



**PCOM-SDI**  
RS232 TO SDI-12 COMMUNICATIONS INTERFACE  
&  
**PCOM/AIM**  
RS232 TO SDI-12 INTERFACE WITH BUILT-IN ANALOG INPUT MODULE

User Reference Manual

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# **PCOM-SDI**

## **RS232 to SDI-12 Communications Interface**

*Pliant Technology Specialists*

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Pliant: readily yielding to influence

### **1. PCOM-SDI: RS232 to SDI-12 Master Interface**

The AMASSER **PCOM-SDI** provides an interface between RS232 and SDI-12 devices. In its standard configuration it serves as an interface between a RS232 host such as a computer or programmable controller, and a SDI-12 slave such as a sensor. Alternatively, it can also be configured so that the SDI-12 device is the master.

The PCOM-SDI is available with a built-in analog input module. This variant, the **PCOM/AIM**, provides a RS232 host with a direct interface to both SDI-12 and analog devices by means of 8 input channels and 16-bit A/D conversion. See section 1.1.

Supporting up to 10 SDI-12 slaves (sensors), the PCOM-SDI enables its user to operate in SDI-12 transparent mode thus bestowing the complex protocol restraints of SDI-12 upon the unit. The host need only send ASCII messages to the AMASSER PCOM-SDI via its RS232 port to obtain data from or setup the SDI-12 sensors on the bus. These messages can be any SDI-12 command supported by the sensors. Upon receiving a command from the RS-232 host, the PCOM-SDI then forwards it to the sensor and performs all the necessary communications and timings to obtain the final response from the sensor as prescribed by the SDI-12 protocol including the D command, retries, timeouts, etc... The PCOM-SDI then transmits the response from the SDI-12 sensor to the host via the RS232 interface.

The host PC or PLC requires a protocol-driver that sends and receives ASCII messages that are transferred in the RS232 data stream and uses relaxed timing and no break handling. The "!" character that terminates all SDI-12 commands serves as the delimiter and triggers the PCOM-SDI into action. The host must wait for a response prior to issuing a new command to the PCOM-SDI.

Firmware Support Providing:

- SDI-12 Transparent Mode ( Manual SDI-12 Communications)
- Master SDI-12 task engine, auto retries, auto data buffer retrieval & auto command time-outs
- Simple Host Protocol
- up to 72 byte messages
- SDI-12 Transparent Mode Support
- Configurable from Auto-retrieve mode to Manual-Retrieve mode (see below)

Hardware Features:

- 1 SDI-12 Serial Digital Interface (10 sensor support) port
- RS-232 Communications Port at 9600 baud (or 19200 baud) (settings for 8 data bits, 2 stop bits, no parity and no flow control)

## 1.1. PCOM/AIM: Built-in Analog Input Module

The AMASSER **PCOM/AIM** provides a RS232 host with a direct interface to both SDI-12 and analog devices by means of 8 input channels and 16-bit A/D conversion. Therefore, with a simple RS232 string the PCOM/AIM allows the host to poll SDI-12 devices as well as convert and retrieve data from analog sensors. The “/AIM” option also provides excitation ports as described below:

The PCOM/AIM is configured for monitoring the following maintenance parameters:

- Primary input voltage of the system (0-20 V input) on channel #7,
- Internal temperature of the system on channel #8.

The remaining channels are available for various analog sensors as follows:

- External 0-20V input (channel #6),
- External temperature on channel #5 (0-2.5V),
- The configuration of channels #1 to #4 depends on the version of PCOM/AIM (see **Options** below).

All versions of the PCOM/AIM provide the following excitation:

- 2.5 V voltage reference
- 5 V voltage reference
- 250 microAmp constant current source

The constant current source is very accurate and temperature-compensated, which provides an ideal excitation for sensors such as RTDs by resolving the problems associated with temperature fluctuations as a result of excessive current draw.

All versions of the PCOM/AIM also include one event counter. The event counter is 16 bit (0 to 65535). It has a mode-selection feature that allows the user to configure the firmware for counting switch closures or pulses as well as to enable or disable the counter-reset function. These modes are named as follows: Switch Closure, Pulse, Read/Reset, and Overflow. In addition, they feature a setup parameter called *scale* which allows the user to define the value of each count.

