SDI-Link
WSDI-M / WSDI-S / WSDI-SIO

Users Manual

OPERATIONS & MAINTENANCE MANUAL

Slave Station

Master Station

Part No. 8800-1179

Rev. 1.21

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1.   Introduction

The SDI-LINK is a *transparent SDI-12,* low power, wireless link that use a 2.4GHz FHSS (Frequency Hopping Spread Spectrum) transceiver with a LOS (line of sight) range up to a mile. A SDI-LINK network consists of one master (WSDI-M) connected to an SDI-12 data recorder and at least one slave (WSDI-S). Each Slave unit can be connected to one or more SDI-12 sensors. The SDI link can also be configured to function as a transparent bi-direction wireless RS232 link.

Features

- 1 mile LOS range

- Transparent drop-in SDI-12 v1.3 link replacement. (No special address requirements)

- Low power consumption.

- Built-in Solar Power input / battery charging circuitry.

- Over the air network configuration and control via SDI-12 commands

- RSSI level indication to indicate Signal strength.

- Multiple Networks can co-exist without interfering with each other.

- Multiple Slaves per Master.

- Transparent RS232 data mode

- SDI-12 <-> RS232 link.

2.   Quick Start

Unpacking

Remove the WSDI-M and WSDI-S units from the shipping container and visually inspect the unit for signs of damage during shipment. Report any such damage to the factory immediately to ensure a prompt response and resolution. Retain one shipping container in the event a factory return is necessary.

Please note that if a return is required, a return material authorization (RMA) number is required. To get this RMA number, call the Sutron Customer Service Department at 703 406 2800.

The antenna has both a 90 degree swivel and it also has the ability to rotate around the RP-SMA connector that it is connected to. The antenna is oriented downward for shipment to prevent breakage and should to be rotated around the RP-SMA connector into an upward orientation upon installation.
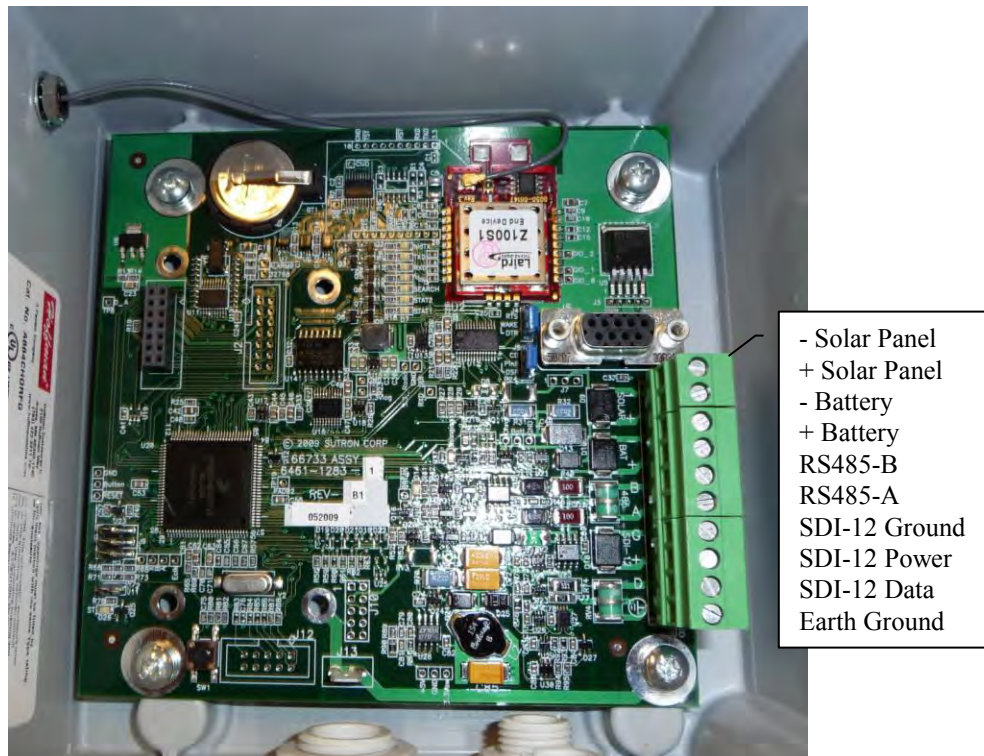

Figure 1 - Demonstrating Antenna Orientation

- Solar Panel
+ Solar Panel
- Battery
+ Battery
RS485-B
RS485-A
SDI-12 Ground
SDI-12 Power
SDI-12 Data
Earth Ground

Figure 2 - Interior showing antenna nut and terminal block

Connections

SDI-12 cables, battery cables, and solar panel cables can be feed into the enclosure through the water tight cable glands in the bottom of the enclosure. The cables are then connected to the terminal block in the enclosure.
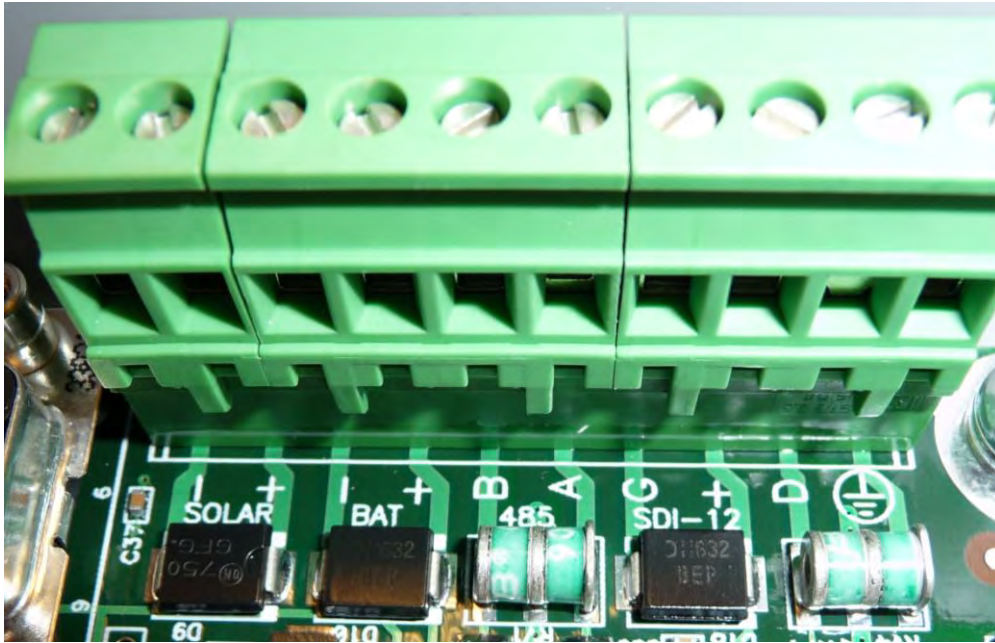
Figure 3 - Closeup of terminal block connections

WSDI-M
The WSDI–M connects to the data logger as any other SDI-12 sensor would. Only three wires are required.

