

///AMASSER PSE-SDI(\D)(\Ev)

Pliant Shaft Encoder (SDI-12 Device)
including the Display option

User Reference Manual

Firmware Revision #181

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<http://www.amassdata.com>

TABLE OF CONTENTS

1. AMASSER SDI-12 SHAFT ENCODER.....	3
1.1. QUADRATURE ENCODER -PRINCIPLE OF OPERATION.....	3
2. SDI-12 PROTOCOL	4
3. SDI-12 AMASSER SE SENSOR COMMANDS	5
3.1. SDI-12 COMMAND SYMBOLS.....	5
3.2. RETRIEVE DATA COMMANDS	5
3.2.1. <i>Get encoder value in scaled units</i>	5
3.2.2. <i>Get minimum or maximum values</i>	6
3.2.3. <i>Start verification command</i>	6
3.2.4. <i>Get event counter values</i>	7
3.2.5. <i>Return data buffer</i>	7
3.2.6. <i>Read encoder value in scaled units</i>	8
3.2.7. <i>Read minimum and maximum values</i>	8
3.2.8. <i>Read the event counter values</i>	9
3.2.9. <i>Return identification string</i>	9
3.2.10. <i>Acknowledge active command</i>	10
3.2.11. <i>Address query command</i>	10
3.2.12. <i>Change SDI device (node) address</i>	11
3.2.13. <i>Read Value of Set-up Parameter</i>	11
3.3. SET COMMANDS.....	12
3.3.1. <i>Set encoder offset</i>	12
3.3.2. <i>Set encoder scale (units per revolution)</i>	12
3.3.3. <i>Set scale of event counters</i>	13
3.3.4. <i>Set mode of event counters</i>	14
3.3.5. <i>Reset event counters</i>	15
4. PSE-SDI\D(\EV) DISPLAY OPERATION	16
5. HOST SOFTWARE OPERATION.....	17
5.1. TROUBLE SHOOTING.....	20
6. INSTALLATION	20
6.1. MECHANICAL	20
6.2. ELECTRICAL.....	21
6.3. CONNECTORS.....	22
<u>6.3.1. Standard SDI-12 models</u>	22
<u>6.3.2. PSE-SDI/RS-485 models</u>	22
7. SPECIFICATIONS	23
APPENDIX A: PSE-SDI(\D)(/EV) SDI-12 COMMAND SET: QUICK REFERENCE.....	24
APPENDIX B: MODE CODES FOR THE EVENT COUNTERS (\EV ONLY)	25

PSE-SDI(\D)(\Ev) AMASSER SDI-12
Pliant Incremental Shaft Encoder
Pliant Technology Specialists

Pliant: readily yielding to influence

1. AMASSER SDI-12 Shaft Encoder

The ///AMASSER Incremental Shaft Encoder is an intelligent and reliable microprocessor-based incremental shaft encoder which may be used with a pulley, tape, and float arrangement to measure stream stage or other fluid levels. Accumulating position data adaptively (hence *pliant*), up to one thousand times per second results in a drastic power consumption reduction.

The standard unit, the PSE-SDI, provides data by means of a SDI-12 cable (see *SDI-12 Protocol*) connected to a Data Collection Platform (DCP) or personal computer. In addition to the features provided by the standard unit there are currently two expansions available: the “\D” option is an 8 digit display with switches that provide an additional interface to the SDI-12 communications , and the “\Ev” option equips the basic unit with 2 event counters.

The optional digital display enables the user to display and set up parameters without the need for a DCP or portable computer. These setup parameters are as follows: the offset and scale of the encoder, the scale and mode of the two event counters (\Ev models only) as well as the node address for SDI-12 communications. Note that the display also allows the user to enter the password that is required to access the setup parameters. When not setting these parameters the display provides the instantaneous position of the encoder , i.e. the water level (see *PSE-SDI\D Display Operation*), as well as the event counts (\Ev models only).

The event counters are 16 bit (0 to 65535) and are practical and adaptable to your needs. They feature mode-selection to configure the firmware to the type of switch that is to be used as well as the way the counter is reset. These modes are as follows: Switch Closure, Pulse, Read/Reset, and Overflow (see 3.3.4). In addition, they feature a setup parameter called *scale* which allows the user to define the value of each count.

The resolution of the encoder is 1/384th of a revolution (standard); when used with a stream stage pulley with a 375 mm circumference, the resolution of the system is 0.98 mm.. When used with a 12.00 inch-circumference pulley, the resolution of the system is 0.03125 inches or 0.0026 feet. It is a two channel optical incremental encoder that contains a lensed LED source, integrated detectors, and a codewheel which rotates between the emitter and the detector. The PSE firmware provides a pulsed LED driver with an adaptive firmware based signal transition detector that provides the 4x quadrature decoder function. This technique of the processor, in conjunction with idle power-down mode, drops the system's current consumption from 45 to 2.3 milliamps (2.5 mA for \D models). A HUGE power savings.

Hardware is powered from a +10.5 to 15 V input for external battery, charger or power supply. A 256byte EEPROM provides non-volatile storage of the device address as well as the following set-up data: the encoder scale and offset, the mode and scale of the event counters (\Ev models only). A 9 V alkaline battery provides backup for a total of approximately 240 hours (220 hrs for \D models) in the event of power supply interruption.

There are no mechanical contacts involved in the measurement process; the only contacting moving parts are the precision shaft bearings. The starting torque is low -- 0.65 inch-oz (47 cm-g) or less -- and the system is not sensitive to vibration. It is housed in a painted aluminum case, and may be installed in exposed locations. It is tested to operate from -40C to +55C, and up to 100% relative humidity.