### 1.1.1. PCOM/AIM options

The configuration of channels #1, #2, #3 and #4 are dependent on the version of PCOM/AIM as shown below:

<b>Model</b>	<b>Configuration of channels #1, #2, #3 and #4</b>
PCOM/AIM	CHANNELS #1 AND #2: 0-5v inputs CHANNELS #3 AND #4: 0-2.5v inputs
PCOM/AIM/2.5	CHANNELS #1, #2, #3 AND #4: 0-2.5v inputs
PCOM/AIM5	CHANNELS #1, #2, #3 AND #4: 0-5v inputs
PCOM/AIM/4-20	CHANNELS #1, #2, #3 AND #4: 4-20mA inputs

## 2. HOST PROTOCOL

### 2.1. PCOM-SDI

All messages that are sent and received from the host are ASCII strings transferred in the RS232 data stream with relaxed timing and no break handling. Your RS232 serial port must have the following settings:

- 9600 baud
- 8 data bits
- no parity
- 1 stop bit

For example, if the AMASS Data [PSE-SDI](#) shaft encoder is connected to the SDI-12 bus at address '0', the proper command to obtain a water level reading is "0M0!". To get the reading, therefore, the RS232 host need only send the ASCII string "0M0!". The AMASSER PCOM-SDI would then obtain the reading from the sensor in the manner prescribed by the SDI-12 protocol and return it to the host on the RS232 line as an ASCII string in the form: "a+<Response String><CR><LF>". Generally, the command/responses take the following form:

**Host command:** aM0! or aM1! or aM2!, etc..

**PCOM-SDI response to host:** attn<CR><LF>

And 'ttt' seconds later...

**PCOM-SDI response to host:** a+<value #1>+<value #2>+...<CR><LF>

where **a**: Address of the sensor on the SDI-12 bus

**<CR>**: Carriage Return character

**<LF>**: Line Feed character

Alternatively, the PCOM-SDI can be configured in the Manual-Retrieve mode using the 'S6' command (see section *COMMAND*). In this mode, the PCOM-SDI transmits its response from the sensor to the host without attempting retrieval of the data with the D command. In Manual-Retrieve mode the host must issue both the 'aM!' command as well as the retrieve buffer command.

For example:

**Host command:** aM0!

**PCOM-SDI response to host:** a0051<CR><LF>

**Host command:** aD0! {host must issue the 'aD0!' command ttt= 5 seconds after the initial response}

**PCOM-SDI response to host:** a+<value><CR><LF>

### 2.2. PCOM/AIM

As described in section 1.1, the PCOM/AIM provides a RS232 host with a direct interface to both SDI-12 and analog devices by means of 8 input channels and 16-bit A/D conversion. Retrieving data from SDI-12 sensors with the PCOM modules is described in the previous section. This section briefly described retrieval of data from analog sensors using the PCOM/AIM.

All strings that are intended for the "AIM" portion of the PCOM/AIM are preceded with the character 'A' (41 hex, ASCII). See section 4.3 for the full set of commands available to the PCOM/AIM.

### 3. SDI-12 PROTOCOL

This section briefly describes the SDI-12 protocol. The PCOM-SDI (or PCOM/AIM) handles the details of this protocol transparently to the user. Therefore, the following information is optional reading.

When the RS232 host sends a command to the AMASSER **PCOM-SDI** (or **PCOM/AIM**) to initiate a measurement, the module becomes a Master SDI-12 controller until data is retrieved from the sensor. The SDI-12 slaves, that is the sensors, are then accessed as prescribed by the SDI-12 protocol.

In order to communicate with a SDI-12 sensor, the controller (PCOM module) sends a "break" signal, which consists of sending a spacing signal (5 V) for more than 12 millisecc. This will wake all sensors connected to the line. The AMASSER PCOM-SDI then sends the command that was submitted by the host onto the SDI-12 bus. The format of each byte of data is 1 start bit, 7 data bits with the least significant bit first, 1 parity bit with even parity, and 1 stop bit. The first significant byte of any message is the address of the sensor; all sensors with different addresses return to the "sleep" state and ignore the rest of the command. The last character of a command is always "!", and the controller turns off its transmitter within 7.5 millisecc after sending the "!". The sensor responds by setting the data line to marking (0 V) for 8.33 millisecc, and then begins its response. The first bit of the response must be sent within 15 millisecc of receiving the last byte of the command as prescribed in the SDI-12 protocol.

The response from the sensor contains information about a) the time that must elapse before the reading will be complete and ready for retrieval and b) the number of values returned by the sensor as a result of the command. The AMASSER PCOM-SDI then sends the "Send Data" (aD!) command to retrieve the data which it then returns to the host on the RS232 line (assuming Automatic-Retrieve mode).