Pin	Description
G	SDI-12 Ground
+	SDI-12 + power
D	SDI-12 Data (logger)

WSDI-S
The WSDI–S fulfills the role of data recorder for the remote sensors. As such, there is the provision to connect a battery to power the unit and the connected SDI-12 sensors. There is also a built in solar panel regulator designed to accommodate 7 AH and larger 12V sealed lead acid batteries. The regulator is designed to handle panels up to 20 W in size.

Pin	Description
SOLAR -	Solar panel Ground
SOLAR +	Solar Panel +power
BAT -	Battery negative (-) or ground terminal
BAT +	Battery positive (+) terminal
G	SDI-12 Ground
+	SDI-12 + power
D	SDI-12 Data(sensor/s)

Powering UP

Connect the WSDI-M/ WSDI-S as indicated above. The red SEARCH LED on the WSDI-S will light up indicating that the unit is searching for a network to join. Once the SEARCH LED is off the network is ready for operation.

The WSDI-M and WSDI-S are SDI-12 sensors themselves and can be polled for various parameters such as signal strength.

Note: To facilitate easy setup with most configurations, the WSDI-M and WSDI-S have default addresses of 8 and 9 respectively. Their addresses can be changed with the standard SDI-12 address change command if these address conflict with other SDI-12 sensors in the system.

3.   Terminal Block Connections

The WSDI-S and WSDI-M have a ten position terminal block that supports plug in screw terminals. The screw terminals are a two position and two four position as described below and in the previous section

Signal	Description
SOLAR -	Solar Panel negative (GND)
SOLAR +	Solar Panel positive
BAT -	Battery Negative (GND)
BAT +	12v Battery positive terminal
RS485-B	(Future feature)
RS485-A	(Future feature)
GND	Supply & SDI-12 Signal Ground
POWER	WSDI-M: 8 to 16 VDC supply input WSDI-S: SDI-12 bus supply line
SDI-12 Data	SDI-12 data line (WSDI-M/ WSDI-S)
Earth Gnd	For transient protection of SDI-12 bus

The WSDI-M would be connected to a Data Recorder via the SDI-12 connections as would any SDI-12 sensor. There is no need for further battery or solar panel connections.

From the SDI-12 sensor's perspective, the WSDI-S replaces the data recorder on the remote end of the connection. The SDI-12 sensors would connect to the WSDI-S just as they would to an SDI-12 data recorder. While power could be applied to the SDI-12 bus to power the WSDI-S and the sensors, the WSDI-S provides the capability to connect a battery directly to it and have the WSDI-S power the SDI-12 bus. It also includes a built in regulator to allow a solar panel to also be connected to keep the battery charged.

Solar Panel Connections

The solar panel connections provide the input to the battery charger regulator. Provisions are made in the circuitry to prevent discharge of the battery through the solar panel at night. No external reverse blocking diode is needed. In addition, the regulator is of a series pass type which means that a 15V DC power supply could be connected to the solar panel inputs to float charge the battery. The charger is designed for a 12V sealed lead acid (SLA) battery "gel cell" and has a built in temperature coefficient to accommodate the temperature dependent charging requirements of a gel cell. The regulator is designed to handle solar panels up to 20W in size. It also designed for 7AH and larger batteries. The regulator's output connects to the battery terminals. Whenever there is sufficient voltage applied to the solar panel inputs to charge the battery, the charging led will light up on the board.

Battery Connections

The battery connections are where a battery can be connected to power the unit. This is expected to be a 12V sealed lead acid battery if the battery charger capability of the solar panel connections is being utilized because this battery will be charged by the solar panel regulator. Connecting a battery is optional in that the unit can also be powered via the SDI-12 bus. The battery input is separate from the SDI-12 power and unit will be powered from which ever is the higher voltage.

SDI-12 Connections

The unit has the standard three wire SDI-12 connections, power, ground, and data. The unit can either be powered via SDI-12 or, it can power the SDI-12 bus. If it is powering the SDI-12 bus, then the bus voltage

will be a fraction of a volt below that of the battery terminals. In addition there is an earth ground terminal. This is separate from the power supply grounds and is intended as a transient shunt connection for the SDI-12 bus. For the best transient protection, it should be connected to a good earth ground.

4.   Setup and Operation

SDI-LINK Network basics

The concepts of a network-id discussed below is only relevant when multiple systems are being setup near one another, in which case, each system can be given its own id, a network-id, so it will not interfere with other systems.

A SDI-LINK network consists of ONLY one master (WSDI-M) and one or more slave (WSDI-S) modules with the same **Network-ID**. All slave units must have the same **Network-ID** as the Master in order to be able to join the Master's network. For the purpose of simplicity, the **Network-ID** can be represented by an imaginary physical wire connecting each **WSDI-S** module to the **WSDI-M** having an identical **Network-ID**, in a star-like topolog**y.** Multiple networks each with their own Master and Slave(s) can coexist within range of each other, provided they have unique **Network-IDS**. The default **Network-ID** (WSDI-M and WSDI-S) for all modules is „2". No two WSDI-M modules with the same **Network-ID** should be within range of each other. All Slaves automatically join a Network having a Master with the same **Network-ID** as their own. The WSDI-M and WSDI-S units themselves behave as SDI-12 sensors with factory default addresses of „8" and „9" respectively. There is no requirement to actually address these units; therefore high addresses were chosen to decrease the likelihood of having to configure the units before using them. The WSDI-M processes all SDI-12 commands addressed to itself and forwards all other SDI-12 commands over the radio to ONLY those WSDI-S modules that are part of its own network. Similarly the WSDI-S processes all SDI-12 commands addressed to it and relays all other SDI-12 commands to the SDI-12 sensors connected to it. Due to this relaying action, the SDI-12 data recorder must issue retries as specified in the SDI-12 standard, but there are no additional requirements about having to address the SDI-LINK units. On receiving a response from any SDI-12 sensor connected to it, the WSDI-S forwards the response back to the WSDI-M over the radio. The WSDI-M on receiving the response relays the response to the Data-Logger over the SDI-12 bus in compliance with the SDI-12 v1.3 specification.

A RS232 port has been provided to enable device configuration using a standard PC. In addition the RS232 port can be configured to act as a transparent bi-directional data link between the Master and the Slave. Initiating an RS232 connection automatically disables the SDI-12 bus.

Modes of operation

The WSDI-M and WSDI-S modules can be used in two primary modes.
- SDI-12 protocol mode
- Command Line mode

SDI-12 protocol Mode

To use the SDI-12 commands you must have a data logger or interface that supports the SDI-12 standard. More details on the SDI-12 interface can be found at http://www.sdi-12.org. The data-logger must support retries in accordance with the SDI-12, v1.2 specifications. In the SDI-12 protocol mode. One or more SDI-12 compatible sensors may be connected to each of WSDI-S modules in the network. In the SDI-12 protocol mode the green status LED near the lower left corner will blink once every 2 seconds to indicate normal operation. The SDI-12 mode of operation is a truly transparent mode of operation requiring no additional programming on the data logger side.

