

# 2500 Series® Slice I/O

## INSTALLATION AND OPERATION GUIDE

Version 1.5



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## Revision History

<b>Revision History</b>		
1.0	20JAN2013	Initial Release
1.1	11FEB2013	Misc corrections
1.2	15OCT2014	+BAT clarification
1.3	13NOV2014	Quick Start power for 26/27-xxxx models
1.4	3JUL2017	Updated Appendix B – Register Access
1.5	20FEB2018	Added note about maturity of 26-XXXX products

## In This Manual...

This manual provides the technical hardware information and configuration instructions required for system design and installation of your 2500 Series® Slice I/O module.

If you have just purchased a 2500S module, we hope that you are as pleased using it as we have been developing it.

If you are reading this manual looking at a future purchase, we hope that you will consider a 2500S module when you have an application that needs I/O expansion and SCADA functions that go beyond just simple I/O.

### Caution or Warning



Usually advises against some action which could result in undesired or detrimental consequences.



### Point to Remember

Highlights a key feature, point, or step which is noteworthy. Keeping these in mind will simplify or enhance device usage.



### Tip

An idea or suggestion

## Support

If you have questions or need help with an application, we hope that you'll take advantage of our free technical support. Simply call us at:

**(865)584-0440**

If you need to send us a fax:

**(865)584-5720**

If you prefer e-mail (we do), especially if you want to send us a sample of a program or other files, you can e-mail us at:

**[support@controltechnology.com](mailto:support@controltechnology.com)**

For additional technical information including datasheets, manuals and software, visit our web site at:

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## Overview

2500S I/O modules can be used to add I/O capacity to a programmable controller, a CTI or Siemens/TI PLC, serve as distributed I/O in a SCADA or DCS system, and/or operate as standalone setpoint/pump controllers, alarm dialers and data loggers. In previous generations, the term I/O module used to imply mainly “Remote I/O” with enhanced communications. 2500S I/O modules have this capability plus much more. Each one has signal processing, data logging, alarming capabilities and support for several different types of user interfaces. Two or more 2500S I/O modules can provide a “mirrored” peer-to-peer I/O link where analog and discrete inputs are replicated as analog and discrete outputs on opposite sides of a communications link. 2500S modules can sense and announce alarm conditions by text message and include a variety of user interfaces for use over the internet, on smart phones and tablets, and by interactive text messaging. Each I/O module has up to several years of historical data storage, with the ability to selectively display the data as graphs on web pages, or download as spreadsheets to a computer.

2500S I/O modules are smart, eliminating the cost of external hardware devices and software, and solving many of the problems that can crop up with competitive systems. Configurable built-in sensor conditioning, digital and analog input filtering, non-volatile high-speed digital and analog totalization, runtime and rate calculation, flexible linear and non-linear scaling, built-in web HMIs, up to several years of historical data logging and totalization, and text message alarming are just a few examples.

### IMPORTANT NOTE

**2500S-26-XXXX modules have been matured and are no longer available for sale. References to those products remain in this manual for reference in existing installations.**

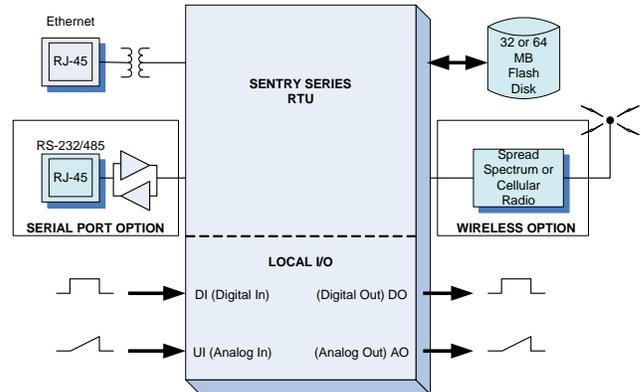
2500S I/O modules are designed for easy configuration and communication using CAMP Ethernet protocol when using CTI 2500 Series® and SIMATIC®/TI Processors. In this configuration, 2500S I/O modules periodically write their input information directly to the PLC memory, and read their output information directly from the PLC memory. Heartbeat information is transferred to a control relay (configurable) on each access to allow the PLC to determine the communications status of the Slice I/O module. When designing systems using Slice I/O modules, the user should observe three important points:

1. Response times between Slice I/O modules and the PLC are not as fast as conventional PLC local and remote I/O. Poll rates are configurable in the Slice I/O module, and total response time depends on which Ethernet connection (2572, 2572-A, 2500P-ECC1, or CPU Ethernet port) is used for communication with the PLC, as well as the topology and traffic levels of the Ethernet network.
2. The user’s PLC program should monitor the control relay containing the 2500S heartbeat, and take appropriate action should there be a loss of Ethernet communications.
3. The user should ensure that PLC memory locations mapped to 2500S I/O module registers do not conflict with memory used for RLL/SFC operations.

## 2500S I/O module Orientation

All 2500S I/O modules share a common core architecture with:

- Built-in high-speed Ethernet
- A 32MB or 64MB internal Flash “Disk”
- Optional RS-232/RS-485 Serial Port
- Optional internal spread spectrum radio or cellular modem



The main difference between models is the quantity and type of sensor and control inputs and outputs.

	UI (Analog Inputs)	AO (Analog Outputs)	DI (Digital Inputs)	DO (Digital Outputs)
2500S-23-XXXX	2	2	4	4
2500S-26-XXXX	2	-	-----	8 (DIO) -----
2500S-27-XXXX	6	-	-----	2 (DIO) -----

## Easy Configuration and User Access

2500S I/O modules do not require any special software to be loaded onto your PC computer for configuration and user access; simply use a web browser that comes with nearly any PC, laptop, tablet computer or smart phone. This includes Internet Explorer (Microsoft), Firefox(Mozilla), Chrome (Google) and Safari (Apple).

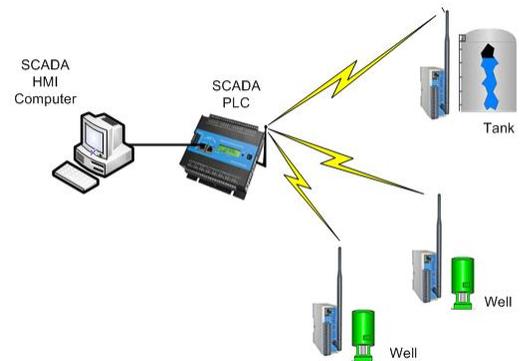
2500S I/O modules have both configuration and user web pages with separate access controls. The configuration web pages are used to set up the operation of the modules. The user web pages are configurable to display select types of information with scaling and tag names to provide a user friendly interface. A special “mobile device” interface for smart phones and tablet computers is included.

A 2500S module configured with an internal cellular modem also supports text messaging as a user interface. Simple text commands allow for “viewing” levels, flows, temperatures and other statuses, along with remote control, all secured with user names and passwords.

### Versatile Communications

2500S I/O modules come with a high-speed Ethernet communications port. They can also have an optional RS-232/RS-485 serial port (for external radios, modems and HMI panels) as well as a built-in spread spectrum or cellular radio. All three ports operate independently and can communicate simultaneously, using **Modbus**, **DF1** (serial/radio only) and **SDX** (encrypted **Secure Data eXchange** protocol). 2500S I/O modules support “bridging” between communications ports, allowing devices on various ports to be accessed from the other ports (for example, a serial or wireless device can be accessed via the Ethernet port) eliminating the need for and cost of external translators and bridges, extra radios, etc.

2500S I/O modules can operate both as slaves that only communicate when talked to by another (Master) device, and as Masters that initiate message transactions. As a Master, a 2500S I/O module can be configured to send I/O information periodically, and/or when there is a change in state or level. Multiple 2500S modules can send to a single 2500S I/O module that acts as an I/O concentrator.

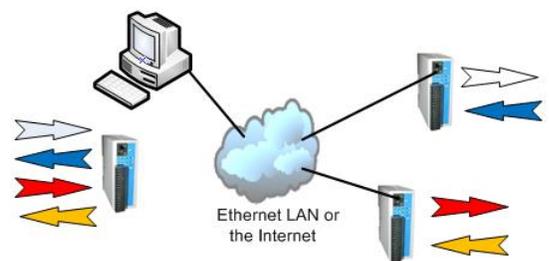


Municipal Water SCADA System with Remote 2500S modules

A 2500S I/O module normally uses the SDX protocol to talk to other 2500S I/O modules for security and efficiency, but it can also use Modbus (I/O module and TCP/IP) to talk to other third party devices.

Any 2500S module can serve as a repeater to extend the range of wireless SCADA systems.

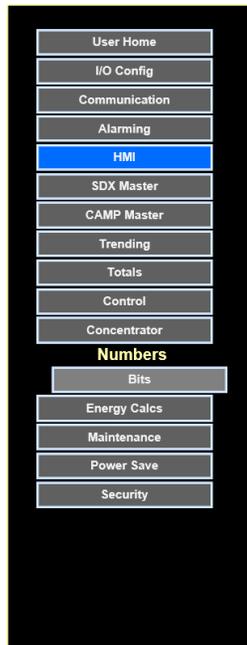
2500S I/O modules can communicate over any high-speed Ethernet network, including the Internet. They include support for Dynamic Name Servers that eliminates static IP addresses, can operate through routers, and include address and name serving capability that eliminate customization of your computers network interface.



Industrial Process and Production Monitoring System

## Communications Concentrator

Besides communicating with other 2500S modules, every 2500S I/O modules can gather data from other intelligent devices using the Modbus protocol over either Ethernet, serial, or wireless links. Each module has a block of 200 general purpose numeric registers and 200 Boolean (bit) registers, and alarms can be triggered and trending data collected off of the received data. So for example, the 2500S modules can communicate with PID loop controllers, variable frequency drives, digital panel displays, etc. without using discrete analog or digital wiring and I/O resources. The 2500S modules can effectively become a web page or cellular interface for these devices!



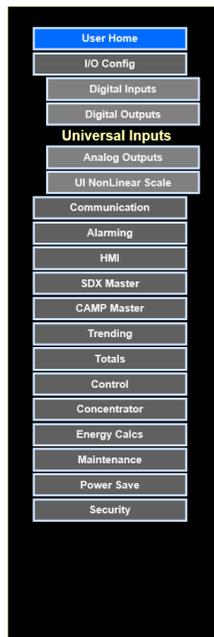
### Numbers - CTI 2500S-23-1050 Slice I/O

	Tag Names	Format	Units	Visible	Write Enable	Retained
1	Variable I01	#####		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2	Variable I02	#####		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3	Variable I03	#####		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4	Variable I04	#####		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5	Variable I05	#####		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6	Variable I06	#####		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7	Variable I07	#####		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8	Variable I08	#####		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9	Variable I09	#####		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10	Variable I10	#####		<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
11	Variable I11	#####		<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
12	Variable I12	#####		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
13	Variable I13	#####		<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
14	Variable I14	#####		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
15	Variable I15	#####		<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
16	Variable I16	#####		<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
17	Variable I17	#####		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

The first 50 registers of each block can have individual tag names and attributes (like non-volatile retention) assigned to them for operator interface purposes. The remainder are primarily used for transparent data collection and forwarding to other equipment.

## Signal Conditioning

2500S I/O modules have powerful signal conditioning capabilities to reduce the real-time requirements on a PLC or other controller, especially useful for remote I/O applications over slower communications links. All modules have Universal Analog Inputs, directly accepting and linearizing sensors such as thermocouples, RTDs, and thermistors as well as accepting mA, mV, and resistance. 2500S modules also support non-linear scaling so that you can customize the linearization curves to match unusual applications such as for volume measurement in odd shaped containers. All digital and analog inputs have configurable filtering to eliminate noise and false triggers in “on-exception” transmission systems. Digital Outputs have configurable flash, pulse and variable duty cycle frequency generation.



### Universal Inputs - CTI 2500S-23-1050 Slice I/O

1      2

Tag Names: AI1      AI2

Visible:      

Force:

Mode: 0-20 mA      0-20 mA

Speed: 0-20 mA NL      4.0mS

Averaging (samples): 0-2 V      16

Scaling    Engineering High: 0-5 V NL      32000

            Engineering Low: +/- 250 mV      0

            Offset: +/- 100 mV      0

Unsigned: 0 - 250 mV     

Format: TC type J      #####

Units: TC type K     

            TC type T     

            TC type E     

            TC type R     

            TC type S     

            TC type B     

            TC type N     

            RTD10 3W     

            RTD10 2W     

            RTD100-385 3W     

            RTD100-385 2W      1

            RTD100-392 3W     

            RTD100-392 2W      #####

            RTD1K-385 3W     

            RTD1K-385 2W     

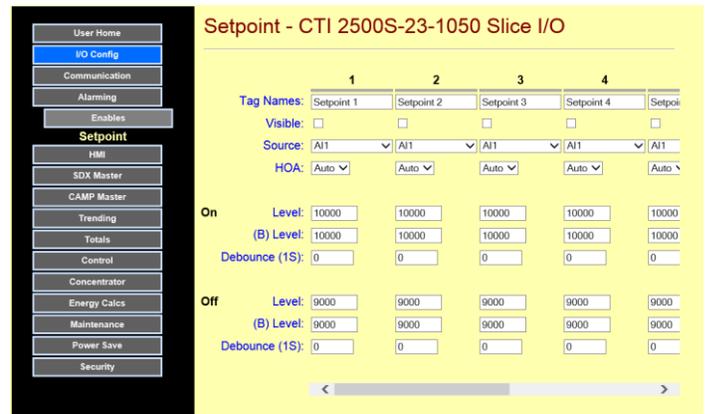
            Thermistor 10K-II     

Totalizer

## Alarming

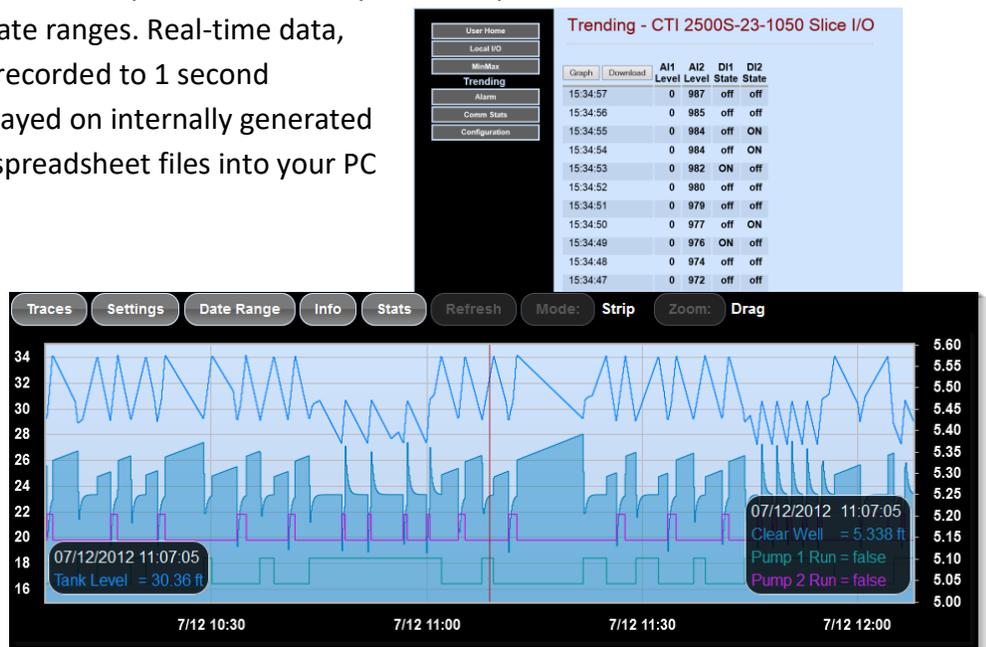
2500S I/O modules with optional internal cellular modems are quickly and easily set up to provide text message alarm notifications. Text message alarming requires no programming, just simple fill-in-the-blanks configuration on a web page. Alarms can be sent to 16 different people, destinations or groups, with up to 16 “on call” schedules. An address book is provided so that schedules can be entered or changed without repeated entry of contact phones numbers.

Schedules include active hours and days for the week. Users can set the active schedule from a web page or by text message. Outstanding alarms can be annunciated, displayed and cleared via text message response, or local pushbutton switch. Elevation is supported so that if an alarm is not responded to, another group can be notified.



## Historical Trending and Logging

2500S I/O modules can record data over a period of several years, and provide built-in web tools to access information for specific date ranges. Real-time data, such as levels and flows, can be recorded to 1 second resolution. The data can be displayed on internally generated trend charts, or downloaded as spreadsheet files into your PC or laptop.



## Historical Totalization

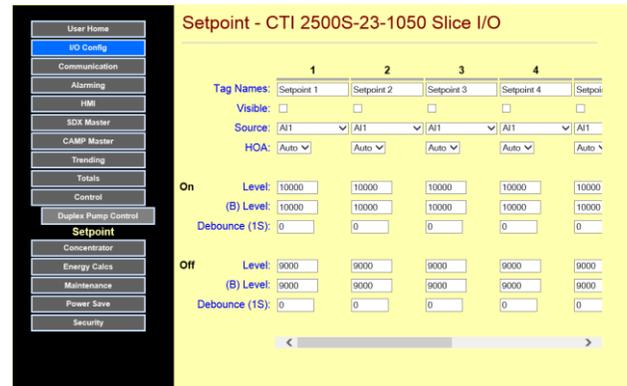
2500S I/O modules can record totalized data over a period of several years, and provide built-in web tools to access information for specific date ranges. The hourly data for yesterday and today, and monthly data for that past two years are presented in tabular form in side-by-side columns for easy comparison. Need more detail? You can selectively graph or download hourly data between any two date ranges that you specify.

## Control

2500S I/O modules have pre-made control functions for setpoint control, duplex pump control and PID control.

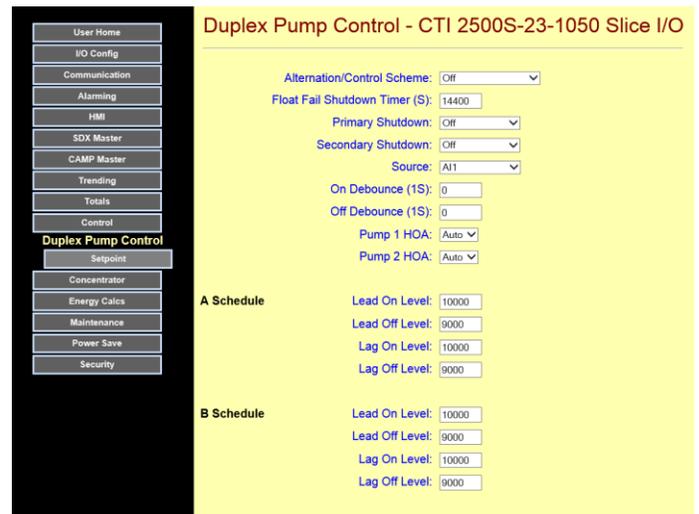
### Setpoint Control

Every 2500S I/O module has eight Setpoint Control Blocks. These blocks have two individual pairs of on and off level setpoints that are compared to a selectable analog value in the I/O module. The setpoint control blocks can also be used to generate level alarms. An active time-of-day range can be assigned to each pair to support time optimized control (for example, time-of-use energy management) and selective alarming based on time of day.



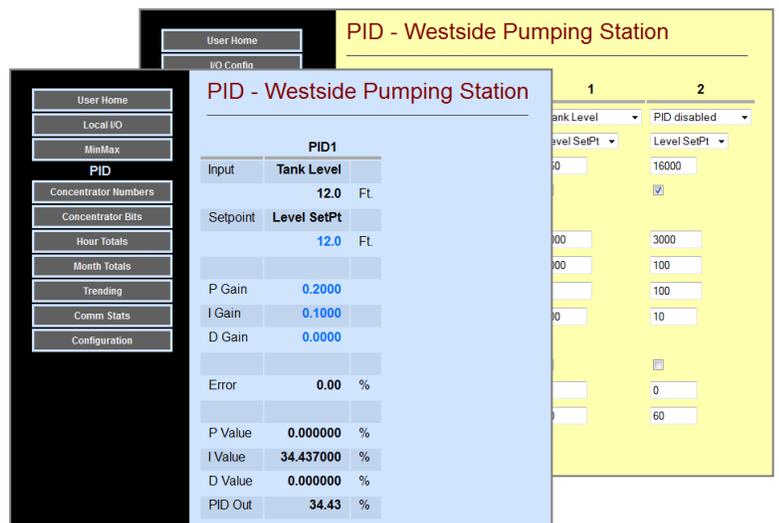
### Duplex Pump Control

Every 2500S I/O module has a duplex pump controller that can operate off of an analog level such as a pressure sensor in a tank, or float switches. The controller can manage alternation between the pumps by flip-flop, by number of starts for each pump, or by pump runtime, in order to distribute wear on the pumps equally. A pair of auxiliary inputs can be units for momentary shutdown, such as low well level drawdown. There are two pairs of setpoints for lead and lag in order to support time-of-use energy optimization.



### PID Control

Every 2500S I/O module has two independent PID (Proportional, Integral & Derivative) control blocks. PID control provides for smooth closed loop operation of pumps, motors, valves and heaters. Many people use PID control to reduce energy consumption in their operation. The PID output can be an analog level or a PWM (Pulse Width Modulated) time on a Digital Output.



## Special Calculations

2500S I/O modules have pre-made calculation functions for calculation of flow without flow meters, and for calculation of energy consumption. Both can be used for instantaneous display and alarming, as well as long-term logging, graphical display and recover as standard spreadsheet files.

### EnergyWatch

EnergyWatch lets 2500S I/O modules compute energy consumption or production, typically in larger industrial environments. By monitoring flow and temperature difference through a heating or cooling loop and, the EnergyWatch feature does the appropriate energy calculations, for energy display, logging and alarming.

### SmartFlow

SmartFlow is a special feature of 2500S I/O modules that can eliminate the need to purchase a flow meter for wells, tanks, and lift stations. By monitoring level change and pump runtime, 2500S I/O modules can compute the minute-by-minute and hour-by-hour outflow from wells and tanks and inflow to lift stations and reservoirs. The calculated flow can be logged as a historical total (above) and also used for alarming. For example, by having the 2500S I/O module check a municipal water storage tank outflow every 2AM, major system leaks can be detected by sensing when that the tank flow exceeds an acceptable threshold.

## Human Machine Interfaces (HMIs)

### User Web Interface

2500S I/O modules include automatically configured web pages to display current operating levels or states, and optionally make changes to setpoints, etc.

### Mobile Web Interface

Besides the standard built-in user and configuration web pages, 2500S I/O modules have a mobile device interface that is easier to use on smart phones and tablets such as iPhones®, Ipads® and Android® devices. Displayed information (black - read only) and changeable items (blue – read/write) are presented on a set of large buttons that are easy to see and press on small screens. The number of buttons per page (up to 4 on the first page and 7 on four others) and the variables on each button are configurable. Other buttons on the first page are used to navigate (links) to additional pages information pages, providing access to approximately 32 variables of any type (bits, integers and floating point numbers). An alarm page is also provided, to indicate current alarms states and to clear alarms.

Tank Level	7.8 Ft.
Lead A On	4.5 Ft.
Lead A Off	10.0 Ft.
Lag A On	4.5 Ft.
Lag A Off	12.0 Ft.
Pump 1 Out	ON
Pump 2 Out	ON
Back	

Most importantly, 2500S I/O modules are designed for extreme reliability, featuring an extended temperature rating for outdoor use without fans and filters.

## Text Messaging and Cellular Support

### Data Transfer

2500S I/O modules configured with an internal cellular modem can utilize low-cost text messaging for data communications between modules and CTI SCADA controllers, along with alarming and user access by cell phones. When text messaging is used to pass data between 2500S I/O modules, the data is encrypted using the same encryption technology used for secure banking financial transactions and by the National Security Agency. All transactions are acknowledged, ensuring that you data is transferred securely and correctly.

### Alarming

Alarms can be sent to selectable list of contacts based upon a schedules entered on a simple web-page form. Two-tiers of alarming lists are available, in order to reach backup and supervisor personnel if an initial set of contacts cannot be reached. When an alarm is texted to the current list of contacts, a simple “ACK” return text message will acknowledge the alarm(s). The 2500S I/O module then texts all personnel on the currently selected contact list, announcing that the alarm has been acknowledged and by whom.

### Remote HMI

Text messages, secured by usernames and passwords, can be used to access process variables and setpoints with only a cell phone – no computer needed! For example, a technician may receive an alarm text message in his truck while servicing another site. After acknowledging the alarm, the technician can use additional text messages to check operating parameters and optionally make changes to setpoints before he makes it to the site. A simple cell phone becomes a low-cost handheld remote HMI.

## Low Power and Solar Operation

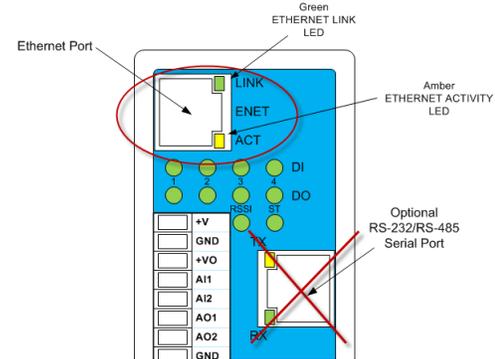
2500S I/O modules may be configured to significantly reduce power consumption for solar and battery operated systems. In fact, a couple of models have a built-in solar controller/charger so supporting solar power only requires the addition of the actual solar panel and a battery. Smaller solar panels and batteries translate into lower system costs. Ethernet interfaces can automatically power off when not used, analog loop power can turn off automatically between analog measurements, CPU speed can be reduced, the internal radio can be powered down when no messages are being sent, internal power supplies can automatically shut down when not required, and status indicator LEDs can be shut off when they are not needed.

## Quick Start

Your 2500S module(s) just arrived and you're facing reading a 150+ page manual. No way! Well here's a quick way to get up and running right away and save the reading for a little later.

**STEP 1:** Start with your 2500S module powered OFF. Connect a 10Vdc to 30Vdc power source to the module power terminals, BUT LEAVE IT OFF.

**STEP 2:** Make sure that the Ethernet cable from your laptop or desktop PC is plugged directly into the 2500S module, not through some network. You can use any standard Ethernet patch cable. If your 2500S module has an optional serial port (second RJ-45 connector on the right-hand side), be sure that your Ethernet connector is NOT plugged into there!



**STEP 3:** Make sure that your computer is set to acquire an address (NOT set to a static IP address).

**STEP 4:** Apply DC power (10Vdc to 30Vdc) to the 2500S module. Note: 26/27-xxxx models require +12VDC power on BAT terminal when operating. +24VDC on +V is okay for configuration.

**STEP 5:** WAIT (about 30 seconds to be safe). You should see the 2500S modules lights cycle, and then the Ethernet "Link" light stay lit on the Ethernet Connector of the 2500S module.

**STEP 6:** Start a browser on your PC. We use either Internet Explorer (supplied with Windows), Firefox, Chrome and Safari. We also test with the Android browser, but that's probably not on your PC!

You will have to wait for the browser to timeout trying to access your default initial web page on the Internet.

**STEP 7:** Enter "CTI.COM" as the search address and try to go there. Refresh if it doesn't work the first time.

Alternatively, if you are accessing the module as shipped from the factory, you can set a static IP in your PC of 192.168.1.xxx where xxx is a value other than 199 and less than 256. In the browser enter the default factory set address of the module; 192.168.1.199

The screenshot shows the web interface for the CTI 2500S-23-1050 Slice I/O. On the left is a navigation menu with options: User Home, Local I/O, MinMax, Trending, Alarm, Comm Stats, and Configuration. The main content area displays the following data:

CTI 2500S-23-1050 Slice I/O	
Input Voltage	23.9
Temperature	80.2
Local Time	13/42/2013 15:41:38
Forcing	---
Comm Faults	[CAMP]
Response Code	500 - Destination IP can not be reached
SDX Master Success %	---
CAMP Master Success %	0
Trending Log Usage (Days)	13.5 of 52.5 (25%)

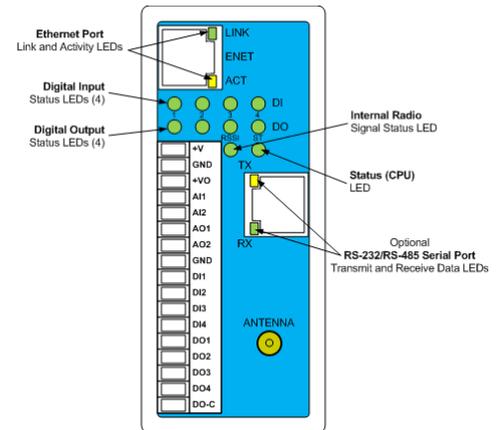
**STEP 8:** You should see the 2500S module home page similar to the one to the right!

**STEP 9:** Most people assign a static IP under **Configuration | Communication | Ethernet** to set the appropriate IP settings for your network. Reset the module (cycle power), and you should be ready to put it onto your network and work with it from there. Feel free to browse around!

# Operation

## Status Indicator LEDs

2500S Input/Output (I/O) modules have LED Status indicators to show the state of the digital inputs and outputs, the states of the Ethernet and optional serial port and internal radio, and the module (CPU). The locations of these indicators are shown in the diagram:



### Ethernet Status LEDs

The Ethernet Port has two LED indicators labeled “LINK” and “ACT”. The Link LED is lit when the 2500S module is connected to an Ethernet device. The ACT (Activity) LED flashes whenever a message is received or transmitted through the Ethernet port.

### Digital Input and Output LEDs

There are individual indicator LEDs for the Digital Inputs and Digital Outputs that will illuminate to indicate when an input or output is ON. These indicators can be disabled as part of the power-saver features of the 2500S I/O module.

### Status LEDs

The Status (ST) LED indicates the current operating state (ST)s for the four Digital Inputs and four Digital Outputs. These indicators will illuminate to indicate when an input or output is ON. These indicators can be disabled as part of the power-saver features of the 2500S I/O module.

#### LED Statuses While BOOTING:

LED	Indication	Status
Status	ON	Good Firmware
Status	1 Blink	Bad Ethernet Chip
Status	2 Blinks	Bad Flash Drive
Status	3 Blinks	No Firmware Loaded
Status	4 Blinks	Firmware file corrupt
RSSI	ON	Bootloader Running
DO's/DI's	Strobing	Waiting for TFTP or IO Config
DO's	Fast strobing	Writing firmware to CPU from File

#### LED Statuses While RUNNING:

LED	Indication	Status
Status	ON	Normal
Status	1 Blink every 2s	Normal w/ LED Disable Checked
Status	Slow blink	Something is being forced
Status	Fast blink	Comm Fail
DO's/DI's	ON/OFF	Actual DI/DO states
RSSI	ON	Radio has good Signal strength

## Inputs and Outputs

There are three models of 2500S I/O modules. Each have identical capabilities, but differ in the type and quantity of inputs and outputs. This section summarizes the functionality of the I/O used in 2500S modules.

## Digital Inputs

The 2500S Digital Inputs support signals from DC sensors with output levels from ground to about 3Vdc up to 30Vdc, or simple contact closures. A ground or low is a “1” or ON. The Digital Inputs have software configurable inversion, forcing, filtering, runtime accumulation, rate measurement and high-speed totalization. Rate and totalizer values are scalable to engineering units. Changes on individual digital inputs can be configured to “wake up” the 2500S module and send off a message.

### Forcing

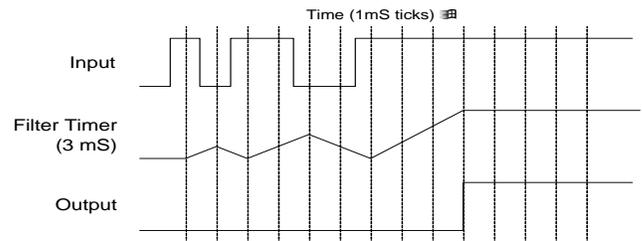
The 2500S Digital Inputs can be “forced” ON or OFF to support system troubleshooting and to temporarily bypass defective sensors. Forcing causes the 2500S module to ignore the “real” input state. Forcing is non-volatile and can be set individually for each input channel via the configuration web interface or via communications registers. When forced, the CPU Status light will blink slowly.

### Invert

The 2500S Digital Inputs accept contacts closures and low-voltage DC input signals. A closed contact to ground or a low input level is registered as an “ON”. An open contact or voltage above a couple of volts is registered as an “OFF”. Digital Inputs can be configured individually to invert this operation via the configuration web interface or via communications registers.

### Filtering/Delay

The 2500S Digital Inputs can be individually configured to filter incoming noise and contact bounce or delay an input signal, in 1mS increments, from 0 to 65 seconds. To register an “ON”, the input must be ON more than it is OFF by the set filter time. The filter/delay time can be set via the configuration web interface or via communications registers.



### DI Stretch

2500S I/O modules support “stretching” the ON time of Digital Inputs so that there is less chance of an input being “missed” over a slow communications network. For example, the press of a pushbutton being read over a slower polled leased line network could easily be missed unless the operator holds the button in for a period of time that exceeds the time between polls. If a PLC reads the stretched DI bit for that input, the operator doesn’t need to hold the button in; the 2500S module does it for him. Stretching only affects the state of a special set of bits that can be read by communications. No other functions including the “normal” digital input bits are affected. The stretching time is configurable in 100mS increments.

### Runtime

2500S I/O modules keeps track of the ON time (runtime) of each Digital Input in 32-bit non-volatile registers that can be accessed by communications or viewed via the web HMI. Internally, runtime is recorded and kept in seconds, but can be displayed as seconds, minutes (to tenths of a minute) or hours (to tenths of an hour) on HMI web pages and displays. The display units are individually configurable for the accumulated runtime on each input channel as ##### Seconds, #####.# Minutes or #####.# Hours.

## Totalization

2500S I/O modules totalize OFF to ON transitions of their Digital Inputs into 32-bit non-volatile registers that can be accessed by communications or viewed via a web or panel HMI. Each totalizer also has a scaled display register that can also be accessed by communications or viewed on HMI web pages and displays. Scaling is configurable with an integer divisor and a decimal point format as follows:

Scaled value = 32-bit Totalizer/Divisor

## Rate

2500S I/O modules continuously measure the transition rate of each Digital Input. The measurement technique can be selected for each input channel to optimize the update speed and measurement resolution. The calculated rate, as well as the “raw” counts and intervals can be accessed by communications. The calculated rate can be displayed on HMI web pages and displays, scaled to engineering units.

For higher pulse rates (greater than 100 pulses /second), the pulses are totalized over a configurable time period (“gate time”). In this mode, the reading is updated at the same rate as the gate time.

When a new sample is recorded at the end of the gate time, the 2500S I/O module will also scale the latest reading so that it can be easily displayed on HMI web pages and displays. Scaling is configurable with an integer offset, numerator and divisor, and a decimal point format as follows:

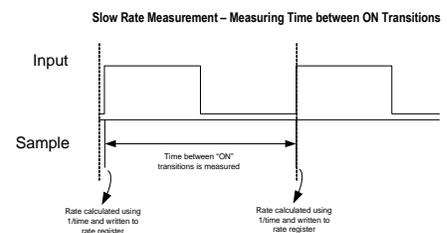
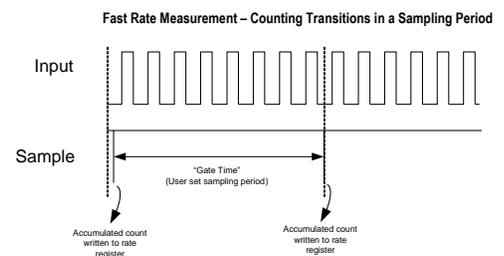
Scaled value = (Rate Count + Offset) x Scale Numerator/Scale Divisor

The offset is normally left as “0” unless you are using certain turbine style flow meters. Follow the manufactures recommendations.

For input channels that will monitor slower pulse rate signals, the 2500S I/O module can be configured to use a “Slow Rate Mode”. For example, a municipal water meter may give us a pulse for every 100 gallons of flow. For a small system, we may only get 6 or 7 pulses every minute, representing 600 to 700 gallons of flow. To get any kind of useful reading resolution using the sampling period technique, we would have to set the sampling period to a very long time, like an hour or a half hour. That means that the flow rate reading would update very slowly also. To solve this problem, the 2500S I/O module has a “Slow Rate Mode”. In this mode, the module measures the time interval (in milliseconds) between OFF to ON transitions, and then calculates the rate using the relationship of:

**Rate = 1/Time(mS)**

Using this technique, the reading is updated on each OFF to ON transition of the input signal. So using the example above, if the module received a pulse 6 times per minute, then the readings would be updated on every transition, or once every 10 seconds. In addition, the resolution of the readings will be much



higher with this technique, so that if the “real” rate is 6.5 pulses per minute, the calculated rate will not jump between 600 and 700 GPM, but read “in between” or 650 GPM.

When a new sample is recorded on each positive transition, the 2500S I/O module will also scale the latest reading so that it can be easily displayed on HMI web pages and displays. Scaling is configurable with an integer numerator and divisor, and a decimal point format as follows:

Scaled value = ((Slow Numerator/Time(mS))+ Offset) \* Scale Numerator/Scale Divisor

Note that this scaling technique applies only to “Slow Rate Mode” measurements. If the normal Fast Rate Mode is selected, the scaling is slightly different as described above.

## Digital Outputs

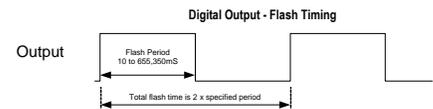
### Forcing

The 2500S Digital Outputs can be “forced” ON or OFF to support system troubleshooting and to temporarily operate control devices. Forcing causes the 2500S module to leave an output in a certain state and ignore commands to change the output state. Forcing is non-volatile and the forcing of each output can be set individually via the configuration web interface or via communications registers.

### Flashing

The 2500S Digital Outputs can be “flashed” at a configurable rate specified in milliseconds. Flashing is **synchronized** between all outputs channels. This function is generally used to operate visual or audible alarm annunciators.

The flashing period is settable in 10mS increments from 10mS to 655,350mS (655 seconds). The flash time is the ON or OFF time (half the total cycle time), so that the total flash period (ON + OFF time) is twice the time specified (50% duty cycle).

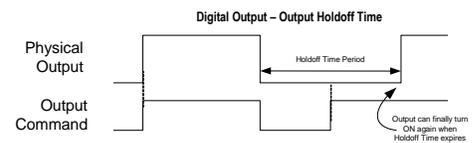


### Output Timing Functions

The 2500S Digital Outputs can be delayed, pulsed or used to generate a frequency with configurable ON and OFF times. Time periods are individually settable for each output channel, from 0 to 65535 milliseconds (655 seconds) in 10 millisecond increments. All output timing functions for a given channel are disabled if both the ON and OFF times are set to zero.

### Output Holdoff (Rapid Cycling Protection)

The 2500S Digital Outputs can be protected against rapid cycling of the individual outputs that could damage certain devices such as high horsepower motors and pumps. There is no delay time if the outputs have been OFF for the specified amount of holdoff time. This feature can also enforce a well “recharge” time. If an outputs holdoff value is set to a non-zero value, the output turn on will be held OFF for the specified amount of time from when it was turned OFF even if it is commanded to turn ON again. This feature will also prevent an output from prematurely turning ON after recovery from a power failure (Holdoff Timers restart on power ON). The Output Holdoff time may be set from 0 to 65535 seconds in 1 second increments.



### Communications Failure Output States

The 2500S Digital Outputs can be individually set to predetermined states when a communications failure occurs, providing a degree of failsafe protection. Each individual Digital Output can be set to hold its last state, turn OFF, or turn ON. Communications failure detection can be enabled individually on each port. When communications is restored, the outputs will remain unchanged until written to by the Host system (they are not automatically restored to their pre-failure condition).

A typical application might turn a set of well pump outputs OFF when communications from a tank (tank level used to control the pumps) fails, in order to avoid overfilling the tank.

## Analog Inputs and Universal Analog Inputs

### Modes

Most 2500S I/O modules have Universal Analog Inputs. These are inputs that can be set to directly accept temperature, resistive and mV sensors without external conditioners or transmitters. All temperature readings are temperature compensated and linearized. The available Universal Analog Input Modes are:

Current:	0 to 1mA, 4 to 20mA, and 0 to 20mA (with both linear/non-linear scaling)
Voltage:	0 to 2V, 0 to 5V (with both linear/non-linear scaling)
Resistance:	0 to 30K ohms (with both linear/non-linear scaling), 0 to 300K ohms
Thermocouples:	J, K, T, E, R, S, B, N
RTDs (2 and 3-wire)	10, 100, 1000 ohm (385 and 392 curves for 100 and 100 ohm RTDs)
Thermistors:	10K ohms, Type II and Type III

Non-universal analog inputs generally offer the current modes.,

### Forcing

The level of individual Analog Inputs in 2500S I/O modules can be “forced” to support system troubleshooting and to temporarily bypass defective sensors. Forcing causes the 2500S module to ignore the “real” input reading. Forcing is non-volatile and can be set individually for each Analog Input channel via the configuration web interface or via communications registers.

