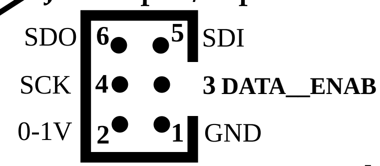
VALTRONICS Application Note A59 - SPI Version 32

2015SPI-1, 4, 8,13

SPI connector

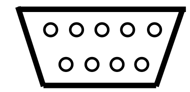
J1: Output / Input



Standard **9 pin "D" RS232** connector

Pin#	***Signal Name***
1	DCD (data carrier detect)
2	**RX** (receive data)
3	**TX** (transmit data)
4	DTR (data terminal ready)
5	**GND** (signal ground)
6	DSR (data set ready)
7	RTS (request to send)
8	CTS (clear to send)
9	RI (ring indicator)
Shell	FG (frame ground)

9 pin "D" RS232

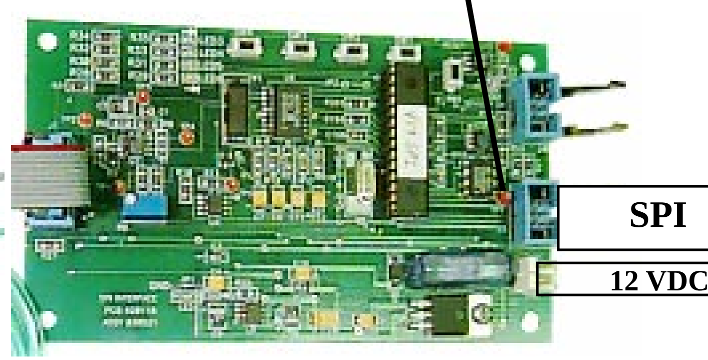


2005SPI-1 Remote diffusion gas cell on 30 inch long cable

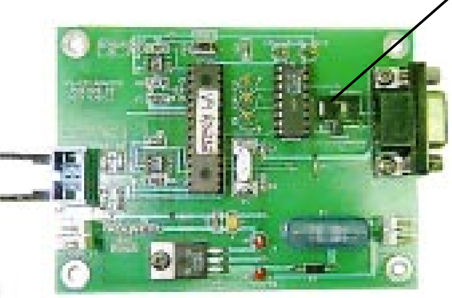
400 ppm (0.04%) CO_2 in gas cell (fresh air)

2005SPI board

0-1 Volt out TP7



RS232 TEST board



null modem switch allows you to reverse pins 2 & 3

9 pin "D" female **RS232** conn.
pin **2** - transmit
pin **3** - receive
pin **5** - digital ground