Command Line Mode

The command Line mode supports communication over a RS232 port. To enter the Command-line mode, connect the RS232 port on the WSDI-M/WSDI-S to a DTE (baud rate = 1200, no parity, 8 data bits, 1 stop bit). On initiating an RS232 connection, the SDI-12 hardware is automatically disabled. In the *command-line* mode any SDI-12 command sent to the WSDI-M over the SDI-12 bus will be ignored. Similarly the WSDI-S will not talk to any SDI-12 sensor connected to it over the SDI-12 bus when a RS232 cable is connected to it. However, initiating an RS232 session on the WSDI-M has no effect on the operation of WSDI-S whatsoever and vice-versa. On initiating an RS232 connection the WSDI module will respond with a „>" prompt to indicate that it is ready. In the **command-line** mode, the green status LED blinks twice (in quick succession), every 2 seconds.

In the command-line mode, the WSDI units can be configured to operate in the **configuration mode** (default) or **transparent-RS232 mode,** using a simple command (refer command table). The mode is retained the next time the units are powered up.

Configuration Mode

The configuration mode can be used to configure various parameters of the WSDI module. All commands in the command table are supported in the configuration mode and must be followed by a „carriage-return" character (ENTER keystroke if using hyperterminal or any similar application).
The WSDI-M processes all commands it receives over the command-line that are addressed to itself and broadcasts all other commands over the radio to all Slaves that are part of its own network.
The Slaves processes all commands they receive from the Master, that are addressed to themselves and relay all other commands over the SDI-12 bus to SDI-12 sensors connected to it (if a RS232 connection is not active). If the Slave is in the command-line mode (RS-232 connection is active), then all commands received from the Master that are not addressed to the slaves are ignored.
The Slaves only process commands that it receives over the command-line that are addressed to it. Any command sent to the slave over the command line that is not addressed to the slave itself is ignored.

Transparent-RS232 mode

In the **transparent mode**, the Master broadcasts all data coming in over the command line to all slaves in its network. The Slaves stream all data received from the Master out through the RS232 port regardless of whether it is in the **transparent mode**. If no RS232 cable is connected to the WSDI-S, the transparent-RS232 data received from the Master is ignored.
The Slaves send incoming data received over the command line, to the Master. To exit the transparent mode and enter the **configuration mode,** use command aXTXMD+0! Where „a" is SDI address of the WSDI module. The receiving module does not have to be in the transparent mode to receive transparent data. A detailed description of the command can be found in the command table below.

Installation

To achieve maximum range and performance ensure that all slave units have line of sight view of the Master. Connect the WSDI-M to a SDI-12 compliant data logger. Connect the WSDI-S to Solar panel and battery and SDI-12 Please refer to the previous section on connections for instruction on connecting SDI-LINK modules to SDI-12 data recorder, SDI-12 sensors, a battery and solar panel.

The SDI LINK includes mounting feet for mounting to a flat surface, for mounting to a pipe, the optional mounting bracket kit should also be ordered.

Optional Mounting Bracket Kit (6661-1300-1)
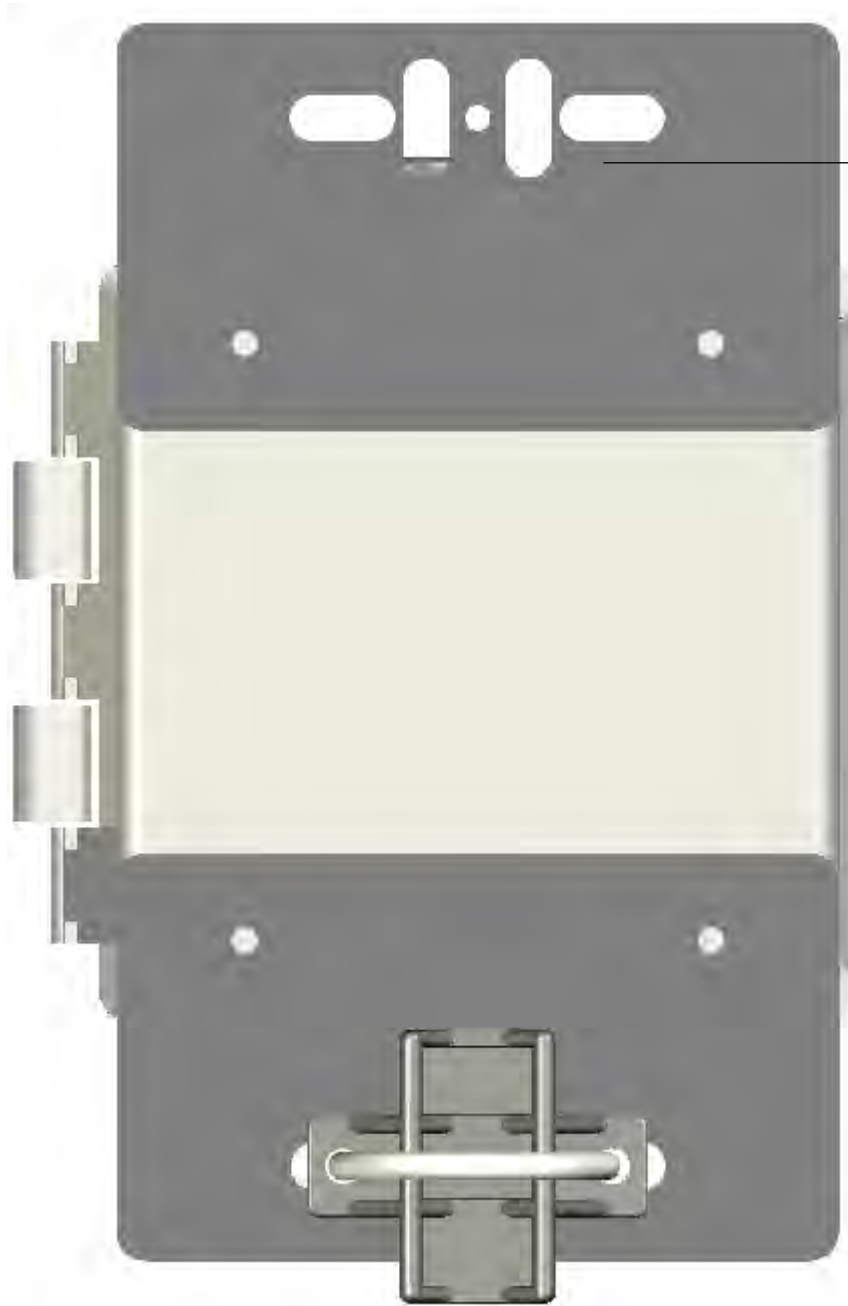
U-bolt and alignment bracket hidden to show slot details.