1.1. Quadrature Encoder -Principle of Operation

The PSE-SDI(\D)(Ev) is provided with an on-board 89C52 microcontroller and firmware which follows the shaft rotation; each transition of either of the quadrature inputs adds or subtracts a count to a 16 bit stored value representing the position of the shaft and therefore the fluid level. A set-up parameter called *scale* is provided to allow the application of a standard-circumference pulley and tape so that the accumulated count represents an accurate fluid level. If using a 1 ft-circumference pulley for instance, the accumulated count would

directly indicate a fluid level in feet by setting the scale = 1.0. The SDI output from the microprocessor is the ASCII code representation calculated to three decimal places and is equal to the position value stored in the internal register divided by 384 (Model K encoder). Communication with an external controller or computer is according to the SDI-12 protocol. The output will be a decimal value in the range +/-999.999 units. The encoder's scale and offset are set using SDI commands, for example, if you are using a 375 mm wheel your scale will be 0.375 and the output will be in meters measured to the nearest mm.. You then have the option of inputting an offset so that if you are 100 meters above sea level and you want your stage to be measured in meters above sea level, you would measure your stage at set-up time, say it was 101.225. You would simply enter 101.225 as your offset and the unit will now track your stage in meters above sea level.

2. SDI-12 Protocol

The Master SDI-12 controller, which may be a portable computer or a DCP equipped with a SDI-12 serial interface, sets an initial offset and units per revolution values for the adaptive quadrature counter and initialises the microcontroller. Commands available to the encoder are listed in the *SDI-12 AMASSER SE Sensor Commands* section. A single computer or controller can supervise an array of up to 10 Incremental Encoders along the 3-wire SDI-12 cable.

The internal microprocessor is normally in an "idle" state; the internal firmware wakes the processor at up to one thousand times per second in order to check the value of the two quadrature outputs from the optical encoder. The polling rate on the SDI port is controlled by the host DAS or DCP.

In order to communicate with a sensor, the controller 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 controller then sends a command selected from below. 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.

The ///AMASSER PSE-SDI(\D)(Ev) Shaft Encoder maintains in its memory a number which represents the current value of the water level, stream stage, or other quantity being measured. Upon receiving the "Measure" (aM!) command, it transfers the current value to the output buffer in the required ASCII format based on the offset and scale parameters; and upon receiving the "Send Data" (aD!) command, the value from the output buffer is sent to the controller.

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>.

3. SDI-12 AMASSER SE Sensor Commands

The PSE-SDI(\D)(Ev) is SDI-12 compatible and as such follows the guidelines set out in that protocol.

3.1. SDI-12 Command Symbols

a : address byte

! : 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>.

Command bytes : one or two byte ASCII character command. Ex.: M0

Identification String : "12AMASS Data PSExxx" where xxx = Revision Level

3.2. Retrieve Data Commands

3.2.1. Get encoder value in scaled units

- command: aM!, aM0!, aC! or aC0!
- response: a0001<cr><lf> data buf: <encoder value>

This command instructs the PSE-SDI(\D)(Ev) unit to measure the current shaft encoder position. The SDI-12 format for the response to this command is : atttn<cr><lf>. As always 'a' is the address byte, 'ttt' is the specified time, in seconds, until the sensor will have the measurement(s) ready and 'n' is the number of measurement values the sensor will make and return in one or more subsequent D commands (see *Return data buffer* below). The implementation of this command to the PSE-SDI(\D)(Ev) yields the response shown above. 'ttt' indicates that the measurement is immediately available for retrieval (000) and 'n' that there was only one measurement made, namely, the encoder value. The measurement is then retrieved using the D! command.

Note that aM! and aM0! are *start measurement* commands whereas aC! and aC0! are *start concurrent measurement* commands. The C commands are favored when a sensor specifies a measurement time of several seconds as they allow the user to send additional commands in the interim. For the encoder measurement, however, the two types are equivalent since it specifies a time of 0 seconds.

Example:

The current host address is 0 and you wish to obtain the current encoder position.

Command: 0M! or 0M0!

Response: 00001\0d\0a

This response indicates that the measurement is immediately retrievable from the buffer and that there was only one measurement made, the encoder position, which may now be retrieved using the D command.

3.2.2. Get minimum or maximum values

- command: aM1! or aC1! (maximum); aM2! or aC2! (minimum)
- response: a0001<cr><lf> data buf <min> or <max>

This command is used to obtain the minimum and maximum values of the encoder position. Minimum and maximum values are determined from a fixed number of samples. Due to the adaptive sampling characteristics of the quadrature encoder the time interval between updates will vary according to shaft rotation speed. Updates of the values occur at least every 1second.

Example:

The current host address is 3 and you wish to obtain the maximum encoder position.

Command: 3C1!

Response: 30001\0d\0a

This indicates that the maximum value is stored in the buffer and can be immediately retrieved using a D command.

3.2.3. Start verification command

- command: aV! or aV0!
- response: a+<data buffer 1>+<data buffer 2>+<data buffer 3><cr><lf>

This command is used to monitor the power supply status of the unit as well as the mode of the event counters (see 3.3.4 *Set mode of event counters*). The data buffers are defined as follows:

Data Buffer 1	Data Buffer 2	Data Buffer 3
<u>EEPROM</u>	<u>Processor Power Supply</u>	<u>Mode of Event Counters</u>
1 (Operational) or 0 (Failure)	1 (Operational) or 0 (Failure)	0 to 15 (mode code)

Example:

The current host address is 0 and you want the status of the power supply as well as the mode of the event counters.

Command: 0V! or 0V0!

Response: 0+1+1+11\0d\0a

This would indicate that the power systems did not fail since the last verification and that the event counters are set to mode 11. To learn the significance of the mode codes refer to section 3.3.4 *Set mode of event counters*.

3.2.4. Get event counter values

- command: aM3! or aC3! (event counter 1); aM4! or aC4! (event counter 2)
- response: a0001<cr><lf> data buf <event count 1> or <event count 2>

This command is used to obtain the event counter values.

