Operations & Maintenance Manual

Part No. 8800-1207 Rev 1.0
February 22, 2016

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1. Scope of Supply

SL3-1	GOES/METEOSAT/INSAT/GMS Satellite transmitter including 11 physical input channels (1xRS485, 2xSDI-12, 2xpulse/status, 2x5V analog, 3xDifferential Analog, 1x 4-20mA), 4 isolated switched supplies, 1 isolated non-switched supply, 2 switched open collector outputs, RS232, USB host, USB device, WiFi, power supply/ground connector, 9 2/3/4 pin connectors for sensors, xx MB measurement memory, 2 status LED, multifunction button with LED, GPS receiver, 2 slots for expansion cards: optional Iridium modem, optional LTE modem, optional Ethernet
	
	     1 quick start guide
	     1 factory acceptance test (FAT) certificate
	     1 USB cable
	     1 screwdriver

SL3-SDI-1	GOES/METEOSAT/INSAT/GMS Satellite transmitter including 2 physical input channels (2xSDI-12) RS232, USB host, USB device, WiFi, power supply/ground connector, xx MB measurement memory, 2 status LED, multifunction button, GPS receiver
	
	     1 quick start guide
	     1 factory acceptance test (FAT) certificate
	     1 USB cable
	     1 screwdriver

SL3-XMTR-1	GOES/METEOSAT/INSAT/GMS Satellite transmitter including RS232, USB host, USB device, power supply/ground connector, 2 status LED, multifunction button, GPS receiver 1 factory acceptance test (FAT) certificate

2. Ordering Numbers

Model	Description
SL3-1	GOES/METEOSAT/INSAT Satellite transmitter with 11 physical input channels
SL3-SDI-1	GOES/METEOSAT/INSAT Satellite transmitter with 2 SDI-12 input channels
SL3-ENC-DISP-2	SL3-1 in NEMA box with 2 line display
SL3-XMTR-1	GOES/METEOSAT/INSAT Satellite transmitter
Optional Modems	**Description**
	Iridium SBD Modem for SL3 (available Q2 2016)
	LTE Modem for SL3 (available Q2 2016)
	Ethernet interface for SL3 (available Q2 2016)
Accessories	**Description**
5000-0021-1	OMNI antenna, Full Wave
5000-0155-1	YAGI GOES Satellite Antenna
5000-0156-1	YAGI GOES Satellite Antenna, Stainless Steel Mast and Elements
5000-0170	GPS Antenna, Bullet (High Gain)
6411-1162-1	Cable Assembly, Antenna, 15ft
8111-1113-1	RF COAX lightning protection, Bulkhead
8111-1099-1	RF COAX lightning protection, panel mount
…	

3. General Safety Information

▸   Read this manual before using Satlink for the first time. Become familiar with the installation and operation of Satlink and its accessories.

▸   Make sure that Satlink is protected against moisture (NEMA 4, IP 66 or better).

▸   Operate Satlink only with approved antenna connected.

▸   Protect the line of the battery supply voltage with a safety fuse (10A/fast).

▸   Before connecting the power supply, check that all wires are properly attached to the screw terminal strips.

▸   Do not open Satlink. There are no user serviceable parts inside.

▸   Have a defective Satlink checked and repaired by the Sutron repair center. Do not attempt to repair Satlink yourself.

▸   Read this manual before using Satlink for the first time. Become familiar with the installation and operation of Satlink and its accessories.

▸   Operate Satlink only with approved antenna connected.

Symbol	Description
‗ ‒ ‗	Direct current.
⏚	Protective earth ground. Connect to an earth ground electrode for lightening protection of internal components.
⏚	Digital ground. Attach digital sensor ground to this terminal. Batteries and solar panel negative terminals are also connected to this terminal.
⏚	Signal ground. Attach analog sensor ground to this terminal.
⏚	Chassis ground.
⚠	Shock hazard.
♽	Do not dispose in trash.

4.   About this manual

This manual covers the following Satlink versions:

- SL3-1
- SL3-SDI-1
- SL3-XMTR-1

You can find the version of the software on the diagnostics tab of LinkComm
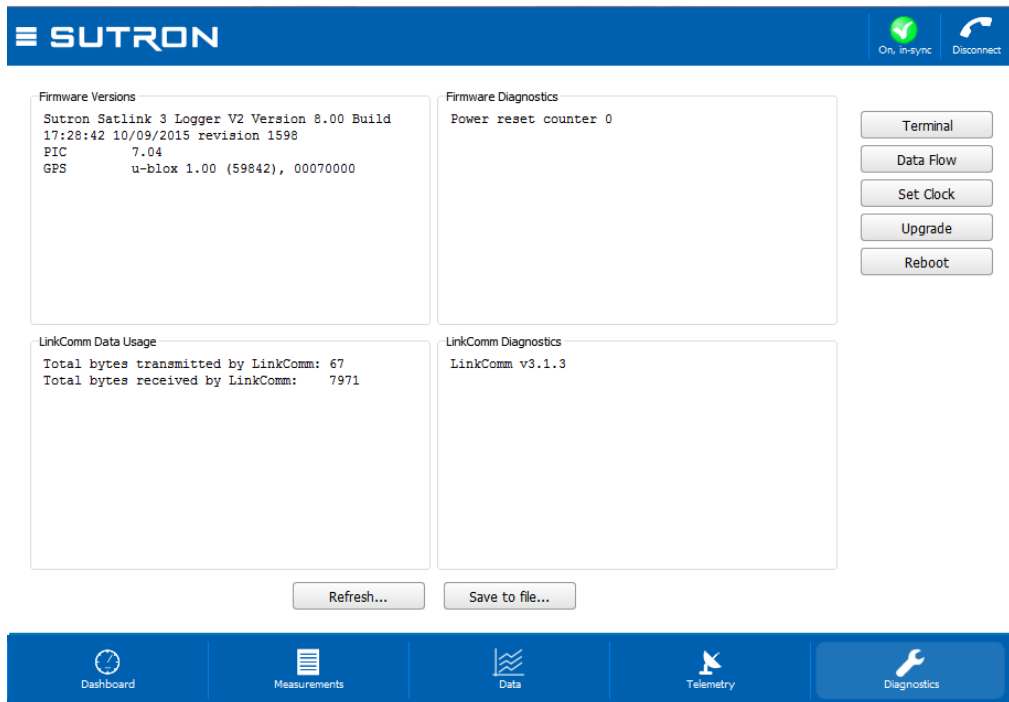
or by issuing the VER command via command line.

5. Introduction

Sutron's Satlink 3 is a datalogger with a built-in satellite transmitter that is especially designed for hydrometry, meteorology and environmental monitoring. It is available in three models: SL3-1, SL3-SDI-1, and SL3-XMTR-1

Satlink 3 can:

▸   Make measurements from sensors monitoring the environment
▸   Perform special calculations
▸   Record data into non-volatile memory
▸   Transmit data to automated receiving systems.

Satlink 3 is certified to operate on the following satellites:

▸   GOES Domestic 300, 1200 bps, timed and random reporting
▸   GOES International
▸   Meteosat, MSG (Meteosat Second Generation), Meteosat HDR, timed and alert reporting
▸   GMS   100 bps domestic and international channels
▸   INSAT   4800 bps domestic channels
▸   FY2B   100 bps domestic channels

Satlink 3 improves on its predecessor SatLink2 and does everything SL3 did with the following enhancements:

▸   Expanded measurements from 16 to 32
▸   Improved analog accuracy & additional channels
▸   Expanded SDI-12 capacity with 2 independent SDI-12 inputs
▸   Optional cell/Iridium modems for redundant 2-way communications

  ‣ Expanded log from 120,000 to 1,000,000 readings, expandable to 1,000,000,000 readings (32 GB) via internal SDHC card
  ‣ Improved GUI program that runs on Android, iPhone, PC or MAC devices

5.1.   SL3- 1

The figure below shows the connections provided by the SL3-1. A description of each of the connections is provided in the following paragraphs.
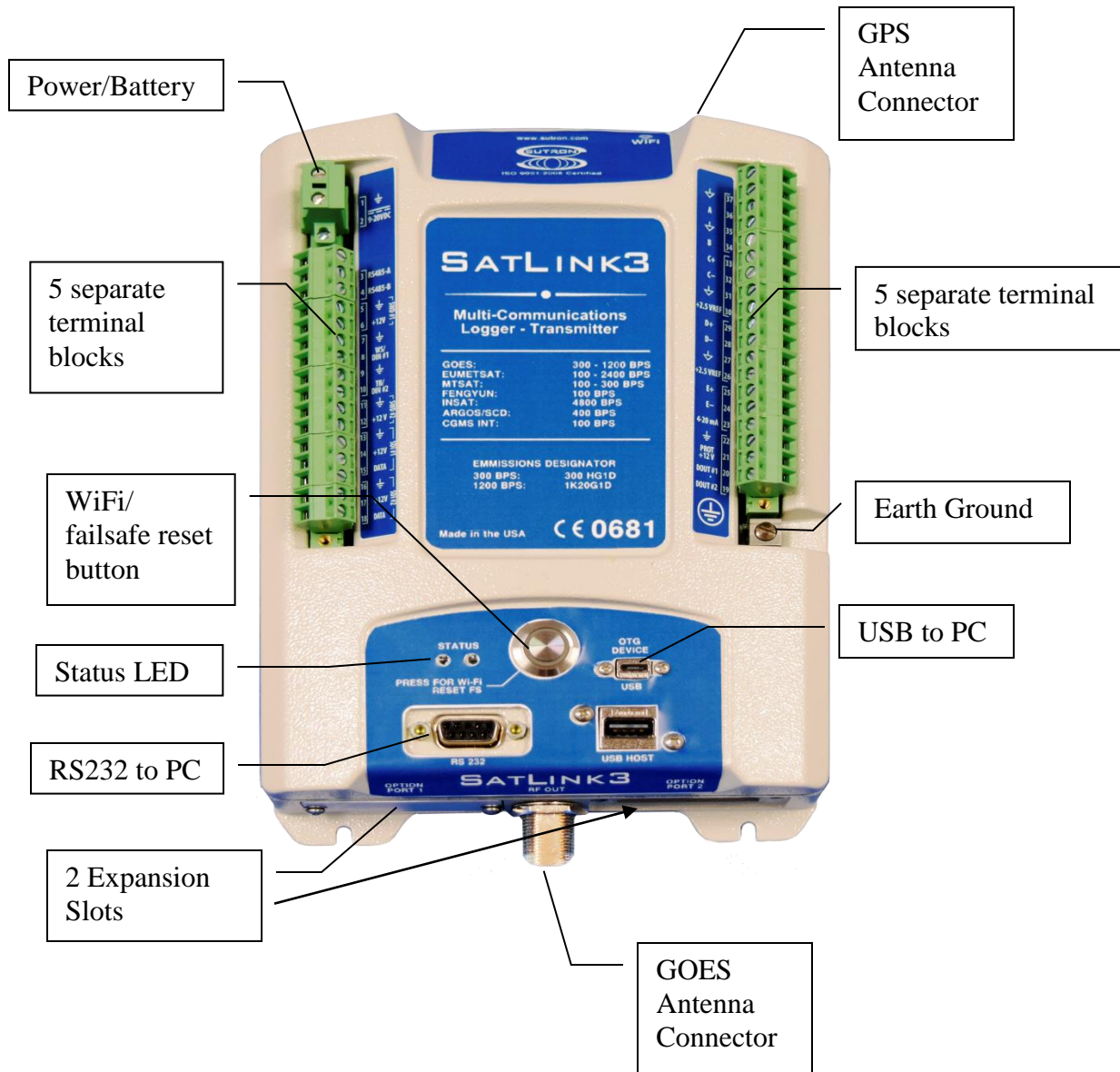
5.2. SL3-SDI-1

The figure below shows the connections provided by the SL3-SDI-1. A description of each of the connections is provided in the following paragraphs.
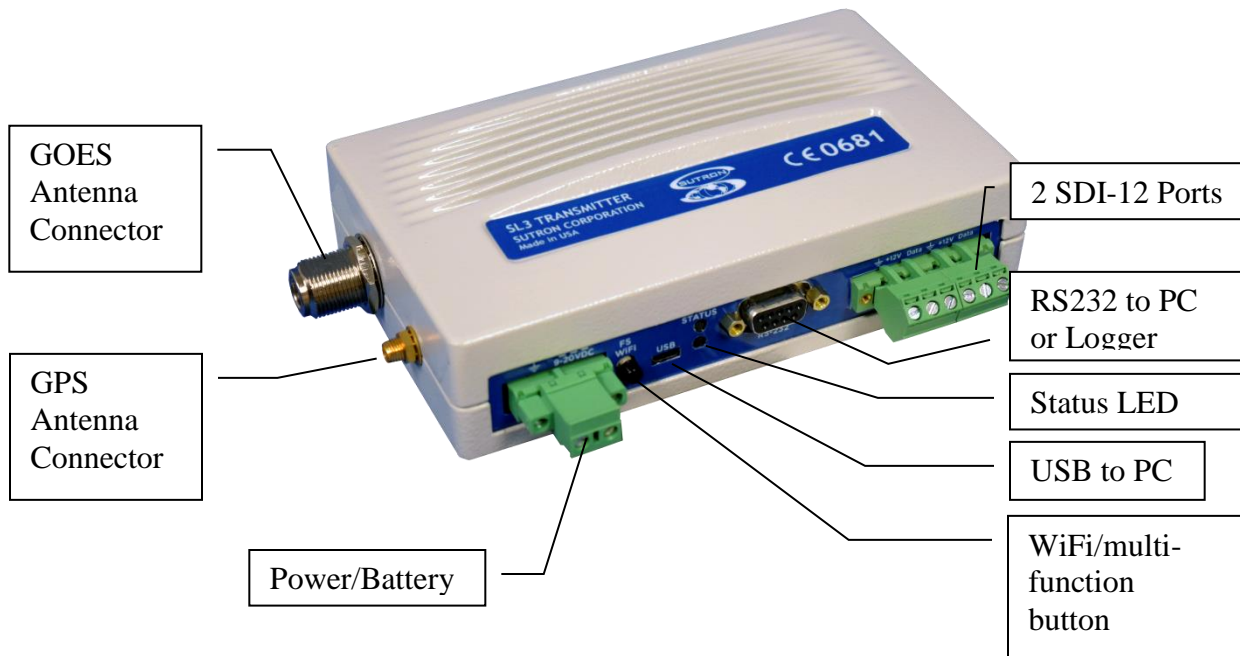
5.3. SL3-XMTR-1

SL3-XMTR-1 is similar to the SL3-SDI-1 with the following changes:

▶ The 2 SDI-12 ports are replaced with an Auxilary DB9 connector. This connector is for factory use only.

▶ There is no WiFi module in the SL3-XMTR-1. The button will not turn on WiFi but is only for failsafe reset.

▶ SL3-XMTR-1 is designed to connect to another logger via the RS232 port. The logger will setup the SL3-XMTR-1 and regularly transfer data to it for transmission. The logger must use Sutron's Satlink Communicator Protocol (SCP) for these setup and data transfer functions.

Contact Sutron customer service for additional information.

5.4. Wakeup/Multi-function Button

Satlink3 has a button installed on the front. Briefly pressing this button will turn on the WiFi to allow the wireless connection to mobile devices. When the WiFi is first activated, the button will rapidly flash blue for a few seconds and then repeat the blue flashes every 4 seconds. During this time, you are free to make a connection to the WiFi using the settings you your mobile device.

Satlink3 acts as its own WiFi Hotspot with the name SutronSL3xxxxx-yyyyy where xxxx is the station name and yyyy is the last few digits of the WiFi adapter. ..

[put picture here of wifi settings in iphone]

If the button is held down for 5 seconds, the red LED will come on too. Keep holding the button until the red LED turns off in order to reboot SL3.

5.5.   Status LED

The Status LED give information on how SL3 is operating. The LED are multi-colored. The following table describes the different colors and states of the LED.

Description	Left/Top LED	Right/Bottom LED	Button
Unit is operating properly	Green blink every 5 seconds		
Unit has a Setup or operating error		Red blink every 4 seconds	
WiFi turned on but no active connection			Blue blink every 4 sec or fast flashing blue
Active WiFi Connection			Solid Blue
Transmitting		Solid Blue	
Power Fail Imminent		Red flash 9Hz	
??	Flashing yellow		
Unit is in Test mode	Green blink every second	Red blink every second	

5.6.   RS232

The RS232 connection is a standard DB9-F connection for serial communications to a PC or other device. The RS232 port has a default baud rate of 9,600 (No parity, 8 data bits, 1 stop bit, HW flow control) but other baud rates are supported. The primary use of the RS232 port is for connecting to a PC for setup, maintenance, and troubleshooting. The PC will typically run LinkComm software which will allow the user complete control over SL3 subject to the password protection in SL3.

The RS232 port also allows the connection of Sutron's 8310, 9210 and Xpert loggers to SL3. With this connection, the Sutron logger can use SL3 as transmitter to send data that it collects, rather than have SL3 collect the data. This is normally done where the field station is very complex and the user desires the advanced capabilities of 8310, 9310, Xpert for the collection and processing of the data.

5.7.   USB

The USB port is the primary port for connecting a PC to SL3. The USB port is a micro-B and compatible with a standard micro-B to Type A male USB cable that works with most PC's. The primary use of the connection is to allow the PC to setup, maintain and troubleshoot SL3. The PC will typically run LinkComm software which will allow the user complete control over SL3 subject to the password protection in SL3.

5.8.   RF Output

SL3 has a type N connector on the bottom of the SL3 and side of the SL3-SDI. See Connecting the GOES/METEOSAT/INSAT antenna for details on how to connect an antenna to SL3. Never operate Satlink without connecting either an antenna or dummy load to this connection.

5.9.   SL3- Left Terminal strip

Two terminal strips built into SL3 provide the connections for sensors, and outputs. The table below describes the purpose of each connection on the left terminal strip. Additional information on using the connections is given in the Chapter xx.

	Description	Note
1	GND	Main Battery/Power Ground
2	9-20VDC	Main Battery/Power +VDC (5 amps max)

3	RS485 A	SDI-12 over RS-485, Modbus slave
4	RS485 B	SDI-12 over RS-485, Modbus slave
5	Ground	Ground
6	+SW POWER 1	Switched Main Power (9-20VDC) (turned on during warm-up and analog sensor measurement)
7	Ground	Ground
8	WS/DIG IN 1	Wind Speed or Digital Input 1
9	Ground	Ground for sensor
10	TB/DIG IN 2	Tipping Bucket or Digital Input 2
11	Ground	Ground
12	+SW POWER 2	Switched Main Power (9-20VDC) (turned on via equations …)
13	Ground	Ground
14	SDI-12 PWR	Isolated Main Power (9-20VDC) to SDI-12 sensors (500 ma max)
15	SDI-12 DATA	SDI-12 Data (Port 1)
16	Ground	Ground
17	SDI-12 PWR	Isolated Main Power (9-20VDC) to SDI-12 sensors (500 ma max)
18	SDI-12 DATA	SDI-12 Data (Port 2)

5.10.   SL3 Right Terminal Strip

Two terminal strips built into SL3 provide the connections for sensors, and outputs. The table below describes the purpose of each connection on the left terminal strip.. Additional information on using the connections is given in the Chapter 6.

	Description	Note
37	Analog Ground	Analog ground
36	0-5V A	Voltage input for sensors with 0-5V output
35	Analog Ground	Analog ground
34	0-5V B	Voltage input for sensors with 0-5V output
33	Diff C+	Differential voltage input for bridge type sensors
32	Diff C-	Differential voltage input for bridge type sensors
31	Analog Ground	Analog ground
30	VREF	2.5V output (turned on during warm-up and analog sensor measurement)
29	Diff D+	Differential voltage input for bridge type sensors
28	Diff D-	Differential voltage input for bridge type sensors
27	Analog Ground	Analog ground
26	VREF	2.5V output (turned on during warm-up and analog sensor measurement)
25	Diff E+	Differential voltage input for bridge type sensors
24	Diff E-	Differential voltage input for bridge type sensors
23	4-20 mA	Input for 4-20ma sensor
22	GND	
21	PROT +12V	Isolated main power (9-20VDC), 1amp max
20	DOUT #1	Digital Output (open collector, turned on manually, with alarms, or via equations)
19	DOUT #2	Digital Output (open collector, turned on manually, with alarms, or via equations)
⏚	Earth Ground	Attach via a heavy gauge (4 to 10 AWG) wire to earth ground rod driven 6 feet into earth.

6. Installing Satlink

6.1.   Attaching the SL3-1

Requirements of the intended installation site are:

▶   Sufficient protection from moisture for an IP 63 device.

▶   Proper space for the electrical cables

▶   Temperature range -40C to +70C.

▶   Space for installation using the mounting ears

▶   Earth ground point for the connection of the SL3 earth ground.

▶   Closed control cabinet or fire protection cabinet if the power supply is not a low power source 12-20VDC.

The dimensions for SL3-1 are shown in figure below along with the locations of the mounting ears.
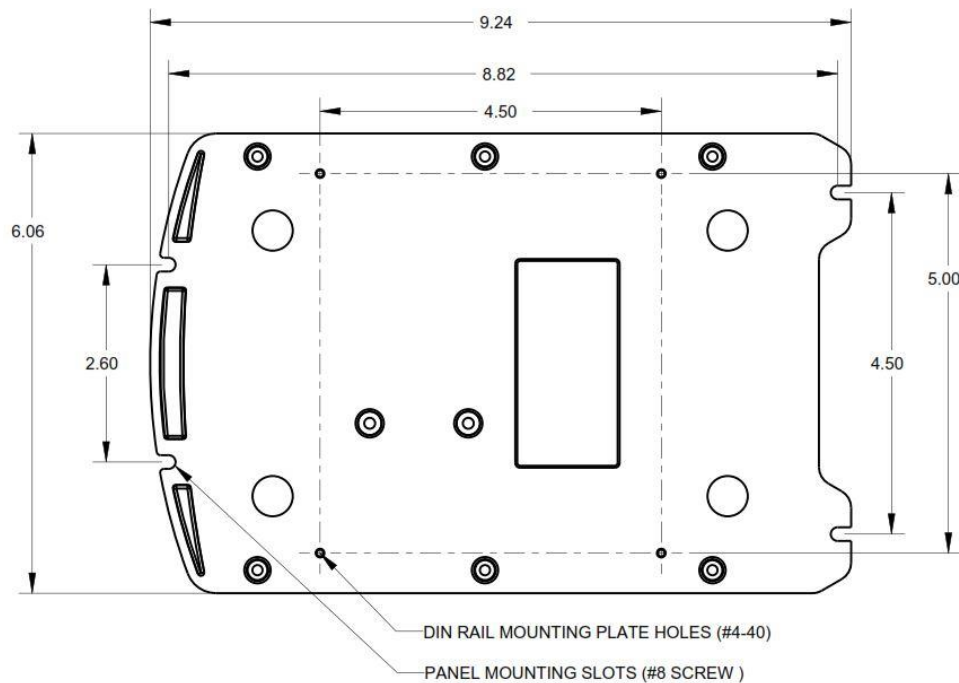
6.2.   Attaching SL3-SDI-1

Requirements of the intended installation site are:

▶ Sufficient protection from moisture for an IP 51 device.

▶ Proper space for the electrical cables

▶ Temperature range -40C to +70C.

▶ Suitable mounting plate or DIN rail clip with Standard top hat rail (TS35) mounted at the installation site.

▶ Earth ground point for the connection of the SL3 earth ground.

▶ Closed control cabinet or fire protection cabinet if the power supply is not a low power source 12-20VDC.

The dimensions for SL3-SDI-1 are shown in the figure below.
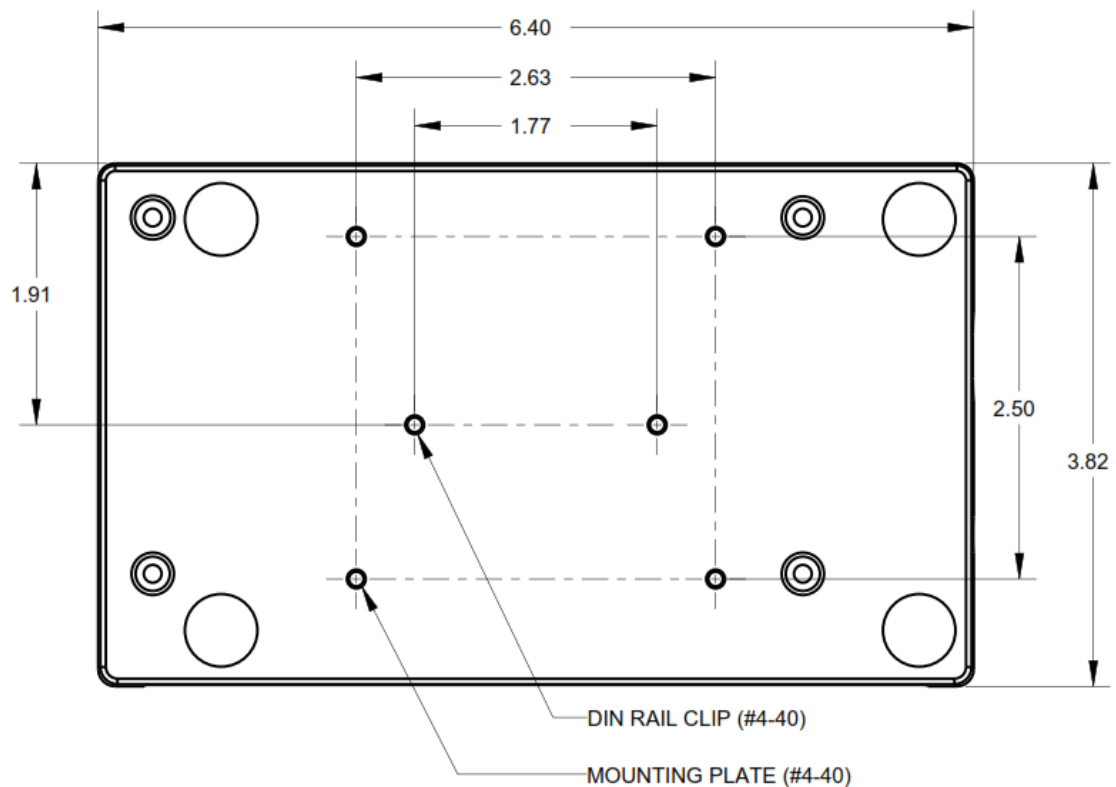
6.3.   Earth Ground Point

A connection point has been provided for an Earth ground on SL3-1. On SL3-SDI-1 the chassis is the earth ground point. Always connect the earth ground to a suitable ground at the site as described below.

Any time a sensor cable is attached to the terminal strip, the unit may be exposed to electrical surges such as those that come from nearby lightning strikes. The SL3 includes spark gaps and other protection devices that shunt the energy to the earth ground. If there is no connection to the earth ground point on SL3, the energy has nowhere to go and the unit can be damaged.

⚠ **Failure to properly connect the Earth ground point will lead to failures in the field due to surges.**

To install a proper ground connection point:

1. Use a copper ground rod driven into the ground at least 6 feet.

2. Attach a very heavy gauge (#4 Solid Copper) wire between the rod and the Satlink Earth ground point. The connection point can accept up to a 4 gauge solid copper wire. If a heavier gauge copper wire is used to connect to the ground rod, a reducer may be necessary to connect to the terminal on Satlink.

⚠ **Firmly secure the screw on the ground point firmly on the copper wire. Do not rely on AC power ground connections as they are not always properly grounded and may introduce other surges.**
Satlink features gas tube protection on all sensor inputs.

6.4.   Connecting the GOES/METEOSAT/INSAT antenna

The transmitter must be connected to an approved antenna to operate with the selected satellite system. Sutron offers a variety of antenna including YAGI and dome types that provide between 3 and 11 dB gain. SL3 will adjust its transmission power based on the type of antenna connected. As a part of the setup process, the type of the antenna will be entered into the setup.

The typical antenna cable is 10 to 20 feet long. Outdoor antenna connections should we wrapped with a self-vulcanizing tape to make sure they are water/weather resistant.