The optional mounting bracket kit provides an easy way to mount the SDI LINK to a 1.5" standard pipe. The kit includes the mounting plates, alignment bracket and u-bolts. The mounting plates are designed to allow other u-bolts and/or hose clamps (not provided) to allow mounting to 1" and 2" pipes as well.

Sensor Configuration

The SDI-LINK modules themselves behave as SDI-12 compliant sensors with and will respond to all SDI-12 commands according to version 1.3 of the standard.

The general form of an SDI-12 command is:

aC!<CR><LF>

Where a is the sensor address 0-9,A-Z,a-z,*, ?. (Addresses * and ? will address any sensor, regardless of its address.)
C is the command and ! is the last character of the command.

It is expected that the user is familiar with SDI-12 and this section is written accordingly.

Setup steps

Verifying Communication

After powering on the Master and Slave modules ensure that the red SEARCH led on the master and slave is not lit, indicating that master and slave(s) have paired up.   (Red Search Led goes out on the slave once they have paired up).
Confirm communication to the WSDI-M by issuing the Identify command – 8I!
Note: „8" is the factory default address for the WSDI-M. If the unit had been configured for another address, then send the identify command to the appropriate address. The WSDI-M module"s reply should be

a13 SUTRON WSDI-M1.0ssssssssAvvv	Where:
a	SDI-12 address
1.3	supports SDI version 1.3 commands
SUTRON	manufacturer SUTRON
WSDI-M	Sutron model number for WSDI-M
1.0	hardware revision level

If you do not get a reply, check the address setting for the Master by making sure that it is the only sensor on the SDI-12 bus and using the query address command
?!
The sensor will respond with its address.

The radio link can be tested by issuing the identify command – 9I!
Note: „9" is the factory default address for the WSDI-S. If the unit had been configured for another address, then send the identify command to the appropriate address. The WSDI-S module"s reply should be

a13 SUTRON WSDI-S1.0sssssssAvvv	Where:
a	SDI-12 address
1.3	supports SDI version 1.3 commands
SUTRON	manufacturer SUTRON
WSDI-S	Sutron model number for WSDI-S
1.0	hardware revision level

If the slave unit does not reply, disconnect all SDI-12 sensors from the SDI-12 bus connected directly to the logger and also ensure that all other WSDI-S units are turned off except the one being tested. If the Network-ID of the Master or slave has been changed, set the Network-ID of the Master to that of the slave module. Test the communication link by issuing SDI-12 command 9I! (Refer to the command reference table for details on changing the Network-ID).

Setting sensor Address

 Once communication with a sensor(s) has been verified, the address can be changed to the desired address by using the change address command. If multiple SDI-12 sensors are to be connected to a data recorder, then each must be assigned a unique address. Since the Master and Slave modules are SDI-12 sensors, ensure that all SDI-LINK modules and SDI-12 sensors connected to the salves and directly to the data logger have unique SDI-12 addresses. If one or more SDI-12 sensors have duplicate address, connect one sensor at a time and change their addresses using the change address command.

0An!	where 0 is the current address of the device, n is the new SDI-12 address (0 to 9, A to Z, a to z).

As an example, the following command would set the sensor's address to 5:

0A5!

The sensor will respond with the new address which is 5.

Subsequently, the address can be set to a different address, 9 for example, by the command:

5A9!

After changing the address, the identify command should be issued to the new address to confirm that everything is operating as expected.

Measurements

The SDI-LINK modules support four classes of measurement commands as specified by the SDI-12 specification.   It supports the M, MC, C, and CC classes. This sensor returns the same measured values for identically numbered commands in all four classes.

To measure the RSSI level as seen by the module, the M (or MC, C, CC) command is used. It returns one RSSI data value. The RSSI level varies from 0(no signal) to 255 (max signal strength). The command also returns the system voltage and the solar panel voltage. Note: The system voltage is higher of the voltages applied to the battery connection and the SDI-12 power connections.

Factory Programmed Default Measurements

The Analog measurements (applicable to WSDI-SIO only) assume these **default values**:

Command	I/O board Pin(s)	Warm-up (seconds)	Averaging (seconds)	Slope	Offset	Description
M1,C1,CC1	1,2	0.010	0.067	N/A	N/A	0-5V A
M2,C2,CC2	1,3	0.010	0.067	N/A	N/A	0-5V B
M3,C3,CC3	6,7	0.010	0.067	N/A	N/A	Diff C
M4,C4,CC4	8,9	0.010	0.067	N/A	N/A	Diff D
M5,C5,CC5	10,11	0.010	0.067	N/A	N/A	4-20mA Input
M6,C6,CC6	12,13	N/A	N/A	0.01	0.0	Counter/Tipping Bucket
M7,C7,CC7	18,19	0.010	0.067	N/A	N/A	Diff E
M8,C8,CC8	20,22	0.0	0.760	N/A	N/A	Frequency measurement
M9,C9,CC9	N/A	N/A	N/A	N/A	N/A	For future use

5.   Command Reference

The SDI-LINK modules are compliant with and will respond to all SDI-12 commands according to version 1.3 of the standard. To use the SDI-12 commands you must have a data logger or interface that supports the SDI-12 standard. More details on the SDI-12 interface can be found at http://www.sdi-12.org.

The general form of an SDI-12 command is:

aC!<CR><LF>

where a is the sensor address 0-9,A-Z,a-z,*, ?. (Addresses * and ? will address any sensor, regardless of its address.)
C is the command and ! is the last character of the command.

Standard SDI-12 commands

Command	Name	Command	Response	Notes
?	Query SDI Address	?!	A where a= address	Only one SDI-12 device should be connected to the bus since all will respond.
	Acknowledge Active	a!	A	
I	Send Identification	aI!	For a master the expected response is a13 SUTRON WSDI-Mv.vv a 13 SUTRON manufacturer WSDI-M model number - Master v.vv software revision number for slaves a13 SUTRON WSDI-Mv.vv a 13 SUTRON manufacturer WSDI-S model number - Slave v.vv software revision number	Identification string for the SDI-LINK modules.
A	Change Address	aAb! Example: 0A5!	B Indicating new address example 5	Ensure that the addresses of the WSDI-M and WSDI-S modules are unique and also not identical to any other SDI-12 sensor connected to the WSDI-S or directly to the data logger.

Command	Name	Command	Response	Notes
M MC C CC	Request RSSI level	aM! (or MC, C, CC) Ex : <u>8M!</u> aD0! Ex: 8D0!	atttn a+RSSI+System Voltage+Solar Voltage n values available in ttt seconds. Use D0 to retrieve data. Ex: 8+40+13.5+18.0	The RSSI level is the RF signal strength seen by the radio receiver on the addressed SDI-LINK module. The RSSI level varies from 0 to maximum signal strength of 100. The System voltage is the higher of: Battery or SDI-12 power The Solar Voltage is the voltage seen between the Solar panel input terminals

Extended SDI-12 commands

Command	Name	Command	Response	Notes
XNWID	Set/display Network ID	aXNWID+*NewID*! Where *NewId* = new Network-ID. Example 0XNWID+3! 0D0! aD0! Ex: 8D0!	atttn a+NWID where NWID is the new Network-ID Ex: 0+3	This command can be addressed to Slave and Master modules. Sending the NWID without providing a NewID parameter queries the existing network ID. Note: When changing the network ID, change the network-ID of all slaves first **before** changing the network-ID for the master module. If the master is mistakenly changed first, it will have to be changed back to the slave network ID and have the slave re-associate with it before the slave network-ID can be changed.