Example:

The current host address is 4 and you wish to obtain the reading of event counter 1.

Command: 4C3!

Response: 40001\0d\0a

This indicates that the event counter 1 value is stored in the buffer and can be immediately retrieved using a D command.

Note that the event counter input must not exceed 5 kHz (or 10 Hz in Switch Closure mode) in order to obtain reliable results (see 3.3.4 *Set mode of event counters*).

3.2.5. Return data buffer

- command: aD! or aD0!
- response: a<data buffer><cr><lf>

This command allows the user to read the most recent sensor measurement which was stored in the buffer. It is issued after an M, C or V command and as such is used to read encoder position, minimum and maximum encoder positions, event counters and power supply status.

Example:

The current host address is 0 and the last “Measure” command was 0M0! (measure the current encoder position). The response would typically be as follows:

Command: 0D0!

Response: 0+2.345\0d\0a

This indicates that the encoder position was +2.345 at the moment the 0M0! command instructed the unit to take a measurement. Note that values returned from the buffer are expressed in engineering units that were defined by the user at set-up time. For instance, if the encoder offset and scale had been set to 0.0 m and +0.375m/rev respectively, the position of +2.345 in this example would represent a rise in fluid levels in meters.

3.2.6. Read encoder value in scaled units

- command: aR! and aR0!
- response: a<data buffer><cr><lf>

This command is similar to its M and C equivalents in that it instructs the PSE-SDI(\D)(Ev) to return the encoder position. With the R command however, the value is returned directly to the host without the need for a D command to retrieve the buffer.

Example:

The current host address is 3 and you wish to obtain the encoder position.

Command: 3R0!

Response: 3+2.345\0d\0a

3.2.7. Read minimum and maximum values

- command: aR1! (maximum) or aR2! (minimum)
- response: a<data buffer><cr><lf>

This command is similar to its M and C equivalents in that it instructs the PSE-SDI(\D)(Ev) to return the maximum and minimum encoder values. With the R command however, the value is returned directly to the host without the need for a D command to retrieve the buffer. Note that the maximum and minimum values are swapped when the scale is set negative.

Minimum and maximum values are determined from a fixed number of samples. Due to the adaptive sampling characteristics of the quadrature encoder the time interval between updates will vary according to shaft rotation speed. Updates of the values occur at least every 1 second.

Example:

The current host address is 7 and you wish to obtain the maximum encoder position.

Command: 7R1!

Response: 7+23.341\0d\0a

Therefore the maximum is 23.341 if the scale was set positive, otherwise this is a minimum value.

3.2.8. Read the event counter values

- command: aR3! (event counter 1) or aR4! (event counter 2)
- response: a<data buffer><cr><lf>

This command is similar to its M and C equivalents in that it instructs the PSE-SDI(\D)(Ev) to return the event counter values. With the R command however, the value is returned directly to the host without the need for a D command to retrieve the buffer.

Example:

The current host address 4 and you wish to obtain the value of event counter 2.

Command: 4R4!

Response: 4+94\0d\0a

Therefore, event counter 2 has 94 counts.

Note that the event counter input must not exceed 5 kHz (or 10 Hz in Switch Closure mode) in order to obtain reliable results (see 3.3.4 *Set mode of event counters*)

3.2.9. Return identification string

- command: aI!
- response: a<identificationstring><cr><lf>

This command instructs the PSE-SDI(\D)(Ev) to return its identification string. The SDI-12 format for the response to this command is : allccccccmmmmmmvvvxxx...xx<cr><lf>. 'll' is the SDI-12 version number indicating SDI-12 version compatibility ; for example, version 1.2 is encoded 12. 'ccccccc' is the vendor identification (ex: AMASSData), 'mmmmmm' is the sensor model (ex: PSE), 'vvv' is the sensor version number (ex: 024) and 'xxx...xx' is an optional field not currently used.

Example:

The current host address is 0 and you wish to obtain the identification string.

Command: '0I!'

Response: '012AMASSDATA PSE070\0d\0a'

Therefore the sensor is manufactured by AMASS Data Technologies, it is a PSE-SDI version 070 and is compatible with SDI-12 version 1.2.

Note that the PSE-SDI\D may be distinguished by its version number (presently 116).

3.2.10. Acknowledge active command

- command: a!
- response: a<cr><lf>

This command allows the user to confirm that the current host address is active.

Example:

The current host address is 3 and you would like confirmation that it is active.

Command: '3!'

Response: '3\0d\0a'

This response is confirmation that host address 3 is active.

3.2.11. Address query command

- command: ?!
- response: a<cr><lf>

This command allows the user to obtain the current node address. This command is simply the *acknowledge active* command but substituting the '?' as a wild card for the host address. The result of this "wild card" feature is that a sensor will respond regardless of its node address. The user must realize, however, that if more than one sensor is connected to the bus, they will all respond, causing a bus contention. An SDI-12 sensor must support the wild card character '?' with the *acknowledge active* command and can, but only optionally, similarly support all other commands.

Example:

There is only one sensor on the bus and you wish to obtain its node (device) address.

Command: ?!

Response: 6\0d\0a

The address of the sensor is therefore 6. To resume communications the host address can be updated to 6 or simply left at ?.

3.2.12. Change SDI device (node) address

- command: aA<new address>!
- response: <new address><cr><lf>

This command changes the node address. In order to communicate with the PSE-SDI(\D)(Ev) the host and node addresses must be the same which makes it is necessary to update the host address following a change of node address.

Example:

The current host (and node) address is 4 and you wish to change the node address to 6.

Command: '4A6!'
Response: '6\0d\0a'

This response confirms that the new node address is 6. The host address must now be updated to 6 in order to communicate with the PSE-SDI(\D)(Ev). The user can then confirm that the new host address is active by sending the *acknowledge active* command.

