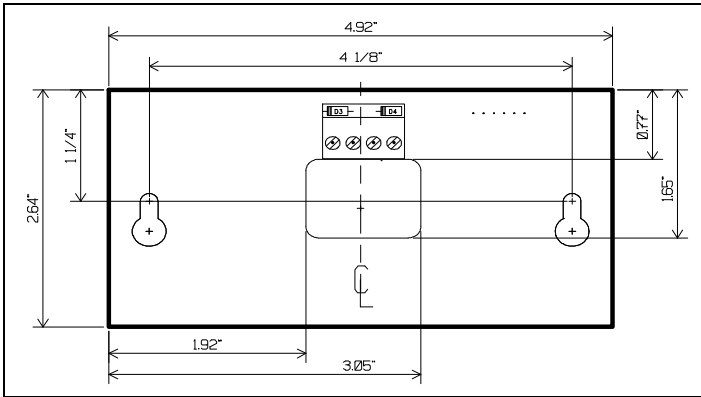


**Model 301A Circuit Board Part Locations**

### Mounting

The Model 301A is designed for flush mounting to a flat surface with two fasteners. The locations of the mounting points are shown in the mounting dimensions figure on page 4. There is a wiring cut-out in the center of the unit near the terminal strip. An optional mounting plate is available for use with a standard simplex (single circuit) junction box.

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**Model 301A Mounting Dimensions**

## Wiring

This section describes the external connections to the Model 301A. Wiring enters the chassis through the cutout in the center of the unit under the four position terminal block. The connections are summarized in the table on page 6, and discussed in more detail in the sections that follow.

## **Power Supply**

The Model 301A will operate from an AC input voltage between 20 and 30 volts RMS or DC voltage input from 18 to 30 VDC. The power supply leads are connected to the two 'Vac' terminals of J50. The polarity of the leads is irrelevant.

## **CAUTION**

Connecting the power supply voltage to the signal output terminals(OUT+, OUT-) will damage the unit and void the warranty!

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## **Signal Output**

The Model 301A provides either a voltage or a 4 - 20 mA output. The output present at the 'OUT +' and 'OUT -' positions of the terminal strip J50 is selected with jumper J51.

The analog output of the Model 301A is completely isolated from the power supply. The common outputs of multiple units can be connected together with no interaction regardless of power supply hook-up.

## Selecting Current or Voltage Output

The type of analog output present at the 'OUT +' and 'OUT -' contacts of the terminal strip J50 is determined by which positions of jumper J51 are connected as shown in the parts location figure on page 3. The default factory setting is for voltage output.

## Voltage

The voltage output appears between the 'OUT +' and 'OUT -' terminals of the terminal strip J50. 'OUT +' is the positive terminal. The output voltage increases linearly from 0 volts at 0 ppm to full scale voltage at 2000 ppm. The standard output voltage range is 0 to 10 volts.

## 4 - 20 mA

The current flows out of the 'OUT +' terminal and into the 'OUT -' terminal. The current ranges from 4 mA at 0 ppm to 20 mA at full scale. The maximum loop resistance is 500 Ohms.

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| Cnctr Number | Contact Designator | Signal Description  |
|--------------|--------------------|---|
| J2           | DISPLAY            | The optional digital LED display is connected here.   |
| J50          | VAC                | AC or DC operating power inputs<br>polarity is irrelevant   |
|              | VAC                |   |
|              | OUT -              | Minus side of output voltage (if J51 is set for voltage output) or current return terminal (if J51 is set for 4-20 mA output).    |
|              | OUT +              | Positive side of output voltage (if J51 is set for voltage output) or current source terminal (if J51 is set for 4-20 mA output). |

## Model 301A Connector Summary

### Verifying Voltage Or Current Output Connection

After the voltage or current output of the Model 301A is connected to a controller or indicator, the following check should be performed to ensure that the connection has been properly established and is transmitting the correct values. (Note that this is a test mode; gas concentration in the cell is not being measured while jumper JP4 is closed.)