### Linear Scaling

To provide meaningful information on HMI web pages and displays, the analog input values in the Voltage, Millivolt, Current, and Resistance modes may be scaled to engineering units (temperature sensor modes are automatically scaled to a temperature reading). Both the unscaled and scaled values can be accessed by communications and on the User Status web page. Analog inputs are scaled by entry of engineering High and Low values that will correspond to the High and Low “raw” values for the selected mode. (see table below)

<b>Mode</b>	<b>Raw Low</b>	<b>Raw High</b>	<b>Signed</b>	<b>Resolution (1 LSB)</b>
0 to 20mA	0	20000	no	1 uAmp
4 to 20mA	4000	20000	no	1 uAmp Low is “clamped” to 4 mA
0 to 1mA	0	1000	no	1 uAmp
0 to 2V	0	20000	no	0.1 mV
0 to 5V	0	50000	no	0.1 mV
0 to 250mV	0	25000	no	0.01 mV
0 to +/-100mV	-10000	+10000	yes	0.01 mV
0 to +/-250mV	-25000	+25000	yes	0.01 mV
0 to 30K ohms	0	30000	no	10 ohms
0 to 300K ohms	0	300000	no	100 ohms

## Non-linear Scaling

Some of the Universal Input modes support non-linear scaling. The 2500S modules support entry of conversion tables with “breakpoints” that the modules use to linearize the display of the levels and volumes of odd-shaped tanks, canals, weirs, etc. readings between the setpoints are interpolated. The non-linear mode labels have an “NL” at the end of their names.

Mode	Raw Low	Raw High	Signed	Resolution (1 LSB)
0 to 20mA NL	0	20000	no	1 uAmp
0 to 5V NL	0	50000	no	0.1 mV
0 to 30K ohms NL	0	30000	no	1 ohm

- User Home
- I/O Config
- Digital Inputs
- Digital Outputs
- Universal Inputs
- Analog Outputs
- UI NonLinear Scale**
- Communication
- Alarming
- HMI
- SDX Master
- CAMP Master
- Trending
- Totals
- Control
- Concentrator
- Energy Calcs
- Maintenance
- Power Save
- Security

### UI NonLinear Scale - CTI 2500S-23-1050 Slice I/O

	UI 1	UI 2
00mA / 0.00V / 0 Ohms	<input type="text" value="0"/>	<input type="text" value="0"/>
01mA / 0.25V / 1.5K	<input type="text" value="0"/>	<input type="text" value="0"/>
02mA / 0.50V / 3.0K	<input type="text" value="0"/>	<input type="text" value="0"/>
03mA / 0.75V / 4.5K	<input type="text" value="0"/>	<input type="text" value="0"/>
04mA / 1.00V / 6.0K	<input type="text" value="0"/>	<input type="text" value="0"/>
05mA / 1.25V / 7.5K	<input type="text" value="0"/>	<input type="text" value="0"/>
06mA / 1.50V / 9.0K	<input type="text" value="0"/>	<input type="text" value="0"/>
07mA / 1.75V / 10.5K	<input type="text" value="0"/>	<input type="text" value="0"/>
08mA / 2.00V / 12.0K	<input type="text" value="0"/>	<input type="text" value="0"/>
09mA / 2.25V / 13.5K	<input type="text" value="0"/>	<input type="text" value="0"/>
10mA / 2.50V / 15.0K	<input type="text" value="0"/>	<input type="text" value="0"/>
11mA / 2.75V / 16.5K	<input type="text" value="0"/>	<input type="text" value="0"/>
12mA / 3.00V / 18.0K	<input type="text" value="0"/>	<input type="text" value="0"/>
13mA / 3.25V / 19.5K	<input type="text" value="0"/>	<input type="text" value="0"/>
14mA / 3.50V / 21.0K	<input type="text" value="0"/>	<input type="text" value="0"/>
15mA / 3.75V / 22.5K	<input type="text" value="0"/>	<input type="text" value="0"/>
16mA / 4.00V / 24.0K	<input type="text" value="0"/>	<input type="text" value="0"/>
17mA / 4.25V / 25.5K	<input type="text" value="0"/>	<input type="text" value="0"/>

### Totalization

2500S I/O modules totalize non temperature analog readings into 32-bit non-volatile registers that can be accessed by communications or viewed via HMIs. The scaled analog input values are added into their respective totalization registers every AI Gate Time Period (a configurable value in 1 second increments).

### Analog Outputs

#### Forcing

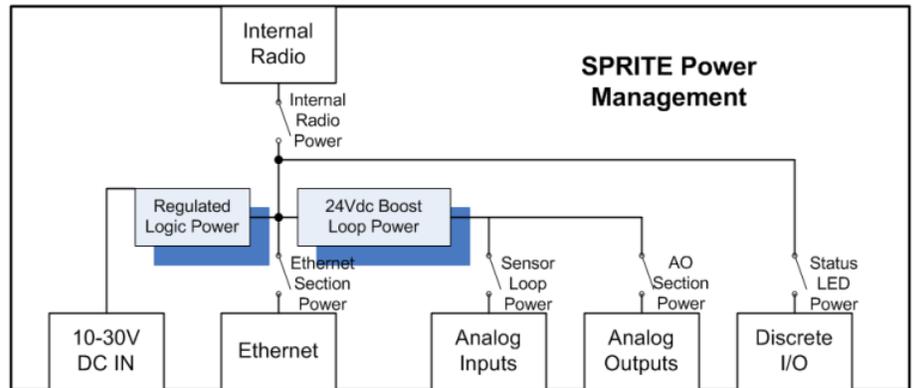
The level of individual Analog Outputs in 2500S I/O modules can be “forced to support system troubleshooting and to temporarily operate analog control devices. Forcing causes the 2500S module to ignore the “real” output value sent via communications. Forcing is non-volatile and can be set individually for each Analog Output channel via the configuration web interface or via communications registers.

#### Communications Failure Output Levels

The 2500S Analog Outputs can be individually set to predetermined levels when a communications failure occurs, providing a degree of failsafe protection. Each individual Analog Output can be set to hold its last level, to be set to a preset level.

### Power Management

2500S I/O modules provide a number of special features to control and reduce power consumption. Refer to this figure for an overview of the power management features:



#### AO Power Disable

If selected, the 24v power to the Analog Output Section is disabled. This can save considerable amounts of power if the Analog Outputs are not being used.

#### Switched Sensor Power Control

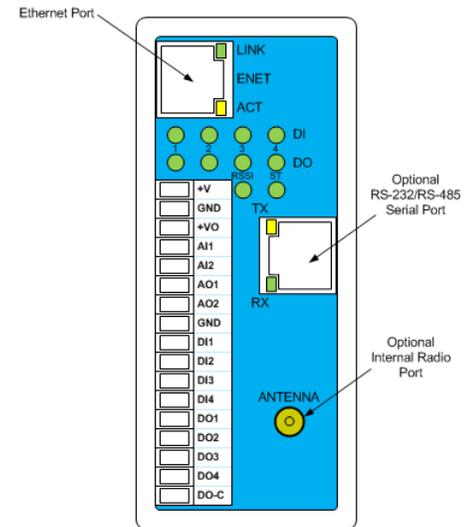
If selected, the 24v power to the Analog Input sensors (+VO) will be switched ON only when the 2500S I/O module is taking a reading. This combined with the Analog Input Sleep time can minimize the total 20mA 24v loop power demand.

Analog Input Sleep Time	This feature puts the Analog input section “to sleep” for periods of time. When combined with using switched sensor power (above) can reduce the heavy power draw of the 20mA loop powered analog input sensors. Increasing the sleep time results in the Analog Input sensors being powered on less frequently, reducing the total overall power consumption.
Ethernet Sleep	If selected, the Ethernet section is automatically powered down if there is no active Ethernet connection to the 2500S I/O module within the first few seconds of being powered ON.
Internal Radio Wakeup	If a radio wakeup time is specified (for the internal radio option), the radio will be powered down until it is actually needed to send a message. Used with “send on change” or slow polling Master Mode operation can significantly reduce power consumption.
LED Disable	If selected, the Digital Input and Output Status LEDs are disabled to eliminate their power consumption.

## Communications Operation

2500S I/O module modules come with a high-speed Ethernet port, with an optional RS-232/RS-485 serial port, as well as an optional internal spread spectrum radio. All three communications ports operate independently.

Unless specifically disabled, all communications ports operate as “slaves” (servers)—listening and responding to requests from external “Masters” (clients). In addition, any single port can be designated as a “Master” that can initiate messages based on a timed interval and/or a change of state on a digital input or a level change on an analog input. The I/O modules can also operate as communications concentrators, supporting Modbus Master protocol to gather data from Modbus serial and Ethernet devices simultaneous with the Master and Slave functions described above.

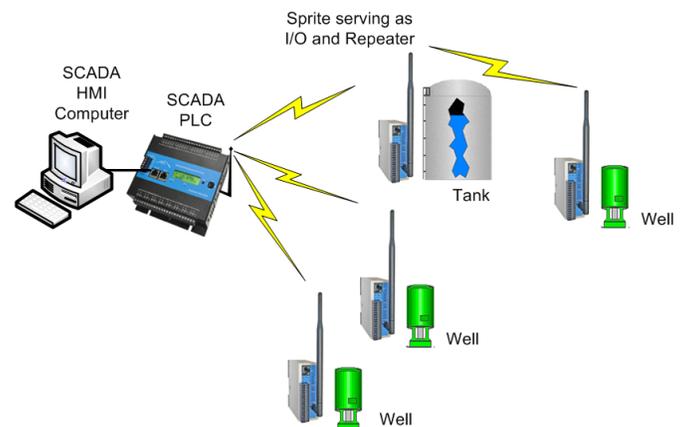


The Ethernet port supports HTTP protocol for serving configuration and user web pages and Modbus and SDX (Secure Data Exchange) for “register” data access. The optional serial and radio ports support Modbus I/O module, DF1, and SDX protocols. SDX is the preferred “over-the-link” protocol for either Ethernet or serial links since it is secure (AES-128 encryption) and can transfer multiple data types in a single packet for maximum efficiency. Modbus and DF1 provide easy connectivity to many third-party PLCs and HMI software and devices. All of these protocols can coexist and operate simultaneously over the same port except for DF1 whose operation is not compatible with simultaneous Modbus operation.

### Distributed I/O

2500S I/O modules can expand the I/O capacity of a PLC system, or serve as remote distributed I/O as part of a SCADA system. Most HMI software packages such as InTouch (Wonderware), FIX (GE/Intellution), VTScada (Trihedral) and most major PLCs can communicate with 2500S I/O modules via Modbus or DF1 communications.

Besides providing basic sensor input and control output functions in a SCADA system, 2500S I/O modules provide filtering and averaging of both analog and digital signals, measure and totalize flow from both analog and digital sensors, and keep track of runtime, offloading these tasks from the central host. This is especially useful when the SCADA system has slower SCADA communications links such as leased-line modems and licensed radios.



### Peer-to-Peer I/O

Two or more 2500S I/O modules can be configured to communicate “back-to-back”, passing Analog and Digital Input and Output signals between locations. This is known as peer-to-peer or “mirrored” I/O.

Peer-to-Peer I/O can operate through any port; Ethernet, serial or internal radio, but only one at a time. All ports are still active as slaves (servers) while any single port is being used for peer-to-peer I/O. This

allows HMI terminals and software, PLCs, etc. to communicate with the 2500S modules while they are actively exchanging I/O information. The built-in user and configuration web pages can be used simultaneously with peer-to-peer I/O operation.

In the simplest form of a peer-to-peer I/O system, there is one “Master” and one “Slave” module. The Master can be configured to repeatedly initiate messages to transfer inputs to outputs in both directions.

Alternately, both sides can be Masters that initiate data exchanges, usually when a change occurs at an input.

Although the most basic configuration is two 2500S modules “talking” back-to-back, systems with more than two modules can be used to share I/O among more locations.

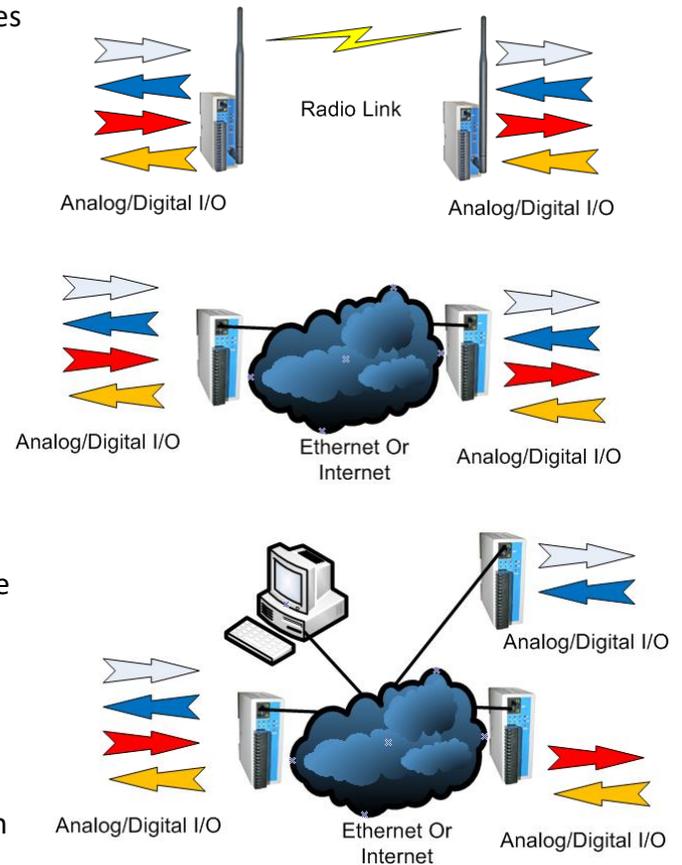
A PC and/or HMI panel can be included anywhere in the system to provide a window on the systems operation to operators. Although not required to make these systems work, other than for possible configuration changes, the User information displays are easy and fast to set up.

When more than two 2500S I/O modules are used, typically portions of the I/O points available in each remote module is brought back to a single central module. For example, in the case above, the I/O going in and out of the left-hand 2500S I/O module is divided between two 2500S modules on the right-hand side. In larger configurations, the central module might be a 2500S I/O module which has several times more I/O than the 2500S modules, and is compatible with them.

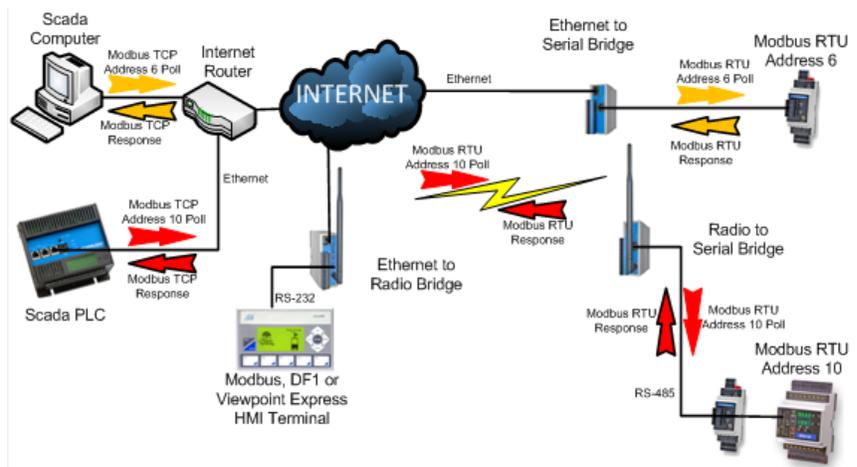
In addition to combining I/O from multiple locations, 2500S I/O modules have built-in Store-and-Forward capabilities, so that any 2500S module can act as a repeater in a wireless system.

### Bridging

2500S modules, with either or both an optional serial and wireless interface as well as the standard Ethernet port have the ability to pass data from the Ethernet port to either optional interfaces and back again. They also have a serial to radio bridging mechanism that essentially ties the radio network to the serial network and treats them as if all of the units can talk to each other. This operation is known as bridging. The following example shows Ethernet to Serial bridging, Radio to Serial and Ethernet to Radio bridging using Modbus TCP to I/O module and back again protocol translation.



There are two examples in the diagram of the Bridging functionality. In the first example, the SCADA Computer polls for unit address 6 over Modbus TCP to the Ethernet to Serial Bridge Over Modbus TCP, the SCADA Computer must know the IP address of the Ethernet Bridge and be able to modify the Modbus address (unit ID) within



the Modbus TCP message to 6 in this case. This poll message is represented by the yellow arrow. When the Ethernet to Serial Bridge 2500S receives this message, it looks at the unit ID (Modbus Address) and sees that it is not for it. It then converts the Modbus TCP message to Modbus I/O module and puts it out on the serial network. In this case to an ICL PicoBrick addressed as 6. The PicoBrick receives the message and acknowledges it with a response. The Ethernet to Serial Bridge 2500S hears that message and converts it back to the appropriate Modbus TCP response and sends the response back to the SCADA Computer. This message is represented by the yellow arrow.

In the second example, a SCADA PLC is talking with Address 10. It polls using a Modbus TCP message to the Ethernet to Radio Bridge in the middle. The Ethernet to Radio Bridge sees that the message is not addressed to it by the Unit ID of the Modbus message and forwards it on to the radio link. The Radio to Serial Bridge unit sees that the message is not for it either and forwards the message out to the serial RS-485 port where Modbus Address 10 and can receive it (in this case ICL MicroBrick). This message is represented by the red arrow. Address 10 then responds to the poll message and the reverse route is taken through the Radio to Serial Bridge and up to the Ethernet to Radio Bridge back to the SCADA PLC. This message is represented by the red arrow.

## Installation

This section describes the mechanical and electrical installation of 2500S I/O module. The examples show a 2500S-23-XXXX module with the optional RS-232/RS-485 serial port and an optional internal radio, but the installation applies to all 2500S I/O modules. Only the mixture of I/O types and options vary between modules as you will see in the electrical installation description.

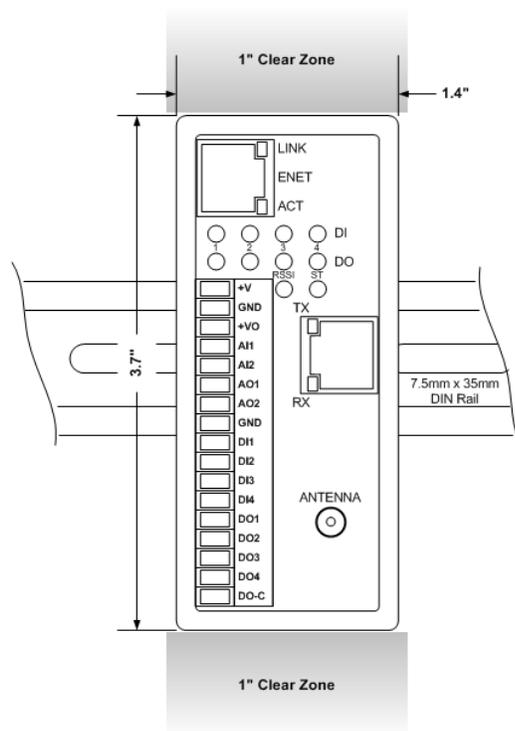
### Mechanical Installation

2500S I/O modules are designed to be installed in NEMA rated electrical enclosures. The cases of the 2500S modules have a built-in clip to snap onto a standard 7.5mm by 35mm DIN rail. The 2500S module has a “footprint of 1.4” x 3.7”. The front edge of the terminal block sits approximately 4” off of the base plate when the module is snapped onto a DIN rail.

The 2500S I/O modules have ventilation slots on the top and bottom of its case. To ensure proper free air circulation and maintain the full temperature rating, the space 1 inch immediately above and below the enclosure must be left clear of any other devices.

### Electrical Installation

All field wiring connections to and from the 2500S modules, except for RS-232 and Ethernet communications are made via removable terminal blocks. Please ensure that the following requirements are made during installation, especially in hazardous environments.



### Use of Equipment in Hazardous Locations

*This equipment is suitable for use in Class I, Division 2, Groups A, B, C, and D or non-hazardous locations only.*

- |                                     |   |
|-------------------------------------|---|
| <b>WARNING – EXPLOSION HAZARD –</b> | Do not disconnect equipment unless power has been removed or the area is known to be non-hazardous.   |
| <b>WARNING – EXPLOSION HAZARD –</b> | Substitution of any components may impair suitability for Class I, Division 2.                        |
| <b>WARNING – EXPLOSION HAZARD –</b> | The area must be known to be non-hazardous before servicing/replacing the unit and before installing. |

### Special Notice Regarding Sealed Relay Devices

The following information is provided in regards to the sealed relay devices used in some of these products.

- WARNING** – Exposure to some chemicals may degrade the sealing properties of materials used in the sealed relay devices.
- RECOMMENDATION** – It is recommended to inspect the Sealed Relay Devices periodically and to check for any degradation of the materials and to replace the complete product, not the sealed device, if any degradation is found.

## Wiring Practices

- Terminal block screws must be tightened to 7 lb-in.
- Use stranded conductors from #14 to #26 AWG, or solid conductors from #12 to #26AWG consisting of either copper or copper-clad aluminum (if allowed by local electrical codes)
- Wires must be rated for 240V, 90°C and suitably current rated. CAUTION: Use supply wires suitable for 15°C above surrounding ambient.
- Wire insulation must be a minimum of 0.9mm (0.031”) thick if subjected to movement, flexing or handling during use or maintenance.
- Wires shall be routed away from sharp edges, screw threads, burrs, fins, moving parts, drawers, and the like. Clamps and guides, if used, shall be provided with smooth, well-rounded edges.
- Wiring that is subject to flexing during servicing such as that from a stationary part to a part mounted on a hinged door shall be provided with additional insulation at any point where flexed.
- Additional insulation, if used, shall be insulating tubing, or a wrapping of not less than two layers of insulating tape. All must be minimum of 90°C and 240V, but at least 15°C above surrounding ambient.
- All splices and connections must be mechanically secure and provide electrical continuity. Conductors are also not to be grouped.

## Power Wiring

### DC Power

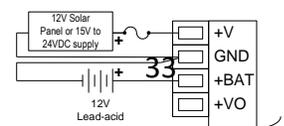
2500S I/O modules require DC power, from 10 to 30Vdc. Input power is applied to the positive (+V) and negative (GND) terminals at the top end of the terminal block. When the input voltage is below the minimum recommended voltage, or reverse polarity power is applied, the 2500S module will turn OFF. Input transients above 36Vdc will open an internal 2A power fuse, unless a lower rated fuse is used externally. An external 1A fast-blow fuse is recommended.

The actual current draw from the DC power supply will vary depending on the 2500S module hardware configuration (extra serial port option, internal radio option, etc.), the software configuration and power saving mode selections, the loop power demand for the analog inputs and outputs, and the number of digital outputs turned ON, especially if they are relay type). Please refer to the specifications in the back of this manual to determine actual power draw for a given configuration.

### Solar Power and Battery Backup Support

Two 2500S modules, the 2500S-26-XXXX and the 2500S-27-XXXX, support battery backup and solar operation. Whether operating from a DC power supply or a solar panel, these modules will charge and monitor a 12Vdc lead-acid battery. When the DC power is lost, or the solar panel fails to provide sufficient DC power, the module will utilize the battery for its power. Battery charge level can be read by communications, and low battery level and/or power loss can be configured to provide alarms.

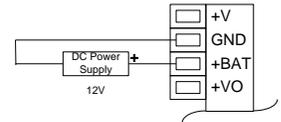
For operation with a battery, either as a DC powered battery-backed system or a solar powered system, connect the solar panel or DC power supply to the +V (power in) terminal and the



positive terminal battery to the +BAT terminal. To properly charge the battery, the DC power supply should be 15V or 24V. The center ground terminal can be shared by both at the terminal itself. Do not splice the grounds together in the field and run a single wire back to the terminal. The battery is typically a 7AH (ampere-hour) or 12 AH size. Charging current is about 1A maximum.

Operation without a battery is not recommended; peak output current not guaranteed. Note that the battery has nothing to do with memory retention. All Slice memory is non-volatile flash.

If you want to operate without a battery, you must supply DC power to the module through the **BATTERY (+BAT)** terminal. Use a power supply voltage of 12V. Never apply a voltage of more than 13.7 volts to this terminal.



### System Grounding

In most applications, it's desirable to ground the system by connecting the system power supply common, to the chassis or panel ground. The negative (GND) side of the DC power input terminal as well as all I/O point terminals labeled GND are connected to chassis ground.

### I/O Wiring

#### Universal and Analog Inputs

2500S I/O modules have both Universal and standard analog inputs. Both types support loop powered and self-powered 20mA sensors/transmitters. Universal Inputs also support voltage and resistance sensors and have conditioning circuitry for standard temperature sensors such as thermocouples and RTDs

Loop powered sensors are two terminal devices that connect between a loop power supply and the analog input. The loop current continues from the power supply, through the sensor and to ground through precision 45 ohm resistors built into the 2500S module.

Self-powered transmitters have three terminals typically labeled *power in*, *signal out* and *common*. The *signal out* terminal connects to the Analog Input Channel, the *common* connects to GND and the *power in* connects to a power supply (usually the same one that powers the 2500S I/O module).

There are three options for the user when selecting the types of 20mA sensors and loop power configurations. In all cases it is important for the user to ensure that the sensor has enough loop voltage for proper operation, including the voltage drop from any other devices (such as loop powered indicators) that are connected into the loop with the sensor. The sensor and other loop-powered device manufacturers supply the minimum operating voltage specification for their devices. The voltage drop across a 2500S analog input in current mode is less than 1V.

#### VO Loop Power

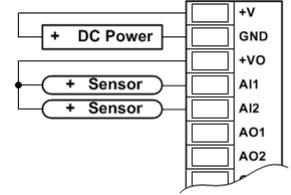
2500S I/O modules supply regulated 24V loop power via the +VO terminal. The +VO power is derived from the incoming power, but regulated so that it's always 24V, regardless of the input voltage.

The advantages of this configuration are:

- The 24V power is typically a high enough compliance voltage for most any 20mA loop application

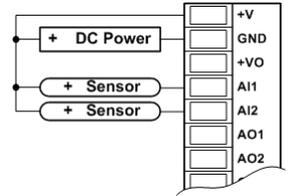
- The power is regulated, very clean and free of transients
- The 2500S I/O module can control the power to the sensors so that the overall power consumption can be reduced by configuring the 2500S I/O module to turn OFF the sensor power between sensor readings.

The main disadvantage of this configuration is if the sensors can operate well from a significantly lower loop voltage (like 12Vdc) and the sensors are read frequently, then some power is wasted by using 24 volts instead of a lower voltage (such as 12 volts). The diagram on the right shows the typical wiring for 2-wire sensors powered by the +VO terminal.



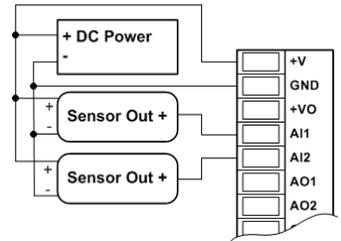
### External Supply Loop Power

The second option is to use an external loop power supply (such as 12V DC power) with 2-wire sensors (typically low-voltage sensors). In this case, the sensors are powered continually. This configuration normally uses the same power supply to power the 2500S I/O module and the sensors.



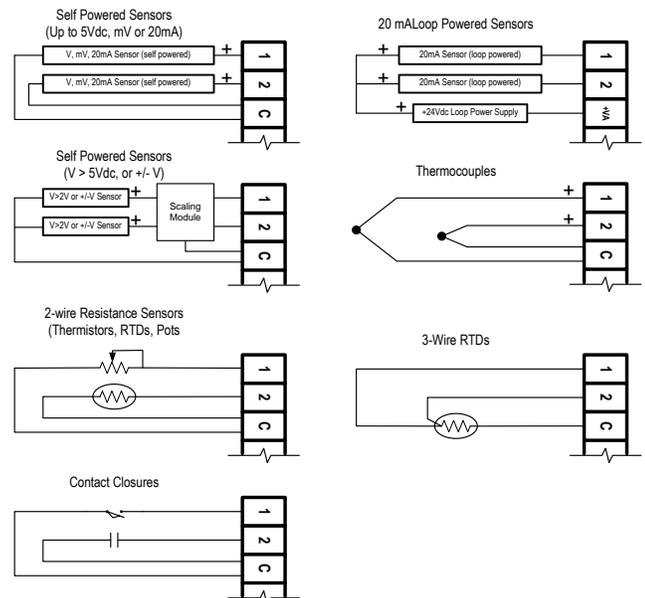
### External Supply 3-Wire Sensors

The third option is to use 3-wire sensors that are powered separately from the loop. This configuration is less common since it tends to be more expensive than 2-wire device solutions, unless the analog signal is being generated by a larger piece of equipment (such as speed feedback from a Variable Frequency Drive).



### Universal Analog Inputs

2500S I/O modules have Universal Inputs that can directly accept and process resistance, contact closure, millivolt and voltage type sensors. This includes thermocouples, RTDs, and thermistors. The diagrams on the right show how these types of sensor are wired to the 2500S modules.

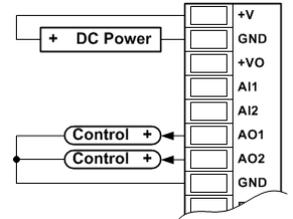


### Analog Outputs

Some 2500S I/O modules have analog outputs. These outputs are designed to provide either 0 to 20mA or 4 to 20mA process control signals, although with the addition of an external resistor, voltage control signals can be generated as shown.

### Current Outputs

The 24V boost power supply within the 2500S I/O module powers the 20mA analog outputs so that no additional external power supply is required. 2-wire control devices are simply connected between the analog output pin(s) and the ground (GND) terminal.

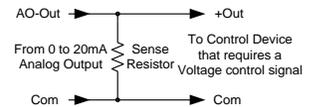


### Voltage Output

Using Voltage Input Control Devices with the 2500S Analog Outputs to obtain voltage outputs, connect a load resistor in parallel with the control device connected to a 2500S Analog Output and GND. The table below lists resistance for three common voltage ranges. The resistance value listed is the parallel resistance of the control device and the load resistor. Normally, the input resistance of the control device is very high and will have negligible effect on the combined resistance.

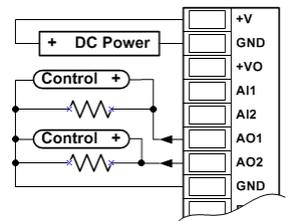
With the addition of a single external resistor (per channel), the outputs can be converted to voltage outputs (i.e. 0 to 5Vdc or 0 to 10Vdc). The resistor value can be calculated as:

$$R_{sense} = V_{out} / 0.02$$



The resistor values required for common output voltage ranges are shown in the table on the left. Standard 1% values of 49, 249 and 499 ohms may be substituted for the “ideal” values shown in the table.

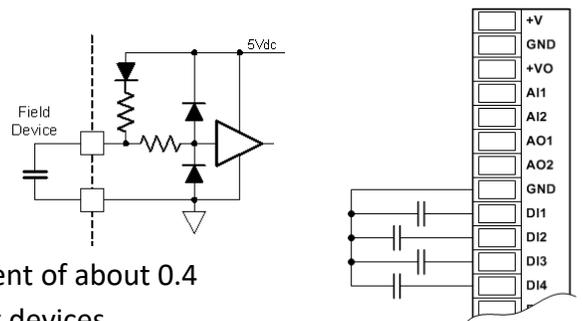
Voltage Range	Resistance
0 to 1V	50 ohms
0 to 5V	250 ohms
0 to 10V	500 ohms



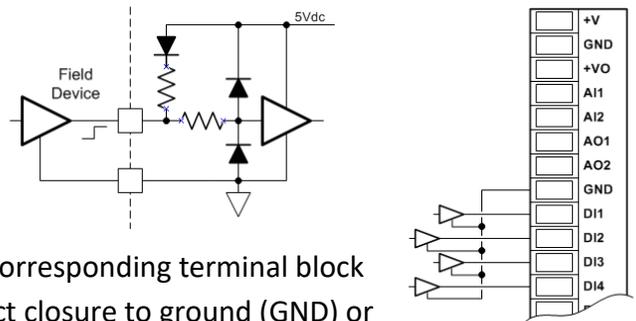
### Digital Inputs

Most 2500S I/O module have digital inputs or combination digital inputs/outputs. Light Emitting Diode (LED) indicators on the front panel show the status of each of the digital inputs. The digital input LEDs can be disabled to conserve power.

The Digital Inputs are for use with sensor devices with (passive) dry contacts such as switches and relay contacts, or transistor type outputs. Transistor outputs are generally referred to as “Open Collector” or “Open Drain” outputs and generally operate as “solid state” contact closures to ground. Each Digital Input provides a pull-up or wetting current of about 0.4 mA/4.3V for the contacts and open collector/drain transistor devices.



The Digital Inputs may also be used with active devices that supply low-voltage DC levels (up to 30Vdc). These devices are typically equipment listed as having “TTL” or “CMOS” outputs.



Abbreviated diagrams of the 2500S Digital Inputs with contact closure and low-voltage active inputs and their corresponding terminal block wiring configurations are shown here. Note that a contact closure to ground (GND) or low voltage level (below 1Vdc) is normally considered an “ON”, but this can be inverted in the 2500S I/O module configuration.

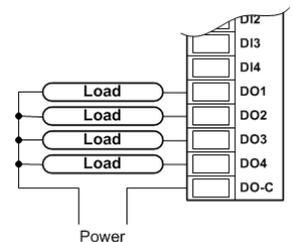
### Digital Outputs

Most 2500S I/O modules have either relay digital outputs or combination transistor digital inputs/outputs. 2500S-23-XXXX modules have relays outputs. All other 2500S modules have solid state transistor inputs/outputs.

The outputs of the 2500S-23-XXXX module are dry contact, mechanical relay outputs. These outputs are Form A (normally open) contacts. Loads can be connected either the high or the low side of the power source. Light Emitting Diodes (LEDs) on the front panel show the status of each of the outputs. The digital output LEDs can be disabled to conserve power.

### Relay Digital Outputs

The correct wiring of the Relay Digital Outputs is pictured below. Note that to simplify wiring, all of the outputs share a common (DO-C).



### Relay Output Load Considerations

Because relays provide simple mechanical contacts, they are easy to interface to. On the other hand, it is important to understand some of the special considerations required for certain types of loads.

The 2500S relay contacts have a 3A rating for resistive loads. The rating is lower for other types of loads. For example, incandescent lamps may have inrush currents that will exceed the rated maximum current of the relay contacts since there is a derating specifically for operating these types of lamps. This inrush current may damage the relay contacts, so interposing relays must be used in these situations. If you want to drive incandescent lamps or other non-resistive load, please check the Specifications section to ensure that loads that you need to control do not exceed the relay ratings.

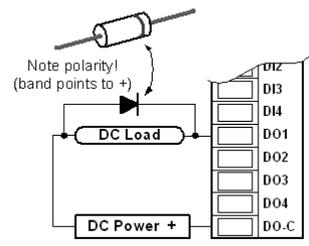
Inductive loads pose another problem. When the current is interrupted to an inductive load (relays, starters, solenoids, etc.), the voltage momentarily spikes up very high. This can cause arcing that damages the relay contacts and eventually causes premature failure. This arcing can also cause radiated noise that disturbs the operation of surrounding equipment. The amount of arcing is not necessarily proportional to the physical size of the device, so even small inductive loads such as “ice cube” relays can be problematic. The solution is to use snubbing diodes for DC systems, and snubbers for AC systems. The snubbing device is wired across the inductive load and should be located as close to the load device as possible. Be careful to verify the polarity of snubbing diodes in DC systems as reversing the diode essentially creates a short circuit around the load device.

### Example of Snubbing DC Loads

Snubbing of DC loads is the most critical, because, as opposed to AC powered loads, DC power doesn't periodically go to zero volts as AC (zero crossover) that helps to extinguish arcs that cause contact damage and electrical interference. Luckily, solving this problem is also very easy and inexpensive, especially for DC circuits.

DC Loads can use low-cost diodes for snubbers. Popular choices are 1N4002, 1N4003, 1N4004 and 1N4007 which are available from virtually any electronic supply house including Radio Shack, and on-line at Digikey.com, Mouser.com and Newark.com. They cost anywhere from 0.07 to 0.99 each, depending on quantity and where you get them from (on-line is generally cheaper).

<b>1N4004</b>	<b>Part#</b>
Radio Shack	276-1103
Digikey.com	641-1311-1-ND
Mouser.com	755-1N4004AT-82
Newark.com	18C8917

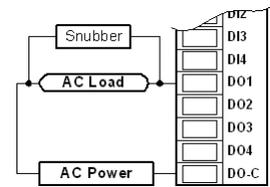


### Example of Snubbing AC Loads

AC Loads require a different type of snubber. There are basically two types commonly used; one that has a resistor and capacitor inside; or some people use a varistor. The varistor solution may be more readily available locally. Be sure to choose a part that matches the AC voltage that you are using. For example, for 120Vac circuits, you can use a V130LA20AP or V130LA20BP varistor which is very popular and fairly

easy to find at vil/O moduleally any electronic supply house including Radio Shack, and on-line at Digikey.com, Mouser.com and Newark.com. They cost anywhere from 0.40 to 1.99 each, depending on quantity and where you get them from (on-line is generally cheaper).

V130LA20AP	Part#
Radio Shack	276-568
Digikey.com	F3030-ND
Mouser.com	576-V130LA20AP
Newark.com	58K7217

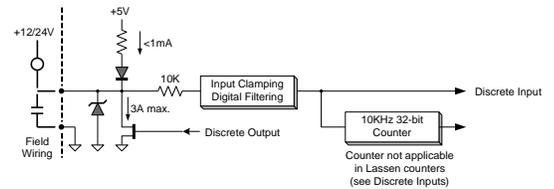


**CAUTION: DO NOT USE VARITORS ON AC MOTOR LOADS! Use a motor starter and put a snubber across the coil of the starter.**

### Transistor (FET) Digital Inputs/Outputs

All 2500S modules EXCEPT for the 2500S-23-XXXX provide transistor type solid-state digital inputs/outputs.

An abbreviated internal diagram of the Transistor Digital Inputs/Outputs is pictured below. Note that like the relay style, all of the outputs share a common, but this common is the ground, the same as the power ground. Inputs can be a simple contact closure, or a voltage that input up to 30 volts. Output loads should be connected between a DC power source of 30 volts or less, and the output terminals. The output will switch to ground when turned ON. Note that like relay outputs, inductive loads must utilize diodes as describes above to mitigate inductive transients.



### Model Specific Wiring

The following section describes the terminal assignments and wiring connections for each member of the 2500S.

All field device and power wiring is terminated on a 17-position vertical terminal block. The signal assignments (pin outs) and typical wiring configurations for each of the three 2500S models is shown on the following pages.

## 2500S-23-XXXX

2500S-23-XXXX is a general purpose I/O module with a symmetrical I/O mix: 2 universal analog Inputs and 2 analog outputs, 4 digital inputs and 4 relay outputs.

**Power** is connected into the top 2 terminals labeled +V and GND . Use 10 to 30Vdc.

**+VA** is switched 24V Loop Power for 20mA analog sensors. Use this as the loop power source for 2-wire 20mA sensors.

**Two Universal Inputs (UI1 and UI2)** are high resolution analog inputs with built-in sensor conditioning

**Two Analog Outputs (AO1 and AO2)** are high resolution 20mA outputs. They are internally powered from a 24V internal source.

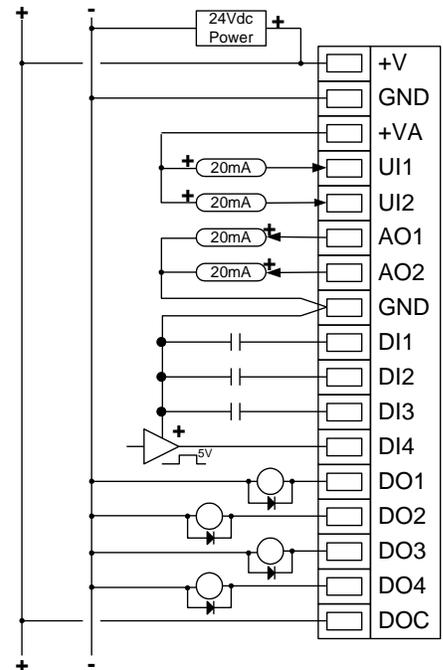
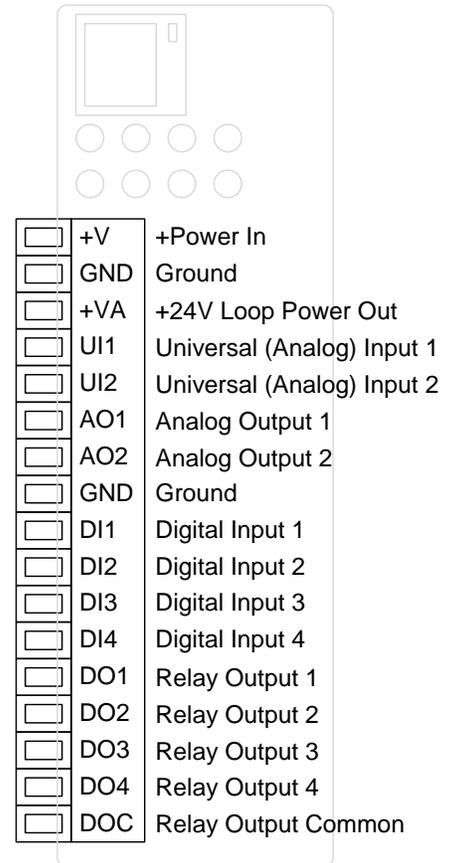
**Four Digital Inputs** accept simple contact closures, or DC input signals up to 30Vdc. All four have configurable filtering and very high-speed counting (up to 10KHz). Use adjacent pairs of inputs for quadrature signals, such as from encoders.

**Four Digital Output (relays)** with their own isolated common terminal (DOC). Each relay can switch up to 3A (resistive load). Snubbers are recommended when driving inductive loads like relays, solenoids and starters. (See the relay wiring recommendation in the previous section).

The diagram on the right shows the typical wiring to a 2500S-23-XXXX module.

The two analog inputs are universal inputs, so they may have any mix of sensors. In this example, they are shown connected to two loop powered 4-20mA devices.

In this example, the relays are sourcing DC power to loads, so the common is connected to the + rail. Diodes are installed across inductive loads to snub the transients that occur when power is turned off to these loads. If AC inductive loads are being switched, replace the diodes with snubbers designed for AC circuits.



