

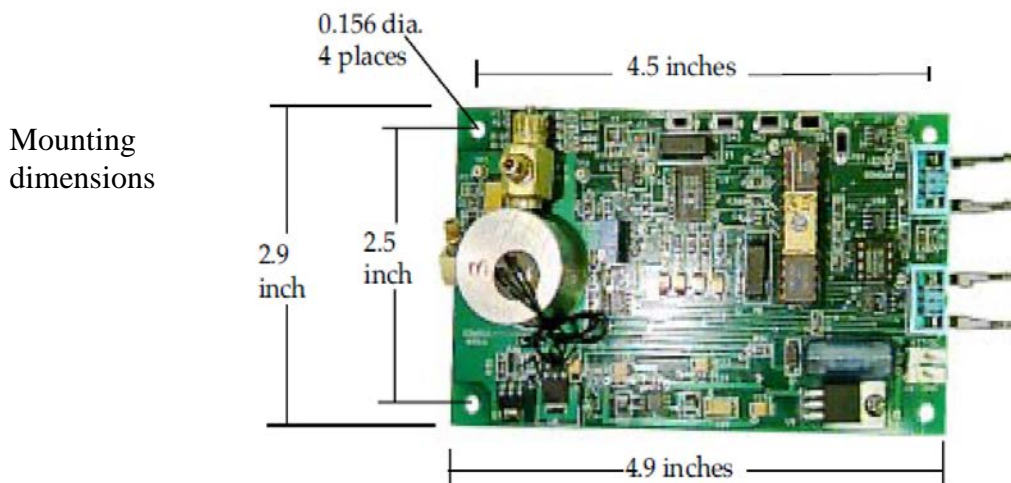
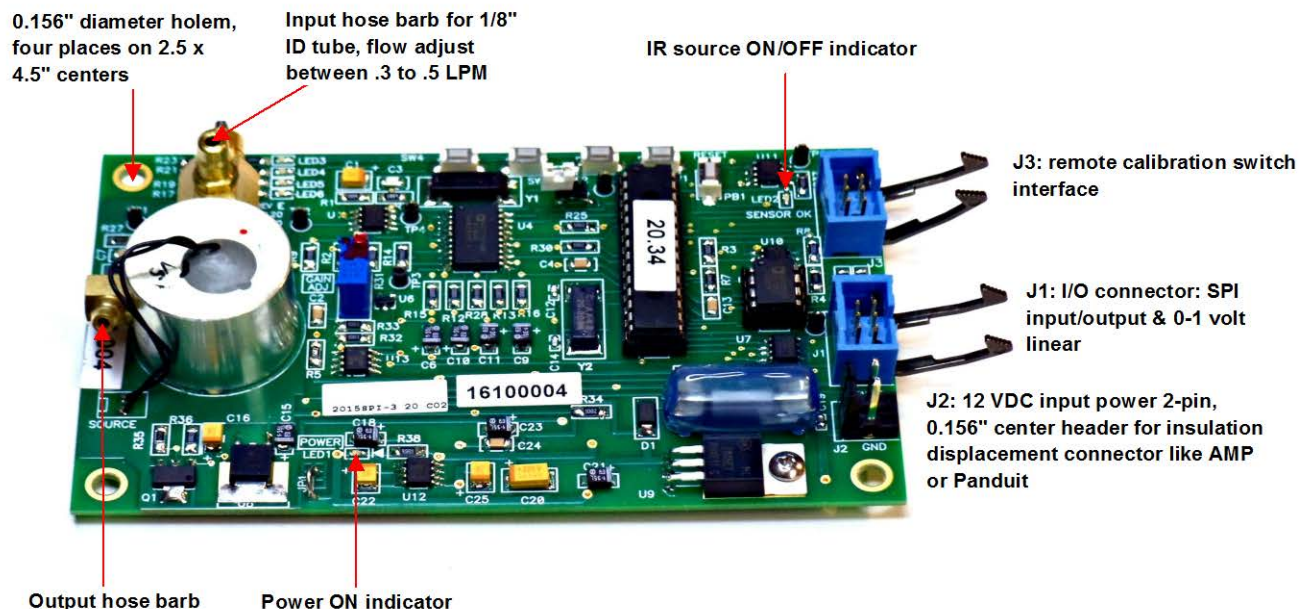