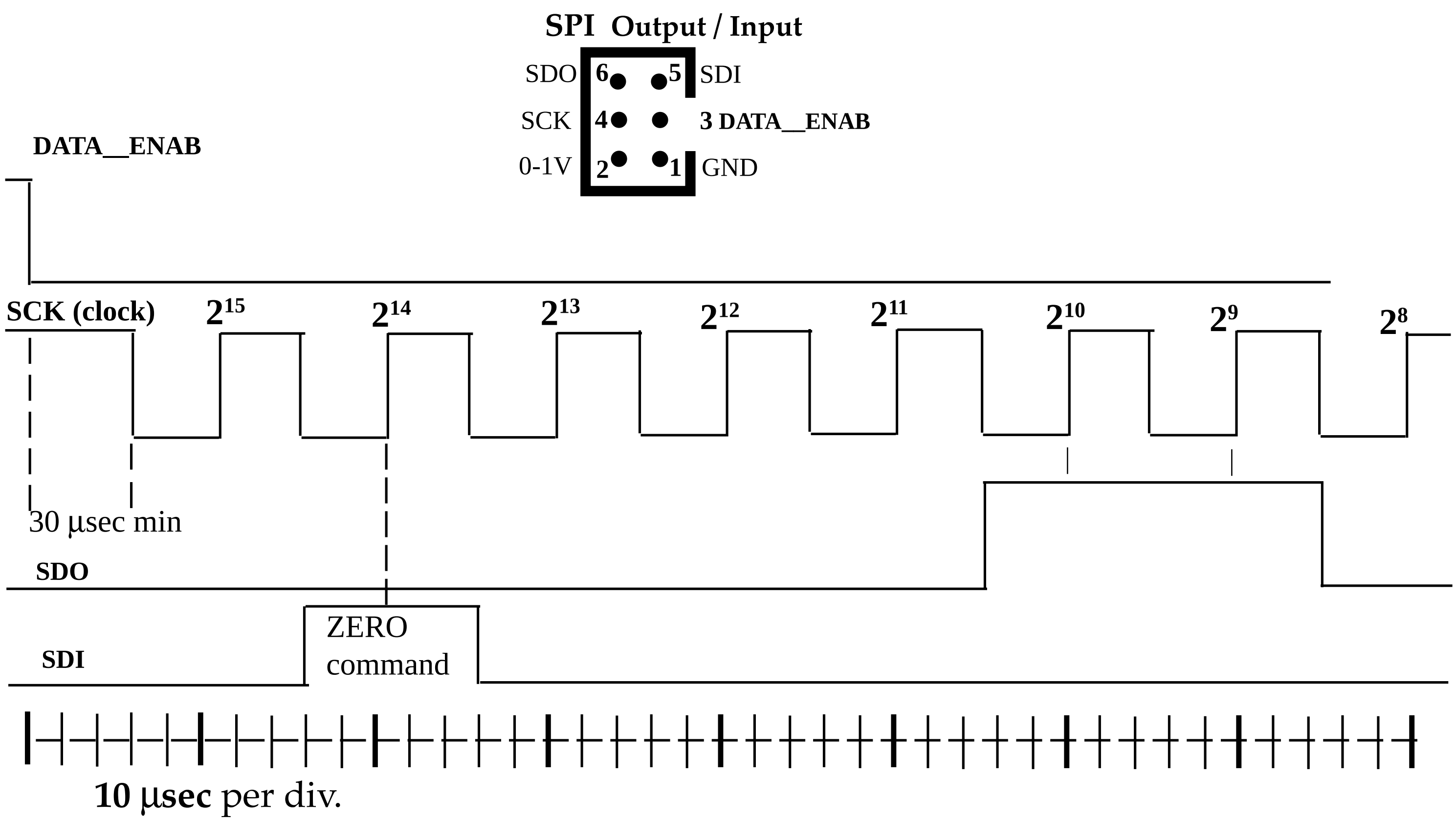
Note: If **JP2** is installed on the **SPI** board then **JP1** needs to be installed on the **RS23**2 board

The Model **2015SPI-3** uses an on board gas cell for the higher full scale of 3 to 20% CO_2. The Model **2015SPI-1** has the longer on board gas cell for a full scale any where from 0.2 to 2.0% CO_2. The Model **2005SPI-2** uses a shorter remote gas cell for the higher full scale of 3 to 20% CO_2. The Model **2005SPI-1** has the longer remote gas cell shown for a full scale anywhere from 0.2 to 2.0% CO_2. The **2015SPI-4** is a 4 to 100% CH_4 unit.

Getting Started: Refer to the individual specification sheet that is shipped with each unit. A print out of the stored **calibration parameters** is shipped with each unit. This can be duplicated using the **RS232 test board** & a PC with **HyperTerminal** program that comes with Windows. **DO NOT** press the calibration switches on the SPI board until you verify proper operation using the **RS232** board. Connect 12 VDC as shown in the specification sheet to both boards. Connect the ribbon cable between the **SPI** connector J1 and the RS232 board as shown. Connect the **RS232** 9-pin "D" connector to one of your **COM ports** on your PC. Set up **HyperTerminal** to talk to that port at 9600 baud, no parity, 8 bits and 1 stop bit, Xon/Xoff under Port Settings in **HyperTerminal** Properties. The RESET switches on each board perform a power on RESET. They do not clear the calibration data. The Print out shipped with each sensor shows the response to keyboard commands **1**, **1 1**, **2**, **3**, and **4** (see page 4). Keyboard command **2** will show you the detectors peak to peak response to nitrogen when it was calibrated like 3.9541 volts and the temperature it was calibrated at like 27.3°C . Command **1 1** will give you the present ambient air detectors Vpp response. Pressing the **SPAN** calibration switch without the **STAR value of span gas** in the cell will result in an incorrect calibration. A **SETS** SPAN should **NOT** be done without first doing a **SETZ** ZERO with nitrogen in the gas cell. The on-board switches perform **one point** field calibrations. See page 2 for **SLAVE Mode** operation.