3.2.13. Read Value of Set-up Parameter

- command: aS0?! Or aS1?! Or aS2?! Or aS3! Or aS4?!
- response: a<data buffer><cr><lf>

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

Examples:

1. The current sensor address is 3 and you wish to determine the current value of the shaft encoder "scale".

Command: '3S1?!'
Response: '3+0.375\0d\0a'

The current value of the shaft encoder scale is therefore "+0.375". Recall that the value for the parameter "scale" represents the engineering units equal to one revolution of the shaft and is equal to the circumference of the pulley mounted on the shaft. Therefore "+0.375" might represent 0.375 meters per revolution. Also recall that a positive value for "scale" represents a clockwise rotation of the shaft for rising water levels. Refer to 3.3.2.

2. The current sensor address is 5 and you wish to determine the "scale" of event counter #1.

Command: '5S3?!'
Response: '5+0.25\0d\0a'

The "scale" for event counter #1 is +0.25. Refer to 3.3.3.

3.3. Set Commands

3.3.1. Set encoder offset

- command: aS0<offset>!
- response: a<cr><lf>

This command sets the initial position or offset of the encoder.

Example:

The current host address is 5 and you wish to set the encoder to measure the elevation above sea level. You would measure your stage at set-up time and enter the offset accordingly. For instance, if the stage level is measured as 101.225 meters above sea level you would enter 101.225 as an offset. All levels measured by the PSE-SDI(\D)(Ev) would then be in meters above sea level.

Command: 5S0+101.225!

Response: 5\0d\0a

3.3.2. Set encoder scale (units per revolution)

- command: aS1<scale>!
- response: a<cr><lf>

This command sets the encoder scale according to the size of pulley in use and the direction of shaft rotation. Note that the offset and scale must be set with consistent engineering units, usually ft or m. In addition, when initializing the scale the user must be aware of the direction of shaft rotation with respect to water levels. Clockwise rotation of the pulley represents rising water levels when the scale is positive, otherwise the scale must be set negative.

Example:

The current host address is 4 and you wish to initialize the encoder scale. The pulley is 375 mm in circumference and the shaft turns counter-clockwise with rising water levels.

Command: 4S1-.375!

Response: 4\0d\0a

Note that the scale is entered in meters because the water levels will be measured in meters (not mm). Also note that the scale is entered as a negative value because in this instance the shaft turns counter-clockwise when the water level is rising.

The commands that follow are applicable to \Ev models only.

3.3.3. Set scale of event counters

- command: aS3+<scale>! (counter 1) or aS4+<scale>! (counter 2)
- response: a<cr><lf>

This command is used to set the *scale* of the event counters. 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:

The current host address is 7 and you wish to set the scale of event counter 1 for a tipping bucket which has 0.01”(0.25mm)/tip.

Command: 7S3+0.01!

Response: 7\0d\0a

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

3.3.4. Set mode of event counters

- command: aS2+<mode for event counters>! (refer to APPENDIX B for mode codes)
- response: a<cr><lf>

This command is used to set the mode for the event counters. The mode-selection feature of the event counters 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 four options are applied individually to each event counter and are defined by a mode code as in APPENDIX B. With reference to this table and the brief descriptions that follow the user will easily prepare the event counters for use.

The first two options are in regards to the type of switch to be used. 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 two options are presented as a means to control whether or not the event counters are reset upon retrieval. For instance, if the PSE-SDI\Ev(D) is 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. Alternatively, if the unit is accessed by a data logger which provides date/time stamping the Read/Reset mode is suitable. 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 (and cannot) be reset. 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.

The modes are represented internally as a 4-bit number as defined in the following table. The mode code is the decimal representation of this number and is converted in APPENDIX B as a convenience for the user.

<u>Bit 3</u>	<u>Bit 2</u>	<u>Bit 1</u>	<u>Bit 0</u>
EC 2 Read/Reset (1) or Overflow (0)	EC 2 Pulse (1) or Switch Closure (0)	EC 1 Read/Reset (1) or Overflow (0)	EC 1 Pulse (1) or Switch Closure (0)

The codes are from 0 to 15 and include every combination of option with the event counters. Note that the current mode of the event counters can be determined with the V command (see *Start verification command*).

Examples:

1. The current address is 3 and you wish to set the event counters as follows: event counter 1 to Pulse and Read/Reset modes and event counter 2 to Switch Closure and Overflow modes. The table shows that this corresponds to “0011” which translates to a mode code of 3. Therefore the following command must be sent:

Command: 3S2+3!
Response: 3\0d\0a

This response confirms that the event counters have been successfully set.

2. Event counter 1 to Switch Closure and Read/Reset modes and event counter 2 to Pulse and Overflow modes with a current address of 4. From the table above the binary mode code is found to be 0110, or 6 decimal .

Command: 4S2+6!
Response: 4\0d\0a

3.3.5. Reset event counters

- command: aS5!
- response: a<cr><lf>

This command is used for resetting both event counters to a count of zero.

Example:

The current sensor address is 7 and you wish to reset both event counters to zero.

Command: 7S5!

Response: 7\0d\0a

Both event counters now have a value of zero counts.

4. PSE-SDI\D(\Ev) Display Operation

The PSE-SDI\D(\Ev) comprises an 8 digit display and two double-position switches that control the display and setup of parameters. The setup parameters are only accessible however, once the correct password has been entered. The front of the unit appears as in Fig.1.