OEM Digital NDIR CO₂ sensor with flow-through gas cell Model 2015SPI-3

The **VALTRONICS** Model 2015SPI-3 is an OEM NDIR CO₂ sensor with digital signal processing and temperature compensation. The firmware VERSION depends upon the specific customer interface requirements. The SPI (Serial Peripheral Interface) is described on pages 2 and 3. Each serial numbered sensor is individually gas calibrated and temperature compensated at the factory. An RS-232 Test Board (which can be connected to a USB port, via an adapter) is needed for field gas calibration & diagnostics (See [Application Note A66](#)). It has on-board & remote switches for calibration. RANGE setting from 3% up to 20% defines 0-1 volt output (see page 4).

Model 2015SPI-3 Specifications:

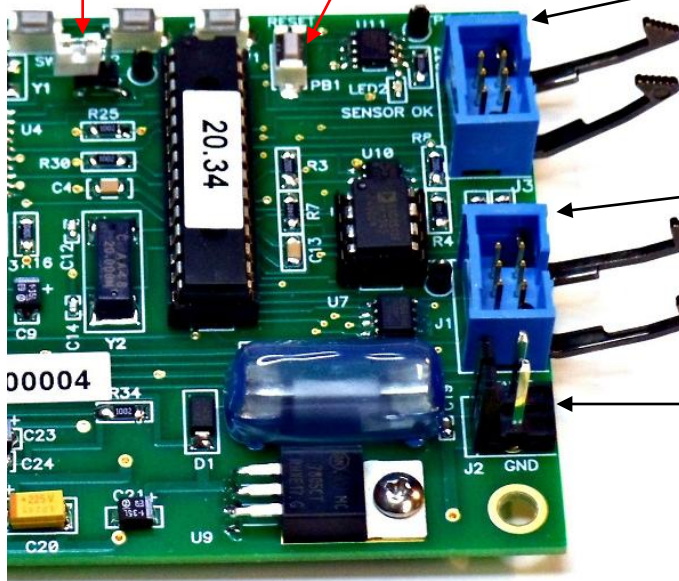
| | |
|-----------------------------------|---|
| Method: | NDIR with Digital Signal Processing and Temperature Compensation |
| Gas: | Carbon Dioxide (CO ₂) |
| Full-scale and RANGE: | 0-20% CO ₂ RANGE user-selectable from 3% to 20%, see page 4 |
| Input Power: | +12 VDC (@ 0.250 amp max, 0.135 amp typical, 16.0 volts max, 8.0 volts min |
| Accuracy: | ±0.25% CO ₂ from 0 to 5.90% CO ₂ , and 5% of reading from 6% to 20% CO ₂ |
| | 16-bit analog to digital converter: Delta-Sigma Conversion Method |
| Resolution / Repeatability: | ±0.05% CO ₂ (challenge with same sample gas multiple times & assure zero) |
| Stability: | Less than 0.05% CO ₂ in any 20-second period of time |
| Warm-up Time: | Less than 3 minutes for use and 5 minutes for accuracy |
| Output Signal: | Digital SPI (Serial Peripheral Interface), Application notes A59 and A61 |
| | Linear 0 to 1 volt output signal, 12-bit resolution. See pages 3 & 4 |
| RS232 Test Board: | For troubleshooting & gas calibration, see Application note A66 |
| LED Indicators: | IR Source ON/OFF Indicator, Power ON Indicator, Cal Switch Indicators |
| Input Signal: | Digital SPI input for calibration & diagnostic modes. See Application Note A59 |
| Calibration Switches: | SW1 (Zero), SW2 (Span Target (STAR)), SW3 (Span), SW4 (Range adj.), remote via J3 |
| Operating Temperature Range: | 0 to 50°C (32° to 122°F), see Application Note A12 |
| Ambient Relative Humidity: ... | 0 to 95% RH non-condensing: see Application note A30 |
| Storage Temperature Range: ... | -40 to +70°C (-40 to 158°F) |
| Weight: | Less than .25 pound (<.011 kilogram) |
| External Dimensions (PCB): ... | 4.9" x 2.9" x 1.5". See page 2 for mounting |



See Application Note A67 for gas conditioning requirements and information about gas sample pumps and filters. A Hydrophobic filter (App Note A79) in front of the inlet hose barb is required to prevent particles & droplets from entering the gas cell. Try to minimize the backpressure inside the gas cell.