XNWST	Scan SDI addresses of all slaves modules in the network (valid for WSDI-M units only).	aXNWST! Ex: 8XNWST! ——————— aD0! Ex: 8D0!	a00305 Maximum of 30 values in 5 seconds Example 8+9 One WSD-S module found at address „9"	Returns the SDI addresses of all WSD-S modules having the same Network-ID as the WSDI-M module.
XTXMD	Enter/Exit transparent mode	aXTXMD+ *NewMode*! *NewMode* = „1" : Enter transparent command-line mode *NewMode* = „0" Enter configuration mode. Example 8XTXMD+1! 8D0! ——————— aD0! Ex: 8D0!	atttn *a+NewMode* n values available in ttt seconds. Use D0 to retrieve data. Ex: 8+1	This command can be addressed to Master/ Slaves from the Master to enter transparent/ configuration mode. If using the command-line on the slave, this can be directly addressed directly to the slave.
Extended comands to configure Analog Options. NOTE: Issuing the command and then an aD0! will return the values, preceeded by the assoiciated M number (i.e. 0XVA!, then 0D0! Will return 0+1+.067+0.01, where the second 1 is telling you M1 is how to read voltage A)				
XVA	Modify/read 0-*5V A* configuration.	aXVA+*Avg*+*Warm-up*! *a: Sd*i Address of module *Avg*: Averaging time in seconds *Warm-up*: Warm-up time in seconds aXVA+FD! *a: Sd*i Address of module *FD*:Factory Default Averaging and warm-up	atttn a+m+Avg+ Warm-up n values available in ttt seconds. Use D0 to retrieve data	Use XVA to change the warm-up and averaging time in seconds or reset them to factory defaults for input *0-5V A*. **Default values** *Avg* = 0.067s *Warm-up* = 0.010s
XVB	Modify/read 0-*5V B* configuration.	aXVB+*Avg*+*Warm-up*! *a: Sd*i Address of module *Avg*: Averaging time in seconds *Warm-up*: Warm-up time in seconds aXVB+*FD*! *a: Sd*i Address of module *FD*:Factory Default Averaging and warm-up	atttn a+m+Avg+ Warm-up n values available in ttt seconds. Use D0 to retrieve data	Use XVB to change the warm-up and averaging time in seconds or reset them to factory defaults for input *0-5V B*. **Default values** *Avg* = 0.067s *Warm-up* = 0.010s

XDC	Modify/read *Diff C* *c*onfiguration.	aXDC+*Avg*+*Warm-up*! *a*: Sdi Address of module *Avg*: Averaging time in seconds *Warm-up*: Warm-up time in seconds aXDC+FD! a: Sdi Address of module FD:Factory Default Averaging and warm-up	atttn a+m+Avg+ Warm-up n values available in ttt seconds. Use D0 to retrieve data	Use XDC to change the averaging and warm-up associated with input *Diff C* or reset them to factory defaults **Default values** *Avg* = 0.067s *Warm-up* = 0.010s
XDD	Modify/read *Diff D* *c*onfiguration.	aXDD+*Avg*+*Warm-up*! *a*: Sdi Address of module *Avg*: Averaging time in seconds *Warm-up*: Warm-up time in seconds aXDD+FD! a: Sdi Address of module FD:Factory Default Averaging and warm-up	atttn a+m+Avg+ Warm-up n values available in ttt seconds. Use D0 to retrieve data	Use XDD to change the averaging and warm-up associated with input *Diff D* or reset them to factory defaults **Default values** *Avg* = 0.067s *Warm-up* = 0.010s
XCM	Modify/read *4-20mA Input measurement c*onfiguration.	aXCM+*Avg*+*Warm-up*! *a*: Sdi Address of module *Avg*: Averaging time in seconds *Warm-up*: Warm-up time in seconds aXCM+FD! *a*: Sdi Address of module FD:Factory Default Averaging and warm-up	atttn a+m+Avg+ Warm-up n values available in ttt seconds. Use D0 to retrieve data	Use XCM to change the averaging and warm-up associated with input *4-20mA Input* or reset them to factory defaults **Default values** *Avg* = 0.760s *Warm-up* = 0.0s
XDE	Modify/read *Diff E* *c*onfiguration.	aXDE+*Avg*+*Warm-up*! *a*: Sdi Address of module *Avg*: Averaging time in seconds *Warm-up*: Warm-up time in seconds aXDE+FD! *a*: Sdi Address of module FD:Factory Default Averaging and warm-up	atttn a+m+Avg+ Warm-up n values available in ttt seconds. Use D0 to retrieve data	Use XDE to change the averaging and warm-up associated with input *Diff E* or reset them to factory defaults **Default values** *Avg* = 0.067s *Warm-up* = 0.010s

XFM	Modify/read *Frequency measurement c*onfiguration.	aXFM+*Avg*+*Warm-up*! *a*: Sdi Address of module *Avg*: Averaging time in seconds *Warm-up*: Warm-up time in seconds aXFM+FD! *a*: Sdi Address of module *FD*:Factory Default Averaging and warm-up	atttn a+m+Avg+ Warm-up n values available in ttt seconds. Use D0 to retrieve data	Use XFM to change the averaging and warm-up associated with frequency measurement input *F* or reset them to factory defaults **Default values** *Avg* = 0.760s *Warm-up* = 0.0s
XTB	Modify/read *Tipping bucket/counter* measurement *c*onfiguration.	aXTB+*Slope*+*Offset*+*initial Count*! *a*: Sdi Address of module *Slope*: Slope to be applied to number of tipping counts. *Offset*: Offset to be applied to number of tipping counts. *Initial Count*: Initial Tip count (set to zero to reset count) aXTBm+FD! *A:* Sdi Address of module *FD*: Factory Default slope and offset	atttn a+m+Slope+ Offset +Current Tip Count n values available in ttt seconds. Use D0 to retrieve data	Use XTB to modify the Slope and Offset associated with the tipping bucket input *CNTR IN* or reset them to default values. **Default values** Slope =0.01 Offset = 0
XCLBD	Modify RS232 port baud rate	aXCLBD+*new baud*! a: Sdi Address of muodule new baud : New Baud rate	atttn a+*new baud* n values available in ttt seconds. Use D0 to retrieve data	Use XCLBD to modify the baud rate for the RS232 port. This change applies to both modes (command mode and transparent)

6.   Troubleshooting and Maintenance

Troubleshooting

The following checklist will help in troubleshooting problems:

Problem	Possible Cause
No response from WSDI-M	Faulty wiring – check all wiring and terminations
	No power – check fuse in the data recorder and power at sensor. There is no fuse in the sensor itself.
	Wrong address requested -- make sure the data recorder is set up to request data at the proper address
	Wrong address set in sensor -- use the identify command to make sure the sensor is responding to the proper address.
	Command or address is wrong case – all commands are capital letters, make sure address is proper case and commands are upper case.
Garbled / no response when a SDI-12 command is addressed to a slave.	Multiple Slaves at same address. Issue a network status command (XNWST) to the master and check for duplicate addresses. Slave has not joined the Network. Ensure that the Slave and the Master have the same Network ID (refer command Table).
WSDI units do not respond to SDI-12 commands addressed to themselves.	Check if the units are in command line mode. Disconnect the RS232 cable from the WSDI-M/WSDI-S.
No response from SDI-12 sensors connected to slave units.	- Check if the Slave is in command line mode. Disconnect the RS232 cable from the Slave. - Check for SDI sensors with duplicate SDI addresses. - SDI address of the sensor may be same as the WSDI-S/WSDI-M module.
No prompt in command line mode.	- Check communication parameters like baud rate, parity, and number of stop bit. - Wrong SDI address used in commands
No response for commands sent over command line.	Check if the WSDI module is in the transparent mode. Issue command *XTXMD+0! To exit transparent mode.
Garbled data	Multiple sensors set to the same address -- check address settings of all SDI sensors. Remove all other sensors from the recorder and add them one at a time.
	Command issued to a wild card address (* or ?). Remove all other sensors from the recorder and try again.

Missing data	- Ensure that the WSDI-M has line-of-sight visibility with all slaves in its network - If multiple networks are co-located, noise caused by the RF switching circuitry may in some situations cause disturbances in a receiver located nearby, leading to data loss. To reduce crosstalk between networks, physically separate networks by a few feet.

Maintenance

Maintenance of the unit should be performed at regular intervals which are dependent upon the conditions of use. Typical maintenance for the unit consists of checking the wiring to make sure it is not corroded or frayed and examining the unit to ensure that there is no physical damage.

FIRMWARE Upgrade

Sutron˝s SDI-LINK has been designed using the most modern techniques such that at any time the system firmware may be upgraded while it is in the field preventing the need to ever return a unit to the factory for firmware upgrades. The factory may offer new features or bug fixes that may only be accessed through firmware upgrades. The technique below will illustrate how to install the upgraded firmware into the unit.

The first step is to download from the Sutron web site the program upgrade file, such as „v1_12mainWirelessSdi1283.upg‟, found at http://www.sutron.com/downloads/software.htm. Select the SDI-LINK and download the UPG file to a temporary folder or desktop location where it may be accessed at a later time.

Open and run HyperTerminal on a PC that has a serial port connected to the internal DB-9 of the SDI-LINK. Set the HyperTerminal session properties to:
> Baud Rate: 115200
> Bits: 8
> Parity: None
> Stop Bits: 1

- Start with the unit powered DOWN.
- Open the serial port with HyperTerminal.
- Power up the unit simultaneously while holding the „Escape‟ key on the keyboard of the computer running HyperTerminal. Release the escape key once the unit has powered up and the character C starts appearing on the computer screen.
- An upper case "C" will repeat every 2 seconds or so over the serial port. At this time, use „Send File‟ and choose „Y-Modem‟ and then select the upgrade file name previously stored on the computer.
- Once the download is completed, the system will reboot.

Appendix A – Specifications

RANGE
> Up to 1 mile Line of Sight (LOS)

TEMPERATURE
> Range   -40°C to +60°C

ELECTRICAL

Supply Voltage	8-16 VDC (Requires at least 10V for WSDI-S if it is powering the SDI-12 Bus)
Current	WSDI-S 6 mA quiescent typical WSDI-M 7 mA quiescent typical
Protocol	SDI-12 V1.3

PHYSICAL – NEMA 4X lockable enclosure

Dimensions	7.5" x 7.5" x 5" plus 6" for antenna
Cable Glands	Two Water Tight PG9 for 0.16-0.31" diameter cables One Water Tight ½" NPT for 0.20-0.35" diameter cables

Ordering Information

WSDI-M	SDI-LINK Master
WSDI-S	SDI-LINK Slave
WSDI-SIO	SDI-Link Slave with I/O

Accessories

5100-0030	7 Amp-hr Battery
5100-0040	24 Amp-hr Battery
5100-0410-1	20 Watt Solar Panel with Mount
6661-1300-1	Mounting bracket kit
6661-1306-20	20 feet low loss cable

Appendix B – FCC information

If the antenna is mounted at least 20cm (8 inches) from nearby people, the application is considered a mobile application (versus a hand held portable application).

> ⚠️ WARNING! This equipment has been approved for mobile applications where the equipment should be used at distances greater than 20 cm from the human body (with the exception of hands, feet, wrists, and ankles). Operation at distances of less than 20 cm is strictly prohibited and requires additional SAR testing.

Contains FCC ID: KQL-2510100

The enclosed device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) This device must accept any interference received, including interference that may cause undesired operation.

Appendix C –WSDI-SIO

Sensor Connections

Analog measurements involve reading a voltage or current provided by a sensor. Analog sensors come with instructions that provide information on how to translate the output voltage into desired units. Translating the analog sensor output into environmental units can be done via slope and offset (Please refer extended commands table for details) for simple sensors.

Two terminal blocks are provided for making connections to analog and digital sensors. These blocks are located inside WSDI-SIO. The terminals are numbered 1 to 22. The following table gives a short description of each of the terminals. Detailed notes describing how to connect sensors to the terminal blocks are provided in the <u>setup section</u> of this manual.
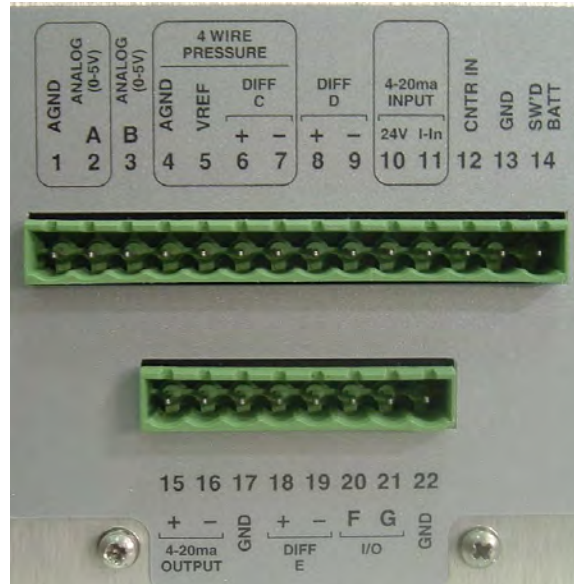

Terminal Block (UPPER)

In the above picture, the circled areas are intended to assist the user in connecting a sensor to the proper group of wires. The section below will help define the input types.