**For detailed information on SDI-12 protocol visit the SDI-12 Support Group's web-site via our home page at <http://www.amassdata.com>.**

## 4. COMMANDS

### 4.1. Standard Set

- Identification command AI!  
Command: 'AI!'  
Response: 'A AMASS Data PCOM-SDI/001'
  
- Configure for SDI-12 Auto-Retrieval mode (see section 2 HOST PROTOCOL)  
Command: 'AS61!' (on, default) or 'AS60!' (off, Manual-retrieval mode)  
Response: 'A'
  
- Read Current Mode  
Command: 'AS6?!'  
Response: 'A-on' or 'A-off'
  
- Acknowledgment command A!  
Command: 'A!'  
Response: 'A'

## 4.2. For SDI-12 Sensors

### ➤ Any Valid SDI-12 Command

Refer to section 2. HOST PROTOCOL. Ex. '0M0!', '0M2!' depending on the commands supported by the sensor and its address.

### 4.2.1. Error Messages

The PCOM-SDI provides error messages with respect to the SDI-12 communications between it and the SDI-12 device as follows:

<b>Error Message</b>	<b>Description</b>
Er0 - Adr/Cmd	An invalid command. For instance, an SDI-12 command which is not preceded with an address.
Er1 - NoCmdRsp	No response from sensor. This may be due to improper addressing, no power to the sensor, improper connections, etc...
Er2 - NoDORsp	The PCOM-SDI timed-out while waiting for a response to the 'D0' command, that is, the "retrieve data buffer" command.
Er3 - CmdRspCharTmout	The time-out timer expired due to a response to the 'M' command (or some form of SDI-12 measurement command) that was not conformant to the SDI-12 spec. The PCOM-SDI verifies total response time as well as byte-to-byte timing as per the SDI-12 specification. Non-conformant sensors are detected.
Er4 - DORspCharTmout	The time-out timer expired due to a response to the 'D0' command that was not conformant to the SDI-12 spec. The PCOM-SDI verifies total response time as well as byte-to-byte timing as per the SDI-12 specification. Non-conformant sensors are detected.
Er5 - TxCmdCharTmout	The time-out timer expired for the transmission of the measurement command.
Er6 - D0TxCharTmout	The time-out timer expired for the transmission of the 'D0' command.



### **4.3. For ANALOG Sensors: “PCOM/AIM” only**

The following commands are for retrieving data from analog sensors. These commands are only applicable to the PCOM/AIM which provides a built-in Analog Input Module.

#### **4.3.1. Command Symbols**

The following symbols are used in the descriptions of the PCOM/AIM commands:

! : Terminates the command

<cr> : The carriage return character which is represented as ‘\0d’ in the ASCII string.

<lf> : The line feed character which is represented as ‘\0a’ in the ASCII string. All responses are terminated with <cr><lf>.

#### **4.3.2. Convert both 0-20 V Inputs**

- command: AM0!
- First response: +<primary voltage>+<external voltage>

This command instructs the PCOM/AIM unit to convert analog inputs #7 and #6 (refer to section **Error! Reference source not found. Error! Reference source not found.**).

Note that the “divide-by-4” circuitry that allows a range of 0 to 20 V for these inputs is jumper-selectable. Therefore, by removing jumpers ‘E4’ and ‘E3’ respectively, channels #7 and #6 become 0 to 5 V inputs.

##### Example:

You wish to measure the Primary Voltage and the 0-20V external input.

Command: AM0!

Response: +12.523+0.000\0d\0a

#### **4.3.3. Convert channels #1 and #2**

- command: AM1!
- response: +<ch #1>+<ch #2>, OR +<ch#1 - ch#2> (see ‘S2’ command)

This command instructs the PCOM/AIM unit to convert analog inputs #1 and #2. These two analog inputs are either 0-5V (PCOM/AIM and PCOM/AIM/5), 0-2.5V (PCOM/AIM/2.5) or 4-20mA inputs (PCOM/AIM/4-20). The connections as shown in **Error! Reference source not found. Error! Reference source not found.** Note that these channels may be configured for differential measurements using the “S2 command” as per section 4.3.10. If so configured, the ‘AM1!’ command returns the value “ch#1 –ch#2”.

##### Example:

You wish to measure the 0-5V analog inputs.

Command: AM1!

Response: +2.111+1.123\0d\0a

#### 4.3.4. Convert channels #3 and #4

- command: AM2!
- response: +<ch #3>+<ch #4>, OR +<ch#3 - ch#4> (see 'S2' command)

This command instructs the PCOM/AIM unit to convert analog inputs #3 and #4. These two analog inputs are either 0-5V (PCOM/AIM/5), 0-2.5V (PCOM/AIM and PCOM/AIM/2.5) or 4-20mA inputs (PCOM/AIM/4-20). The connections as shown in **Error! Reference source not found. Error! Reference source not found.** Note that these channels may be configured for differential measurements using the "S2 command" as per section 4.3.10. If so configured, the 'aM2!' command loads the buffer with the value "ch#3 -ch#4".