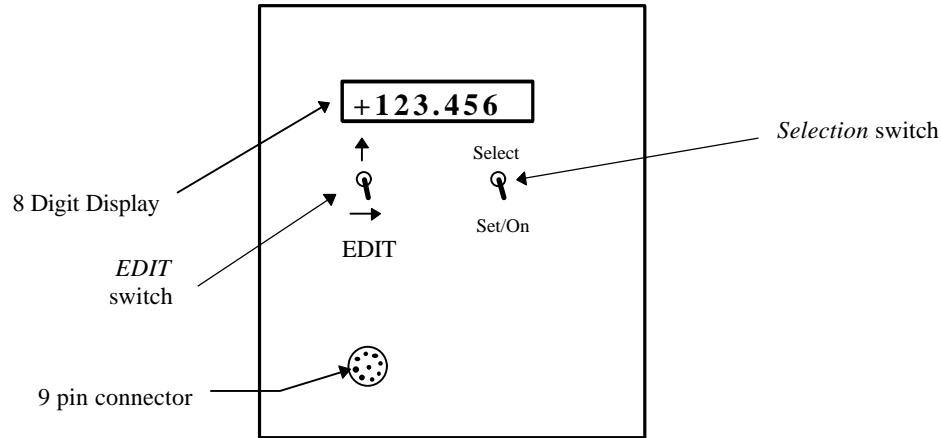


Fig.1 Front view of the PSE-SDI\D(\Ev).

The four switch positions allow the user to display the current fluid level and event counts (\Ev models only) as well as setup the following parameters: the encoder offset and scale, the scale and mode of the event counters (\Ev models only), and the node address for SDI-12 communications.

The right switch is used to *select* the parameter to be displayed and/or altered. It is also used as an enter key to *set* the new values of setup parameters, and as an *on* switch for the display. The left switch allows the user to *EDIT* the value displayed at the screen. The lower position of this switch is labeled with a right-arrow and is used to select the digit that is to be edited; the “active” digit is the one flashing on the screen. The upper position, which is labelled with an up-arrow, edits the active digit by scrolling through the available options: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, ., +, -, .

To use the display to view the current fluid level or event counts simply turn it on with *set/On*. The current fluid level appears. The value of both event counters can then be viewed in turn by using *select*. Note that the event counters are displayed by flashing the label “EVENT 1” or “EVENT 2” followed by its corresponding value. To return to the fluid level display use *select* until “PASSWORD” appears, then once more for the initial display of the fluid level.

To begin the setup of the PSE-SDI\D(\Ev) using the display (setup can also be done using its SDI-12 capability and a DCP or portable computer) switch it on with *set/On*. The current encoder position, i.e. water level, is displayed. Now use *select* until “PASSWORD” appears then use *set/On* (“+000” appears). The default password of “+000” can now be edited to your own using the *EDIT* switch. When entering the four-character password the following characters are valid: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, ., +, -, <space>. The password can only be viewed or altered from the display and must be entered correctly to view the remaining setup parameters. Note that the correct password that was entered to gain entry to the setup parameters can be viewed as long as the display has not switched off with the auto power-off feature (see below). If the display does shut off however, and is turned back on “PASSWORD” will display the default value, namely “+000”, which must be edited once again to obtain access. Never forget your password otherwise you will not be able to change the setup parameters from the display at a later date. In the event that it is forgotten contact AMASS Data Technologies Inc.

When the correct password is entered use *set* then *select* to view the following parameter labels in turn: offset, scale, node address, scale of event counter 1, scale of event counter 2 and event counter mode (\Ev models only). Use *set/on* to view the current value of any one of these parameters. For instance, to display the value of

the encoder scale use *select* until the word “scale” appears, then trigger *set/on*. If you then wish to change its value from, say, +0.375 m to -0.375 m because of the direction of shaft rotation (see 3.3.2 *Set Encoder Scale*) use the *EDIT* switch. Note that the left-most character, the “+” sign, is flashing. The up-arrow edit switch can now be used to obtain the character that you require, i.e. the “-“ sign. The value that now appears is -0.375 and it may be entered by using the *set/on* switch. If the remaining digits had to be changed one would use the right-arrow edit switch to shift the active position on the display from left to right. For example, if the offset (see 3.3.1 *Set Encoder Offset*) is to be changed from +0.000 to +10.123 use the right-arrow to edit each digit in turn from left to right.

From the above it will be noted that the operation of this display is very simple and practical. It is a good practice however, to review the values following a setup session in order to be assured that they were entered properly. In particular, it should be noted that when entering values for the offset and scale the decimal point must be entered as these parameters are floating point variables. The “+” or “-“ sign must also be entered for these parameters. For instance, a scale of +1.000 may be entered as “+1.” but not as “+1”, “1.” or “1”. Use *set/on* repetitively to review the list of parameters and their respective values.

As noted, the value of a parameter is displayed and entered using *set/on*. If the value that is displayed is correct it may be left unaltered by simply reentering it using *set/on*. On the other hand, any changes made to a value that has not yet been saved may be disregarded by using *select*.

The PSE-SDI\D(\Ev) is an SDI-12 device and as such allows all of the above to be accomplished via communication with a DCP or portable computer (see 3.0 *SDI-12 AMASSER SE Sensor Commands*). In addition, the SDI-12 also allows you to obtain minimum/maximum encoder data; a feature not incorporated on the display. The node address by which SDI-12 communication takes place is among the parameters that may be set on the display. This is done in the same manner as with the other parameters: *select* the parameter to be edited, i.e. “Node Adr”, use *set/on* to view its current value, use the *EDIT* switch as required, then enter the value using *set/on*. Given that ten SDI-12 devices may be supported on a given bus, the node addresses are numbered from 0 to 9.

The display comprises an auto power-off feature. It switches the display off following an inactive period of approximately 5 minutes in order to save energy. Note that although the PSE-SDI\D(\Ev) consumes as little as 2.5 mA when the display is off the current consumption is about 90 mA when it is on.