Users are encouraged to use a separate lightning arrestor for the antenna such as the one shown below.
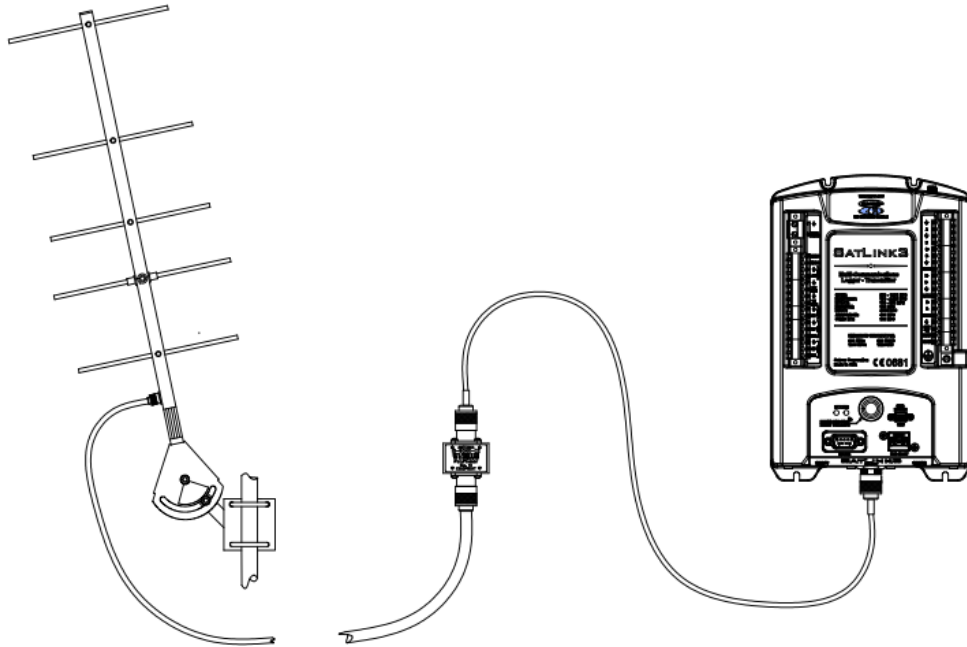
6.5.   Connecting the GPS antenna

The GPS antenna connection is at the top of the SL3. On SL3-SDI-1, the SMA connector is to the right of the power connection. Sutron provides a GPS antenna with each Satlink. The port can be connected to any active GPS antenna (xxx voltage). SL3 has special circuitry to detect whether or not the GPS antenna is connected.

The GPS antenna is normally mounted outdoors. Occasionally, you can mount the GPS antenna indoors if the GPS signal penetrates the structure or enclosure where it is located. The GPS antenna should be installed in a way to reduce the buildup of snow that might affect its operation.

Only approved GPS antenna should be connected to Satlink.

6.6.   Connecting the power supply

The Power/Battery connection for the SL3-1 is at the top left of the unit. A two position removable plug is provided for the connection. SL3 operates off 9-20VDC and can use up to 4 amps. Because of the high amperage requirements, an AWG 18 wire should be used.

Note: Even though SL3 will operate below 12V some sensors will not operate when the power supply is 12V.

A standard 12VDC lead-acid or Gel battery is typically used as the power source for SL3. Do not power SL3 off AC power supplies without additional precautions to ensure the power supply is properly rated and the system is enclosed in a fire protection cabinet.
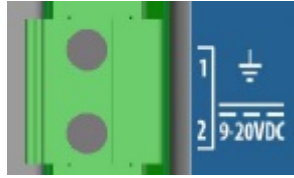
It is a good practice to make all sensor connections with the unit powered off.

As soon as power is applied, the LED will flash as the unit goes through a self-test sequence. Then the LED will flash depending on the setup of SL3.   The LED will flash green when everything is OK. Red means an error. Normally the button will flash blue every 4 seconds indicating that WiFi is turned on and ready for a connection.   Other combinations are possible if the unit has been previously setup. See section 5.5

6.7.   Connecting sensors having an SDI-12 interface

SL3 supports two independent SDI-12 sensor busses. Each is provided with its own isolated power connection rated for 500mA. Because SDI-12 sensors are addressable, multiple SDI-12 sensors may be connected to these terminals as long as no two sensors on the same bus have the same address.

When multiple new SDI sensors are connected to a bus, they should be connected one at a time so the address can be made unique using the SDI A command. (See xxx)

The figure below shows the typical SDI-12 sensor connections.
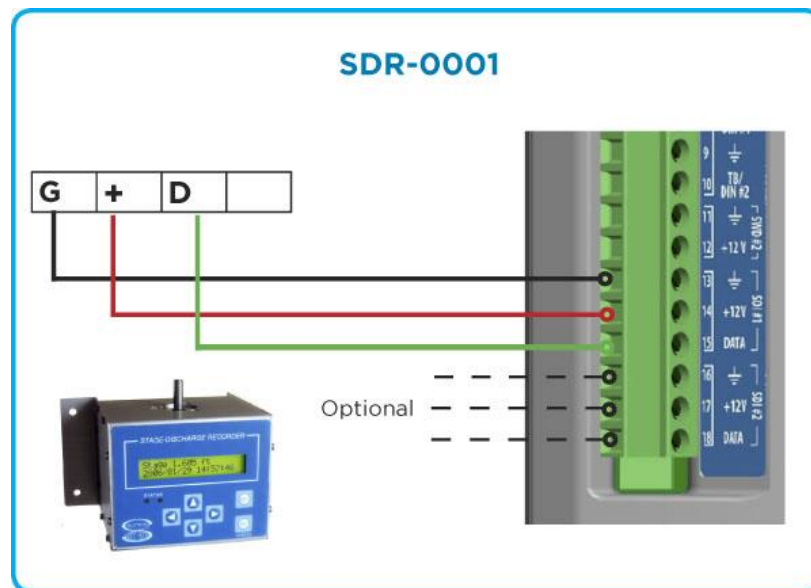
6.8.   Connecting sensors having an RS485 interface

SL3 supports RS485 sensors that use the SDI-12 protocol for its messaging. SL3 will not be able to read data from RS485 sensor that do not support SDI-12.

The typical connection of the RS485 sensor is shown below:

6.9.   Connecting a tipping bucket rain gauge.

SL3-1 supports a tipping bucket rain gauge using its TB/DIN2 connection. This connection provides a pullup resistor (100K) to 5V to provide power for the contact switch in the rain gauge. Each time the bucket in the rain gauge "tips" the internal switch closes momentarily causing a pulse on the TB/DIN2 connection. This pulse is counted and used to provide accumulated precipitation or precipitation rate data.

The key settings for a tipping bucker rain gauge are:
▸ Measurement Type: precip accumulation or precip rate
▸ Slope: 0.1mm, 0.2mm, 0.01inches or other value to match the calibration of the sensor.

(Note: Measurement type: digital/counter1 or counter2 can also be used for tipping bucket rain gauges. Be sure to select "debounce" for this measurement type as most tipping bucket rain gauge switches are noisy and can produce multiple counts per tip if they are not de-bounced.

The typical connection of the tipping bucket rain gauge is shown below.
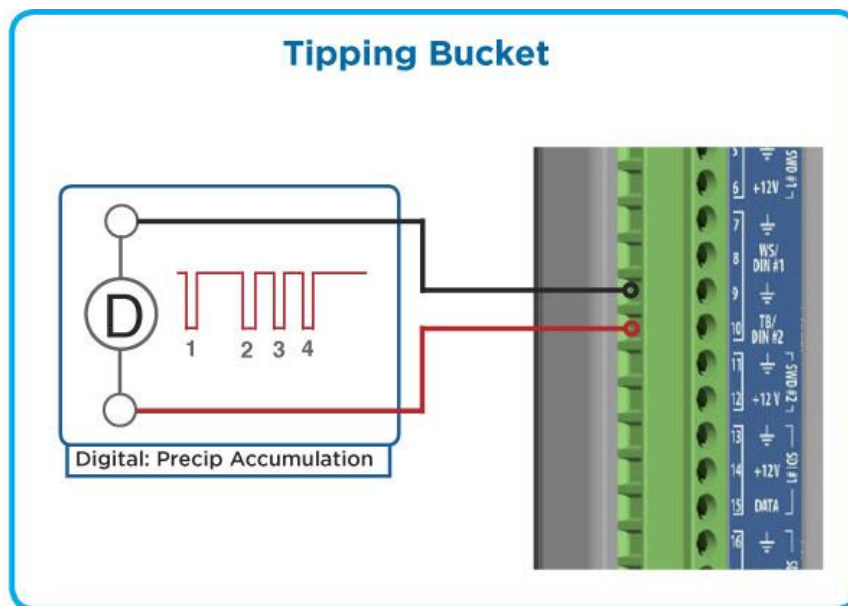
6.10.   Connecting sensors having a pulse output

SL3-1 supports up to 2 sensors with pulse output. The pulse output can come from a switch that is momentarily closed (as in most flow meters and tipping buckets) or it can come from a device that actively puts out pulses to represent the value to be measured. Pulses are measured by the Digital inputs DIN #1 or DIN #2. SL3 can count at a rate up to 10,000 counts per second (de-bounce off) and 500 counts per second (debounce on).
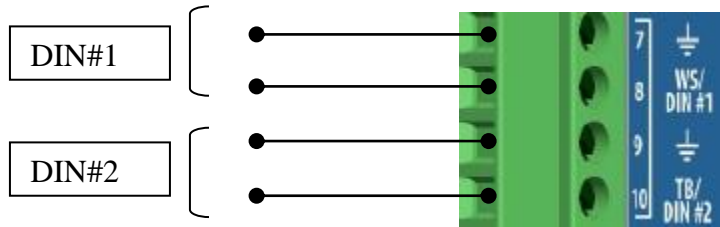
The key settings for pulse sensors are:
- ▸ Measurement Type: Digital
- ▸ Digital type: counter1 or counter2
- ▸ Debounce: yes/no

6.11.   Connecting sensors having a frequency output

SL3-1 supports up to 2 sensors with frequency output. The pulse output can come from a switch that is momentarily closed as in most flow meters and tipping buckets or it can come from a device that actively puts out pulses to represent the value to be measured such as a soil moisture probe with frequency output or an anemometer..

The pulse output sensors connect to the DIN #1 or DIN #2 inputs. DIN #1 supports sensors with a low level AC output (100 mVp-p) or high level output while DIN#2 supports only sensors with a high level output (switch closure or 0-5VDC).

The frequency measurement circuitry can measure frequencies from 3Hz to 10KHz with an accuracy of 0.01%. The system takes 0.75 seconds to make the measurement.
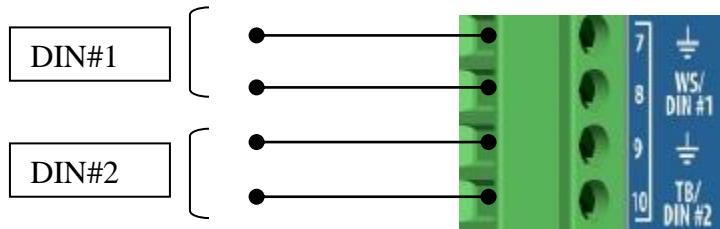
The key settings for frequency sensors are:
- ▸ Measurement Type: Digital
- ▸ Digital type: Frequency1 or Frequency2
    Note: Use Frequency1 for sensors with a low level AC output voltage (such as an RMYoung) and specify (AC Low Level). Frequency2 is always expecting a DC high level signal.

6.12.   Connecting sensors having a 0-5V output

SL3-1 supports up to 2 sensors with an output voltage up to 5 VDC. The sensor must be connected to the signal ground and may be powered from VREF, PROT+12V, SWD+12V. These inputs are compatible with sensors thermistors, potentiometers, strain gauges, etc.

The key settings for 0-5V analog sensors are:
▶   Measurement Type: Analog
▶   Analog Type: 0-5V A or B.

6.13.   Connecting sensors having a 4-20ma current output

SL3-1 supports up to 3 sensors with a 4-20mA output. One sensor can connect direct to the 4-20mA input (terminal 23) as shown below. The other sensors can connect to A or B (0-5V) analog channels with an external load resistor. The sensor/loop must be powered from PROT+12V, SWD+12V, main power, or other source with common ground to SL3.
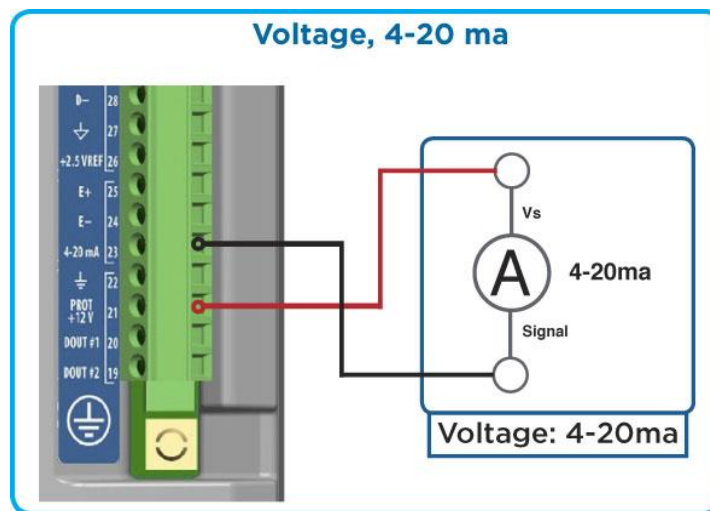
The key settings for 4-20mA sensors connected to the 4-20mA input are:
▶   Measurement Type: Analog
▶   Analog Type: 4-20mA

The built-in 4-20mA connection has an internal 200 ohm load consisting of transient protection and a precision 100 ohm sense resistor. External load resistors should also be 100 ohm in order for the system to operate down to voltages between 10-12VDC. In some cases, the 4-20mA

sensor may need supply voltages > 12VDC to operate. The supply voltage needs to be greater than the minimum voltage the sensor requires plus the maximum voltage across the load resistance (2V for 100 ohms).

The key settings for 4-20mA sensor connected to A and B are:
- ▸ Measurement Type: Analog
- ▸ Analog Type: 0-5V A or B.
- ▸ Add a 100 ohm load resistor between A or B and Signal ground.

6.14.   Connecting sensors having a status output

A status output is a switch that is open or closed. SL3-1 supports up to 2 status outputs using either of the digital inputs (DIN#1 or DIN#2). An internal pullup resistor on DIN#1 or DIN#2 provides the excitation voltage for the switch.

SL3 will return a 0 when the switch is open and a 1 when the switch is closed.
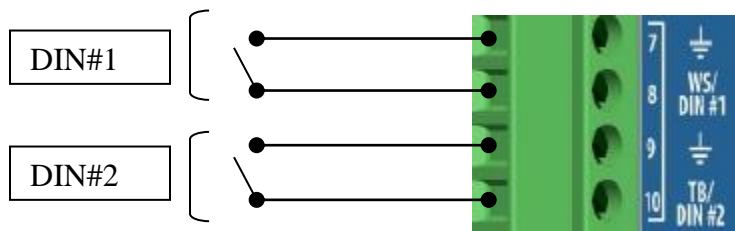
The key settings for pulse sensors are:
- ▸ Measurement Type: Digital
- ▸ Digital type: Level1 or Level2

6.15.   Connecting sensors having a potentiometer output

A potentiometer connects to SL3 to the A or B analog channels as shown below.
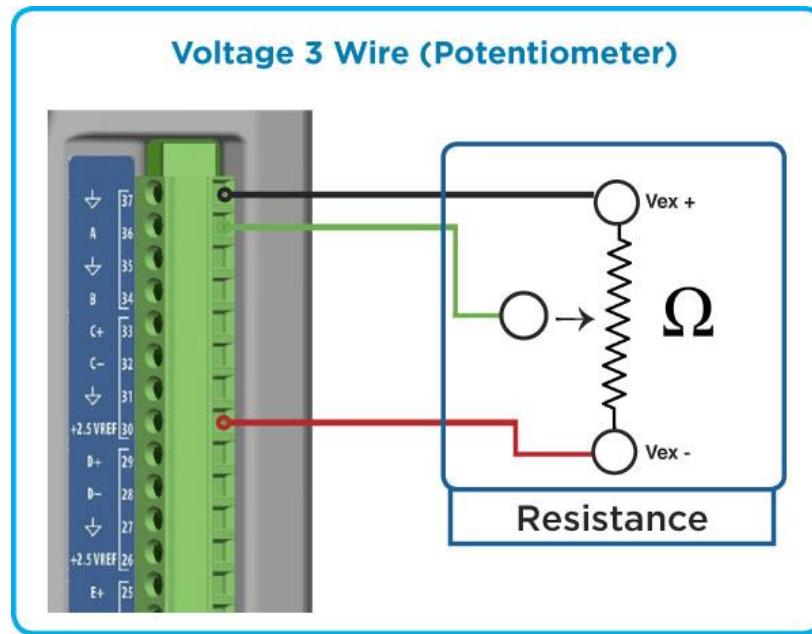
The key settings for potentiometer sensors are:
- ▸ Measurement Type: Analog
- ▸ Analog type: A or B

Note: VREF is 2.5V.

6.16.   Connecting sensors having a mV output

mV output sensors such as pyranometers connect to SL3 to the C, D or E channels as shown below.
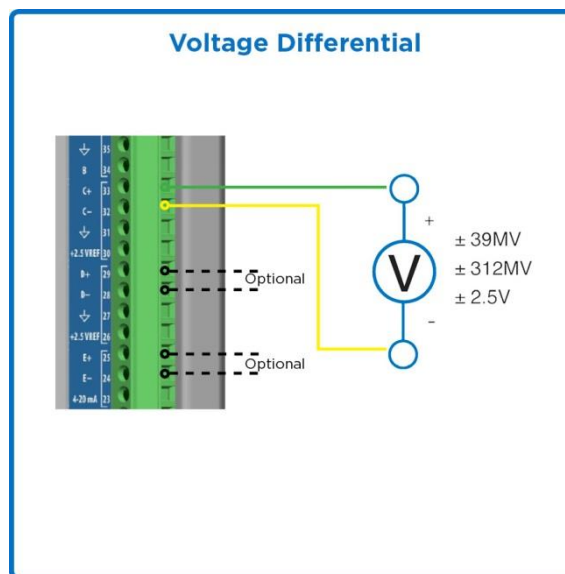
The key settings for mv output sensors are:
- ▸ Measurement Type: Analog

▸ Analog type: Diff C, D or E
▸ Input Range: 39mV, 312mV, 2.5V, 39mV w/Bias, 312mv w/Bias.
Note: use the range with Bias for any sensor (such as a pyranometer) that does not connect to VREF or other SL3 power

6.17.   Connecting thermistors

Thermistors connect to SL3 to the A or B channels as shown below. Note there is a precision 10K reference resistor between the input and +2.5VREF.
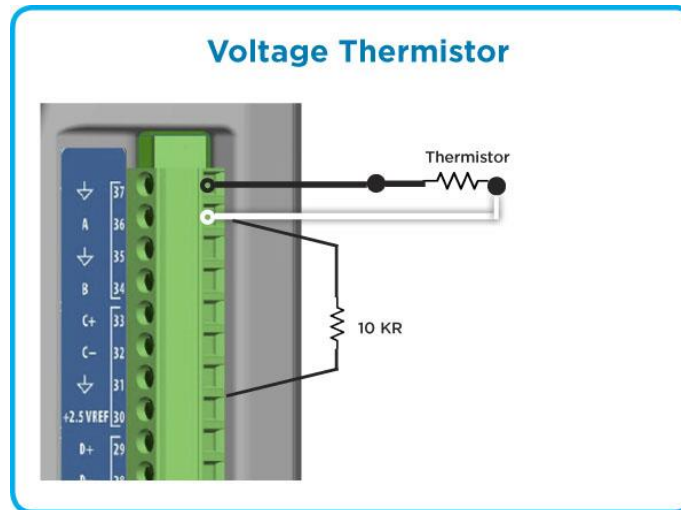
The key settings for thermistors are:
▸ Measurement Type: Analog
▸ Analog type: A or B
▸ Equation to compute temperature (Celsius):
Steinhart((10000)*X/(vref-X), A, B, C) (see table below for A, B, C)
Note: The 10000 is the reference resistor value in ohms.
▸ Slope: 1.8; Offset: 32 to convert to Fahrenheit.

Model	TYPE	A	B	C
44006 44031	10K, 006	0.0010295	0.0002391	1.568E-07
44005 44030	3K, 005	1.40510E-03	2.36900E-04	1.019E-07
44008 44032	30K, 008	9.354011E-04	2.210605E-04	1.27472E-07
44016 44036 5600-0025 5600-0030	10K, 016	1.12610E-03	2.34545E-04	8.63589E-08

▸

6.18.   Connecting thermocouples

Thermocouples connect to SL3 to the C, D or E channels as shown below.
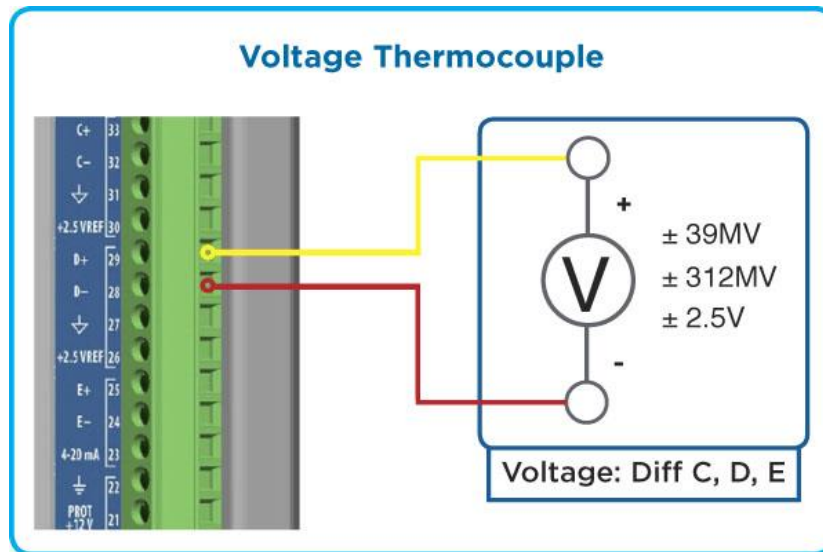
The key settings for thermocouples are:

▸   Measurement Type: Analog
▸   Analog type: Diff C, D or E.
▸   Input Range: 39mV with Bias
▸   Equation: 24716*X+Terminal_temp {K type thermocouple, -8C to 64C}

For more accurate results, here are some other K-Type Equations:

Linear delta T range of ± 20°C. Approximation error is ±0.20°C.
        Temp (°C) = 25.346 * X*1000 – 0.1114 + Terminal_temp

Linear delta T range of ± 40°C. Approximation error is ±0.83°C.
        Temp (°C) = 25.419 * X*1000 – 0.3847 + Terminal_temp

3rd order Poly delta T range of ± 20°C. Approximation error is ±0.01°C
        Temp (°C) = Poly((X*1000), (Terminal_temp -0.0107), 25.263, -0.4443, 0.2053)

3rd order Poly delta T range of ± 40°C. Approximation error is ±0.03°C
        Temp (°C) = Poly((X*1000), (Terminal_temp -0.0115), 25.326, -0.4305, 0.0861)

T-Type Equations:

Linear delta T range of ± 20°C. Approximation error is ±0.30°C.
        Temp (°C) = 25.892 * X*1000 – 0.151 + Terminal_temp

Linear delta T range of ± 40°C. Approximation error is ±1.20°C.
        Temp (°C) = 25.851 * X*1000 – 0.612 + Terminal_temp

3rd order Poly delta T range of ± 20°C. Approximation error is ±0.01°C
        Temp (°C) = Poly((X*1000), (Terminal_temp + 0.0051), 25.881, -0.688, 0.0277)

3rd order Poly delta T range of ± 40°C. Approximation error is ±0.03°C

Temp (°C) = Poly((X*1000), (Terminal_temp + 0.0234), 25.868, -0.755, 0.0616)

6.19.   Connecting strain gauges

Strain gauges connect to SL3 to the C, D or E channels as shown below.
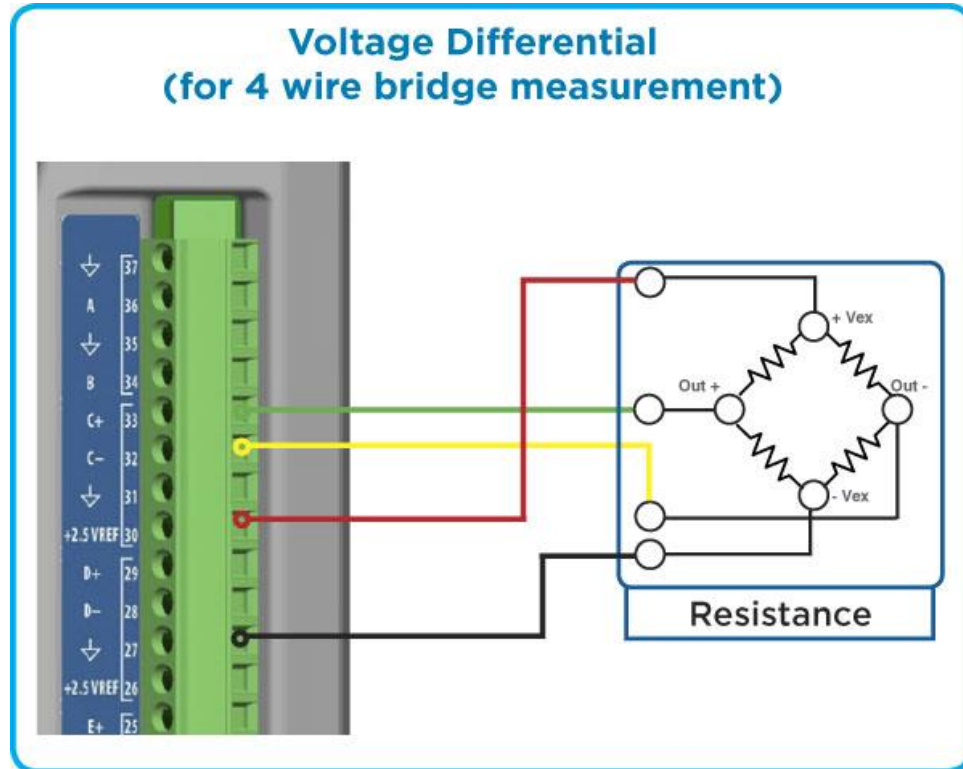
The key settings for strain gauge sensors are:
- ▸   Measurement Type: Analog
- ▸   Analog type: Diff C, D or E
- ▸   Input Range: 39mV or 312mV (**no bias needed)
- ▸   Slope: as needed to scale the reading.

6.20.   Connecting Wind Sensors

The RMYoung wind sensor has a potentiometer direction and frequency output for speed. The RMYoung connects to SL3 as shown below. WS/DIN#1 is used for the frequency as it can handle low level AC as well as high level DC pulses for speed.

R.M. Young Prop & Vane Wind Sensor
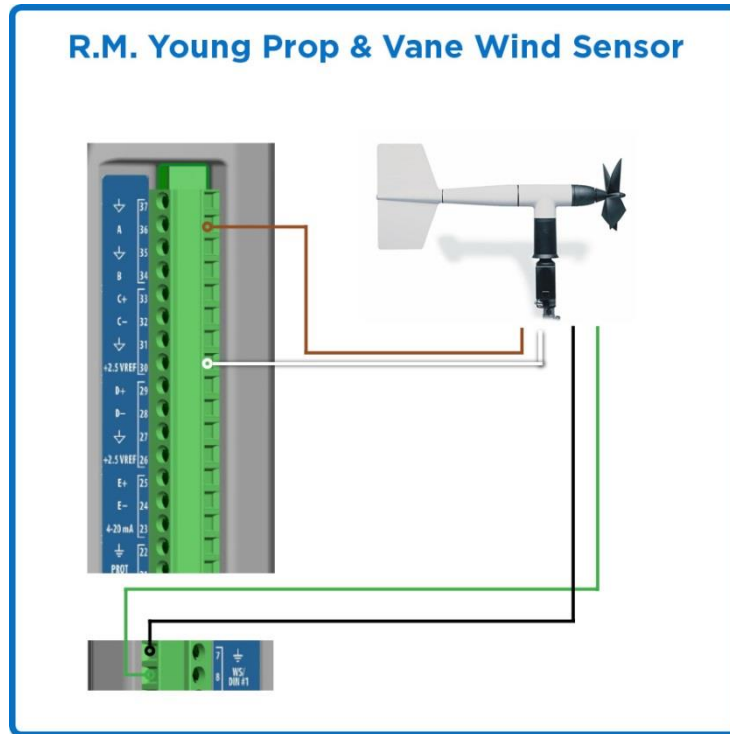
* A 1.0 MOhm resistor needs to be placed from VREF (or SIGNAL GROUND) to AZ SIG. This ensures that the value always goes to 355 (or 0 with SIGNAL GROUND) when the potentiometer is in the open region.