##### Example:

You want to measure channels #3 and #4.  
Command: AM2!  
Response: +1.010+0.000\0d\0a

#### 4.3.5. Convert the Temperature Inputs

- command: AM3!
- response: +< internal temp°C>+<ext. temperature>

This command instructs the PCOM/AIM unit to convert channel #8 (internal temperature) and channel #5 (external temperature). Note that channel #8 makes use of the on-board temperature sensor but that this is in fact jumper-deselectable (jumper 'E5'). Therefore, although the PCOM/AIM is shipped with jumper 'E5' installed so that the user can monitor the internal temperature, channel#8 can in fact be used as an external 0-2.5V input. Refer to **Error! Reference source not found. Error! Reference source not found.** for the pin assignments of this input to the 28 pin AMP CPC connector.

##### Example:

You want to measure the internal temperature.  
Command: AM3!  
Response: +23.123+12.111\0d\0a

#### 4.3.6. **Get the Event Counter Value**

- command: AM4!
- response: <event counter>

This command is used to obtain the event counter value.

##### Example:

You wish to obtain the reading of the event counter.

Command: 4M4!

Response: +12.500\0d\0a

The event counter thus reads '12.500'. The PCOM/AIM allows the user to define the value of each count of the event counter. Therefore, if a tipping bucket rain gauge with a tip = 0.25mm of rain is connected to the event counter the user defines the parameter *scale*= 0.25 using the 'AS2!' command as per section 4.3.9.

Note that the event counter input must not exceed 10 Hz in Switch Closure mode (or 5 kHz in Pulse mode) in order to obtain reliable results (see 4.3.10).

#### 4.3.7. **Calculate the AVERAGE, MINIMUM and MAXIMUM**

- Command: AM6! (ch#1), aM7! (ch#2), aM8! (ch#3) and aM9! (ch#4)
- Response: +<average>+<maximum>+<minimum>

This command initiates multiple samples of the desired channel (#1, #2, #3 or #4) and returns the average, minimum and maximum. The number of samples and the sampling period is configured using the 'AS6' command (see section 4.3.12 Configure the AVERAGING).

##### Example:

You wish to obtain the average of the sensor connected to channel #3. Proceed as follows:

Command: AM8!

Response: +1.111+1.129+1.101\0d\0a

The delay time for these commands (11 seconds by default) is a function of the number of samples taken as well as the sampling period as set with the 'AS6' command.

#### **4.3.8. Read Value of Set-up Parameter**

- command: AS2?!, AS3?! or AS4?!
- Response: <data buffer><cr><lf>

This command enables the user to read the current value of any given set-up parameter. Its use is simple. Send the command normally used for setting the parameter in question but substitute the data value with the character '?'.

##### Examples:

You wish to determine the current “scale” of event counter #1.

Command: 'AS3?!'

Response: '+0.25\0d\0a'

So the scale of event counter #1 is set at 0.25 units/count. Refer to 4.3.9 *Set Scale Of Event Counter*.

#### **4.3.9. Set Scale Of Event Counter**

- command: AS3+<scale>!
- response: A<cr><lf>

This command is used to set the scale of the event counter. The scale is set according to the application in question. For instance, with tipping buckets the scale can be set to the amount of rain that each count represents. The engineering unit that is used for the scale will also represent the event counter value.

The following range of values may be used for the scale: 0.001 < range < 32.766. Negative values cannot be used for the scale.

##### Example:

You wish to set the scale of the event counter for a tipping bucket which has 0.01”(0.25mm)/tip.

Command: AS3+0.01!

Response: A\0d\0a

This response confirms that the scale has been successfully set. The event counter readings will henceforth represent inches of rain.

#### 4.3.10. The S2 command

- command: AS2+XY!
- response: A<cr><lf>

Where X: configuration number of channels 1 to 4, Y: event counter configuration.

- Configures channels #1, #2, #3 and #4 for use as single-ended or differential inputs and
- Configures the event counter mode.

‘X’ and ‘Y’ are as follows:

X	Channel#1	Channel#2	Channel#3	Channel#4
0*	Single-ended	Single-ended	Single-ended	Single-ended
1	Differential #1-#2		Single-ended	Single-ended
2	Single-ended	Single-ended	Differential #3-#4	
3	Differential #1-#2		Differential #3-#4	

\*X=0 by default.