5. Host Software Operation

The demo software that is supplied with the PSE-SDI(\D)(Ev) is menu-driven host software (PSE-SDI.EXE) that may be used as an interface for sending and receiving the proper commands that are described above. To initiate the program type “PSE-SDI” from the command prompt (the program is currently available for MS-DOS and QNX4). Possible command line options include: “PSE-SDI -s com#” where # represents the port number which is being used. When the default port is being used the latter is unnecessary. Another command line option is to use “PSE-SDI -a #” to initiate the program with host address # (host addresses are actually numbered from 0 to 9).

Upon start-up the program displays the main menu with the default host address of 0 displayed at the *Command line prompt*. The user may then confirm that this host address is active, that is, equal to the node address of the device, by selecting item ‘a’ to send the *acknowledge active* command. The display would then be as follows:

[Addr=0] Command? (Command line prompt)

+ - Change Host address (Main menu)
s - Setup menu (Access to *Setup* sub-menu)
r - Read current encoder and event counter values (Access to *Read* sub-menu)
l - Read sensor Identification (all)
a - Request Acknowledgment (a!)
n - Change Node (device) address (aAb!)
v - Start Verification command (aV0!)
m - Send Manual command
c - Toggle Continuous mode
q - Quit

The current node address: 0 (Infoline message)

Sending: '0!' (Communications section)

Received: '0\0d\0a'

The Infoline indicates that the host address is indeed active. If it had not been, the user could have changed the host address to ? by using the '+' item, and then selecting item 'a' to effectively send an *address query* command and in so doing determining the active host address.

The *Change node address* item sets the PSE-SDI(\D)(Ev) node address to something other than the default address of 0. To reestablish communication after such a change the host address must be set to the new node address by using '+'. A successful link occurs if the Infoline message does not display "No response from sensor" (see *Trouble Shooting*). One can always confirm that the current host address is active by using the *acknowledge* or *identify* items.

Items 'i' and 'v' are to send the *identification* and *verification* commands respectively (see 3.2.9 and 3.2.3).

Initializing the parameters of the PSE-SDI(\D)(Ev) unit is accomplished in the *Setup* sub-menu. For instance, to set the initial position of the encoder press '0' from the sub-menu. The command line then prompts the user to enter the encoder position. Upon entering the position the *communications section* displays the command being sent and received by the host PC as a result of your menu selection. The InfoLine then displays "Encoder set" or the error message "No response from sensor" (see *Trouble Shooting*). The screen would appear as below if the position had been set to 101.225. To return to the main menu press the *ESC* key.

Note that when initializing the scale with item '1' the user must be aware of the direction of shaft rotation when the water level rises as described in section 3.3.2.

[Addr=0] Command? (Command line prompt)

0 - Set encoder Position (aS0+x!) (Setup sub-menu)
1 - Set encoder Scale (aS1+x!)
2 - Set mode of event counters: Pulse, Switch, Read/Reset and Overflow (aS2+x!)
3 - Set event counter 1 scale(aS3+x!)
4 - Set event counter 2 scale(aS4+x!)

Encoder set (Infoline message)

Sending: '0S0+101.225!' (Communications section)

Received: '0\0d\0a'

Item '2' of this menu is used to set the mode of operation of the event counters (\Ev models only) which provide the user with some control as to how the counters are reset as well as being able to configure them for use with either mechanical switches or electronic pulse-generating-type switches (see 3.3.4 *Set Mode of Event Counters*).

Items '3' and '4' are used to set the scale of the event counters as described in section 3.3.3.

Obtaining shaft encoder and event counter readings is accomplished in the *Read* sub-menu. For instance, to get the current shaft position one would select '0'. The following would then be displayed on the screen:

[Addr=0] Command? (Command line prompt)

0 - Get current Encoder position (aM0!,aD!) (Read sub-menu)

1 - Read minimum and maximum encoder values (aM1!,aM2!,aD!)

3 - Get event counter 1 (aM3!,aD!)

4 - Get event counter 2 (aM4!,aD!)

m - Send Manual command

c - Toggle Continuous mode

Encoder position is: 101.225

Sending: '0M0!'

Received: '00001\0d\0a'

Sending: '0D!'

Received: '0+101.225\0a\0a'

Note that two commands were required to obtain the reading as described in *SDI-12 AMASSER SE Sensor Commands*.

Item 'm' allows the user to type any command which appears in the *SDI-12 AMASSER SE Sensor Commands* section. This is done at the *command line* at the following prompt: "Manual cmd:". When entering manual commands however, the host address need not be put at the beginning of the string since the current host address is added by the software before it is sent to the PSE-SDI(\D)(Ev). For instance, the command aR0! should be entered as R0!.

Press 'c' to enter the *continuous mode*. In this mode any subsequent readings will be continuously updated at the Infoline. For instance, if the current encoder value had been viewed in *continuous mode* in the example above, the instantaneous position would be displayed at the InfoLine as the shaft rotates. Any menu item may be selected while in continuous mode. Manual commands may also be viewed in continuous mode by pressing 'm' so that the last manual command that was entered is continuously updated. When in the *continuous mode* the command line reads: [Addr=0] Continuous command ?.

The command line editor that appears when entering manual or set commands uses a buffered input which allows the user to edit what is typed before it is entered. It also allows one to recall previous entries by using the up and down arrow keys at the command prompt.

5.1. Trouble Shooting

Problem: The InfoLine displays “No response from sensor”

Solutions:

- You must use a RS232 to SDI-12 interface such as the “CONV-SDI” available from AMASS Data Technologies Inc. Without this product your PC cannot communicate with the PSE-SDI(\D)(Ev). Contact ADT for the current price of the CONV-SDI.
- The current host address is not active, that is, it is not equal to the node (device) address. If these addresses are not equal there cannot be communication between host and PSE-SDI(\D)(Ev). The default address for both host and PSE-SDI(\D)(Ev) is 0, however, if one is changed the other must be updated to resume functions. To determine the current node address the user can send the *Address Query* command by selecting host address ‘?’ (located after ‘9’) and by selecting the *acknowledgment* item from the main menu.
- The improper port was specified upon startup of the host software. Recall that the port designation is specified as a command line option. For instance, if the connection is made on “com2” the startup would be as follows: “PSE-SDI -s com2”.
- Of course, a faulty connection is possible. Check the integrity of all connections.
- No power to PSE-SDI(\D)(Ev).
- Reset the PSE-SDI(\D)(Ev) and reattempt a command. To reset simply remove the connector from the PSE-SDI(\D)(Ev) and reconnect. Note that the initial position of the shaft, i.e. the configuration parameter “offset”, will have to be reentered if you wish the encoder to monitor the correct stage level.

