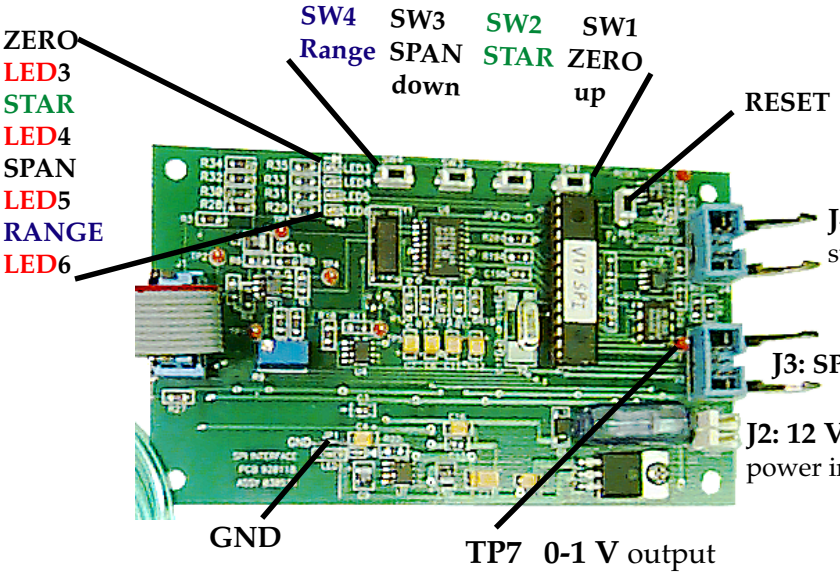
VALTRONICS

Application Note A54

Model 2005SPI-1 Gas Calibration

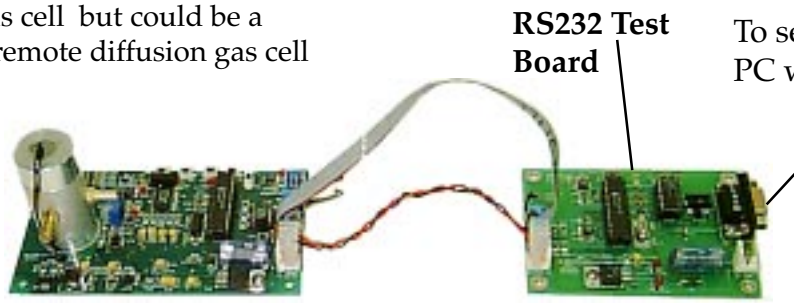
(see 2005SPI-1 specification)



Remote diffusion gas cell

WINDOWS interface: Connect the RS232 test board to the 2005SPI-1 via J3 and to a serial COM port on your PC. Any **PC** terminal program like **HyperTerminal** set up on any com port at 9600 baud, no parity, 8 bits and 1 stop bit, Xon/Xoff under Port Settings in HyperTerminal Properties. Type: **" VTI "** to **UNLOCK**

SPI sensor board happens to be a 2015SPI-1 flow through gas cell but could be a 2005SPI-1 or -2 remote diffusion gas cell



Gas calibration may be initiated via a command from the SPI input on **J3** (see page 4 of 2005SPI-1 spec) or from the on board or remote **switches** (Logic "0" to initiate) below:

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 6 find the voltage value that corresponds to the full scale that you want from 0.2 to 2.0%. **LED6** will be **ON** . Use SW1 as an **UP** and SW3 as a **DOWN** switch to adjust this value (examples: 2% = 1.00 v, 1% = 0.50 v, 0.2% = 0.10v).

STAR (**SW2** or remote J4-5): To set the Span Target (calibration gas value) **press** and **hold SW2**. **LED4** will be **ON** Use SWI as an **UP** and SW3 as a **DOWN** switch to adjust this value read on the DVM. See chart on page 6.

SPAN (**SW3** or remote J4-4): To SPAN calibrate while flowing certified span gas like 5.0±0.01% CO_2 in gas calibration tube for at least 30 seconds at about 300 ml/min. Press & hold **SW2** for **2 seconds**.**LED5** will be **ON** . The meter voltage should snap to the **STAR value** entered above & **LED3** through **6** will flash on & off together.

Application Note A54 Model 2005SPI-1 Gas Calibration

Below is a table that shows the 0 to 1 volt output equivalent to any value for **Full Scale Range** anywhere from **0.2** to **2.0**% CO_2. If the full scale **range** is set to **2.0,** the 0 to 1 volt output will be **1.00 volt** when you press and hold SW4. An ideal **span gas** or **STAR** would be 1.00 % CO_2. To set the **target span point** (**STAR**), Press and hold **SW2** . Use **SWI as UP** and **SW3 as DOWN** switch to adjust the value read on the DVM to **0.500** volts = 1.00% CO_2. Then use certified 1.00±0.02% CO_2 gas.