Y	Event Counter Mode
0*	Overflow and Switch Closure
1	Overflow and Pulse
2	Read/Reset and Switch Closure
3	Read/Reset and Pulse

\*Y=0 by default.

Differential measurements may be undertaken once the PCOM/AIM is properly configured as shown above (i.e. X=1, 2 or 3). Ensure that the range of the channels to be used is appropriate to the sensor in question. Proper connections of the sensor for differential measurement as follows:

If using channels #1 and #2:

- ‘+V’ sensor connection to #1
- ‘-V’ sensor connection to #2

If using channels #3 and #4:

- ‘+V’ sensor connection to #3
- ‘-V’ sensor connection to #4

The mode-selection feature of the event counter allows the user to configure the system to a particular application. The modes that are available are as follows: Pulse versus Switch Closure modes and Read/Reset versus Overflow modes.

The Switch Closure mode features a “debouncing” capability that is required in order to obtain an accurate count with switches that produce a “noisy” signal. Mechanical switches must be used in Switch Closure mode unless they are “debounced” externally. This mode is limited to a frequency of 10 Hz.

The Pulse mode is to be used with switches that generate electronic pulses, i.e. noiseless signals. This mode allows reliable readings up to a frequency of 5 kHz.

The last Read/Reset and Overflow options are presented as a means to control whether or not the event counter is reset upon retrieval. For instance, if the PCOM/AIM were to be operated by multiple users with a portable computer you may want the event counters to maintain a cumulative count which is not cleared when read; this would require setting them to Overflow mode. Otherwise the event counter may be configured to Read/Reset. While in the Read/Reset mode the event counter is automatically reset to zero when retrieved with an M, C (subsequently D) or R command. Therefore it is the user's responsibility to record the event counter readings upon retrieval since these are then automatically erased. If the event counter should ever reach the 16-bit maximum (65535) it overflows and starts over again.

While in the Overflow mode the event counter is not automatically reset (can be manually reset with the 'aS5!' command). In order to obtain the proper value therefore, the user must subtract the previous reading from the current reading and take overflow into consideration. So if the last reading was 64300 and the current reading is 1200, the actual count would be  $(65536 - 64300) + 1200 = 2436$  counts.

**EXAMPLE 1:**

You wish to configure the PCOM/AIM as follows: channels #1 to #4 for single-ended inputs and set the event counter to mode 1.

Command: AS2+11!

Response: A\0d\0a

This response confirms that the configuration has succeeded. Note that the command 'AM1!' will henceforth load the buffer with the difference between the potential at channel #1 and #2 (see 4.3.3).

**EXAMPLE 2:**

You have connected a -5V to +5V sensor to channels #1 and #2 with '+V' to #1 and '-V' to #2. The event counter is to remain at the default mode of '0'.

Command: AS2+10!

Response: A\0d\0a

The set-up is complete! The converted data for channel #1 as returned by the command 'AM1!' will henceforth be the difference between channels #1 and #2, expressed in Volts. Note that the value returned for channel #2 will represent the potential of this channel with respect to ground, and NOT the difference between #1 and #2. Note that the parameters "Scale" and "Offset" are omitted here because a *Custom Equation* was not specified.

#### **4.3.11. Reset Event Counter**

- command: AS5!
- response: A<cr><lf>

This command is used for resetting the event counter to a count of zero.

**Example:**

you wish to reset the event counter to zero.

Command: AS5!

Response: A\0d\0a

#### 4.3.12. Configure the AVERAGING

- command: AS6+<ch #1,#2,#3 or #4>+<sampling period>+<number of samples>!
- response: A<cr><lf>

where the 'sampling period' is expressed in 0.1 second increments.

PCOM/AIM units, with firmware 119 and later, have a built-in averaging feature for channels #1 to #4. This feature allows the PCOM/AIM to perform multiple samples of an analog sensor with a single command and return the Average, Maximum and Minimum. The samples are based on a user-definable sampling period and number of samples as configured with the 'AS6' command.

Note that the sampling period is expressed in 0.1second increments.

The Average, Maximum and Minimum are obtained with the AM6! (channel#1), AM7! (channel#2), AM8! (channel#3) and AM9! (channel#4) commands as per section 4.3.7. The 'AS6' command sets the parameters used in calculating the average, minimum and maximum in a set of samples. This set is determined by the "sampling period" and the "number of samples" as configured with 'AS6!'. See also the description of the 'AM5!' command in section 4.3.7 Calculate the AVERAGE, MINIMUM and MAXIMUM.