The key settings for RMYoung wind sensors are as follows (note that 2 measurements are setup).
- ▸ Measurement Type: Wind (future release)
- ▸ Wind Averaging: Scalar or Vector
- ▸ Wind Type: Wind Dir Analog
- ▸ Analog Type: 0-5A
- ▸ Equation: X/VREF*355 {converts to degrees}

- ▸ Measurement Type: Wind
- ▸ Wind Averaging: Scalar or Vector (to match direction)
- ▸ Wind Type: Wind Speed Freq DIN1
- ▸ Slope:

Wind Speed Units	Slope
m/s	0.098
knots	0.1904
mph	0.2194
kph (km/h)	0.3528

You can also connect SDI-12 wind sensors, analog output wind sensors and others by selecting the appropriate wind types:
- • Wind Dir Analog
- • Wind Dir SDI
- • Wind Speed DIN1
- • Wind Speed SDI
- • Wind Speed Analog

6.21.   Connecting to the Digital outputs

The digital outputs are DOUT#1 and DOUT#2. The digital output is an open collector type output. This provides direct interface to many products. The open collector output sinks 100mA (rated at >400mA) on a continuous basis.

The outputs are controlled by the Other Setup/Digital Output settings, Command line or equation OUTPUT function.

It is expected that a pull-up resistor will be connected to the Prot+12V or other supply. The value of the pull-up may be determined by the impedance of the connected load. A10 kOhm resistor may be used as a default.

With a pull-up resistor connected
   o   When the output is **turned on**, the output sinks current from all attached devices.
   o   When the output is **turned off**, the output is pulled up to the supplying voltage.

(drawing of relay connected)

6.22.   Connecting a Sampler that is triggered by Stage

Many samplers can be triggered to collect a sample by SL3's Digital output DOUT#1 or DOUT#2. Simply connect DOUT#1 or 2 to the "trigger" line of the sampler along with ground and program an equation to generate the pulse based on the desired criteria.

For example, If you want to trigger a sample when the stage is > 12.50 feet do the following:

   ▸   Setup a measurement for stage, type to match the sensor you are using
   ▸   Setup a measurement to control the sampler, type: Meta.
   ▸   Set the Index to point to the stage measurement
   ▸   Set the equation to: OUTPUT(X,2,1,1000) for DOUT#2, PULSE, 1000 ms.

6.23.   Connecting to the Switched Power

There are two switched power connections SWD#1 and SWD#2. Each will provide up to 1A of the input power. The setup and software control when the switched power lines are turned on and off.

SWD#1	Turned on during each measurement of Analog/Digital/SDI sensor. Warmup can increase the time
SWD#2	Turned on only from an equation OUTPUT function or Command line command

6.24.   Connecting to the protected power

The protected power is labeled PROT+12V. This power provides 1A of the main power. This can be used for sensors or equipment that needs to remain powered at all times. It can be turned on/off/pulsed only via an equation OUTPUT function.

7.   Installing and Running LinkComm

LinkComm is a software application designed setup and operate Satlink. LinkComm is used to:

▸   Check Satlink status
▸   Set up an Satlink station
▸   Download and graph the log from Satlink
▸   Upgrade Satlink firmware
▸   Calibrate connected sensors

7.1.   Installing the LinkComm mobile app

Mobile versions of LinkComm are available to run on Apple iPad and iPhone, and on Google Android phones and tablets. They can be found on the Apple® App Store™, and Google® Play Store™, respectively. These applications are installed just like any other app for the device that is being used.

7.2.   Installing the PC version of of LinkComm

The PC version of LinkComm is available for download from http://www.sutron.com/downloads.htm. The PC version is supported on Windows 7 and higher. Operation on Windows XP is possible so long as a graphics driver is installed that *fully* supports either OpenGL v2.1 or DirectX 9.0.

After downloading LinkComm, run the program and follow the instructions on the screen. For Windows, extract all files to a folder on your computer. You may run LinkComm directly from this folder by double-clicking "LinkComm.exe", or, to *install* LinkComm so that it appears on the Start menu, double-click "setup.exe" (Administrator privileges are required to *install* LinkComm).

If your PC is running windows 7, you will need to install the USB drivers after installing LinkComm. Note: this is not needed for Windows 8 and beyond.
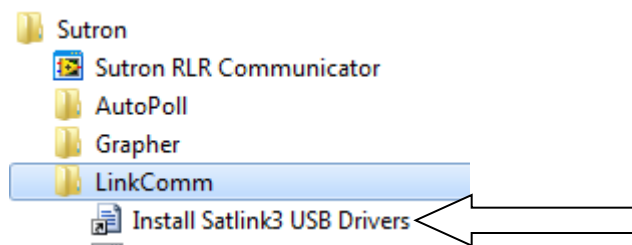
7.3.   Running LinkComm

When LinkComm starts it displays a list of stations that have previously been setup in the software along with the details of the selected station. The details include the station name, type, connection settings, notes and images.
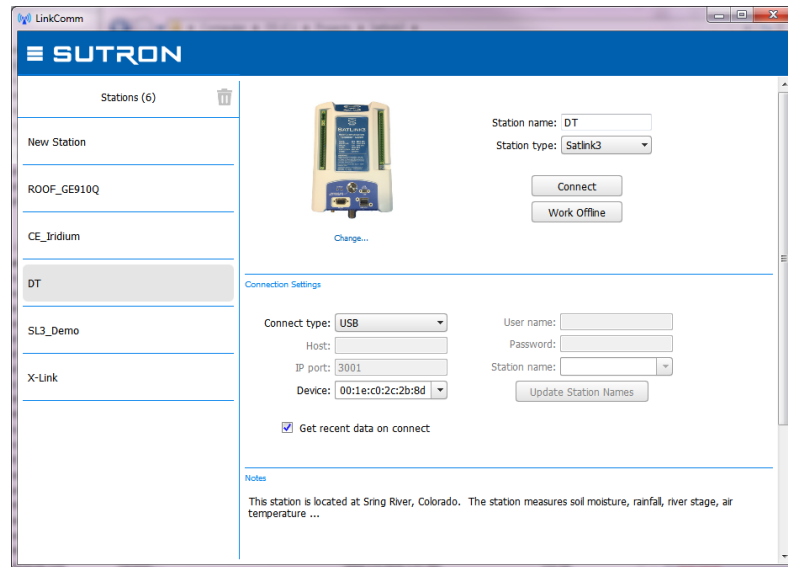
On small displays, the station list is hidden. Press < Stations to see the station list.
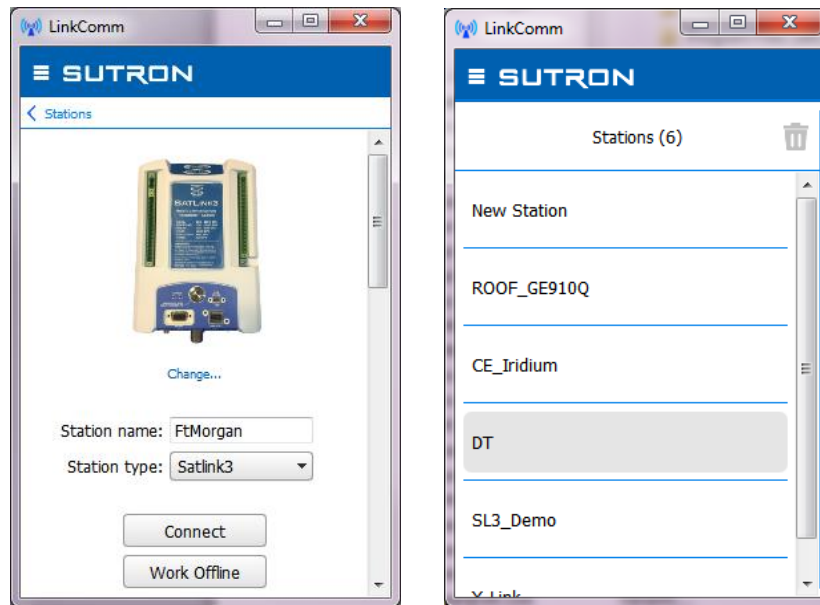
To work with the selected station, press "Connect". The software will use connection settings (USB, RS232, WiFi) and try to communicate with the site.

If you have problems connecting to the site, check your communication settings and or cables/WiFi settings and see the following sections that detail USB and WiFi connections.

To create a new station, select "New Station" at the top of the station list (1). Then set the Station Type (2) to match your type of Satlink, set "Connect type" (3) to WiFi, USB or "Serial" and press Connect (4). Additional information on the WiFi, USB and serial connections are provided in the next sections.
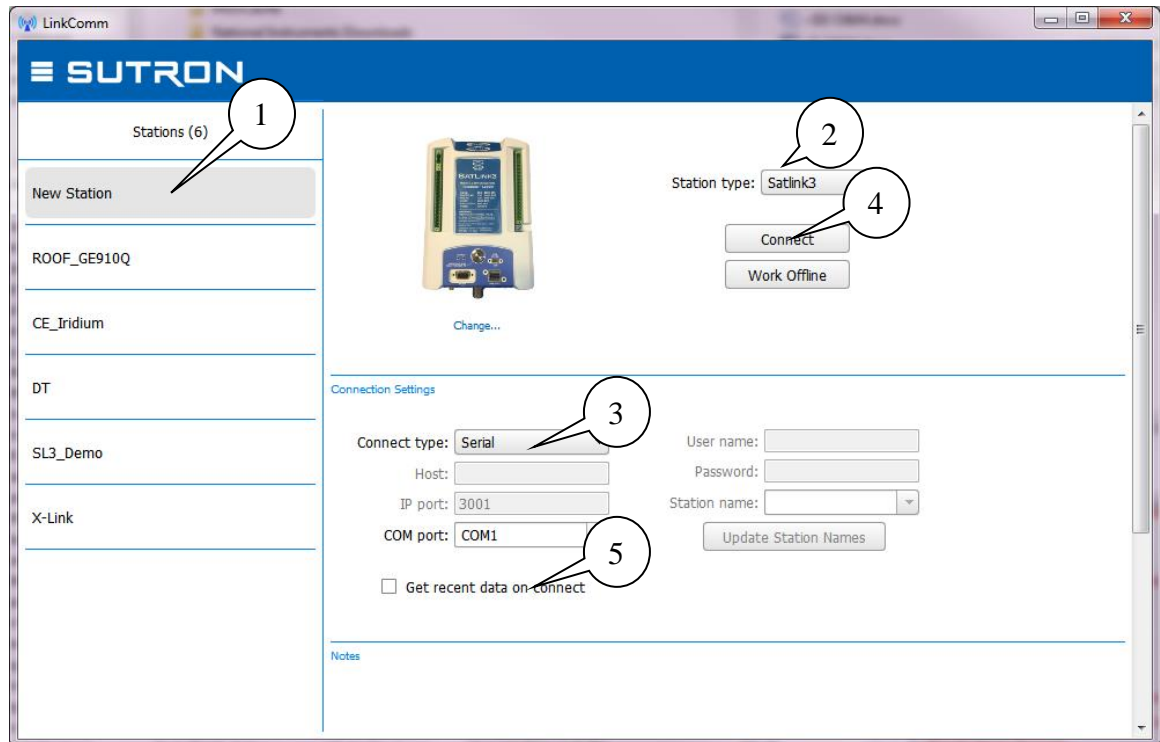
You can also set the software to get recent data (5). "Get recent data on connect", when checked, will cause LinkComm to download the last week of data for display in a graph on the dashboard tab, every time you connect to Satlink. This can be a considerable amount of data (several k-bytes). Here again, you may choose to disable this feature to reduce data costs.

"Check setup on connect", when checked, will cause LinkComm to retrieve the setup from Satlink every time you connect. You may choose to disable this feature to reduce data costs (e.g., for cellular connections that cost money).

7.3.1.1.   *Connecting via USB*

LinkComm can connect directly to Satlink via a USB cable. Simply connect a USB cable from your computer to Satlink and select "USB" as the Connect type.

You will need to pick the appropriate USB device:
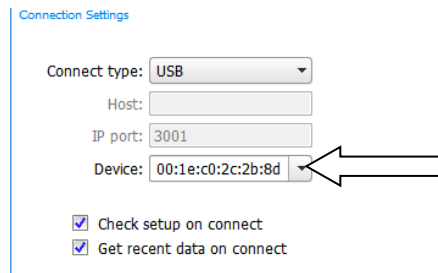
7.3.1.3.   *Connecting via Wi-Fi*

Satlink can provide a Wi-Fi hotspot that LinkComm can connect to. The Wi-Fi feature is useful for connecting to Satlink with a mobile phone, tablet, or laptop.

In order for LinkComm to connect to Satlink via Wi-Fi, the device that is running LinkComm must first connect to the Wi-Fi hotspot provided by Satlink.

To connect to Satlink via Wi-Fi, follow this sequence:

1. Have Satlink turn on the Wi-Fi by pushing the wakeup button located on the front. Satlink will blink the blue LED to acknowledge the button press. *Please see below for other ways to turn on Wi-Fi.*
2. Have your computer (Laptop, iPhone, or Android) connect to Satlink's Wi-Fi hotspot.
    a. Satlink will name its hotspot *SL3_xxxx_aaaa*, where *xxxx* is the station name and *aaaa* is a unique number.
3. Create a new station in LinkComm with "Connect type" set to "Station WiFi" (if LinkComm detects you are connected to an Satlink via WiFi, it will set this type by default)
    a. If you need to manually enter the IP address for Satlink, it is 192.168.88.1:3001.
4. LinkComm is now connected to Satlink. It is possible to check status, change setup, download log, and perform almost all other operations.
5. Once the LinkComm session is complete, **make sure to disconnect from Satlink's WiFi hotspot.**

7.3.2. Working Offline

To "work offline" means to make changes to the setup in LinkComm setup while disconnected from Satlink. You enter this mode by selecting "Work Offline" in the station view. The changes you make to the setup are automatically saved in LinkComm but not in the Satlink.

When you later connect to Satlink, you need to send the setup to Satlink to bring the setups "in-sync". If you checked "Get setup on connect" in the station's Connection Settings, then when you first connect, LinkComm will prompt to overwrite your changes. If you answer "No", LinkComm will then prompt to send your changes to Satlink. Answer "Yes" at this point to bring the setups "in-sync".

7.3.3. Notes

This section is used to enter notes in this section related to station setup and maintenance. For example, you might store information about the last time the station was visited, plans for future visits, and notes on calibrations, etc.

Note: All settings (station and connect settings, notes, and site images) for every station you define are saved automatically as you make changes. Hence, there is no need to select any kind of "Save" menu item.

7.3.4. Site Images

This section allows you store pictures of the site. Click "Add New Image" to browse for images to store. If a camera is available, you'll have the option to take pictures to store as new site images.

When you click a site image, it expands to fill the available window.

To delete a site image, right-click (or press-and-hold) the image and select "Delete Site Image" in the subsequent prompt.

7.4.   Main Menu

Press the ▤ button in the upper left to access the main menu. The main menu shows more options when connected vs disconnected.

Station	
Stations...	Disconnect and return to the Stations List View
Log in...	LinkComm prompts for password and then attempts to log in to Satlink
Change password...	LinkComm prompts for new password to use to log in to Satlink
Setup	
Import setup...	Load a setup from an external file. The setup file was typically saved by a prior "Export setup…" action
Export setup...	Save the current setup to an external file. The setup file is a text file containing property-value assignments
Send setup to Satlink3	Send the current setup to Satlink*
Get setup from Satlink3	Get the setup from Satlink*
Stop recording...	Start (or Stop, if applicable) recording*
Help	
About...	Display a dialog showing information about LinkComm, including version
Sutron Website...	Visit the Sutron website
Event Log...	Show LinkComm event log. This is a text file showing diagnostic information about LinkComm operation
Exit	
Exit	Exit LinkComm (not present in mobile app)

* these items are only displayed if connected

7.5.   Station Detail View – Connected or Working Offline

After you press either "Connect" or "Work Offline" in the stations list view, LinkComm transitions to the "Station View", where you see several tabs, e.g., Dashboard, Measurements, Data, etc., each showing information about status and/or setup for the selected Satlink.

The following picture is of the station view with the Dashboard tab selected:
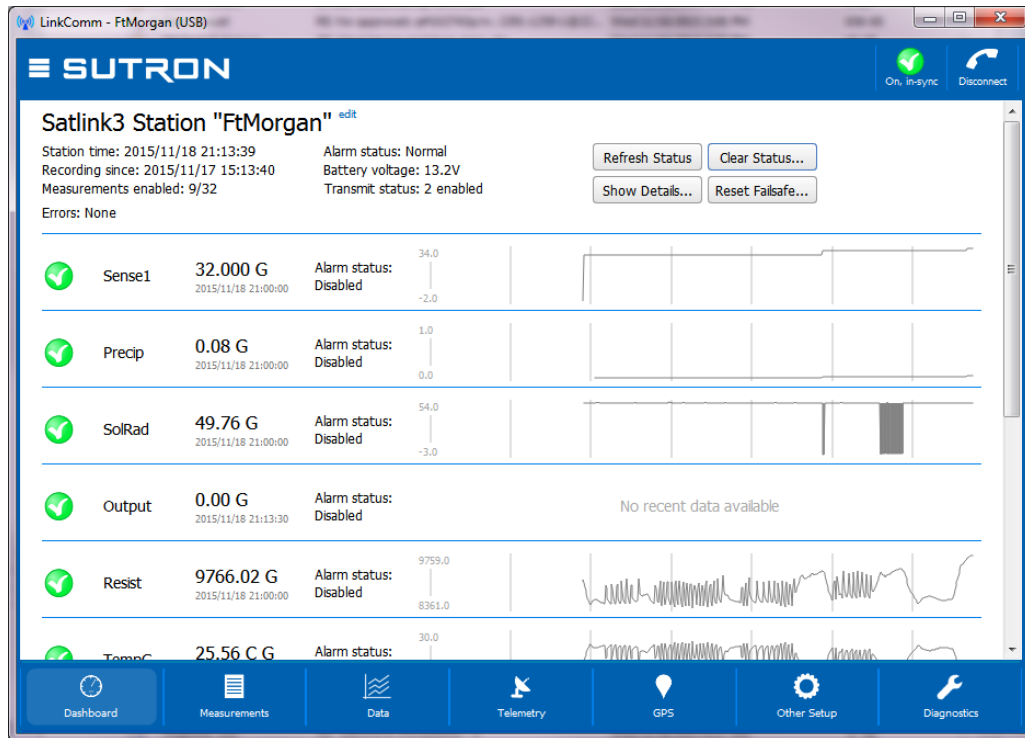
7.5.1. Connect Button

The right header button is the "Connect Button". It shows the status of the current connection from LinkComm to Satlink. The button has two possible states:

	LinkComm is connected to Satlink	Pressing the button in this state will cause LinkComm to disconnect from Satlink
	LinkComm is not connected to Satlink	Pressing the button in this state will cause LinkComm to try to connect to Satlink

7.5.2. Setup Status Button

The left header button is the "setup status button". This button shows status related to the setup, including whether the setup is "in-sync", i.e., the same in both LinkComm and Satlink, and recording status.
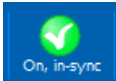
Pressing the setup status button typically prompts the user to take the next logical step towards getting the setup in-sync between LinkComm and Satlink, with recording on.

> **Note: When the setup displayed by LinkComm is the same as the setup in Satlink, then we say the setups are "in-sync". When the setups are not the same, the setup status button displays a warning sign, and you must send the setup to Satlink to get the setups "in-sync".**

After making changes to the setup locally, you need to send those changes to Satlink to bring the setups "in-sync". You do this by pressing the setup status button (or by selecting the main menu item, "Send Setup to Satlink").

The following table describes the different states maintained by the setup status button, and describes what happens when you press the button in each of the states:

On, in-sync	LinkComm is connected to Satlink, recording is ON, and the setups are "in-sync"	Press the button to turn off recording. LinkComm will prompt for confirmation.
Changed	A change has been made to the setup in LinkComm (it no longer matches the setup in Satlink)	Press the button to send setup changes to Satlink. LinkComm will prompt for confirmation. If "Yes", only the changes required to be "in-sync" are sent. If "No", LinkComm prompts to retrieve the setup from Satlink, overwriting local changes
Changed?	The setup in Satlink is unknown, and so may differ from the one displayed by LinkComm	Press the button to send the setup to Satlink. LinkComm will prompt for confirmation. If "Yes", LinkComm first sets the setup in Satlink to defaults, and then sends the changes required to be in-sync
STOP Rec Off!	Recording is OFF in Satlink. This means no measurements are being made	Press the button to turn recording ON in Satlink. LinkComm will prompt for confirmation
Offline	LinkComm is working off line (not connected to Satlink)	Press the button to connect to Satlink

> **The setup that is shown in LinkComm is not necessarily the same setup that is in a connected Satlink**

- To read a setup from an Satlink and show it in LinkComm, you may either use the setup status button as described in the previous section, or select the **Get Setup From Satlink** item from the main menu

- To give a setup created by LinkComm to Satlink, you may either use the setup status button as described in the previous section, or select the **Send Setup To Satlink** item from the main menu

> **Unless the setup status button menu item is selected, or the Send Setup to Satlink button is clicked, none of the changes made to the setup in LinkComm will be in Satlink!**

7.5.3. Handling Setup Differences Following Setup Send

On some occasions, LinkComm will detect that differences remain after sending setup changes to Satlink. This can happen because of a communication error, but more commonly, it occurs because Satlink doesn't allow certain changes to occur remotely.

In any case, when LinkComm detects such a difference exists, LinkComm warns you that changes still exist, and will offer a dialog to "View Differences". To rectify the situation, it is usually best to get the setup from Satlink to again be "in-sync", and then try making and sending your changes again.

7.5.4. Setup Files

You can save a Satlink setup to a file and later re-use that setup by loading it into LinkComm. To save a Satlink setup to a file, select **Export setup…** from the main menu.

You may find it helpful to save reference copies of setups outside of LinkComm, as a backup in case you accidentally overwrite changes to the setup in LinkComm. Use the export setup menu item to achieve this.

To load a Satlink setup from a file, select **Import setup…** from the main menu. After loading the setup file, you still need to send the changes to Satlink. As always, use either the setup status button, or the **Send Setup to Satlink** menu item, to send the setup to Satlink.

7.5.5. Metadata - Pictures, Wiring Diagrams, and Special Text

LinkComm enables you to associate pictures, wiring diagrams, and special text items with your Satlink station definitions. This "metadata" is NOT stored in the Satlink logger, since the logger needs to use its storage space for more important things like sensor readings.

Some examples of metadata in LinkComm:

- Station picture, notes, and site images
- Measurement picture, model, manufacturer, description, units

Metadata is typically unique for a given station. If LinkComm detects you've started using a station definition with a different Satlink, LinkComm will prompt whether to delete the metadata. This can save you time in clearing it manually.

7.6.   Dashboard Tab

The Dashboard tab is the first tab displayed after you connect to Satlink. When LinkComm connects to Satlink, it retrieves the current station status, and current data values for measurements, and displays this data on the Dashboard.

> The data displayed on the Dashboard always reflects the state of Satlink the last time you refreshed status, regardless of the measurements you may or may not have defined under Measurements.
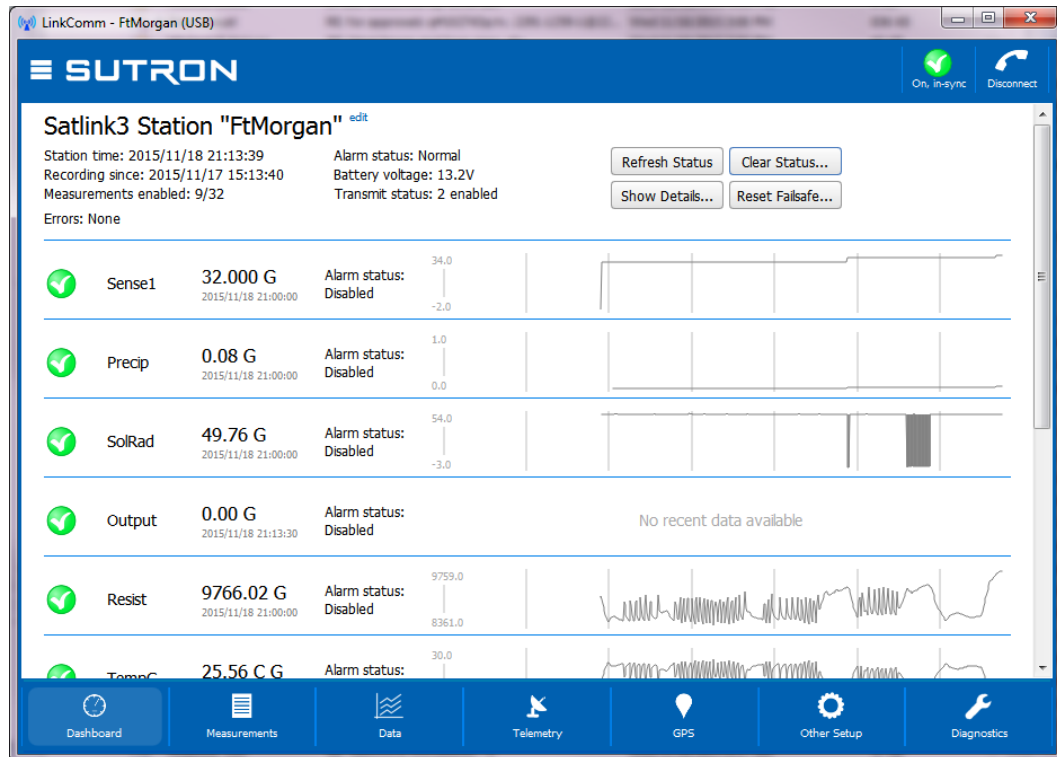
- To refresh the current status, click the **Refresh Status** button
- To reset the station status, including the transmission counters, tallies and system errors, click the **Clear Status** button. Once the status is reset, the previous status is lost
- To show the status text actually received from the logger, press the **Show Details** button
  High level telemetry status is also shown on this page. To see low level details about telemetry, please see the Telemetry tab. If the station has any active errors, these are shown in RED just below the status area.

  Right-clicking on the graph (or touching the graph in the mobile app), reveals a pop-up menu that allows you to:

- Refresh recent data (all items, not just the selected)
- View the current data item in the larger graph on the Data tab

7.6.1. Changing the Station Name

The station name can only be changed from the Dashboard tab, and is actually the *only* setup item that can be changed from the Dashboard tab. To change the station name, press the blue "edit" text, next to the station name.

LinkComm will prompt for the new station name. Just as with every other station setup change, the change is not complete until you have sent the setup to Satlink. Do this using either the setup status button in the main header, or the **Send Setup to Satlink** item in the main menu.

7.7.   Measurements Tab

The measurements tab is the first tab displayed when you select **Work Offline** in the stations list view. This is the tab where all sensors are configured. Up to 16 sensors may be enabled and configured. The measurements tab also provides some test functions to help you ensure the sensor is properly configured.
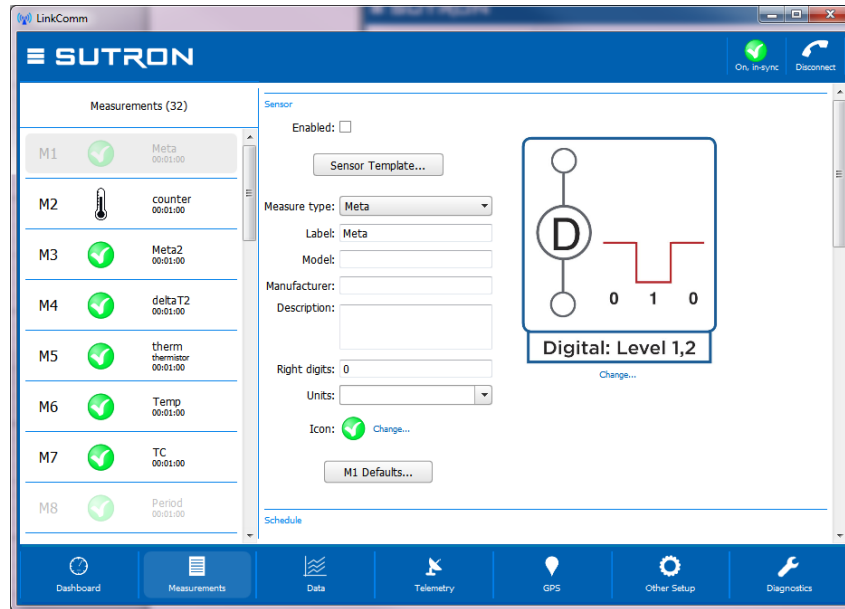
The left side of the measurements tab shows a list of all possible measurements. The right side of the measurements tab shows the details of the selected measurement. The details are the settings used to determine how the measurement is taken and how the data is processed by the system. The settings include schedule, Configuration (including wiring diagram), Processing, Alarms, Logging, Tx Content.

