



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. **RS-232 Test Board** for field gas calibration & diagnostics (See **Application Note A66**). 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 (CO₂)**
- Full Scale and RANGE:** **0-20% CO₂** **RANGE** is **user selectable** from **3%** to **20%** CO₂, see **page 4**
- Input Power **+12 VDC** (@ 0.250 amp max., 0.135 amp typ, 16.0 volts max, 8.0 volts min)
- Accuracy: **±0.25% CO₂** from 0 to 5.90% CO₂, and 5% of reading from 6 to 20% CO₂.
..... **16 bit** analog to digital converter: Delta-Sigma Conversion Method
- Resolution / Repeatability : **±0.05% CO₂** (challenge with same gas sample multiple times & assure zero)
- Stability: Less than 0.05% CO₂ in any 20 second period of time.
- Warm-up Time: Less than 2 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 2, 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), 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 0.25 pound (<0.11 kilogram)
- External Dimensions: PCB Card: ... **4.9 inch x 2.9 inch x 1.5 inch** see page 2 for mounting

See **Application Note A75** for **interface connector** part numbers.

0.156 dia. hole four places on 2.5 x 4.5 inch centers

input hose barb for 1/8 inch ID tube, Flow adjust between 0.3 to 1.0 LPM

IR source ON/OFF indicator

output hose barb



Power on indicator

J3: remote cal switch intfc:
Thomas & Betts 501-06-27ES

J1: I/O connector: Thomas & Betts 501-06-27ES
a 6 pin keyed header with ejector latches.
SPI input/output & 0-1 volt linear

J2: 12 VDC input power
2 pin, 0.156 inch center header for insulation displacement connector like AMP or Panduit.



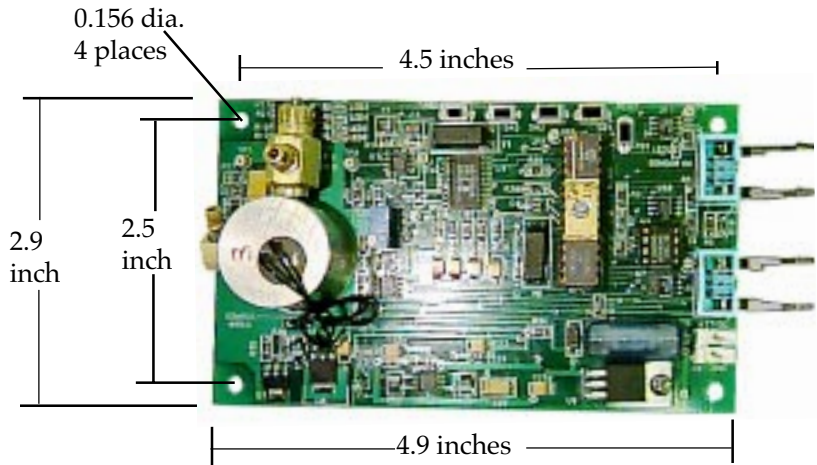
Model 2015SPI-3

input Flow adjust
between 0.3 to 1.0 LPM

input hose barb for
1/8 inch ID tube



output
hose
barb



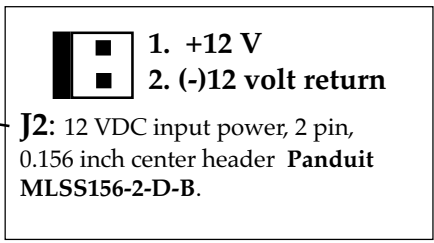
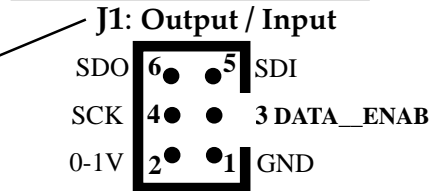
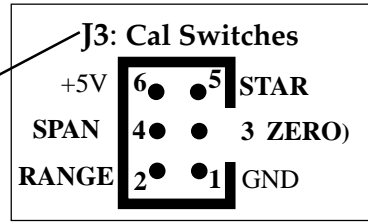
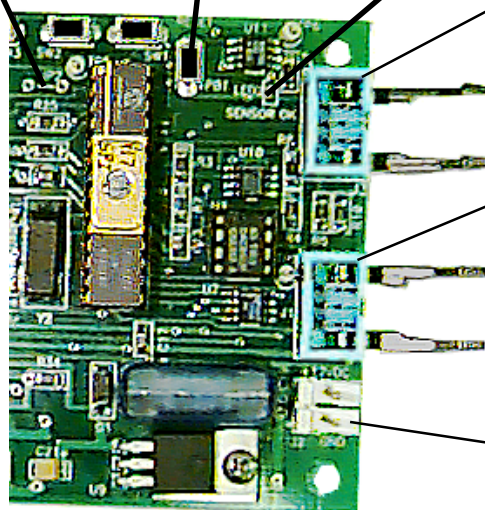
See **Application Note A67** for gas conditioning requirements and information about gas sample pumps and filters. A hydrophobic filter (**App Note A79**) in front of the inlet hose barb is required to prevent particles & droplets from entering the gas cell. Try to minimize the outflow resistance to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

