Scadaflex II

Installation and Hardware Reference Manual

Controller Hardware features:

4 Analog Inputs

2 Analog Outputs

12 Discrete Inputs (optically isolated)

2 High-speed Pulse Inputs (10KHz +)

4 Discrete Outputs (FET transistor or relay)

Optional built-in cellular modem

Optional built-in 900Mhz meshing radio

Optional built-in LOCAL/keypad HMI

Optional battery backup

10 to 30Vdc power

Extended Operating Temperature

Controller Hardware Expansion:

Wireless and wired I/O expansion, and AC power support is available in similar and compatible packaging.

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Scadaflex II

Installation and Hardware Reference Manual

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In This Manual…

This manual provides the technical hardware information and configuration instructions required for system design and installation of Scadaflex II SCADA Controllers.

If you have just purchased a Scadaflex II System, 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 Scadaflex II SCADA system when you need a complete integrated solution with built-in graphical, LOCAL, text message and e-mail HMIs, decades of historical trending capacity, alarming, programmable logic, as well as Ethernet, serial, wireless and cellular communications, all in a ready-to-run enclosure.

Throughout this manual, you will find these icons:

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:

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If you need to send us a fax:

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If you find a problem with this manual, or you have any suggestions for how this manual could be made more useful to you, please contact us at the address below:

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Overview

Scadaflex II controllers provide all of the functionality of a "full blown" SCADA system at a fraction of the cost and complexity. They include:

- Built-in web graphical and textual HMIs
- Built-in Local HMI
- Historical Trending
- Event Data Logging
- Alarming
- Radio and cellular communications
- Programmable Logic (ladder, function block and text)

Controller Hardware

Scadaflex II controllers, remote I/O modules and AC power supply are supplied "ready-to-run", packaged in polycarbonate enclosures.

The standard controller hardware (SC-1 and SC-2) includes:

4 analog inputs

2 analog outputs

12 discrete inputs (optically isolated)

2 High-speed discrete inputs (10KHz +)

4 discrete outputs - FET transistor (SC-1) or relay (SC-2)

1 Micro SD card socket for long-term trending

1 10/100 Ethernet port

1 RS-232/RS-485 serial port

10 to 30Vdc power with optional internal battery backup

Optional built-in HMI (high contrast OLED)

Optional built-in 4G/LTE cellular modem

Optional built-in 900Mhz 1/4 radio (meshing or spread spectrum)

I/O Expansion Hardware

There are wired and wireless I/O expansion modules to supplement the inputs and outputs of the Scadaflex II controllers.

Low Power Remote (LPR) I/O

Low Power Remote (LPR) I/O modules provide wireless I/O expansion up to 64 locations. They have an internal lithium "D" cell battery that can power them for several years, and also support external DC power (frequently, this is from solar power). When powered externally, the internal battery can serve as backup power.

LPR modules use mesh networking for wide area coverage with very low power consumption. Each node is a built-in repeater. The wireless network automatically attempts to heal itself, If a node being used as a repeater goes down, another node will attempt to take over to maintain the integrity of the system.

To use LPR modules, the "master" Scadaflex II controller must have the Mesh Radio option.

LPR modules achieve their long battery life by sleeping most of the time. In sleep mode, the battery drain is reduced to a few micro amps. The sleeping and waking of the nodes is coordinated by a master Scadaflex II controller so that the nodes are available to each other as repeaters when awake, yet maximize power savings with long sleep periods. “On-change" operation is supported. Digital input changes can be transmitted immediately. Analog inputs are sampled periodically, transmitting only when there is a significant change. Multiple Scadaflex II controller masters can co-exist on a network, but each LPR can have only one master.

LPR modules have the following inputs and outputs:

8 analog inputs: 4 resistance sensors including soil moisture and 4 process - order as 20mA or 5V

4 discrete inputs (contact closure). 2 are high-speed with totalizers.

2 discrete outputs (latching relays)

1 optional ultra-sonic level sensor with a 10 meter/32.5 foot range

LPR modules can supply up to 50mA of boosted (12V) power for sensors. Note that 5V sensors are generally recommended for their lower power consumption. No more than two (loop powered) 20mA sensors can be powered from the modules sensor power output.

Configuration and firmware updates to the LPR modules are done through the master Scadaflex II controller.

Configuration information is edited in web-page forms on the controller. Each time the controller talks to the LPR module, it updates the module with the latest configuration in those pages. When operating in sleep mode, the module receives the latest updates when it wakes up and talks to the Scadaflex II master.

When an LPR module communicates with a Scadaflex II master, the controller checks to see if the module is using the latest firmware. If the module needs updating, the controller will automatically download the new firmware before placing the module on-line. No manual intervention is required.

Remote I/O (RIO)

Remote I/O (RIO) modules provide either wired or wireless I/O expansion up to 64 locations. They operate from DC power ranging from 10Vdc to 30Vdc.

Wireless RIO modules are network compatible with LPR I/O modules, Scadaflex II controllers outfitted with mesh radios, and Modulus Mesh Communications modules. Each node can also automatically serve as a repeater. In a wireless mesh network, if a node fails, the network automatically attempts to heal itself. If the node that drops out was being used as a repeater, another node will attempt to take over to maintain the integrity of the system.