e-mail: **bpynenb@goldrush.com** • 3463 Double Springs Road • Valley Springs, CA 95252 • (209) 754-0707 • FAX (209) 754-0104

2005SPI and 2015SPI timing diagram for Slave Mode Operation
Version 27 firmware & later



The high to low transition of the clock (**SCK**) must occur at least 30 microseconds after the high to low transition of the **DATA__ENAB** control for that sensor. In **SLAVE Mode** the clock is controlled by you, the Master microprocessor. The **SDO** data output changes on the high to low transition of the clock (**SCK**) and the data should be read on the low to high transition of the clock (**SCK**). The example in the timing diagram above shows a % gas reading of **15.36%** which is equal to a binary output of 0000 0**11**0 0000 0000 (only bits $\mathbf{2^{10}}$ and $\mathbf{2^{9}}$ are high "1"). The last eight bits (least significant byte LSB) are not shown on the diagram but they are all low "0". You must wait (stop the clock) a minimum of 100 microseconds between the end of the **MSB** (Most Significant 8 bits) and the beginning of the **LSB** (Least Significant 8 bits).

The Serial Data Input (**SDI**) may initiate a **SETZ command** by sending **C000 hex** (binary **11**00 0000 0000 0000). You need to make sure that there is zero gas in the gas cell and that the gas concentration is stable when you do this This is the first part of a two point calibration and should be followed by a SETS command using a know concentration of gas in the cell. This is the first command of a two point calibration and should be followed by a SETS command.

The Serial Data Input (**SDI**) may initiate a **SETS command** by sending **AXXX hex** (binary **1**0**1**0 XXXX XXXX XXXX) where the least significant **12 bits** is the **STAR gas value**. You need to make sure that the correct value SPAN gas in the gas cell and that the gas concentration is stable when you do this. An example of a SPAN command at **5.0% gas** would be an **SDI** of binary **1**0**1**0 0000 00**11** 0010 with the decimal point implied. That would make the STAR value = 5.00

The Serial Data Input (**SDI**) may initiate a **RESET command** by sending **1000 hex** (binary 000**1** 0000 0000 0000). This command resets the SPI board and should be initiated whenever the master microprocessor resets.