1. Note whether the shorting block at jumper JP5 is covering both pins or only a single pin, then borrow the shorting block and slide it over the two pins of jumper JP4 (see part location figure on page 3). With jumper JP5 closed, momentarily close jumper JP4 using a screwdriver or similar tool.
2. The Model 301A sets its output to 95% of full scale. The receiving device should be responding accordingly.  
If the receiving device shows no change after completing step 1 above, verify that the wiring is correct.
3. Remove the shorting block from JP4 and restore it to its original position at jumper JP5. The Model 301A output now corresponds to the actual detected CO<sub>2</sub> concentration.

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## Altitude Correction

The Model 301A is factory calibrated for operation at sea level. When operated at higher elevations, the calibration must be adjusted by the amount shown in the altitude correction table below.

### **Altitude Correction Procedure**

To adjust the calibration of a unit currently calibrated for sea level operation to a new altitude proceed as follows.

1. Let the Model 301A stabilize to the ambient CO<sub>2</sub> concentration, and record the reading in ppm.
2. Multiply the reading by the scale factor corresponding to the operating altitude in the altitude correction table.

For instance if the unit is operating at an altitude of 4000 ft, the scale factor from the table is 1.14. If the concentration reads 420 ppm, multiply 420 times 1.14 giving 478 ppm. Adjust the display to read 480 using the calibration buttons SW1 and SW2.

3. Note whether the shorting block at jumper JP5 is covering both pins or only a single pin, then borrow the shorting block and slide it over the two pins of jumper JP2 (see part location figure on page 3).

Use the calibration buttons (SW1 & SW2) to change the concentration to the value just calculated.

Because of internal averaging, the response to these buttons is delayed. Be sure to wait at least 15 seconds after the last button press to make sure the display value is stable before proceeding to the next step.

4. Remove the shorting block from jumper JP2 and return it to its previous position over one or both pins of jumper JP5.

| <b>ALTITUDE CORRECTION TABLE</b> |                              |
|----------------------------------|------------------------------|
| <b>Altitude [feet]</b>           | <b>Multiplication Factor</b> |
| 0                                | 1.0                          |
| 500                              | 1.02                         |
| 1000                             | 1.03                         |
| 1500                             | 1.05                         |
| 2000                             | 1.07                         |
| 2500                             | 1.08                         |
| 3000                             | 1.10                         |
| 3500                             | 1.12                         |
| 4000                             | 1.14                         |
| 4500                             | 1.16                         |
| 5000                             | 1.18                         |

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## **Calibration Verification Procedure**

A quick but approximate calibration verification can be done by supplying the unit with outside air and letting the reading stabilize. CO<sub>2</sub> concentrations in outside air are typically between 350 and 450 ppm.

A more accurate calibration check requires the use of calibration gas of known concentration.

## **Cover Replacement**

Orient the cover so that the louvers are to the left and slide the cover evenly over the electronics so that the four retainers at the corners engage their receptacles in the base plate. After all four retainers are engaged, press the cover down firmly to lock the retainers.

## **Operation**

This section describes the operation of the standard features common to all versions of the Model 301A, as well as the optional features that are not implemented unless specifically ordered.

### **Normal Operation**

The Model 301A measures the volumetric concentration of carbon dioxide (CO<sub>2</sub>) in the air and reports the result in parts per million (ppm). 10,000 ppm is equal to 1%.

Measurement results are updated approximately every second. Primary measurement output is either a voltage or current analog signal.

The Model 301A is operational whenever appropriate power is applied to the two contacts marked 'VAC' on J50. There is no power switch on the unit.

The Model 301A is designed for use as a sensing component in a control or measurement system which provides the Model 301A's operating power.

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## **Power On Response**

When first powered the Model 301A will immediately generate a full scale analog output. If present, the optional display will briefly show the firmware revision number and then read 'HI'

As the unit warms-up the display (if present) and the analog output will slowly drop to the actual reading. This process takes several minutes depending on ambient temperature.

## **RF Susceptibility**

Because of the sensitive nature of the Model 301A's measurement system, the detected concentration may change in the presence of strong electromagnetic interference. If this happens, the concentration reading will return to the correct value when the interference becomes less severe.

## **Optional Features**

This section describes the operation of the Model 301A's optional features. These features are not supplied with the Model 301A unless explicitly ordered.

## **High CO<sub>2</sub> Limit Option**

The high limit option consists of a small circuit board located above the main board to the right of the sensor assembly. The contact terminals are on this board.