## 2500S-26-XXXX

2500S-26-XXXX is designed from the ground up as a solar-powered or battery backed I/O module. When powered from a solar panel or power supply through the +V input, it must have a lead-acid battery attached to support peak loads. It will provide up to 1A of charging current. If powering from a power supply without a battery, use the +BAT terminal for input power (12Vdc)

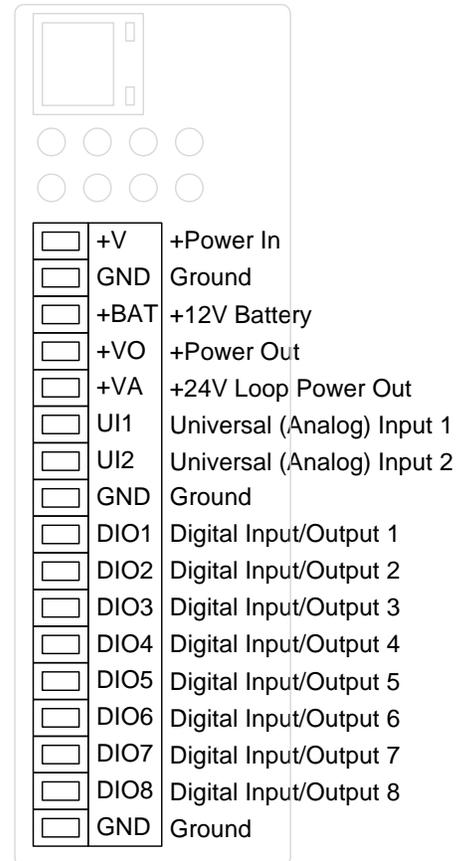
**For solar powered or battery-backed applications,** source DC power into the top two terminals and connect a 12V lead-acid battery between +BAT and GND. When using just a DC power supply (no battery), connect it between the +BAT terminal and GND.

**+VO** is battery backed power out to external devices (up to 1A)

**+VA** is switched 24V Loop Power for 20mA analog sensors. Use this as the loop power source for 2-wire analog devices.

**Two Universal Inputs (UI1 and UI2)** are high resolution analog inputs with built-in sensor conditioning.

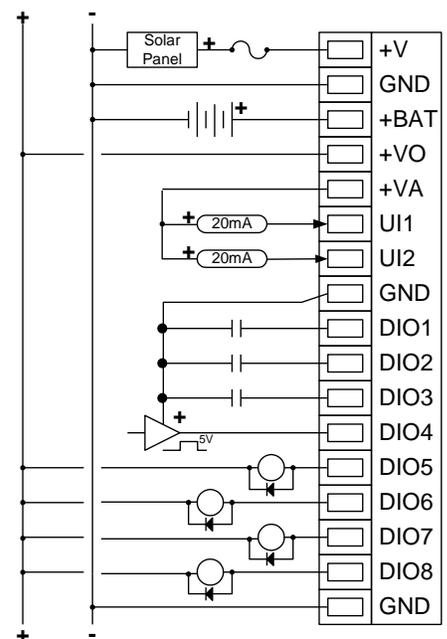
**Eight Digital Input/Outputs (DIO1 through DIO8)** can individually function as low-voltage or contact-closure digital inputs, or low voltage Field Effect Transistor outputs (open drain) switching up to 1A to ground each. All eight inputs have configurable filtering and very high-speed counting (up to 10KHz). Use adjacent pairs of inputs for quadrature signals, such as from encoders.



The diagram on the right shows the typical field device and power wiring to a 2500S-26-XXXX module. Note the connections for the solar panel and battery. If a DC power supply is used without a battery, connect it into the battery terminal.

The two analog inputs are universal inputs, so they may have any mix of sensors. In this example, they are shown connected to two loop powered 4-20mA devices.

In this example, the last four DIOs are driving the DC output loads by switching to ground. The common (ground) is connected to the - rail. Diodes are installed across inductive loads to snub the transients that occur when power is turned off to these loads. These diodes are not required on non-inductive loads such as LED indicators.



## 2500S-27-XXXX

2500S-27-XXXX is also designed from the ground up as a solar-powered or battery backed I/O module, but mostly for monitoring and alarming applications. When powered from a solar panel or power supply through the +V input, it must have a lead-acid battery attached to support peak loads. It will provide up to 1A of charging current. If powering the I/O module from a power supply without a battery, use the +BAT terminal for input power (12Vdc)

**For solar powered or battery-backed applications,** source DC power into the top two terminals and connect a 12V lead-acid battery between +BAT and GND. When only using a DC power supply (no battery), connect it between the +BAT terminal and GND.

**+VO** is battery backed power out to external devices (up to 1A)

**+VA** is switched 24V Loop Power for 20mA analog sensors. Use this as the common source for 2-wire analog devices.

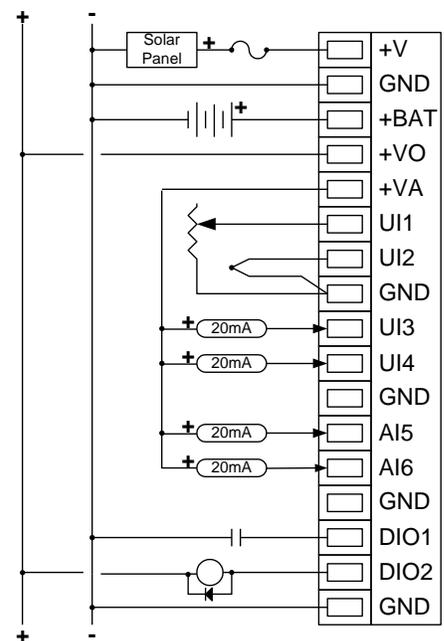
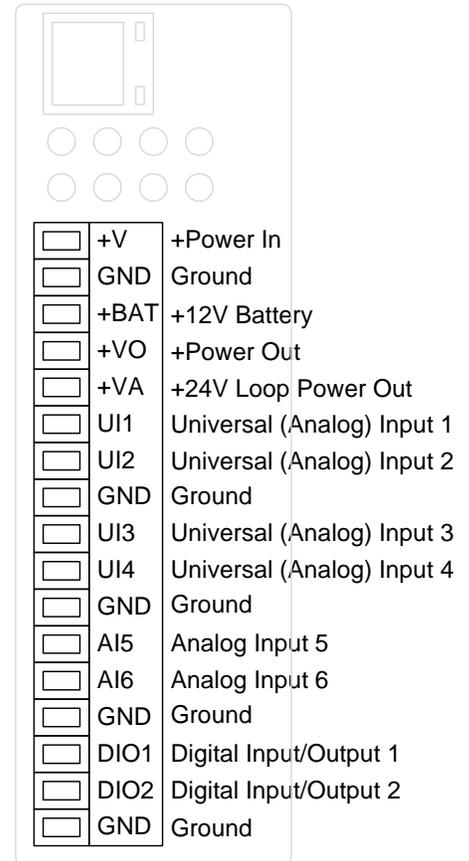
**Four Universal Inputs (UI1 – UI4)** are high resolution analog inputs with built-in sensor conditioning. The other two analog inputs (**AI5 and AI6**) are designed for 20mA sensors only.

**Two Digital Input/Outputs (DIO1 and DIO2)** can individually function as low-voltage or contact-closure digital inputs, or low voltage Field Effect Transistor outputs (open drain), each switching up to 1A to ground. Both inputs have configurable filtering and high-speed counting (up to 10KHz). Use pairs of DIOs for encoder quadrature signals.

The diagram on the right shows the typical field device and power wiring to a 2500S-27-XXXX module. Note the connections for the solar panel and battery. If a DC power supply is used without a battery, connect it into the battery terminal.

The first four analog inputs are universal inputs, so they may have any mix of sensors. In this example, the first two inputs have resistive and thermocouple devices, while the second two have loop powered 4-20mA devices. The last two analog inputs will only accept signals from 20mA devices.

In this example, the last DIO is driving a DC output load by switching to ground. The common (ground) is connected to the - rail. Diodes are installed across inductive loads to snub the transients that occur when power is turned off to these loads. These diodes are not required on non-inductive loads such as LED indicators.



## Communications Wiring

2500S modules come with a high-speed Ethernet port plus the option of both or either an RS-232/RS-485 serial port and an internal spread spectrum or cellular radio.

Both the Ethernet and serial port use RJ-45 connectors and standard low-cost Ethernet cables which are readily available. Serial cables then have a selection of adapters to connect 9-pin D connectors like those commonly found on personal computers, external radios, and modems.

The internal radio option only requires a single antenna cable connection (RPSMA or MMCX depending on the radio ordered).

The communication port wiring for the Ethernet and optional Serial port are described in this section.

### Ethernet Port Connections

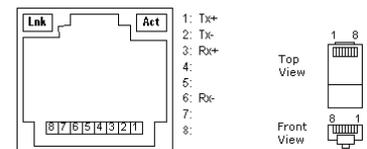
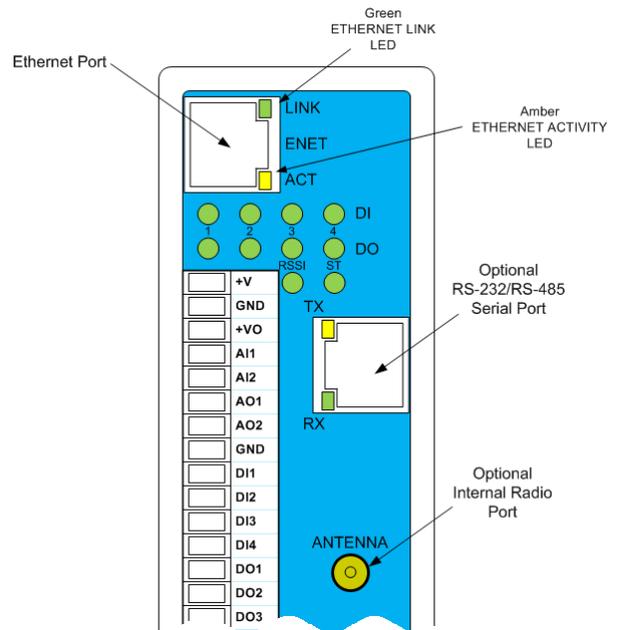
2500S I/O modules have a single high-speed Ethernet port with an industry standard RJ-45 connector that can be connected directly to a wall jack, hub or switch using Category 5 (or better) patch cables. Ethernet provides a reliable low-cost interface that is electrically isolated making it ideal for industrial installations.

The Ethernet connector has two LED indicators in the upper and lower right hand corners. The GREEN LED in the upper left hand corner is the “Link” Status LED. It illuminates when the I/O module is electrically connected to an active Ethernet device. The AMBER LED in the lower right hand corner is the “Activity” Status LED. It illuminates whenever there’s an Ethernet message transaction going on.

The 10/100Base-T Ethernet specification limits the maximum Ethernet cable run to 100m or approximately 325 feet. Ethernet cables should not be run in parallel with power or any cables that generate noise.

High quality “straight-thru” and “crossover” Ethernet cables are available from Control Technology Inc. The part numbers for these cables are listed in the table below:

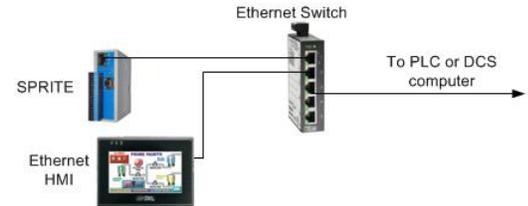
Description	Part#
RJ-45 Ethernet Cable Assembly, 0.5ft. (6")	99-1000
RJ-45 Ethernet Cable Assembly, 1ft.	99-1001
RJ-45 Ethernet Cable Assembly, 2ft.	99-1002
RJ-45 Ethernet Cable Assembly, 3ft.	99-1003
RJ-45 Ethernet Cable Assembly,, 5ft.	99-1005
RJ-45 Ethernet Cable Assembly, 7ft.	99-1007
RJ-45 Ethernet Cable Assembly, 10ft.	99-1010



### Ethernet System Configurations

The Ethernet port on 2500S I/O modules supports the 100BASE-T twisted pair standard. When the I/O module is connected to a single Ethernet device, only a simple low-cost cable with RJ-45 modular connectors on either end is required. Unlike coax based Ethernet, twisted pair Ethernet cannot be “multi-dropped”. Instead, when more than two Ethernet devices must be tied together, an Ethernet switch or hub is used. These days, mostly switches are used because they cost the same as hubs, are more available, and they eliminate message collisions for higher throughput. Routers and wireless access points typically have at least a 4-port switch built into them.

The Ethernet ports of 2500S I/O Modules are “Auto MDX” compatible, so a “crossover” cable is not needed in order to swap the transmit and receive data pairs when connecting the I/O module directly to a PC computer or other Ethernet device.



### Serial Port Connections

The most common serial communications standards in SCADA and industrial control systems are still RS-232 for short point-to-point connections and RS-485 for longer point-to-point and networked communications. 2500S I/O modules support both standards when ordered with the optional serial port.

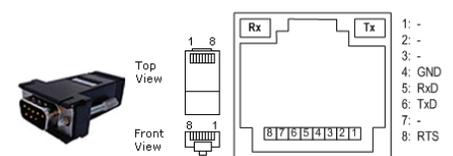
The physical RS-232 serial port connection utilizes a standard RJ-45 connector similar to Ethernet connectors. Since Ethernet connections are isolated, no damage will occur if an Ethernet connector is accidentally plugged into a serial port on the I/O module, or vice-versa.

The connector for the optional Serial Port has two LED indicators in the upper and lower left hand corners. The AMBER LED in the upper left hand corner is the “transmit Data” status LED. It illuminates when a message is being sent to an RS-232 or RS-485 device. The GREEN LED in the lower left hand corner is the “Receive Data” status LED. It illuminates whenever a message is being received from an RS-232 or RS-485 device.

The wiring of the RS-232 connector is based upon the EIA/TIA-561 standard. Using standard RJ-45 connectors enables low-cost Ethernet patch cables to be used as high-quality RS-232 cables. RS-232 cables require RJ-45 to DB-9 (male or female) adapters while RS-485 cables. Ethernet patch cables are readily available in a variety of lengths, allowing for a variety of serial communications cable lengths to be “built up” in the field without any soldering.

2500S I/O modules support the following RS-232 serial communications signals:

- TxD** Transmit Data (outgoing data from the 2500S I/O module to external devices)
- RxD** Receive Data (incoming data from external devices into the 2500S I/O module)
- RTS** Request-to-Send (only needed if required by legacy communications devices)
- GND** Signal Ground



i  
Connections and status LED locations for the 2500S RS-232 and RS-485 (RJ-45) serial port.

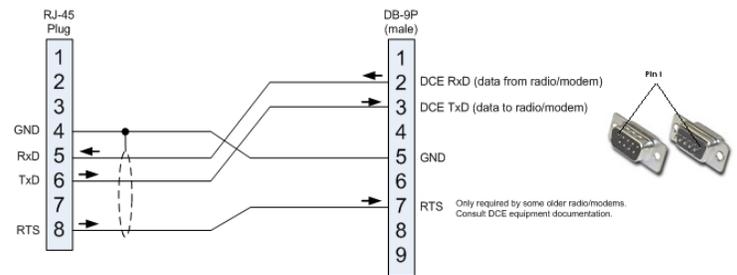
## RS-232 Serial Wiring Connections

RJ-45 (8-pin) connections	2500S Serial DTE Function	DB-9P RS-232 connections
1	RS-485 +	-
2	RS-485 -	-
3	-	-
4	GND	-
5	RxD	2
6	TxD	3
7	-	-
8	RTS	7

Note: 2500S I/O modules only need 3 wire; transmit, Receive and Ground. RTS is provided for some radio and modems

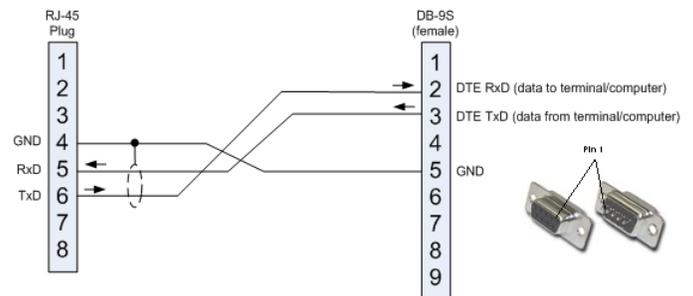
## RS-232 Serial Communications Interface Applications

RS-232 is still the most common hardwired communications interface for point-to-point links spanning distances of up to 100 ft. An optional RS-232 interface on the 2500S I/O module is typically used to connect the I/O module to a DCE (Data Communications Equipment) device such as a radio or modem or to a DTE (Data Terminal Equipment) device such as an HMI terminal or PC computer.



Wiring from 2500S Serial Option to a DCE Radio or Modem Device

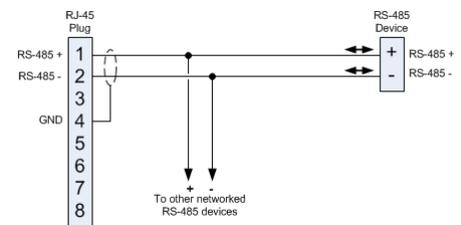
The cable going to a DCE device normally has a 9-pin D male connector, while the cable to a DTE device is normally a 9-pin female connector as shown below.



Wiring from 2500S Serial Option to a DTE PC or HMI Device

## RS-485 Serial Communications Interface

RS-485 is a 2-wire communications interface designed to span distances of up to 5,000 ft. and support multidrop networked operation. The RS-485 interface in 2500S I/O modules is typically used for connections to HMIs and I/O expansion modules (such as other 2500S modules). Many types of industrial equipment also have RS-485 interfaces and can be used in combination with the 2500S I/O modules. Up to 32 devices can share an RS-485 network.



Traditionally, RS-485 networks use a 100Ω resistor termination at each end of the network. This technique does not work well with certain protocols such as Modbus that do not have a lead-in message header to eliminate garbage on the beginning of a message. CTI controllers and I/O module have series termination resistors that eliminate this problem. In most cases on longer networks, separate termination is not required. If termination is used, it should be AC coupled. Call CTI technical support for additional information if you think that you need additional network termination.

### *Certified RS-232 Serial Communications Cables*

High quality RS-232 modular cables are available for most common applications; prewired and pretested. These certified cables are configured for typical connections to RS-232 DCE devices such as radios and modems that have a 9-pin D FEMALE connector, or DTE devices such as HMI terminals and PC computers that have a 9-pin D MALE.

The part numbers for these cables are listed below:

	RS-232 DCE (DB9S - Female)	RS-232 DTE (DB9P - Male)
RJ-45 to DB9 adapter plug	99-2000	99-2100
RJ-45 Serial Cable Assembly, 1ft.	99-2001	99-2101
RJ-45 Serial Cable Assembly, 2ft.	99-2002	99-2102
RJ-45 Serial Cable Assembly, 3ft.	99-2003	99-2103
RJ-45 Serial Cable Assembly, 5ft.	99-2005	99-2105
RJ-45 Serial Cable Assembly, 7ft.	99-2007	99-2107
RJ-45 Serial Cable Assembly, 10ft.	99-2010	99-2110

## USER Web Pages

The User web pages provide a view of current I/O status as well as logged data in tabular and graphic forms, using a standard web browser such as Internet Explorer (supplied with Windows), Firefox, Chrome (Google), or Safari (Apple). The User Web pages are the pages displayed when the module is first accessed over a network or the Internet (main User web page is the “home” page).

If security is enabled, every user will need to enter their username and password to access the I/O module. Turning on security and setting up usernames and passwords are part of the configuration process.

If security is not turned on, this screen is bypassed and the User Home page (mobile or full web page) is displayed. 2500S I/O modules are shipped from the factory with security turned OFF.

### User Home (Home Page)

The Home Page of a 2500S I/O module provides overall operating information about the module and its communications interfaces. This page is displayed right after a user logs into the module, unless the “Mobile Interface” has been enabled. If so, even though Mobile Interface has a button to get to this web page (“Full Web Site”).



CTI 2500S Slice I/O	
Input Voltage	23.9
Temperature	82.9
Local Time	13/42/2013 19:56:15
Forcing	---
Comm Faults	---
Response Code	---
SDX Master Success %	---
CAMP Master Success %	---

The look of this page will vary depending on the communications ports and options installed and the functions that have been configured. For example, the screen shot shown here is captured from a 2500S-23-XXXX outfitted with an optional RS-232/RS-485 serial port and a cellular modem. So besides the Input Voltage, Temperature and Clock settings included in all configurations, it also shows the last signal strength reading to the cell tower, the local (2500S) cellular number as well as the cellular number of the last “caller”. A summary of the status of the communications ports is also shown. More detailed communications statistics are available under the “Comm Stats” button.

When you select the User Home page, a message warning that the modules time is not in sync with you computer may be displayed. You will be asked if the clock should be synchronized to your computer. This is mostly useful for standalone modules that do not have a cellular connection, since modules with internal cellular modems will automatically synchronize their clocks from a cellular network if a network connection is available.

## Local I/O

The Local I/O page is a configurable display of the physical inputs and outputs of the module, as well as the applicable totalizers, runtimes and calculated rates. Every point can be given a “tag name” and a “units” suffix to help identify their functions. For example, on the sample page on the right, the default name of “Universal In 1” has been changed to “Level” with a “units” suffix of “ft.” By entering tag names as part of the configuration process, the user will see more informative labels. Analog values are displayed in their scaled forms, unless the “RAW” button is selected. Totalizers, Runtime , and Rate measurements can also be scaled.

		Values	Raw
DI1	Digital In 01		
DI2	Digital In 02		
DI3	Digital In 03		
DI4	Digital In 04		
DO1	Digital Out 01		
DO2	Digital Out 02		
DO3	Digital Out 03		
DO4	Digital Out 04		
UI1	Universal In 1	0.000	
UI2	Universal In 2	0.000	
AO1	Analog Out 01	0.000	mA
AO2	Analog Out 02	0.000	mA

On the Local I/O Page, any items colored blue can be changed “on-the-fly”. Simply click on the item. Boolean items (single bits) such as digital outputs are toggled from OFF to ON and vice-versa for each click. Numeric items such as analog outputs open an entry window when clicked on to accept a new value. Totals and runtimes are cleared (with a warning confirmation window) when you click on them.

## Min/Max

For any analog input signals, digital input rate calculations and energy calculations that have been made “visible” in their configuration (visibility checkbox checked), the controller also latches the value and time of when those signals hit their high and low points (minimums and maximums). These are displayed under the “Min/Max” button.

	Min	Timestamp	Max	Timestamp
Universal In 1	0.000		0.000	
Universal In 2	0.000		0.000	

## Control and Setpoints

The Control and Setpoints page shows the current state of the outputs of the Pump Controller and Setpoint Control blocks as well as their setpoint values. These are only displayed if the pump controller is enabled or the control blocks are made “visible” in their respective configurations. If the logged in user has permission, these pages also allow the setpoints to be changed (values displayed in blue). The “Control” and “Setpoints” buttons on the left hand sidebar will not appear if the pump controller is not enabled or if none of the control blocks are made “visible” in their configuration settings.

	Inputs	Out	On	Off
High Alarm	Level 0.0	1	25.0	24.0
Low Alarm	Level 0.0	2	20.0	19.0

## Concentrator Numbers and Bits

2500S I/O modules have numeric registers and bits set aside for collecting data from other devices and sites (concentrator function) or providing remote setpoints to these devices. These registers are also accessible by computers, PLCs, or other I/O module. The first 50 numeric registers and first 50 bits may be assigned a local “tag name” and “units” to help identify their functions and magnitude, as well as attributes (visible, non-volatile, and read or read/write). Read/write values are typically used for setpoints to be adjusted by an operator while Read Only values usually show process variables from the field (remote devices). Any of these registers that are configured as “visible” will be displayed on this page. User changeable values are indicated in blue text when displayed.

Register Number	Tag Name	Value	Units
01	Outflow Rate	0	GPM
02	Outflow Total	237652	Gal

Bit Number	Tag Name
01	Remote Alarm

The Concentrator buttons on the left hand sidebar will not appear if none of the concentrator number or bit registers are made “visible” in their configuration settings.

## Hourly and Monthly Totals

2500S I/O modules can collect and record totalizers and runtimes for up to four separate Digital or Analog Inputs, or values from remote modules in the concentrator registers. Besides current and peak hourly and monthly totals, the I/O modules display the last two days and two years of totals or runtimes, side by side, for comparison. The totals data can be viewed, or downloaded as a CSV (spreadsheet) file, or graphed.

The “Hours Totals” and “Month Totals” buttons on the left hand sidebar will not appear if none of the totalizers has been assigned a variable to totalize.

Clicking on the “Graph” button will cause the last couple of days worth of hourly data, or a user specifiable number of hours or hourly data, to be graphed on a web page. Tools are provided that allow you to pan and zoom through the data. Clicking on the “Download” button causes the data to be downloaded to your computer as a CSV spreadsheet file.

Hour Totals - Sprite II Combo I/O Module					
	Production 1 (Gals)	Production 2 (cnts)			
Current Hour Totals	531	92580			
Peak Hour Totals	819	1149428			
Current Day Totals	18524	14321460			
Last Day Totals	0	0			
Peak Day Totals	18524	14321460			
== Day ==	Yesterday	Today	Yesterday	Today	
01:00	0	818	0	748711	
02:00	0	818	0	550347	
03:00	0	818	0	353984	
04:00	0	818	0	157620	
05:00	0	818	0	56696	

## Trending

2500S modules can collect and record the values of up to 16 inputs and outputs (analog or digital), or other variables such as input voltage, temperature, battery voltage, or communications rates. This data can be sampled and recorded at speeds ranging from once per second to once per minute.

Clicking on the “Graph” button will cause the collected data, over a specifiable time period, to be graphed on a web page. Tools are provided that allow you to pan and zoom through the data. Clicking on the “Download” button causes the data to be downloaded to your computer as a CSV spreadsheet file.

Trending - Sprite II Combo IO Module					
	Input Voltage	Temperature	Universal In 1 Level	In Flow State	Out Flow State
14:30:10	14.7	91.4	0.000	off	off
14:30:00	14.6	91.4	0.000	off	off
14:29:50	14.4	91.4	0.000	off	off
14:29:40	14.3	91.4	0.000	off	off
14:29:30	14.3	91.4	0.000	off	off
14:29:20	14.3	91.4	0.000	off	off
14:29:10	14.3	91.4	0.000	off	off
14:29:00	14.4	91.4	0.000	off	off
14:28:50	14.5	91.4	0.000	off	off
14:28:40	14.7	91.4	0.000	off	off
14:28:30	14.6	91.4	0.000	off	off
14:28:20	14.6	91.4	0.000	off	off
14:28:10	14.4	91.4	0.000	off	off
14:28:00	14.3	91.4	0.000	off	off
14:27:50	14.6	91.4	0.000	off	off
14:27:40	14.6	91.4	0.000	off	off
14:27:30	14.3	91.4	0.000	off	off
14:27:20	14.7	91.4	0.000	off	off
14:27:10	14.7	91.4	0.000	off	off

## About Totals and Trend Graphs

The built-in graphing tools are powerful tools for data analysis and extraction. They provide both strip chart display and historical access to up to 16 different variables and 4 sets of totals and runtimes. Each variable can be tied to either the left or right axis, depending on the most appropriate range of each scale (The scale displays automatically generated from the range of the displayed data, but variables with similar ranges should be tied to the same axis). There are a set of controls that enable the user to tailor the displayed graph and the information shown.

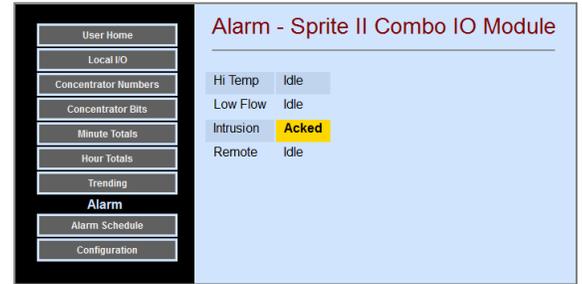


- Traces** This button selects a menu enables individual variables to be displayed or hidden on the graph to avoid clutter.
- Settings** This button selects a menu enables the user to adjust the display of data, such as the zero axis, and the rate at which the display is automatically “refreshed”.
- Date Range** This button selects a menu enables the user to select displayed date range. You can also select a range for zooming by clicking and dragging with the right mouse button.
- Info** This button selects a menu provides information primarily for technical support.
- Stats** In History Mode, this button selects a window that shows the Min, Max and Average values of a highlighted (selected) area on the graph.
- Refresh** Clicking on this button causes the graph to be manually refreshed once.
- Mode** Clicking on this button alternates the graph mode between Chart and History. Chart mode is like a chart recorder, showing the mode recent data on the right hand edge and moving to the left over time. History displays the stored values for the selected dates.

## Alarm and Alarm Schedule Pages

The alarm page shows the status of all configured alarm points, and provides a means of acknowledging alarms. The alarm points may have any one of three states:

- Idle** This point is currently not in alarm.
- !!ALARM!!** This point is currently in alarm, and not been acknowledged.
- Acked** This point is currently in alarm (the alarm condition still exists), but the alarm has already been acknowledged



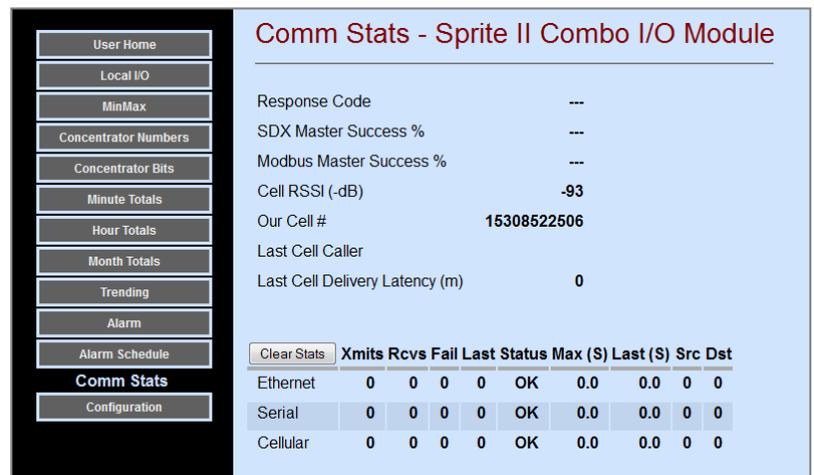
The Alarm Schedule page shows the current “call list” schedule, and provides a means for the user to select a new list. Call list schedules are created using the Configuration screens.

Note that the user can also click on a button to generate a “Test alarm.”



## Comm Stats

Detailed communications performance information is available under the “Comm Stats” page. The look of this page and the information presented will vary depending on the communications options installed in the module and the module communications configuration. Besides showing a summary of each links operation, detailed statistics are kept on the number of transmitted and received messages, communications failure (all retries in a transaction failed), from whom the last message was received (Last), the minimum, maximum and last latency times for a full roundtrip transaction on each port, and the last source and destination addresses sent to and seen over the network (“seen” messages may have been initiated by another unit).



## I/O Configuration Pages

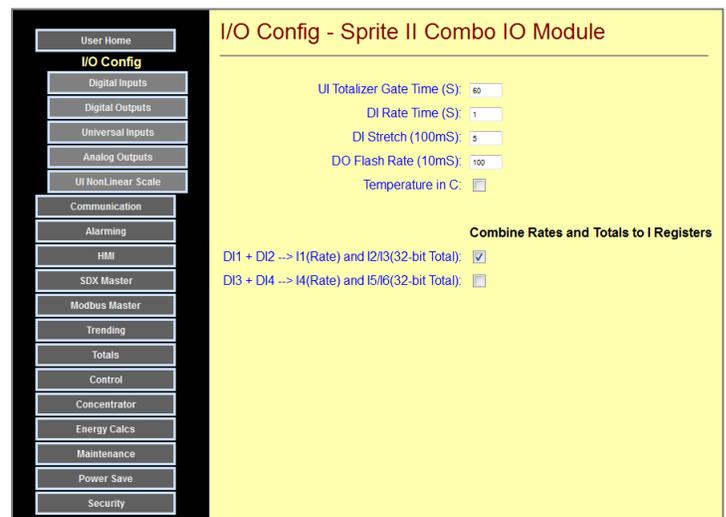
Clicking on the configuration but on the User Pages takes you to the modules configuration pages if you have security permissions to access them. The module continues to function during configuration. Any changes made to the modules configuration take effect within 1 second without resetting the module.

2500S modules have built-in analog and discrete inputs and outputs. There are five models, each with their own mixtures of inputs and outputs. The types of available I/O points include:

- Universal Analog Inputs
- Isolated Analog Inputs
- Analog Outputs
- Discrete Inputs
- Discrete Outputs
- Discrete Inputs/Outputs

Each of these I/O types have configurable parameters; inputs with filtering, totalization, scaling, etc., and outputs with configurable modes, All I/O points have tag names, HMI “visibility”, forcing, etc.

The web pages selected under the **Configuration | I/O Config** button provide simple fill-in-the-blanks access to the I/O configuration parameters with individual buttons for configuring each I/O type. The look of the screens will vary depending on the 2500S model number and I/O mix.



- UI Totalizer Gate** Sets the rate at which Universal Analog Inputs are sampled and totalized
- DI Rate Time** Sets the sampling rate for Discrete Inputs rate calculations, and totalization
- DI Stretch** If the I/O module is polled, momentary inputs like pushbutton switches may be missed. The DI stretch parameter ensures that regardless of the input period, the DI is “seen” for at least the “stretch” time period.
- DO Flash Rate** If one or more Digital Outputs are commanded to flash, this parameter sets the flashing rate. Flashing is synchronized between outputs
- Temperature in C** Check if you want temperatures to be displayed in degrees C
- Summed Rate/Totals** Some flow meters have dual pulse outputs for high and low flow. Checking these boxes causes the flow rates and totals for DI pairs to be combines in I registers.

## Digital Inputs Configuration

The screenshot shows the 'Digital Inputs - Sprite II Combo I/O Module' configuration screen. On the left is a navigation menu with options like 'User Home', 'IO Config', 'Digital Inputs', 'Digital Outputs', 'Universal Inputs', 'Analog Outputs', 'UI NonLinear Scale', 'Communication', 'Alarming', 'HMI', 'SDX Master', 'Modbus RTU Master', 'Modbus TCP/IP Master', 'Trending', 'Totals', 'Control', 'Concentrator', 'Energy Calcs', 'Maintenance', 'Power Save', and 'Security'. The main configuration area is divided into sections for each of the four digital input channels (1, 2, 3, 4). Each channel has the following settings:

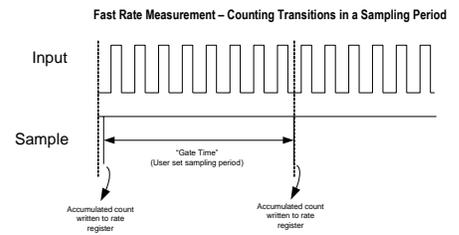
- Tag Names:** Digital In 01, Digital In 02, Digital In 03, Digital In 04
- Visible:**  for all channels
- Force:** Disabled (dropdown) for all channels
- Filters (mS):** 0 for all channels
- Invert:**  for all channels
- Run Time:** Visible: ; Units: Seconds (dropdown) for all channels
- Totalizer:** Visible:  for channel 1,  for others; Numerator: 1; Divisor: 1; Format: ##### (dropdown); Units: cnts
- Rate:** Visible:  for channel 1,  for others; Slow Mode:  for channel 1,  for others; PreScaler: 100 (dropdown) for channel 1, 1 for others; Offset: 0; Scale Numerator: 1; Scale Divisor: 1; Format: #### (dropdown); Units: cpm

- Tag Names** This is where you enter the names for the Digital Inputs for the various HMIs
- Visible** Check these boxes to make individual Digital Inputs “visible” on the HMIs
- Force** Over-ride the actual Digital Input signal state as ON or OFF.
- Invert** Inverts the polarity of an input; ON is a high or OPEN, OFF is a low or CLOSED.
- Filters (mS)** Sets noise filtering or delay in milliseconds
- Runtime** Controls for making the measured Runtime “visible” on a channel, and selecting the runtime measurement units (seconds, minutes to mm.m, hours to hh.h)
- Totalizer** Controls for making the measured Totals “visible” for a channel, and scaling the totalized value. The totalizer scaling makes readings display in engineering units (for example, gallons or liters), and to shift the readings to more manageable readings in decimal increments (like KGAL instead of GAL). Totalizer registers are 32-bit.
- Rate** Controls for making the measured Rates “visible” for a channel, selecting the measurement method, and scaling/formatting the results. “Slow Mode” measures the period between pulses and calculates the rate for very slow signals with better resolution and faster update rates.

## Fast Rate Mode

Rate Fast Mode measures the number of pulses that occur within a precise time period known as the “gate time”. This is also the reading update time. This time defaults to 1 second, but can be adjusted on the main I/O Config page.

When a new sample is recorded at the end of the gate time, the 2500S I/O Modules will also scale the latest reading so that it can be easily displayed on HMI web pages and displays. Scaling is configurable with an integer offset, numerator and divisor, and a decimal point format as follows:



**Scaled value = (Rate Count + Offset)/Prescale x Scaling Numerator/Scaling Divisor**

Note that this scaling technique applies only to high-speed rate measurements. If Slow Rate Mode is selected, the scaling is slightly different as described further on. The offset is normally used only with certain turbine flow meters. Otherwise it is set to “0”.

The prescale divides the raw accumulated rate by 1, 10, 100, or 1000. Be sure to adjust the DI Rate Gate Time under the main I/O Config button accordingly. For example, with the default gate time of 1 second, the rates will be reported as Hertz (pulses per second). If the gate time is changed to 10 seconds, the accumulated values would be ten times larger than Hz, but changing the prescaler will divide it back down. This division happens before the offset is added in.

In the following example, the 2500S I/O module counts pulses from a flow meter. Every pulse represents 1.2 gallons of flow and the flow can reach up to 1000 gallons per minute. By counting the pulses over a one minute sampling period (“gate time”), the flow rate can be calculated.

### **Example #1: FAST FLOW METER Every pulse = 1.2 gallons and sample (gate) time is 60 seconds**

Rate Mode: Normal (fast)

Gate Time: 60 seconds

Prescale: 1

Offset: 0

Scale Numerator: 12

Scale Divisor: 1

Format: #####.#

Every pulse in from a flow meter represents 1.2 gallons of flow, so every 10 counts that we record within the 1 minute sampling period equals 12 gallons. The 2500S I/O module is configured to first multiply the sampled count by 12 (numerator) and then divide the result by 1 (divisor) so that the HMI display will show gallons per minute (GPM) with a resolution to tenths of gallons (#####.# GPM)

OK, well that was easy because we want to read out in gallons per minute and our sampling time is one minute. What if we want to see our reading get updated twice as fast using a faster gate time?

### **Example #2: FAST FLOW METER Every pulse = 1.2 gallons and sample time is 30 seconds**

Rate Mode: Normal (fast)

Gate Time: 30 seconds

Prescale: xxxxx (divide by 1)

Offset: 0

Scale Numerator: 24

Scale Divisor: 1

Format: #####.#

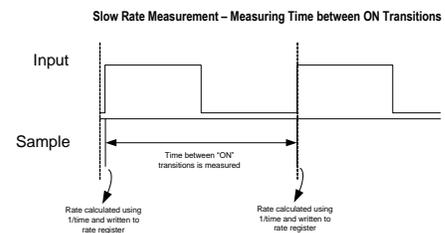
Every pulse in from a flow meter represents 1.2 gallons of flow, so every 10 counts that we record within the 30 second sampling period equals 12 gallons. Since the sampling period is now half of a minute, the 2500S I/O module is configured to first multiply the sampled count by 24 (numerator) and then divide the result by 1 (divisor) so that the HMI display will show gallons per minute (GPM) with a resolution to tenths of gallons (#####.# GPM). Note that we doubled the numerator to compensate for halving the sampling time. Because we're using a faster sampling period, the reading will update faster, but we'll be working with fewer sampling counts, so the reading may jump around a little more and be a little bit less accurate.

### Slow Rate Mode

For input channels that will monitor slower pulse rate signals, the 2500S I/O module can be configured to use a "Slow Rate Mode". For example, a municipal water meter may give us a pulse for every 100 gallons of flow. For a small system, we may only get 6 or 7 pulses every minute, representing 600 to 700 gallons of flow. To get any kind of useful reading resolution using the sampling period technique, we would have to set the sampling period to a very long time, like an hour or a half hour. That means that the flow rate reading would update very slowly also. To solve this problem, the 2500S I/O module has a "Slow Rate Mode". In this mode, the module measures the time interval (in milliseconds) between OFF to ON transitions, and then calculates the rate using the relationship of:

$$\text{Rate} = 1/\text{Time(mS)}$$

Using this technique, the reading is updated on each OFF to ON transition of the input signal. So using the example above, if the module received a pulse 6 times per minute, then the readings would be updated on every transition, or once every 10 seconds. In addition, the resolution of the readings will be much higher with this technique, so that if the "real" rate is 6.5 pulses per minute, the calculated rate will not jump between 600 and 700 GPM, but read "in between" or 650 GPM.



When a new sample is recorded on each positive transition, the 2500S I/O module will also scale the latest reading so that it can be easily displayed on HMI web pages and displays. Scaling is configurable with an integer numerator and divisor, and a decimal point format as follows:

$$\text{Scaled Value} = ((\text{Prescaler} * 1000/\text{Time(mS)}) + \text{Offset}) * \text{Scaling Numerator}/\text{Scaling Divisor}$$

Note that this scaling technique applies only to "Slow Rate Mode" measurements. If the normal Fast Rate Mode is selected, the scaling is slightly different as described above.