7.8.   Data Tab

The data tab shows historical measurement readings made by Satlink. If recent data was downloaded when connecting to Satlink, the graph displays this data the first time you select the Data tab.

To zoom-in on subsets of data, click-and-drag to create a rectangle around the data you want to zoom to. To restore the zoom to all data, double-click. When using a touchscreen, you may use your finger to draw the rectangle, and double-tap to reset the zoom.

Right-clicking (or touching) the graph will show a menu allowing you to select all series, deselect all series, or show points. You may select or deselect individual data series for display using the legend just below the graph.

Change the span of the period to graph using the **Span** control. Several options are available. Whenever a change to span is made, you must press the **Download** button to retrieve the data for display. When the defined span no longer matches the displayed span, the download button text changes to "Download***".

Press **Save File…** to save the raw data to a text file. Press **Save Image…** to save an image of the graph to disk. On mobile platforms, rather than save files to disk, you are prompted to "share" the files via other services like Email, Dropbox (if installed), etc.

7.9.   Telemetry Tab

The Telemetry tab is used to configure a station for Environmental Satellite (GOES), Iridium or Cellular communications. The contents of the tab differ for each telemetry type.

Telemetry tab showing Environmental Satellite shows the following:
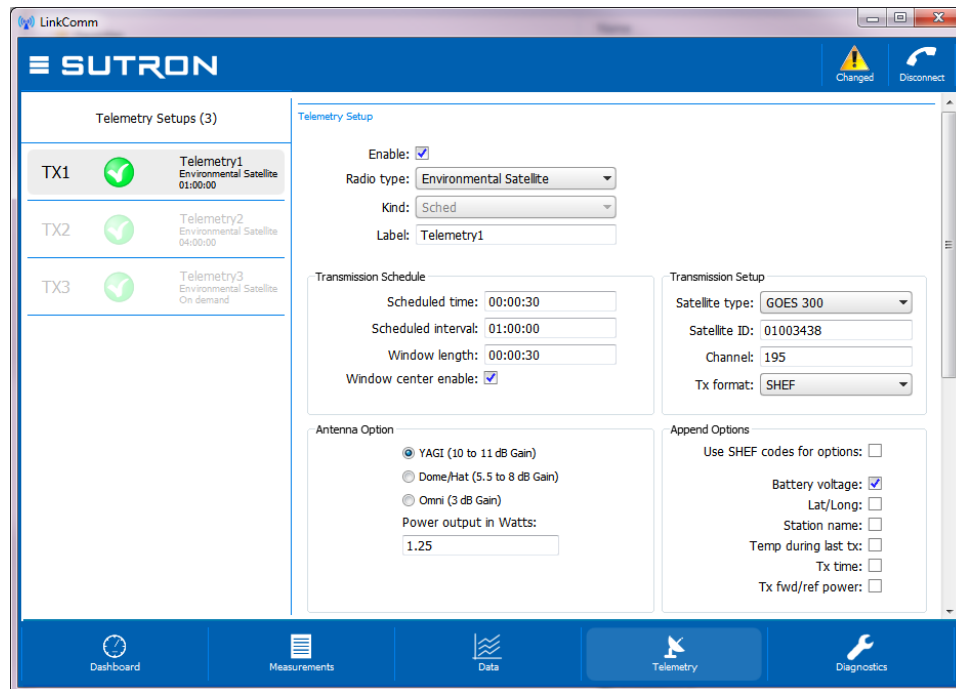
The telemetry status section is below the setup area, and is accessed by scrolling down.
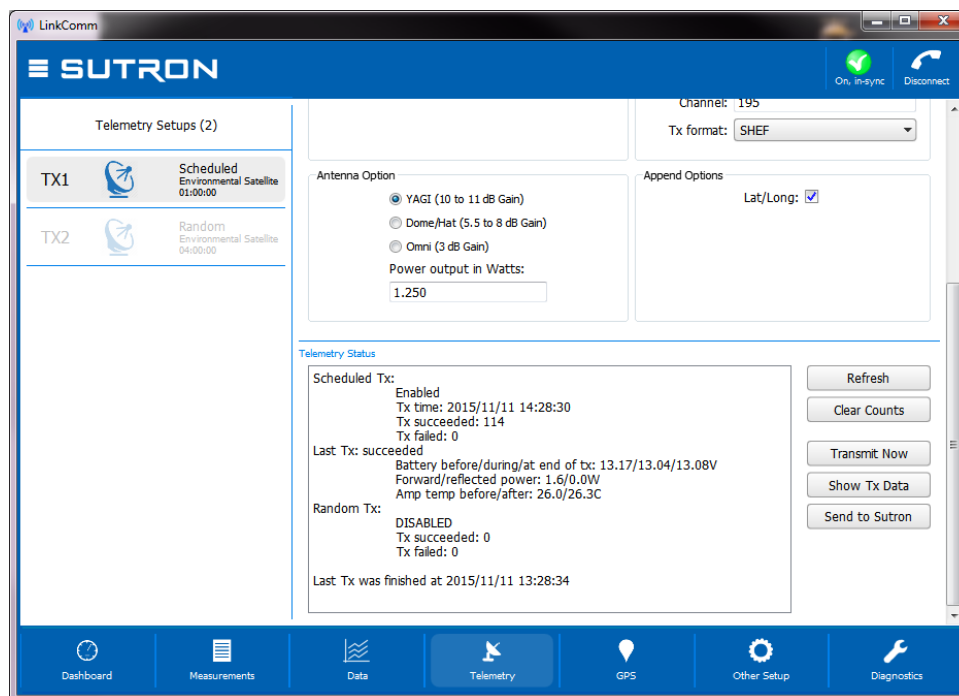
The status text is retrieved from Satlink the first time you display the telemetry tab, and can be refreshed as needed on demand.

- Press the **Refresh** button to update the status text to the latest
- Press the **Clear Counts** button to clear all telemetry tallies
- Press **Transmit Now** to cause Satlink to transmit now

- Press **Show Tx Data** to show the data in Satlink's transmit buffer along with an estimate of how long the transmission will take and other transmission metrics.
- Press **Send to Sutron** to have Satlink send a diagnostic transmission to Sutron. Before the transmission is made, you will be prompted to select the desired channel (195 East or 196 West).

7.10.   GPS Tab

Every Satlink Logger transmitter has a built-in GPS module. The GPS module provides time and frequency information needed for the on-going operation of SL3. SL3 is certified to operate for 30 days without GPS.

There is only one setting on the GPS tab: Local Time Offset (min). GPS provides UTC time to Satlink. The field labeled "Local Time Offset" can be used to have Satlink use local time instead of UTC. Enter the offset from UTC in minutes to have Satlink use local time. Leave the setting at zero to have Satlink use UTC. E.g. to have Satlink run on US Eastern Standard Time, enter -300, indicating that EST is 300 minutes behind UTC. Note:Satlink will not automatically switch between daylight savings time and standard time. Note: if you set a local time offset, all times used by Satlink will be in local time – even the scheduled transmit time. You may need to adjust your scheduled transmission time to local time if you use a local time offset.
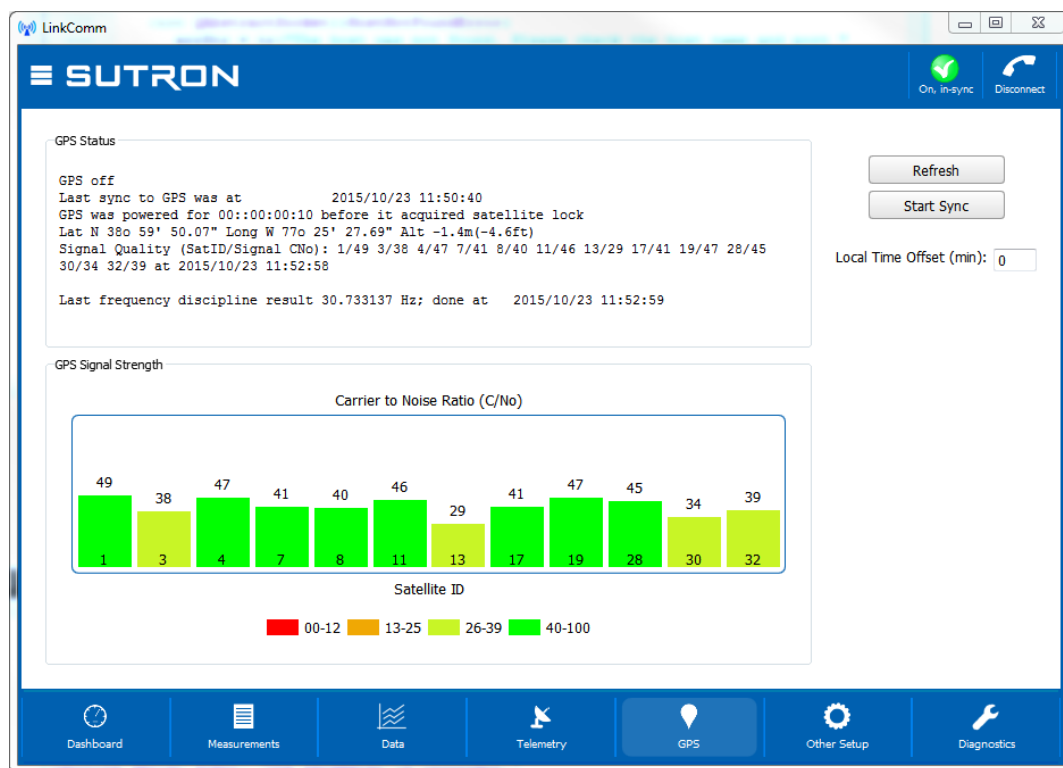
In order to give the user a better idea of the quality of the GPS signal, Satlink Logger provides messages that indicate how long the GPS module was powered before a time sync was initiated. If the last GPS sync was a part of a transmission, this number should roughly be equal to the GPS acquire time. If the last sync was user initiated, then this number will indicate how long it took the GPS module to acquire the signal necessary to provide an accurate time.

The Signal Quality reported by Satlink consists of a graph of the signal strength for each satellite in view of the station. The satellite number is on the bottom of each bar and the signal strength

is the height of the bar. The signal strength is also color coded for easy recognition of how well the satellites are being received. Note that it is natural for the signal strength to be below 40 as satellites orbit out of view. The GPS needs at least 4 satellites to get valid time and frequency information.

The only controls on the tab are to refresh the screen and start a new sync. Normally, Satlink will attempt to get a time sync from GPS 10 minutes before a scheduled transmission. The synchronization process takes about a minute and ensures that Satlink is ready to transmit on time. If the sync fails for any reason, the transmission will still be able to operate for up to 30 days. In fact, just one sync in thirty days is all that Satlink needs to operate indefinitely. If there are no scheduled transmissions scheduled, Satlink will attempt a sync …TBD ADI or Chris.

7.11.   Other Setup

Various settings are displayed in the Other Setup dialog, which is accessed from the Telemetry tab by pressing the **Other Setup** button. The settings shown include those for:

- Wi-Fi
- Log daily values
- DCP Command
- Digital Output DOUT
- Modbus RS-485
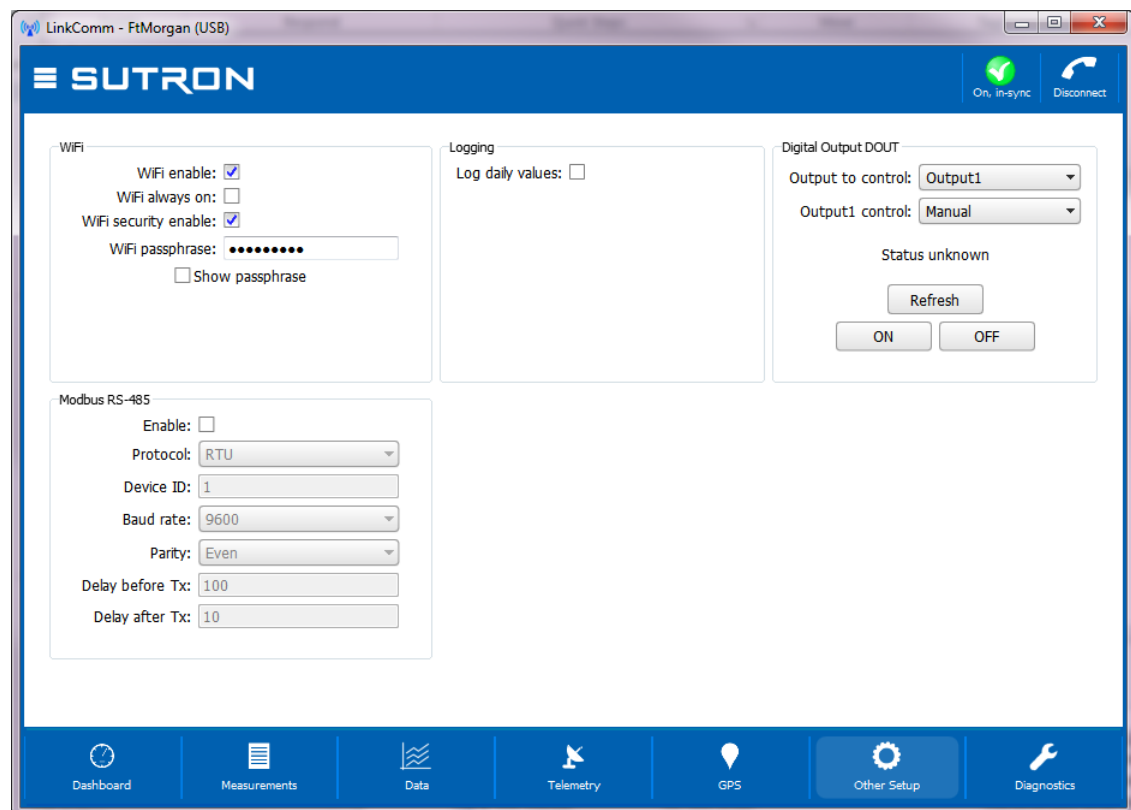
The controls in the **Digital Output DOUT** section can be used to view the status of the digital output, and to control its state. Press the **Refresh** button to display the current state of DOUT.

The current state is displayed just above the button. Press the **ON** button to turn DOUT on. Press the **OFF** button to turn DOUT off.

7.12.   Diagnostics Tab

This tab provides extensive diagnostics information, and offers tools for performing various diagnostics and maintenance operations. For example:

▸ Get diagnostics information including software versions and data usage
▸ Terminal and Data Flow views
▸ SDI-12 command utility
▸ Set the clock in Satlink
▸ Upgrade Satlink
▸ Resetting Satlink to factory defaults
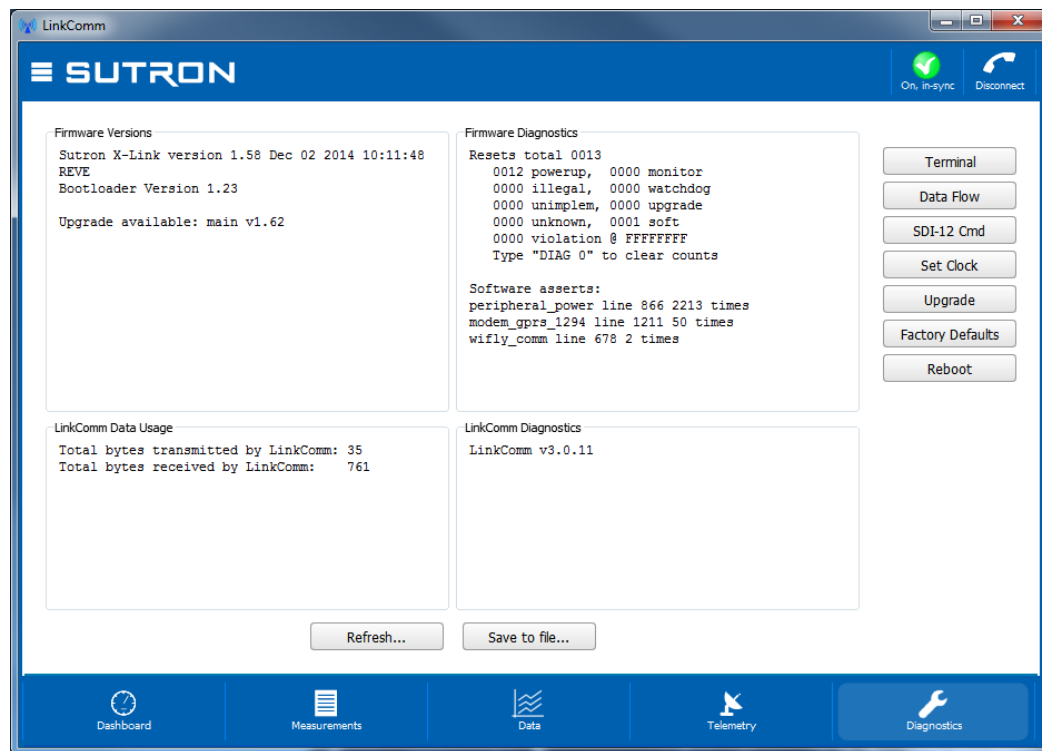
7.12.1.   Firmware Versions and Diagnostics

The top two text areas on the Diagnostics tab display information about the firmware installed in the connected Satlink.

The **Firmware Versions** section displays the current versions of firmware installed in Satlink. If LinkComm detects a newer version of firmware is available, this text area contains a message saying such. The **Firmware Diagnostics** area displays recent diagnostics information reported by Satlink.

Press the **Refresh…** button to update this data to the latest. Press the **Save to file…** button to save all diagnostic text data to an external file.

7.12.2.   LinkComm Versions and Diagnostics

The bottom two text areas on the Diagnostics tab display information about LinkComm.

The **LinkComm Data Usage** section displays the total byte counts between LinkComm and Satlink for the current session. The LinkComm Diagnostics section displays LinkComm's version information.

Press the **Refresh…** button to update this data to the latest. Press the **Save to file…** button to save all diagnostic text data to an external file.

7.12.3.   Terminal

LinkComm features a built in terminal monitor program. All communications between LinkComm and Satlink uses the command line interface. The Terminal window can be used to view a history of command traffic, and can be used to access the command line interface directly.

To see the details of the communication between LinkComm and Satlink, bring up the terminal window via the **Terminal** button on the Diagnostic tab.

You may type into the terminal window. Data typed will be sent to Satlink. Any replies from Satlink will be shown in the Terminal window.
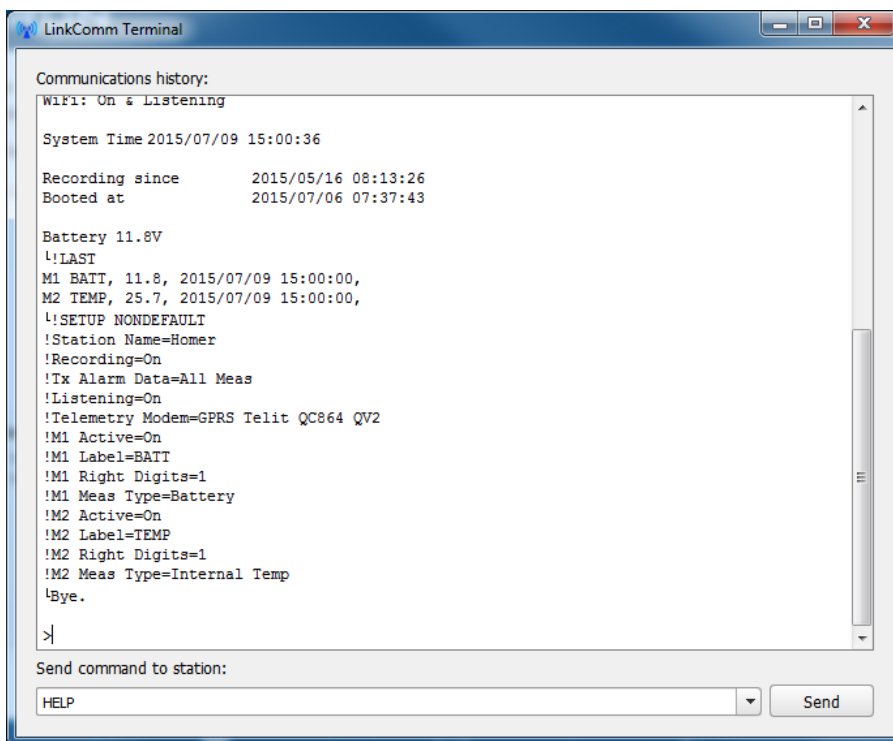
7.12.4.   Data Flow

The Data Flow dialog shows recent command line traffic in Hexadecimal, and shows traffic direction and timestamp information. To open the dialog, press the **Data Flow** button on the Diagnostic tab.

When "Autoscroll on data" is checked, the window advances when new data becomes available.

7.12.5.   Firmware Upgrade

The software running in Satlink can be upgraded. The latest version of Satlink firmware is delivered as part of the LinkComm download package obtained from the Sutron web site. LinkComm may be downloaded from http://www.sutron.com/downloads.htm (search on "LinkComm").

Upgrades may be done over RS232, USB or WiFi.

Upgrade files are packaged into the same download with the LinkComm program. Upgrade files will have names such as *SL3EuropaActual_800r1695.sl3u*

To initiate an upgrade of your Satlink, select the **Upgrade** button on the Diagnostics tab. If LinkComm detects a newer version of firmware on your PC, LinkComm will suggest that an upgrade be made using it. If you select "No", then use the file-open dialog that follows to browse for, and select, the upgrade file to use.

7.12.6.   Setting to Factory Defaults

Setting the station to factory defaults will permanently erase all setup and status. The setup will be set to defaults. To set Satlink to factory defaults, press the **Factory Defaults** button on the Diagnostics tab and answer "Yes" to the prompt for confirmation.

7.12.7.   Rebooting Satlink

Clicking the **Reboot** button on the Diagnostics tab will have LinkComm issue the reboot command to Satlink. Satlink will perform a software reset. LinkComm will then disconnect from Satlink.

If you are issuing the command remotely, please note that Satlink will need a minute to get back on the internet before it is ready to talk again.

7.12.8.   Password

Password protection can be configured to prevent unauthorized access.

If password protection is enabled, a user who is connected can view setup and data. However, no changes to setup are allowed until a password is entered. A password prompt automatically appears when a setup change is attempted.

LinkComm provides a Password menu that can be used to log in, change the password, and log out. LinkComm will prompt for a password when it is needed.

7.12.9.   Creating a Password

Creating a Password via Command Line

Using the command line, type *PASSWORD = XXX* to set password to XXX. To log in, type *LOGIN=XXX*. Type *PASSWORD =* to disable password usage.

Working with a Password-Protected Station

When sending a message to a password protected station, the first line of the message must have the login command *LOGIN=XXX*.

Logging out is accomplished either by:

▶ selecting the **Password->Log Out** menu in LinkComm,
▶ typing EXIT in the command line,
▶ disconnecting the USB cable,
▶ powering down the unit.

8. Operating SL3

The following scenarios describe how to perform some common functions with an SL3. They assume that the SL3 is powered up and that LinkComm is running and can connect to the station via USB, RS232, WiFi. For help connecting to a station, refer to Connecting via USB or Connecting via Wi-Fi.

8.1. Creating a new station in the station list (off-line)

- Select "New Station" from the top of the station list.
- Press "Work Offline"
- On the Dashboard tab, edit the station name
- Use the Measurements and Telemetry tab to make other settings.
- Press [icon] and then select Save Station. The station will be added to the station list and can be loaded by the procedure in 8.2 below.

8.2. Loading an SL3 with a new setup

- Select the station from the station list (see 8.1 for instructions on how to create a new setup and save it in the station list.)
- Select/verify the connection type and related settings.
- Press "Connect"
  - o If the SL3 has not previously been setup, the setup will be loaded into SL3.
  - o If the SL3 already has a setup, LinkComm will warn you that "the setup in the station differs from the setup in LinkComm. Do you want to send the setup to the station so its settings will match those you see in LinkComm?".
    - ▪ Press YES to send the new setup to SL3 overwriting the old setup.

8.3. Connecting to an SL3 which is already in your station list

- Select the station from the station view
- Select the connection type and related settings.
- Press connect
- LinkComm will read the setup from the station and report any differences it finds. If no message is displayed, the setups match.
- If the setup differs, a message will be displayed. Press "View Diffs…" to see the differences. Then press YES to send the Linkcomm setup to SL3 or NO to have a chance to get the setup from SL3.

8.4.   Connecting to an SL3 for which is not in your station list

- Press "Select "New Station" from the top of the station list.
- Specify the Station type, Connect type and related settings.
- Press connect. LinkComm will read the station name and setup into its memory.
- If you return to the station list or exit the program, you will be prompted to "save the current setup as a new station entry in your station list.". You may also select "save station" from the LinkComm menu.

8.5.   Importing a setup to create a station in the station list

- Select "New Station" from the top of the station list.
- Select "Import Setup …" from the menu.
- Locate the desired setup file and press open
  - Note, the setup file is a .txt file and it may have been created via Export or Diagnostics.
- If prompted that Linkcomm will "replace the current setup…Continue with import?", select YES. The setup is now resident in LinkComm.
- If you return to the station list or exit the program, you will be prompted to "save the current setup as a new station entry in your station list." You may also select "save station" from the LinkComm menu.

8.6.   Testing Measurements

- Go to the measurements tab.
- Select a measurement
- Scroll to the Processing Section
- Press "Refresh" to view last measurement
- Press Force to make a new measurement.

8.7.   Examine measurements

- Go to the Dashboard
- Press "Refresh Status" to see latest data from each measurement
- Right click and select "Refresh recent data" to update graphs.

8.8.   Examine transmissions

- Go to Dashboard
- Select "Show Details". Statistics on the Scheduled and Random Tx will be displayed
- You may also see the telemetry statistics on the Telemetry tab, Telemetry Status section.

8.9.   Examine transmission data

- Go to Telemetry

- Select "Show Tx Data". The data from the last transmission is displayed along with data that would be transmitted if one were made now. Details on the size and time required to transmit are also displayed.

8.10.   Entering manual data

- Go to Measurements
- Select the desired measurement
- Scroll to Processing, select "Force", and enter the desired value and press OK.

8.11.   Calibrating Sensors

- Go to Measurements
- Select the desired measurement
- Scroll to Processing, select "Calibrate", enter the desired sensor reading and press OK.

8.12.   Configuring SDI-12 Sensors

- Go to Measurements
- Select the desired measurement of an SDI-12 sensor
- Scroll to Configuration and press "Send SDI-12 Command". A menu will be provided that allow you to select Port1/Port2, Address, and commands for SDI-12.
- If the desired command is not in the Command drop-down list, simply enter it yourself in the command box.
- You may also access the SDI command menu from the Diagnostics tab.

8.13.   Downloading log data

- Go to Data
- Select desired "Span" and press "Download".
- When download is complete, press "Save File…". Note the file is named by the end time in the span.

8.14.   Viewing/Clearing the Status

- Go to Dashboard
- The status is displayed in the top left giving the station name, time, number of measurements enabled, errors, alarm status, battery voltage, transmission status.
- Press "Refresh Status" to update the status.
- Press "Show Details" to see additional information.
- Press "Clear Status" to clear any errors.

8.15.   Setting the Time

Every Satlink Logger transmitter has a built-in GPS module. The GPS module has the ability to get the time from the GPS satellites. The GPS module needs to be connected to an antenna and that antenna needs to have a clear view of the sky so the GPS can track the satellites. Satlink also contains an internal clock. Satlink will frequently update its clock to the time reported by the GPS module. You never need to set Satlink's time as long as GPS is operational.

Should GPS fail for any reason, the Satlink will continue to operate the transmitter for up to 30 days. During this time, Satlink will be using its own internal clock to maintain the time within xxx ms of UTC. After 30 days, there is a chance that the internal clock has drifted more then xxx ms and the transmissions are suspended. During this time, normal data collection and logging continues.

Satlink time can be viewed via LinkComm on the Dashboard tab. Note that the time shown in the dashboard is a snapshot of the time. To see the current time, press refresh for an update. The time displayed will be UTC or local time depending on the Local time offset setting. Note that the time may be off by a second or two because of the time needed to retrieve the status from Satlink.

You can get additional information on the time on the GPS tab.

8.16.   SDI Clock Synchronization (future build)

Certain Sutron SDI-12 sensors (such as the SDR, RLR, and the CF Bubbler) support a command to set the time of the sensor via SDI-12. Satlink takes advantage of that feature, and periodically sets the clock of the sensors using an SDI-12 command, ensuring that all devices share a common time.