The **Full Scale Range** will set what % CO_2 will give an output of 1.00 volt in **normal operation**.
A Range of **2.0** will give a 0-1 V output of **0.500** volt for a reading of **1.0**% CO_2 .

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

Range / STAR % gas	0 to1 V Output	Range / STAR % gas	0 to1 V Output	Range / STAR % gas	0 to1 V Output	Range / STAR % gas	0 to1 V Output
2.000	1.000	**1.500**	0.750	**1.000**	0.500	**0.500**	0.250
1.990	0.995	**1.490**	0.745	**0.990**	0.495	**0.490**	0.245
1.980	0.990	**1.480**	0.740	**0.980**	0.490	**0.480**	0.240
1.970	0.985	**1.470**	0.735	**0.970**	0.485	**0.470**	0.235
1.960	0.980	**1.460**	0.730	**0.960**	0.480	**0.460**	0.230
1.950	0.975	**1.450**	0.725	**0.950**	0.475	**0.450**	0.225
1.940	0.970	**1.440**	0.720	**0.940**	0.470	**0.440**	0.220
1.930	0.965	**1.430**	0.715	**0.930**	0.465	**0.430**	0.215
1.920	0.960	**1.420**	0.710	**0.920**	0.460	**0.420**	0.210
1.910	0.955	**1.410**	0.705	**0.910**	0.455	**0.410**	0.205
1.900	0.950	**1.400**	0.700	**0.900**	0.450	**0.400**	0.200
1.890	0.945	**1.390**	0.695	**0.890**	0.445	**0.390**	0.195
1.880	0.940	**1.380**	0.690	**0.880**	0.440	**0.380**	0.190
1.870	0.935	**1.370**	0.685	**0.870**	0.435	**0.370**	0.185
1.860	0.930	**1.360**	0.680	**0.860**	0.430	**0.360**	0.180
1.850	0.925	**1.350**	0.675	**0.850**	0.425	**0.350**	0.175
1.840	0.920	**1.340**	0.670	**0.840**	0.420	**0.340**	0.170
1.830	0.915	**1.330**	0.665	**0.830**	0.415	**0.330**	0.165
1.820	0.910	**1.320**	0.660	**0.820**	0.410	**0.320**	0.160
1.810	0.905	**1.310**	0.655	**0.810**	0.405	**0.310**	0.155
1.800	0.900	**1.300**	0.650	**0.800**	0.400	**0.300**	0.150
1.790	0.895	**1.290**	0.645	**0.790**	0.395	**0.290**	0.145
1.780	0.890	**1.280**	0.640	**0.780**	0.390	**0.280**	0.140
1.770	0.885	**1.270**	0.635	**0.770**	0.385	**0.270**	0.135
1.760	0.880	**1.260**	0.630	**0.760**	0.380	**0.260**	0.130
1.750	0.875	**1.250**	0.625	**0.750**	0.375	**0.250**	0.125
1.740	0.870	**1.240**	0.620	**0.740**	0.370	**0.240**	0.120
1.730	0.865	**1.230**	0.615	**0.730**	0.365	**0.230**	0.115
1.720	0.860	**1.220**	0.610	**0.720**	0.360	**0.220**	0.110
1.710	0.855	**1.210**	0.605	**0.710**	0.355	**0.210**	0.105
1.700	0.850	**1.200**	0.600	**0.700**	0.350	**0.200**	0.100
1.690	0.845	**1.190**	0.595	**0.690**	0.345		
1.680	0.840	**1.180**	0.590	**0.680**	0.340		
1.670	0.835	**1.170**	0.585	**0.670**	0.335		
1.660	0.830	**1.160**	0.580	**0.660**	0.330		
1.650	0.825	**1.150**	0.575	**0.650**	0.325		
1.640	0.820	**1.140**	0.570	**0.640**	0.320		
1.630	0.815	**1.130**	0.565	**0.630**	0.315		
1.620	0.810	**1.120**	0.560	**0.620**	0.310		
1.610	0.805	**1.110**	0.555	**0.610**	0.305		
1.600	0.800	**1.100**	0.550	**0.600**	0.300		
1.590	0.795	**1.090**	0.545	**0.590**	0.295		
1.580	0.790	**1.080**	0.540	**0.580**	0.290		
1.570	0.785	**1.070**	0.535	**0.570**	0.285		
1.560	0.780	**1.060**	0.530	**0.560**	0.280		
1.550	0.775	**1.050**	0.525	**0.550**	0.275		
1.540	0.770	**1.040**	0.520	**0.540**	0.270		
1.530	0.765	**1.030**	0.515	**0.530**	0.265		
1.520	0.760	**1.020**	0.510	**0.520**	0.260		
1.510	0.755	**1.010**	0.505	**0.510**	0.255		

To Check what **RANGE** (Full Scale) is selected, press & hold SW4 and measure the voltage out at **TP7**.