##### Example:

you wish to set channel 3 for 10 samples with 1 second spacing:

Command: AS6+3+10+10!

Response: A\0d\0a

Henceforth, all 'AM8!' will load the buffer with the average, min and max of 10 samples taken 1 second apart. The delay time for the 'AM8!' will be computed as 11 seconds ({number of samples X seconds/sample} + 1 second = 11 seconds).

#### 4.3.13. Configure the Analog Channels

- command: ASA+<channel>+<state>+/-<scale>+/-<offset>!
- response: A<cr><lf>

This command allows the operator to define equations for conversion of the analog data to appropriate engineering units.

As mentioned in the introduction to this manual, the PCOM/AIM is equipped with 8 channels, two of which, channel #7 and #8, are dedicated to maintenance parameters (the primary voltage and the internal temperature). Also, channel#6 is configured as a 0-20V input and channel #5 as an external temperature input. The remaining four channels (channels #1 to #4) provide raw data as per section 1.1.1 PCOM/AIM options. The PCOM/AIM allows the user to define conversion equations to be applied to this incoming raw data. Note that these equations are stored in non-volatile memory and are thus not lost during power-down.

Each channel that is connected to an analog sensor must be configured for that sensor with the 'ASA' command while specifying the proper *State* and a "scale" and "offset" if required. Select the proper *State* from the table below:

STATE	TYPE OF CONVERSION
1	0-5V conversion
2	0-2.5V conversion
3	Custom Equation
4	4-20mA
5	0-2.5V conversion to temperature °C (e.g. AD-34 sensor)
6	0-20V conversion

The analog sensors must be connected (refer to 6.2 Connectors) to the appropriate channels based on the range of output of those sensors.

These various "states" are best explained with a few examples. Further explanations are added where warranted.

#### EXAMPLE 1:

You have connected a 0 to 5V sensor to channel #2 and it is being used to monitor a tank of pressurized gas. You wish to convert the readings to pressure in "PSI". The measurement range of the sensor is 0 to 3000 psi within the operational output range of 0.5 to 4.5V. Assuming that you wish to display the results to one decimal place, proceed as follows:

Command: ASA+2+3+0.05722-375.0!

Response: A\0d\0a

The set-up is complete! The PCOM/AIM will convert the analog data of channel #2 to 'PSI' based on a full-scale value of 3000psi when the sensor outputs 4.5 V and 0psi for 0.5V.

Note that the number of decimal places of the converted data is specified by the value entered for the offset. The number of decimal places of the converted data will be equal to that of the value specified for the "offset". Therefore, given that the offset was expressed to one decimal place in



the example above, the converted data (pressure) will be also be to one decimal place, for example, 1507.4 psi.

The values for “**Scale**” and “**Offset**” are simply determined by the properties of the linear sensor in question:

$$\begin{aligned} \text{Scale} = \text{Slope} &= \frac{(P_{FS} - P_0)}{\{(4.5/5)\text{max. count} - (0.5/5)\text{ max. count}\}} \\ &= \frac{(3000 - 0)}{\{(4.5/5) 65535 - (0.5/5) 65535\}} \\ \text{Scale} &= 0.05722 \end{aligned}$$

Note that the maximum count is equal to  $(2^{16}-1)=65535$  because the conversion is done with 16 bits.

**EXAMPLE 2:**

You have connected a 4-20 mA sensor to channel#3.

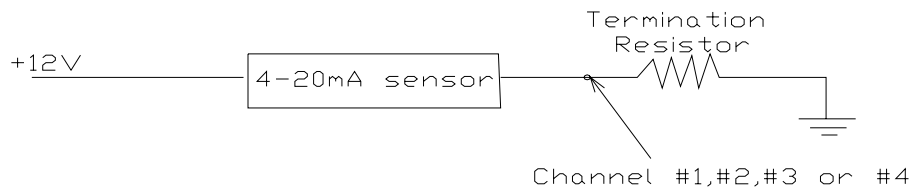
Command: ASA+3+4!

Response: A\0d\0a

The set-up is complete! The 4mA bias has been removed. The analog data of channel #3 will henceforth be converted such that the output range of the sensor is from 0.5 (zero counts) to 2.5V (full scale). By selecting *State’4’*, the user has the option of defining a custom equation by specifying a *Scale* and an *Offset*.