In the following example, the 2500S I/O module counts pulses from a municipal flow meter. Every pulse represents 100 gallons of flow and the flow can reach up to 1000 gallons per minute. By counting the time between pulses, the flow rate can be calculated with very good accuracy and updates rates.

**Example #1: SLOW FLOW METER Every pulse = 100 gallons Max. flow rate is 1000 GPM (10 pulses per minute)**

Rate Mode: Slow

Prescale: xxx.xx (times 100)

Offset: 0

Numerator: 10000

Scale Multiplier: 60

Scale Divisor: 0

Format: #####

Every pulse in from a flow meter represents 100 gallons of flow. At 1000 gallons per minute, the period between pulses will be 6 Seconds. We don't expect any shorter time period because 1000 GPM is the absolute maximum flow. If our Prescaler is set to 100, then at the maximum flow rate of 1000 GPM, the numerator of 100000 (prescaler x 1000) divided by the time period in milliseconds (6000) will equal 16.67 (none decimal portion dropped). When we multiply that by 60 ("Scale Multiplier"), we get a readout of approximately 1000 GPM resolving to 1 GPM. We can tweak the Scale Multiplier and Divisor to get the number exact for other non-integer scaling values.

If the flow rate is slower than that, say 5 pulses per minute, the time period between ON transitions is longer (12000 mS), and our readings change according:

$$100000/12000(\text{mS}) \times 60 = 500 \text{ GPM}$$

If you want an extra decimal place, just use a larger Prescaler, like 1000 would give readings of XXX.X GPM.

**Example #2: SLOW FLOW METER Meter manufacturer gives Offset and K Factors**

Rate Mode: Slow

Prescaler 100

Offset: 168 (1.68 x 100)

Scale Numerator : K Factor (524)

Scale Divisor: 1

Format: #####.##

Sometimes meter manufactures don't directly tell you a number of pulses per second or minute, but give you calibration values of offsets and K factors. Even if these numbers having many decimal places, the accuracy of the meters are typically 1% or less, so we can adjust these values from the manufacturer to reasonable numbers for flow readouts.

Use a Prescaler of 100 to make the integer calculations have two decimal places of accuracy. The rate reading will read 100 x the pulses per second (Hz). If there is an offset, multiply it by 100 (or whatever prescale value you're using) and use the integer portion (no decimal points!) to add to the 100 x rate. You can put the K factor into the Scale Numerator. The readings will now read the flow to two decimal places. You can adjust the Scale numerator and Divisor to come up with other reading options or use non integer K factors. For example, using a scaling Divisor of 60 will give you gallons per minute. Be sure to set the format to reading correctly.

## Digital Outputs Configuration

	1	2	3	4
Tag Names:	Digital Out 01	Digital Out 02	Digital Out 03	Digital Out 04
Visible:	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Force:	Disabled	Disabled	Disabled	Disabled
On time (10mS):	0	0	0	0
Off time (10mS):	0	0	0	0
Mode:	PWM	PWM	PWM	PWM
Recycle Holdoff (S):	0	0	0	0
Link to DO:	Off	Off	Off	Off
Comm Fail:	Hold	Hold	Hold	Hold

### Tag Names

This is where you enter the names that will show up on the various HMIs for each Digital Output.

### Visible

Check these boxes to make individual Digital Outputs “visible” on the HMIs

### Force

Over-ride the actual Digital Output signal state as ON or OFF. Digital Outputs can be “forced” ON or OFF to support system troubleshooting and to temporarily operate control devices. Forcing causes the 2500S module to leave an output in a certain state and ignore commands to change the output state. Forcing is non-volatile and the forcing of each output can be set individually via the configuration web interface or via communications registers.

**On/Off Time & Mode** When a Digital Output is commanded ON, based on its configured Mode, it may provide a single pulse, a delayed pulse, or a toggling (alternating) output. These three settings per channel configure the outputs operation for each output.

**Recycle Holdoff** When an output has been turned OFF, the I/O module will not let the output turn back ON for the specified time. This feature is used to protect large motors.

### Link to DO

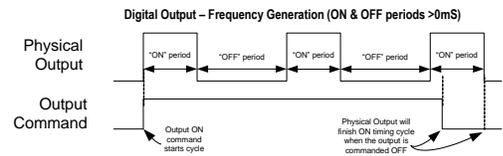
This pull-down list is used to select an alternative source for the DO. For example, the output can be “connected” to one of the pump control block or setpoint block outputs for local control functions.

### Comm Fail

Sets how the I/O module should manage each outputs state when communications fails: Hold, turn OFF or turn ON.

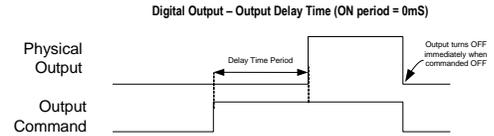
## PWM

If the output mode is set to “PWM” (Pulse Width Modulation), the digital output will continually cycle ON and OFF for the specified times as long as the output is commanded “ON”. This mode is frequently used with heaters, metering pumps and other devices that are controlled by varying their ON to OFF time duty cycle ratio.



## Delay

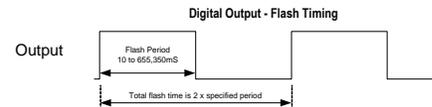
If the output mode is set to “Delay”, the output will be delayed for the specified time period, and then turned ON until it is commanded OFF.



A typical application is duplex pump control, where by setting the delay times differently between two pump call outputs, the pumps will not turn ON simultaneously, avoiding high peak power demands and stressing pipes with pressure surges.

## Flash

If the output mode is set to “Flash”, a digital output can be “flashed” at a configurable rate specified in milliseconds. Flashing is **synchronized** between all outputs channels configured to flash. This function is generally used to operate visual or audible alarm annunciators and avoid a visual “wave” effect.



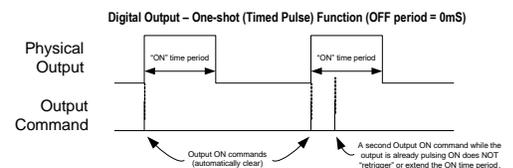
The flashing period is settable in 10mS increments from 10mS to 655,350mS (655 seconds). The flash rate is set on the main I/O Config page. The flash time is the ON or OFF time (half the total cycle time), so that the total flash period (ON + OFF time) is twice the time specified (50% duty cycle).

## Toggle Modes

If the output mode is set to “Toggle” or “OS Toggle”, a digital output can be alternately turned on and off. For example, this can be used to emulate a push on – push off pushbutton switch if the output is “linked” to a pushbutton input. Both toggle modes alternate the output on a positive transition of the output being turned “ON”. The “Toggle” mode requires the output to be commanded ON, and then commanded OFF. The clearing primes the next toggle. In the “OS Toggle” mode, each time the output is commanded ON, the physical output will toggle and then turn OFF after the specified time period.

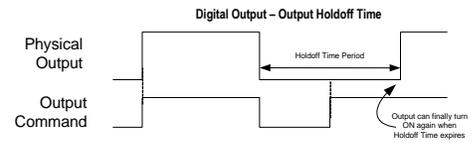
## OS Pulse ON

If the output mode is set to “OS Pulse ON”, a digital output will be pulsed ON for the specified time period and then turned OFF (one-shot), after a delay of the specified “OFF” time, each time the channel is commanded “ON”. It is not necessary to command the channel OFF again before re-firing the output. If a second output ON command is received while the output is already ON, the output time will be “retriggered”. A typical application is control of motorized actuators and dampers to move an approximate distance based upon actuation time.



### ***Output Holdoff (Rapid Cycling Protection)***

The 2500S Digital Outputs can be protected against rapid cycling of the individual outputs that could damage certain devices such as high horsepower motors and pumps. There is no delay time if the outputs have been OFF for the specified amount of holdoff time. This feature can also enforce a well “recharge” time. If an outputs holdoff value is set to a non-zero value, the output will be held OFF for the specified amount of time from when it was turned OFF even if it is commanded to turn ON again.



### ***Communications Failure Output States***

The 2500S Digital Outputs can be individually set to predetermined states when a communications failure occurs, providing a degree of failsafe protection. Each individual Digital Output can be set to hold its last state, turn OFF or turn ON. Communications failure detection can be enabled individually on each port. When communications is restored, the outputs will remain unchanged until written to by the Host system (they are not automatically restored to their pre-failure condition).

A typical application might turn a set of well pump outputs OFF when communications from a tank (tank level used to control the pumps) fails, in order to avoid overfilling the tank.

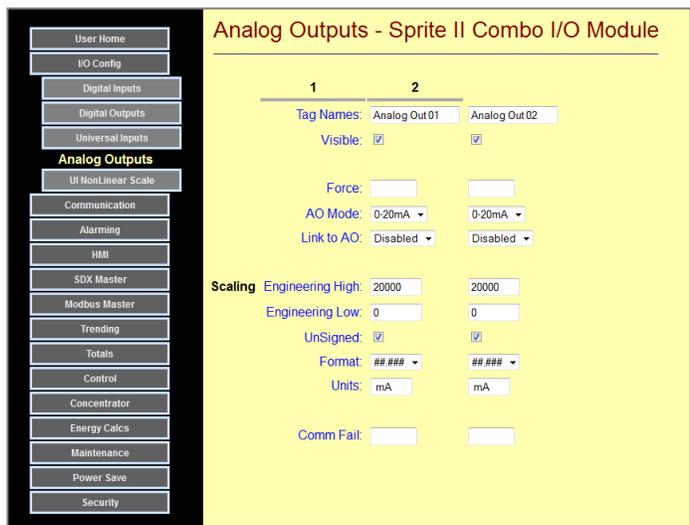
## Universal Inputs Configuration

The screenshot shows the configuration interface for the Universal Inputs of a Sprite II Combo I/O Module. The interface is split into two columns for channel 1 and channel 2. The configuration options include:

- Tag Names:** Universal In 1, Universal In 2
- Visible:**  for both channels
- Force:** (empty fields)
- Mode:** 0-20 mA (dropdown) for both channels
- Speed:** 62.5mS (dropdown) for both channels
- Averaging (samples):** 32 (dropdown) for both channels
- Scaling:**
  - Engineering High: 20000
  - Engineering Low: 0
  - Offset: 0
- UnSigned:**  for both channels
- Format:** #### (dropdown) for both channels
- Units:** (empty fields)
- Totalizer:**
  - Visible:
  - Divisor: 1
  - Format: ##### (dropdown)
  - Units: cnts

- Tag Names** This is where you enter the names that will show up on the various HMIs for each Universal Input.
- Visible** Check these boxes to make individual Universal Inputs “visible” on the HMIs
- Force** Over-ride the actual analog reading on a Universal Input
- Mode** Selects the type of sensor conditioning for each Universal Input. Universal Input can support 0-20mA, 4-20mA, 0 -1mA, +/- 100mV, 0-250mV, 0-2Vdc, 0-5Vdc, 0-30K ohms, 0-300K ohms, Thermocouples (types J,K,T,E,R,S,B), 2 and 3-wire RTDs (10, 100, 1000 ohm) and 10K thermistors (type II and III). (xxNL) = Non-linear scaling (user entered table)
- Speed** Sets the conversion speed for each channel, from 1.2mS to 125mS. Slower speeds are better for noise rejection, but with a high-speed Ethernet interface, you may want faster conversions.
- Averaging** The I/O module can continually average the last 2, 4, 8, 16, 02 32 readings to filter out noise.
- Scaling** Provides a means of calculating measurements into engineering units (such as mA to feet or GPM), format with a decimal point, and attach a units label (up to 4 characters). Enter engineering low and high values for the raw input range for linear scaling; 0 to 20000 for 0 to 20mA, 0 to 50000 for 0 to 5Vdc, or 0 to 30000 for ohms. The temperature measurement modes read out as temperature x 10 (32.5° reads as 325). Check “unsigned” for raw values that exceed 32,767.
- Totalizer** Controls for making the measured totals “visible” for a channel, and scaling them to engineering units.

## Analog Outputs Configuration



- Tag Names** This is where you enter the names that will show up on the various HMIs for each Analog Output.
- Visible** Check these boxes to make individual Analog Outputs “visible” on the HMIs
- Force** Over-ride the analog signal on an Analog Output
- AO Mode** Sets the full scale output to 0-20mA, 4 to 20mA, or 0-1mA.
- Link to AO** Tie an analog input, rate or energy calculation, or a concentrator register to an analog output. For example, this can be used to create an analog transmitter or a rate/energy to analog converter.
- Scaling** Sets the displayed engineering values displayed for the analog output range. Check “unsigned” for raw values that exceed 32,767.
- Comm Fail** Sets how the I/O module should set the output level when communications fails: Blank leaves the output at its last level, otherwise 0 to 20,000 for 0 to 20mA.

## Non - linear Scaling Configuration

2500S modules can perform non-linear scaling for some current and voltage measurement modes. When a non-linear scaling mode (NL) is selected, the module looks at the values entered in a table at 5% increments to extrapolate a scaled value. This technique may be used to linearize volume and flow readings from odd shaped tanks, canals, etc. to name a few. Individual non-linear scaling tables are provided for each analog input and universal analog input.



## Communication Configuration Pages

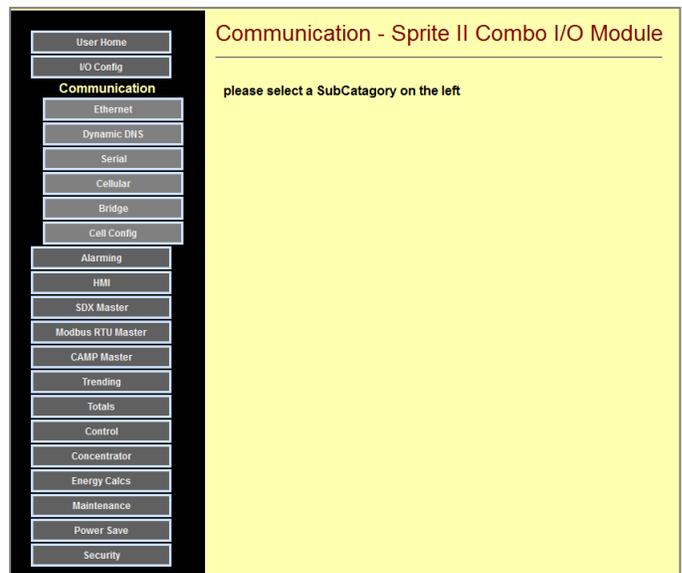
2500S modules connect to a large variety of 3<sup>rd</sup> party equipment, using industry standard communications protocols. These include:

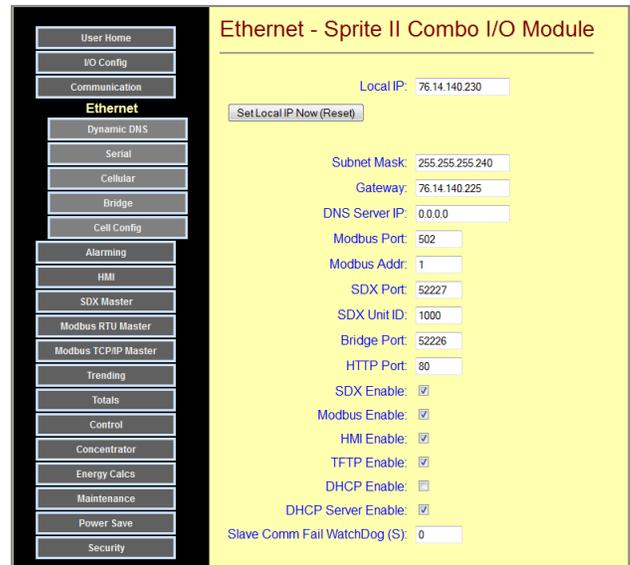
- **Modbus** (I/O module and TCP/IP)
- **DF1** (Allen Bradley serial)
- **SDX** (Secure Data Exchange – encrypted data over Ethernet and serial)
- **HTTP** – Web pages over Ethernet
- **TFTP** – File Transfer Protocol over Ethernet

The first four protocols in the list are used to transfer register data, such as with a Programmable Logic Controller or HMI software package. The later are used for data presentation on web pages and transferring collected data in files over a network or the Internet.

2500S modules normally operate as slaves, responding to requests initiated by another device. They do though have a “Master Mode” that enables them to initiate message transmissions, periodically, or on level or status changes. This section is used to configure the communications functions of a 2500S module, including protocols, addresses, features and hardware configuration items.

Configuration of communication functions is done under the **Configuration | Communication Config** button and additional buttons for configuring the Ethernet, Dynamic Name Server, Optional Serial and Internal Radio, and bridging functions.





- Local IP** This is the Ethernet address, Subnet Mask and Gateway (router) address) of the 2500S
- Subnet Mask** module. Note that the Gateway address is only required if you need to access the 2500S
- Gateway** module through a router, such as when the module is connected to the Internet. Be careful – if you change these settings, you will have to change the IP address setting in your browser, and possibly the network settings in your computer. The setting changes take effect immediately when entered.
- DNS Server IP** This is the network address of a name server to be used for Name to IP address translation. This is only needed for “Master Mode” over Ethernet, where the destination is a name, not and address. This is typically used over the Internet.
- Ports** Every Ethernet protocol uses a “port” number. There are default numbers for each protocol, but they can be changed, typically for security reasons.
- Addresses & Unit IDs** These fields set the device addresses used by Modbus and SDX. They are really “sub” addresses of the modules IP address, so that multiple devices can be addressed at a single IP address.
- Enables** 2500S modules allow for several different protocols to be used. Unused protocols typically should be disabled here to avoid possible unauthorized access.
- Comm Fail W’dog** If this value in non-zero and a message has not been received with the specified time period, a communications failure will be detected. When this occurs, outputs will be set to go to preset states (see I/O configuration – Digital and Analog Outputs).

## Configuring Ethernet Operation

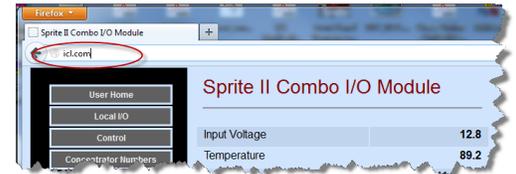
2500S I/O modules support Ethernet as the primary means of both communications and configuration. The 2500S I/O modules use web pages for both configuration and user information display. The I/O modules use Modbus TCP/IP and SDX for register data communications through the serial port. If you intend to use a 2500S I/O module on an existing network, most likely you will need to change the I/O modules Ethernet settings.



**CAUTION: DO NOT connect the I/O module to an existing Ethernet network without first verifying that its address settings will not cause it to interfere with any other devices on the network.**

To configure the Ethernet port, you must be logged into the I/O module. This is a bit of a Paradox, but it's easier than you think. First of all, when 2500S I/O modules ship from the factory, they have a default address of **192.168.1.199**. To communicate with the I/O module, you will need to set your computer to a static IP{ address that is similar but not exactly the same). For example **192.168.1.100**. If you're not sure how to change your computer IP address settings, please contact technical support.

The I/O modules also ships with its own address server enabled. This allows you to access the I/O modules web pages without knowing it's address. Simply plug in your laptops Ethernet port (set to obtain an address), what about a minute, and then enter "**CTI.com**" into the address bar.

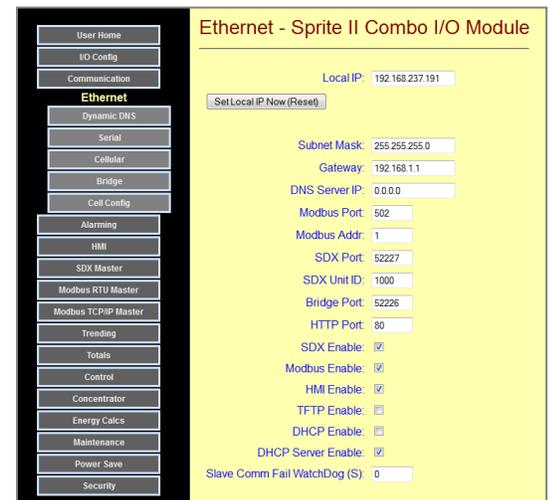


Once you successfully bring up the "home page", then . . .

- 1) Go to the **Configuration | Communication | Ethernet** page.
- 2) Set the Local IP, Subnet Mask and Gateway to whatever address your network administrator tells you. The first three digits will probably be the same as the other equipment on the network, and the last (far right) digit will be unique.



**NOTE: All IP setting changes take effect right away except for the IP address. If you want changes to it to take effect, click on the "Set Local IP Now" button or reset/cycle power to the I/O module.**

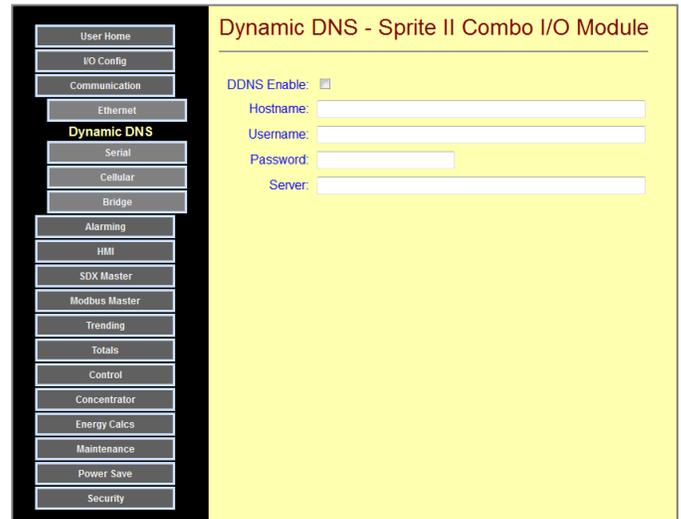


- 3) Generally, to get started, you can leave the other settings at their factory defaults, except:
  - a) Set the Modbus Address and SDX address if you are going to use this I/O module as part of a networked system
  - b) Consider unchecking any protocol enable boxes for protocols that will not be used.
  - c) Uncheck the DHCP Server Enable box if you are going to connect this I/O module to a network that already has a name server.

- 4) If you are using I/O mirroring, or some other device polling the I/O module, set the Slave Comm Fail Watchdog time a little longer than the twice the polling time. In the I/O Configuration area, be sure to set up the comm. fail outputs levels and states.

## Dynamic DNS Configuration

Sometimes, 2500S modules need to be installed without a fixed or “static” IP address. This is typically the case when the module is connected to the Internet or into a cellular data network. In these situations, the module is provided a temporary address by the network provider’s equipment. This temporary address can change at any time making it difficult to reliably communicate with the module. To solve this problem, 2500S modules can use a Dynamic DNS service. Each time the 2500S module powers up or anytime a new address is received, the 2500S module reports its new address to the Dynamic DNS server. That way, the module can be accessed by its name, and the Dynamic DNS server translates this to the latest IP address assigned.



The recommended Dynamic DNS services are [www.no-ip.com](http://www.no-ip.com) and [www.dyndns.com](http://www.dyndns.com) Cost is minimal to free with either service.

- DDNS Enable**            Select this box to enable the Dynamic DNS functionality
- Hostname**                These are configuration items that will be set up when you sign up with the Dynamic
- Username**                DNS Service provider
- Password**
- Server**

### Setting Up Dynamic DNS

Dynamic DNS is a technique supported by 2500S modules to provide remote access without having to receive static IP address assignments from Internet Services Providers (ISPs).

#### DNS

To explain Dynamic DNS, one must first explain DNS (Domain Name System). When you type an address into the address field of your browser (or click on a link in a web page), before the page can load, the name that you typed is submitted to your Domain Name System server and a lookup is done using the domain portion of the address. Examples of domain names are “yahoo.com” and “google.com”. The “www.” of the address usually applies to a specific server (computer) at the domain itself. For example, “www.yahoo.com” can be a different IP address than “mail.yahoo.com” even though they are technically on the same domain.

There is more to this than just making the IP address more palatable to our eyes and memory. If the underlying IP address changes, the same server name can be used for the new IP address. The end user never sees that the IP address has changed and has no real need to. This is the primary purpose of the DNS protocol.

User enters the DNS name.

The browser sends the name to the DNS server.

DNS server looks up the IP address.

The IP address is returned to the browser.

The browser then gets the page information requested from the IP address.

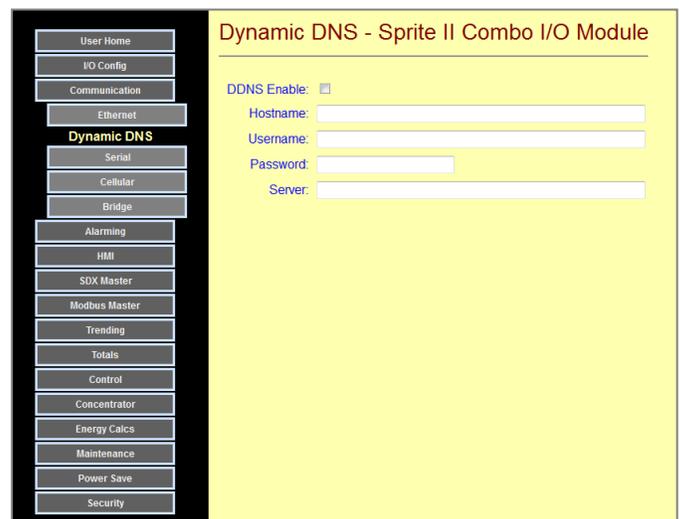
Most servers out on the Internet use a static IP address to identify themselves to the rest of the Internet which means the IP addresses change little unless the owners change providers or reconfigure their own networks.

## DHCP

The purpose of Dynamic Host Control Protocol is to not only simplify the tracking of IP addresses, Gateways, Network Masks and DNS Servers but also to reuse the limited number addresses on the Internet. For this reason your Internet Service Provider (ISP) prefers that you use dynamic IP addresses that it provides and charges less for them than static IP addresses. Since most Internet connections (browsers) are clients, this works fine for most users. When using a controller or an I/O module however, it is far more likely that either of these devices need to act as servers so that I/O and other data they contain can be accessed from the outside world. When using DHCP, it is possible to access your IP address even though it is “dynamic”. With Dynamic DNS, a name is provided by a DDNS server that will be applied to whatever IP address your I/O module or controller is given.

## Dynamic DNS

The purpose of Dynamic DNS applies to dynamically obtained IP address on the Internet. It allows a non static IP address to be used as a named server to access an I/O module or controller residing behind a router or firewall. This address can change anytime the router/firewall gets disconnected or powered down. All that is required to utilize this functionality is a free account on a Dynamic DNS server. CTI modules can easily utilize and have been tested with two different DDNS servers: **No-IP.com** and **DynDNS.com**.



The screenshot shows a web interface for configuring Dynamic DNS on a Sprite II Combo I/O Module. On the left is a vertical sidebar with buttons for various settings: User Home, I/O Config, Communication, Ethernet, Dynamic DNS (highlighted), Serial, Cellular, Bridge, Alarming, HMI, SDX Master, Modbus Master, Trending, Totals, Control, Concentrator, Energy Calcs, Maintenance, Power Save, and Security. The main panel is titled 'Dynamic DNS - Sprite II Combo I/O Module' and features a 'DDNS Enable' checkbox which is checked. Below it are four input fields: 'Hostname', 'Username', 'Password', and 'Server'.



*In the examples on the next page, you must use your own usernames, email addresses and passwords. These parameters below are strictly examples.*

### ***DDNS on No-Ip.com***

Setup an account with No-Ip.com. This requires a valid email address, a password, your name, and some answers to a security questions. You will receive an email to confirm your account. Click on the activation link and activate your No-Ip account.

Goto [www.no-ip.com](http://www.no-ip.com) and log in with your email address and password you used above. In this example, we are using 2500S@hotmail.com and mypassword—you should use your own email and password.

Click on “Add a Host”.

Enter a Host Name for this example we are using “2500Smaster”

Select a domain name—for this example we are using “no-ip.org”

This will give you a domain name of “2500Smaster.no-ip.org”.

- Get to the Dynamic DNS configuration (see Web Page Configuration section)
- Go to the 2500S [Communications | Dynamic DNS web page](#)
- Check the **DDNS Enable: [x]** checkbox
- Enter the **Hostname** (2500Smaster.no-ip.org)
- Enter your email
- address in the **Username** field (ex. 2500S@hotmail.com)
- Enter your **Password** above (ex. mypassword)
- Enter the **Server** for no-ip.com which is “dynupdate.no-ip.com/nic/update”
- Click the Update button.

### ***DDNS on DynDNS.com***

Goto **[www.dyndns.com](http://www.dyndns.com)**

Enter a free domain name and click Add

Enter a Username, they will not accept an email address.

Enter a Password (ex. mypassword).

Enter an email address (ex. 2500S@hotmail.com)

Enter the security information

Click Create Account

You will receive an email on the account given

Click on the link to complete the account creation process.

To check your setup, go to the Testing Your DDNS Configuration section.

- Get to the web page configuration (see Web Page Configuration section)
- Go to the 2500S [Communications | Dynamic DNS configuration web page](#)
- Check the **DDNS Enable** checkbox
- Enter the **Hostname** (2500Smaster.dyndns.org)
- Enter your account **Username** (from the first step when you created your DynDNS account)
- Enter your **Password** above (mypassword)
- Enter the **Server** for dyndns.com which is “members.dyndns.org/nic/update”
- Click the Update button.

## Testing Your DDNS Configuration

Be sure that you have a static IP on your internal network and that your Network Mask, Gateway, and DNS Server are setup properly to get out to the Internet.

Power cycle the unit to get it to send out the DDNS login. You can check to see that it was successful in several ways. Go to the **User Home** page and click on the **Status** link. On this page is a item called “Response Code”—this item should read 1000. If there was an error logging on to the no-ip.com server, then a 2000+ error will be displayed:

1000	DyDNS_GOOD	Dynamic DNS Service has been successfully Updated.
2000	DyDNS_NoDNS	Aborted DDNS Server IP is 0.0.0.0 or the Dynamic DNS Server name is blank
2001	DyDNS_BadResponse	DDNS Service got a Bad response from the Dynamic DNS Server
2002	DyDNS_Timeout	DDNS Service was aborted because of a bad configuration or timeout
2100	DNS_BadResponse	Bad response from DNS Server
2200	DHCP_Timeout	DHCP did not finish. We will retry again

Open a command prompt in windows and type nslookup <yourname.yourselecteddomain>. An IP address should come back confirming that the lookup is successful.

## Opening the Ports on Your Router/Firewall.

The only thing left to do is open a couple of ports in your router. This is different for every router/firewall. The ports you should redirect to your internal IP address are:

Protocol	Port Number	Protocol Type
HTTP	80	TCP/IP
SDX	52227	UDP
Modbus TCP/UDP	502	TCP/IP and or UDP

To get to the web pages on the unit, type http://yourname.yourselecteddomain. If the configurations of the router are correct, you should be able to access your I/O module.

## Serial Communication Configuration

2500S modules can be ordered with an optional internal serial port that supports both RS-232 and RS-485 communications. If this option is installed, the communications baud rates, protocols and repeaters functions are configured on these pages.



### Baud Rate/Parity

This sets the speed and parity used to communicate with an external device or radio through the optional serial port. It must match the settings of the device itself. 115,200 baud and no parity (“none”) are the factory default settings.

### Modbus/DF1/BN Address

Modbus and DF1 protocols require that every device have an address. This same 8-bit address (settable up to 255) for all of these protocols regardless of which of these is used. This is NOT the same address as is used for SDX which is a 16-bit address that can be set up to 65535.

### SDX Unit ID

This is the local address of the 2500S module for its native SDX protocol. This can also be set on the individual port configuration pages.

### Enables

2500S modules allow for several different protocols to be used. Unused protocols typically should be disabled here to avoid possible unauthorized access.

### TxEn Delay

This value sets the amount of time that the Request-to-Send (RTS) signal and RS-485 transmitter enable signals are turned ON before data is transmitted. This allows older radios to “key up there transmitter” circuits and RS-485 lines to stabilize. Older radios may need up to 1 second (1000 mS), and RS-485 links may need up to 5mS.

### Comm Fail W’dog

If this value is non-zero and a message has not been received with the specified time period, a communications failure will be detected. When this occurs, outputs will be forced to preset states (see I/O configuration – Digital and Analog Outputs)

### Modbus S&F

These parameters are used to configure “Store and Forward” operation using Modbus protocol over any serial or wireless link. Additional information on how store and Forward operation works using Modbus, please refer to Appendix A - Protocol Support (Modbus Communications).

## Using the Optional Serial Port as a SCADA Slave

2500S I/O modules support Modbus, DF1, SDX (encrypted secure CTI protocol) communications protocols as a slave, through an optional serial port. For proper operation with equipment interfaced to this port, you will need to set up basic communications parameters such as baud rate, address, etc. Also, for security purposes, only the protocols that you are using should actually be **enabled**. In this description, as a special case for Modbus based systems peer-to-peer (VHF or UHF) radios, the Slave can also be configured as a “Store-and-Forward repeater. The following is a step-by-step procedure for configuring a 2500S I/O module to respond to various serial protocols. You will need to use this procedure when you are setting up a mirrored I/O system, or simple remote I/O modules for a full SCADA system using external radios or modems.

- 1) Go to the **Configuration | Communication | Radio** page.
- 2) Set the baud rate and parity to match the external radio or modem. The factory setting is 115,200 baud, no parity.
- 3) Set the address under Modbus/DF1 for all protocols except SDX. These can range from 1 to 255 (0 is OK for DF1). For SDX, set the “SDX Unit ID” can be any address from 1 to 65535.
- 4) Check the appropriate box(s) for the protocol(s) that you want to enable. Uncheck the others for security. Do NOT enable DF1 and Modbus at the same time as they will conflict with each other.
- 5) If you are using I/O mirroring, or some other device polling the I/O module, set the Slave Comm Fail Watchdog time a little longer than the twice the polling time. In the I/O Configuration area, be sure to set up the comm. fail outputs levels and states.

The screenshot displays the configuration page for the Serial - Sprite II Combo I/O Module. On the left is a vertical navigation menu with buttons for various system settings. The main area on the right is titled 'Serial - Sprite II Combo I/O Module' and contains several configuration fields. The 'Serial' section includes Baud Rate (115,200), Parity (None), Modbus/DF1/BN Addr (1), SDX Unit ID (1000), SDX Enable (checked), Modbus Enable (checked), DF1 Enable (unchecked), BrickNet Enable (checked), TxEn Delay (mS) (2), and Slave Comm Fail WatchDog (S) (0). The 'Modbus S&F' section includes In Address (0), Out Address (0), and Block Size (0).

### For Modbus Store & Forward with Peer-to-peer radios

- 1) **If you are using radios that support peer-to-peer communications**, and want this Slave to also act as a Modbus repeater using the I/O module, then follow these steps.
- 2) Set the first address or addresses of a block that the Master will use to communicate with the remotes as the “In Address”
- 3) Set the starting address of that these addresses will be translated too. These are the actual addresses used by the remotes. The 2500S module will take in the incoming addresses and rebroadcast the messages to the translated address.
- 4) Set the block size (the number of address to be translated).

## Radio Communication Configuration

2500S modules can be ordered with an optional internal radio, either from Digi or Freewave. If either of these radios are installed, their communications interface baud rates, protocols and repeaters functions are configured on this page.

The radios used in 2500S modules are intelligent devices in and of themselves, so they have settings that affect their Radio transmission performance, and provide radio system diagnostic tools. A separate page provides direct access to the radio and its built-in configuration and diagnostic tools as described in the back of this section, one for Digi radios, the other for Freewave radios, both 2500S module options.

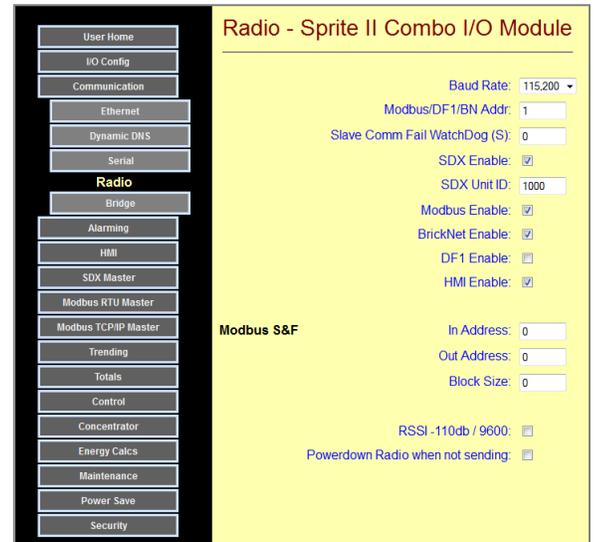


- |                              |  |
|------------------------------|--|
| <b>Baud Rate</b>             | This is the communications speed of the communications port connected to the internal radio module. Note that this may be different from the actual “over the air” data rate which is a setting in the radio itself. As shipped from the factory, all internal radios are configured for 115,200 baud. |
| <b>Modbus/DF1/BN Address</b> | Modbus and DF1 protocols require that every device have an address. This same 8-bit address (settable up to 255) for all of these protocols regardless of which of these is used. This is NOT the same address as is used for SDX which is a 16-bit address that can be set up to 65535.               |
| <b>SDX Unit ID</b>           | This is the local address of the 2500S module for its native SDX protocol. This can also be set on the individual port configuration pages.  |
| <b>Protocol Enables</b>      | 2500S modules allow for several different protocols to be used. Unused protocols typically should be disabled here to avoid possible unauthorized access.  |
| <b>Comm Fail W'dog</b>       | If this value is non-zero and a message has not been received within the specified time period, a communications failure will be detected. When this occurs, outputs will be forced to preset states (see I/O configuration – Digital and Analog Outputs)  |
| <b>Modbus S&amp;F</b>        | These parameters are used to configure “Store and Forward” operation using Modbus protocol over any serial or wireless link. Additional information on how store and Forward operation works using Modbus, please refer to Appendix A - Protocol Support (Modbus Communication)                        |
| <b>RSSI -110db/9600</b>      | For Digi radios only. Check this box if the Digi radio is set for 9600 baud over-the-air communications to properly calibrate the RSSI indication.   |
| <b>Radio Power Down</b>      | Check this box for extra low-power operation in wake up on change systems.   |

## Using the Optional Internal Radio as a SCADA Slave

2500S I/O modules support Modbus, DF1, SDX (new secure CTI protocol) communications protocols as a slave, through an optional internal radio. For proper operation, you will need to set up basic communications parameters such as baud rate, address, etc. Also, for security purposes, only the protocols that you are using should actually be **enabled**. In this description, as a special case for Modbus based systems using Xtend radios, the Slave can also be configured as a “Store-and-Forward repeater. The following is a step-by-step procedure for configuring a 2500S I/O module to respond to various serial protocols. You will need to use this procedure when you are setting up a mirrored I/O system, or simple remote I/O modules for a full SCADA system using internal radios.

- 1) Go to the **Configuration | Communication | Radio** page.
- 2) Set the baud rate to match the internal radio. The factory setting is 115,200 baud.
- 3) Set the address under Modbus/DF1 for all protocols except SDX. These can range from 1 to 255 (0 is OK for DF1). For SDX, set the “SDX Unit ID” can be any address from 1 to 65535.
- 4) Check the appropriate box(s) for the protocol(s) that you want to enable. Uncheck the others for security. Do NOT enable DF1 and Modbus at the same time as they will conflict with each other.



**Radio - Sprite II Combo I/O Module**

Baud Rate: 115,200

Modbus/DF1/BN Addr: 1

Slave Comm Fail WatchDog (S): 0

SDX Enable:

SDX Unit ID: 1000

Modbus Enable:

BrickNet Enable:

DF1 Enable:

HMI Enable:

**Modbus S&F**

In Address: 0

Out Address: 0

Block Size: 0

RSSI -110db / 9600:

Powerdown Radio when not sending:

- 5) Xtend radios can be configured to operate at two different speeds “over the air”; 9600 baud or 115K baud. The slower speed has 10db better sensitivity. To calibrate the RSSI (Received Signal Strength Indication) value, please check the appropriate box if you are going to run 9600 baud.
- 6) If you are using I/O mirroring, or some other device polling the I/O module, set the Slave Comm Fail Watchdog time a little longer than the twice the polling time. In the I/O Configuration area, be sure to set up the comm. fail outputs levels and states.

### For Modbus Store & Forward with Xtend radios

- 5) **If you are using Xtend internal radios** and want this Slave to also act as a Modbus repeater using the I/O module, then follow these steps.
- 6) Set the first address or addresses of a block that the Master will use to communicate with the remotes as the “In Address”
- 7) Set the starting address of that these addresses will be translated too. These are the actual addresses used by the remotes. The 2500S module will take in the incoming addresses and rebroadcast the messages to the translated address.
- 8) Set the block size (the number of address to be translated.

# Communication Bridging Configuration

Bridging is the automatic routing of messages from one communications port/medium to another communications port/medium. For example, messages from a PC may come in through the modules Ethernet port. The module automatically determines that it must be routed to an optional serial port or radio port, creating a “vii/O moduleal” port for the PC. This allows devices such as PCs to share a 2500S modules wireless or Ethernet resources. For example, a serial badge reader on a serial port accessible through the internal radio of a 2500S module. Bridging can be configured between any pair of ports.



Bridging can be configured to transparently pass messages, or for known protocols such as Modbus, convert between the Ethernet and serial protocol formats as required. This selection is available for Ethernet bridging.

The look and elements on this page will vary depending on the installed communications ports and options.