As an example **TP7** will read **1.000 volt** for a full scale range of **2.0**% CO_2.

TP7 will read **0.500 volt** for a full scale range of **1.0**% CO_2.

TP7 will read **0.100 volt** for a full scale range of **0.2**% CO_2.

After the range is changed to something like **0.2**% CO_2. the 0 to 1 volt output in normal operation will be relative to that new full scale; i.e., 0.04% CO_2 (fresh air) will give a 0 to 1 volt output of 0.04/0.2 = 1/5 = **0.200 V.**
See scale on pages 3.

After the range is changed to something like **1.5**% CO_2. the 0 to 1 volt output in normal operation will give an output of **0. 027 volt** for 0.04% CO_2 (**fresh air**).

Application Note A54 Model 2005SPI-1 Gas Calibration

After the range is changed to something like **0.2**% CO_2. the 0 to 1 volt output in normal operation will be relative to that new full scale; i.e., 0.04% (fresh air) will give a 0 to 1 volt output of 0.04/0.2 = 4/20 = **0.200 volt.** The **STAR switch SW2** will now indicate the **Target Span Gas** value per the new chart listed below. Example, if you press and hold SW2 and use the **UP** (SW1) and **DOWN** (SW3) switches for a 0 to 1 volt output at **TP7** for **0.500 volt** then the **Target Span Gas** value will be **0.100**% (1000 ppm) CO_2. The MIN and MAX are related to the accuracy spec of 5% of mid-scale for 0 to mid-scale and ±5% of reading from mid to full-scale. Hence the **±0.025 volt tolerance** is equal to **±0.005% (±50 ppm) CO_2** accuracy from 0 to 0.100% (1000 ppm)CO_2 . The **resolution** and **repeatability** is at least **0.002% CO_2** measured using the same gas sample repeatedly.

%Gas	0-1V out	MIN	MAX
0.000	0.000	0.025	-0.025
0.002	0.010	0.035	-0.015
0.004	0.020	0.045	-0.005
0.006	0.030	0.055	0.005
0.008	0.040	0.065	0.015
0.010	0.050	0.075	0.025
0.012	0.060	0.085	0.035
0.014	0.070	0.095	0.045
0.016	0.080	0.105	0.055
0.018	0.090	0.115	0.065
0.020	0.100	0.125	0.075
0.022	0.110	0.135	0.085
0.024	0.120	0.145	0.095
0.026	0.130	0.155	0.105
0.028	0.140	0.165	0.115
0.030	0.150	0.175	0.125
0.032	0.160	0.185	0.135
0.034	0.170	0.195	0.145
0.036	0.180	0.205	0.155
0.038	0.190	0.215	0.165
0.040	0.200	0.225	0.175
0.042	0.210	0.235	0.185
0.044	0.220	0.245	0.195
0.046	0.230	0.255	0.205
0.048	0.240	0.265	0.215
0.050	0.250	0.275	0.225
0.052	0.260	0.285	0.235
0.054	0.270	0.295	0.245
0.056	0.280	0.305	0.255
0.058	0.290	0.315	0.265
0.060	0.300	0.325	0.275
0.062	0.310	0.335	0.285
0.064	0.320	0.345	0.295
0.066	0.330	0.355	0.305
0.068	0.340	0.365	0.315
0.070	0.350	0.375	0.325
0.072	0.360	0.385	0.335
0.074	0.370	0.395	0.345
0.076	0.380	0.405	0.355
0.078	0.390	0.415	0.365
0.080	0.400	0.425	0.375
0.082	0.410	0.435	0.385
0.084	0.420	0.445	0.395
0.086	0.430	0.455	0.405
0.088	0.440	0.465	0.415
0.090	0.450	0.475	0.425
0.092	0.460	0.485	0.435
0.094	0.470	0.495	0.445
0.096	0.480	0.505	0.455
0.098	0.490	0.515	0.465
0.100	0.500	0.525	0.475