**NOTE:** When connecting a 4-20 mA sensor to the PCOM/AIM be sure to use the proper **precision** resistor (+/-1% tolerance) in series with the sensor in the current loop as follows:

Input range	Proper termination resistor
0-1V (preferred choice for 4-20mA applications)	50Ω
0-2.5 V	125 Ω
0-5 V	250 Ω



**Figure 1. Termination resistor required with 4-20mA output.**

## 5. /SW Option: PCOM-SDI only

PCOM-SDI/SW units are equipped with a switch to enable “SPY” mode. This mode allows a user to monitor all SDI-12 communications on the bus by means of a computer or any other device with a RS232 serial port.

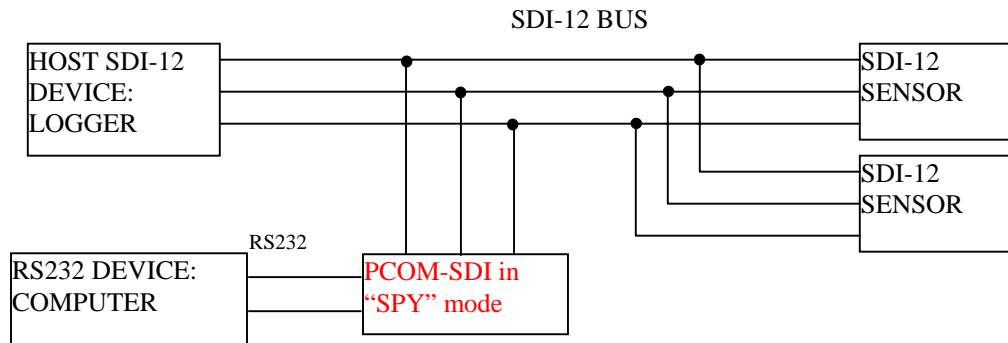


Figure 2. PCOM-SDI in "SPY" configuration.

### ENABLING “SPY” MODE

- Connect the PCOM-SDI/SW as per Figure 2. Connect the SDI-12 bus, Ground and +12VDC:
  - WHITE :SDI-12
  - BLACK: Ground
  - RED: +12VDC
- Connect the PCOM-SDI/SW RS232 connector (DB9S) to your computer serial port.
- Launch your communications application or terminal emulator (eg. Hyperterminal, ...). Set the communications to 9600 baud, 8 data bits, no parity, 1 stop bit.
- Ensure that the toggle switch is in “Normal” mode.
- Confirm communications with the following command:
  - Command: AI!
  - Response: 13PCOM-SDI 150
- Set the PCOM-SDI/SW to “SPY” mode with the following command:
  - Command: ASS!
  - Response: none issued
- Set the toggle switch to “SPY” mode.
- Change the settings of your RS232 serial port to the following in order to monitor the SDI-12 bus:
  - 1200 baud
  - 7 data bits
  - even parity
  - 1 stop bit

Your terminal will now display activity on the SDI-12 bus. Return to “Normal” mode by setting the switch to “normal” mode and by cycling the power to the PCOM-SDI (i.e. performing a reset).

**NOTE:** The PCOM-SDI/SW defaults to “normal” mode upon power-up. Therefore, the switch of the PCOM-SDI/SW must be set to “normal” upon power-up (9600baud, 8 data bits, 1 stop bit, no parity).

## 6. INSTALLATION

### 6.1. Electrical

The PCOM-SDI power source must deliver between +8VDC and +30VDC.

Proper connection sequence is as follows:

- Connect the cable to the PCOM-SDI. Connect the SDI-12 (white or green wire), Ground (Black) and +12VDC (Red).
- With the PCOM-SDI powered up you may then connect the DB9 connector to the RS232 serial port.

ALWAYS ENSURE THAT THE PCOM-SDI IS POWERED-UP BEFORE CONNECTING THE CABLE TO THE RS232 HOST. If this is not respected your serial communications device may “lock-up” and may need to be rebooted.

### 6.2. Connectors

#### PCOM-SDI:

- DB9S for connection to your serial port (RS232 communications )
- Tinned ends for SDI-12, +12VDC and Ground as follows:

<b>Color</b>	<b>Signal</b>
Red	+12VDC
White	SDI-12 data
Black	Ground

#### PCOM/AIM:

To be announced

## 7. SPECIFICATIONS

Processor : Atmel 89S8252 @ 3.6864 MHz.  
Word Size : 8 bit data - 8 bit instruction  
Memory : 89S8252, 256 bytes RAM  
EEPROM 2 kbytes

### INPUT/OUTPUT of ALL PCOM MODULES

- ASCII strings via RS232 data line (standard configuration: RS232 master): 9600 baud, 8 data bits, 1 stop bit, no parity and no flow control  
Can also be configured for SDI-12 master
- SDI-12 protocol (standard configuration):  
Master SDI-12 task engine, auto retries,  
auto data buffer retrieval & auto command  
time-outs.  
Can also be configured RS232 slaves

### Connector

**PCOM-SDI:** DB9S (RS232), tinned ends  
(Red:+12VDC, White:SDI-12 data,  
Black:Ground)

**PCOM/AIM:** 25-pin DB25S comm connector  
(RS-232, SDI-12, +12VDC port, analog inputs  
and outputs)

### Power Supply

Power supplied by a 8 to 30 VDC source.