- Eth <-> Serial** This drop down menu is available for modules with an optional serial port or internal
- Eth <-> Radio** radio to enable bridging, and to select between transparent and protocol modes.
- Serial <-> Radio** A checkbox to enable bridging between the serial port and radio. No protocol translation is available for this mode.
- Packet Timeout** This is a timing parameter to determine when the end of a message is received. If no characters are received in this time period, the message is forwarded.
- Bridge Port Values** The Bridge Port is the Ethernet port at the modules address that software transfers data through. You will need to configure the Bridge Port values to match software such as vii/O moduleal serial port on your PC. By default, response messages will be sent back to the port number from which the last bridging message was received, unless the “Respond to Bridge Port” check box is selected. In this case, the same Bridge Port address as in the module is used. You may need to contact technical support for specific applications.
- Destination IP** For Serial Port or Radio to Ethernet bridging, sets the IP address that the encapsulated messages should be sent to.

## Configuring the Xtend Radio Option

Xtend radios feature the ability to operate peer-to peer (no Master) and have very fast turn-around times for high actual message throughput. They can also be set to various “hopping” configurations so that multiple networks of Xtend radios can operate in close proximity, but not interfere with each other. A series of AT modem style commands are used to configure the radio through a special configuration web page provided.

1) Go to the **Configuration | Communication | Radio Config** or the **Configuration | Maintenance | Radio Config** page.

2) Click on the “Init (+++)” button at the top. You should see an “OK” response on the screen. If any of the following commands don’t seem to work, try clicking on the “Init(+++)” button again. If there is too long a delay, the radio will time out and you will need to send this command again.



Command	Description	Parameter
ATBR	RF Data Rate	0(9600),1(115200)
ATCN	Exit Command Mode	none
ATCT	Command Mode TimeOut	2 - 0xFFFF
ATDT	Destination Address	0 - 0xFFFF
ATHP	Hopping Channel	0 - 9
ATMK	Address Mask	0 - 0xFFFF
ATMT	Multi-Transmit	0 - 0xFF
ATMY	Source Address	0 - 0xFFFF
ATWR	Write (Save changes)	none
ATRC	Ambient power - Single Chl	0 - 0x31 [dBm, read-only]
ATRM	Ambient power - All Channels	none - 0x7D0

3) Click on the “ATBR” command and hit “Send” (or press the Enter key on your keyboard). It should say that it’s equal to 0 (9600 baud) or 1 (115,200 baud). The lower speed provides greater sensitivity. If you want to change it, click on the “ATBR” again and enter “=0” or “=1” after it in the entry window, then press “Send”. Make sure that all radios in the system are set the same.

4) Click on the “ATHP” command and hit “Send” (or press the Enter key). It should return a value from 0 to 9. All radios in the system must be set to the same value, and different from any other nearby systems. If you want to change it, click on the “ATHP” followed by the new number, and click on “Send”

5) Click on “ATWR and hit “Send” (or press the Enter key) to make all of the changes final. Then click on “ATCN” to exit the configuration mode.

## Diagnosing Interference issues with Xtend Radios

The success of a radio data transmission depends heavily on the ratio of incoming signal strength to received noise. A weak signal in a “clean” environment may actually be more reliable than a strong signal amongst heavy interference.

Xtend radios provide a means of checking the background signal levels using the “ATRM” command for all frequencies, and the “ATRC” for one specific frequency. When a value is added to the end of the command, this command will scan each of the 50 frequencies that the radio can use, and report the signal strength. If no other radios in the system are transmitting (make sure that you turn OFF any polling Masters!), then any signal greater than the minimum will compete with the real data signal, potentially corrupting the message. By entering a value after the command, the radio will scan the frequency or frequencies and report the peak result over those multiple scans. This may give a better indication of sporadic interference than a single scan.

```
OK
ATRM
Ch 0 -104 dBm
Ch 1 -104 dBm
Ch 2 -104 dBm
Ch 3 -104 dBm
Ch 4 -104 dBm
Ch 5 -104 dBm
Ch 6 -104 dBm
Ch 7 -104 dBm
Ch 8 -104 dBm
Ch 9 -104 dBm
Ch 10 -104 dBm
Ch 11 -104 dBm
Ch 12 -104 dBm
Ch 13 -104 dBm
Ch 14 -104 dBm
Ch 15 -104 dBm
Ch 16 -104 dBm
Ch 17 -104 dBm
Ch 18 -104 dBm
Ch 19 -104 dBm
Ch 20 -104 dBm
Ch 21 -104 dBm
Ch 22 -104 dBm
Ch 23 -104 dBm
Ch 24 -104 dBm
Ch 25 -104 dBm
Ch 26 -104 dBm
Ch 27 -104 dBm
Ch 28 -104 dBm
Ch 29 -104 dBm
Ch 30 -104 dBm
Ch 31 -104 dBm
Ch 32 -104 dBm
Ch 33 -104 dBm
Ch 34 -104 dBm
Ch 35 -104 dBm
```

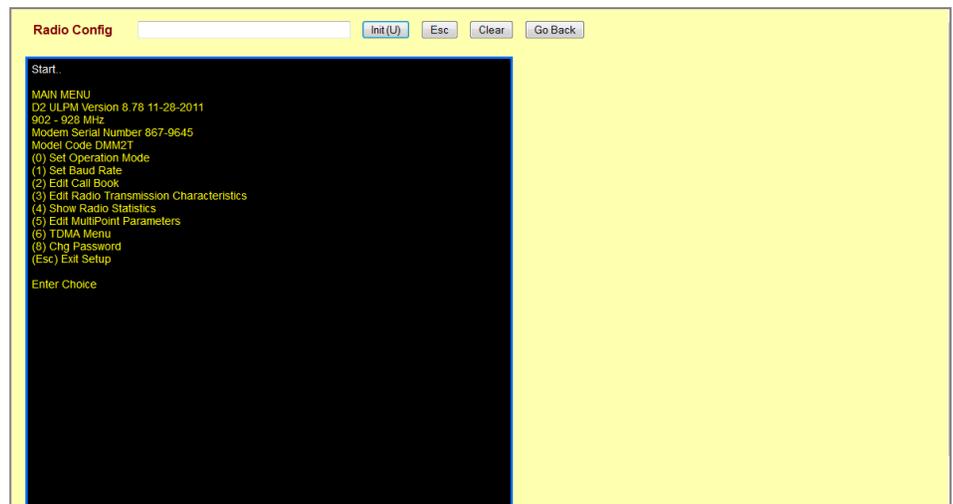
The signal levels are displayed in dB. Depending on the “over the air” speed setting (ATBR), the minimum reported signal strength is -104db for 115,200 baud (ATBR=1) and -110dB for 9600 baud (ATBR = 0). Be sure that no part of your system is generating radio messaging (like a SCADA master) when you are evaluating these readings. In general, the best radio system performance will be obtained when the background noise is less than -100db. If you are seeing noise levels significantly higher than this, you may want to install a bandpass filter which is available from CTI.

## Configuring the Freewave Radio Option

Freewave radios utilize a system of configuration menus to tailor their operation. Lowering their over-the-air data rate will not increase their sensitivity. They do have the ability to configure a radio to be a part of an isolated network which will not interfere with other Freewave radio in close proximity. Freewave radios do not support peer-to-peer operation, so one (and only one) radio must be configured as a “Master” and the remainder as “Slaves”. In polled system, normally the radio Master is the same as the radio used for polling (SCADA Master), since the slave radios can only “talk” to the Master, not to any other slaves.

Because Freewave radios do not support peer-to-peer operation, the only way to have them operate as both a slave and a repeater is by configuration of the radio itself. I/O module Store-and-Forward operation (Modbus) and dynamic routing SDX) cannot be used. This means that manual radio configuration is required whenever a radio/I/O module is replaced in the field.

- 1) Go to the **Configuration | Communication | Radio Config** or the **Configuration | Maintenance | Radio Config** page.
- 2) Click on the “Init(U)” button to put the radio into configuration mode.
- 3) In any menu, you can click on the “Esc” button to get back to the Main Menu, or in the Main Menu, you can click on the Esc button to get out of the configuration mode and back into normal operation.



- 4) If no activity is sensed for a while, the radio automatically turns off the configuration mode, so if the menu commands quit responding after a pause in your work, you may have to click on the “Init(U)” button again.
- 5) Generally, you will only need to change the settings in Menus 0 (Set Operation Mode), 3 (Edit Radio Transmission Characteristics, and 5 (Edit Multipoint Parameters). Editing values in any of the other menus can “break” a radio system. Please only do so with instruction from Technical Support.

## Configuring the Freewave Radio Operating Mode (Menu #0)

Freewave Radios must be set for an operating mode, depending on the role that they play in a system. There are eleven possible settings, of which only three are generally used in the 2500S I/O modules:

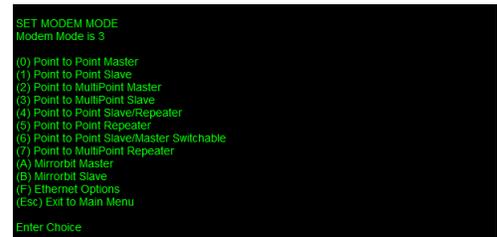
Mode	Description
(2)	Point to MultiPoint Master
(3)	Point to MultiPoint Slave
(7)	Point to MultiPoint Repeater (can also act as a Slave in this mode)

Please do not set the operating mode to any of the other modes without working with Technical Support.

The Radio Operating Mode is Menu Item #3 on the Main Menu (type in 3 in the entry field and press the “Enter” button to get to this page).

At the top of the page, the current Operating Mode is displayed (“Modem Mode is 3”).

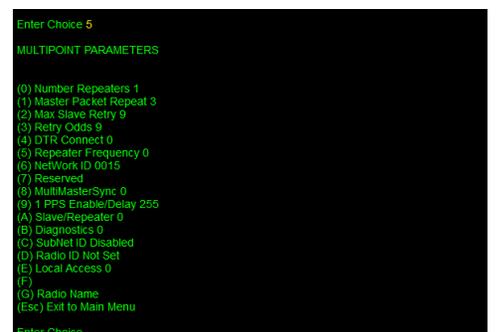
To change the Operating Mode, type in the number of the new mode (2, 3, or 7) in the entry field and press the “Enter” button.



## Configuring the Freewave MultiPoint Parameters (Menu #5)

Freewave Radios allow for radio transmission speeds, power and other performance settings to be changed through the Radio Parameters screen (#3). Generally, the factory settings should not be altered, unless instructed to by Technical support. The factory default settings are:

Selection	Description	Factory Value
(0)	Number of Repeaters	1
(1)	Master {Packet Repeat	3
(2)	Max Slave Retry	9
(3)	Retry Odds	9
(4)	DTR Connect	4
(5)	Repeater Frequency	0
(6)	Network ID	0015
(7)	Reserved	
(8)	MultiMaster Sync	0
(9)	1 PPS Enable Delay	255
(A)	Slave Repeater	0
(B)	Diagnostics	0
(C)	Subnet ID	Disabled
(D)	Radio ID	Not Set
(E)	Local Access	
(F)		
(G)	Radio Name	



Of these parameters, these are the ones that you may end up adjusting.

## (0) Number of Repeaters

This parameter must be set to a 1 if there are any radios configured as repeaters. The setting must be the same for all radios in the same system.

## (1) Master Packet Repeat

To increase the chances of a message getting through, the radio can be set to repeat the message multiple times. Redundant messages are automatically thrown away by the receiving radio. Setting this value to higher number can sometimes increase overall message throughput by eliminating retries, although it does significantly increase the amount of data sent for each message, which with a reliable link, will also degrade performance.

## (6) Network ID

Setting this value can isolate a radio system from another one nearby. The Network ID must be set the same for all radios in a system, and must not be set to 255, or to a value greater than 4095.

## (A) Slave/Repeater

Setting this value enables a radio to act as a repeater as long as the Repeater Operating Mode is also set to (7).

## (C) Subnet ID

This setting must be set to establish a repeater path in a Slave/Repeater.

There are two components to the Subnet ID:

1. Rcv Subnet ID. This setting identifies who a repeater or slave will listen to.
2. Xmit Subnet ID. This setting identifies the sub network this device transmits on, and in turn which devices will listen to it.

To disable the Subnet ID both Rcv Subnet ID and Xmit Subnet ID should be set to F.

**Note:** The Subnet ID settings are irrelevant for the Master.

**Note:** The Master always transmits on Subnet ID=0, regardless of the setting. To force communications directly through the Master the Slave or Repeater's Rcv SubnetID must be set to 0.

**Note:** The Subnet ID works only in Multipoint Networks using NetworkID.

**Note:** In typical Multipoint Networks the Freq Key must be at the same setting for all transceivers. If the SubnetID is used the sub network may be set to a different Freq Key.

**Note:** If both Rcv SubnetID and Xmit SubnetID are set to 0 the SubnetID will show **Roaming** in the menu. This setting will allow a mobile slave to roam from subnet to subnet within a network.

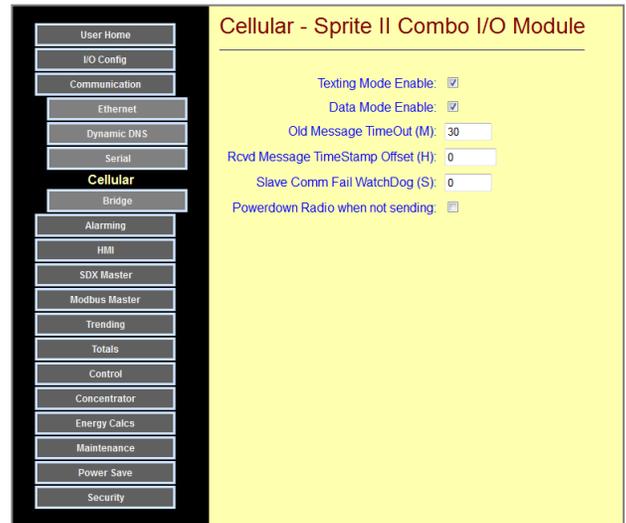


# Cellular Modem Configuration

When a 2500S module is configured with an optional cellular modem, the module can:

- Exchange data and I/O with other CTI modules and controllers with encrypted communications
- Annunciate alarms and provide a means of remotely acknowledging them
- Provide secure remote access from a cell phone to process data, setpoints and configuration

The cellular option uses text messaging for all of these functions, eliminating the need for complex “IP” installation configurations (just uses a telephone number) and at a significant cost savings over data plans.



- Mode Enables** For security, please disable unused modes of operation
- Old Msg Timeout** Occasionally, a cellular network delays message traffic – by a lot! This parameter prevent the module from taking control action on very old commands,
- Rcvd Msg TS Offset** Some cellular carriers provide timestamps that need to be shifted for the above timeout function to work properly, especially in locations near time zone boundaries. A “Last Cell Delivery Latency” reading on the Home Page can show how much of an offset is in the last received message. This can be used to correct for this cellular carrier “feature”.
- Comm Fail W’dog** If this value in non-zero and a message has not been received with the specified time period, a communications failure will be detected. When this occurs, outputs will forced to preset states (see I/O configuration – Digital and Analog Outputs)
- Power down Radio** When checked, the cellular modem will be powered down between transmissions. Do not use this function if you need to periodically send messages to this unit.

## Configuring the Cell Modem Option

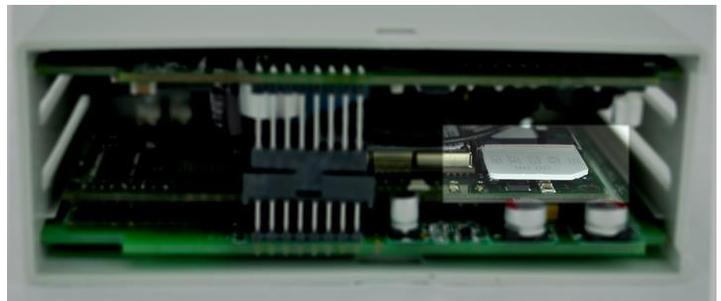
Unlike the internal radio options, there are really no configuration parameters required other than the basic factory configuration.

When the 2500S I/O module is received, you will need to register it and the cellular modem in the I/O module with the local carrier and the cellular system. This process differs depending on whether the cellular carrier uses GSM technology (AT&T, T-Mobile, Rogers, Telus, Bell, Claro, Movistar, Personal) or CDMA technology (Verizon, Sprint, Bell Mobility).

### GSM

For GSM technology carriers, your carrier will supply a SIM plastic “SIM” card that is electronically encoded with your account information. It must be inserted into the mating receptacle on the cellular modem board in the I/O module. The access to this receptacle:

- 1) Remove all cables from the front of the I/O module
- 2) Gently remove the black bottom of the I/O module by prying the sides slightly outward on both sides so that the cover slides over the retainer snaps.
- 3) Locate the SIM receptacle.
- 4) Insert the SIM with the notched end facing outwards and to the right.
- 5) Close the cover over the snaps.



### CDMA

For CDMA technology carriers, your carrier will ask you to supply them with a Mobile Equipment ID number. This number is printed on the I/O module's serial number label. The MEID is a 14-digit code with a mix of letters and numbers.

If you need help registering your cell modem with a carrier, please contact technical support.

## Alarming Configuration Pages

2500S modules equipped with an optional internal cellular modem can provide text message alerts for configured alarm conditions. Non cellular versions provide a simple alarm contact closure. The possible alarms can range from discrete inputs turning ON or OFF, analog levels exceeding or dropping below setpoint limits, accumulated totals reaching threshold limits, or alarm bits from remote sites. Up to sixteen destinations can be contacted. A scheduling feature allows selectable groups of contact numbers to receive alarms during predetermined hours and days of the week. Alarms are acknowledged by texting an “ACK” back to the I/O module, pressing an ACK key on an HMI panel, or via a switch contact closure. An alarm elevation feature enables separate selection of people to be contacted if an alarm is not acknowledged by someone in the primary response group. When an alarm is acknowledged, a text message is sent to all people in the current response group identifying who acknowledged the alarm and the current alarm states.

Configuration of the alarming functions is done under the **Configuration | Alarming** button and four additional buttons under it for configuring the conditions that will initiate an alarm, the “phone book” will alarm contact names and numbers, the scheduling of alarm contacts and groups.

The screenshot shows the 'Alarming - Boiler Monitor' configuration page. The left sidebar has a menu with 'Alarming' selected. The main area contains the following settings:

- Alarm Retry Timer (S): 300
- Alarm Retry Counts: 2
- Alarm Group: Default
- Acked Alarms in Alarm Messages: [checkbox]
- Show Idle Alarms on Website: [checkbox]
- Ack All with DI: disable
- Site ID: [text]
- Remote PLC Alarm Tag Name: Remote
- Remote PLC Alarm Test: [text]
- 'I am Alive' Message Enable: [checkbox]
- Hour to Send 'I am Alive' Message: 9:00am
- Setpoint Schedule:
  - A: Start Time Hours: Midnight, Start Time Minutes: 0
  - B: Start Time Hours: Midnight, Start Time Minutes: 0

<b>Alarm Retry Timer</b>	Sets the time between text message text attempts (see retry counts)
<b>Alarm Retry Counts</b>	Set the numbers of alarm messaging attempts that the 2500S module will try (if the alarm is not acknowledged) for each alarm event.
<b>Alarm Group</b>	Alarm contacts can be arranged in up to 8 groups. This is a drop-down list to select the currently active group, and on the user pages.
<b>ACKed Alarms in Msgs</b>	Check this box if you want alarm messages to contain both new alarms as well as acknowledged alarms that have not been cleared.
<b>Show Idle Alarms</b>	Check this box if you want to see all possible alarms on the User Alarms web page, even the ones that are not currently active.
<b>ACK All with DI</b>	Can be used to select a Digital Input for acknowledging alarms.
<b>Site ID</b>	A name that will pre-pend all alarms text to identify the alarming site.
<b>Remote PLC Alm Tag Name</b>	Alarms can be sent as strings from a remote PLC. This field names the displayed name of this alarm selection.
<b>Remote PLC Alarm Test</b>	Enter a test message here to simulate an alarm message from a remote PLC.
<b>Setpoint Schedule</b>	Sets the actives times used by the alarm setpoints.

## Alarming Enables Configuration

This web page has a list of checkboxes, one for each possible condition that can cause an alarm. These can include:

- A digital input turning ON
- Reaching a setpoint threshold (Hi or Low)
- Reaching a Totalizer or Runtime Threshold
- A remote alarm message sent by a remote HMI or PLC
- A communications Failure (on some other port)
- A loss of primary power (on solar powered or battery backed module – Solaras or 2500S-27-XXXX)
- Any one of 50 concentrator bits read into or written to from remote equipment or sites

Check the appropriate boxes for the alarms that you want text messages generated for. Note that default names are displayed unless a tag name has been entered on the appropriate configuration screen.

## Alarm Address Book

This web page is used to enter all of the possible alarm contacts and their cell phone numbers. The Contact Names will appear in drop-down lists when setting up alarm schedule groups.

## Alarm Schedule Configuration

This web page is used to set up groups of contacts and their schedules for when they are on call for alarms. Contact Names are set up separately on the “Address Book” page. Group Names are set up on the “Groups” page. Setting the Start and End times to midnight (or any identical time) means “on call 24 hours/day”. The same Contact Name may have several schedules (hours and active days) depending on the group selected. If the “Elevate box is checked, that contact will be called if no one in the normal schedule acknowledges the alarm for the number of specified attempts (Alarm Retry Counts). The schedule items including days of the week and active group still apply. A contact with the elevate box checked just means that the contact will only be called on the “second pass” if none of the primary contacts acknowledges the alarm after the retry attempts are exhausted. Elevated alarms will also be retried for the specified number of times.

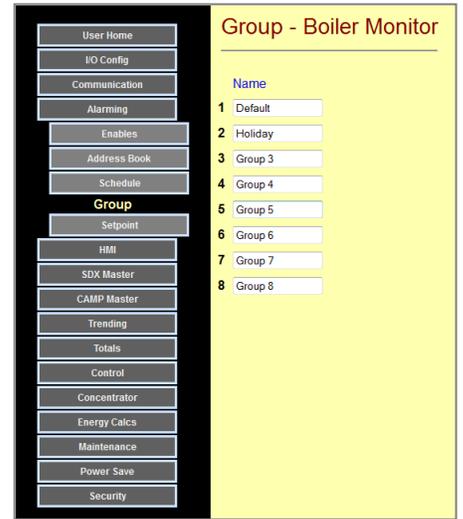
The currently active alarm schedule is available, and can also be set, on the User Web Pages.

Contact	Start	End	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Group	Elevate
1 Jims Cell	Midnight	Midnight	<input checked="" type="checkbox"/>	Default	<input type="checkbox"/>						
2 Jims Home	8:00am	10:00pm	<input checked="" type="checkbox"/>	Default	<input type="checkbox"/>						
3 Johns Cell	Midnight	Midnight	<input checked="" type="checkbox"/>	Holiday	<input type="checkbox"/>						
4 Alarm Service	Midnight	Midnight	<input checked="" type="checkbox"/>	Default	<input checked="" type="checkbox"/>						
5 Alarm Service	Midnight	Midnight	<input checked="" type="checkbox"/>	Holiday	<input checked="" type="checkbox"/>						
6 Disabled	Midnight	Midnight	<input checked="" type="checkbox"/>	Default	<input type="checkbox"/>						
7 Disabled	Midnight	Midnight	<input checked="" type="checkbox"/>	Default	<input type="checkbox"/>						
8 Disabled	Midnight	Midnight	<input checked="" type="checkbox"/>	Default	<input type="checkbox"/>						
9 Disabled	Midnight	Midnight	<input checked="" type="checkbox"/>	Default	<input type="checkbox"/>						
10 Disabled	Midnight	Midnight	<input checked="" type="checkbox"/>	Default	<input type="checkbox"/>						
11 Disabled	Midnight	Midnight	<input checked="" type="checkbox"/>	Default	<input type="checkbox"/>						
12 Disabled	Midnight	Midnight	<input checked="" type="checkbox"/>	Default	<input type="checkbox"/>						
13 Disabled	Midnight	Midnight	<input checked="" type="checkbox"/>	Default	<input type="checkbox"/>						
14 Disabled	Midnight	Midnight	<input checked="" type="checkbox"/>	Default	<input type="checkbox"/>						
15 Disabled	Midnight	Midnight	<input checked="" type="checkbox"/>	Default	<input type="checkbox"/>						
16 Disabled	Midnight	Midnight	<input checked="" type="checkbox"/>	Default	<input type="checkbox"/>						

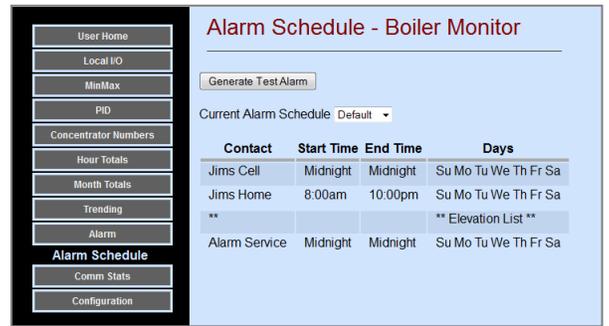
Contact	Start Time	End Time	Days
Jims Cell	Midnight	Midnight	Su Mo Tu We Th Fr Sa
Jims Home	8:00am	10:00pm	Su Mo Tu We Th Fr Sa
**			** Elevation List **
Alarm Service	Midnight	Midnight	Su Mo Tu We Th Fr Sa

## Alarm Groups Configuration

Individuals listed on the “Alarm Schedule” Page can be organized into groups. The active group can be selected by a lower access level user on the “Alarm Schedule” user web page. This allows for different individuals to be selected by group name. The names of the groups are defined on this page. For instance, in the example below, there are three alarm groups: default (normal work days), weekends, and holidays.



When at least one Alarm Schedule is configured, user pages to view alarms and see/select the current alarm schedule are made available on the User web pages, and any current alarms new or acknowledged but still active) can be viewed.



## Alarm Setpoint Configuration Pages

2500S modules have 8 built-in setpoint control blocks to sense shutdown and alarm conditions as well as for simple control functions. The setpoint control blocks can monitor:

- Any analog or universal input
- Any analog output
- Any of the first 50 “I” registers
- A rate from a digital input
- The energy calculation

There are two sets of on/off setpoints based on time-of-day (and weekend). The active times are set on the main Alarm Configuration page.

On this page, no formatting or units are shown for the setpoints. Instead, these characteristics are automatically inherited from the source being monitored and will be displayed properly on the user interfaces.

Be sure to use the slider bar to access more the last control blocks (there are 8 blocks).

	1	2	3	4
Tag Names:	Setpoint 1	Setpoint 2	Setpoint 3	Setpoint 4
Visible:	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Source:	Universal In 1	Universal In 1	Universal In 1	Universal In 1
HOA:	Auto	Auto	Auto	Auto
Schedule:	A Untimed	A Untimed	A Untimed	A Untimed
Debounce On (1S):	0	0	0	0
Debounce Off (1S):	0	0	0	0
Level A On:	10000	10000	10000	10000
Level A Off:	9000	9000	9000	9000
Level B On:	10000	10000	10000	10000
Level B Off:	9000	9000	9000	9000

**Tag Names** This is where you enter the names that will show up on the various HMIs for setpoint block settings.

**Visible** Check these boxes to make the setpoint block settings and output visible and changeable on the HMIs

**Source** The analog level that comparisons will be made to.

**HOA** Hand-Off-Auto. “Auto” enables the comparison logic to generate alarms. OFF and ON can either disable or manually cause an alarm, primarily for testing.

**Schedule** This selection determines the time schedule operation that enables or disables an alarm (based on the setpoint schedule times on the first alarm configuration page).

- **A or B Untimed** (the specified setpoints are always used, no schedule times)
- **A or B Timed** (the specified setpoints are active during the specified time. When the next schedule time is reached, the setpoints are disabled, turning OFF the output. For example, to enable an alarm only from 8am to 5pm.)
- **A or B Momentary** (the specified setpoints are active only for the minute of the schedule time. For example, to check a flow rate at a specific time.)
- **A/B Timed or Momentary** (same as above but using both pairs of times and setpoints.)

- Debounce** The conditions that cause an output to turn ON or OFF must remain true for the specified “debounce” time for the output to actually change. This helps to eliminate spurious responses to transient conditions.
- ON/OFF Levels** There are two ON levels and two OFF levels, one for each set of schedule times.

## Managing Alarms with Text Messaging

The text message HMI interface may be used to manage alarm responder groups, to acknowledge alarms as they come in, and to show the status of any outstanding alarms, either acknowledged or not acknowledged.

### Displaying and Selecting the current Responder Alarm Group

2500S I/O modules with the built-in cellular modem option have an alarm scheduler that allows for alarm responder schedules to be grouped, making it easy to change the people who will get notified during holidays and other alternative times. The available groups can be displayed by texting

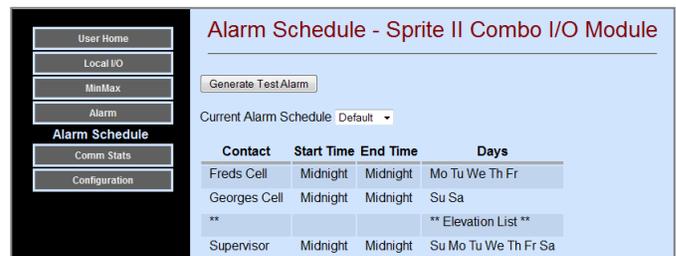
ALARMGROUPS

to the I/O module. The I/O module will respond with a list of the names of the alarm groups. If you want to know the currently selected alarm group, use the

ALARMGROUP

Command. To set the current alarm group, add an = and either the name or a number from 1 to 8 to the ALARMGROUP command.

On the User Web pages, the currently selected alarm group and the schedules of the responders in this group are displayed.



Contact	Start Time	End Time	Days
Freds Cell	Midnight	Midnight	Mo Tu We Th Fr
Georges Cell	Midnight	Midnight	Su Sa
**			** Elevation List **
Supervisor	Midnight	Midnight	Su Mo Tu We Th Fr Sa

### Acknowledging an Alarm

When an alarm occurs, the following text message is sent to all of the responders in the currently selected group (based on their dates and times selected”

ALARMS:

<alarm description>

The alarm can be acknowledged by texting

ACK

back to the I/O module (or using a local pushbutton switch). When the alarm is acknowledged, all people on the current alarm responder list receive notice of who acknowledged the alarm, and a list of any outstanding unacknowledged or acknowledged alarms.

### Displaying current alarms

The current outstanding alarms (all, unacknowledged and acknowledged) can be displayed with the following commands.

ALARMS

UN

ACKED

# Using the Text Message HMI

## Overview

2500S modules ordered with an optional internal cellular modem can support text messaging as a user interface. So besides alarming and data communications, text messaging can be used to access any of the 2500S module data and configuration information. A user can text a request or change to the module, and gets a response typically in about 6 to 10 seconds (round trip time). This can eliminate the need for a computer or computer access in the field. For example, if there is a problem, the 2500S module can send an alarm text message out to the list of recipients designated to receive alarms at that time. The alarm can be acknowledge by text message, and then further checks on readings and setpoint adjustments can be made, simply by text message interaction using a standard phone.

## How It Works

Text message commands are generally short in order to minimize typing, and the responses are brief since the basic cellular text message technology limits messages to about 140 characters. If the 2500S module needs to send more text information in a response, it will break up the response into two or more texts.

When the user arranges for a cellular “plan”, they will sign up for a certain number of “free” texts per month, or in some cases, an unlimited plan (preferred but more costly). To estimate the texting traffic, generally the concern is the text used to send DATA and ALARMS, since this generally occurs more frequently than user texts from their cell phone. On the other hand, if you do want to include user text, keep in mind that all commands and requests are acknowledged (get a response). Therefore every text **transaction** requires at least two text messages, one for the command or request. Then one for the response (or more for large responses).

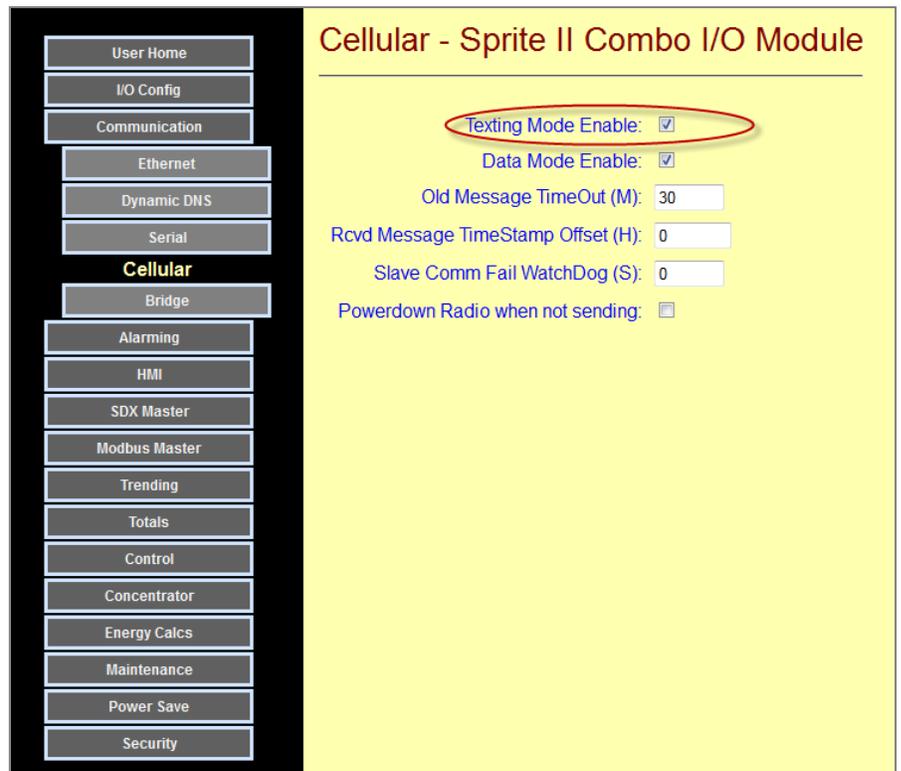
Multiple commands or requests can be sent in a single text. This can help to reduce the total number of transactions and speed things up if you know of several changes or requests to be done.

## Security

The text message HMI interface uses the 2500S module security system. If enabled, a user must be logged in order to access information in the module. Each user (by username) has an access level, so if the user has read write access, then they will be able to make setpoint and configuration changes by texting. The format of the text message commands and requests allows for the username and password to be included as part of the command or response text. This can further minimize the number of text transactions and time. Once logged in, either be a separate login transaction, or by successful login incorporated in a command or response, the system “remembers” the user for the current session (from this telephone number and no further login is required (a username and password is not required for every transaction). If there is no activity for 10 minutes, the session is automatically cancelled.

### Enabling the Text Message HMI

The text message HMI interface must be enabled to be used. This allows the module to be secured if the text messaging feature is not desired. The checkbox to enable the text messaging HMI feature is located under **Configuration | Communications | Cellular**.



### Text Message Commands and Responses

The Command Structure to text a command or request to a 2500S module is :

**[Command][Register]<-End Register><.SubCommand>< = Value>**

Or

**[TagName]<.SubCommand><=Value>**

- Commands are to be separated by commas.
- White Space is ignored (except inside tag names).
- There is a 160 Character Packet size limit with the SMS Messages, if the response goes over this size then it will send as many messages as it takes to fill the request.
- To set a value, add an equal sign after the command followed by the value. Booleans can be set with either On/Off or 1/0. To Unforce a forcing register don't add any value after the equal sign.
- If Security is enabled, a User and Password need to be entered first. The format is:  
**.User.Password: <command>**
- Ranges cannot be used with tag names.
- Users will be logged out after 10 minutes of inactivity

The 2500S modules ALWAYS respond to a command or response, therefore every transaction is at least 2 messages (one in either direction).

## Text Messaging Examples

(note: case is ignored except for passwords)

<b>?</b>	Return all “visible” items
<b>ALARMS</b>	Return all alarms
<b>DO=1</b>	Turn ON Digital Output #1
or if Digital Output #1 has the name “Light”, you can also use:	
<b>LIGHT = 1</b>	Turn ON Digital Output #1
<b>ACK</b>	Acknowledge ALL outstanding alarms
<b>HELP</b>	Send a brief summary of the available text commands
<b>FAI2=1000,FAI1=,DI1-5.T,STS</b>	Force AI2 to 1000
	Unforce AI1
	Return the values of the DI1 through DI5 totalizers
	Return the Serial Communications Statistics
<b>.User.pass:Di4, DO2=1</b>	Login with User(name) and Pass(word)
	Return DI4 State
	Turn ON DO2

## Tag Names

Tag names can be used in place of the generic I/O name (DI, DO, AI, AO, B ,I & SP) for registers

For example, if the tag name for DI1 is “Pump Run”, then you can request the status information using “DI1” or “Pump Run”

When requesting information, the state or value of the register is always returned, along with any associated registers (like runtime, rate, totals, etc.) that have “visibility” turned ON. You can also access just a specific register by using a dot extension. Only the first couple of characters are required, or you can enter the entire word:

**.runtime**

**.rate**

**.totalizer**

For example

DI1.Ru or Pump Run.Ru

Return the runtime for DI1 (Pump Run)

Command	Description	R/W	Notes
HELP	Display Help		
?	Display All	R	Displays all visible DI's, DO's, AI's, Numbers & Bits
*(0..5)	Display VPPII Group	R	Display a Page from the VPPII System
ACK	Acknowledge Alarms	W	Clears ALL Alarm Flag's
ACKED	Acked Alarms	R	Show Acknowledged Alarms
ALARMS	Show All Alarms	R	
UN	UnAcked Alarms		Show UnAcknowledged Alarms
ALARMGROUP	Current Alarm Group	R/W	
ALARMGROUPS	List Alarm Groups	R	
ST	General Stat's	R	VIN, Temp, CF, etc. ...
STC	Cell Stats	R/W	STC=0 clears Stats, no register number needed
STE	Ethernet Stats	R/W	STE=0 clears Stats, no register number needed
STS	Serial Stats	R/W	STS=0 clears Stats, no register number needed
STM	Master Stats	R/W	STM=0 clears Stats, no register number needed
Pump	Pump Controller	R	Display All Pump Controller Status
LEADA.ON	LeadA On Value	R/W	Pump Controller Lead A (Day)
LEADA.OF(F)	LeadA Off Value	R/W	Pump Controller Lead A (Day)
LEADB.ON	LeadB On Value	R/W	Pump Controller Lead B (Night)
LEADB.OF(F)	LeadB Off Value	R/W	Pump Controller Lead B (Night)
LAGA.ON	LagA On Value	R/W	Pump Controller Lag A (Day)
LAGA.OF(F)	LagA Off Value	R/W	Pump Controller Lag A (Day)
LAGB.ON	LagB On Value	R/W	Pump Controller Lag B (Night)
LAGB.OF(F)	LagB Off Value	R/W	Pump Controller Lag B (Night)
AI#	AI Scaled	R	Also will display AI#.T if visible
AI#.T(OTALS)	AI Counters	R/W	Read Scaled; Write Raw
AI#.F(ORCE)	Force AI	R/W	"AI1.F =" will clear any forcing on AI 1
AO#	AO Register	R/W	
AO#.F(ORCE)	Force AO	R/W	"AI1.F =" will clear any forcing on AO 1
DI#	DI Register	R	Also will display DI#.T, .Run, .Rate if visible
DI#.T(OTALS)	DI Counters	R/W	Read Scaled; Write Raw
DI#.Ru(ntime)	DI Run Time	R/W	Read Scaled; Write Raw
DI#.R(ATE)	DI Rate	R	
DI#.F(ORCE)	Force DI	R/W	
DO#	DO Register	R/W	DO1=On, DO2=1 both ways to turn on
DO#.F(OURCE)	Force DO	R/W	DO1.F= will turn off forcing of DO1
SP#	Setpoint Bit	R	Also will display SP#.On & .Off
SP#.ON	Setpoint On Value	R/W	
SP#.OF(F)	Setpoint Off Value	R/W	
I#	I Register	R/W	I Programming Registers
B#	B Registers	R/W	B Programming Registers
IR	Input Reg	R	Modbus Input Registers
OR	I/O Reg	R/W	Modbus Holding Registers
IB	Input Bool	R	Modbus Status Boolean Registers
OB	I/O Bool	R/W	Modbus Coils Boolean Registers

## Managing Alarms with Text Messaging

The text message HMI interface may be used to manage alarm responder groups, to acknowledge alarms as they come in, and to show the status of any outstanding alarms, either acknowledged or not acknowledged.

### Displaying and Selecting the current Responder Alarm Group

2500S I/O modules with the built-in cellular modem option have an alarm scheduler that allows for alarm responder schedules to be grouped, making it easy to change the people who will get notified during holidays and other alternative times. The available groups can be displayed by texting

ALARMGROUPS

to the I/O module. The I/O module will respond with a list of the names of the alarm groups. If you want to know the currently selected alarm group, use the

ALARMGROUP

Command. To set the current alarm group, add an = and either the name or a number from 1 to 8 to the ALARMGROUP command.

On the User Web pages, the currently selected alarm group and the schedules of the responders in this group are displayed.



Contact	Start Time	End Time	Days
Freds Cell	Midnight	Midnight	Mo Tu We Th Fr
Georges Cell	Midnight	Midnight	Su Sa
**			** Elevation List **
Supervisor	Midnight	Midnight	Su Mo Tu We Th Fr Sa

### Acknowledging an Alarm

When an alarm occurs, the following text message is sent to all of the responders in the currently selected group (based on their dates and times selected”

ALARMS:

<alarm description>

The alarm can be acknowledged by texting

ACK

back to the I/O module (or using a local pushbutton switch). When the alarm is acknowledged, all people on the current alarm responder list receive notice of who acknowledged the alarm, and a list of any outstanding unacknowledged or acknowledged alarms.

### Displaying current alarms

The current outstanding alarms (all, unacknowledged and acknowledged) can be displayed with the following commands.