Terminal Block	Description	Notes
1	AGND	Analog ground
2	Analog 0-5V „A‟	Voltage input for sensors with 0-5V output
3	Analog 0-5V „B‟	Voltage input for sensors with 0-5V output
4	AGND	Analog ground
5	VREF	2.5V output (turned on during warmup and analog sensor measurement)
6	DIFF „C‟ (+)	Differential voltage input for bridge type sensors
7	DIFF „C‟ (-)	
8	DIFF „D‟ (+)	Differential voltage input for bridge type sensors
9	DIFF „D‟ (-)	
10	24V (4-20ma)	24 Volt output for 2 wire 4-20ma sensor
11	I-Input (4-20ma)	Current input for 2 wire 4-20ma sensor
12	Counter Input	Digital input (discrete)
13	Gnd	Digital ground
14	SW‟D Batt	Switched battery (turned on during warmup and analog sensor measurement)
15	4-20ma Output (+)	For calibration purposes only
16	4-20ma Output (-)	For calibration purposes only
17	GND	Digital ground
18	DIFF „E‟ (+)	Differential voltage input for bridge type sensors
19	DIFF „E‟ (-)	Differential voltage input for bridge type sensors
20	I/O „F‟	Frequency/period measurements
21	I/O „G‟	For Future use
22	GND	Ground

Analog Input

Single Ended Input Voltage (0 to 5 Volts) 0-5V A, 0-5V B

This input is designed to be a general purpose 0-5 volt dc input. While sometimes referred to as a single ended input, it is designed to measure voltage with respect to analog GROUND. This input has a high impedance (>2 Meg Ohms) and will not load down or draw significant current. Two inputs are labeled "Analog 0-5V "on the panel, they are „A‟ and „B‟.
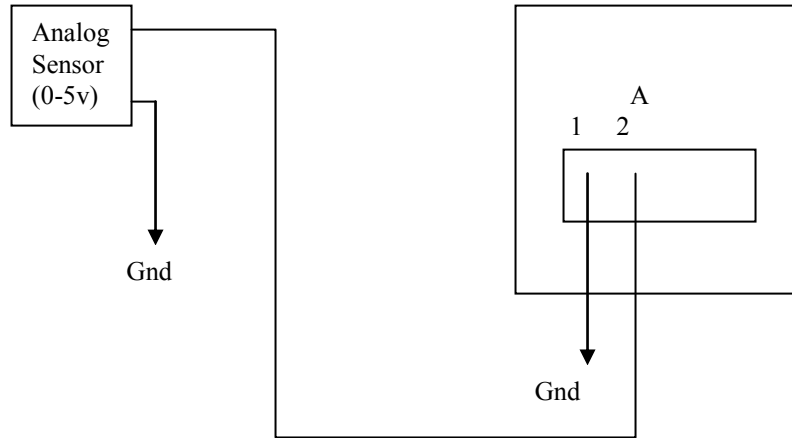
When the measurement type "Analog A 0-5" is selected, the system will make a voltage reading from the sensor connected on the input labeled Analog "A". It will then apply the user entered SLOPE and OFFSET to convert the voltage reading to a stage level by applying the following equation:

$$Stage = (Voltage * SLOPE) + OFFSET$$

Differential Input Voltage (+/- 39mV range) Diff C, Diff D, Diff E

This input is designed to operate with a special type of analog output found on many pressure sensors that use a "bridge" configuration or any sensor that outputs a very small voltage. This input type has a "+" and "-" input that connects to the sensor output.
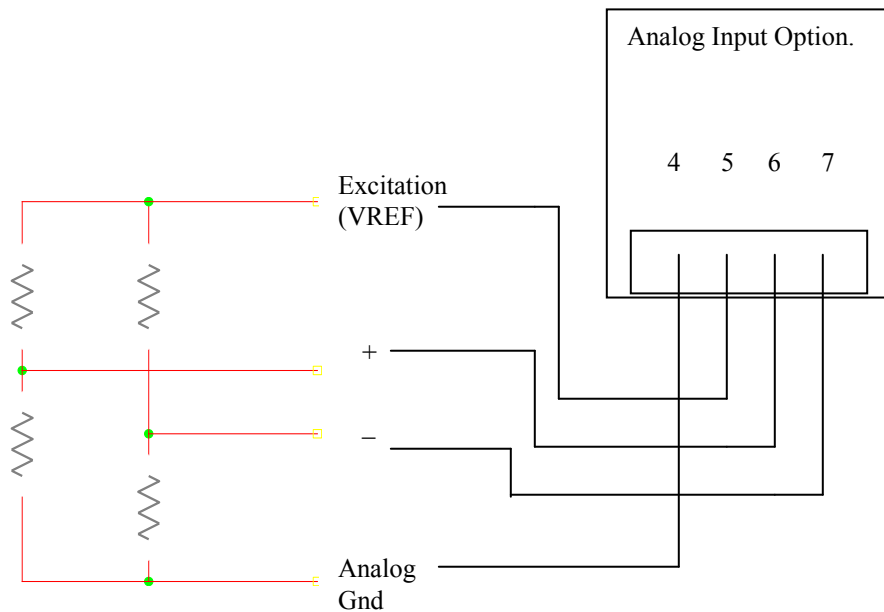

Typically a bridge sensor will be powered on "VREF" (sometimes referred to as excitation), have a "signal +" and "signal −", and provide a wire for the analog ground. NOTE: If after wiring the sensor, it displays a negative reading, you may reverse the "+" and "-" leads coming from the sensor.

NOTE: The common mode voltage for differential sensors is 0.5V to 3.7V. If the sensor is floating, it should be tied to VREF and not to AGND in order to maintain this common mode voltage. Sensors that are not powered by WSDI-SIO are generally floating (such as a pyranometer).

4 to 20 ma Current Loop Input

This input is designed to function with sensors that have a 4 to 20ma current loop interface. This type of interface is superior to voltage outputs when the cables to the sensors must travel a long distance or when the equipment is located in electrically noisy environments. WSDI-SIO will measure the current flowing when connected to the „4-20ma Input". Typical 4-20ma sensors will give a 4 to 20ma current for a 0 and 100% FS. Readings that are greater than 21mA will be considered a fault. The current required for the sensor is provided by the 2 wire loop and does not typically require additional connections. WSDI_SIO provides a 24 Volt supply that is designed just for the 2 wire interface 4-20ma loop.
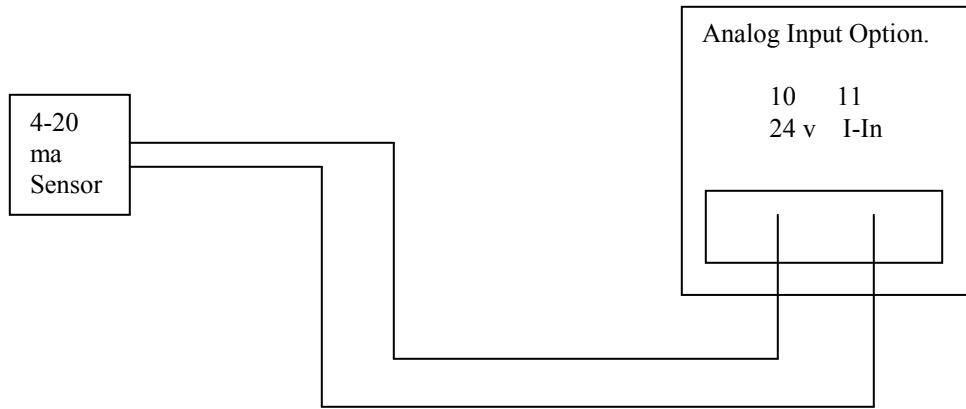
Example loop powered sensor.