Master/Slave jumper J2

Reset Switch



J3 - cal switches, pin-out

- +5V 6● ●5 STAR
- SPAN 4● ●3 ZERO
- RANGE 2● ●1 Ground

J1 - Input/Output, pin-out

- SDO 6● ●5 SDI
- SCK 4● ●3 DATA ENAB
- 0-1V 2● ●1 Ground

J2 12 VDC Input Power, pin-out

1. + 12V
2. (-) 12 V Return

See Application Note A75 for J1, J2 & J3 mating connector part numbers. Keep J1 interface cable shorter than 18". See Application Note A61 for 16-bit serial digital output timing diagram.

Gas calibration may be initiated via a command from the SPI input on J1 (see Application Note A59) or from the on-board or remote switches via J3 (Logic "0" to initiate).

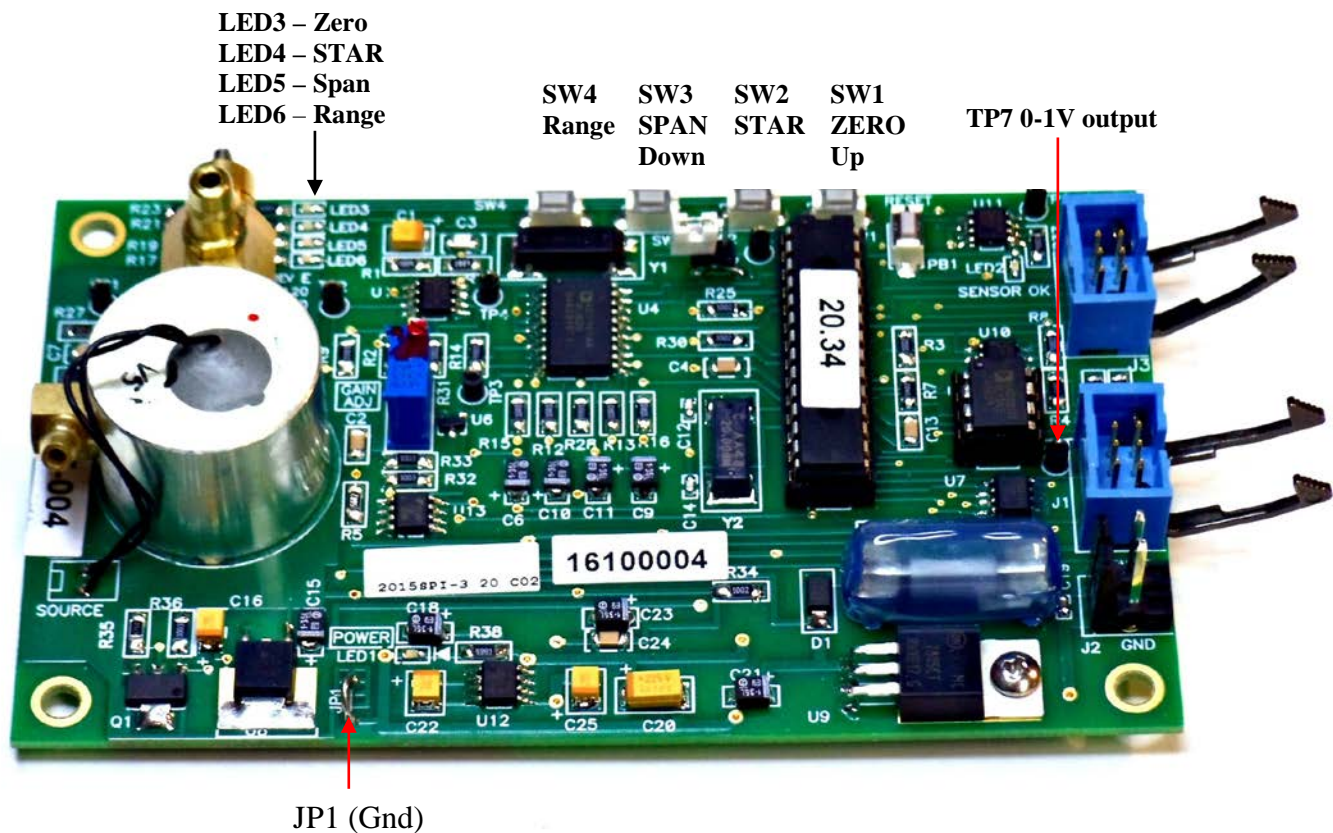
For the locations of the on-board switches, test points and LEDs 3 - 6, refer to the illustration on the next page.