ALARMS

UN

ACKED

## SDX Master Mode Configuration Pages

2500S modules can send and request various types of I/O and collected/calculated data to/from up to eight destinations (Slaves). This is known as Master Mode. Master Mode can operate over Ethernet, through the internal radio or cellular modem, or through an external radio or modem via the modules optional serial port. SDX Master Mode messages are encrypted for security, can route messages through multiple repeaters (up to 10 for non-cellular modules), and can exchange all analog and digital data (integers and Booleans) in a single efficient transaction.

Configuration of Master Mode is done under **Configuration | SDX Master Mode**.

The look of the main SDX Master page will differ depending on the selected communications “Port”, so each option is described in detail on the following pages.

A typical use of Master Mode is “mirroring”. Inputs at one site (the Master) are transmitted to a second site where the signals are regenerated as outputs. The Master can also request the inputs from the slave site, and regenerate them. Thus, I/O information can pass both ways, initiated by any Master. If there are two or more sites, any or all of the sites can be Masters that initiate data transfers. All sites are automatically Slaves, able to receive and respond to commands, even if they are configured as Slaves.

A Slave can have multiple Masters. For example, a single Slave tank site may poll for level information by multiple well sites (Masters) makes control decisions locally.

A Master can also have up to eight Slaves. So for example, in the above system, the tank site could be configured as a Master, so as the level in a tank changes, the Master could update the level information in each one of the well sites (Slaves), as the level changes.

With the SDX Master Mode, 2500S modules can initiate transmissions at a fixed time interval (polling), as well as when the state or level of an input point changes (on-change), or both. On-change operation can be very important for cellular and other low-bandwidth systems, to limit the number of transmissions, for low-power applications such as when the site only has solar power, or when there are a large number of sites and relying on polling would be too slow. For the lowest power on-change operation, the 2500S module can be configured to periodically turn on the power to the sensors, wait for a configurable “warm up” time, sample the inputs, turn off sensor power, evaluate if any inputs have changed, and if so, power on the radio, wait for a radio “warm-up” (stabilization) time, send a transmission.

## SDX Master over Ethernet

Using an SDX Master on an Ethernet network, the destination can be to either an IP address, or a name (the 2500S module performs an IP address name lookup). To that IP address or name, The Master can transfer data to any of up to 8 SDX addresses at the destination IP address (SDX routing).

- Port** Set the communications Port to **Ethernet** here.
- Enable SDX Master** Check this box to enable Master Mode transmissions. When unchecked, the module will only transmit when responding to a command or request from another Master.
- Our Address** Every device in the communications system needs an address. This is where you set the local address of the master (this unit).
- Destination IP/Name** Set the destination IP address or name here (use only one or the other). If you are using a name, make sure that you have set an address for a “DNS Server IP” so that the controller can perform a name to IP lookup for you. This is under the **Configuration | Ethernet** button.
- Polling Time (S)** If you want to use polling, set the polling time here. If set to 0, the module polls as fast as possible (about 300 times per second using Ethernet).
- Send on Change** Check this box if you want to send when an input changes. This can be used in conjunction with polling.
- Sample Analog on Digital Change** Check this box if you want to send updated analog levels when a digital change is reported. This can reduce transmissions in active systems.
- Response Timeout** Set the maximum time that it should take to get a response back here. The module will not initiate another message (retry or new), until this time period has expired. With an Ethernet network, this number is normally very small (typically 1 or 2 for 100 or 200mS).
- Retrigger Holdoff** Set the fastest that changes should initiate transmissions here.. This can be used to protect against “flooding” the network when inputs are changing rapidly (i.e. a defective sensor). The Retrigger Holdoff Time starts after the Response Timeout. The sum of the two times determines when the next message can go out.

- Retry Count** Set the maximum number of times that a message transmission should be retried if previous attempts don't make it through.
- Comm Fail Probe** Set the timing that you want to use to try to see if the network or destination device is back up after a communications failure by occasionally attempting to re-establish communications. Set this time slower than the normal polling time, so that you don't waste time rapidly polling a dead destination unit.
- Use retries on probe** Check this box if you want to retry when a probe message fails to get through, even when the destination unit is "up" (difficult networks).

## SDX Master over Internal Radio or Serial Port

Using an SDX Master on an (internal or external) radio or modem network, the Master can access up to 8 destinations, with up to four hops of store-and-forward routing (repeating) per destination. This allows for wide area coverage, even with low-power radios.

SDX Master - Sprite II Combo I/O Module

Port: Radio

Enable SDX Master:

Baud Rate: 115,200

Our Address: 1000

Polling time (S): 5

Send on Change:

Sample Analog on Digital Change:

Retrigger holdoff time (100mS): 0

Response timeout (100mS): 40

Retry Count: 0

Comm Fail Probe Time (S): 0

Use Retries on Probing:

Quiet Time (mS): 1

Powerdown Radio when not sending:

Message Size Limit: 262

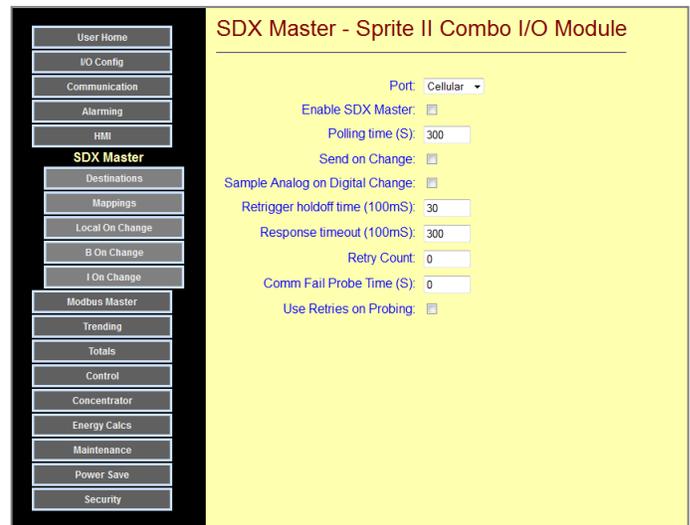
- Port** Set the communications Port to **Serial or Radio** here.
- Enable SDX Master** Check this box to enable Master Mode transmissions. When unchecked, the module will only transmit when responding to a command or request from another Master.
- Baud Rate** Transmission data rate. This must match the radio or modem that you are using.
- Our Address** Every device in the communications system needs an address. This is where you set the local address of the master (this unit).
- Polling Time (S)** If you want to use polling, set the polling time here. If set to 0, the module polls as fast as the radio or modem will go.
- Send on Change** Check this box if you want to send when an input changes. This can be used in conjunction with polling.
- Sample Analog on Digital Change** Check this box if you want to send updated analog levels when a digital change is reported. This can reduce transmissions in active systems.
- Response Timeout** Set the maximum time that it should take to get a response back here. The module will not initiate another message (retry or new), until this time period has expired. With a radio network, this number will typically range from 5 (500mS) to several seconds.
- Retrigger Holdoff** Set the fastest that changes should initiate transmissions here.. This can be used to protect against “flooding” the network when inputs are changing rapidly (i.e. a defective sensor). The Retrigger Holdoff Time starts after the Response Timeout. The sum of the two times determines when the next message can go out.
- Retry Count** Set the maximum number of times that a message transmission should be retried if previous attempts don’t make it through.

- Comm Fail Probe** Set the timing that you want to use to try to see if the network or destination device is back up after a communications failure by occasionally attempting to re-establish communications. Set this time slower than the normal polling time, so that you don't waste time rapidly polling a dead destination unit.
- Use retries on probe** Check this box if you want to retry when a probe message fails to get through, even when the destination unit is "up" (difficult networks).
- Quiet Time** In a system with multiple Masters, two or more Masters may try to send messages at the same time. Set the quiet time to have this 2500S module listen a while before sending a message. This can help avoid wasting time retrying after collisions.
- Power down Radio When Not Sending** **(Internal Radio Only)** Check this box if you want to power off the radio when the module is not trying to send data. This will save power when the radio does not need to be "up" all the time to receive commands or requests.
- Message Size Limit** Some radios and modems cannot handle longer messages. In this case, set the limit to slightly less than what the radio or modem can handle. This will cause the 2500S module to break up the messages into smaller pieces. The down side is that each transaction may require multiple transmissions.

## SDX Master over Cellular (Text Message)

Using an SDX Master on a cellular network, the Master can access up to 8 destinations (phone numbers). All data transfers between modules and controllers are converted to encrypted text packets of about 140 characters each to leverage the low-cost of cellular text messaging plans when only small amounts of data need to be transferred.

Note that when selecting a cellular plan, you will want to order a “Text Message (only) Plan”. Two text messages (a command and a response) are required for every transaction, so a 500 message per month plan will support 250 transactions without “overage” charges.



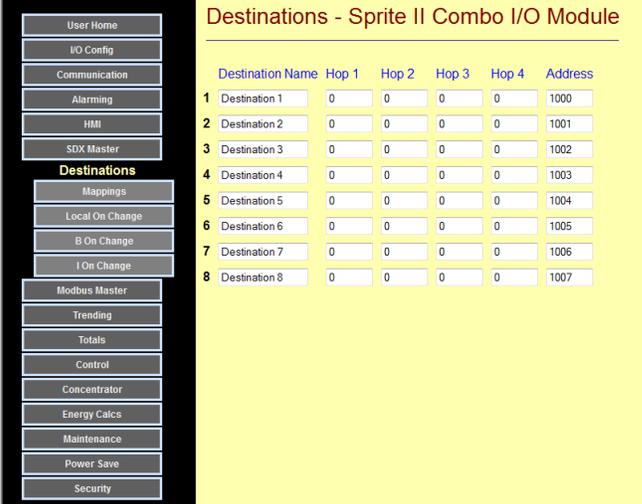
- |  |   |
|--|---|
| <b>Port</b>                            | Set the communications Port to <b>Cellular</b> here.  |
| <b>Enable SDX Master</b>               | Check this box to enable Master Mode transmissions. When unchecked, the module will only transmit when responding to a <b>command</b> or request from another Master.   |
| <b>Polling Time (S)</b>                | If you want to use polling, set the polling time here. If set to 0, polling is <b>DISABLED</b> . Note that this is different for Ethernet and Serial port operation where 0 means “poll as fast as possible”.   |
| <b>Send on Change</b>                  | Check this box if you want to send when an input changes. This can be used in conjunction with polling.   |
| <b>Sample Analog on Digital Change</b> | Check this box if you want to send updated analog levels when a digital change is reported. This can reduce transmissions in active systems.  |
| <b>Response Timeout</b>                | Set the maximum time that it should take to get a response back here. The module will not initiate another message (retry or new), until this time period has expired. With a cellular network, this number will typically range from 100 to 300 (10 to 30 seconds).  |
| <b>Retrigger Holdoff</b>               | Set the fastest that changes should initiate transmissions here. This can be used to protect against “flooding” the network when inputs are changing rapidly (i.e. a defective sensor). The Retrigger Holdoff Time starts after the Response Timeout. The sum of the two times determines when the next message can go out. |
| <b>Retry Count</b>                     | Set the maximum number of times that a message transmission should be retried if previous attempts don’t make it through.   |

**Comm Fail Probe** Set the timing that you want to use to try to see if the network or destination device is back up after a communications failure by occasionally attempting to re-establish communications. Set this time slower than the normal polling time, so that you don't waste time rapidly polling a dead destination unit.

**Use retries on probe** Check this box if you want to retry when a probe message fails to get through, even when the destination unit is "up" (difficult networks).

## Destinations

In Master Mode, regardless of the physical medium (Ethernet, Radio, Cellular, etc.), 2500S modules can initiate transmissions that read and write various pieces of data between the local (Master) up to 8 remote (Slave) units. Each destination has a name, up to 4 hops (store-and-forward repeats) and a final address. The destination information is configured on this page.



	Destination Name	Hop 1	Hop 2	Hop 3	Hop 4	Address
1	Destination 1	0	0	0	0	1000
2	Destination 2	0	0	0	0	1001
3	Destination 3	0	0	0	0	1002
4	Destination 4	0	0	0	0	1003
5	Destination 5	0	0	0	0	1004
6	Destination 6	0	0	0	0	1005
7	Destination 7	0	0	0	0	1006
8	Destination 8	0	0	0	0	1007

**Destination Name** Give each final destination a meaningful name. This name will be used when configuring the Master Mode data transactions.

**Hops** Hops are a form of routing or store-and-forward repeating. Normally they are used to extend the range of radio links, so if the connection between two sites cannot be made directly, intermediate sites may be used as “repeaters”. Placing a non-zero address in a Hop field causes the system to route messages, in order, through that unit.

**Address** This should be set to the final address of the destination.

## (Read & Write) Mappings

In Master Mode, 2500S modules can initiate transmissions that read and write various pieces of data between the local (Master) and a remote (Slave) unit. Data is read and written in blocks (groups). The type, direction and locations of data to be transferred between the Master and the Slave devices are specified the “Mappings” screen. Up to 40 transactions are supported.

	Destination	Message Type	Local Index	Remote Index	Block Size
1	Destination 1	Local DO from Remote DI	1	1	4
2	Destination 1	Local AO from Remote UI	1	1	2
3	Destination 1	Local DI to Remote DO	1	1	4
4	Destination 1	Local UI/AI to Remote AO	1	1	2
5	disabled	Local DO from Remote DI	1	1	0
6	disabled	Local DO from Remote DI	1	1	0
7	disabled	Local DO from Remote DI	1	1	0
8	disabled	Local DO from Remote DI	1	1	0
9	disabled	Local DO from Remote DI	1	1	0
10	disabled	Local DO from Remote DI	1	1	0
11	disabled	Local DO from Remote DI	1	1	0
12	disabled	Local DO from Remote DI	1	1	0
13	disabled	Local DO from Remote DI	1	1	0
14	disabled	Local DO from Remote DI	1	1	0
15	disabled	Local DO from Remote DI	1	1	0
16	disabled	Local DO from Remote DI	1	1	0
17	disabled	Local DO from Remote DI	1	1	0
18	disabled	Local DO from Remote DI	1	1	0

**Destination** Name of the destination for this transaction

**Message Type** The type of data and direction for the transfer are selected using pull-down lists

**Local/Remote Index** The first address in the **local** 2500S module and the **remote** module or controller that will be used for the data transfer

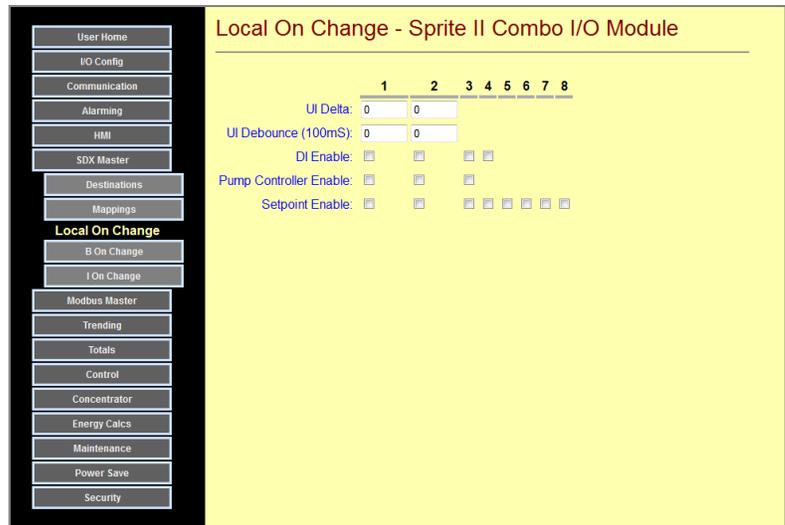
**Size** The number of items to be transferred (block size)

This allows for very flexible configurations. For example, a 2500S-23-XXXX module has four digital inputs and four digital outputs. By specifying different destination starting addresses and numbers of point to transfer, up to four 2500S masters could transfer a single contact closure to the four outputs of a single 2500S slave. Different models of 2500S controllers can be mixed to accommodate different site I/O configurations.

## Local On-Change Settings

In Master Mode, 2500S modules can initiate transmissions that read and write various pieces of data between the local (Master) and a remote (Slave) unit when a local input changes. This can be a digital input state or an analog input level.

The Local On-Change Settings screen allows for selection of digital inputs that will be monitored for change, as well as the analog inputs to be monitored, along with the amount of level shift to be considered a change in these analog inputs. In order to avoid false triggering with noisy or “bouncy” analog inputs, a debounce time may also be entered. This prevents a spurious level change from registering until that level change has exceeded the configured change threshold for a specified period of “debounce” time.

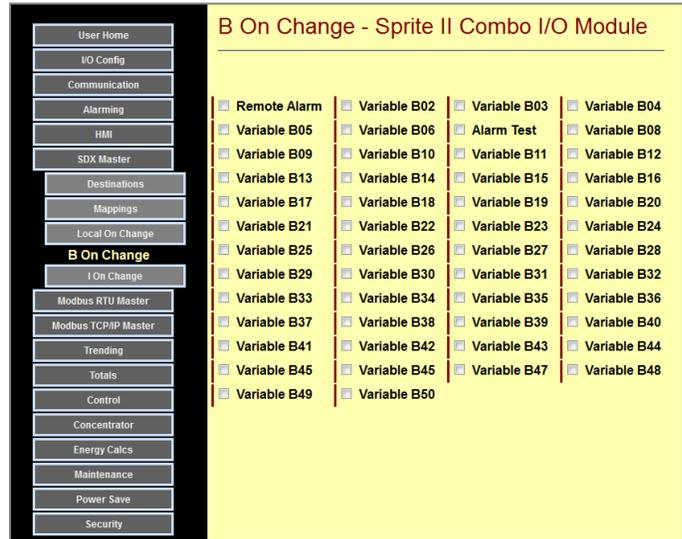


- UI Delta**                    The amount of change in the (scaled) analog readings that will cause a transmission
- UI Debounce**              A filter that prevents spurious changes in the analog readings from triggering a transmission. The reading must exceed the UI delta for the specified time period to qualify the transmission.
- DI Enable**                    Check the boxes for the Digital Inputs that will initiate a transmission when they change.
- Pump Controller Enable**    Check these boxes if you want to send a transmission when an output of the Duplex Pump Controller block changes.
- Setpoint Enable**            Check these boxes if you want to send a transmission when an output of the Setpoint Control blocks changes

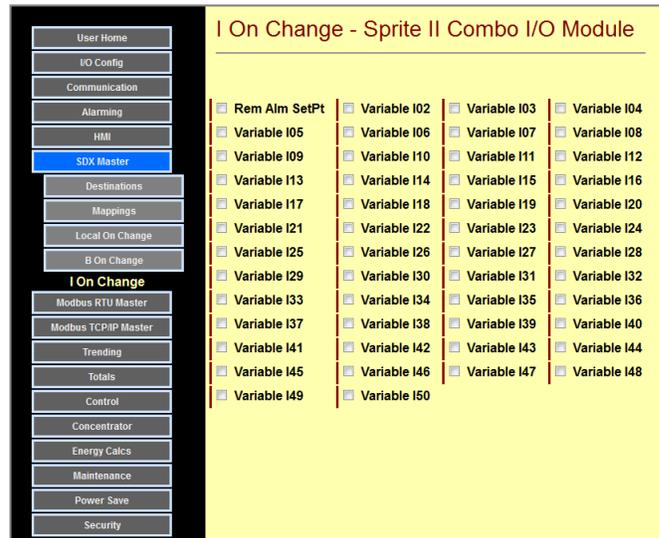
## B/I Register On-Change Selectors

The B and I registers are general purpose memory locations generally used to collect data from other modules or controllers, or setpoint values from a user HMI.

There are 200 B (Bit) and I (Integer) registers, of which the first 50 of each can be monitored for changes that trigger message transactions. These screens enable selecting the B and I values that will be monitored for changes. The names of the registers are set under the “Concentrator” tab.



“B” on change enables



“B”I” on change enables

## Configuring Mirrored I/O

Mirrored I/O replicates analog and digital signals from one end of a communication link to another. This places all of the responsibility for communications on the I/O modules which are designed for such work, and offloads other equipment which may not be communications savvy. For example, a PLC may not be easy to configure for a text-message cellular connection, but using a pair of 2500S I/O Modules to handle the communications as well as the I/O makes it much easier. Also, SDX communications is encrypted for additional security.

A mirrored I/O system may be literally a pair of 2500S I/O modules back-to-back so that an analog/digital is replicated at the other end as an analog/digital output, or the analog/digital levels may be read by a PLC, PC or other intelligent device using a standard protocol (Modbus, DF1, etc.). The later is usually preferable since it eliminates wiring and extra I/O, and for analog signals, reduces the number of conversion steps.

A mirrored I/O system consists of a Master, and up to 8 Slaves. The Master will exchange its I/O information to the slaves at either a periodic rate (polled), upon a change, or both. The later makes the best use of communications bandwidth and generally provides the best responsiveness, while assuring that a link is in good working order by periodically transmitting. Any unit can be a Master. “Master” just means that an I/O module can initiate messages. There can be multiple Masters in a system.

2500S modules provide several features that simplify mirrored I/O system. For example, because they can totalize and measure rate at each I/O module, there is no need to have a high-speed data link to “keep up” with a high speed pulse train” such as from a flow meter. You can simply let the remote unit totalize and perform the measurements, and send the results across a much slower (cheaper) communications link. With their universal analog inputs, 2500S I/O modules can serve as wireless signal conditioners. For example, a 2500S module can take in a thermocouple signal at one end and deliver a 4-20mA output on the other.

Mirrored I/O can operate over nearly any type of data link; Ethernet, internal radio, external radio or modem, or cellular (text message and data). In fact, multiple types of data links can be combined. For example, in a manufacturing facility, Ethernet may be used to get close to the destination(s), but wireless can be used for the final connectivity using the “bridging” facility of the I/O module (see Configuring Bridging).

In radio based systems (either internal or external), the I/O modules can provided store-and-forward repeating to effectively extend the range of the radio system. I/O modules and intermediate positions along the way can also serve as repeaters, storing and forwarding the messages between sites. Each data link can have up to 5 hops (4 repeaters).

Configuration of I/O Mirroring is set up under the **Configuration |SDX Master** button.

The screenshot displays the configuration page for the SDX Master on a Sprite II Combo I/O Module. On the left is a vertical navigation menu with buttons for various system functions. The main area is titled "SDX Master - Sprite II Combo I/O Module" and contains several configuration parameters. The "Port" dropdown menu is highlighted with a red circle and is currently set to "Ethernet". Other visible settings include "Enable SDX Master" (unchecked), "Our Address" (1000), "Destination IP" (76.14.140.231), "Polling time (100mS)" (2), "Response timeout (100mS)" (15), and "Retry Count" (0).

Based on the port selection at the top of the page (Ethernet, Serial, Radio, Cellular), the contents of the SDX Master (main) and SDX Master - Destinations web pages will “morph” to configuration information appropriate for the selected port. The following four pages describe the data to be entered for any of these four possible configurations.

## SDX Master - Ethernet

If **Ethernet** is selected, the Main SDX page looks like the one pictured on the right.

1) Set the destination IP address and. You'll have a chance to set up destinations (unit IDs) on another screen, but this is the destination network address.

2) Check (enable) the SDX Master mode.

3) If you want to periodically exchange data (polling), enter the Polling Time in 100mS increments. If you set this to 0, the I/O module will send a fast as possible.

4) If you want to enable initiating data exchanges when I/O or concentrator data changes, check the "Send on Change" box. There are other places in this section to configure what changes will be monitored.

5) "Sample Analog on Digital Change" will send updated analog readings whenever a digital input changes.

6) If you're using the Send on Change mode, you can prevent "flooding" of the network when inputs change rapidly (such as wave action in a tank ,a noisy signal or an analog on-change level setpoint set very low ) by setting a Retrigger Holdoff time. Since most Ethernet links are so fast, this number can normally be 0. If you're using slower Ethernet or satellite radios, you may want to consider other values.

7) Set the Response Timeout to the longest time that you would expect a message to be responded. If you're not sure, set the number to a high value of 1 or 2 seconds. The communications statistics on the user pages include a latency measurement to help you adjust this value later. Lower values will let the controller recover from a sporadic communications "hit" faster (shorter timeout) wait.

8) Set a retry count that determines how many times to retry sending a message if the preceding attempts fail. A typical value is 2 for a total of 3 tries (1 initial attempt plus 2 retries).

9) If the number of retries is exhausted so that communications fails, the I/O module can be set to use a slower probing rate to determine when the destination units comes back up. Since most Ethernet links are so fast, this number can normally be 0. If you're using slower Ethernet or satellite radios, you may want to consider other values.

10) Normally, a probe attempt is only a single message. Check this box if you want the I/O module to perform sequential retries in a single probe attempt sequence.

## SDX Master – Ethernet - Destinations

- 1) Under the **SDX Master | Destinations** button, you can name and provide unit IDs (16-bit SDX addresses) for up to 8 destinations. Since this may be routed over a wireless network using “bridging” you may need to fill in “Hop” address for the repeaters, otherwise leave these blank.

The screenshot shows the SDX Master web interface. On the left is a vertical sidebar with navigation buttons: User Home, I/O Config, Communication, Alarming, HMI, SDX Master, Destinations (highlighted), Mappings, Local On Change, B On Change, I On Change, Modbus RTU Master, CAMP Master, Trending, Totals, Control, Concentrator, Energy Calcs, Maintenance, Power Save, and Security. The main content area is titled "Destinations - Sprite II Combo I/O Module" and contains a table with the following data:

	Destination Name	Hop 1	Hop 2	Hop 3	Hop 4	Address
1	Destination 1	0	0	0	0	1000
2	Destination 2	0	0	0	0	1001
3	Destination 3	0	0	0	0	1002
4	Destination 4	0	0	0	0	1003
5	Destination 5	0	0	0	0	1004
6	Destination 6	0	0	0	0	1005
7	Destination 7	0	0	0	0	1006
8	Destination 8	0	0	0	0	1007

## SDX Master – Serial or Radio

If **Serial or Radio** is selected, the Main SDX page looks like the one pictured on the right.

SDX Master - Sprite II Combo I/O Module

Port: Serial

Enable SDX Master:

Baud Rate: 115,200

Our Address: 1000

Polling time (S): 5

Send on Change:

Sample Analog on Digital Change:

Retrigger holdoff time (100mS): 0

Response timeout (100mS): 30

Retry Count: 0

Comm Fail Probe Time (S): 0

Use Retries on Probing:

Quiet Time (mS): 1

Message Size Limit: 262

- 1) Check (enable) the SDX Master mode.
- 2) Our (SDX) address and the port baud rate are normally already set up from the **Configuration | Communication | Serial or Radio** page, but check them here. Be sure the baud rate matches your radio or modem (115,200 is standard).
- 3) If you want to periodically exchange data (polling), enter the Polling Time in 1 second increments. If you set this to 0, the I/O module will send as fast as possible.
- 4) If you want to enable initiating data exchanges when I/O or concentrator data changes, check the “Send on Change” box. There are other places in this section to configure what changes will be monitored.
- 5) “Sample Analog on Digital Change” will send analog readings with digital input changes.
- 6) If you’re using the Send on Change mode, you can prevent “flooding” of the network when inputs change rapidly (such as wave action in a tank, a noisy signal or an analog on-change level setpoint set very low) by setting a Retrigger Holdoff time.
- 7) Set the Response Timeout to the longest time that you would expect a message to be responded. If you’re not sure, set the number to a high value of several seconds. The communications statistics on the user pages include a latency measurement to help you adjust this value later. Lower values will let the controller recover from a sporadic communications “hit” faster (shorter timeout) wait.
- 8) Set a retry count that determines how many times to retry sending a message if the preceding attempts fail. A typical value is 2 for a total of 3 tries (1 initial attempt plus 2 retries).
- 9) If the number of retries is exhausted so that communications fails, the I/O module can be set to use a slower probing rate to determine when the destination units come back up. This can reduce the slowing effect of polling known “down” units.
- 10) Normally, a probe attempt is only a single message. Check the Use Retries on Probing” box if you want the I/O module to perform sequential retries in a single probe attempt sequence.
- 11) Quiet Time (mS) is the amount of time that the I/O module will listen to network traffic before attempting to jump in and send a message. This helps to prevent collisions in systems with multiple Masters trying to send messages at the same time. This generally applies to radio and RS-484 systems. This parameter is not displayed for the internal radios because they are already inherently protected.
- 12) Some older equipment cannot handle long messages. This field lets you match the I/O module to the capabilities of your radio or modem.

## SDX Master – Serial or Radio - Destinations

- 1) Under the **SDX Master | Destinations** button, you can name and provide unit IDs (16-bit SDX addresses) for up to 8 destinations. Since this may be routed over a wireless network using “bridging” you may need to fill in “Hop” address for the repeaters, otherwise leave these blank.

	Destination Name	Hop 1	Hop 2	Hop 3	Hop 4	Address
1	Destination 1	0	0	0	0	1000
2	Destination 2	0	0	0	0	1001
3	Destination 3	0	0	0	0	1002
4	Destination 4	0	0	0	0	1003
5	Destination 5	0	0	0	0	1004
6	Destination 6	0	0	0	0	1005
7	Destination 7	0	0	0	0	1006
8	Destination 8	0	0	0	0	1007

## SDX Master -Cellular

The internal cellular modem uses text messaging to send encrypted data. If (Internal) **Cellular** is selected, the Main SDX page looks like the one pictured here.



- 1) Check (enable) the SDX Master mode.
- 2) If you want to periodically exchange data (polling), enter the Polling Time in 1 second increments. If you set this to 0, the I/O module will NOT poll. Since cellular communications is normally charged by the message, you should probably use larger values for this.
- 3) If you want to enable initiating data exchanges when I/O or concentrator data changes, check the “Send on Change” box. There are other places in this section to configure what changes will be monitored.
- 4) “Sample Analog on Digital Change” will send updated analog readings whenever a digital input changes.
- 5) If you’re using the Send on Change mode, you can prevent “flooding” of the network when inputs change rapidly (such as wave action in a tank ,a noisy signal or an analog on-change level setpoint set very low ) by setting a Retrigger Holdoff time. Since Text Messaging is so slow, consider using longer times.
- 6) Set the Response Timeout to the longest time that you would expect a message to be responded. If you’re not sure, set the number to a high value of 30 seconds. The communications statistics on the user pages include a latency measurement to help you adjust this value later. Lower values will let the controller recover from a sporadic communications “hit” faster (shorter timeout) wait. Typically, we’ve been seeing round-trip times of around 8 seconds, but this is not guaranteed.
- 7) Set a retry count that determines how many times to retry sending a message if the preceding attempts fail. A typical value is 2 for a total of 3 tries (1 initial attempt plus 2 retries).
- 8) If the number of retries is exhausted so that communications fails, the I/O module can be set to use a slower probing rate to determine when the destination units comes back up. This can reduce the slowing effect of polling known “down” units.
- 9) Normally, a probe attempt is only a single message. Check the Use Retries on Probing” box if you want the I/O module to perform sequential retries in a single probe attempt sequence.

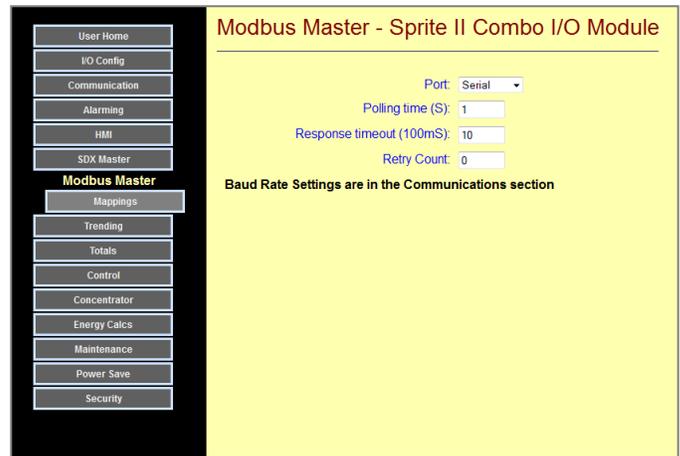
# SDX Master – Cellular - Destinations

2) Under the **SDX Master | Destinations** button, you can name and provide texting phone numbers for up to 8 destinations.



## Modbus I/O module (Serial) Master Configuration Pages

2500S modules can send and request various types of I/O and collected/calculated data to/from intelligent Modbus I/O module slave devices over serial data links (RS-232, RS-485 or wireless). The data is collected into the 2500S module general purpose (B and I) Concentrator registers. This capability allows data to be collected from these smart devices or performing remote control using communications in addition to “real” I/O. Most all of the 2500S module functionality can be applied to Modbus data, including historical trending and alarming.



- Port** Can be set to Disabled, or to select either the optional serial port or internal radio
- Polling Time (S)** Set the rate at which the 2500S module will attempt to initiate message transactions with the Modbus serial device(s). The time may end up being longer depending on how fast the devices respond to the 2500S modules messages.
- Response Timeout** Set the maximum time that it should take to get a response back here. The module will not initiate another message (retry or new), until this time period has expired. The time value will depend on the speed of the devices that are being talked to. The Comm Stats User page includes maximum and last latency times that can help you “tune” this parameter.
- Probe Time** The probe time is the polling rate for devices that have failed to respond to previous messages. When a remote device fails to respond to a message from the 2500S I/O module, it is removed from the normal “poll list” and placed onto a “probe list”. The probing time is generally much longer than the standard polling time so that most of the communications bandwidth can be spent talking to available units, instead of attempting to talk to one or more dead units, forcing long timeout delays.

## (Read & Write) Mappings

Use this page to set up the Modbus transactions, reading and writing status bits and coils to/from B (bit) registers, and input and holding registers to/from I (Integer registers. Up to 16 Modbus transactions can be configured.

	Dest Addr	Message Type	Local Index	Remote Index	Block Size
1	1	1xxxx Status Read	1	1	24
2	1	2xxxx Coil Write	17	9	8
3	2	3xxxx Input Read	1	1	64
4	2	4xxxx Holding Write	101	101	32
5	0	1xxxx Status Read	1	1	0
6	0	1xxxx Status Read	1	1	0
7	0	1xxxx Status Read	1	1	0
8	0	1xxxx Status Read	1	1	0
9	0	1xxxx Status Read	1	1	0
10	0	1xxxx Status Read	1	1	0
11	0	1xxxx Status Read	1	1	0
12	0	1xxxx Status Read	1	1	0
13	0	1xxxx Status Read	1	1	0
14	0	1xxxx Status Read	1	1	0
15	0	1xxxx Status Read	1	1	0
16	0	1xxxx Status Read	1	1	0

**Destination** Modbus address of the destination for this transaction

**Message Type** The type of data and direction for the transfer are selected using pull-down lists

**Local/Remote Index** The first address in the **local** 2500S module and the **remote** module or controller that will be used for the data transfer

**Size** The number of items to be transferred (block size)

## Modbus TCP/IP Master Configuration Pages

2500S modules can send and request various types of I/O and collected/calculated data to/from intelligent Modbus TCP/IP (Ethernet) slave devices. The data is collected into the 2500S module general purpose (B and I) Concentrator registers. This capability allows data to be collected from these smart devices or performing remote control using communications in addition to “real” I/O. Most all of the 2500S module functionality can be applied to Modbus data, including historical trending and alarming.

The screenshot shows the 'Modbus TCP/IP Master - Sprite II Combo I/O Module' configuration page. On the left is a vertical navigation menu with buttons for: User Home, IO Config, Communication, Alarming, HMI, SDX Master, Modbus Master, Modbus TCP/IP Master (highlighted), Destinations, Mappings, Trending, Totals, Control, Concentrator, Energy Calcs, Maintenance, Power Save, and Security. The main content area on the right has a yellow background and contains the following settings:

- Enable Modbus TCP/IP Master:
- Polling time (10mS):
- Response timeout (100mS):
- Comm Fail Probe Time (S):

**Enable** Use this checkbox to turn this feature ON or OFF

**Polling Time (10mS)** Set the rate at which the 2500S module will attempt to initiate message transactions with the Modbus serial device(s). The time may end up being longer depending on how fast the devices respond to the 2500S modules messages.

**Response Timeout** Set the maximum time that it should take to get a response back here. The module will not initiate another message (retry or new), until this time period has expired. The time value will depend on the speed of the devices that are being talked to. The Comm Stats User page includes maximum and last latency times that can help you “tune” this parameter.

**Probe Time** The probe time is the polling rate for devices that have failed to respond to previous messages. When a remote device fails to respond to a message from the 2500S I/O module, it is removed from the normal “poll list” and placed onto a “probe list”. The probing time is generally much longer than the standard polling time so that most of the communications bandwidth can be spent talking to available units, instead of attempting to talk to one or more dead units, forcing long timeout delays.

## Destinations

Use this page to set up the Modbus TCP/IP destination names, IP addresses, Ethernet Ports, and Modbus device addresses.



The screenshot shows a web interface for configuring destinations. On the left is a vertical navigation menu with buttons for: User Home, IO Config, Communication, Alarming, HMI, SDX Master, Modbus Master, Modbus TCP/IP Master, Destinations (highlighted), Mappings, Trending, Totals, Control, Concentrator, Energy Calcs, Maintenance, Power Save, and Security. The main content area is titled "Destinations - Sprite II Combo I/O Module" and contains a table with the following data:

	Destination Name	IP	Port	Modbus Addr
1	Tank 190	192.168.237.190	502	1
2	Pump Stn 190.3	192.168.237.190	502	3
3	Pump S 190.255	192.168.237.190	502	255
4	IP Deet 4	0.0.0.0	502	0

**Destination Name** Any text description for the user

**IP Address** The Ethernet address for this destination

**Port** The Modbus Ethernet Port for this destination. Industry convention is port number 502, but some people change this for security reasons.

**Modbus Address** Modbus TCP/IP devices have a Modbus address in addition to their IP address. This facilitates “bridging”, allowing access to multiple Modbus devices at a single IP address. Most device default this value to “1”. Do not use “0”.

## (Read & Write) Mappings

Use this page to set up the Modbus TCP/IP transactions, reading and writing status bits and coils to/from B (bit) registers, and input and holding registers to/from I (Integer) registers. Up to 32 Modbus transactions can be configured.

	Destination	Message Type	Local Index	Remote Index	Block Size
1	Pump Stn 190.3	3xxxx Input to Local I	1	1	2
2	disabled	1xxxx Status to Local B	1	1	0
3	Tank 190	1xxxx Status to Local B	1	1	4
4	disabled	1xxxx Status to Local B	1	1	0
5	disabled	2xxxx Coil from Local B	1	1	4
6	Tank 190	2xxxx Coil to Local B	5	1	4
7	disabled	1xxxx Status to Local B	1	1	0
8	disabled	1xxxx Status to Local B	1	1	0
9	disabled	1xxxx Status to Local B	1	1	0
10	Tank 190	3xxxx Input to Local I	11	191	4
11	disabled	1xxxx Status to Local B	1	1	0
12	Pump S 190.255	3xxxx Input to Local I	21	1	2
13	disabled	1xxxx Status to Local B	1	1	0
14	disabled	1xxxx Status to Local B	1	1	0
15	disabled	1xxxx Status to Local B	1	1	0

**Destination** Name of the device to be accessed (see “Destinations” page)

**Message Type** The type of data and direction for the transfer are selected using pull-down lists

**Local/Remote Index** The first address in the **local** 2500S module and the **remote** module or controller that will be used for the data transfer

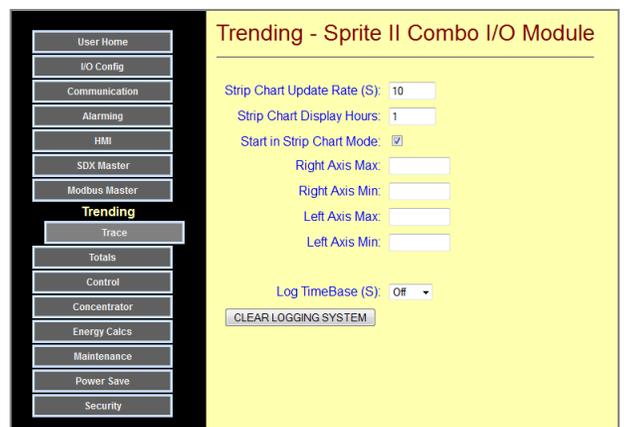
**Size** The number of items to be transferred (block size)

## Trending Configuration Pages

2500S modules can keep detailed records of up to 16 variables with resolutions down to 1 second. The data is stored, in the 2500S module, in a solid-state internal flash disk. Depending on the number of variables recorded and the recording resolution (interval), the module can record up to several years worth of data. The accumulated data is available as registers, a displayed tabular list on a web page, a CSV spreadsheet file, and graphed in a web browser. The values that can be recorded are:

- Analog Inputs
- Analog Outputs
- Digital Inputs
- Digital Outs
- Calculated Energy Usage Measurements
- Calculated Digital Input Totals
- Input Voltage
- Internal Temperature
- Master Mode Communications %
- Setpoint Block Outputs
- Pump Controller Block Outputs
- Communication Fail flags for all ports
- I (Integer) Registers 1 through 50
- B (Boolean) Registers 1 through 50

Configuration of what items are recorded by this mechanism, how fast they are recorded and some visual configuration controls and how this data is retrieved is set up under the **Configuration | Trending** button.



**Strip Chart Settings** Trends graph have a strip chart mode (continuously changing display) and a historical mode. These values set graphing parameters for the trends graphs such as the strip chart time base (how often updates across the screen), the numbers of hours of data displayed (by default) in strip chart mode, and if the graph starts in strip chart mode initially. The strip chart timing parameters may be changed by the user will the chart is displayed.

**Axis Scaling** These settings may be used to “lock” the scales on the trend graph. If they are blank, the graph is auto-scaled from the data. If you put in values, the scaling will be locked to the values that you set. There are separate pairs of values for the left hand and right hand axis.