Digital Input

WSDI-SIO supports the following types of digital inputs:
- o   Input F (terminal 20)
- o   Counter/Tipping bucket (terminal 12)

Frequency Measurement

- *Frequency measurement* (terminal 12) can be used to measure sensors that output a frequency. . Additionally, the RM Young sensor type requires the use of this input too.
- *Frequency* will have WSDI-SIO sample the input for pre-configured amount of time (Refer Extended command table). It will provide a result that is the average frequency of the input during that time span. If no signals are noticed on the input during the time, the measurement is considered bad.
- *Slope* and *Offset* can be applied (Refer Extended command table)

Counter/Tipping bucket

WSDI-SIO can be setup with a tipping bucket in order to measure rainfall. Precipitation accumulation is used to tally the total amount of precipitation since the station has powered up. Count is set to zero whenever the unit resets.

Usually, a slope is applied to convert the counts from the tipping bucket into inches of rain. For example, setting the *Slope* to 0.01 means that one hundred counts from the tipping bucket equal to one inch of rain.

Warmup

Analog/digital sensors are powered by WSDI-SIO via one of several outputs:
- VREF (reference voltage) which provides 2.5V
- Switched Battery which provides whatever voltage is powering MONITOR, presumably 12V

- 24V which is normally used for 4-20mA sensors

Normally, these outputs are off. Prior to making an analog measurement, WSDI-SIO will turn on these outputs.   After that, WSDI-SIO waits *Warmup* amount of time (which is expressed in seconds) before measuring the output of the sensors. This *Warmup* time gives the sensors a chance to power up and prepare

If *Warmup* is set to zero, WSDI-SIO will not wait at all prior to measuring. The value *Warmup* should be set to depend on the analog sensor being measured.

Averaging

The WSDI-SIO can be setup to do **simple averaging**, meaning that it will collect data the user specified amount of time. Once the time is up, it will sum up all the samples and divide the sum by the number of samples collected. Averaging time should be used for noisy sensors and for choppy water surfaces.

If averaging time is zero (which is the default), no averaging is done. If it is not zero, the unit will collect data for however long the averaging time is setup for. The value can be set anywhere from 0 seconds (no averaging) to 900 seconds (15 minutes).

Appendix D – Sutron Customer Service Policy

CUSTOMER SERVICE POLICY

Dear Customer:

Thank you for making the important decision to purchase Sutron equipment. All Sutron equipment is manufactured and tested to the highest quality standards as set by **Sutron's Quality Assurance Department.** Our Customer Service Representatives have years of experience with equipment, systems, and services. They are electronic technicians with field and applications experience, not just with a technical background.

Customer Phone Support
Customer Service Representatives routinely handle a wide variety of questions every day. If questions arise, please feel free to contact me or one of the Customer Service Representatives. We are available from 8:00 am to 5:00 pm Monday through Friday and will be happy to take your call.

We can answer most sensor and interface questions on the first call. If we cannot quickly answer a question on an interface, we will work with you until we find a solution.

Sometimes a problem is application related. Although we pride ourselves on handling 95% of application related questions over the phone, we maintain constant contact with our Integrated Systems Division and Engineering Division for additional assistance.

Introductory Training
Training is an important part of the Sutron Customer Service philosophy. The Sutron training policy is simple---If you buy Sutron equipment, you get Sutron training! Without the proper training, you cannot take advantage of the benefits and advantages that Sutron equipment provides. We often supply on-site introductory training at your facility for no charge. You provide the classroom, students, equipment, and coffee---we'll provide the instructor.

On-Site Visits
Of course not all problems can be fixed over the phone. Sometimes a customer needs an on-site technician to identify site related problems or troubleshoot a network. Sutron can provide these services at a reasonable cost. Call for details. If you would like to learn more about Sutron products email sales@sutron.com

Thanks again for your order,

Paul Delisi
Customer Service Manager
Sutron Corporation

Appendix E– Commercial Warranty

SUTRON MANUFACTURED EQUIPMENT

THE SUTRON CORPORATION WARRANTS that the equipment manufactured by its manufacturing division shall conform to applicable specifications and shall remain free from defects in workmanship and material for a period ending two years from the date of shipment from Sutron's plant.

Sutron's obligation under this Warranty shall be limited to repair at the factory (22400 Davis Drive, Sterling, VA 20164), or at its option, replacement of defective product. In no event shall Sutron be responsible for incidental or consequential damages, whether or not foreseeable or whether or not Sutron has knowledge of the possibility of such damages. This warranty shall not apply to products that have been damaged through negligence, accident, misuse, or acts of nature such as floods, fires, earthquakes, lightning strikes, etc.
Sutron's liability, whether in contract or in tort, arising out of warranties or representations, instructions or defects from any cause, shall be limited exclusively to repair or replacement parts under the aforesaid conditions.
Sutron requires the return of the defective electronic products or parts to the factory to establish claim under this warranty. The customer shall prepay transportation charges to the factory. Sutron shall pay transportation for the return of the repaired equipment to the customer when the validity of the damage claim has been established. Otherwise, Sutron will prepay shipment and bill the customer. All shipments shall be accomplished by best-way surface freight. Sutron shall in no event assume any responsibility for repairs or alterations made other than by Sutron. Any products repaired or replaced under this warranty will be warranted for the balance of the warranty period or for a period of 90 days from the repair shipment date, whichever is greater. Products repaired at cost will be warranted for 90 days from the date of shipment.

NON-SUTRON MANUFACTURED EQUIPMENT

The above Warranty applies only to products manufactured by Sutron. Equipment provided, but not manufactured by Sutron, is warranted and will be repaired to the extent of and according to the current terms and conditions of the respective equipment manufacturers.

REPAIR AND RETURN POLICY

Sutron maintains a repair department at the factory, 22400 Davis Drive, Sterling, VA 20164. Turn around time normally ranges from 10-30 days after Sutron receives equipment for repair. **Call Customer Service at (703) 406-2800 for a Return Material Authorization (RMA) number.** Return the defective equipment to the factory, transportation charges paid.

EXTENDED WARRANTY AND ON-SITE MAINTENANCE

Extended warranty and on-site maintenance contracts are available. Price quotations may be obtained from Sutron customer service representatives.