%Gas	0-1V out	MIN	MAX
0.102	0.510	0.485	0.536
0.104	0.520	0.494	0.546
0.106	0.530	0.504	0.557
0.108	0.540	0.513	0.567
0.110	0.550	0.523	0.578
0.112	0.560	0.532	0.588
0.114	0.570	0.542	0.599
0.116	0.580	0.551	0.609
0.118	0.590	0.561	0.620
0.120	0.600	0.570	0.630
0.122	0.610	0.580	0.641
0.124	0.620	0.589	0.651
0.126	0.630	0.599	0.662
0.128	0.640	0.608	0.672
0.130	0.650	0.618	0.683
0.132	0.660	0.627	0.693
0.134	0.670	0.637	0.704
0.136	0.680	0.646	0.714
0.138	0.690	0.656	0.725
0.140	0.700	0.665	0.735
0.142	0.710	0.675	0.746
0.144	0.720	0.684	0.756
0.146	0.730	0.694	0.767
0.148	0.740	0.703	0.777
0.150	0.750	0.713	0.788
0.152	0.760	0.722	0.798
0.154	0.770	0.732	0.809
0.156	0.780	0.741	0.819
0.158	0.790	0.751	0.830
0.160	0.800	0.760	0.840
0.162	0.810	0.770	0.851
0.164	0.820	0.779	0.861
0.166	0.830	0.789	0.872
0.168	0.840	0.798	0.882
0.170	0.850	0.808	0.893
0.172	0.860	0.817	0.903
0.174	0.870	0.827	0.914
0.176	0.880	0.836	0.924
0.178	0.890	0.846	0.935
0.180	0.900	0.855	0.945
0.182	0.910	0.865	0.956
0.184	0.920	0.874	0.966
0.186	0.930	0.884	0.977
0.188	0.940	0.893	0.987
0.190	0.950	0.903	0.998
0.192	0.960	0.912	1.008
0.194	0.970	0.922	1.019
0.196	0.980	0.931	1.029
0.198	0.990	0.941	1.040
0.200	1.000	0.950	1.050

Application Note A54 Model 2005SPI-1 Gas Calibration

Using the **RS232 test board** is the most effective way to test and calibrate a sensor because you can view all the critical parameters that are used by the microcomputer to calculate the % gas in the cell. You will be able to view the last calibration data before you recalibrate, record it and compare the new calibration data to see the differences. The RS232 test board is like having a digital storage oscilloscope. You may view (Command **2**)the peak to peak detector response to ZERO gas (**VZ**) as well as the peak to peak detector response to full scale SPAN gas (**VS**) at the calibration temperature of the gas cell in °C for both ZERO (**TZ**) and SPAN calibration (**TS**). You may view the ZERO temperature coefficient (**ZTC**)and the SPANtemperature coefficient (**STC**) for this serial numbered sensor. You may change parameters but make sure you do that with care and understanding.

See **Application Note A59**

MASTER mode: (data is only example data which varies from serial # to serial #, **VS** & **VZ** are not usually entered)

Command	Action
1	**D.DDDD** % gas Continuous
1	Toggles all calculated values:
	--- Measurements --
(first "1" scrolls % gas	0.0000% gas
data, the next "1" gives	0.1233 volts
measurement table to right,	16.67 Deg C
next "1" goes back to scroll)	0.9693 Atten
	2.000 **Range**
	0.000 **0 to 1 V out**
	4.0836 VZ TC'd
	3.1743 VSTC'd
2	Displays all calibration data
	---------- Cal ----------
	VZ 3.8638 Volts
	VS 2.7334 Volts (full scale)
	TZ 29.41 Deg C (zero cal temp)
	TS 28.92 Deg C (span cal temp)
	ZTC -0.004263 V/degC
	STC -0.000478 V/degC
	STAR 0.4950 % CO_2 (target calibration gas)
	OFF 1.0000 Volts (aging factor as a result of field1 point calibration)
3	Displays all response curve coefficients
	---------- Curve ---------
	C0 0.00000
	C1 0.265090
	C2 0.304330
	C3 2.017600
	C4 -2.578900
	C5 1.988500
	C6 0.000000 If coefficients C6 & C7 are 0.0 then the curve fit equation is a 5th order polynomial
	C7 0.000000
4	Display miscellaneous data
	----- Sys Info ------
	UNV.13 RS232 Rev (read from e-prom)
	2.26 SPI Rev (read from e-prom)
	DATE **9904312** (factory calibration date Apr 1999 / **serial #**)
	Filter 10 Secs (variable 1 to 10 seconds, factory set at 10)

Command	Action
VTI	Unlocks for changing set-up, time out 5 min
CX DDD.DDDD	Enter Curve Coefficient X =0-7 & value D
STC D.DDDDD	Enter Span Temperature Coefficient D
ZTC D.DDDDD	Enter Zero Temperature Coefficient D
STAR DD.DDD	Enter Span Target value D
VS D.DDDD	Enter Span voltage D (measured by ZERO)
VZ D.DDDD	Enter Zero voltage D (measured by SPAN)
SETS	Perform auto**SPAN** to STAR & store VS & TS
SETZ	Perform auto **ZERO** & store VZ & TZ
OFF D.DDDD	Enter new AgingFactor, effects Field Calib.
FILTER D	Enter new filter value D 1-10 lamp cycles ave
D CCCCCCCC	Enter Cal Date (9 alphanumeric characters)
RT	RESETS the RS232 Test Board

Note: Type: **" VTI "** to **UNLOCK**

All values are stored on EEPROM so they are not lost during power failures.