When recording is enabled and every 24 hours thereafter, Satlink performs a time sync with all the Sutron devices that support the XDT! command. Every time sync is started by sending an I! command to every SDI-12 device that Satlink has been set up to measure. If the device replies favorably to the I! command, an XDT! command is issued to the device. Satlink then decides whether to sync that device's clock based on time validity, the presence of a GPS (either on Satlink or on one of the attached devices), and the time difference between Satlink and the device.

The XDT set time command takes the format aXDTYYYY/MM/DD HH:MM:SS!

> a is address
> XDT is the command to set the date and time
> YYYY is the year
> MM is the month (01 to 12)
> DD is the day of the month (01 to 31)
> HH is the hour (military time 0 to 23)
> MM is the minutes
> SS is the seconds

Example set date time command: 0XDT2008/06/26 13:15:00!

9. Setting SL3 operating parameters

Satlink operation is controlled by its setup. The user has the option of changing any part of the setup. The setup is stored in non-volatile memory and will not be affected when the unit loses power.

The LinkComm application is the easiest and fastest way to program your station..

Setup can be changed while Satlink is collecting data. However, if the station is in the middle of making a measurement when the relevant setup is changed, unexpected effects may occur. Even if unexpected effects occur, the next measurement will be made correctly.

Changes to setup will not affect previously logged data.

Every time setup is changed, it is noted in the log with the entry setup changed. Details of the setup change are not logged.

If a password is enabled, changes to setup cannot be made until the password is entered.

The setup is broken into three sections discussed in detail in the next chapters:

‣ measurement setup
‣ telemetry setup
‣ other setup

Remember that if you ever see at the top of LinkComm, the setup in LinkComm differs from the setup in the SL3. If the change is deliberate, press the "changed" control to update the SL3 setup. If the change is accidental, use the Main Menu, Get setup from Satlink3 function.

You can also change the setup by sending messages to Satlink via one of the optional modems. As an alternative to LinkComm, you can use any terminal program to access all of Satlink's features via the command line interface described in Chapter 15

10. Measurement Setup

The measurements tab in LinkComm is where the measurement setups are managed.

A measurement is the process of collecting data from a sensor. SL3 provides the ability to establish up to 32 measurements, each with its unique settings. Each measurement will occur periodically and provide one or more values or results. How a measurement behaves is governed by its setup. Each of the 32 measurements has its own setup. Changing the setup of one measurement will not affect other measurements (except for *Meta* measurements).

Measurement results may be logged or just used for alarms or by other measurements. The log can hold over 1,000,000 readings. Logged measurement results may be transmitted via GOES or other telemetry installed.

The measurement setup is divided into the following sections described below:

- Sensor – enabled, measure type, label, model, manufacturer, description, right digits, units, Icon and picture
- Schedule – time, interval, averaging time
- Configuration – type, type specific settings, wiring diagram
- Processing – slope, offset, last reading, time
- Alarms – type, threshold, tx mode, deadband, logging, ROC interval.
- Logging – log all, log error value
- TxContent – tx data content settings.

10.1.   Sensor

10.1.1.   Enabled
Making a measurement "enabled" is the first step in setup of a measurement. If a measurement is not enabled, you can still enter a setup; however, the measurement will not be performed.

10.1.2.   Sensor Template
LinkComm provides templates for many sensors often used with Satlink. The template configures settings for the most important sensor parameters, and also includes sensor metadata, e.g., a picture of the sensor, its wiring diagram, manufacturer, model, description, and units. Setting up a sensor using the Sensor template is a great way to avoid mistakes

Note: Sensor metadata (picture, wiring diagram, etc.), is NOT stored in the Satlink logger, but only in the station definition in LinkComm.

The following is an example of a template for an air temperature/relative humidity sensor.

To use the template:

▶ Use the right and left arrows on the sides of the sensor picture to scroll between the available sensor templates.

▶ Use "Filter Options" to restrict the available sensor templates on the basis of manufacturer or interface.

▶ Once you are displaying the desired sensor template, select the related parameters such as interface, parameter before pressing select.

10.1.3. Measure Type:

SL3 has built-in measure types to support its measurement circuitry (SDI-12, analog, Digital …) and some special measure types that add some additional or special processing (Precip Accum, Precip Rate, Wind). The measure type also controls the configuration that follows in the setup. For example, when you select measure type "analog" the configuration section will allow you to enter "Analog type" and other related settings.
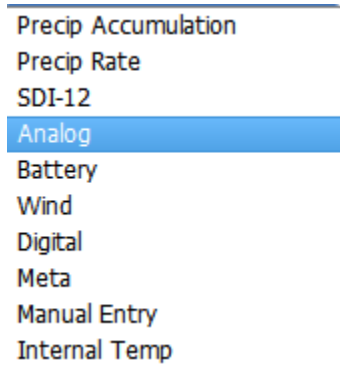
For details on the different measure types, please see section 10.3.1.

10.1.4.   Label

User set name given to measurement, up to 7 bytes. This is used to identify and differentiate measurements. This value will be placed in the log each time a measurement is made, so that changing a label will not affect previously logged data. Example labels: AT, Stage, Baro, Precip, Batt.

10.1.5.   Model

Model is a text field available to enter the model name or number for a sensor. This is metadata stored in LinkComm but not in SL3.

10.1.6.   Manufacturer

Manufacturer is a text field available to enter manufacturer information for the sensor. This is metadata stored in LinkComm but not in SL3.

10.1.7.   Description

Description is a text field available to enter additional information for the sensor. This is metadata stored in LinkComm but not in SL3.

10.1.8.   Right Digits

The number of digits shown after the decimal place is referred to as the right digits. To make the measurement read 10.12 rather than 10.12345, set the right digits to 2. Note that Satlink will round to the requested number of digits *before* logging the data.

10.1.9.   Units

Units can be specified for any measurement and will be stored with the data when it is logged. Use the dropdown list to pick from the built-in list of units. You may also enter the units text directly into the text box. The units text can only be 3 characters long.

10.1.10.   Icon

You can select an Icon for the measurement. The icon will show on the dashboard and measurement list. Press "Change" to choose an image in the computer or take a picture. Remember the icon is small and cannot show detailed information.

10.1.11.   Picture

A picture of the sensor is shown to the right of the sensor information. LinkComm includes pictures for many common sensors and Measurement Types. Press "Change" to choose an image in the computer or take a picture to use.

10.1.12.   Mx Defaults

Press the Mx Defaults control to set all the settings for the measurement to default values. Note the default measurement type is SDI-12. Setting defaults will also set the meta data (picture, icon, description etc.) to default values.

10.2.   Schedule

10.2.1.   Measurement Interval

Measurement interval is simply the time between scheduled measurements. See Measurement Time.

10.2.2.   Measurement Time

Measurement interval and time dictate when the measurement will be made. The interval controls how often the measurement is made, and the time controls when the measurement is started.

- **Example 1 (The measurement is logged every 10 minutes at 0 seconds past the minute): time 00:00:00 interval 00:10:00**
    - 00:10:00 data measured and logged
    - 00:20:00 data measured and logged
    - 00:30:00 data measured and logged
    - and every 10 minutes afterwards…
- **Example 2 (The measurement is taken and logged every 5 minutes at 30 seconds past the minute): time 00:00:30 interval 00:05:00**
    - 00:00:30 data measured and logged
    - 00:05:30 data measured and logged
    - 00:10:30 data measured and logged

Please note that if the setup is changed while Satlink is running, it may take up to twice the measurement interval before Satlink switches to the new schedule. To avoid the wait, reboot or toggle Recording.

10.2.3.   Averaging Time, Sampling Interval, Subsamples, and Results

Satlink can collect multiple samples and average them in order to produce a single result. Averaging is useful for measuring changing conditions, such as wind and water level. For example, correctly measuring the level of choppy water requires that wave action be cancelled. That can be accomplished by averaging over several minutes.

Setting the *Averaging Time* to 00:00:00 (zero) disables averaging -- one sample is to be collected. This is the default setup. If *Averaging Time* is zero, *Sampling Interval* and *Subsamples* will not be shown in the setup.

When averaging, Satlink takes several samples and averages them into a final result. Each sample may also be composed of several subsamples.

- *Averaging Time* determines **how long** to collect samples for.
- *Sampling Interval* dictates **how often** to collect each sample.
- *Subsamples* tell how many sensor readings to include in each sample. Do not use *Subsamples* unless you need two levels of averaging.

The simplest averaging requires only the use of *Averaging Time.*

Example: Average temperature over an hour

If you want to know the average temperature for an hour, you would set up the *Averaging Time* to one hour. *Sampling Interval* or *Subsamples* would not need to be changed. Satlink will collect sensor data all throughout the hour as fast as possible.

However, if the power consumption for measuring the sensor continuously for an hour were unacceptable, you would use the *Sampling Interval.*

To take one sample every minute, the *Sampling Interval* should be set to one minute. That way, Satlink will take 60 samples every hour, with approximately a one-minute break between each sample.

If the sensor being used was noisy and needed filtering, Satlink could take several *Subsamples* and average them into each sample.

In the setup for temperature above, if the number of *Subsamples* were set to five, Satlink would take five readings at the start of every minute and average them. That result would be used as a sample. Once an hour, 60 samples would be averaged into a final result.

Data collection starts at *Measurement Time + Measurement Interval – Averaging Time + Sampling Interval*, and the last sample is taken at *Measurement Time + Measurement Interval*.

In the example below, temperature is measured every 15 minutes and averaged for an hour:

- *Measurement Time 00:00:00*
- *Measurement Interval 01:00:00*
- *Averaging Time 01:00:00*
- *Sampling Interval 900* (900 seconds is 15 minutes)
- **Data Collection**
    - o 00:15:00 first sample collected
    - o 00:30:00 next sample collected
    - o 00:45:00 next sample collected
    - o 01:00:00 last sample collected
    - o 01:00:00 all four samples are averaged and the result is logged with the 01:00:00 timestamp

The *Results* field will be shown only if averaging is enabled. If it is enabled, you can select **average, minimum**, or **maximum** to be the logged result value.

If average is selected, the average of all collected samples will be the result of the measurement. Alternatively, you can choose to use the minimum or the maximum as the result.

If *Details* (a setting in the Logging section) is enabled, Satlink can log and display the **average, minimum** and **maximum** sample collected. Individual samples are not recorded. Minimum and maximum *Subsamples* are not recorded.

Enabling Details does NOT result in the average, minimum and maximum being transmitted! Use Results setting to control which one result to transmit.

The subtle distinction between the *Results* and *Details* settings.

If *Details* is enabled, average, minimum, and maximum values are logged. However, if *Results* is set to average, only the average will be transmitted.

If you want to transmit both the minimum and the maximum results, you need to set up two identical measurements except for the *Results* field: one measurement would choose minimum and the other maximum. If you just wanted to log both the minimum and the maximum, it would be sufficient to set *Details* to enabled.

10.3.   Configuration Settings

10.3.1.   Measurement Type

The *Measurement Type* setting (in the Sensor section) will determine what kind of measurement is made. Each of the different types will unlock other settings. For example, choosing *Analog* as the *Measurement Type* will unlock the *Analog Type* setting.

The available *Measurement Type* options are

‣ Precip Accumulation
‣ Precip Rate
‣ SDI-12
‣ Analog
‣ Battery Voltage
‣ Wind (future release)
‣ Digital
‣ Meta
‣ Manual Entry
‣ Internal Temp

Below are listed all the *Measurement Types* available.

10.3.2.   Measure Type: Precip Accumulation and Precip Rate

Connection: terminals 10, TB/DIN#2 and 9, Ground

Precip Accumulation and Precip rate are designed to measure the pulses from a tipping bucket type rain gauge.

Precipitation accumulation is used to tally the total amount of precipitation since the station has powered up. Count must be set to zero by the user when the station is installed. Counts persist between power-ups.

Precipitation rate, unlike precipitation accumulation, measures the precipitation that has occurred since the last measurement. So, if the measurement interval is 15 minutes, this measurement will report the rainfall in the last 15 minutes only.

Multiple measurements can be set up with the same input. For example, if you wanted to know the daily rainfall and the rainfall during the last hour, set up two measurements: one a *Precip Rate* with an interval of one hour, and another as *Precip Rate* with an interval of one day.

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 each tip of the bucket is 0.01".

Precip readings are debounced for 3ms.

10.3.3.   Measure Type: SDI-12

Connection:
        PORT 1: terminals #13 GND, #14, +12V and #15, Data.
        PORT 2: terminals #16 GND, #17, +12V and #18, Data

        Note: each port is independent with isolated +12V power and Data connections. Power is limited to 500mA. Sensors that use more than 500mA (such as bubblers) must connect to an independent power supply.

SDI-12 is a standardized three wire digital interface. Many manufacturers provide SDI-12 sensors that measure different environmental effects. SDI-12 sensors provide digital data which improves their reliability and accuracy in terms of logger sensor communications.

10.3.3.1.   *SDI-12 Port*

SDI-12 sensors can be assigned to Port1, Port2 or RS485. Remember that multiple sensors can be connected to either bus as long as each sensor has a unique address.   Use RS485 when you need long cable runs to the sensor and the sensor supports SDI-12 over RS485.

10.3.3.2.   *SDI-12 Address*

Multiple sensors can be connected to the same SDI-12 bus. However, each sensor needs a unique address. The address is a single ASCII character. Most sensors default with the address 0. If you are connecting several sensors, connect them one at a time. As each sensor is connected, issue the 0Ax! command, changing the sensor's address from 0 to x, where x is a unique number or letter of your choice.

10.3.3.3.   *SDI-12 Command*

Select the desired SDI-12 command from the drop-down list or enter a unique command into the text box. The drop-down list includes M!, M1!, MC!, C!, CC!, M2!. Consult the operating manual for the sensor to know what command to use. The software automatically adds the address when issuing the command. The software also automatically issues the commands to retrieve the data after the measurement command is issued.

10.3.3.4.   *SDI-12 Param*

Most SDI-12 sensors will respond to the measure command with multiple data values. The *SDI-12 Param* designates which of these data values the user is interested in.

Setting the parameter to 1 tells Satlink to use the first value returned from the device; setting parameter to 3 tells Satlink to use the third value returned from the device.

If you want to record (and transmit) more than one parameter from a single SDI-12 sensor, a different measurement needs to be set up for each parameter. These measurements should have identical setups, except for the *SDI-12 Param* setting. Be sure to keep the measurement

time and interval the same for these measurements and SL3 will make a single measurement to provide the data for both. If you vary the time and interval, Satlink will end up taking multiple sensor measurements even though one would have sufficed (thus slowing down the system and using more power).

In the case of devices which require multiple commands to be issued (e.g. 0M1! retrieves pressure, 0M2! retrieves temperature) multiple measurements need to be set up. It does not matter if these measurements are scheduled for the same time, as Satlink will have to issue multiple commands to the sensors.

When multiple measurements of type SDI-12 are scheduled to go at the same time, Satlink orders the measurement commands so that concurrent measurements are commanded first. Non-concurrent measurements occur while waiting for concurrent results. Also, Satlink is able to recognize when two different measurement schedules rely on data from a single measurement command (e.g., measurement 1 commands 0M! and expects parameter 1 while measurement 2 commands the same and expects parameter 2, both scheduled at the same time). In such cases, Satlink outputs the measurement command only once.

10.3.3.5.   *Warmup*

If this number is not zero, then the Switched Power line (terminal #6, SWD#1 +12V) and VREF (terminal #26 and #30) will be turned on for warmup seconds prior to talking to the SDI-12 sensor. The line will be kept on until the measurement completes.

You may use SWD#1 12V instead of SDI-12 Power to supply power to the SDI-12 sensor as long as the sensor does not require to be powered on all the time.   Some sensors (such as the Sutron SDR) need to be powered on all the time and will not work correctly if powered from the Switched Power line.

If you power the sensor via Switched Power, you must setup the Warmup to at least one second!

Why use Switched Power instead of SDI-12 Power? To reduce power consumption of the SDI-12 sensor. SDI-12 Power is turned on all the time, while Switched Power is only turned on during the measurement if Warmup is not zero.
Please note that using LinkComm's Send SDI-12 Command window will NOT turn on Switched Power. However, doing a Live/Forced measurement will.

10.3.3.6.   *SDI-12 Command Utility*

The SDI-12 command utility dialog is used to send SDI-12 commands to sensors connected to Satlink. It can also be used to quickly find what sensors are connected to the SDI-12 bus.
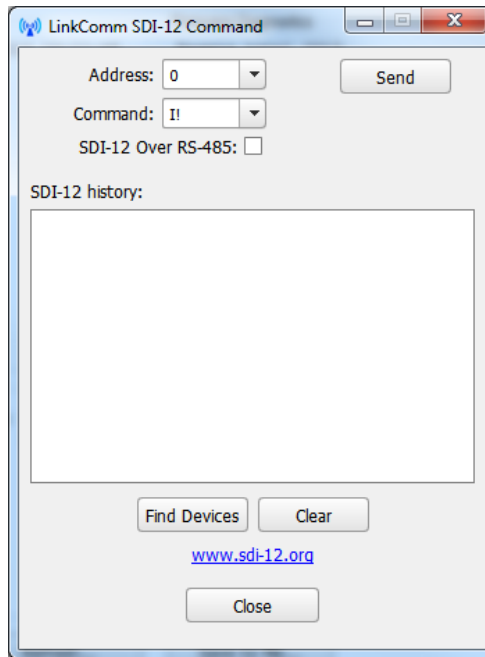
To send a command to an SDI-12 device connected to Satlink, enter the **Address** and **Command** fields, and then press the **Send** button. Be sure to check **SDI-12 over RS-485**, if you need to send the command over the RS-485 bus. The results of the command are shown in the SDI-12 history window.

To have Satlink look for any and all sensors on the SDI-12 bus, press the **Find Devices** button. Information regarding what sensors are found is displayed in the SDI-12 history window.

Press the **Clear** button to clear the SDI-12 history window.

10.3.4.   Measure Type: Analog

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 for simple sensors, and via equations for non-linear sensors.

10.3.4.1.   *Analog Type*

This setting directs the input channel to which the sensor should be connected and the type of analog measurement to make. These options are available

▸   0-5V A
▸   0-5V B
▸   Diff C
▸   Diff D
▸   Diff E
▸   4-20 mA

10.3.4.2.   *0-5V A and 0-5V B*

Connection A: 0-5V A Terminal #36 and Signal ground Terminal #37
Connection B: 0-5V B Terminal #34and Signal ground Terminal #35

Inputs 0-5V A and 0-5B are designed to be 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 signal ground. These inputs have a high impedance (>2 Meg Ohms) and will not load down or draw significant current. The input range is 0V to 5V. Negative voltages with respect to SIGNAL GROUND may NOT be measured on these inputs.

To connect a sensor:

▸   The voltage **output** by the sensor should be connected to either A or B.
▸   The **analog ground** from the sensor needs to be connected to Signal ground.
▸   The sensor will likely require **power** – connect that to VREF if 2.5V is appropriate or to +SWD#1 POWER which is 12V (or whatever power Satlink is supplied with). Make sure to set up the warmup (the amount of time to power the sensor before reading its output) as required by the sensor.
▸   If the sensor has a power ground, connect that to Signal Ground.

10.3.4.3.   *Diff C, Diff , Diff E*
Connection: Diff C (Terminal #32 and #33)
Connection: Diff D (Terminal #28 and #29)
Connection: Diff E (Terminal #24 and #25)
Optional connection to VREF (#26 or #30) and Signal ground (#27 and #31) as needed

Measurements Diff C, Diff D, and Diff E are designed to operate with a special type of analog output found on many 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.

Reading Negative Output Voltages on Differential Inputs:

In limited cases, sensors with negative outputs may be used on the differential inputs with the following limitations:

1)   The negative line from the sensor must not connect to the digital ground of the sensor with the sensor making a ground connection to the ground (including antenna ground) of the Satlink logger. (i.e. the sensor outputs must be able to be floated with respect the grounding of the sensor itself)
2)   The negative voltage (or positive voltage) must remain within the range of the differential input range selected.
3)   The common mode input range of the differential inputs must not be exceeded (see below).

While the differential inputs are capable of reading negative voltages, it is important to keep the voltages with respect to ground within in the common mode input range of 0.5 to 3.7 volts. In the case of a bridge sensor, by using the vref and signal ground to establish the voltage on the network, you are assured of having a positive voltage with respect to signal ground. In the case

of the bridge, you simply need to remain within the voltage range selected (see 6.1.4.12 below) and simultaneously remaining in the common mode range of the inputs or 0.5 volts to 3.7 volts.

10.3.4.4.   *Input Range*

This setting is relevant only to analog differential measurements. Remember that the system must read a voltage that falls into the common mode range mentioned in the above note. Voltages that are negative with respect to the SIGNAL GROUND terminal may not be measured. The following options are available:

▶   -39 to +39mV
▶   -312 to +312mV
▶   -2.5 to +2.5V
▶   -39 to +39mV with Bias
▶   -312 to +312mV with Bias
▶

Choose the option that is close to and greater than the input range of the sensor that is being connected.

For example, if a sensor provides a reading from 0 to 100mV, choose the 312mV option. If you were to choose the 39mV option, when the sensor provided a reading greater than 39mV, the unit would indicate a sensor failure.

Use the range "with Bias" if the sensor is not powered by Satlink such as a pyranometer or thermocouple.

10.3.4.5.   *4-20 mA*

Connection: 4-20ma IN (Terminal #23)

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. Satlink 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.

NOTE: Satlink does not provide a dedicated power supply for 4-20ma sensors. The sensor shall have its own supply or run off the 12 volt supply of Satlink. While the internal 4-20 measurement is made using an accurate 100 ohm resistor, the overall loop resistance is 200 ohms due to an additional 100 Ohms series protection resistor. This means that a sensor at a full 20 ma current output, approximately 4 volts should be allotted for overhead voltage. This is typically not an issue when an external voltage source is provided to operate the sensor that may be in the 18 to 24 volt range. However, if a 12.5 volt battery is used to source the voltage for the sensor in the current loop, then only 8.5 volts will be supplied to the sensor at max sensor current output. Therefore if a full 12 volts is necessary for the sensor, an external loop supply will be necessary or alternately the sensor may be wired to a single ended voltage input with the use of an external 100 Ohm accurate and stable resistor also attached to the voltage input port.

10.3.4.6.   *Warmup*

Analog sensors are powered by Satlink via one of several outputs:

▶   VREF (reference voltage) which provides 2.5V, terminal #26 and #30.

 ▸   Switched Power which provides whatever voltage is powering Satlink, presumably 12V,
        terminal #6

Normally, these outputs are off. Prior to making an analog measurement, Satlink will turn on
these outputs. After that, Satlink 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 their outputs.

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

> **Warmup is also used for *Digital and SDI-12* type sensors. If a such a sensor (or
> a wind sensor that uses digital or SDI-12 inputs) is set up with a warmup, then
> VREF and Switched Power (SWD#1) will both be turned on. If warmup is set to
> zero, those output lines will not be turned on. This is different for *Analog*
> measurements which turn on the lines regardless whether warmup is zero.**

10.3.5.   Measure Type: Battery

This type measures the voltage of the battery connection to Satlink. This measurement is a useful
diagnostic for tracking the performance of the battery and any solar panel or other charging
equipment.

10.3.6.   Measure Type: Wind (future release)

Satlink supports a variety of wind sensors, including RM Young and Gill Ultrasonic sensors. Any
sensor that provides an analog, frequency, or SDI-12 output can be handled by Satlink. RS-232
sensors are *not* supported.

Wind sensors, sometimes referred to as anemometers, provide two readings: wind speed and
wind direction (sometimes referred to as azimuth). Wind speed is expressed in units of velocity
(mph, kph, etc), while wind direction is expressed in degrees (0 to 360).

10.3.6.1.   *Wind Type*

Each wind measurement can be one of the following

 ▸   Wind Direction Analog
 ▸   Wind Direction SDI-12
 ▸   Wind Speed Frequency
 ▸   Wind Speed Analog
 ▸   Wind Speed SDI-12

Wind is unlike all the other measurements in that it is a combination of two measurements: one
setup for wind direction and the other setup for wind speed.

In order to correctly set up a wind sensor, two measurements must be set up. One
measurement must be wind speed, and the other wind direction. Set up the measurements in
order, for example, make measurement one a wind speed sensor and measurement two a wind
direction sensor.

Both the wind speed and the wind direction measurements must have the following fields set up
exactly the same:

 ▸   Measurement Time

    ▸   Measurement Interval
    ▸   Averaging Time
    ▸   Sampling Interval

If the fields are not set up exactly the same way, Satlink will show an error, Bad Wind Setup.

Additional settings will appear based on the *Wind Type* chosen. Analog types will allow the selection of analog input and warmup time. SDI-12 types will allow SDI-12 command and parameters to be chosen.

10.3.6.2.   *Wind Averaging*

This setting can be set to *Scalar* or *Vector*.

- Scalar Speed:
    - Mean Speed Scalar – This is the scalar wind speed, not taking direction into account. The scalar average of 10mph for an hour and 20mph for an hour is 15mph, regardless of changing direction.
- Scalar Direction:
    - Mean Direction Unit – This is the wind direction (in degrees) not weighted for wind speed. Here, the average of 10mph at 0° with 20mph at 90° is 45°.
- Vector Speed:
    - Mean Magnitude Wind – This is the vector average of the wind speed which takes direction into account. Here, the average of 10mph at 0° for 1 hour and 20mph at 180° for 1 hour is negative 5mph.
- Vector Direction:
    - Mean Direction Wind – This is the wind direction (in degrees) weighted for wind speed. Here, the average of 10mph at 0° with 100mph at 90° is 84°.

The *raw* reading (the reading before slope, offset, and equation processing are applied) is not available for wind measurements.

10.3.7.   Measure Type: Digital

Use the setting *Digital Type* to tell Satlink what kind of sensor is connected.

10.3.7.1.   *Digital Type*

Satlink supports the following digital types:

- Level 1&2 (terminal 8 and 10)
- Counter 1&2 (terminal 8 and 10)
- Frequency 1&2 (terminal 8 and 10)
- Period 1&2 (terminal 8 and 10)

Frequency will have Satlink sample the input for 750ms. It will provide a result that is the average frequency of the input during that time span.

10kHz is the maximum input frequency that Satlink supports.

When *Period* is the chosen type, Satlink will watch the input line for up to 10 seconds. Satlink stops watching as soon as one wave period is noticed on the input.

Digital measurements also use the *Warmup* setting. If *Warmup* is not zero, then switched power and VREF will be turned on during a *Digital* measurement. See the section on analog measurement types for details on *Warmup.*

Counter type readings may be optionally debounced for 3ms using the debounce setting. The 3ms debouncing eliminates false counts from tipping buckets and other devices with noisy switches.

Counter type readings may also be limited by a *rollover* value. With *rollover* set to 0, the counter will increase until it reaches 4,294,967,296 (2^32).   With *rollover* set to a non-zero value, the counter will be reset to 0 when it exceeds the *rollover* value. For example, if *rollover* is set to 9999, the counter will be set to 0 on the next count.

Satlink will allow the setup of multiple measurements on the same digital input. For example, it is possible to setup both a tipping bucket rate and a tipping bucket accumulation on the same input.

That being said, some setups that share digital inputs will yield unpredictable results.

- o   Setting up any number of tipping bucket and counters on DIn2 with debouncing will work well.
- o   Setting up a tipping bucket and counters without debouncing on DIn2 will not work correctly as far as debouncing is concerned.
- o   Setting up a level measurement will work in combination with any other measurement.
- o   Setting up multiple frequency and period measurements on the same input will work as long as the measurements do not overlap.
- o   For frequency and period readings on the same input, one measurement must finish before a second one starts for the readings to be correct.
- o   For frequency and period readings, SL3 will not hold up one measurement until another completes.
- o   Overlapped frequency and period measurements are not consider a meaningful setup.
- o   Setting up a frequency or period measurement on the same input as a tipping bucket or counter will not work correctly.

If you want to measure both frequency and count from an input you will need to either jumper it to both digital inputs and setup one measurement for the counter (e.g. counter 1) and the other for a frequency (e.g. frequency 2).

10.3.8.   Measure Type: Meta

Meta measurements use the result of another measurement as their basis. Usually, a *Meta* measurement is used to average results of another measurement.

10.3.8.1.   *Meta Index*

This setting tells Satlink what other measurement this *Meta* measurement refers to.