**Log Time Base** Sets the resolution of the recorded trend data in seconds. Faster recording provides more detail, but will use up the trending storage much faster. For example, selecting a 1 second time base (the fastest), the module can store two channels for about two months, but using a longer interval can stretch the storage capacity to years.

**CLEAR LOGGING** Click on this button to clear and reset and previously recorded trending data

## Trace Configuration

Clicking on the “Trace” button brings up a trace configuration screen for up to 16 trend traces. This is where you can select which variables will be recorded, as well as their trace color, style and associated axis (for scaling) when the values are display in a graph.

	Enable	Color	Style	Right Axis
1	Tank Level - Level	Orange	Line	<input type="checkbox"/>
2	Input Voltage	Light Purple	Line	<input type="checkbox"/>
3	Temperature	Red	Line	<input type="checkbox"/>
4	Hi Level - State	Green	Line	<input type="checkbox"/>
5	disabled	Purple	Line	<input type="checkbox"/>
6	disabled	Mauve	Line	<input type="checkbox"/>
7	disabled	Light Green	Line	<input type="checkbox"/>
8	disabled	Blue	Line	<input type="checkbox"/>
9	disabled	Orange	Line	<input type="checkbox"/>
10	disabled	Light Purple	Line	<input type="checkbox"/>
11	disabled	Red	Line	<input type="checkbox"/>
12	disabled	Green	Line	<input type="checkbox"/>
13	disabled	Purple	Line	<input type="checkbox"/>
14	disabled	Mauve	Line	<input type="checkbox"/>
15	disabled	Light Green	Line	<input type="checkbox"/>
16	disabled	Blue	Line	<input type="checkbox"/>

### Color & Style

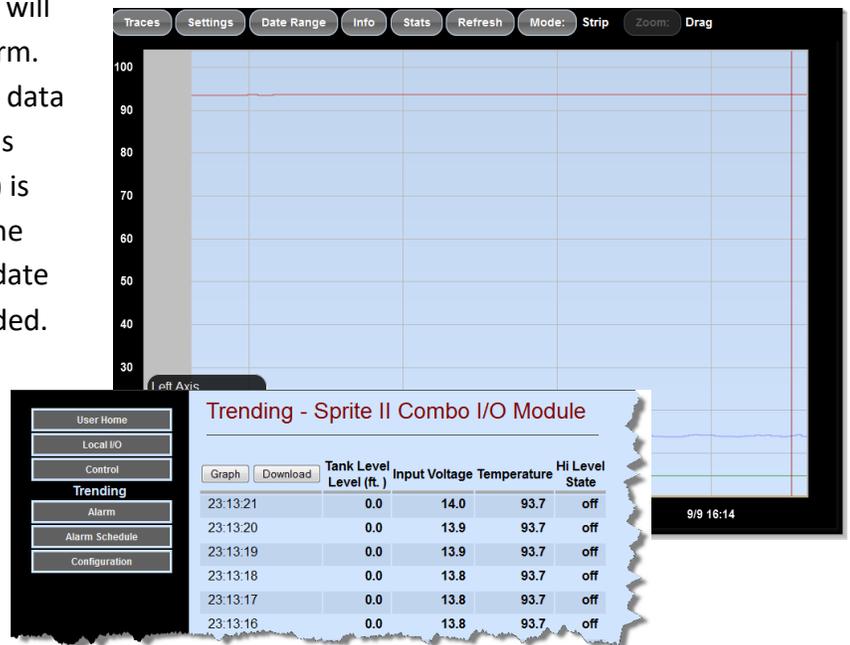
Used to make it easier to differentiate between displayed traces.

### Right Axis

Traces are normally tied to the left access scale. If some traces will have significantly different ranges of values, you can tie their display to a second (right hand) axis scale.

When the user first accesses a trend, they will see constantly updating data in tabular form. Clicking on the “Graph” button causes the data to be graphed. Any invalidate data (such as while the I/O module was powered down) is grayed out. Various controls for altering the mode (Strip chart or historical), selecting date ranges and zooming into details are provided.

The user also has the option of downloading the data to their computer in spreadsheet (CSV) format by clicking on the “Download” button.



# Totals Configuration Pages

2500S modules can keep details records of up to 4 totalized items. Applications include monitoring of energy, water and other commodity usage. The accumulated values for these four items are recorded by hour for seven years. The accumulated data is available as registers, displayed tabular lists on a web page showing the last 2 days by hour, and the last 2 years by month, hourly CSV spreadsheet files, and hourly data graphed in a web browser.

Totals that are normally accumulated include counts of pulses from digital inputs, energy calculations, pump and setpoint controller output cycles, runtimes, and a few of the general purpose “I” registers.

Configuration of which items are recorded by this mechanism and how this data is retrieved set up under the **Configuration | Totals** button.



**Totals Hour Offset** This value sets the hour for the start of a new day. Normally, this is 0 (midnight), but, for example, some manufacturing systems start the new days around 8am, so this value would be set to 8 in that case. This parameter must be set to value from 0 to 23

**CLEAR/RESET** Click on this button to clear and reset and previously recorded totals and restart the accumulation

**Axis Scaling** These settings may be used to “lock” the scales on the Totals graph. If they are blank, the graphs are auto-scaled from the data. If you put in values, the scaling will be locked to the values that you set. There are separate pairs of values for the left hand and right hand axis.

**Lcl Time Download** Check this box if you want to download data as CSV files with the time stamps set to the local time. Use this mode is you are downloading into a text document. DO NOT check this mode if you are downloading into a spreadsheet program such as Excel, since these programs expect time as GMT (Greenwich Mean Time) and then automatically adjust the display to the local time zone and daylight savings settings.

**Days to Log in CSV** Sets the number of days of data to be downloaded from the internal log file. This can also be set from the user screens.

## Totals Trace Configuration

Clicking on the “Trace” button brings up a trace configuration screen for 4 totals traces. This is where you can select which variables will be recorded, as well as their trace color, style and associated axis (for scaling) when the values are displayed as a graph.



### Color & Style

Used to make it easier to differentiate between displayed traces.

### Right Axis

Traces are normally tied to the left access scale. If some traces will have significantly different ranges of values, you can tie their display to a second (right hand) axis scale.

## Alarm Setpoints Configuration

Accumulated totals can be used to trigger text message alarms. For example, you can configure your 2500S module to annunciate excessive flows, high energy usage or long runtimes. This web page is used to enter the high limits on the four possible monitored totals selected under Totals | Traces. Any values set to zero are ignored (don't generate alarms). Note that the names on the left of the page are the user entered tag names followed by the “totals” text.



## Control & Setpoint Configuration Pages

2500S modules have a full duplex pump controller and eight independent setpoint blocks to perform local control, monitoring and alarming without programming; just fill-in-the-blanks configuration.

Configuration of the duplex pump control section and the setpoint blocks is performed under the **Configuration | Control** button.

All pump control and setpoint blocks have dual sets of ON and OFF setpoints based on time of day. For example, this can be used to minimize energy costs, such as by filling tanks higher on off peak hours. In addition, the setpoint blocks can be used to verify limits on an analog signals, and generate an alarm (see Alarms Section).



How the A and B schedule times will be used is determined by a selection associated with each setpoint block. The schedules can be used individually to select specific time that control actions can take effect, or combined so that different setpoint values are used when a new schedule time is reached.

## Duplex Pump Control Configuration Page

2500S modules have a built-in duplex pump controller (control block). Either a single pump or two pumps can be controlled. If two pumps are controlled, the block can be configured to alternate based on:

- Runtimes
- Starts
- simple flip
- no alternation

The pump control can be based on a level signal, or from float switches. If a level signal is used, there are two sets of lead/lag setpoints based on time-of-day (and weekend) settings for energy time-of-use energy management. The output of the level control block can operate local outputs, or remote locations by wired or wireless communications.

**Alternation Scheme** This is a selection box that either turns OFF (disables) the level controller or selects one of the various types of setpoint or float based alternation schemes.

**Float Fail Timer** Under float switch control, this value is used as a timer setpoint to automatically turn off the pump output(s) if an OFF float switch input signal is not received with the specified Fail Timer time entered.

**Pri/Sec Shutdown** These pull-down lists allow for configuration of input conditions that can turn OFF the pump outputs. Up to two of these conditions can be configured. These include:

- A signal from one of the digital inputs
- An output from one of the setpoint blocks
- One of the first 8 “B” registers turning ON (Remote site Booleans)

A typical application would be to use a setpoint block to sense when a well level has been drawn down too low. When this occurs, the output of the setpoint block could pause the pump(s).

**On/Off Debounce** The conditions that cause a pump to turn ON or OFF must remain true for the specified “debounce” time for the pump start to actually change. This overcomes problems that can occur from wave action of water hammer as examples. The times are entered in seconds.

**Setpoints/Schedules** This is where the Lead and Lag On and OFF setpoints can be preset. The controller can “pump up” or “pump down” by changing whether the ON setpoints are greater or less than the OFF setpoints. The setpoint values can also be changed on the User web pages. There are two sets of setpoints that can be used based on the time of day, and weekend day selections. Typically this will be used to vary the pump operation based on the time of day. Some power companies give better rates for off-peak time operation, which may be the best time to top off a tank. There are also selectors to use the secondary setpoints all day on individually selectable weekend days. The time settings and weekday/weekend settings here also apply to the A/B setpoints in the Setpoint Controllers blocks.

## Setpoint Control Configuration Pages

2500S modules have 8 built-in setpoint controllers (control blocks), typically used to sense shutdown and alarm conditions. The setpoint control blocks can monitor:

- Any analog or universal input
  - Any analog output
  - Any of the first 50 “I” registers
  - A rate from a digital input
- Calculated energy (EnergyWatch) or flow (SmartFlow)

There are two sets of on/off setpoints based on time-of-day (and weekend) settings for time-of-use energy management. The output of the level control block can operate local outputs, or remote locations by wired or wireless communications.

Be sure to use the slider bar to access more the last control blocks.

	1	2	3	4
Tag Names:	Hi Level	Setpoint 2	Setpoint 3	Setpoint 4
Visible:	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Source:	Tank Level	Tank Level	Tank Level	Tank Level
On Level:	10000	10000	10000	10000
(B) Level:	10000	10000	10000	10000
Debounce (1S):	0	0	0	0
Off Level:	9000	9000	9000	9000
(B) Level:	9000	9000	9000	9000
Debounce (1S):	0	0	0	0

### Tag Names

This is where you enter the names that will show up on the various HMIs for setpoint block settings.

### Visible

Check these boxes to make the setpoint block settings and output visible and changeable on the HMIs

### Source

The analog level that comparisons will be made to for control actions.

### HOA

Hand-Off-Auto. “Auto” enables the comparison logic to generate control actions. OFF and ON can either disable or manually cause an output to be forced OFF or ON, primarily for testing.

### Schedule

This selection determines the time schedule operation that enables or disables an alarm (based on the setpoint schedule times on the first alarm configuration page).

- **A or B Untimed** (the specified setpoints are always used, no schedule times)
- **A or B Timed** (the specified setpoints are active during the specified time. When the next schedule time is reached, the setpoints are disabled, turning OFF the output. For example, to enable control only from 8am to 5pm.)
- **A or B Momentary** (the specified setpoints are active only for the minute of the schedule time.)
- **A/B Timed or Momentary** (same as above but using both pairs of times and setpoints.)

- Debounce** The conditions that cause an output to turn ON or OFF must remain true for the specified “debounce” time for the output to actually change. This helps to eliminate spurious responses to transient conditions.
- ON/OFF Levels** There are two ON levels and two OFF levels, one for each set of schedule times.

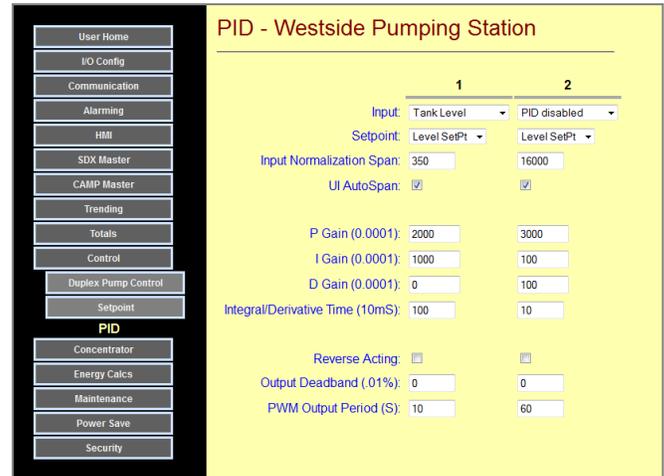
## PID Control Configuration Pages

2500S modules have two built-in PID (**P**roportional, **I**ntegral & **D**erivative) controllers (control blocks) for closed loop control applications. The PID control blocks can control from the following “analog” values in the I/O module:

- Any analog or universal input
- A rate from a digital input
- Any of the first 50 “I” registers

All calculations are performed as a percentage of the input span (difference between a minimum and maximum value). If the PID input is from a Universal Analog Input, an “Autospan” function will use the default span for the selected mode as the span.

The output can be either an analog value or a digital pulse-width duty cycle. A deadband can be specified to reduce wear-and-tear on valves from “hunting”.



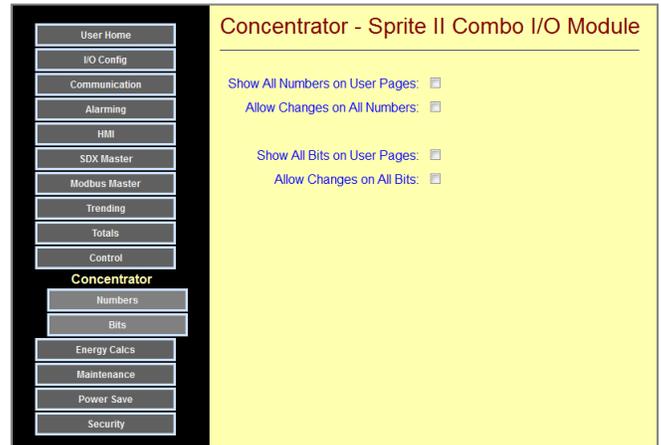
The PID block operates by calculating an “error” (difference between Input and Setpoint) as a percentage of Input Span. The “P” section multiplies this error by the P Gain. The “I” section samples the error every Integral/Derivative Time period and adds the sequential error readings into a temporary register as long as the PID output is not at a full 0% or 100% level (to prevent windup). This value is multiplied by the I Gain. The D section compares successive error readings and the difference is multiplied by the D Gain. The outputs of the three sections are then summed together. If used to drive an analog output, the span will automatically match the output mode (100% = 16000 for 4 to 20mA, 20000 for 0 to 20mA, etc.). Use the “Link to AO’ and “Link to DO” settings in the I/O configurations sections to select the physical I/O output.

- |                          |  |
|--------------------------|--|
| <b>Input</b>             | Analog input source (sensor) from your process   |
| <b>Setpoint</b>          | Desired point for the process to operate (setpoint is compared to the analog input)  |
| <b>Input Span</b>        | Difference between highest and lowest expected input – used for percentages  |
| <b>I/D Time</b>          | The time between calculations run by the Integral and Derivative sections  |
| <b>Reverse Acting</b>    | The output is reduced for increasing process output values   |
| <b>Output Deadband</b>   | The amount of calculated output required to actually effect an physical output change. Allows for small calculated output changes to not operate the control device, reducing mechanical wear and tear.                  |
| <b>PWM Output Period</b> | Timing for full PWM output cycle. For example, a heater might be set to a 30 second PWM cycle, so when the PWM calculations call for 50% output, the digital output will cycle ON for 15 seconds and OFF for 15 seconds. |

## I & B Variables Configuration Pages

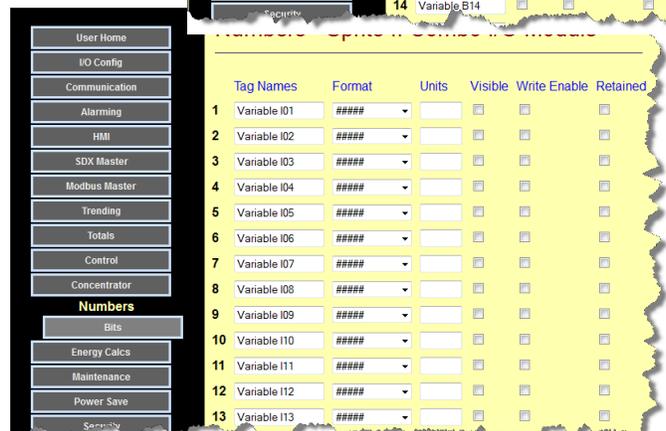
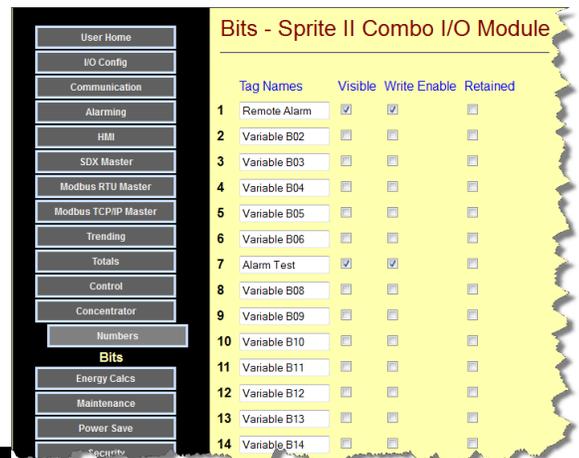
2500S modules have 200 general purpose integer registers and 200 general purpose Boolean registers to facilitate using the modules as “communications concentrators”. In a system with multiple modules, frequently there is one that serves as a central device that is connected to a network and/or other PLCs. This central device receives data from the other field devices and passes setpoints and control information back out to those same field devices. The first 50 of each register type can have tag names and units assigned to them for use in the modules HMIs, level and setpoint controls, and logging and trending functions. The remainder are primarily “communications mailboxes” for access by other computers and PLCs. In these web pages, you can configure the first fifty of each register group.

Configuration of the Numbers and Bits concentrator variables is set up under the **Configuration | Numbers (I Variables)** button and the **Configuration | Bits (B Variables)** button.



The following shows the Bit (B) Variables and Number (I) Variables configuration web pages.

These pages are very long, so you may need to scroll down to reach the variable that you want to configure.



<b>Tag Names</b>	This is where you enter the names that will show up on the various HMIs. Tag Names can be up to 14 characters long.
<b>Format</b>	By selecting the appropriate format, you can display a decimal point in values on the various HMIs. For example, you can make 500 read as 50.0 by selecting the xxxxx.x format. Be sure that you scale the variables with an extra 10x multiplier.
<b>Units</b>	This is where you enter the text units (on the right of each variable) that will show up on the various HMIs. Units can be up to 4 characters long.
<b>Visible</b>	Check this box if this variable is to show up on the HMIs.
<b>Write Enable</b>	Check this box if this variable can be changed from and HMI.
<b>Retained</b>	Check this box if this variable is to be preserved through a power failure. This is generally recommending for setpoints.

## Special Calculation Configuration Pages

2500S modules have special calculation functions for measuring flow and energy usage/gain that can eliminate external sensors. These functions are configured under the “Special Calcs” button under “Configuration.”

### SmartFlow

SmartFlow is a special feature of 2500S I/O modules that uses pump runtimes and level measurements to calculate flow, eliminating the cost and complexity of separate flow meters. SmartFlow works in systems with single pumps and in duplex pumping applications. For proper operation, the output capacity of each pump must be known, and the variation in head pressure that the pumps push against should be relatively constant. Usually, the variation in tank level is much less than the well to tank water column, so this later is normally not an issue. The calculated flow can be logged periodically as historical totals, graphed, downloaded as a spreadsheet file, and also used for alarming such as for system leak sensing.

Configuration of the Energy Calculations is set up under the **Configuration | Special Calcs | SmartFlow** button.

**Tank Level Input** Numeric level signal, normally scaled to tenths of a foot (i.e. 324 = 32.4 ft.).

**Volume/Level Unit** If the level input is in tenths of a foot, enter the number of gallons in one tenth foot. If you have a cylindrical tank, the tank volume is:

$$\text{Volume (gallons)} = \text{Tank Radius (ft.)} \times \text{Tank Radius (ft.)} \times 2.35$$

**Pump Runs** Select digital points here for each pump that will so when the pump is running

**Pump Flow Rating** Enter the one-minute pump output for each pump. Note that if this is a duplex (two pump) system, you will also need to enter the output capacity when both pumps are running. This will be less than the sum of the individual pump outputs.

**Production Units** Up to 4 characters that describe the flow units, typically GPM for gallons per minute.

**Output** The calculated flow output can be directed to an “I” register for transmission to a remote site or alarming using a setpoint block. This output “I” register is not needed for simple hourly totals logging which can directly access the calculated flow.

## EnergyWatch

2500S modules can calculate energy rates and usage from the values of field inputs and data external modules (via “I” registers). Models with two analog inputs can perform two energy calculation “runs” (i.e. heating and cooling), while the 2500S-27-XXXX with 6 analog inputs and Sprit with 8 analog inputs can perform two independent calculations.

The energy calculation performed is:

**Flow x (Temp1 – Temp2) x K x Scaling** where **K** is a constant for the cooling liquid (1 for water).

The flow is multiplied by a temperature rise (or drop) and compensated for the cooling or heating liquid. There is also a separate scaling adjust to provide a bit more flexibility. The calculation yields an instantaneous energy usage. A long-term energy totalizer (watt meter?) is also provided for long-term continuous energy totalization. Hourly energy usage recording can be set up under the “Totals” configuration section. This section also provides hourly and monthly displays as well as graphing, and spreadsheet download tools that can help analyze energy usage.

Configuration of the Energy Calculations is set up under the **Configuration | Special Calcs | EnergyWatch** button.

The screenshot shows the configuration page for the EnergyWatch module. On the left is a navigation menu with buttons for User Home, I/O Config, Communication, Alarming, HMI, SDX Master, CAMP Master, Trending, Totals, Control, Concentrator, Special Calcs, EnergyWatch (highlighted), SmartFlow, Maintenance, Power Save, and Security. The main area is titled 'EnergyWatch - Sprite II Combo I/O Module' and is divided into two columns, 1 and 2. The central configuration area is as follows:

	1	2
Tag Name:	BTU-001	E2
Visible:	<input checked="" type="checkbox"/>	<input type="checkbox"/>
<b>E = Flow Rate * (Temperature 1 - Temperature 2) * K * Scaling</b>		
Flow Rate:	Main Feed 1A Rate	Disable
Temperature 1:	Inlet Temp	Disable
Temperature 2:	Outlet Temp	Disable
K:	500	500
<b>Scaling</b>		
Numerator:	1	1
Divisor:	10	10
Format:	####	####
Units:	BTU	BTU
<b>Totalizer</b>		
Visible:	<input type="checkbox"/>	<input type="checkbox"/>
Divisor:	1	1
Format:	#####	#####
Units:	BTUH	BTUH
Totalization Gate Time (S):	60	60

### Tag Names

This is where you enter the name of the energy calculation results if they will show up on an HMI readout. Tag Names can be up to 14 characters.

### Visible

Check this box if this variable is to show up on the HMIs.

### Temperature 1

This is the measured temperature **before** the process which is adding or using energy. It will be used to calculate a temperature differential. Usually, you will select one of the Universal (analog) inputs or an “I” register if the temperature is being reported by a remote unit. If this input provides differential temperature, disable the second temperature input below.

- Temperature 2** This is the measured temperature **after** the process which is adding or using energy. It will be subtracted from “Temperature 1” to calculate a temperature differential. You will select one of the Universal (analog) inputs for temperature readings.
- K** This is a constant used to scale the reading to some meaningful units such as “Kilowatts”.
- Scaling** This is where you can apply an additional calculation to scale the results to meaningful engineering units, primarily for HMI display. The I/O module will take the results of the above energy calculation and multiply by the “Numerator”, then divide that result by the Denominator”. For example, convert watts to kilowatts by making the denominator 1000, or use a smaller denominator if the selected format will apply a decimal point to the reading (like 123.456 kilowatts)
- Totalizer Gate Time** This is where you set up a long-term totalizer that will keep a running total of energy usage, perhaps over a period of years. Hourly and monthly totals, as well as peaks can be recorded in the “Totals” section.

## Maintenance Configuration Pages

2500S modules numerous features to assist in system installation and testing accessed through the Maintenance Configuration Pages, set up under the **Configuration | Maintenance** button.

**Maintenance - Sprite II Combo I/O Module**

- Name: Sprite II Combo I/O Module
- MAC: 00-50-C2-CE-02-12
- Mfg ID: 586011
- Serial#: 86074
- Manufacturing Date: 04/16/2012
- Factory Cal. Date: 01/04/2012
- User Cal. Date: 01/04/2012
- Software: 1.08.07
- Software Config #: 41
- Starts: 32
- System Time: 09/09/2012 23:37:28
- Local Time: 09/09/2012 23:37:28
- TimeZone Offset: 0

### Test Mode Configuration Page

2500S modules have a “test” mode that sequentially simulates the activation of Digital Inputs and a continuous ramping up and down of the analog inputs. This feature can be used to test data transfers over communications links, generate test alarms, etc.



## CAUTION!

Be careful that the simulated inputs will not cause outputs that are controlling live equipment to be turned on accidentally, before enabling this mode!

**Test Mode - Sprite II Combo I/O Module**

- Test Mode Enable:
- Cycle Time (100mS): 10
- WARNING: Test Mode Cycles All DI channels and ramps the UIs from 0 to 20000**

**Test Mode Enable** Check this box to turn on Demo mode

**Cycle Time** Sets how fast the Digital Inputs get cycled (in 100mS increments)

## System Configuration Page

2500S modules can have their configurations backed up and their program code and configurations can be field updated using standard software tools that support the TFTP protocol. No special software is required. These tools transfer files between your PC computer and the disk drive within the target 2500S module. If you do not have a program that supports this protocol, you can download one from the 2500S module using the “Download TFTP Program” button, and install it on your PC.



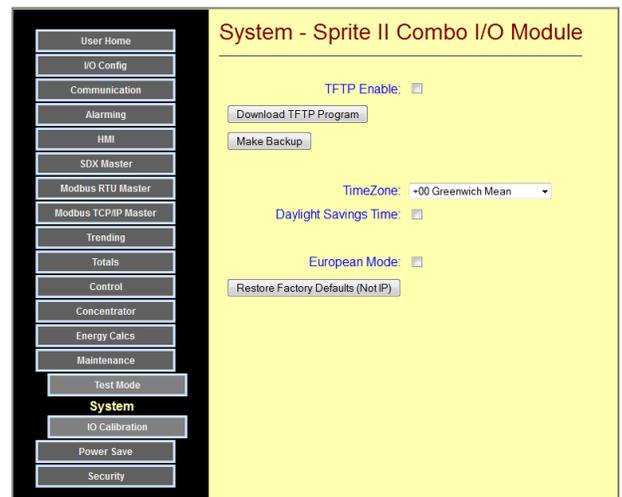
Be sure that you check the “Enable TFTP box before attempting a download.



When you don't need to download a program of configuration we recommend turning the TFTP Enable OFF for security reasons.

You can also extract a backup of your module configuration in “CSV” format using the “Make Backup” button. To restore a configuration, use the TFTP tool. Please do not alter filenames and extensions without first consulting CTI Technical Support!

For detailed information on using the built-in TFTP program, please refer the description in the following section.



The System Configuration Page also has controls for the Real Time Clock. For proper display of trends and graphs, please set the TimeZone and Daylight Savings setting for the location of the module.

**TFTP Enable** Check this box to turn on Demo mode

**Time Zone** Set to your local time zone. If this is set incorrectly, the displayed times in trend and log data will be wrong, and scheduling will be off (although trend graphs and spreadsheet files that are sent to a PC will always match the PC settings).

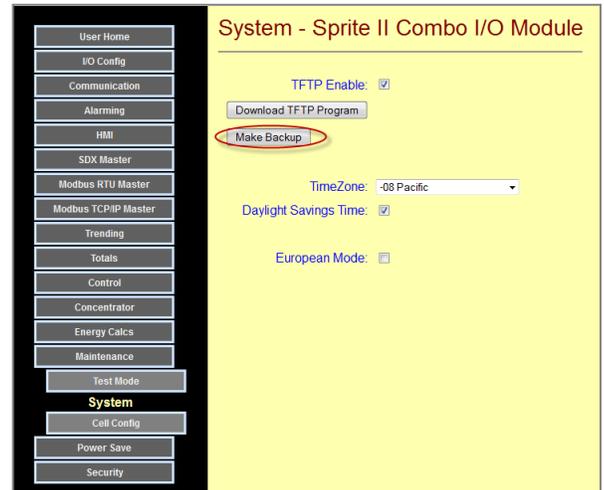
**Daylight Savings** Check this box if you hour should be shifted for Daylight Savings..

**European Mode** Adjusts numbers to use a “,” for decimal points and ; delimiters for spreadsheet files as used by most European and South American countries.

**Restore Factory Defaults** Click on this button to restore all configuration values (except for the IP address) to the factory default settings

## Backing up and Restoring an I/O module Configuration

2500S modules can have their configurations backed up in the field. The backup file is a spreadsheet that the I/O module sends to your PC when you click on the “Make Backup” button. This file can be loaded and edited with a standard spreadsheet program such as Microsoft Excel or a simple Text Editor program. Backup files can be loaded back into an I/O module using a standard protocol known as “TFTP” (Tiny File Transfer Protocol). Please see “TFTP Downloads and Uploads (File Transfers)” in the next section for detailed instruction on installing a free TFTP program and using it to download into the I/O module.



## I/O Calibration

The analog input section of 2500S I/O modules can be calibrated electronically by adjusting setting under the **Maintenance | IO Calibration** button.

If a mistake is made, the original factory calibration settings can be restored by clicking on the “Restore Factory Calibrations” button.

The screenshot shows the 'IO Calibration - Sprite II Combo I/O Module' configuration interface. On the left is a vertical menu with the following items: User Home, IO Config, Communication, Alarming, HMI, SDX Master, Modbus RTU Master, Modbus TCP/IP Master, Trending, Totals, Control, Concentrator, Energy Calcs, Maintenance, Test Mode, System, **IO Calibration**, Power Save, and Security. The 'IO Calibration' option is highlighted. The main content area has a yellow background and contains the following settings:

- VIN: 3060
- I Gain**
  - UI1: 45300
  - UI2: 45211
- R Gain**
  - UI1: 5000
  - UI2: 5000
- V Gain**
  - UI1/2: 40961
- V5 Gain**
  - UI1/2: 34952
- mV Gain**
  - UI1/2: 51202
- AO1**: 22500
- AO2**: 22123
- Offset**
  - AO1: 0
  - AO2: 0
- mV UI1/2: 0

At the bottom of the main area is a button labeled 'Restore Factory Calibrations'.

## TFTP Downloads and Uploads (File Transfers)

2500S modules can have their configurations backed up and their program code and configurations updated in the field. A standard protocol known as "TFTP" (Tiny File Transfer Protocol) is used to transfer data between the 2500S modules and a PC. If you do not have a TFTP program, you can download a free "Open Source" program from the 2500S module and install it on your PC. The program is called "Pumpkin" from the "Klever Group". This program is designed to work with 32-bit operating systems, including 32-bit versions of Windows 7.

The TFTP Client program supplied in 2500S modules is a program made available by the Klever Group based upon the following written statement from them:

### PUMPKIN TFTP Program

Copyright © [Klever Group \(http://www.klever.net/\)](http://www.klever.net/)

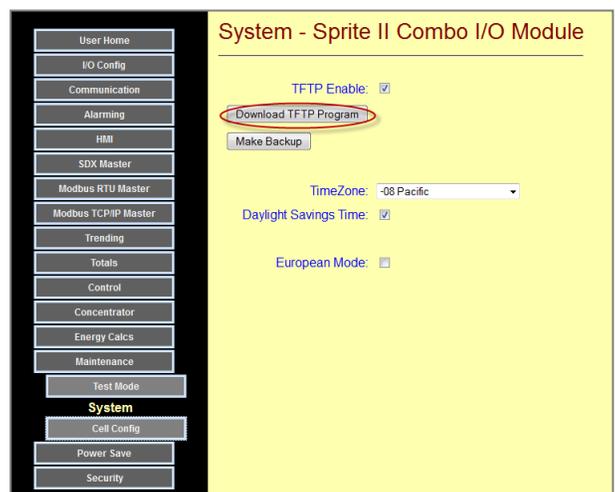
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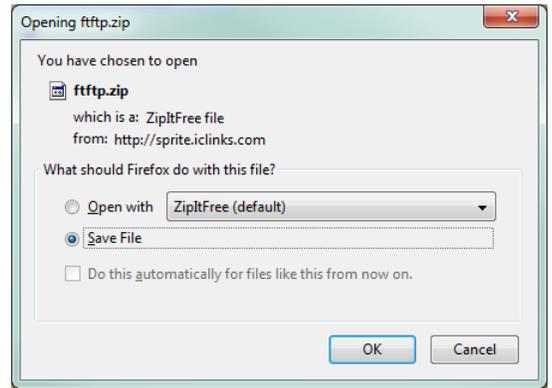
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## Installing the Pumpkin TFTP Program on your PC

**STEP 1:** Click on the Download TFTP Program



**STEP 2:** Windows will open the following dialogue box. Please save the program to your hard drive.

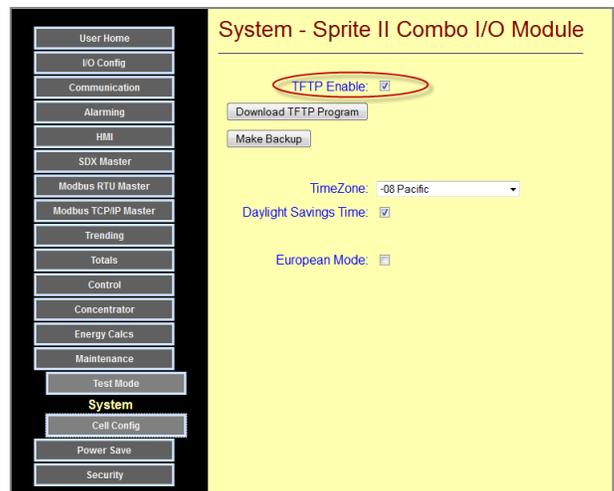


**STEP 3:** Please RUN the downloaded program. The program will be installed on your computer as “Pumpkin” in a folder called “Klever Group” in you Windows “Program Files” folder.

**STEP 4:** We recommend opening Windows Explorer (Right Click on the start button) and placing a shortcut of the Pumpkin program on your desktop.

### Using the PTFTP Program to Download to a 2500S module

**STEP 1:** Make sure that TFTP is enabled in the 2500S module

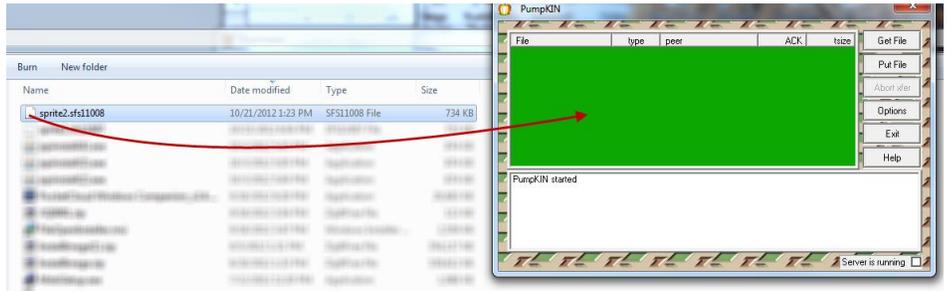


**STEP 2:** Start the Pumpkin program (double click on the icon that on your PC desktop from making the shortcut).

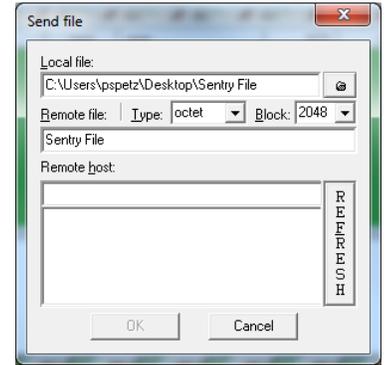
**STEP 3:** You will see the following screen:



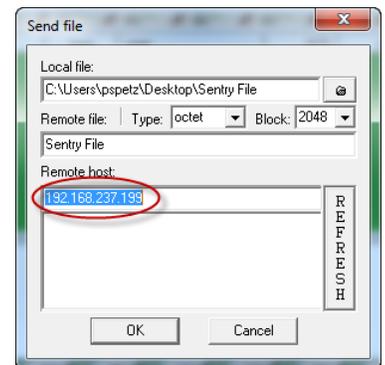
**STEP 4:** DRAG the file that you want to download onto the green window of the Pumpkin program.



**STEP 5:** You should see this dialogue window pop up. The entry under “Local file” will show the program and its path that you just dragged over. The “Remote file” will show just the file name. It will NOT be called “2500S File”, but the actual file names depending on the type of file that you downloading into the module.



**STEP 6:** Enter the IP address of the 2500S module. If all is right, you will see the program download (byte counts on the green background) and a completion message.



**STEP 7:** For security, be sure to turn OFF the TFTP enable



**IMPORTANT!**

**STEP 8:** Cycle power to the 2500S module to reset it and let it “reboot”.

**STEP 9:** If you downloaded a new program (not a configuration), you can verify that the new version is running by clicking on the **Configuration | Maintenance** button.

## Optional Radio/Cell Configuration Page

2500S modules can optionally have a Freewave or Digi (formerly Maxstream) internal spread spectrum radio, or an internal cellular modem. Most of these devices will require some limited configuration when they are installed in a system. Depending on the device, each radio or modem accepts configuration commands or even has their own configuration menu system. 2500S modules provide a means of directly accessing the internal radios and modems to support these configuration mechanisms. The configuration interface for both internal Freewave and Digi radios, as well as internal cellular modems are individually described below.

### Digi (formerly Maxstream) Spread Spectrum Radio Option

When a 2500S module is ordered with an internal Digi radio option, a special purpose configuration screen is accessed via the “Radio Configuration” selection under the Maintenance button. Digi radios are similar to other types of modems that use a +++ attention sequence and commands that are preceded with an “AT”. The Digi radio configuration web page has a button to generate the timing sensitive attention sequence as well as the ability to enter AT configuration commands and see their responses. Messages typed into the entry field are sent to the modem when the “Send” button is clicked on. A menu of “clickable” frequently used commands are

included on the right side to simply radio configuration. All message traffic to and from the modem (i.e. to/from the I/O module) is displayed in the window. Yellow text is data going to the cell modem, and the responses are in green text.



Command	Description	Parameter
ATBR	RF Data Rate	0(9600),1(115200)
ATCN	Exit Command Mode	none
ATCT	Command Mode TimeOut	2 - 0xFFFF
ATDT	Destination Address	0 - 0xFFFF
ATHP	Hopping Channel	0 - 9
ATMK	Address Mask	0 - 0xFFFF
ATMT	Multi-Transmit	0 - 0xFF
ATMY	Source Address	0 - 0xFFFF
ATWR	Write (Save changes)	none
ATRC	Ambient power - Single Chl	0 - 0x31 [dBm, read-only]
ATRM	Ambient power - All Channels	none - 0x7D0

A menu of “clickable” frequently used commands are included to simply radio configuration.

There is additional information on configuring Digi Xtend radios under the “Communication Configuration” section of this manual.

Please be careful to know the effects of any parameter change that you do make, as some settings (such as changing host port baud rate) could “break” an otherwise working system. For more detailed information, please request a copy of the Digi Xtend technical manual from CTI Technical Support, or download it from the manufactures web site: [www.digi.com](http://www.digi.com) The latest manual at the time of this manuals publications was at:

[http://ftp1.digi.com/support/documentation/90000958\\_E.pdf](http://ftp1.digi.com/support/documentation/90000958_E.pdf)

## Important Digi Radio Commands

### **ATBR View/Set the RF Data Rate**

All of the radios in a system must be set to the same RF data rate in order to communicate with each other. The RF data rate can be set to either 9600 baud (0) or 115,200 baud (1). Unlike other some other spread spectrum radios, Digi Xtend radio send a complete message on one frequency before “hopping” to another frequency. Therefore, the RF baud rate setting determines how long a message will take to transmit before the radio switches frequencies. At the higher speeds, the messages are delivered faster (and possibly less vulnerable to interference because they have less exposure time), but the radios sensitivity is 10dB less than using the lower speed setting.

### **ATMT View/Set the Multi Transmit Setting**

In order to reduce the chances of a message not getting through, especially in noisy environments, the Xtend radio can be set to automatically transmit multiple “copies” of a message, each on a different frequency. This slows the overall message throughput, but may actually be faster by eliminating the need to retry messages. The number of messages sent is the setting plus 1.

### **ATHP View/Set the Hopping Channel Setting**

In order avoid interference between Xtend radio systems located in close proximity to each other, each radio of the same system should given the same hopping number (pattern), and this value should be different from any other nearby radio system. Hopping numbers can range from 0 to 9.

### **ATRC View the ambient signal level of a Single Channel**

Xtend radios hop among 50 different frequencies, helping them avoid inference at any one or several frequencies from stopping messages from get through. This command enables sampling of the ambient signal level at any one of those frequencies. The command format is ATRC<channel#>.