ZERO (SW1 or remote J3-3): With nitrogen flowing in gas calibration tube press and hold SW1 for 2 seconds. LED 3 through 6 will flash on & off together. If they flash on/off sequentially the sensor has detected an error and the RESET button must be pressed. Wait 1 minute and continue where you left off. The 0 to 1 volt output should snap to 0.0 ±0.01 volt measured with a DVM "+" lead connected to TP7 and "-" lead connected to GND test point. LED 3 will be ON to indicate a ZERO calibration.

RANGE (SW4 or remote J3-2): To set the full scale or range press and hold SW4. From the chart on page 5 find the voltage value that corresponds to the full scale that you want from 3 to 20%. LED 6 will be ON. Use SW1 as an UP and SW3 as a DOWN switch to adjust this value (examples: 20% = 1.00 v, 10% = 0.50 v, 3% = 0.15 v).

STAR (SW2 or remote J3-5): To set the Span Target (calibration gas value) press and hold SW2. LED 4 will be ON. Use SW1 as an UP and SW3 as a DOWN switch to adjust this value read on the DVM. See chart on page 5.

SPAN (SW3 or remote J3-4): To SPAN calibrate while flowing certified span gas (like 5.0 ±0.01% CO²) in gas calibration tube for at least 30 seconds at about 300 ml/min. Press & hold SW3 for 2 seconds. LED 5 will be ON. The DVM voltage should snap to the STAR value entered above & LED 3 through 6 will flash on & off together.



On the next page is a table that shows the 0 to 1 volt output equivalent to any Full Scale **RANGE** or Span **TARGET (STAR)** anywhere from 3 to 20% CO₂. Version 20.34 or later allows a **STAR** to be as low as **1.00%** CO₂. The ideal Span **TARGET** gas for best accuracy is near mid-scale, like **10.0 ±0.2%** certified CO₂, or near your typical measurement point. A typical application would be a full-scale **RANGE** of **20.0** and a **STAR** of **5.00**. If the serial digital output is used (see App Note A61) the **RANGE** value does not affect it. The serial digital output has a 16-bit resolution over the whole 0 to 20% scale.

The Full-Scale **RANGE** will set **what % CO₂** will give an output of **1.00 volt**.

A Range of 3.0 will give a 0-1V output of **0.500** volt for a gas reading of **1.5%** CO₂.

A Range of 5.0 will give a 0-1V output of **0.500** volt for a gas reading of **2.5%** CO₂.

A Range of 20.0 will give a 0-1V output of **0.250** volt for a gas reading of **5.0%** CO₂.

In other words, the 0-1V output is a decimal representation of the percent of full scale: for a Range of 20.0, 5.0% gas is ¼ or 25% of the full-scale (5 divided by 20), which is a decimal value of .25, which would be .250 volt. 10% gas is ½ or 50% of the full-scale, which is a decimal value of .5, which would be .500 volt.