Why use meta measurements? If you had set up an hourly averaged temperature measurement, a *Meta* measurement could be set up to be the daily average of all those hourly readings.

- ▸   *Measurement M1* (used for Hourly Temperature)
- ▸   Measurement Type: Analog
- ▸   Analog Type: 0-5VA

‣ Measurement Interval: 1 hour
‣ Averaging Time: 1 hour
‣ Sampling Interval: 1 second
‣ *Measurement M2* (used for Daily Temperature)
‣ Measurement Type: Meta
‣ *Meta Index:* 1 (meaning it refers to measurement M1)
‣ Measurement Interval: 24 hours
‣ Averaging Time: 24 hours
‣ Sampling Interval: 1 hour

When scheduling meta measurements, take care that they occur at the same time or after the measurement they reference. If the meta and the reference are scheduled for the same time, Satlink will try to delay the meta measurement until the reference completes.

10.3.9.   Measure Type: Manual Entry

Manual entry measurement types allow the user to enter a reading manually. That value becomes the reading of the measurement. Satlink will store the user entered value in the *Offset* field.

To enter a manual entry reading, use LinkComm's Calibrate button.

10.3.10.   Measure Type: Internal Temperature

Internal Temperature measurements use a temperature sensor installed inside Satlink. Every Satlink comes with a built in temperature sensor. The reading provided is in degrees Celsius. To convert from Celsius to Fahrenheit set the slope to 1.8 and the offset to 32.

10.4.   Processing Settings

10.4.1.   Slope

See Offset below.

10.4.2.   Offset

Every measurement is computed by taking the sensor reading, multiplying it by slope and adding offset to it.

Measurement result = (sensor output)*slope + offset

Slope defaults to 1.0 and offset defaults to 0.0, meaning they will not affect measurement result by default.

Traditionally, when using an analog sensor, slope and offset are required to convert the voltage output by the sensor into desired units. The required slope and offset are provided by the sensor manufacturer.

Satlink supports more complex equation processing (see *Equations* below). Slope and offset are applied *after* equations.

The reading before slope and offset are applied is referred to as the *raw* reading. For example, if an analog sensor were to provide a voltage of 2 volts, and the user had set up the *Slope* as 5 and *Offset* as 1, the final reading would be 11 (2*5 + 1). The *raw* reading would be 2. If *Details* is enabled, the raw reading is displayed on the command line by typing MEAS or LAST.

Satlink offers easy ways to change the current reading of the measurement by modifying just the offset or both the slope and offset via the calibration functions.

10.4.3.   Use Equation

Select "Use Equation" to allow an entry of the equation in the box below it. See the next section for examples.

10.4.4.   Equation

Data collected from sensors to be processed by an equation. If the reading provided by the sensor needs more than just an offset and a slope applied, equations provide that functionality.

The field *Use Equations* can be set to enabled or to disabled. It determines whether equation processing is to be applied to the raw data. The field *Equation* can be set to an ASCII string no longer than 128 bytes (per measurement). That field contains the equation to be applied.

If both *Equations* and *Slope* and *Offset* are used, *Slope* and *Offset* are applied after the equation is processed.

For example, to convert Fahrenheit to Celsius, type into command line:

$$M1\ EQUATION = (X-32.0)*5/9$$

In the example above, X refers to the sensor reading.

LinkComm comes preloaded with equations for many types of sensors. To see the equations, press "Template…" and then select the desired equation from the dropdown box.
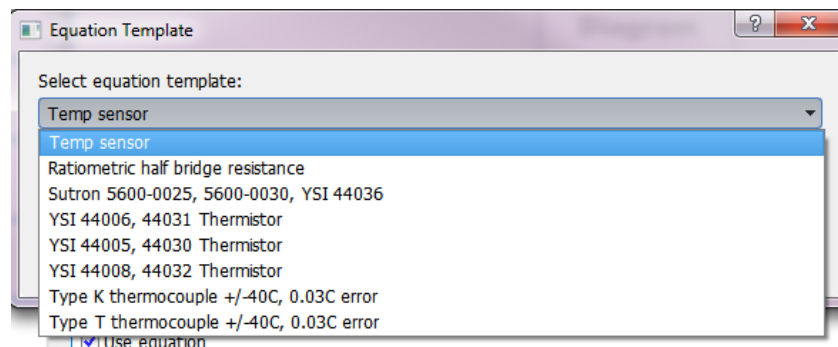
> **Equation processing can take a while to complete (up to several seconds). If you are using a lengthy equation, Satlink may not be able to complete a measurement every second, or even every two seconds (see *Bad Schedule* in the Error section).**

10.4.5.   Equations: Syntax

The equation is expressed in terms of "X" which will be applied to incoming sensor data. You may also reference each measurement by its label which is defined on the Measurement tab. If you wish to use the analog reference voltage in the equation, use Vref.

The expression is not case sensitive.

The following functions are available:

SIN, COS, TAN, ARCTAN, eg COS(90) = 0

SQRT is square root, eg SQRT(9) = 3

To raise a number to a power, multiply it by itself. So, for example, to find x squared, input x*x.

EXP, if EXP(x) = y, then LN(y) = x, eg EXP(1) = 2.718282

LN, natural log, eg LN(2.718282) = 1

LOG, 10 based log, eg LOG(10) = 1

INT returns the integral portion of a real number
   INT(11.456) = 11.000 INT(-1.345) = -1.000
FRACT returns the fractional portion of a real number.
   FRACT(11.456) = 0.456 FRACT(-1.345) = -0.345
ABS returns the absolute value of a real number.
   ABS(11.456) = 11.456 ABS(-1.345) = 1.345
POLY is used to compute up to a 5th level polynomial equation:
   POLY(x, A, B, C, D, E, F) equates to $A + Bx + Cx^2 + Dx^3 + Ex^4 + Fx^5$
STEINHART(x, A, B, C) is used for Steinhart-Hart equations,
   where x is the resistance and result is the temperature in Celsius
   A, B and C are thermistor specific constants
   Steinhart result is computed like so: $1/(A + B*ln(x) + C*(ln(x)^3)) - 273.15$

MINDAY returns minutes into the day.
SECDAY returns seconds into the day.

Comparisons can be performed using <, >, <=, >=, !=, and =. The result of a comparison is 1 for true or 0 for false.

The following bitwise boolean operators are supported: AND, OR, XOR, SHL, and SHR. The last two are shift-left and shift-right. For instance (X SHL 4) would shift X left by 4 bits. AND & OR can also be used in logical expressions. For instance (X>100) OR (X<50) would result in 1 if X is above 100 or below 50; otherwise it would result in 0.

The NOT operator is logical not bitwise. This means that NOT 0 is 1 and NOT 1 is 0. Also, the NOT of any non-zero number is 0, eg. (X AND 128) != 0 results in a 1 if bit 7 in X is set or 0 if bit 7 is clear. The bit mask 128 is 2^7. This assumes bit 0 is the least significant bit. In general, the bit mask for any bit N is 2^N.

OUTPUT(A,B,C,D) controls one of the 2 digital outputs or 3 switchable voltages.
   A is the conditional. If 0, no output happens; if 1 output activates.
   B is the output (1 = DOUT#1, 2 = DOUT#2, 3 = SWD#1, 4 = SWD#2, 5 = PROT12
   C tells whether to switch (0) or to pulse (1)
   if switching (C=0), D is direction to drive (0 open, 1 closed. line is open by default.)
   if pulsing (C=1), D is duration of the pulse in ms

Equations can also contain references to other sensors: eg. (X + AirTemp)/2, would add X to the AirTemp value and divide by 2.

Use Prev1, Prev2, Prev3.. to access the previously made reading by said measurement. And, use DeltaT1, DeltaT2, Delta T3.. to access the amount of time in seconds between the most recent and the previous measurements.
12:00:00 Measurement M1 has made a reading of 1.0
At this point, we do not have enough data to compute Prev1 or DeltaT1
12:05:00 Measurement M1 has made a reading of 2.0

At this point, M1 = 2.0, Prev1 = 1.0, DeltaT1 = 300
12:15:00 Measurement M1 has made a reading of 3.0
At this point, M1 = 3.0, Prev1 = 2.0, DeltaT1 = 300

Comments can be contained within braces { }. For example:
{convert from degrees Celsius to degrees Fahrenheit} X*9/5+32

Other examples:
        SIN(X)+COS(X)+X^3+LOG(X)
        (X>1000)*1000 + (X<=1000)*X {would limit the value so that it could never be greater
than 1000}

Troubleshooting:
The only true test of equation processing is to hit Force Measurement after the equation has
been set.

The equation is expressed in terms of X which will be applied to incoming sensor data. You may
also reference each measurement by its label which is defined on the Measurement tab. If you
wish to use the analog reference voltage in the equation, use Vref.

10.4.6.   Equations: Referencing other measurements

If you are setting up an equation that references another measurement, set the measurement
type to meta, and make sure the measurement time and interval are the same as the referenced
measurement.

For example, if you wanted to trigger a sampler via the digital output when a conductivity sensor
reading exceeded 80, do the following:

1. Setup measurement M1 to collect data from the conductivity sensor.

2. Setup measurement M2 as a Meta measurement, with the Meta Index set to 1 in order
   to reference M1. This ensures that M2 will wait for M1 to complete before producing a
   result.   Make sure the schedule for M1 and M2 is the same.

3. Setup the equation of M2 to PULSE12(M1>80, 2000). That will cause Satlink to pulse
   DOUT for 2 seconds whenever the conductivity sensor exceeds 80.

10.5.   Alarm Settings

Alarms are used to send immediate notifications when sensor readings read a certain threshold.
They can also be used to control an output (page xx88.)

When a measurement is made, if alarms are enabled for that measurement, the sensor reading is
compared to the *Alarm Threshold* and *Alarm Deadband*. If certain criteria are met, the alarm
triggers (see below).

- When a sensor reading reaches a certain threshold, the station is said to **go into alarm.**
- While that sensor reading stays above the threshold, the system is considered to be **in alarm.**
- After the sensor reading drops below the threshold, the system **goes out of alarm**.
  When the station is in alarm, it is noted in the station's status.

When a station goes into or out of alarms, the reading causing the alarm is logged. Additionally, an event is recorded in the log.

Satlink can be set up to send transmissions when it goes into alarm. Alternatively, Satlink can be set up to make a transmission when it goes into alarm **and** to make another transmission when it goes out of alarm.

Satlink can control its digital output based on alarm conditions. See the Output section for details.

Most sensor readings cause alarms at the time the measurement is scheduled. If a temperature sensor is set up for alarms with a *Measurement Interval* of 15 minutes, the station will read the sensor every 15 minutes and decide whether to go into alarms.

Some sensors, including the tipping bucket and sensors setup as digital counter and level, can cause instant alarms. When the tipping bucket tips, Satlink is immediately notified. If the tip causes an alarm condition, the station goes into alarms right away, even if it was not time to make a measurement.

Each measurement may be set up with up to three different alarms. This way, it is possible to get an alarm when the stage reaches 3 feet, another alarm when it reaches 4 feet, and a third alarm when it reaches 6 feet.

If more than three alarms are needed for one sensor, set up two measurements to read the same sensor, but give them different alarm conditions.

10.5.1.   Alarm 1, Alarm 2, and Alarm 3
Each of these settings can have one of the following values

- Off
- Hi
- Low
- ROC
These settings are used to determine what kind of computation is made when checking a sensor for alarms. Read on for a complete explanation.

10.5.2.   Threshold 1, Threshold 2, and Threshold 3
The threshold is a value that is compared to the sensor reading in order to determine whether to go into or out of alarms.

10.5.3.   Deadband
The *Deadband,* along with the *Threshold* value is used to compute whether the measurement will go **out of alarms**. Deadband helps the system ignore noise on the input that would cause the measurement to go in and out of alarm on each measurement.

10.5.4.   Alarm Tx Mode
Alarm Tx Mode determines whether transmissions are made when the station goes (into alarm) or (when it goes into *and* out of alarm).

- If the *Alarm Tx Mode* is *Tx In*, the station will only make a transmission when it goes into alarm.
- If the *Alarm Tx Mode* is *Tx In And Out*, the station will make a transmission when it goes into alarm and it will make another transmission when it goes out of alarm.

ROC alarms setup for *Since Last Tx* do not generate out of alarm events or transmissions.

10.5.5.   Alarm Logging

- If Alarm Logging is set to Every Measurement, the system logs on the Measurement Interval.
- If Alarm Logging is set to Use Logging Interval, the system logs on the Logging Interval.
  This setting is only relevant if the customer setup the *Measurement Interval* to be more frequent than the *Logging Interval*. In that case, the system can be configured to log more frequently when it is in alarm.

Here is an example of a system setup to log more frequently while in alarms. The system is set up to read the temperature sensor every two minutes and check for alarms. If the temperature exceeds 20 degrees, the system will go into alarm. The system will log once every two minutes when in alarm, and once an hour when not in alarm.

        Measurement Interval = 00:02:00
        Logging Interval = 01:00:00
        Alarm Logging = Every Measurement
        Alarm 1 = Hi
        Threshold = 20

10.5.6.   Alarm ROC Interval

This setting affects ROC (Rate of Change) alarms. When set to *Since Last Meas* the system will compare two consecutive scheduled readings when deciding whether to trigger alarms.

When it is set to *Since Last Tx*, the system will compare the current sensor reading with the last transmitted reading. If there is no past transmission, the first reading made after boot up is used.

10.6.   Alarm Computation Details

This section contains details on how Satlink decides whether to go into alarms. The section is broken down by the user chosen *Alarm Type* setting:

10.6.1.   Hi Alarm

When the Alarm Type is set to Hi, if the sensor reading is greater than or equal to Alarm Threshold, the station goes into alarm.

That station will go out of alarm when the sensor reading goes below Alarm Threshold minus Alarm Deadband.

10.6.2.   Low Alarm

When the Alarm Type is set to Low, if the sensor reading is less than or equal to Alarm Threshold, the station goes into alarm.

That station will go out of alarm when the sensor reading goes above Alarm Threshold plus Alarm Deadband.

10.6.3.   ROC Alarm

ROC stands for Rate Of Change. ROC alarms compare the current measurement reading with a past reading. If *Alarm ROC Interval* is *Since Last Meas*, the past reading is the last scheduled reading made according to *Measurement Time* and *Measurement Interval.*

If *Alarm ROC Interval* is *Since Last Tx*, the past reading is the one that was included in the last alarm transmission. If there is no past transmission, the first reading made after boot up is used.

If the absolute difference between the two readings (absolute of current reading minus past reading) is greater or equal to the *Alarm Threshold*, the station goes into alarm.

The same station goes out of alarm if the absolute difference between the two readings (absolute of current reading minus past reading) is less than the *Alarm Threshold* minus *Alarm Deadband.*

Exception: ROC alarms setup for *Since Last Tx* do not generate out of alarm events or transmissions.

10.7.   Logging Settings

10.7.1.   Logging Interval

Logging Interval dictates how often to log sensor data.

Change the *Logging Interval* to measure sensors more frequently than to log them. This is useful for alarm setups, in which you want to check the water level once a minute in order to detect fast rising water, but one only wants to log the water level data once an hour. For this scenario, the *Measurement Interval* would be one minute, and the *Logging Interval* would be one hour.

For alarm conditions, it is possible to set *Alarm Logging* to *Every Reading.* That would result in the water level in the example above being logged once a minute when the system was in alarm, and logging once only once an hour when not in alarm.

If *Logging Interval* is set to zero, Satlink will log every measurement. It is the same as having the *Logging Interval* equal to the *Measurement Interval.*

LinkComm provides a *Log All* checkbox: when checked Satlink will measure and log at the *Measurement Interval.*

Having a *Logging Interval* that is shorter than the *Measurement Interval* is a bad setup.

Only logged readings may be transmitted.

It is not possible to entirely disable logging of measurement results. However, one can set the logging interval as slow as once a day.

10.7.2.   Log Error Value

When Satlink cannot get valid data from a sensor (more specifically, when a sensor failure error occurs), Satlink will change the sensor reading to match the user-set *Log Error Value,* which defaults to -99999. Such atypical numbers are used to attract the user's attention when viewing the log.

10.7.3.   Details

Details can be enabled or disabled. If they are disabled (which is the default), the final result is the only data logged after a measurement completes. If Details are enabled, several readings are logged along with the final result:

- Minimum (the lowest sample collected)
- Maximum (the highest sample collected)
- Number of samples collected
  Details can only be enabled if averaging (see page 57) is taking place; otherwise, the number of samples would be 1, and the minimum and maximum would be equal to the final result. Details are useful for diagnostics and for capturing the minimum and maximum values.

10.8.   Transmission Data Content Settings

10.8.1.   Tx Data Content

Tx Data Content tells Satlink which readings to include in the transmission. Each measurement has the *Tx Data Content* setting.

The options are All, Individual, Last, and Exclude.

- By selecting *All*, all the measurements that are logged are also set to be transmitted. Only readings made since the last transmission are included. This setting is dependent on the Log Interval setting.
- *Last* means to transmit only the last logged value.
- By selecting *Exclude*, no readings of this measurement are transmitted.

See Tx Data Time and Interval below for the Individual setting.

10.8.2.   Tx Data Time And Interval

If *Individual* is selected for *Tx Data Content*, the fields *Tx Data Time* and *Tx Data Interval* will appear, allowing the choice of what data to include in the transmission.

This options should only be used to measure and log data more frequently than to include it in transmissions. For example, if one wanted to measure and log data once a minute, one would set the *Measurement and Logging Intervals* to one minute. Since it may be expensive to transmit all that data, one can choose to transmit only every 10th reading by setting the *Tx Data Interval* to 00:10:00.

The example below uses Measurement and Logging Intervals of 15 minutes. Tx Data Content is set to Individual.

Timeline:

- 11:00 measure and log data
- 11:15 measure and log data
- 11:30 measure and log data
- 11:45 measure and log data
- 11:50 transmission
  Setup options:

- The user could set up to transmit all four of those values.
    - *Tx Data Content = All*
- The user could set up to transmit the data from 11:15 and 11:45.
    - TX Data Time = 00:15:00, Tx Data Interval = 00:30:00.
- The user could set up to transmit only the data from 11:45.
    - Tx Data Time=00:45:00, Tx Data Interval = 01:00:00.
- The user could set up to transmit only the data from 11:00.
    - Tx Data Time=00:00:00, Tx Data Interval= 01:00:00
- **Limitation:** The user could NOT set up to transmit the data from 11:30 and 11:45

Tx Data Interval **must be a multiple of the** *Logging Interval.* **Setting** *Logging Interval* **to 15 minutes and** *Tx Data Interval* **to 20 minutes is not a good idea.**

10.9.   Measurement Setup Defaults

To change the setup of a single measurement to its defaults, type M1 SETUP DEFAULT on the command line to reset measurement one. This will affect only one measurement.

10.10. Measurement Calibration

Satlink offers an easy way to change the current reading of any measurement. Press the Calibrate button on the Measurements tab in LinkComm and enter the desired reading.

Via command line, type M1=10.5 to set the reading of measurement one to 10.5

This calibration procedure has the effect of modifying the measurement's O*ffset*.

When a sensor is calibrated, Satlink will log the readings before and after the calibration along with a calibration event:

>M1 = 12
Measurement M1 STAGE set to 12.000

04/18/2012,13:19:49,STAGE,8.119
04/18/2012,13:19:49,Calibration,1
04/18/2012,13:19:49,STAGE,12.000

10.11. Measurement Two-Point Calibration (future build)

Changing the slope and offset of a measurement can be accomplished by using the automated two point calibration. You will need to be able to affect the sensor so that it can provide two different readings.

On the command line, type M1 CAL. This procedure requires that the sensor be placed so that it provides one known value, then placed again to provide a different known value. This procedure will affect both S*lope* and O*ffset* of a measurement.

10.12. Multiple Measurements Using the Same Sensor

You can set up multiple measurements with the same input. For example, to log the daily rainfall and the rainfall during the last hour, set up two measurements: one a precipitation rate with an interval of one hour, and another as precipitation rate with an interval of one day.

To log the daily temperature **and** the hourly temperature, only one physical temperature sensor is needed. Set up two measurements with the same setup; change the *Measurement Interval* and the A*veraging Time* and use a different *Label* for each. One would happen once a day (*Measurement Interval* 24 hours, A*veraging Time* 24 hours), and the other once an hour (*Measurement Interval* 1 hour, A*veraging Time* 1 hour). It would be a good idea to set up the sampling Interval to one minute for both sensors in order to save power (See page 57).

If two separate measurements are scheduled to measure the same sensor at the same time (as they will in the examples above), only one reading of the sensor is made and the result is shared by both measurements.

11. Telemetry Setup

Satlink has built-in a satellite transmitter certified by NESDIS, Eumetsat, Insat and other satellite agencies. These satellites provide reliable one way communications of data from remote locations to receive stations/computer systems around the world. For more information on the different satellite agencies, …

The setup for the transmitter and its status is provided on the Telemetry tab as shown below.

The column on the left shows that multiple setups are possible with the satellite -- one for scheduled transmissions, one for random transmissions and one for on-demand transmissions. Each is configured and enabled separately. If none of the telemetry setups are enabled, the system will show an error if on the dashboard.
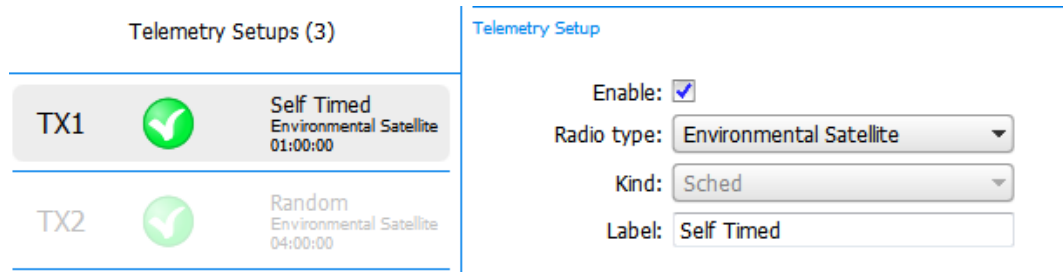
The column on the right has two main sections – Telemetry Setup and Telemetry Status. You may need to scroll down to see the Telemetry Status

The setup consists of information that tells Satlink when to transmit, what type of satellite to use, the channel, the antenna type and other critical information. Most of this information originates from the agency that operates the satellite (e.g. NESDIS) and is unique for each

station. Incorrect information can cause the system to mishandle the information you send or interfere with the operation of another station. Always check to make sure the information you have for the station is unique for that station and correct.

11.2.   Telemetry Setup for Scheduled Transmissions

TX1 setup is for the scheduled transmissions. Enable it if you want Satlink to transmit at fixed times each day. You can set your own label for the setup that shows up in the panel on the left.

Satlink is certified to operate with NESDIS, EUMETSAT, INSAT and other agencies who operate their respective satellite systems. The governing agency will assign to each transmitter a unique Satellite ID, channel (and associated type) and scheduled time and interval. The combination of these settings is unique to each field station.

Warning: Any errors entering the information may cause the transmitter to interfere with other stations in the field.

11.2.1.   Tx Enable

Enables scheduled (sometimes called self-timed) transmissions. If this setting is enabled, Satlink will periodically deliver sensor data to the designated destination. If disabled, Satlink will not initiate any scheduled transmissions.

11.2.1.   Transmission Schedule -- Scheduled Time, Interval, Length, Window Center

The governing agency will assign a specific transmission time and interval for scheduled transmissions. For example, a station may be assigned to transmit on GOES 300 baud channel 195 at a time of 00:02:30, an interval of 04:00:00 and the time slot is 30 seconds long. That means the transmitter is allowed to transmit at 00:02:30, 04:02:30 …20:02:30 and transmissions are to last no more than 30 seconds. All scheduled times are related to UTC.

Any transmission outside the assigned time, either early or late may interfere with other field stations.

Any transmission longer than the assigned window length will be truncated to the window length.

Window center enable causes Satlink to delay a transmission that does not last the entire allowed length so it is centered during the assigned window. Window centering helps the satellite system to operate more efficiently.

11.2.2.   Satellite Type and Channel

The satellite types are as follows. Each type has a number of channels that can be used for the transmitter. The channels are assigned by the governing agency. Any error entering the channel may cause the transmitter to interfere with other stations.

Satellite Type	Channels
GOES 300 (V2)	1..266, 301..566
GOES 1200 (V2)	3,6 …264 301, 304..565
Eumetsat MSG	1..223, 666
CGMS 100 International	1..10
Japan GMS	1..100
Insat	1..400
FengYun	1..100

11.2.3.   Satellite ID

The Satellite ID is an 8 character Hexadecimal value (0-9, A-F) that is assigned by the governing satellite agency to uniquely identify the transmitter. Any errors entering the Satellite ID may cause the transmitted message to be lost or ignored.

11.2.4.   TX Format

The TX Format field sets the format that Satlink uses when it transmits its data.   There are several different format types: "SHEF", "SHEFFIX", "Pseudobinary", "ASCII Column", and "ASCII Sensor". Each has its own distinctive advantages.

"**SHEF**" formats the data into readable ASCII messages. "**SHEFFIX**" is just a modified version of "SHEF" where the data is positioned in fixed spacing so that it will line up better when displayed. However, both the SHEF and SHEFFIX formats generally create long messages.

The "**Pseudobinary**" format encodes the data into 3 characters that you cannot read without the aid of a program. This format is over 50% shorter than the SHEF and SHEFFIX formats which results in shorter transmissions and lower power consumption. Although it is much harder for a person to visually inspect the data in this format, it is a much more efficient format for sending data.

"ASCII Column" and "ASCII Sensor" formats are similar to SHEF in that they create human readable and lengthy messages.

"**ASCII Column**" transposes the data, showing data from different sensors on each line. The columns will have data from the same sensor.

"**ASCII Sensor**" mode formats each sensor reading into four digits after multiplying the reading by 100. No decimal point is used in this format.

The specifics of formatting are covered in greater detail in Appendix D -Data Formats

To see what your data will look like after it has been formatted, click the "Show Tx Data" button in the Telemetry Status section of the telemetry tab.

11.2.5.   Antenna Options

In the setup, you specify the antenna option: Yagi, Dome or Omni. Each of these choices represent a type of antenna with different gain. Each satellite agency has specified the nominal power for transmitting to the satellite. Depending on the gain of the antenna that is connected, the transmitter must use the proper power in order to properly operate with the satellite. All you need to do is tell Satlink what antenna is connected and the software does the rest. The resultant transmission power is displayed on the screen. The following table shows the power (during the carrier portion of the transmission) for each of the Satellite types.

Satellite Type	Yagi (10-11dB gain) Watts	Dome (5-8dB gain) Watts	Omni (3dB Gain) Watts
GOES 300	1.25	2.5	7
GOES 1200	5	10	14
Eumetsat MSG	7	10	14
CGMS 100 International	7	10	14
Japan GMS 100	7	10	14
Feny Yun 100			
INSAT PRBS	5	7	10
INSAT TDMA	5	7	10

11.2.6.   Append Options

The "Append Options" attach additional information to the data transmitted,

Batt Voltage and Lat/Long will be appended regardless of the formatting type, but "Station Name" and "Temp during last tx" will only if the "Sensor data formatting" is set to SHEF or SHEFFIX.

The extra information is appended after external data (which is appended after sensor data). The battery voltage was measured during the last transmission (under load). Therefore the first transmission after bootup will report battery voltage of zero.

If "Lat/Long" checkbox is marked, the coordinate information will be added to the end of the transmission. If SHEF or SHEFFIX is used to encode the transmission, the latitude and longitude will be in a readable format. If Pseudobinary is used, the information will be encoded into an 8-byte value. The formula for decoding this is located in Appendix D -Data Formats "Station Name" will appear in the message just as it does on the "Main" tab of the Communicator. "Temp during last tx" is the temperature recorded by Satlink prior to the **last** transmission. "Fwd/Ref" power is the power level in Watts from the **last** scheduled transmission.

11.2.7.   Advanced Options

11.2.7.1.   *Circular Buffers*

Circular buffers is an advanced option that is only useful if you have varying amounts of data to transmit. Please consult the factory before trying to use it. If Circular buffer is enabled, Satlink Logger will transmit only a portion of its data every time, and keep the rest for the next

transmission. If a number of bytes to be transmitted is specified ("Bytes to Tx at a time"), then Satlink Logger will transmit only that many bytes, and leave the rest of the data in the buffer for the next transmission. If "Transmit all data that can fit" is selected, then Satlink Logger will transmit all the data that can fit into the transmission. (All transmissions are time limited).

If Circular Buffers are not enabled, Satlink Logger will throw away any data it cannot fit into the transmission.