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

Master/Slave jumper JP2
Slave mode if installed

Reset
Switch

LED2 **IR** source
ON/OFF indicator

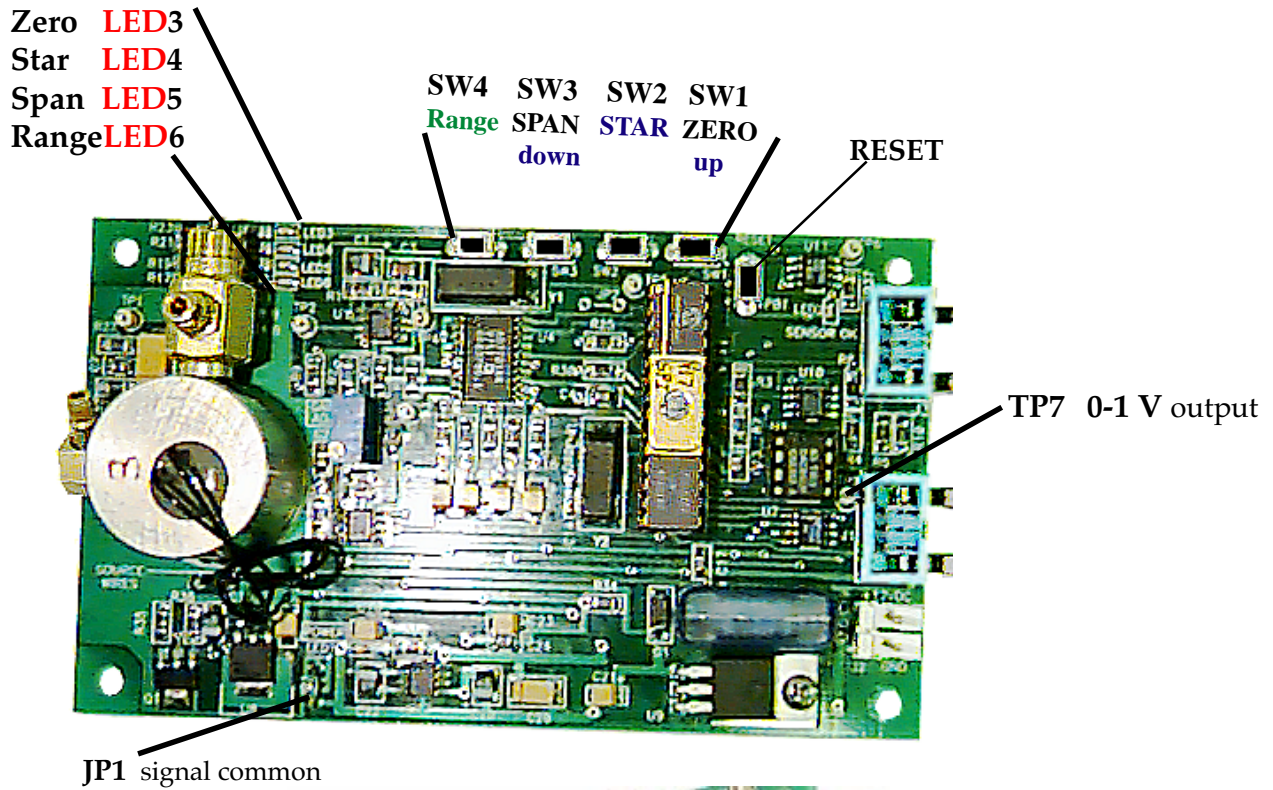


Gas calibration may be initiated via a command from the SPI input on **J3** (see Application Note A59) or from the on board or remote **switches via J4** (Logic "0" to initiate) below : (theRS-232 Test Board is easier)
ZERO (SW1 or remote J4-3): With nitrogen flowing in gas calibration tube press and hold SW1 for 2 seconds. **LED3** through 6 will flash on & off together. If they flash on/off sequentially the sensor has detected an error & 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. **LED3** will be **ON** to indicate a **ZERO** calibration.

RANGE (SW4 or remote J4-2): To set the full scale or range press and hold SW4. From the chart on page 4 find the voltage value that corresponds to the full scale that you want from 3 to 20%. **LED6** 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 J4-5): To set the Span Target (calibration gas value) press and hold SW2. **LED4** 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 4.

SPAN (SW3 or remote J4-4): 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.**LED5** will be **ON** . The DVM voltage should snap to the STAR value entered above & **LED3** through 6 will flash on & off together.



Below 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. See the procedure on page 5 for more detail. A typical application would be a full scale **RANGE** of 20.0 and a **STAR** of 5.00. If you use the serial digital output (see App Note A61) the **RANGE** value does not effect it. The serial digital output has 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 0-1 V output of 0.500 volt for a reading of 1.5% CO₂.

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

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

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 selected. **Version 20.34** allows a STAR value as low at 1.00% CO₂.

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

Range / STAR 0 to 1 V % gas	Output	Range / STAR 0 to 1 V % gas	Output	Range / STAR 0 to 1 V % gas	Output	Range / STAR 0 to 1 V % gas	Output
20.0	1.000						
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
15.0	0.750	10.0	0.500	5.0	0.250	0.0	0.000

To Check what **RANGE** (Full Scale for 0- 1 volt output) is selected, press & hold **SW4** (see page 3) 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 with the **STAR** switch **SW2** pressed of 0.50 volt. A **STAR** of 5.0% CO₂ with a full scale **RANGE** of 20% will give a 0 to 1 volt output with the **STAR** switch pressed of 0.25 volt.

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 an **OUT** of **RANGE** signal from being transmitted.