Please remember that **calibration** using the **RS-232 Test Board** will give the user much better visibility as to what **RANGE** and what **STAR** value is selected¹. **Version 20.34** or later allows a **STAR** to be as low as **1.00%** CO₂.

¹ Most computers nowadays do not have an RS-232 port, so a RS-232 to USB adapter would be needed.



Model 2015SPI-3

Table used for **Calibration** for setting the Full-Scale & the Span **TAR**get value, **STAR** (certified tank %).

| Range/STAR | 0 to 1V | Range/STAR | 0 to 1V | Range/STAR | 0 to 1V | Range/STAR | 0 to 1V |
|------------|---------|------------|---------|------------|---------|------------|---------|
| % gas | Ouput | % gas | Ouput | % gas | Ouput | % gas | Ouput |
| 20.0 | 1.000 | 15.0 | 0.750 | 10.0 | 0.500 | 5.0 | 0.250 |
| 19.9 | 0.995 | 14.9 | 0.745 | 9.9 | 0.495 | 4.9 | 0.245 |
| 19.8 | 0.990 | 14.8 | 0.740 | 9.8 | 0.490 | 4.8 | 0.240 |
| 19.7 | 0.985 | 14.7 | 0.735 | 9.7 | 0.485 | 4.7 | 0.235 |
| 19.6 | 0.980 | 14.6 | 0.730 | 9.6 | 0.480 | 4.6 | 0.230 |
| 19.5 | 0.975 | 14.5 | 0.725 | 9.5 | 0.475 | 4.5 | 0.225 |
| 19.4 | 0.970 | 14.4 | 0.720 | 9.4 | 0.470 | 4.4 | 0.220 |
| 19.3 | 0.965 | 14.3 | 0.715 | 9.3 | 0.465 | 4.3 | 0.215 |
| 19.2 | 0.960 | 14.2 | 0.710 | 9.2 | 0.460 | 4.2 | 0.210 |
| 19.1 | 0.955 | 14.1 | 0.705 | 9.1 | 0.455 | 4.1 | 0.205 |
| 19.0 | 0.950 | 14.0 | 0.700 | 9.0 | 0.450 | 4.0 | 0.200 |
| 18.9 | 0.945 | 13.9 | 0.695 | 8.9 | 0.445 | 3.9 | 0.195 |
| 18.8 | 0.940 | 13.8 | 0.690 | 8.8 | 0.440 | 3.8 | 0.190 |
| 18.7 | 0.935 | 13.7 | 0.685 | 8.7 | 0.435 | 3.7 | 0.185 |
| 18.6 | 0.930 | 13.6 | 0.680 | 8.6 | 0.430 | 3.6 | 0.180 |
| 18.5 | 0.925 | 13.5 | 0.675 | 8.5 | 0.425 | 3.5 | 0.175 |
| 18.4 | 0.920 | 13.4 | 0.670 | 8.4 | 0.420 | 3.4 | 0.170 |
| 18.3 | 0.915 | 13.3 | 0.665 | 8.3 | 0.415 | 3.3 | 0.165 |
| 18.2 | 0.910 | 13.2 | 0.660 | 8.2 | 0.410 | 3.2 | 0.160 |
| 18.1 | 0.905 | 13.1 | 0.655 | 8.1 | 0.405 | 3.1 | 0.155 |
| 18.0 | 0.900 | 13.0 | 0.650 | 8.0 | 0.400 | 3.0 | 0.150 |
| 17.9 | 0.895 | 12.9 | 0.645 | 7.9 | 0.395 | 2.9 | 0.145 |
| 17.8 | 0.890 | 12.8 | 0.640 | 7.8 | 0.390 | 2.8 | 0.140 |
| 17.7 | 0.885 | 12.7 | 0.635 | 7.7 | 0.385 | 2.7 | 0.135 |
| 17.6 | 0.880 | 12.6 | 0.630 | 7.6 | 0.380 | 2.6 | 0.130 |
| 17.5 | 0.875 | 12.5 | 0.625 | 7.5 | 0.375 | 2.5 | 0.125 |
| 17.4 | 0.870 | 12.4 | 0.620 | 7.4 | 0.370 | 2.4 | 0.120 |
| 17.3 | 0.865 | 12.3 | 0.615 | 7.3 | 0.365 | 2.3 | 0.115 |