11.2.7.2.   *Dumb Logger mode*

The "Dumb Logger" mode is used to have Satlink transmit data from a logger that does not speak the Satlink serial port communications protocol. If this mode is enabled, any data coming into the serial port that is not of Satlink protocol gets put into the scheduled transmission buffer.

In order for Satlink to accept data from another logger, besides having the dumb logger mode enabled, the user must ensure that the logger talk at 9600 bps, 8 data bits, no parity, one stop bit, no flow control. There are two ways to wake Satlink up: either assert RTS or send a wake up character. That wake up character should be binary 0. After waking Satlink make sure to wait at least 6 milliseconds. After Satlink is woken, it will acknowledge by asserting CTS. If woken with a character, Satlink will stay awake for five seconds after the last character comes in. If woken with an RTS, Satlink will stay awake for as long as RTS is asserted. Note that you are likely to need a null modem in order to connect logger to Satlink.

11.3.   Telemetry Setup for Random Transmissions

TX2 setup is for the random transmissions. Enable it if you want Satlink to transmit at fixed times each day. You can set your own label for the setup that shows up in the panel on the left.

The telemetry setup for Random transmissions is similar to that for the scheduled transmissions with the following changes:

1.   There is no assigned transmisison time. Instead, you assign three intervals to control when transmissions are made.

2.   Random transmissions should be kept as short as possible. Sutron recommends using only Pseudobinary B, C and D formats for random transmissions.

3.   When there are no measurement alarms, Satlink will transmit data based on "Normal Interval". The maximum setting is 24:00:00 which will provide one transmission per day. This allows the system to make daily transmissions to ensure the communications system is operating properly.

4. When a measurement goes into alarm, Satlink will send 1 or more transmissions at the "Burst Interval". The "Number of tx per burst" setting controls how many are sent. The reason for sending more than one transmission is that there is no guarantee that a single random message will not be interfered with by another station. Multiple transmissions increase the probability that at least one of the messages will make it through.

5. As long as the measurement remains in alarm, Satlink will transmit at the alarm interval.

6. All transmissions are randomized in time so they do not synchronize to measurements or the real-time clock. For this reason, you should never see random transmissions occurring at the same time each day.

11.4.   Telemetry Status

Telemetry status provides details for each type of transmission setup. The details can give valuable insights into how each type of telemetry is performing.

11.4.1.   Refresh

The telemetry status does will not update automatically. The "refresh" control retrieves from Satlink current information.

11.4.2.   Clear Counts

This control clears the succeeded and failed counts. Sutron recommends clearing the counts during each field visit.

11.4.3.   Transmit Now

Transmit Now causes Satlink to initiate a transmission on the selected setup (TX1, TX2, …).

Warning – Do not use "transmit now" unless you are sure that your transmission will not interfere with another station. Disconnecting the antenna and connecting a dummy load is the best way to do this. Note that the transmission will not start immediately but may start 30-60 seconds after pressing "Yes".
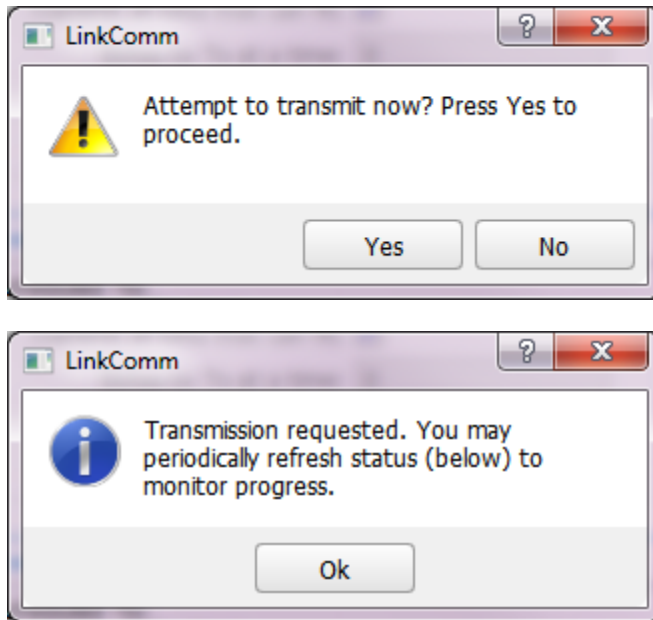
During the transmission, you may see the status indicate what the transmitter is doing.

11.4.4.   Show Tx Data

Show Tx Data is a great way to confirm that Satlink has been properly setup to transmit your intended data. The display shows the last transmission and what will be transmitted by the next transmission. Review the information carefully to make sure that you have the right number of readings marked for tx and the transmission fits in the specified window.

```
LinkComm

Tx data:

Last transmission (TXBUF):

:AT 4 #15 210.096 210.041 210.095 210.097 :BL 13.09


Current transmission (TXFORM):

Tx data would look like this

:AT 10 #15 210.096 210.041 210.095 210.097 :BL 13.09

Current message is 52 bytes (00:00:03 seconds) out of 1093 bytes (00:00:30
seconds)
Available space is 1041 bytes
In that message, sensor data is 42 bytes

Worst case SENSOR data (excluding append) is 49 bytes (00:00:03 seconds) (7
bytes per reading)
Worst case available space is 1044 bytes
1 meas are active; 1 readings are marked for tx
```

12. Other Setup

The Other Setup tab provides settings for WiFi, Logging, Digital Output DOUT and Modbus RS-485. The settings for each is described below.

12.1.   WiFi

The WiFi section controls the operation of the WiFi hot spot built into SL3. In order to conserve power, SL3 only turns on the Wi-Fi hot spot at certain times. There are two settings that control when Satlink3 turns on the Wi-Fi hotspot:

- *Wifi Enable:* If this setting is off, Satlink3 will never turn on it's Wi-Fi automatically.

  Please note that pressing the wakeup button will turn on the Wi-Fi hotspot even if Wifi Enable is off.

- *Wifi Always On:* if this setting is on, the Wi-Fi spot provided by SatlinkSatlink3 will always be turned on. Turning this setting on will result in increased power consumption, but it will make Satlink3 always available to connect to.

- *Wifi Security enable:* This setting enables WPA2-AES security. A pass phrase must be entered to allow WiFi access.

The table below describes when the Wi-Fi hotspot is on.

Wifi Enable	Wifi Always On	Result
OFF	-	The Wi-Fi hotspot is off. It is only turned on if the wakeup button is pressed. It stays on for one hour after the button press.
ON	ON	The Wi-Fi hotspot is always on.
ON	OFF	The Wi-Fi hotspot is turned on for 10 minutes: • at boot up • when the station is connected to, whether via USB, over the modem, or over Wi-Fi • after an SMS is received • after a TXLISTEN command. The Wi-Fi hotspot turns on for one hour when: • The wakeup button is pressed • The station goes into alarm

.

12.2. Log Daily Values

Satlink can log diagnostic information at 23:59:59 each day. That information consists of battery voltage and telemetry accounting, such as the number of transmissions made and the number of bytes transmitted. To prevent this data from being logged, disable the *Log Daily Values* setting as shown below.

12.3. Digital Output DOUT

Satlink features a digital output labeled DOUT. Satlink can automatically activate the output based on the settings below. The outputs are controlled by the Other Setup/Digital Output settings (shown below), Command line or equation OUTPUT function.

LinkComm allows setting either or both outputs to be turned on/off based on the Output control. The output control has the settings for each output.

Manual	the output is not operated on alarm. It can be operated via equations or command line
Alarm in only	the output is turned on when SL3 has a measurement that goes into alarm. The output remains on until ???
Alarm in and out	the output is turned on when SL3 has a measurement that goes into alarm. The output is turned off when the measurement goes out of alarm.

Warning: controlling an output via alarms and also by equations or command line can have unpredictable results.

The digital outputs are DOUT#1 (Output1) and DOUT#2 (Output2). The digital output is an open collector type output. This provides direct interface to many products. The open collector output sinks 100mA (rated at >400mA) on a continuous basis.

It is expected that a pull-up resistor will be connected to the Prot+12V or other supply. The value of the pull-up may be determined by the impedance of the connected load. A10 kOhm resistor may be used as a default.

With a pull-up resistor connected
  o   When the output is **turned on**, the output sinks current from all attached devices.
  o   When the output is **turned off**, the output is pulled up to the supplying voltage.

12.3.1.   Modbus

Modbus functionality is not yet implemented in Satlink3.

12.4.   Output

Satlink includes two digital output labeled as DOUT 1 and DOUT2.

The digital output may be activated via several means.

- Manually via command line. A command may be sent using LinkComm by directly connecting to Satlink via USB, sending GPRSLink an SMS, sending an email to an IRIDIUMLink, or via any other means of connecting to Satlink.

- Alarms: any sensor going into alarm may trigger the digital output.

- Equations: any measurement setup with the Output function in an equation may pulse the digital output for a specified amount of time. Please see the Equations Syntax section on page 69 for details.

Satlink can automatically activate the output based on alarms. The setting *Output1 Control* dictates whether alarm activity triggers the output.

The setting *Output1 Control* can be set to:

- *Manual:* Satlink will do nothing with the digital output when it goes into and out of alarms.
- *Alarm In*: Satlink turns on digital output when any measurement goes into alarm. Satlink does nothing with the output when it goes out of alarm.
- *Alarm In And Out*: Satlink turns on digital output when any measurement goes into alarm and it turns off digital output when any measurement goes out of alarm.

Output 1 can be controlled manually. You can send a message or connect via LinkComm in order to control the output.

LinkComm has the Output1 Control setting on the Other Setup dialog. Pressing the Control button on the same tab will bring up the Output Control window which can be used to see the current state and to control DOUT.

Command line access to output 1:

- OUTPUT1 tells whether the output is currently on. Satlink's possible replies:
    - Output1 is NOT active
    - Output1 is ACTIVE
- OUTPUT1 ON turns on the output
- OUTPUT1 OFF turns off the output

If the digital output is turned off via command line while the system is in alarm, the system will not turn it back on until it goes out of alarm and later back into alarm.

A measurement setup for a *ROC Alarm* and an *Alarm ROC Interval* set to *Since Last Tx* does not have a going out of alarm state. Those alarms will never turn off the digital output.

13. Logging

Satlink automatically logs the sensor data that it collects based setup (see Logging Settings). Data is logged on a secure flash memory with a capacity of over 1,000,000 entries. A log entry looks like this:

04/02/2012,09:25:00,STAGE,20.50,FT,G

- Data is logged according to the *Logging Interval* (see Logging Interval)
- Data will *not* be lost if power is removed. Once the log is full, the oldest data will be overwritten.
- Only logged data may be transmitted.
- Satlink logs events such as power up, log download, and setup change.

Each log entry consists of:

- date and time (with a one-second resolution)
- name (e.g. STAGE)
- measurement reading (optional)
- measurement quality (optional)

The format of logged data is the Sutron Standard CSV format, which was introduced in the 2009. It is a format common to current Sutron products.

The general format specification for Sutron Standard CSV format is:

mm/dd/yyyy,hh:mm:ss,label,data,units,qual

Here are some examples of log entries:

- 01/19/2015,09:30:00,Stage,1.25,ft,G
- 01/19/2015,09:45:00,Stage,1.27,ft,G
- 01/19/2015,09:50:27,Setup Change,,G

To help preserve data integrity and reliability, there is no way to erase data from the log.

13.1.1.   Downloading the Log

Logged data can be downloaded using LinkComm or via a terminal program using the LOG command.

The downloaded data is in Sutron Standard CSV format and can be easily displayed using Sutron's GRAPHER program (downloadable from www.sutron.com) or common spreadsheet/word processing programs.

You can download the whole log or only parts of it. You may specify the start date and optionally the end date for the downloaded data. You may also ask for data from the last X days.

There are options to download only data from a specific measurement. Events can be excluded from the log download.

Satlink remembers the last log download and will allow downloads since last download. This means that the only parts of the log downloaded are those that have not been previously downloaded.

13.2.   Log Events

Occasionally, Satlink will log events. Events are used to help troubleshoot the data.

The following actions will cause the Satlink to log an event:

- Setup change (when any setting is changed)
- Log download (when the log is downloaded)
- Reset (log contains reset type and count)
- Errors (such as low battery and sensor failure)
- Before cal and after cal (logged when the user sets the sensor level to record the value before and after the calibration)
- Log in events (if password is enabled), including failure to log in.
- Telemetry events (transmission made, message received, etc.)
- Alarm events

The setting *Log Daily Values* (Log Daily Values) determines whether certain log events are logged every day before midnight.

The setting Log Diagnostics (command line only) sets the software to log transmission diagnostic information.

13.3.   Logged Time

Measurements are not instant. Once initiated, a measurement takes the user-defined averaging time, plus some overhead, to complete.

For measurements without averaging, t**he timestamp of the logged measurement is the time the measurement was started.** The same is true for transmissions. The timestamp of the transmission is the time when the transmission process was started, not when it was completed.

This means that if a SDI-12 sensor takes 1 minute to provide a result, and the measurement is setup to go every 15 minutes, the measurement will start at 00:15:00 and complete at 00:16:00. The logged data will have the timestamp of 00:15:00.

Satlink handles averaged readings in such a way that the last sample is collected at *Meas Time + Meas Interval.* Please see the averaging section Averaging Time, Sampling Interval, Subsamples, and Results for details.

14. Errors

During operation, Satlink may notice system errors. If it does, it will blink the red LED on the front panel.

To see the error details, check the status with LinkComm. Via command line, type STATUS to see any potential errors.

14.1. Clearing Errors

Some errors can only be cleared by fixing the condition that is causing them. Most errors can be cleared with LinkComm's Clear Status button on the main tab. On the command line, type STATUS 0 to clear the errors.

14.2. Measurement Errors

Measurement errors occur as the system collects sensor data. When data from the sensor contains an error, that error is logged along with the sensor reading. The system notes this error until the system is rebooted or until the error is cleared. Even if the error were to occur only once, it remains in the system until cleared or rebooted.

14.2.1. Sensor Failure

This error indicates a problem with a sensor or a setup. This error is recorded for SDI-12 sensors when the SDI-12 sensor does not reply to the measure and to the data commands. It is also recorded for analog measurements when the analog to digital converter indicates a problem reading the input which could be to the input voltage being out of range or not being connected (Satlink cannot always be able to tell if an analog sensor is present).

When the sensor failure error occurs, Satlink changes the sensor reading to match the user set *Log Error Value,* which defaults to -99999. Such outlandish numbers are used to attract the user's attention when viewing the log.

14.2.2. Meas Interval Too Short

If this error is present, then the measurement schedule is inappropriate.

This error means that Satlink missed a scheduled measurement. This gets logged when the system realizes that more than one measurement interval has passed between two subsequent measurements. One of the following likely took place:

- The system missed a scheduled measurement (likely due to measurement taking longer than *Meas Interval* to complete – e.g. system was told to measure every 5 seconds even though the sensor takes 10 seconds to finish a reading
- *Equations* are enabled and the *Meas Interval* is short (once a second or once every two seconds). Satlink can take several seconds to compute a lengthy equation and cannot complete a measurement as quickly.

14.2.3.   Sampling Too Short

This happens when the sensor response time is longer than the sampling interval. SDI-12 readings are a good example: if a sensor requires 10 seconds to produce a reading, and the sampling interval is 10 seconds, this error gets set.

14.2.4.   Averaging Too Short

The averaging interval is either shorter than the sampling interval or than the sensor reply time.

14.2.5.   Bad Setup

This error is recorded to indicate one of the following:

• The equation processor reported an error (could be a divide by 0 or syntax error)
• A meta measurement referenced an inappropriate measurement
• The SDI-12 Command was set to an invalid value
• The SDI-12 sensor did not provide enough data values in the result (check *SDI-12 Param*)

14.2.6.   Bad Wind Setup

Satlink requires that two measurements to be set up for wind: a speed and a direction and that the two measurements have an identical schedule. See section on wind setup.

14.3.   System Errors

14.3.1.   Recording Off

If recording is turned off, Satlink is not collecting data. That is why this condition is considered an error. This error persists until recording is turned on.

14.3.2.   Time Not Set

This error is noted when Satlink does not have valid time. This error can only be fixed by allowing the system to sync its time via GPS.

Satlink has an RTC (real time clock) backed by an internal battery. The clock is set at the factory. The RTC keeps ticking even if the main battery is removed. This means that Satlink should not forget the correct time when it loses power. The battery lifetime is more than five years.

14.3.3.   Battery Low

Satlink considers any battery voltage below 10.5V to be an error in an effort to indicate that the battery needs to be changed. The only way to fix this error is to provide a supply of more than 10.5V.

14.3.4.   Transmission Failures

A variety of issues can cause problems with transmissions:

• Two or more consecutive transmissions failing cause an error.
• If more than 25 percent of total transmissions fail, an error is flagged.
• If no measurements are set up to be included in the transmission data, the system flags an error.

14.3.5.   Hardware Failure

This error is recorded if any hardware issues were noted since boot up. The errors will also be placed in the log. Every hardware error has a code logged with it. A hardware error usually

indicates a serious problem with the unit. Contact Sutron customer support at 703 406 2800 for help with hardware errors.

Error codes

Test Only		
5002	Batt sanity	
5003	Batt range	
5004	Coin cell sanity	
5005	Coin cell range	
5006	Analog 05V A	
5007	Analog 05V B	
5008	Analog DIFF C	
5009	Analog DIFF D	
5010	Analog DIFF E	
5011	Analog 420	
5012	Sdcard size	
5013	Sdcard type	
5014	SDI sensor ID fail	
5015	Sdi switched power fail	
5016	Sdi rs485 no tx rx loop	
5017	Sdi no tx rx loop	
5018	No sdi2 rs485 loop	
5019	Digital 1 not lo	
5020	Digital 1 not hi	
5021	Digital 2 not lo	
5022	Digital 2 not hi	
5023	PROT12 fail	
5024	External EEPROM test fail	
5025	External RTC test fail	
5026	IoExpander test fail	
5027	Failsafe test fail	
5028	No rs232 data loop	
5029	No rs232 control loop	
5030	No rs232 power loop	
5031	Unsupported cpu devid	
5032	Unsupported cpu revision	
5033	Switched power fail	
Hardware Errors:		
5101	Flash erase fail	
5102	Flash write fail	
5103	Flash init fail	
5120	Amp temp sensor fail	
5121	AD7794 Failure	
5122	STM ATD test fail	
5123	Exar uart init fail	
5124	External EEPROM write fail	

5125	External EEPROM init fail	
5126	External EEPROM timed out	
5127	EXT RTC init fail	
5128	RTC temp sensor fail	
5129	Base log sector invalid	
5130	Multiple current log sectors	
5131	Log sector has no valid data	
5132	Unmarked log sector	
5133	GPS comm problem	
5134	No GPS Detected	
5135	IO expander direction setup fail	
5136	IO expander fail to default	
5137	IO expander input error	
5138	IO expander output readback fail	
5139	Loops not locked	
5140	WiFi comm error	
5141	WiFi setup error	
5142	Wifi Upgrade Fail	
5143	WiFi firmware old	
5144	Modulator init fail	
5145	Sym Int not active	
5146	Failsafe circuit comm error	
5147	Failsafe circuit failure	
5148	Power fail malfunction	
5149	Rtc/Cpu frequency error	
5150	Rtc stopped	
5151	Sdram test fail	
5152	Tx board not detected	
5153	Upconverter init fail	
Operational Errors:		
5501	Active measurement has zero interval	
5502	No forward power detected	
5503	Already Transmitting	
5504	Amp overheat during	
5505	Amp overheat before	
5506	Invalid Argos interval range - must be 40 to 300 seconds	
5507	Battery High	
5508	Battery Low	
5509	Cimel comm failure	
5510	Discipline result drifted too far	
5511	Equation failed	
5512	Failed to log-log busy	
5513	Failsafe not reset	
5514	Forced measurement in progress	
5515	Freq Disc Out of Range	
5516	GPS Antenna Short Circuit	

5517	GPS failed to acquire time	
5518	Time way off	
5519	Internal timing error	
5520	Invalid Output Power or Antenna	
5521	Invalid samples	
5522	Invalid satellite type	
5523	Invalid channel	
5524	Low forward power	
5525	Measurement interval too short	
5526	Missed scheduled measurement	
5527	Missing samples	
5528	Weak battery self shutdown	
5529	Not all data transmitted	
5530	Failsafe circuit operation aborted	
5531	Failsafe circuit too busy	
5532	Frequency discipline failed	
5533	Discipline incomplete	
5534	Failsafe tripped	
5535	RTC Discipline error	
5536	Satellite ID not set	
5537	Satellite ID set out of range	
5538	Invalid satellite type for random tx	
5539	Invalid SDI-12 port	
5540	SDI-12 setup error	
5541	SDI-12 bus busy for too long	
5542	SDI-12 comm failure	
5543	SDI-12 time set failure	
5544	Transmission time miscalculated	
5545	Error syncing clock to GPS	
5546	Frequency not disciplined	
5547	System clock changed	
5548	Tx data content cap reached	
5549	Tx interval is zero	
5550	Tx not complete in time	
5551	Window centering set to zero	
5552	User aborted Tx	
5553	User erased log	
5554	Frequency discipline failed TCXO	
5555	Frequency discipline failed GPS	

15. Command Line Interface

The best way to set up and talk to Satlink is by using LinkComm software. Connect Satlink to a PC via a USB cable, install any required drivers, and run LinkComm.

SMS messages may be sent to Satlink from a cell phone, and Iridium messages may be sent via email. LinkComm cannot send messages to Satlink.

Satlink uses a command line interface. You can use a terminal program instead of LinkComm to talk to Satlink. All of Satlink's features are available over command line. In fact, LinkComm uses the command line interface to talk to Satlink. When messages are sent to Satlink via SMS or Iridium, they use the same format as regular command line communications.

15.1.   Why Use Command Line?

LinkComm provides an easy user friendly way to interact with Satlink. You should never *have* to use Satlink's command line interface. However, some people prefer command-line interactions. Also, if you want to send an SMS to a GPRSLink to check the station status, you would need to find out what the command for checking status is.

15.2.   About the Command Line Interface

The command line interface provides a way to interact with Satlink. Any terminal program can be used to connect to Satlink. You can connect via the USB port, send a message via SMS (or Iridium), or attach to the TCP/IP address of GPRSLink that has *Listening* enabled.

By default the interface operates at 115200 Baud, no parity, 8 data bits, 1 stop bit. Satlink supports hardware handshaking; its use is recommended. Allow at least a half-second between opening the communications port and starting communication.

To start command line mode, send carriage return or line feed (or both). If using a terminal program, press ENTER. Satlink will respond with a prompt >

Once in command line mode, type HELP to get a list of supported commands. Also try HELP SETUP.

While it is not recommended, changing the baud rate can be done by typing BAUD RATE. The default baud rate is 9600.

With the terminal program, if the emulation is set for VT100, pressing the up arrow brings back the last typed command.

15.3.   Sending Messages

This section has been hidden pending release of the modem.

15.4.   Status

To check the status, type STATUS (or just S).

>STATUS
Satlink: Satlink ver 1.04 …

15.5.   Setup

To view the whole measurement setup, type SETUP. To view just the setup of measurement one, type M1. Likewise, M2 shows the setup of the second measurement. Only pertinent data is shown. If a measurement is not active, it will not show its setup fields. If a measurement is of type analog, it will not show its SDI-12 setup fields.

The command SETUP NONDEFAULTS only shows the fields that have been changed from defaults.

An easy way of setting up your station is to type WIZARD or just W. A setup wizard will guide you through the most commonly used settings of the station and of each measurement. The setup wizard may be used to configure one specific measurement: typing M1 WIZARD or M1 W will set up measurement one.

Every setup field can be changed by typing *setup = value* where setup is the name of the field and value is the new value. By just typing the name of the field, the current value and the range of the field are shown.

For example, typing STATION NAME shows the current station name. Typing STATION NAME = SUTRON changes the station name.

>STATION NAME
Setup NOT changed
Station Name = DEMO, max length 23

To change setup try STATION NAME = SUTRON.

>STATION NAME = SUTRON DEV 1
Setup changed
Station Name = SUTRON DEV 1, max length 23

Changing measurement setup fields requires that the measurement be named. For example, to change the *Measurement Type* it is not enough to type MEAS TYPE. You need to provide the number of the measurement in question: M1 MEAS TYPE shows the *Measurement Type* of the first measurement. M2 MEAS TYPE works for the second measurement.

>M1 MEAS TYPE
Setup NOT changed
Meas Type = SDI-12, Range (0=Precip Accumulation, 1=Precip Rate, 2=SDI-12, 3=Analog, 4=Battery, 5=Wind, 6=Digital, 7=Meta, 8=Manual Entry, 9=Internal Temp, 10=Accubar Pressure, 11=Accubar Temp)

To change setup try Station Name = Sutron

In the example above, the user typed M1 MEAS TYPE, which will show the measurement type field of the first measurement. The example shows the type as being *Internal Temp.* After the current type is shown, the range shows all the options for the measurement type. To set up the measurement as SDI-12, the user may type either M1 MEAS TYPE = SDI-12 or M1 MEAS TYPE = 2.

Setting the whole setup to defaults can be accomplished by typing SETUP DEFAULTS. Setting just measurement one to defaults can be done via M1 SETUP DEFAULTS.

15.6.   Measurements

To view the setup and the last reading made measurement one, type M1. Use M2 for measurement two, etc.

To view all the last measured readings, type LAST. It will show a reading for every active sensor. Typing LAST does not initiate new measurement.

To initiate a new measurement for each active sensor, type MEAS. Satlink will measure each sensor one at a time and display results as it goes along.

If you are interested in only one specific measurement try M1 LAST and M1 MEAS. Those will show the last measured value and initiate a new measurement, respectively. To get more details on the measurement readings from LAST and MEAS, type M1 DETAILS = ON.

Instead of using M1, M2, etc., you may also the measurement's *Label*. For example, if you have named measurement one as BARO, typing BARO will show the setup of the measurement and typing BARO MEAS will make a new measurement and show the results.

To change the current reading of a sensor, type M1 = 12.5. This will change the *Measurement Offset* such that the said measurement reads the user entered value. For example, if my water level sensor, once set up, read 3.50, and I knew the water level was at 1.50, I would type M1 = 1.50. The next it was measured, M1 would read 1.50 (assuming the level does not change). The *Measurement Offset* would have changed from 0 to -2.00.

A two-level calibration procedure is also available. It requires that the sensor be able to produce two readings and results in changes to both *measurement Slope and Offset.* Issue M1 CAL to start the two-level calibration.

>M1 CAL
Position sensor
Enter sensor reading :20.5
Calculating...
Raw sensor: 10.1500

Position sensor
Enter sensor reading :23.1
Calculating...
Raw sensor: 13.8140
Measurement M1 STAGE
Slope = 0.709607

Offset = 13.297492

15.7.   Recording

To start Satlink, click the Start button in LinkComm, or type RECORDING = ON.

15.8.   Downloading the Log

Satlink will save the measured data in its flash memory each time a measurement is made. This data is then available to download to via the RS232 port. The command LOG command will start a transfer of the log to the connected device.

- Use NH to exclude the header; Use NE to omit events.
- Help Log gives details on downloading the log.
    >HELP LOG
            DOWNLOAD or LOG will transfer the log from the unit
            LOG ALL gets whole log, just LOG gets since last download,
            LOG X gets X last days ("LOG 3" gets last 3 days worth of data)
            LOG timeStart gets data since provided date
            LOG timeStart timeEnd gets data between provided dates
            time can be YYYY/MM/DD HH:MM:SS or YYYY/MM/DD or HH:MM:SS
            eg. "LOG 12:00:00 13:00:00"
            eg. "LOG 2006/01/20 12:00:00 2006/01/21 12:00:00"
            append M1 to include only data from measurement one
            eg. "LOG 3 M1 M2
            append NH to omit log header, NE to omit events
            There is no YModem support

15.9.   Machine-to-Machine Communication

All commands may be preceded with an !. If they are, there is no echo, and a concise reply meant for machine-to-machine interaction is returned.

Commands would be preceded by an ! if they were sent by an Xpert or some such computer. For example, instead of typing SETUP, you may type !SETUP.

When command are preceded with an !, no help text is given, no range is shown for measurement, no confirmation of commands is shown, and no key stroke is expected between scrolling pages.