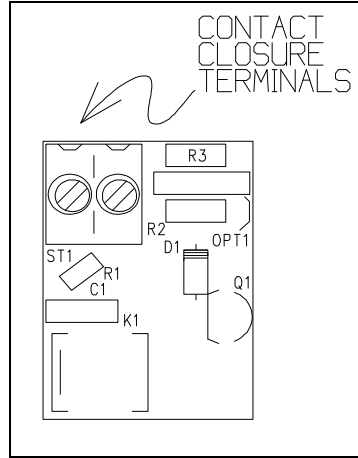
The high CO<sub>2</sub> limit option provides a 24 volt contact closure that activates when the detected concentration rises above the preset limit. The high limit setpoint can be varied over the full range of the sensor. The polarity of the contact (i.e. normally open or normally closed) is controlled by the setting of jumper JP5

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The setpoint hysteresis is approximately 50 ppm. Relay contacts are rated at 2A/24V.

## Adjusting Setpoint

The high limit setpoint is factory preset to 1000. The set point is adjusted by closing jumper JP3 and using the calibration buttons (SW1 & SW2) to select the desired set point. If the optional display is installed, the setpoint value is displayed while jumper JP3 is closed. If the display is not present the analog output will indicate the set point while jumper JP3 is closed.



**High Limit Option Board**

## High Limit Contact Polarity

Jumper JP5 sets the alarm state of the relay as shown in the table below.

| <b>JP5 State</b> | <b>Relay Contact is CLOSED</b> |
|------------------|--------------------------------|
| OPEN             | <b>below</b> setpoint          |
| CLOSED           | <b>above</b> setpoint          |

The Model 301A ships from the factory with a shorting block closing jumper JP5. For normally closed operation remove the shorting block from both pins of JP5 and store it by placing it over only a single pin on JP5. The shorting block should not be discarded: it is required during the calibration procedure.

## **LED Display**

An optional 4 digit LED display assembly can be factory installed. Units equipped with this option have a display window in the cover.

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The optional display shows the measured CO<sub>2</sub> concentration in ppm (parts per million).

## **Calibration**

This section describes the calibration verification procedure and calibration adjustment procedures.

### **Quick Verification Procedure**

A quick but approximate calibration verification can be done by supplying the unit with outside air and letting the reading stabilize. CO<sub>2</sub> concentrations in outside air are typically between 350 and 450 ppm.

### **Full Verification and Adjustment**

A more accurate calibration check requires the use of calibration gas of known concentration. A calibration kit is available from the factory. To verify the Model 301A's calibration proceed as follows:

1. Remove the front cover of the unit (see procedure on page 3).
2. Note whether the shorting block at jumper JP5 is covering both pins or only a single pin; the shorting block must be returned to the same position at the end of this procedure. Remove the shorting block and slide it over both pins of jumper JP2 (see part location figure on page 3).
3. If the display option is present, calibrate the display reading, not the analog output.

If the display option is not present connect an appropriate meter:

If the analog output jumper (see page 5) is set for voltage connect a volt meter to the 'OUT +' and 'OUT -' terminals.

If the analog output jumper is set for current, connect a milliamp meter in series with the lead at the 'OUT +' terminal.

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4. Remove the dust cover from the calibration nipple, attach a flexible tube and establish a flow of between 50 and 100 cc/min of calibration gas through the sensor. Allow about a minute for the reading to stabilize.
5. If the reading differs by more than  $\pm 75$  ppm from the known concentration of the calibration gas, use calibration buttons (see parts location drawing on page 3) to adjust the reading.  
Because of internal averaging the response to the 'UP' and 'DOWN' buttons is not immediate. Allow several seconds for the display to catch up after making an adjustment
6. When the reading on the display or meter agrees with the concentration of the calibration gas, remove the shorting block on jumper JP2, and replace in its original position at jumper JP5.
7. Turn off the calibration gas flow, disconnect the gas tubing from the calibration nipple and replace its dust cover. Remove the meter leads from the terminal strip and replace the front cover (see procedure on page 8).

### **Analog Calibration Procedure**

Analog calibration procedure changed with firmware version SPL\_V003.

#### **Calibrating Offset**

- 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 optional display will read 005.