6. Installation

6.1. Mechanical

All AMASSER Incremental Shaft Encoders may be attached to a flat surface using #10 bolts or screws through the four holes located in the mounting brackets on the PSE-SDI(\D)(Ev) housing as shown in Fig.2. When installed to measure water level, it may be attached to a horizontal or vertical surface in a gauge house, with the shaft extending horizontally over the stilling well. A pulley is mounted to the unit by means of the aluminum clamping assembly which is threaded to the shaft.. The clamping assembly accepts standard L&S or F&P pulleys. Any model may be used to indicate the position of any shaft which can be coupled or geared to the encoder shaft. With suitable mechanical coupling, linear positions may also be measured. For more information on the physical characteristics of the PSE-SDI(\D)(Ev) refer to *Specifications*.

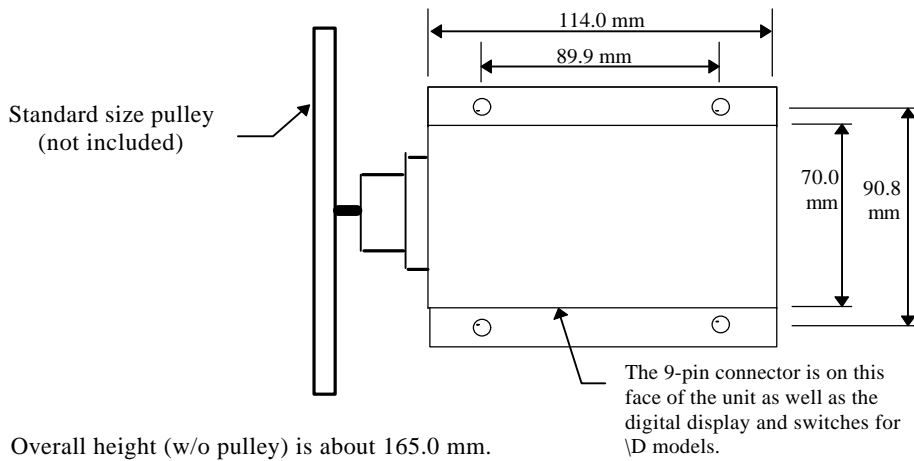


Fig 2. Top view of PSE-SDI(\D)(Ev) with mounting brackets installed.

The sensor may be installed in any orientation that a particular application may require. Weights or other mechanical loads at right angles to the shaft centre line should not exceed 10 lb (4.5 kg). Larger loads will distort the bearings, increase the starting torque, and decrease the bearing life.

6.2. Electrical

The Encoder is internally protected against transient voltages and lightning surges on the signal input lines. However,

IT IS ESSENTIAL TO PROVIDE PRIMARY EXTERNAL LIGHTNING PROTECTION.

The 9 V battery backup is only enabled when the 9 pin connector is secured to the unit. Therefore if the connector remains mounted to the unit the 9V battery will provide backup if the power supply fails or becomes disconnected (at the power supply, not the PSE-SDI(\D)(Ev)). If the connector is removed at the PSE-SDI(\D)(Ev) however the buffers are cleared and the unit must be reinitialized using the *Setup sub-menu*. This is because the connector closes the backup circuit through pins 7 and 9 (see *Connectors*) so that if it is not mounted the 9V battery-backup facility becomes disabled. Note that the backup is provided regardless of whether the cable is connected to a source or not as long as the connector is mounted to the PSE-SDI(\D)(Ev). The open circuit that results when the connector is not mounted means that the PSE-SDI(\D)(Ev) can be stored without depleting the 9 V battery.

The event counter input must not exceed 10 Hz when in Switch Closure mode or 5 kHz when in Pulse mode (applicable to \Ev models only, see 3.3.4).

6.3. Connectors

6.3.1. Standard SDI-12 models

1 9 pin AMP CPC Connector

Connections are as follows:

PIN	SIGNAL	Cable Color
1	+ 12 Vin	Red
2	Event 1	Blue
3	Ground	Black
4	SDI Data	White
5	Event 2	Green
6	Ground	Brown
7	+9 V bat input	Jumper across 7and 9
8	none	none
9	+9 V battery	Jumper across 7and 9

6.3.2. PSE-SDI/RS-485 models

1 9 pin AMP CPC Connector

Connections are as follows:

PIN	SIGNAL	Cable Color
1	+ 12 Vin	Red
2	Event 1	Green
3	Ground	Black
4	none	none
5	Event 2	Black
6	DATA	Black
7	+9 V bat input	Jumper across 7and 9
8	DATA*	white
9	+9 V battery	Jumper across 7and 9

7. Specifications

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

Shaft Encoder

K-Model

Sensor type - two channel optical incremental encoder 96 x 4 counts per revolution
Resolution - 384 counts per revolution;
software conversion to engineering units provided in firmware. (Units per revolution)

Range

+/- 32.0 m with .375 m circumference pulley
+/- 85.3 ft with 1.00 ft circumference pulley

Max. Response Speed

2.5 rev/sec.