Sample "C" Source Code for Digital SPI Interface

```
YourFunctionName( )         // Slave mode control to emulate customer equipment
{
        #define NORMAL_OP_FIELD            0     // MUST agree with Gas board!
        #define ZERO_OFF_FIELD            64     // 64d Ver 25 (SPI Board) change
        #define SPAN_OFF_FIELD           128     // 128d

        unsigned char byte2send[2];
        int           gasread;
        unsigned int  span_target;

        port.bim &= 0xfd;    // dummy port where changes are made
        PORTB = port.bim;    // RB1=0 for Data_Enable (OUTPUT)

        MilliSeconds(1);     // Delay added to ensure MSB is first

                // typing 'ZERO' = 'field zero' in Master mode
                // cal.command is a Global Variable we use to control the commands to be sent

                if ( cal.command == FIELD_ZERO )
                {
                byte2send[0] = ZERO_OFF_FIELD;                 //command = ZERO (0100 0000)
                byte2send[1] = 0;
                }

                else if (cal.command == FIELD_SPAN)
                {
                span_target =  (unsigned int)(cal.span_target * 10);       // Double value to int value
                byte2send[1] = (unsigned char)( span_target & 0x00FF );        // load last 8 bits
                span_target = (span_target >> 8);
                byte2send[0] = (unsigned char)( span_target & 0x00FF );        // load 1st 4 bits
                byte2send[0] = (byte2send[0] | SPAN_OFF_FIELD);    // Load Command, = 128 (1000 0000b)

                }
                else    // normal op, get reading
                {
                byte2send[0] = NORMAL_OP_FIELD;
                byte2send[1] = 0;
                }
                // ALWAYS receive gas reading
                gasread = SendByteSPI(byte2send[0]);     // msb loaded into SPI buffer and sent
                gasread = (gasread << 8);

                //make sure to leave at least 100usec between sending of bytes :)
                gasread  |= SendByteSPI(byte2send[1]);   // lsb loaded into SPI buffer and sent

                calc.gas_percent = gasread;                    //latest data from gas board

                port.bim |= 0x02;     // dummy port where changes are made
                PORTB = port.bim;   // RB1=1 for Data_Enable (OUTPUT)

                if ( cal.command != FALSE )                        // Displays "DONE" to show we
                {                                                        // made it though this function
                cal.command =  FALSE;
                SendRS232 ( DONE );

                }
}        // end of Slave Command function
```


RS232 Test Board Terminal Emulation Interfaces

For test and troubleshooting you may connect an RS232 test board to the SPI connector as shown on page 1 and the RS232 9pin D connector to your computer's COM port. A terminal emulation program (VT100 or VT220 type dumb terminal) **HyperTerminal** program that comes with Windows or a program like **PCPLUS** in DOS may be used to talk to the RS232 Test Board. If you have properly configured your terminal program and connected the correct COM port to the RS232 connector you should get a response on your screen of "LOCKED" when your press the RESET switch on the RS232 Test Board. Type **VTI** and it will unlock. This will allow you to type the commands listed below: See **Application Note A66.**

Command	Action
1	DD.DD% gas Continuous
1	Toggles all calculated values:

(first "1" scrolls % gas data, the next "1" gives measurement table to right, next "1" goes back to scroll)

--- Measurements --
0.00 % gas
3.8818 volts
27.45 Deg C
0.0010 Atten
20.0 **Range**
0.000 **0-1 V out**
3.8855 VZ TC'd
1.9708 VSTC'd

ZERO switch
SPAN switch

2 Displays all calibration data

----------- Cal -----------

VZ	3.8801 Volts
VS	1.9683 Volts (full scale)
TZ	28.43 Deg C (zero cal temp)
TS	28.43 Deg C (span cal temp)
ZTC	-0.005486 V/degC
STC	0.002904 V/degCs
STAR	20.0 % gas (target calibration gas)
OFF	1.0000 Volts (aging factor as a result of field1 point calibration)

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 DDD.DD	Enter Span Target value D
VS D.DDDD	Enter Span voltage D (measured by SPAN)
VZ D.DDDD	Enter Zero voltage D (measured by ZERO)
SETZ	Perform auto **ZERO** & store VZ & TZ
SETS	Perform auto**SPAN** to STAR & store VS & TS
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
RS	**RESETS the SPI board**

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

3 Displays all response curve coefficients:

---------- Curve ---------

CO	-0.030000
C1	8.438299
C2	33.528999
C3	66.509003
C4	16.270000
C5	-24.007000
C6	0.000000 (if coefficient is "0" the term will drop out. Hence this is an example of a **5th**)
C7	0.000000

Command	Action
5	Change % Gas reading & STAR values to 4 decimal places in SLAVE mode only. Press **RESET** or type **RT** to reset back to two decimal places.

4 Display miscellaneous data

----- Sys Info ------

UNV.16	RS232 Rev	(read from e-prom)
20.30	**SPI** Rev	(read from e-prom)
DATE	**9904243**	(factory calibration date & serial number: April 1999 # 243)
Filter	15 Secs	(variable 1 to 10 seconds, factory set at 15 seconds)