15.10. Command Reference

Documentation Legend:

- 0 **If a 0 follows** a listed command, it means that the command can optionally be followed by the character 0. E.g. DIAG will show the system diagnostic status. DIAG 0 will first show current status and then clear the status.
- [Mx] indicates specifying a measurement is optional
- TXx indicates specifying a TX1, TX2 …

All commands may be preceded with an !. If they are, a concise reply meant for machine to machine interaction is returned. Commands would be preceded by an ! if they were sent by an Xpert or some such computer.
E.g. MEAS will show
Measurement M1 Sense1 reading
2.17
2015/11/24 17:43:11

!MEAS will show
M1 Sense1, 2.17, 2015/11/24 17:42:24,

Every setup variable can be viewed by typing its name.
E.g. STATION NAME will show the current name.
Every setup variable can be changed by typing its name = new value.
E.g. STATION NAME = STURON will set the current name to SUTRON.
For a list of all the setup names, type "SETUP".

15.10.1.   List of Commands

Command	Description
BATTERY	Shows the current battery reading.
DIAG 0	Shows system diagnostics, including system resets. If followed by 0, it will clear system resets.
DOWNLOAD	See LOG

Command	Description
EXIT	Quits command line.
FACTORY DEFAULTS	This command sets the setup to defaults, clears status (which includes system errors and transmission counts), zeroes reset counts, and clears asserts.
HELP HELP LOG HELP SDI HELP SETUP HELP OUTPUT	Brings up the help (lists commands).
HI	System replies with Hello and blinks green LED.
LAST [Mx] LAST	Shows the last measured reading of every active measurement. This command does not make a new measurement, only shows the last results of the last measurement. If preceded by the measurement designator (E.g. M1 LEAS), it shows only one sensor.
LOG	This command is used to download the log. Try LOG HELP. See Downloading the Log section above for more details.
LOG DAILY VALUES	Enable for SL3 to log additional values at midnight 23:59:59. See Log Daily Values
LOG DIAGNOSTICS	Enable for SL3 to log additional diagnostic values.
LOGIN	To log into a password protected station, type LOGIN=XXX where XXX is the password. Optionally, type LOGIN=USERNAME,XXX and USERNAME will be ignored. See PASSWORD below.
M1..M32	Type M1 to see the setup of the first measurement. Type M2 to see the setup of the second measurement. Type M1 SETUP DEFAULTS to change to defaults only the setup of measurement one. Type M1 LAST to see the last measured value, and type M1 MEAS to make a new reading. Additionally, you may say M1 = 15.0 to calibrate the sensor. That ends up changing the offset. There is also a two=point calibration that changes the slope and the offset. Two point calibration is started by typing M1 CAL
MEAS [Mx] Meas	Use this to make a measurement on all or some sensors. After receiving this command, Satlink will measure every active sensor and display the results. If preceded by the measurement designator (for example, M1 MEAS), it measures only one sensor.
OUTPUT1 OUTPUT2	This command controls Satlink's digital output. OUTPUT1 tells whether the output is currently on. OUTPUT1 ON turns on the output. OUTPUT1 OFF turns off the output
PASSWORD	Used to prevent unauthorized access to station. type PASSWORD = XXX to set password to XXX. To log in, type LOGIN=XXX. Type PASSWORD = to disable password usage.
REBOOT	Does a software resets of the system.
RESETS 0	Shows system diagnostics, including system resets. If followed by 0, it will clear system diagnostic status.
SDI	Use this command to gain access to the SDI-12 bus. You may put any command on the SDI-12 bus and see any reply. SDI xxx puts xxx on the SDI-12 bus. E.g. type SDI 0M! to send the 0M!

Command	Description
	command. Additionally, type SDI FIND to seek sensors. Satlink will issue I! commands to all SDI-12 addresses in hopes of locating sensors.
SETUP	If provided without any other parameters, it lists all setup details. That includes each setup variable and its current value. Can be followed by a setup variable name and a new value for that variable. E.g. STATION NAME = SUTRON If SETUP DEFAULT is issued, it will reset the entire setup to defaults.
STATUS 0	Shows system status including time, boot time, battery readings, last measurements, current internal sensor readings, and any hardware errors that may exist. If followed by 0, it clears the hardware errors.
STATUS TX	Shows details transmission status.
TEMP	Returns current internal temperature.
TIME	Shows the current system date and time. If followed by a new time, it changes the system time. E.g. TIME = 2008/12/12 changes the date. TIME = 10:15:30 changes the time.
TXx TXBUF	This command shows the data content of the transmission buffer. Normally, the transmission buffer will contain data from the last transmission. The transmission buffer can hold more data than can fit into a single transmission, meaning that the modem may need to send multiple transmissions to transmit all the data in the buffer. The data in the buffer will be in whatever format the user has selected (via the Tx Data Format setting). In addition to the transmission buffer content, the command will tell how much data (in bytes) is in the buffer and when the buffer was filled. Issuing the command TXFORM (see below) will have the Satlink fill the transmission buffer with data which can be helpful to ensure that the station is set up properly.
TXx TXFORM	Issuing this command will have Satlink fill the transmission buffer with data. This command will cause Satlink to overwrite whatever data was in the transmission buffer. This command can help properly set up the station. Once the measurements have been set up for transmission, issue the TXFORM command to see what the transmission will look like. Even though Satlink may not have collected the data it would during normal operation, this command can help determine the size and contents of the transmission. If recording is on, the unit may not be able to access the transmission buffers immediately. This can happen if another transmission has filled the buffer with data that needs to be transmitted first. Once the other transmission completes, the command will be executed. This command can be followed with optional parameters that will dictate what data gets transmitted. The parameters are the same as foe the command TXNOW which is described below.
TXx TXNOW	Issue this command to have Satlink make a transmission as soon

Command	Description
	as possible. This command is useful for getting logged data from the unit.
	If connected to the unit directly or remotely (as opposed to sending the command in a message), you may issue the TXBUF command immediately afterward to see what the data content will look like (only useful for diagnostics).
	If command line is active (not a message), you will need to disconnect before the unit will be able to make a transmission.
	If issued without additional parameters, Satlink will make a transmission that is similar to a scheduled transmission. Otherwise, provide parameters that will specify what data to include in the transmission:
	TX1 TXNOW timeStart timeEnd includes data between the dates
	time can be YYYY/MM/DD HH:MM:SS or YYYY/MM/DD or HH:MM:SS
	e.g. TXNOW 12:00:00 13:00:00
	e.g. TXNOW 2006/01/20 12:00:00 2006/01/21 12:00:00
	append M1 to include only data from measurement one
	e.g. TXNOW M1 M2 12:00:00 13:00:00
VER	Shows the current software version, including build date and time and the bootloader version.
VER BOOT	Shows the current software version of the bootloader.
WIZARD [Mx] WIZARD	Guides the user through station set up. Typing M1 WIZARD will do the setup just for measurement one.

16. Appendix A – Specifications

ELECTRICAL	
Input Voltage	9-20 VDC 10 -16 V for SDI-12 sensor support Reverse power protected
CURRENT CONSUMPTION @ 12V	
Standby (all sensors unpowered)	1.5mA typical
Measuring	6 to 15mA
Transmissions 1.25W, 300 Baud 2.5W, 300 Baud 5W, 300 Baud 7W, 300 Baud 10W, 300 Baud	Wakeup: 50mA for 107 seconds (GPS sync, frequency discipline …) Warmup: 320mA for 16 seconds Transmitting: 1.5A for 2 to 60 seconds based on number of values to transmit 1.8A for 2 to 60 seconds … 2.6A for 2 to 60 seconds … 2.9A for 2 to 60 seconds … 3.5A for 2 to 60 seconds …
Wi-Fi on	11mA
MECHANICAL	
Dimensions	SL3-1: 6.06"x9.24"x2.0" (not including connectors) SL3-SDI-1: 6.40"x3.82" (not including connectors)
Power Connection	2 position pluggable terminal strip (12-18 AWG)
SDI-12 Port	2x3 position pluggable terminal strips (16-24 AWG)
Sensor Connections	10x 2, 3, or 4 position pluggable terminal strips (16-24 AWG)
DB9-F	RS232 DCE
USB (SL3-SDI-1)	Micro-B receptacle
USB OTG (SL3-1)	Micro-AB receptacle
USB Host (SL3-1)	Type A receptacle
2 Status LED	Indicates status
Earth GND	0.2" screw terminal (SL3-1 only)

ENVIRONMENTAL

Temperature	-40°C to +70°C
Humidity	0-95% Non-condensing

KEY FEATURES

Clock	Internal real-time clock w/battery backup.
Clock Accuracy	
Log Capacity	>1,000,000 readings, 32MB

SDI-12 INTERFACE

- Dual independent SDI-12 busses
- SDI V1.3 compliant logger
- +12V connection (supply voltage) @ 500mA

OPTIONAL MODEMS (SL3-1 ONLY)

GPRSLink	Quad Band GPRS Modem
HSPALink	Quad Band GSM Modem with 4G speeds
CDMALink	CDMA Modem
IRIDIUMLink	IRIDIUM Modem

SINGLE ENDED ANALOG INPUTS (SL3-1 ONLY)

Number available	2
Input Range	0 to 5V (with respect to ground)
Resolution	0.298 µV
Noise (p/p) @25°C	12.0 µV (p/p)
Noise (RMS) @25°C	4.24 µV RMS
Accuracy @25°C	0.003% (typical) Midscale 0.004% Max
Input Impedance	> 1MegOhm @25°C

DIFFERENTIAL ANALOG INPUTS (SL3-1 ONLY)

Number Available	3
Range (SW selectable)	±39mV; AIN pin Voltage Range with respect to AGND 0.5 to 3.7 Volts ±312mV; AIN pin Voltage Range with respect to AGND 0.5 to 3.7 Volts ± 2.5V ; AIN pin Voltage Range with respect to AGND 0.1 to 4.7 Volt
Resolution	4.657 nV @ ±39mv scale 37.25 nV @ ±312mv scale 298 nV @ ±2.5 scale
Noise (p/p) @25°C	1.6 µV (p/p) (±39 mV /±312 mV scale)

Noise (RMS) @25°C	0.38μV RMS
Accuracy @25°C	0.004% Max @ ±2.5 V scale
Input Impedance	>5 Meg Ohm 312mV FS Differential @25°C

4-20mA ANALOG INPUT (SL3-1 ONLY)

Range	0 - 22mA
Resolution	<1nA
Accuracy @25°C	0.02%
Loop Power	External
Loop Resistance	200 Ohm

TEMPERATURE MEASUREMENT (INTERNAL)

Range	-40°C to +70°C
Accuracy	± 3 deg

DIGITAL INPUT 1,2 (SL3-1 ONLY)

Switch Contact Type
Pulse Width between 30ms & 120ms
Range DC to 120 tips/min. (min)

DIGITAL INPUT 1,2 - FREQUENCY TYPE (SL3-1 ONLY)

Input Range	Low level AC (DIN1 only) (100 mVp-p to ±15V) 0-5 V (DIN1 and 2) (15V max)
Minimum Frequency	2.8 Hz
Maximum Frequency	10 kHz

DIGITAL INPUT 1,2 - COUNTER TYPE (SL3-1 ONLY)

Input Range	0-5 V (15V max)
Maximum Frequency without Debouncing	10 kHz
Maximum Frequency with Debouncing	300Hz

17. Appendix B – Sutron 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

18. Appendix C – Commercial Warranty

18.1.   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.

18.2.   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.

18.3.   Repair and Return Policy

Sutron maintains a repair department at the factory, 22400 Davis Drive, Sterling, VA 20164. Turnaround 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.

19. Appendix D -Data Formats

19.1.   Pseudobinary B Data Format

This format is based on GOES pseudobinary format. It is used when the user selects P*seudobinary B* as the choice for *Tx Format.* The format uses ASCII characters. Three bytes are used for each data value. To correctly decode the measurement, you need to know how many readings of each measurement are included in the transmission. There is no metadata that would describe which measurement is which.

BLOCK IDENTIFIER	BLOCK-IDENTIFIER is always sent as B to indicate the start of a binary data group.
GROUP ID	GROUP-ID is sent as B1 to indicate a scheduled transmission. Other transmissions, including alarms, send 2.
OFFSET	Each record is prefixed with an <OFFSET>, which is a 1 byte binary encoded number indicating the number of minutes ago the most recent data was recorded. .
MEASUREMENT DATA	Measurement data collected: This data contains only those measurements set up to be included in the transmission (see *Tx Data Content)*. The data values are 3 byte binary encoded signed numbers allowing a range of: -131072 to +131071. The actual 6-bit binary encoded format is described later. The value transmitted will be value * 10^RightDigits. The string /// will be sent if the data was never measured or was erased. All the required values for one sensor (most recent first) before proceeding to the next measurement. This format is similar to that used by the Sutron Satlink but different from the 8210.
BATTERY VOLTAGE	This is the battery voltage measured prior to making the transmission. The range of the number will be -32 to +31 and can be converted to volts by multiplying by 0.234 and adding 10.6 allowing a range of 3.1 to 18.1 volts.

19.1.1.   Pseudobinary B Example

Here is a transmission with three active measurements; each one is set to include two readings.

```
B1@@Gt@Gs@Sx@Sr@@i@@il
|||| | | | | | | |
|||| | | | | | | |
|||| | | | | | | |
|||| | | | | | +------------ Battery Voltage
|||| | | | | +--------------- Temp #2
|||| | | | +------------------ Temp #1
|||| | | +-------------------- Precip #2
```

```
|||| | +---------------------- Precip #1
|||| +------------------------- Stage #2
|||+---------------------------- Stage #1
||+----------------------------- Delta Time
|+------------------------------ Group ID
+------------------------------- Block ID
```

19.2.   Pseudobinary C Data Format

This format is based on the pseudobinary B format. It uses slightly more bandwidth than the B format, but it is self-descriptive. It is used when the user selects P*seudobinary C* as the choice for *Tx Format.*

Name	Bytes	Description
Block identifier	1	BLOCK-IDENTIFIER is always sent as C to indicate that this is the pseudobinary C format.
Group id	1	GROUP-ID can be 1 to indicate a scheduled transmission, 2 meaning an alarm transmission, 3 indicating a forced transmission, and 4 indicating a retransmission.
Measurement Delimiter	1	This byte is always a + and it is used to denote the start of measurement data.
Measurement Index	1	This is encoded 6 bit binary encoded (see below) number which, when translated, tells the measurement index. Satlink assigns a measurement index (starting with 1 and ending with 16) to each user setup sensor.
Day	2	This 2 byte encoded 6 bit binary encoded (see below) number represents the Julian day of the year. The day tells when the most recent (first) sensor reading of this measurement was made.
Time	2	This 2 byte encoded 6 bit binary encoded (see below) number is a number of minutes into the day. It tells when the most recent (first) sensor reading of this measurement was made.
Interval	2	This 2 byte encoded 6 bit binary encoded (see below) number tells the measurement interval in minutes, or the amount of time between readings of this measurement.
Measurement Data	3 for each sensor reading	Measurement data collected: This data contains only those measurements set up to be included in the transmission (see *Tx Data Content)*. The data values are 3 byte binary encoded signed numbers allowing a range of: -131072 to +131071. The actual 6-bit binary encoded format is described later. The value transmitted will be value * 10^RightDigits. The string /// will be sent if the data was never measured or was erased. All the required values for one sensor (most recent first) before proceeding to the next measurement. This format is similar to that used by the Sutron Satlink but different from the 8210. There will be 3 bytes of encoded data for every sensor reading. The number of readings depends on the user setup.
Additional Measurements	Variable	If more than one measurement was set up for transmission, more data will follow. Each measurement setup will have data starting with the Measurement Delimiter and ending with

Name	Bytes	Description
		Measurement Data.
Final Delimiter	1	This byte is always . and it is used to denote the end of all measurement data.
Battery voltage	1	This is the battery voltage measured prior to making the transmission. The range of the number will be -32 to +31 and can be converted to volts by multiplying by 0.234 and adding 10.6 allowing a range of 3.1 to 18.1 volts.

19.2.1.   Example of Pseudobinary C

To help understand the message below, here is a relevant bit of Satlink's setup:

M1 Right Digits	2
M1 Meas Interval	00:01:00
M1 Tx Data Content	All Logged
M2 Right Digits	1
M2 Meas Interval	00:01:00
M2 Tx Data Content	Last
Tx Time	00:00:30
Tx Interval	00:03:00

C1+ABeHq@A@E|@FG@FM+BBeHq@A@@O.K

Pseudobinary values	Decoded into decimal	Completely decoded	Description
C			Denotes Pseudobinary C format
1			Scheduled transmission
+			Delimiter for next measurement
A	1	M1	Measurement M1
Be	165	June 14th	M1 day of the year of the most recent reading. For 2013, it is June 14th.
Hq	561	09:21AM	M1 minutes into the day of the most recent reading: 9:21AM
@A	1	1 minute	M1 measurement interval in minutes.
@E|	380	3.80	M1 most recent sensor reading made at 09:21AM
@FG	391	3.91	M1 sensor reading made at 09:20AM
@FM	397	3.97	M1 oldest sensor reading made at 09:19AM
+			Delimiter for next measurement
B			Measurement M2
Be	165	June 14th	M2 day of the year of the most recent reading.
Hq	561	09:21AM	M2 minutes into the day of the most recent reading.
@A	1	1 minute	M2 measurement interval in minutes.
@@O	15	1.5	M2 sensor reading
.			Delimiter for end of measurement data
K	11	13.174V	Battery voltage (11*0.234+10.6)

19.3.   Pseudobinary D Data Format

This is another compact data format. It differes from Pseudobinary B in that it has a timestamp at the start of the message.   The timestamp indicates when the transmission should have taken place and helps decode when the data was collected. Pseudobinary D is 4 bytes larger than format B.

The timestamp is similar to the one in Pseudobinary C. Pseudobinary D is smaller than Pseudobinary C and it lacks detailed timestamps that would allow one to completely reconstruct the time the data was collected from the message itself. To correctly use Pseudobinary D, the decoder needs to know the measurement setup used.

The benefit of using Pseudobinary D is being able to correctly decode data regardless of when it was sent or received. This allows stations to re-transmit old data and have it correctly interpreted by the decoder while keeping the message size at a minimum.

Name	Bytes	Description
Block identifier	1	BLOCK-IDENTIFIER is always sent as D to indicate that this is the Pseudobinary D format.
Group id	1	GROUP-ID can be 1 to indicate a scheduled transmission, 2 meaning an alarm transmission, 3 indicating a forced transmission, and 4 indicating a retransmission.
Day	2	This 2 byte encoded 6 bit binary encoded (see below) number represents the Julian day of the year. The day tells when the transmission was originally scheduled to take place.
Time	2	This 2 byte encoded 6 bit binary encoded (see below) number is a number of minutes into the day. It tells when the transmission was originally scheduled to take place.
Measurement Data	3 for each sensor reading	Measurement data collected: This data contains only those measurements set up to be included in the transmission (see Tx Data Content). The data values are 3 byte binary encoded signed numbers allowing a range of: -131072 to +131071. The actual 6-bit binary encoded format is described later. The value transmitted will be value * 10^RightDigits. The string /// will be sent if the data was never measured or was erased. All the required values for one sensor (most recent first) before proceeding to the next measurement. This format is similar to that used by the Sutron Satlink but different from the 8210. There will be 3 bytes of encoded data for every sensor reading. The number of readings depends on the user setup.
Additional Measurements	Variable	If more than one measurement was set up for transmission, more data will follow. Each measurement setup will have data starting with the Measurement Delimiter and ending with Measurement Data.
Battery voltage	1	This is the battery voltage measured prior to making the transmission. The range of the number will be -32 to +31 and can be converted to volts by multiplying by 0.234 and adding 10.6 allowing a range of 3.1 to 18.1 volts.

19.3.1.   Example of Pseudobinary D

To help understand the message below, here is a relevant bit of Satlink's setup:

M1 Right Digits	2
M1 Meas Interval	00:01:00
M1 Tx Data Content	All Logged
M2 Right Digits	1
M2 Meas Interval	00:05:00
M2 Tx Data Content	Last
Tx Time	00:00:30
Tx Interval	00:05:00

<div align="center">

D1D~A8@NI@NH@NG@NF@NE@DGF

</div>

Pseudobinary values	Decoded into decimal	Completely decoded	Description
D			Denotes Pseudobinary D format
4			Retransmission
D~	318	Nov 14th	Day of the year of the most recent reading. For 2014, it is Nov 14th.
A8	120	2:00 AM	Minutes into the day. We can tell that this transmission should have been made at 02:00 on Nov14th and parse the data accordingly.
@NI	905	9.05	Sensor M1 collected at 02:00
@NH	904	9.04	Sensor M1 collected at 01:59
@NG	903	9.03	Sensor M1 collected at 01:58
@NF	902	9.02	Sensor M1 collected at 01:57
@NE	901	9.01	Sensor M1 collected at 01:56
@DG	263	26.3	Sensor M2 collected at 02:00
F	12	12.00V	Battery voltage

19.4.   Six Bit Binary Encoded Format

The 6 bit binary format is used to encode numbers into displayable ASCII characters. Fractional numbers cannot be represented, so, for instance a battery voltage of 13.04 volts set up with 2 right digits will be sent as 1304.

- A 1 byte encoded number can range from -32 to +31.
- A 2 byte encoded number can range from -2048 to +2047
- A 3 byte encoded number can range from -131072 to +131071
Binary encoded numbers are always sent most significant bytes first. The number itself is broken down into 6-bit digits, and each digit is placed in one byte of data. The number 64 (ASCII @) is added to each digit to make it fall within the range of displayable ASCII characters. The only exception is that 127 (ASCII <DEL>) is sent as 63 (ASCII ?)

19.4.1.   Example 1: Encoding the Number 10 in 1 Byte

Since 10 will fit in 6-bits we only have to add 64 which would yield 74. So the number 10 would appear as ASCII 74 or the letter J.

19.4.2.   Example 2: Encoding the Number 12345 in 3 Bytes

1. First we have to convert 12345 into binary in 6-bit pieces:

    12345 (base 10) = 11 000000 111001 (base 2)

2. Now we can convert each piece back to base 10:

    11 000000 111001 (base 2) = 3, 0, 57

3. Finally, we add 64 to each piece and convert to ASCII:

    67, 64, 121 = ASCII C@y

19.4.3.   Example 3. Encoding the Number -12345 in 3 Bytes

1. First we have to convert -12345 into two's complement 18-bit binary: -12345 (base 10) = 111100 111111 000111 (base 2)

2. Now we can convert each piece back to base 10: 111100 111111 000111 (base 2) = 60, 63, 7

3. Finally, we add 64 to each piece and convert to ASCII (since the second piece is 63 we leave it alone):

    124, 63, 71 = ASCII |?G

19.4.3.1.   *Example 4. Decoding the 3 byte string @SW:*

This is just like encoding except we follow the steps backward.

1. First we convert all the characters to ASCII decimal codes:

    ASCII @SW = 64, 83, 87

2. Now we subtract 64 from each piece and convert to 6-bit binary:

    0, 19, 23 = 000000 010011 010111

3. Finally, we combine all the bits to form one 18-bit two's complement number and convert to base 10:

    000000010011010111 = 1239

19.5.   Pseudobinary over SMS

Some bytes that are normally used as a part of Pseudobinary transmissions are not allowed in SMS. When Satlink sends Pseudobinary data over SMS, those bytes are replaced according to the following table:

Original Byte ASCII	Original Byte Hex	Replacement Byte ASCII
[	5B	1

\	5C	2
]	5D	3
^	5E	4
`	60	5
{	7B	6
|	7C	7
}	7D	8
~	7E	9
[	5B	1

19.6.   SHEF and SHEFFIX Data Format

SHEF is a format that is commonly used by Sutron's Satlink satellite transmitter. It is an ASCII format that is easy to read and contains some self-descriptive information.

The format of the transmission data is:

> : <LABEL1> <OFFSET> #<INTERVAL> <DATA1> <DATA1> ... <DATA1)>
> : <LABEL2> <OFFSET> #<INTERVAL> <DATA2> <DATA2> ... <DATA2>   ...
> : <LABEL(N)> <OFFSET> #<INTERVAL> <DATA(N)> <DATA(N)> ... <DATA(N)>

LABEL	This is the *Label* entered as a part of the setup for each measurement. The label can be a SHEF two-character parameter code such as HF for gauge height or PC for cumulative precipitation or it can be any string you enter. Refer to http://noaasis.noaa.gov/DCS/htmfiles/schefcodes.html for a list of SHEF codes commonly used.
OFFSET	This number indicates how long ago the sensor reading was made. The number is in minutes and it refers to the most recent data. It is relative to transmission start.
INTERVAL	The interval indicates how often the measurement was made. It corresponds to the setting *Meas Interval.*
DATA	This is data collected and logged by Satlink through measurements. Only logged data may be transmitted. If *Tx Data Content* is set to *Exclude,* no data from that measurement will be transmitted. Like the binary formats, the SHEF format groups all the related data from one measurement. The data is transmitted in ASCII with sign and decimal point (if needed). If a data value has not yet been recorded (or has been erased) the letter M for missing data will be sent. The most recent data is always sent first. The number of values sent for each measurement is set on a measurement by measurement basis.

19.6.1.   SHEF Example

Here is a message with three active measurements. Each is set to include two readings. The random buffer contains the string EXT. This string was given by an external device through the RS232 port. Notice how much longer this message is compared to the earlier binary examples.

```
:HG 3 #15 10.20 10.15 :PC 1 #15 50 49 :TA 0 #15 -22.1 -22.0 :VB 0 12.2
 | | | |   |   | | | | | |  | | | |   |   | | |
 | | | |   |   | | | | | |  | | | |   |   | | +- VB Reading
 | | | |   |   | | | | | |  | | | |   |   | + -- Offset time
 | | | |   |   | | | | | |  | | | |   |   +------ Label, VB
 | | | |   |   | | | | | |  | | | |   +------------ TA #2
 | | | |   |   | | | | | |  | | | +------------------ TA #1
 | | | |   |   | | | | | |  | | +--------------------- Interval
 | | | |   |   | | | | | |  | +----------------------- Offset time
 | | | |   |   | | | | | |  +--------------------------- Label, TA
 | | | |   |   | | | | +------------------------------ PC #2
 | | | |   |   | | | +--------------------------------- PC #1
 | | | |   |   | | +------------------------------------- Interval
 | | | |   |   | +--------------------------------------- Offset time
 | | | |   |   +----------------------------------------- Label, PC
 | | | |   +------------------------------------------------ HG #2
 | | | +---------------------------------------------------- HG #1
 | | +------------------------------------------------------- Interval
 | +--------------------------------------------------------- Offset time
 +----------------------------------------------------------- Label, HG
```

In the example above *:HG 3 #15 10.20 10.15* means that the sensor labeled HG read the value 10.20 three minutes prior to the start of the transmission. It read 10.15 18 minutes before the start of the transmission, or 15 minutes before it read 10.20.

SHEFFIX is a modified version of SHEF where the data is positioned in fixed spacing so that it will line up better when displayed. Each measurement reading is given seven bytes. If a reading uses fewer bytes it is padded with spaces. SHEIFIX transmissions are larger than SHEF transmissions.

19.6.1.1.   *SHEFFIX Example*

:STAGE 0 #2 20.50 20.50 20.50 20.50 :PRECIP 3 #5 12.00 12.01 :TEMP 3 #5 23.5 23.2 :BV 1 #3 14

19.7.   Sutron Standard CSV

Logs downloaded from Satlink will be in the Sutron Standard CSV format. It is possible to transmit data in the CSV format. However, CSV messages are too large for most applications and are generally used to help set up a station.

The format was introduced in 2009 and is common to current Sutron products. The general format specification for Sutron Standard CSV format is

mm/dd/yyyy,hh:mm:ss,label,data[,units,qual][,label,data[,units,qual]]

19.7.1.   Sutron Standard CSV Example

04/02/2012,09:23:45,STAGE,20.50
04/02/2012,09:23:50,STAGE,20.50
04/02/2012,09:23:53,Setup Change
04/02/2012,09:24:00,BV,14
04/02/2012,09:25:00,PRECIP,34.5
04/02/2012,09:25:00,TEMP,23.5
04/02/2012,09:25:00,STAGE,20.54

20. Appendix E – Approvals and Certifications

20.1.   NESDIS

Contains FCC ID: OA3RN1723

20.2.   Eumetsat

Contains FCC ID: OA3RN1723

20.3.   INSAT

Contains FCC ID: OA3RN1723

20.4.   CE

Contains FCC ID: OA3RN1723

20.5.   WiFi Module

Contains FCC ID: OA3RN1723

This 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.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy, and if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures: • Reorient or relocate the receiving antenna. • Increase the separation between the equipment and receiver. • Connect the equipment into an outlet on a circuit different from that to which the receiver is connected. • Consult the dealer or an experienced radio/TV technician for help.