| 17.2 | 0.860 | 12.2 | 0.610 | 7.2 | 0.360 | 2.2 | 0.110 |
| 17.1 | 0.855 | 12.1 | 0.605 | 7.1 | 0.355 | 2.1 | 0.105 |
| 17.0 | 0.850 | 12.0 | 0.600 | 7.0 | 0.350 | 2.0 | 0.100 |
| 16.9 | 0.845 | 11.9 | 0.595 | 6.9 | 0.345 | 1.9 | 0.095 |
| 16.8 | 0.840 | 11.8 | 0.590 | 6.8 | 0.340 | 1.8 | 0.090 |
| 16.7 | 0.835 | 11.7 | 0.585 | 6.7 | 0.335 | 1.7 | 0.085 |
| 16.6 | 0.830 | 11.6 | 0.580 | 6.6 | 0.330 | 1.6 | 0.080 |
| 16.5 | 0.825 | 11.5 | 0.575 | 6.5 | 0.325 | 1.5 | 0.075 |
| 16.4 | 0.820 | 11.4 | 0.570 | 6.4 | 0.320 | 1.4 | 0.070 |
| 16.3 | 0.815 | 11.3 | 0.565 | 6.3 | 0.315 | 1.3 | 0.065 |
| 16.2 | 0.810 | 11.2 | 0.560 | 6.2 | 0.310 | 1.2 | 0.060 |
| 16.1 | 0.805 | 11.1 | 0.555 | 6.1 | 0.305 | 1.1 | 0.055 |
| 16.0 | 0.800 | 11.0 | 0.550 | 6.0 | 0.300 | 1.0 | 0.050 |
| 15.9 | 0.795 | 10.9 | 0.545 | 5.9 | 0.295 | 0.9 | 0.045 |
| 15.8 | 0.790 | 10.8 | 0.540 | 5.8 | 0.290 | 0.8 | 0.040 |
| 15.7 | 0.785 | 10.7 | 0.535 | 5.7 | 0.285 | 0.7 | 0.035 |
| 15.6 | 0.780 | 10.6 | 0.530 | 5.6 | 0.280 | 0.6 | 0.030 |
| 15.5 | 0.775 | 10.5 | 0.525 | 5.5 | 0.275 | 0.5 | 0.025 |
| 15.4 | 0.770 | 10.4 | 0.520 | 5.4 | 0.270 | 0.4 | 0.020 |
| 15.3 | 0.765 | 10.3 | 0.515 | 5.3 | 0.265 | 0.3 | 0.015 |
| 15.2 | 0.760 | 10.2 | 0.510 | 5.2 | 0.260 | 0.2 | 0.010 |
| 15.1 | 0.755 | 10.1 | 0.505 | 5.1 | 0.255 | 0.1 | 0.005 |

To check what RANGE (Full-Scale for 0-1 volt output) is selected, press and hold SW4 (see page 4) and measure the voltage out at TP7. As an example, TP7 will read 0.50 volt for a full-scale RANGE of 10.0% CO₂. The STAR will be relative to the new full scale RANGE. As an example, a STAR of 5.0% CO₂ with a full-scale RANGE of 10% will give a 0 to 1 volt output of 0.5 volt when the STAR switch SW2 is pressed. A STAR of 5.0% CO₂ with a full-scale RANGE of 20% will give a 0 to 1 volt output of .25 volt when the STAR switch SW2 is pressed.

CAUTION: It is easy to get confused when you are pressing these different switches. Please make sure to double-check where you have set the RANGE and STAR. If you attempt to gas calibrate and the STAR does not match the certified gas % when you press the SPAN SW3, the sensor will obviously give you incorrect measurements.

Version 20.33 and later disables the digital and the analog 0 to 1 volt outputs during the first 40 seconds after a power-on RESET to prevent and out-of-range signal from being transmitted.