### Power Consumption

10.5 mA without DB9 connected to host  
17.5mA with DB9 connected to host

### Environmental Characteristics

Operating : -40 to +55 C  
Storage : -60 to +100C  
Humidity : <= 100% non-condensing

### A/D Converter (PCOM/AIM only)

Converter: Crystal CS5524/28  
Type: Delta-Sigma A/D Converter  
Noise-free resolution: 18 bits  
Buffered Bipolar/Unipolar Ranges of 25mV,  
55mV, 100mV, 1V, 2.5V and 5V

### PCOM/AIM Output

2.5V and 5V reference  
250 microAmp constant current source

### PHYSICAL CHARACTERISTICS

**PCOM-SDI:** Height - 25 mm. (1 in.)  
Width - 60 mm. (2.3 in.)  
Depth - 95 mm. (3.75 in.)

**PCOM/AIM:** Height - 152.0 mm. (6.0 in.)

Width - 196.0 mm. (7.75 in.)

Depth - 41.3 mm. (1.625 in.)

Weight : 1 Kg (2.2 lb.)

Mounting : One Mounting bracket, Standard  
Use four #10 bolts or screws.

### PCOM/AIM Input

Internal Temperature ( 0 - 2.5V): Ch#8

Primary Voltage (0 - 20V): Ch#7

One Ext. Voltage (0-20V): Ch#6

One Ext. Temperature (0-2.5V): Ch#5

Two 0-2.5V & Two 0-5V, OR

4-20 OPTION:

Four 4-20 mA

2.5 OPTION:

Four Ext. Voltage (0 - 2.5V)

5 OPTION:

Four Ext. Voltage (0-5V)

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## **PCOM/AIM SDI-12 Command Set**

### **Retrieve Data Commands**

1. Convert both 0-20 V inputs (channels #7 and #6)
  - command: AM0!
  - response: +<primary voltage>+<external voltage>
2. Convert channels #1 and #2
  - command: AM1!
  - response: +<ch #1>+<ch #2>, OR +<ch#1 - ch#2> (see 'S2' command)
3. Convert channels #3 and #4
  - command: AM2!
  - response: +<ch #3>+<ch #4>, OR +<ch#3 - ch#4> (see 'S2' command)
4. Convert the internal (channel#8) and external (ch#5) temperature inputs (both 0-2.5V inputs)
  - command: AM3!
  - response: +< internal temp°C>+<ext. temperature>
5. Calculate the AVERAGE, MAXIMUM and MINIMUM of channels #1, #2, #3 and #4
  1. Command: AM6! (ch#1), AM7! (ch#2), AM8! (ch#3) and AM9! (ch#4)
  2. Response: +<average>+<maximum>+<minimum>  
Response time calculated as a function of parameters set with 'AS6' command
1. Get Event Counter value
  1. Command: AM4!
  - Response: +<event counter>
1. Read value of set-up parameter
  2. Command : AS2?! Or AS6+<ch>?! Or ASA+<ch>?!
  3. Response: A<set-up parameters><cr><lf>
1. Read Gain Register
  - command: ArG#! Where #: a channel number from 1 to 8
  - response: AXXXXXX<cr><lf> whereX: hexadecimal digit
2. Read Offset Register
  - command: ArO#! Where #: a channel number from 1 to 8
  - response: AXXXXXX<cr><lf> whereX: hexadecimal digit

### **Set Commands**

1. The S2 Command
  - command: AS2+XY! Where X: configuration of ch#1-#4 (S.E. or Diff.), Y: mode of the event counter
  - response: A<cr><lf>
2. Configure the AVERAGING feature.
  - command: AS6+<CH#>+<Sampling period>+<Number of samples>!
  3. response: A<cr><lf> where #: 1, 2, 3 or 4
4. Define the conversion equation of channels #1, #2, #3 and #4
  - command: ASA+<CH#>+<STATE>+<SCALE>+<OFFSET>!
  - response: A<cr><lf> where #: 1, 2, 3 or 4

All other commands are reserved for use by the factory for R/W of calibration data into/from the EEPROM.