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

| <b>Output</b> | <b>Offset Cal. Value</b> |
|---------------|--------------------------|
| 4 - 20 mA     | 4.080mA                  |
| 0 - 10 Volts  | 0.050 Volts              |

### Calibrating Span

- 1) Ensure that there is no shorting block on jumper JP4.  
Momentarily close jumper JP5 while placing the shorting block on jumper JP4  
If installed, the optional display will read 950.
- 2) Use the 'UP' and 'DOWN' buttons to adjust the output as shown in the table below.

| <b>Output</b> | <b>Span Cal. Value</b> |
|---------------|------------------------|
| 4 - 20 mA     | 19.20 mA               |
| 0 - 10 Volts  | 9.50 Volts             |

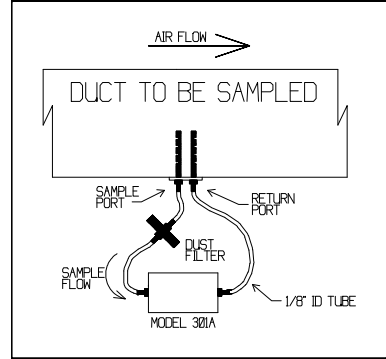
- 3) Remove the shorting block from JP4

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## Duct Sampling Option

The duct sampling option is used to divert a portion of the duct airflow through the model 301A. The difference between the total pressure at the upstream sample port and the static pressure at the downstream return port propels the sample stream. Minimum recommended flow rate is 200 feet per minute.

A Model 301A with the duct sample option has a sample draw adapter fitted to the bottom of its enclosure. The duct probe assembly is connected to tubing nipples on the adapter.



**Duct Sampling Schematic**

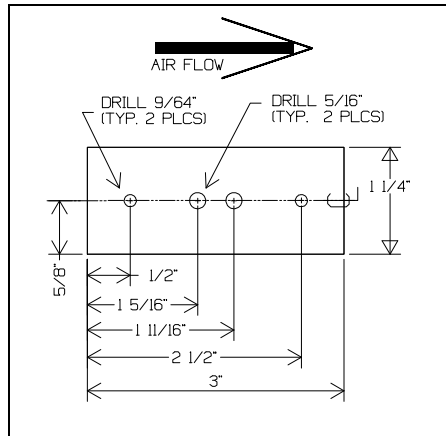
### Duct Kit Contents

- 1 dust filter
- 1 gasket
- 2 lengths of 1/8" ID tubing

- 1 duct probe assembly
- 2 sheet metal screws

### Duct Kit Installation

- 1) Select a point along the duct where the probe assembly can be installed into unrestricted airflow without interfering with any internal duct components such as dampers, radiators, etc.
- 2) Mark and drill the four holes for the duct probe as shown in the drawing to the right. The centerline must be parallel to the air



**Duct Probe Installation Dimensions**

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flow through the duct.

- 3) Position the gasket on the inside of the cover plate and install the duct probe assembly through the holes just drilled. Secure in place with the two sheet metal screws.
- 4) Connect the inlet side of the dust filter to the upstream tube of the duct probe assembly using a piece of the supplied tubing.
- 5) Connect the outlet side of the dust filter to either of the tube barbs on the side of the Model 301A with a length of the supplied tubing.
- 6) Connect the downstream tube of the duct probe assembly to the other sample port of the Model 301A with a length of the supplied tubing.

**Limited Warranty And Remedies.**

DCS warrants to Buyer that for two 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.

**The warranty in this section is in lieu of all other warranties, express or implied. DCS expressly disclaims all implied warranties, including the warranties of merchantability and fitness for a particular purpose. DCS is not responsible in any way for damage to a product, property damage or physical injury resulting in whole or in part from (1) improper or careless use, (2) unauthorized modifications, or (3) other causes beyond DCS' control. In no event is DCS liable to the buyer or any other person for cost of procurement of substitute goods, loss of profits, or for any other special, incidental or consequential damages.**

To obtain service under this warranty, unless DCS agrees otherwise, Buyer must obtain preauthorization from the factory in the form of a return merchandise authorization (RMA) number. Buyer must supply DCS with a brief description of the nonconformity before an RMA number will be issued.

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Nonconforming Product must be packed carefully and shipped, postpaid or freight prepaid, to DCS at its then current place of business before the expiration of the warranty period. Any actions for breach of this warranty must be brought within one year 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.

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