Output

SDI-12 protocol :

- ASCII accumulated level
- 2 event counters (\Ev models)

Event Counter Input (\Ev models)

5 kHz max. (Pulse mode)
10 Hz max.(Switch Closure mode)

Physical Characteristics

Height : 152.0 mm. (6.0 in.)
Width : 114.0 mm. (4.5 in.)
Depth : 70.0 mm. (2.75 in.)
Weight : 1.35 Kg (3.0 lb.)
Mounting : Four Mounting brackets, Standard
Use four #10 bolts or screws.

Connector

9 pin AMP CPC Connector
Current Carrying Capability - 1.5 Amp rating
Dielectric Withstanding Voltage >1500V

Power Supply

+10.5 to 15 VDC input for external battery, charger or power supply

Power Consumption

< 2.3 mA (2.5 mA for \D models)quiescent current at shaft encoder for a sample rate of once per second.
maximum current : < 30 mA (with display off)

Battery Backup

9 V 565 mAHr alkaline battery backup
(Only if 9 pin connector is mounted)

Mechanical Interface

Threaded shaft

1/4 x 32 thread plus clamp assembly
#303 stainless

Maximum safe load

10 lb 4.5 kg.

Starting Torque

0.65 inch-oz (47 cm-g) max.

Environmental Characteristics

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

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APPENDIX A: PSE-SDI(\D)(/Ev) SDI-12 Command Set: Quick reference

Retrieve Data Commands

1. Get encoder value in scaled units
 - command: aM!, aM0!, aC! or aC0!
 - response: a0001<cr><lf> data buf: <encoder value>
2. Get minimum or maximum values
 - command: aM1! or aC1! (maximum); aM2! or aC2! (minimum)
 - response: a0001<cr><lf> data buf <min> or <max>
3. Start verification command
 - command: aV! or aV0!
 - response: a+<data buffer 1>+<data buffer 2>+<data buffer 3><cr><lf>
4. Get event counter values
 - command: aM3! or aC3! (event counter 1); aM4! or aC4! (event counter 2)
 - response: a0001<cr><lf> data buf <event count 1> or <event count 2>
5. Return data buffer
 - command: aD! or aD0! Response: a<data buffer><cr><lf>
6. Read encoder value in scaled units
 - command: aR! or aR0! Response: a<data buffer><cr><lf>
7. Read minimum and maximum values
 - command: aR1! (maximum) or aR2! (minimum) Response: a<data buffer><cr><lf>
8. Read the event counter values
 - command: aR3! (event counter 1) or aR4! (event counter 2)
 - response: a<data buffer><cr><lf>
9. Return identification string
 - command: aI! Response: a<identificationstring><cr><lf>
10. Acknowledge active command
 - command: a! Response: a<cr><lf>
11. Address query command
 - command: ?! Response: a<cr><lf>
12. Change SDI device (node) address
 - command: aA<new address>! Response: <new address><cr><lf>
13. Read Value of Set-up Parameter
 - command: aS0?!, aS1?!, aS2?!, aS3?! or aS4?! Response: a<data buffer><cr><lf>

Set Commands

1. Set encoder offset
 - command: aS0<offset>! Response: a<cr><lf>
2. Set encoder scale (units per revolution)
 - command: aS1<scale>! Response: a<cr><lf>
3. Set mode of event counters (\Ev models only)
 - command: aS2+<mode for event counters>! (refer to APPENDIX B for mode codes)
 - response: a<cr><lf>
4. Set scale of event counters (\Ev models only)
 - command: aS3+<scale>! (counter 1) or aS4+<scale>! (counter 2)
 - response: a<cr><lf>
5. Reset event counters
 - command: aS5! Response: a<cr><lf>

APPENDIX B: Mode Codes for the Event Counters (\Ev only)

Mode code	EC2 R/R or Overflow	EC 2 Pulse or Switch	EC1 R/R or Overflow	EC 1:Pulse or Switch
0	Overflow (0)	Switch Closure(0)	Overflow (0)	Switch Closure(0)
1	Overflow (0)	Switch Closure(0)	Overflow (0)	Pulse (1)
2	Overflow (0)	Switch Closure(0)	Read/Reset (1)	Switch Closure(0)
3	Overflow (0)	Switch Closure(0)	Read/Reset (1)	Pulse (1)
4	Overflow (0)	Pulse (1)	Overflow (0)	Switch Closure(0)
5	Overflow (0)	Pulse (1)	Overflow (0)	Pulse (1)
6	Overflow (0)	Pulse (1)	Read/Reset (1)	Switch Closure(0)
7	Overflow (0)	Pulse (1)	Read/Reset (1)	Pulse (1)
8	Read/Reset (1)	Switch Closure(0)	Overflow (0)	Switch Closure(0)
9	Read/Reset (1)	Switch Closure(0)	Overflow (0)	Pulse (1)
10	Read/Reset (1)	Switch Closure(0)	Read/Reset (1)	Switch Closure(0)
11	Read/Reset (1)	Switch Closure(0)	Read/Reset (1)	Pulse (1)
12	Read/Reset (1)	Pulse (1)	Overflow (0)	Switch Closure(0)
13	Read/Reset (1)	Pulse (1)	Overflow (0)	Pulse (1)
14	Read/Reset (1)	Pulse (1)	Read/Reset (1)	Switch Closure(0)
15	Read/Reset (1)	Pulse (1)	Read/Reset (1)	Pulse (1)

R/R: stands for 'Read/Reset'. In this mode the event counter is cleared upon sampling. If the count exceeds the 16-bit maximum (65536) prior to sampling it overflows to 0 and starts over.

OVERFLOW: Otherwise known as 'roll-over', in this mode the event counter is cumulative. When the count exceeds the 16-bit maximum (65767) it overflows to 0 and starts over.

PULSE: In this mode the event counters are set to count pulses. The maximum frequency is 5 kHz.

SWITCH CLOSURE: In this mode the event counters are set to count switch closures and accommodate moderately noisy signals which are typical of switch closures. The minimal period of the closure is 20 msec.