### **ATRM View the ambient signal level of all Channels**

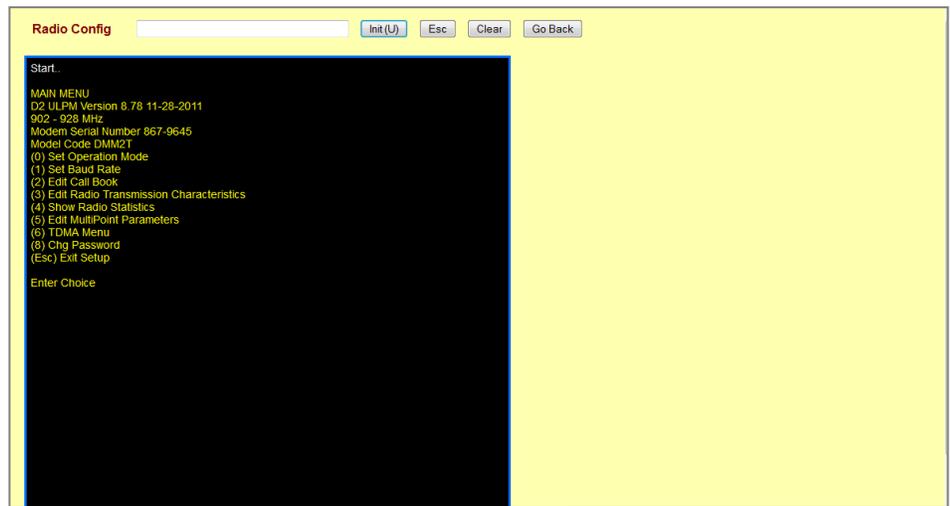
Xtend radios hop among 50 different frequencies, helping them avoid interference at any one or several frequencies from stopping messages from get through. This command enables sampling of the ambient signal levels at all frequency channels. The command can have a parameter which specifies how many times the channels should be scanned, so that catching spurious interference is more likely. The command format is ATRM<number of scans>. This command is VERY useful to determine if nearby sources of interference (cell towers, TV stations, etc.) are affecting data exchanges. A band pass filter can be used to minimize the effects of these noise sources if high levels of interference are found.

### **ATWR Make changes permanent**

Any changes made with AT command take effect right away, but they are volatile, meaning that if the I/O module and radio are powered OFF, the changes will be lost. Use this command to save the changes permanently.

## Freewave Spread Spectrum Radio Option

When a 2500S module is ordered with an internal Freewave radio option, a special purpose configuration screen is accessed via the “Radio Configuration” selection under the Maintenance button. Freewave radios have their own built-in menu system, so the 2500S module simply provides a means of accessing the menus through a web page interface. A button is provided to generate the “U” attention command required by Freewave. This will bring up the first menu (Menu “0”). From then on, entering commands, typically number, into the entry bar and pressing send, provides a means of configuring the internal Freewave radio.



Usually, you will need to set AT LEAST the following in each Freewave radio in the system:

- Set Operation Mode (Point-to-MultiPoint Master, Slave, Slave Repeater)
- Set Radio Transmission Characteristics (Transmit Power, Data Rates, etc.)
- Show Radio Statistics (Diagnostic information)
- Edit Multipoint Parameters (number of radio repeaters, repeater path, Network ID, etc.)

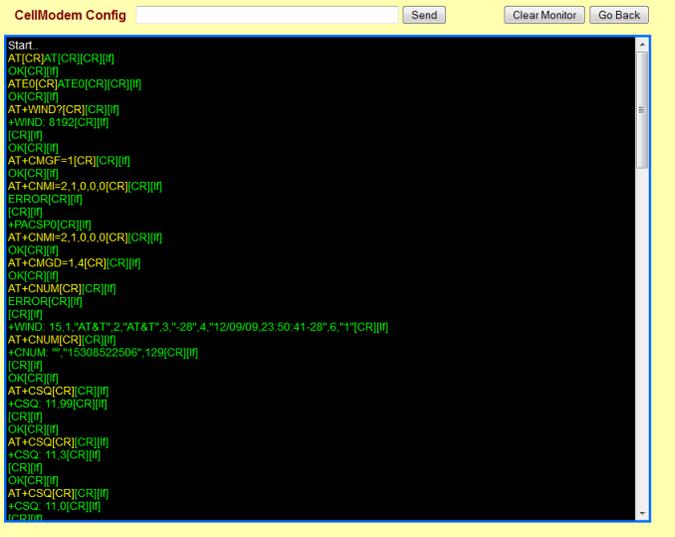
There is additional information on configuring Freewave radios under the “Communication Configuration” section of this manual.

Please be careful to know the effects of any parameter change that you do make, as some settings (such as changing host port baud rate) could “break” an otherwise working system. For more detailed configuration information, please request a copy of the Freewave MM2 technical manual from CTI Technical Support, or download it from the manufactures web site: [www.freewave.com](http://www.freewave.com)

## Cellular Modem Option

When a 2500S module is ordered with an internal cellular option, a special purpose configuration screen is accessed via the “Cell Modem Configuration” selection under the Maintenance button. The actual cell modem supplied will vary by cell carrier being supported. For the most part, users will not need to make configuration changes to the factory supplied configuration, but if requested by CTI Technical Support, the facility to make changes in the field is provided.

Messages typed into the entry field are sent to the modem when the “Send” button is clicked on. All message traffic to and from the modem (i.e. to/from the I/O module) is displayed in the window. Yellow text is data going to the cell modem, and the responses are in green text.



The screenshot shows a window titled "CellModem Config" with a "Send" button and "Clear Monitor" and "Go Back" buttons. The main area displays a series of AT commands and responses. Yellow text represents commands sent to the modem, and green text represents responses received from the modem. The commands include AT, AT+WMND?, AT+CNMI=2,1,0,0,0, AT+CMGF=1, AT+CMGD=1,4, AT+NUM, AT+CSQ, and AT+NUM. The responses include OK, ERROR, and various status codes like +WIND, +PASSP, +CSQ, and +NUM.

```
Start.
AT[CR]AT[CR][CR][M]
OK[CR][M]
ATE0[CR]ATE0[CR][CR][M]
OK[CR][M]
AT+WIND? [CR][CR][M]
+WIND: 8192[CR][M]
[CR][M]
OK[CR][M]
AT+CMGF=1[CR][CR][M]
OK[CR][M]
AT+CNMI=2,1,0,0,0[CR][CR][M]
ERROR[CR][M]
[CR][M]
+PASSP[CR][M]
AT+CNMI=2,1,0,0,0[CR][CR][M]
OK[CR][M]
AT+CMGD=1,4[CR][CR][M]
OK[CR][M]
AT+NUM[CR][CR][M]
ERROR[CR][M]
[CR][M]
+WIND: 15,1,"AT&T",2,"AT&T",3,"28",4,"12/09/09,23:50:41-28",6,"1"[CR][M]
AT+NUM[CR][CR][M]
+NUM: "15308522506",129[CR][M]
[CR][M]
OK[CR][M]
AT+CSQ[CR][CR][M]
+CSQ: 11,99[CR][M]
[CR][M]
OK[CR][M]
AT+CSQ[CR][CR][M]
+CSQ: 11,3[CR][M]
[CR][M]
OK[CR][M]
AT+CSQ[CR][CR][M]
+CSQ: 11,0[CR][M]
[CR][M]
```

# Power Saving Configuration

2500S modules can be used in power restricted applications like solar powered installations and sites that may have to depend on battery backup for main power. In fact, some 2500S modules incorporate solar controllers and battery backup circuitry within them. A “Power Save” page is used to configure these items.



**AO Power Disable** 2500S modules with analog outputs generate 24V loop power from any input voltage ranging from 10 to 30Vdc. If the analog outputs are not used, the power consumption of the circuitry that generates the 24V loop power can be eliminated.

**UI Sleep Controls** Universal Analog Inputs can be configured to take periodic samples with long intervals in between to conserve power. For example, a slow moving tank level may only need to be sampled once per hour. The UI sleep time sets the interval between measurements. The UI Sleep Samples Averaging helps reduce wave and transient effects by averaging readings over 1 to 16 samples. Between analog samples, the module can be configured to turn off loop or sensor power. If this feature is used, you may want to average the readings across the readings taken at each awakening (UI Sleep Samples Averaging). Note that this differs from the UI averaging parameter in the I/O Configuration section in that this is a long term typically averaging over very long time periods of multiple wakeup/sample cycles, whereas the I/O configuration averaging is the number of averages used during EACH awake cycle.

**Sensor Power** 2500S modules with analog inputs generate 24V loop power from any input voltage ranging from 10 to 30Vdc. If this loop power is not needed, the power consumption of the circuitry that generates the 24V loop power can be eliminated. If the loop power is only required for a short time over long measurement intervals (see UI sleep time), then the loop power can be “switched” ON only for the short actual measurement time.

**Low Power Mode** Checking this box reduces the speed of the internal computer chip to reduce power consumption by about half when slower module operation is acceptable.

**LED Disable** Turns OFF the front panel LED status indicators

**Ethernet Auto Power Down** Turns OFF the Ethernet section if not being used

## Security Configuration Pages

Access to 2500S modules, via its web pages or text messaging can be controlled by individual User Names and Passwords. In addition, data transfers can be secured (using SDX and SDM protocols) by encryption, and write access by non-secure protocols can be limited by requiring a code in a register. All of these security options are configured in the Security Configuration web pages.

Configuration of security is set up under the **Configuration | Security** button.

The screenshot shows the 'Security - Sprite II Combo I/O Module' configuration page. On the left is a vertical sidebar with buttons for: User Home, I/O Config, Communication, Alarming, HMI, SDX Master, Modbus Master, Trending, Totals, Control, Concentrator, Energy Calcs, Maintenance, Power Save, Security (highlighted), and Accounts. The main content area has a yellow background and contains the following settings:

- Disable Outside HTTP Config:
- AES Encryption Key: ABCD1234abcd1CL
- Register Write Key: 12345
- Master Admin Account Below MUST be filled out to Enable Security
- User Name:
- Password:
- Enable Security:

**Disable Outside HTTP** This box can prevent remote access (such as from the Internet) for using the configuration web pages in the 2500S module. If checked, only access from a local (none routed) network is allowed.

**AES Encryption Key** Communications can be used by using SDX (Ethernet, Serial or radio) or SDM (Cellular Text Messaging) to transfer data securely because these protocols use AES-128 encryption. This is the same technology recommended by the National Security Agency and implemented by corporate, military, and financial entities. AES-128 encryption uses a 16 byte (character) “key” that must be set to the same value in each unit to talk to each other. We strongly recommend entering your own custom key instead of the default key that comes set in the 2500S modules.

**Register Write Key** 2500S modules can be protected from accidental or malicious changes by communications. Even though older protocols are not secure, this feature can help protect the module configuration. If a “Register Write Key” value is set, the same value must be written to a non-visible (non-readable) location in each 2500S module register map before any other configuration values may be written (by register communications).

**Master Admin Acct.** Web page and text messaging access can be controlled by username/password access controls. Only users with “Administrator” access level control can create or change user access permissions. On this web page, a “Master” administrator account username and password may be set. Once this is set, security can be enabled. This prevents users from “locking themselves out of the box” by not having at least one administrator account.

## Security Accounts

Every 2500S module can have up to sixteen Username/Password accounts with selectable security access levels, in addition to the Master administration account on the previous web page. Keep in mind that these are used for both web page and text message access. If text messaging is being used, try to keep these name and passwords short to simplify text access.

	User Names	Passwords	Permission Level
1			User read Only
2			User read Only
3			User read Only
4			User read Only
5			User read Only
6			User read Only
7			User read Only
8			User read Only
9			User read Only
10			User read Only
11			User read Only
12			User read Only
13			User read Only
14			User read Only
15			User read Only

Under Permission Levels, there are five selections:

- Admin** No access limits, including account setup and any configuration parameters access
- Config Read/Write** Can read or change any configuration value, except account changes, and has no user web page access limitations.
- User Full** Cannot access configurations pages, but has unlimited user page access including totalizer resets, etc.
- User Read/Write** Cannot access configurations pages, but can change setpoints, etc. on user pages
- User Read Only** Cannot access configurations pages, and may not clear or change any values.

## Appendix A – Protocol Support

### Modbus Communications

2500S I/O modules support the Modbus I/O module/TCP/UDP communications protocol. This protocol was originally developed for Modicon Programmable Logic Controllers (PLCs). Now, Modbus is supported by nearly any PLC and I/O module, and most HMI/MMI software packages. The modules can be used in a large number of existing systems and will work without special drivers with many different “Hosts”.

I/O module support the following four standard Modbus data types:

Data Type	Modbus Type	Description
Status	10xxx	Read Only bits
Coils	00xxx	Read/Write bits
Input Registers	30xxx	Read Only 16-bit values (two combined for 32-bit values)
Holding Registers	40xxx	Read/Write 16-bit values (two combined for 32-bit values)

Note: Do not confuse the Modbus Type with the command codes used to access the various data types.

Both the single and multiple element forms of the Modbus commands that access these data types are supported. For example, there is a command to read or write a single Holding Register, and another command to access a block of Holding Registers. The I/O support both command types.

All totalizers are 32-bit registers. These registers are accessible as two consecutive 16-bit Modbus registers. The Most Significant (high order) portion of the 32-bit value is accessed in the first register, immediately followed by a second register with the Least Significant (low order) portion of the 32-bit value. 32-bit values should always be accessed with the Read/Write multiple registers form of Modbus messaging so that both portions of the 32-bit value are read together in a single message.

I/O module allow up to 128 registers of any type to be accessed in a single message. Be careful to only access valid registers. In general, messages that access unassigned registers are rejected as invalid messages, unless they are reserved for future use.

Detailed information on the Modbus protocol is available at: [www.modbus.org](http://www.modbus.org)

For a detailed register map, see the 2500S module protocol register maps in the back of this section

### Network Addressing

I/O module have a web page configuration interface for viewing and changing the Modbus network address. The network address may also be changed via a Modbus holding register. In order to simplify this setup function, I/O module always respond to address 255 regardless of the current network address setting. Do not use 255 as an address in a network! Address 0 is also not supported and should not be used.

## Modbus Store & Forward (serial and radio interfaces only)

I/O module can be used as Remote Terminal Units (I/O modules) in radio based systems. To extend the effective range of radio systems, they may be configured to digitally repeat messages destined for other I/O module or controllers that are not directly accessible to the Modbus Master. Although the Modbus standard has no definition for this function, I/O module use a simple form of block address translation to support Store & Forward operation within the Modbus specification framework.

The following “rules” are used for Store and Forward operation:

The network addresses to be translated and forwarded must be in a single contiguous block.

The translated addresses must be unique and NOT include the local I/O modules address.

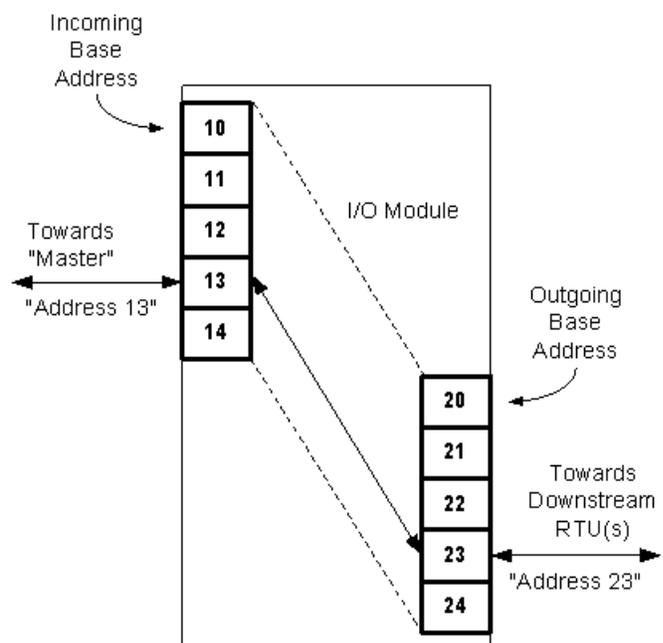
The Master must be capable of ignoring the messages generated with translated addresses (as CTI controllers do). Some Modbus Masters may not like seeing what appears to be a response message with a different address. Since the repeater is by definition “in radio range”, the Master is certain to “see” these messages.

I/O module have three holding registers that control the Store and Forward address translation functions; an “In Address” register, an “Out Address” register, and a “Block Size” register.

When a message is received by a I/O module, it first checks to see if the message is intended for itself. If not, it then checks to see if the message falls within the Incoming range of addresses (Incoming Base through Incoming Base + Block Size - 1) or within the Outgoing range of addresses (Outgoing Base through Outgoing Base + Block Size - 1).

If a message falls within the Incoming Range, then the I/O module knows that the message came from the Master (or a previous repeater en route from the Master) and it translates the address to the Outgoing Range, calculates a new message CRC check block, and retransmits the modified message. Likewise, if a message falls within the Outgoing Range, then the I/O module knows that the message came from a downstream I/O module (or a previous repeater) and it translates the address to the Incoming Range, calculates a new message CRC check block, and retransmits the modified message back towards the Master.

There is no limit to the number of repeater hops that can be used other than the total number of available addresses (255).



### *Modbus Message Store and Forward Address Translation*

In this example, the Incoming Base Address is set to “10”, the Outgoing Base Address is set to “20”, and the Block Size is set to “5”.

A message that comes from the direction of the Master with an address of “13” is translated to an address of “23” and rebroadcast. Likewise, when the downstream unit responds, the message will come from address “23” and be translated and rebroadcast as address “13”. As far as the Modbus Master is concerned, it is communicating with address “13”, but with some additional delay caused by the repeating process.

## DF1 Communications

Allen-Bradley programmable logic controllers can use the DF1 protocol as a means of interfacing to CTI controllers and I/O module's. In the DF1 protocol, a single Master communicates with up to 254 slaves. Slaves do not send messages, they respond to messages from the Master. DF1 is designed to operate over serial networks; RS-232 for short point-to-point connections, RS-485 for longer distance hard-wired networks, and radios and modems for even longer distances. DF1 can support two types of data; bits, and integers. DF1 over Ethernet is not supported at this time.

2500S units can respond to messages that are sent from a DF1 master device. These messages can read and write information stored in registers.

<b>Data Type</b>	<b>DF1 Type</b>	<b>Description</b>
Digital Input	B3	Read Only bits
Digital Output	B13	Read/Write bits
Analog Input	N7	Read Only 16-bit values
Analog Output	N17	Read/Write 16-bit values

Note: 32-bit registers are not currently supported in CTI's I/O module implementation of DF1 but can be accessed via two 16 "N" type registers.

See the back of this section for register assignments.

Note: ScadaWorks controller users will not use the 'N' character when setting up r/w DF1 events. Instead they will select the 'Number' option from the 'Source' dropdown in the network event configuration window and enter in either '13' or '17'.

*CTI I/O modules support the serial, half-duplex version of DF1 with CRC error checking. BCC error checking in I/O module units is not supported at this time.*

## Secure Data Exchange (SDX/STM) Communications

### SDX Protocol

The 2500S modules support CTI's Secure Data Exchange protocol otherwise known as SDX as well as the text messaging implementation over cellular known as Secure Text Messaging (STM). These protocols are used for secure data communications over RS-232, RS-485, radio, cellular, dialup as well as Ethernet (UDP). SDX and STM are 128 bit AES encrypted protocols with a 16 character user defined key. All units communicating on the same network must be configured with the same 16 character key. SDX can support up to 65535 addresses may be used in a single network. STM uses 10-digit phone numbers instead of addresses as part of the cellular network.

### I/O module Compatibility

SDX and STM is fully compatible with all 2500S I/O modules. When the 2500S modules are configured for "on-change" operation, they can send data based on change of state or change of level, as well as periodically. This is extremely efficient, especially for systems with large numbers of units, limited bandwidth, or charges by the byte/message (cellular). The periodic transmission feature ensures that the destination device is aware that the unit is still alive in a "quiet" quiescent system (few changes) without constant rapid polling.

### SDX Routing

In 2500S modules, SDX messages may be routed through any SDX compatible units up to ten hops (repeaters). No extra configuration is necessary as the initiating unit defines the routing information at transmission time. The "route" information is encrypted in the message and used by any SDX remote the message is addressed to. By definition, any SDX remote or controller is a router. The remotes, when receiving a routed message, will automatically turn the message around and use the same remotes to route the response back to the imitating "master".

### SDX Objects, Message Efficiency, and Data Security

SDX is also capable of combining multiple data types into one message. In most traditional protocols, only one data type can be transacted at any given time. SDX is object oriented where not only is each data type an object but also each I/O type can also be an object. If there are several object types to be sent to a particular unit, SDX can combine the object types into one message eliminating the need for multiple transactions—this saves on the amount of air time consumed over a radio system for example. All this is done over AES 128 bit encryption so all of the data is safe and secure. After the data is decrypted by the AES engine with the 128 bit (16 character) key, it is checked again by two Cyclic Redundancy Checks (CRC's), one for the transport layer then one for the object layer (data content layer). Only when both of these CRC tests have passed, will the remote or master unit receiving the message begin to parse the actual object data.

## Appendix B – Register Access

2500S I/O support Modbus and DF1 protocol register access by register type (file # for DF1) and number. SDX uses a class system that does not rely in register numbers. The most common I/O register assignments used for Modbus and DF1 communications are listed below for each 2500S Module. For advanced access to configuration and file access registers, please contact technical support.

### Inputs (bits)

Discrete Inputs Modbus 100xx, DF1 File# B3	#	23-xxxx	26-xxxx	27-xxxx
DI1 - Filtered	1	*	*	*
DI2 - Filtered	2	*	*	*
DI3 - Filtered	3	*	*	
DI4 - Filtered	4	*	*	
DI5 - Filtered	5		*	
DI6 - Filtered	6		*	
DI7 - Filtered	7		*	
DI8 - Filtered	8		*	
DI1 - Raw	9	*	*	*
DI2 - Raw	10	*	*	*
DI3 - Raw	11	*	*	
DI4 - Raw	12	*	*	
DI5 - Raw	13		*	
DI6 - Raw	14		*	
DI7 - Raw	15		*	
DI8 - Raw	16		*	
DI1 - Stretched	17	*	*	*
DI2 - Stretched	18	*	*	*
DI3 - Stretched	19	*	*	
DI4 - Stretched	20	*	*	
DI5 - Stretched	21		*	
DI6 - Stretched	22		*	
DI7 - Stretched	23		*	
DI8 - Stretched	24		*	
DO1 – Raw Output State	25	*	*	*
DO2 – Raw Output State	26	*	*	*
DO3 – Raw Output State	27	*	*	
DO4 – Raw Output State	28	*	*	
DO5 – Raw Output State	29		*	
DO6 – Raw Output State	30		*	
DO7 – Raw Output State	31		*	
DO8 – Raw Output State	32		*	
At least one DI Forced	33	*	*	*
At least one DO Forced	34	*	*	*
At least one AI Forced	35	*	*	*
At least one AO Forced	36	*	*	*
reserved	37			
reserved	38			
Remote PLC Error Flag	39	*	*	*
Remote PLC Sent Flag	40	*	*	*
COMM FAIL – Serial Slave	41	*	*	*
COMM FAIL – Radio/cell Slave	42	*	*	*
COMM FAIL – Ethernet Slave	43	*	*	*
COMM FAIL – Cell Tower Fail	44	*	*	*
COMM FAIL – Any Master	45	*	*	*
COMM FAIL – Modbus RTU Master (serial)	46	*	*	*
COMM FAIL – Modbus TCP/IP Master (Ethernet)	47	*	*	*
COMM FAIL – SDX Master	48	*	*	*
SDX Master Comm Fail – Destination 1	49	*	*	*
SDX Master Comm Fail – Destination 2	50	*	*	*
SDX Master Comm Fail – Destination 3	51	*	*	*
SDX Master Comm Fail – Destination 4	52	*	*	*
SDX Master Comm Fail – Destination 5	53	*	*	*

SDX Master Comm Fail – Destination 6	54	*	*	*
SDX Master Comm Fail – Destination 7	55	*	*	*
SDX Master Comm Fail – Destination 8	56	*	*	*
SDX Master Comm Fail – Destination 9	57	*	*	*
SDX Master Comm Fail – Destination 10	58	*	*	*
SDX Master Comm Fail – Destination 11	59	*	*	*
SDX Master Comm Fail – Destination 12	60	*	*	*
SDX Master Comm Fail – Destination 13	61	*	*	*
SDX Master Comm Fail – Destination 14	62	*	*	*
SDX Master Comm Fail – Destination 15	63	*	*	*
SDX Master Comm Fail – Destination 16	64	*	*	*
Modbus TCP/CAMP Master Comm Fail – Destination 1	65	*	*	*
Modbus TCP/CAMP Master Comm Fail – Destination 2	66	*	*	*
Modbus TCP/CAMP Master Comm Fail – Destination 3	67	*	*	*
Modbus TCP/CAMP Master Comm Fail – Destination 4	68	*	*	*
Modbus TCP/CAMP Master Comm Fail – Destination 5	69	*	*	*
Modbus TCP/CAMP Master Comm Fail – Destination 6	70	*	*	*
Modbus TCP/CAMP Master Comm Fail – Destination 7	71	*	*	*
Modbus TCP/CAMP Master Comm Fail – Destination 8	72	*	*	*
Modbus RTU Master – Destination 1	73	*	*	*
Modbus RTU Master – Destination 2	74	*	*	*
Modbus RTU Master – Destination 3	75	*	*	*
Modbus RTU Master – Destination 4	76	*	*	*
Modbus RTU Master – Destination 5	77	*	*	*
Modbus RTU Master – Destination 6	78	*	*	*
Modbus RTU Master – Destination 7	79	*	*	*
Modbus RTU Master – Destination 8	80	*	*	*
Modbus RTU Master – Destination 9	81	*	*	*
Modbus RTU Master – Destination 10	82	*	*	*
Modbus RTU Master – Destination 11	83	*	*	*
Modbus RTU Master – Destination 12	84	*	*	*
Modbus RTU Master – Destination 13	85	*	*	*
Modbus RTU Master – Destination 14	86	*	*	*
Modbus RTU Master – Destination 15	87	*	*	*
Modbus RTU Master – Destination 16	88	*	*	*

### Outputs (bits)

Discrete Outputs Modbus 000xx, DF1 File# B13	#	23-xxxx	26-xxxx	27-xxxx
DO1	1	*	*	*
DO2	2	*	*	*
DO3	3	*	*	*
DO4	4	*	*	*
DO5	5	*	*	*
DO6	6	*	*	*
DO7	7	*	*	*
DO8	8	*	*	*
B1 to B200 Concentrator Bits (B1=#9, B200 = #208)	9+	*	*	*
CLEAR DI Runtimes	1	*	*	*
CLEAR DI Totalizers	2	*	*	*
CLEAR Peak Totalizers	3	*	*	*
CLEAR UI/AI/Energy Totalizers	4	*	*	*
CLEAR Min/Max Values	5	*	*	*
CLEAR COMM Stats	6	*	*	*
reserved	7			
reserved	8			

## Input Registers – 16 bit (32-bit entities use two registers)

Analog Input Registers Modbus 3xxxx, DF1 File# N7	#	23-xxxx	26-xxxx	27-xxxx
Universal Input / Analog Input 1 (Raw)	1	*	*	*
Universal Input / Analog Input 2 (Raw)	2	*	*	*
Universal Input / Analog Input 3 (Raw)	3			*
Universal Input / Analog Input 4 (Raw)	4			*
Universal Input / Analog Input 5 (Raw)	5			*
Universal Input / Analog Input 6 (Raw)	6			*
Universal Input / Analog Input 7 (Raw)	7			
Universal Input / Analog Input 8 (Raw)	8			
VIN (x 0.1V)	9	*	*	*
VBAT (x 0.1V)	10	*	*	*
Temperature (x 0.1 degree)	11	*	*	*
Reserved	12			
DIs packed	13	*	*	*
DOs packed	14	*	*	*
Universal Input / Analog Input 1 (Scaled)	15	*	*	*
Universal Input / Analog Input 2 (Scaled)	16	*	*	*
Universal Input / Analog Input 3 (Scaled)	17			*
Universal Input / Analog Input 4 (Scaled)	18			*
Universal Input / Analog Input 5 (Scaled)	19			*
Universal Input / Analog Input 6 (Scaled)	20			*
Universal Input / Analog Input 7 (Scaled)	21			*
Universal Input / Analog Input 8 (Scaled)	22			*
Scaled Energy 1	23	*	*	*
Scaled Energy 2	24	*	*	*
Raw DI Rate - DI1	25	*	*	*
Raw DI Rate - DI2	26	*	*	*
Raw DI Rate - DI3	27	*	*	
Raw DI Rate - DI4	28	*	*	
Raw DI Rate - DI5	29		*	
Raw DI Rate - DI6	30		*	
Raw DI Rate - DI7	31		*	
Raw DI Rate - DI8	32		*	
Scaled DI Rate - DI1	33	*	*	*
Scaled DI Rate - DI2	34	*	*	*
Scaled DI Rate - DI3	35	*	*	
Scaled DI Rate - DI4	36	*	*	
Scaled DI Rate - DI5	37		*	
Scaled DI Rate - DI6	38		*	
Scaled DI Rate - DI7	39		*	
Scaled DI Rate - DI8	40		*	
DI Interval - DI1	41	*	*	*
DI Interval - DI2	42	*	*	*
DI Interval - DI3	43	*	*	
DI Interval - DI4	44	*	*	
DI Interval - DI5	45		*	
DI Interval - DI6	46		*	
DI Interval - DI7	47		*	
DI Interval - DI8	48		*	
Scaled DI Runtime - (LSW) - DI1	49	*	*	*
Scaled DI Runtime - (MSW) - DI1	50	*	*	*
Scaled DI Runtime - (LSW) - DI2	51	*	*	*
Scaled DI Runtime - (MSW) - DI2	52	*	*	*
Scaled DI Runtime - (LSW) - DI3	53	*	*	
Scaled DI Runtime - (MSW) - DI3	54	*	*	
Scaled DI Runtime - (LSW) - DI4	55	*	*	
Scaled DI Runtime - (MSW) - DI4	56	*	*	
Scaled DI Runtime - (LSW) - DI5	57		*	
Scaled DI Runtime - (MSW) - DI5	58		*	

Scaled DI Runtime - (LSW) - DI6	59		*	
Scaled DI Runtime - (MSW) - DI6	60		*	
Scaled DI Runtime - (LSW) - DI7	61		*	
Scaled DI Runtime - (MSW) - DI7	62		*	
Scaled DI Runtime - (LSW) - DI8	63		*	
Scaled DI Runtime - (MSW) - DI8	64		*	
Pump Lead Runtime - (LSW)	65	*	*	
Pump Lead Runtime - (MSW)	66	*	*	
Pump Lag Runtime - (LSW)	67	*	*	
Pump Lag Runtime - (MSW)	68	*	*	
Scaled UI (AI) Totalizer - (LSW) - UI1	69	*	*	*
Scaled UI (AI) Totalizer - (MSW) - UI1	70	*	*	*
Scaled UI (AI) Totalizer - (LSW) - UI2	71	*	*	*
Scaled UI (AI) Totalizer - (MSW) - UI2	72	*	*	*
Scaled UI (AI) Totalizer - (LSW) - UI3	73			*
Scaled UI (AI) Totalizer - (MSW) - UI3	74			*
Scaled UI (AI) Totalizer - (LSW) - UI4	75			*
Scaled UI (AI) Totalizer - (MSW) - UI4	76			*
Scaled UI (AI) Totalizer - (LSW) - AI5	77			*
Scaled UI (AI) Totalizer - (MSW) - AI5	78			*
Scaled UI (AI) Totalizer - (LSW) - AI6	79			*
Scaled UI (AI) Totalizer - (MSW) - AI6	80			*
Scaled UI (AI) Totalizer - (LSW) - AI5	81			*
Scaled UI (AI) Totalizer - (MSW) - AI5	82			*
Scaled UI (AI) Totalizer - (LSW) - AI6	83			*
Scaled UI (AI) Totalizer - (MSW) - AI6	84			*
Scaled UI (AI) Totalizer - (LSW) - AI7	85			
Scaled UI (AI) Totalizer - (MSW) - AI7	86			
Scaled UI (AI) Totalizer - (LSW) - AI8	87			
Scaled UI (AI) Totalizer - (MSW) - AI8	88			
Scaled Energy Totalizer - (LSW) - 1	89	*	*	*
Scaled Energy Totalizer - (MSW) - 1	90	*	*	*
Scaled Energy Totalizer - (LSW) - 2	91	*	*	*
Scaled Energy Totalizer - (MSW) - 2	92	*	*	*
Scaled DI Totalizer - (LSW) - DI1	93	*	*	*
Scaled DI Totalizer - (MSW) - DI1	94	*	*	*
Scaled DI Totalizer - (LSW) - DI2	95	*	*	*
Scaled DI Totalizer - (MSW) - DI2	96	*	*	*
Scaled DI Totalizer - (LSW) - DI3	97	*	*	
Scaled DI Totalizer - (MSW) - DI3	98	*	*	
Scaled DI Totalizer - (LSW) - DI4	99	*	*	
Scaled DI Totalizer - (MSW) - DI4	100	*	*	
Scaled DI Totalizer - (LSW) - DI5	101		*	
Scaled DI Totalizer - (MSW) - DI5	102		*	
Scaled DI Totalizer - (LSW) - DI6	103		*	
Scaled DI Totalizer - (MSW) - DI6	104		*	
Scaled DI Totalizer - (LSW) - DI7	105		*	
Scaled DI Totalizer - (MSW) - DI7	106		*	
Scaled DI Totalizer - (LSW) - DI8	107		*	
Scaled DI Totalizer - (MSW) - DI8	108		*	
Scaled DI Totalizer - (LSW) - Pump1	109			
Scaled DI Totalizer - (MSW) - Pump1	110			
Scaled DI Totalizer - (LSW) - Pump2	111			
Scaled DI Totalizer - (MSW) - Pump2	112			
History Totalizer - Hour A (LSW)	113	*	*	*
History Totalizer - Hour A (MSW)	114	*	*	*
History Totalizer - Hour B (LSW)	115	*	*	*
History Totalizer - Hour B (MSW)	116	*	*	*
History Totalizer - Hour C (LSW)	117	*	*	*
History Totalizer - Hour C (MSW)	118	*	*	*
History Totalizer - Hour D (LSW)	119	*	*	*

History Totalizer – Hour D (MSW)	120	*	*	*
History Totalizer – Day A (LSW)	121	*	*	*
History Totalizer – Day A (MSW)	122	*	*	*
History Totalizer – Day B (LSW)	123	*	*	*
History Totalizer – Day B (MSW)	124	*	*	*
History Totalizer – Day C (LSW)	125	*	*	*
History Totalizer – Day C (MSW)	126	*	*	*
History Totalizer – Day D (LSW)	127	*	*	*
History Totalizer – Day D (MSW)	128	*	*	*
History Totalizer – Last Day A (LSW)	129	*	*	*
History Totalizer – Last Day A (MSW)	130	*	*	*
History Totalizer – Last Day B (LSW)	131	*	*	*
History Totalizer – Last Day B (MSW)	132	*	*	*
History Totalizer – Last Day C (LSW)	133	*	*	*
History Totalizer – Last Day C (MSW)	134	*	*	*
History Totalizer – Last Day D (LSW)	135	*	*	*
History Totalizer – Last Day D (MSW)	136	*	*	*

### Holding Registers – 16 bit (32-bit entities use two registers)

Analog Output (Holding) Registers Modbus 4xxxx, DF1 File# N17		23-xxxx	26-xxxx	27-xxxx
AO1	1	*		*
AO2	2	*		*
AO3	3			*
AO4	4			*
AO5	5			*
AO6	6			*
reserved	7			
Packed DOs	8	*	*	*
I1 to I200 Concentrator Registers (I1=#9, I200 = #208)	9+	*	*	*
Remote PLC Alarm Buffer Bytes 1 to 59 (Bytes 1/2=#209, Bytes 59/60 = #238)	209+	*	*	*
Register Write Key (12345 = Write Enabled)	239	*	*	*
PWM ON Time x 0.01 sec – DO1	240	*	*	*
PWM ON Time x 0.01 sec – DO2	241	*	*	*
PWM ON Time x 0.01 sec – DO3	242	*	*	
PWM ON Time x 0.01 sec – DO4	243	*	*	
PWM ON Time x 0.01 sec – DO5	244		*	
PWM ON Time x 0.01 sec – DO6	245		*	
PWM ON Time x 0.01 sec – DO7	246		*	
PWM ON Time x 0.01 sec – DO8	247		*	
PWM OFF Time x 0.01 sec – DO1	248	*	*	*
PWM OFF Time x 0.01 sec – DO2	249	*	*	*
PWM OFF Time x 0.01 sec – DO3	250	*	*	
PWM OFF Time x 0.01 sec – DO4	251	*	*	
PWM OFF Time x 0.01 sec – DO5	252		*	
PWM OFF Time x 0.01 sec – DO6	253		*	
PWM OFF Time x 0.01 sec – DO7	254		*	
PWM OFF Time x 0.01 sec – DO8	255		*	

# Appendix C – Specifications

**2500S-23-XXXX      2500S-26-XXXX      2500S-27-XXXX**

## Universal/Analog Inputs

Type/Resolution  
Sensor Support – Universal Inputs

2UI + Input V	2UI + Input V & Bat	4UI / 2AI* Input V & Bat	Input V
Universal Inputs – 16bits	Analog Inputs (20mA) and Power/Battery Voltages – 12bits		
20mA, 5V, mV, Thermocouple (J, K, T, E, R, S), 10K ohm Thermistor (Type II and Type III), 2 & 3 wire RTD (10, 100, 1K ohm), 10K/100K ohms			

Accuracy (UI) mA, V, mV, Thermistor, RTD  
Thermocouples

-----	-----	-----	-----
		0.1% of Full Scale (-40°C to 70°C)	
		0.1% of Full Scale +/- 3°C (-40°C to 70°C)	

Input Functions (each Input)

Accumulator (integrate/totalize input with 1 to 255 sec sampling interval), BTU Calculator/Totalizer

## Analog Outputs

Type/Resolution  
Accuracy

2	0	0	6
20mA, 16-bit			
-----	-----	-----	-----
		0.1% of Full Scale (-40°C to 70°C)	

## Discrete Inputs

Type  
Measurement Functions

4	8**	2**	6**
Inputs: C contact Closure or DC up to 30Vdc			
Runtime, Totalizers (10KHz), Rate			

## Discrete Outputs

Type  
Output Functions (each output)

4	8**	2**	6**
Relay (3A max. resistive)	Protected FET (1A max./output, protected at 4.5A typical) --		
Flash (sync'd with other outputs), Pulse (one-shot) 1 to 65,535mS, PWM -1 to 65,535mS On/Off times			

\* Note: This model has 4 Universal Inputs (sensor support) and 2 20mA analog inputs  
\*\* Note: These models have combined DIOs, usable in any combination as discrete inputs OR output.

## Ethernet

Protocol support  
Security

10/100 Base T / Modbus TCP (Slave), Modbus UDP (Slave), HTTP, ARP, SDX (CTI), TFTP, Serial Port Forwarding to serial port or internal radio  
128-bit AES encryption on data transfer. Separate passwords on user and configuration web pages and cellular access.

## Serial Port (optional)

Protocols & Security

RS-232 and RS-485  
Modbus I/O module Slave (Modicon), DF1 (Allen-Bradley), SDX (CTI), Store & Forward (Modbus & SDX). SDX uses 128-bit AES encryption

## Internal Radio (optional)

Radio type (900MHz, 1 watt)  
Digi/Maxstream  
Freewave  
Microhard  
Radio type (2400MHz, 1 watt)  
Microhard  
Antenna Connection:  
Protocol support

Choice of 3 radios; Digi (Xtend), Freewave (MR2), Microhard (Nano)  
902MHz to 928MHz Spread Spectrum, frequency hopping, (plus MESH networking with Digi Xtend radio)  
Sensitivity: -110dBm @9600 baud, -100dBm @115K baud, point to multipoint & peer to peer, DigiMesh  
Sensitivity: -108dBm (BER 10<sup>-6</sup>), 32-bit CRC, point to multipoint, network diagnostics, FGR-115 compatible  
Sensitivity: -108dBm (BER 10<sup>-6</sup>), 32-bit CRC, point to multipoint, network diagnostics, Nano n920 compatible  
2.4000 GHz to 2.4835 GHz Spread Spectrum, frequency hopping  
Sensitivity: -107dBm (BER 10<sup>-6</sup>), 32-bit CRC, point to multipoint, network diagnostics, Nano n920 compatible  
Reverse polarity SMA (Xtend option only), or MMCX (Xtend, Freewave, Microhard)  
Modbus I/O module Slave (Modicon), DF1 (Allen-Bradley), SDX (CTI), Store & Forward (Modbus & SDX)

## Cellular (optional)

Protocol & Security

GSM/GPRS (AT&T, T-Mobile, Rogers), HSPDA (Telus, AT&T, T-Mobile, Rogers) or CDMA (Verizon or Sprint)  
Secure Text Messaging (128-bit AES encryption) for data exchange, password protected text messaging for remote cell phone access

## Datalogging/Trending

Approx 30MB flash disk storage, typically sufficient several years (up to 16 traces, 1, 5, 10, 30, 60 second selectable sampling resolutions)

## Terminal Blocks

Removable, 3.5mm (0.138"), 12 to 22AWG, 15A/contact maximum

## Dimensions & Environment

1.4"W x 3.7"H x 3.8"D (Including terminal blocks and DIN rail mount), - 40°F(- 40°C) to 158°F (70 °C), 5%RH to 95% RH, non-condensing

## Power

DC Power  
Built-in 12V Solar Panel/UPS Support  
Ethernet/Radio/DIOs/AOs OFF  
Ethernet ON  
DOs ON  
AOs ON  
Ethernet ON/ALL DOs-AOs ON/ Radio Xmit

-----	-----	10 to 30Vdc	-----
no	yes (12V Gel Cel battery supplied by customer		no
0.36W	0.36W (not charging batt.)		0.36W
-----	-----	+1.2W	-----
+0.15W/DO			+0.01W/DO
+0.5W/AO			
4.2W max	3W max (not charging battery)		4.2W max