To use wireless RIO I/O modules, the "master" Scadaflex II controller must have the Mesh Radio option. Wired RIO modules are compatible with the built-in RS-485 port of the controller so no optional hardware is required. They may also be used with many third party devices that can act as Modbus RTU masters.

Wired RIO modules support RS-485 communications. Besides supporting Scadaflex II and Modulus controllers, they may be used with many third party devices that can act as Modbus RTU masters. RIO modules also support encrypted SDX protocol communications.

RIO modules have the following inputs and outputs:

4 analog inputs individually software configurable as 20mA, 5V, 65K ohms, or thermistor

10 discrete inputs (optically isolated)

1 High-speed discrete input with totalizer.

10 discrete outputs (relay)

Configuration and firmware updates to wireless RIO modules are done through the master Scadaflex II or Modulus Mesh controller. Wired RIO modules use Modbus or SDX register access to change their configuration (primarily analog modes). Firmware updates require a serial download program that is supplied free of charge by ICL technical support.

Wireless RIO configuration information is edited in web-page forms on the controller. Each time the controller talks to the RIO module, it updates the module with the latest configuration information in those pages.

When a wireless RIO module communicates with a Scadaflex II master, the controller checks to see if the module is using the latest firmware compatible with the controller. If the module needs updating, the controller will automatically download the new firmware before placing the module on-line. No manual intervention is required.

Scadaflex II Controller - Hardware Tour

Scadaflex II controllers are complete SCADA systems in an enclosure. They include flash disk storage for their operating programs and programmable logic and a micro SD card support for long term recording of trend data. They have sufficient inputs and outputs to run a typical duplex pumping station including VFD control. An internal local HMI is available. They can be outfitted with both an internal 4G/LTE cellular modem and a license-free radio to communicate between controllers as well as with wireless remote I/O.

Scadaflex II controllers include . . .

Ethernet Port - a high-speed communications port that can be used for:

- configuration and programming by built-in web pages
- a graphical fully-animated configurable web HMI
- display and retrieval of historical trending and event log data
- e-mail and text message alarming
- communications with PLCs and other "smart" devices via Modbus, Ethernet IP or SDX
- custom programming using any combination of ladder logic, function block or text languages
- backup and restoration of configuration/programming

There is a switch to enable sourcing the incoming DC controller power to the Ethernet connector to supply Power Over Ethernet (POE) devices that are compatible with the controller input voltage level. This is frequently used with Wi-Fi access points.

Serial Port - Scadaflex II controllers include a dual-function serial port (RJ-45 connector) with RS-232 and RS-485 interfaces. The serial port may be used to communicate with PLCs or other smart devices using Modbus, DF1 (Allen Bradley), SNP (GE) or SDX.

Local I/O - Scadaflex II Controllers come with a mix of analog and discrete inputs and outputs. There are four high-resolution (16-bit) analog inputs and two analog outputs. The I/O counts are expandable with add-on modules to over 500 analog inputs and outputs. There are twelve optically isolated discrete inputs and two additional contact closure/low-voltage DC inputs to measure pulse rates and totalize pulses up to 10KHz. There are four solid-state electronically protected (SC-1) or relay (SC-2) discrete outputs.

Trending and Event Logging - Scadaflex II controllers have a micro SD card memory socket. All historical trending data is recorded to a user-supplied micro SD memory card. A 16 GB micro SD card provides sufficient storage for recording 30 years of 63 trending points, providing a huge savings over both paper and paperless chart recorders. Scadaflex II controllers also have event logging functionality which records data to an internal flash disk drive. Only trending data is recorded to the micro SD card. Without a micro SD card, only the historical trending affected.

Local HMI option - Scadaflex II controllers can be ordered with an optional local display and keypad. Before the end of 2018, this was a backlit LCD display. The display has now been upgraded to a high contrast OLED type. The HMI can be configured to show, and potentially change, up to 50 different variables (registers) in the controller. It has a scan mode that sequentially display selected registers. The backlight (LCD) or entire display (OLED) is configurable to turn OFF after a configurable time of no keypad actvity.

OLED displays loose some brightness over time, so having them shut off when not used is recommended.

900Mhz Radio options - Scadaflex II controllers can optionally include an internal 1/4W 900MHz radio—standard or meshing spread spectrum. These radios enable the controllers to communicate with wireless remote I/O as well as other controllers. Standard radios have greater sensitivity (about 10dB) at slower data rates but lack the "self healing" network repeating capabilities of the mesh radios—though standard radios can be manually configured as repeaters. A mesh radio is required to communicate with the available battery powered remote I/O.

A small whip antenna is included with either type of radio. A larger antenna can be connected to the standard RP-SMA connector on the top of the enclosure.

Cellular Modem option - Scadaflex II controllers can include an internal 4G/LTE cellular modem providing web interfacing, Internet access, long distance remote I/O support, and high-speed data communications over distances that are not practical to achieve by radio. The internal cellular modem supports both text messaging (for alarming, HMI and small data transfers) and data modes (for web page interaction and larger data transfers).

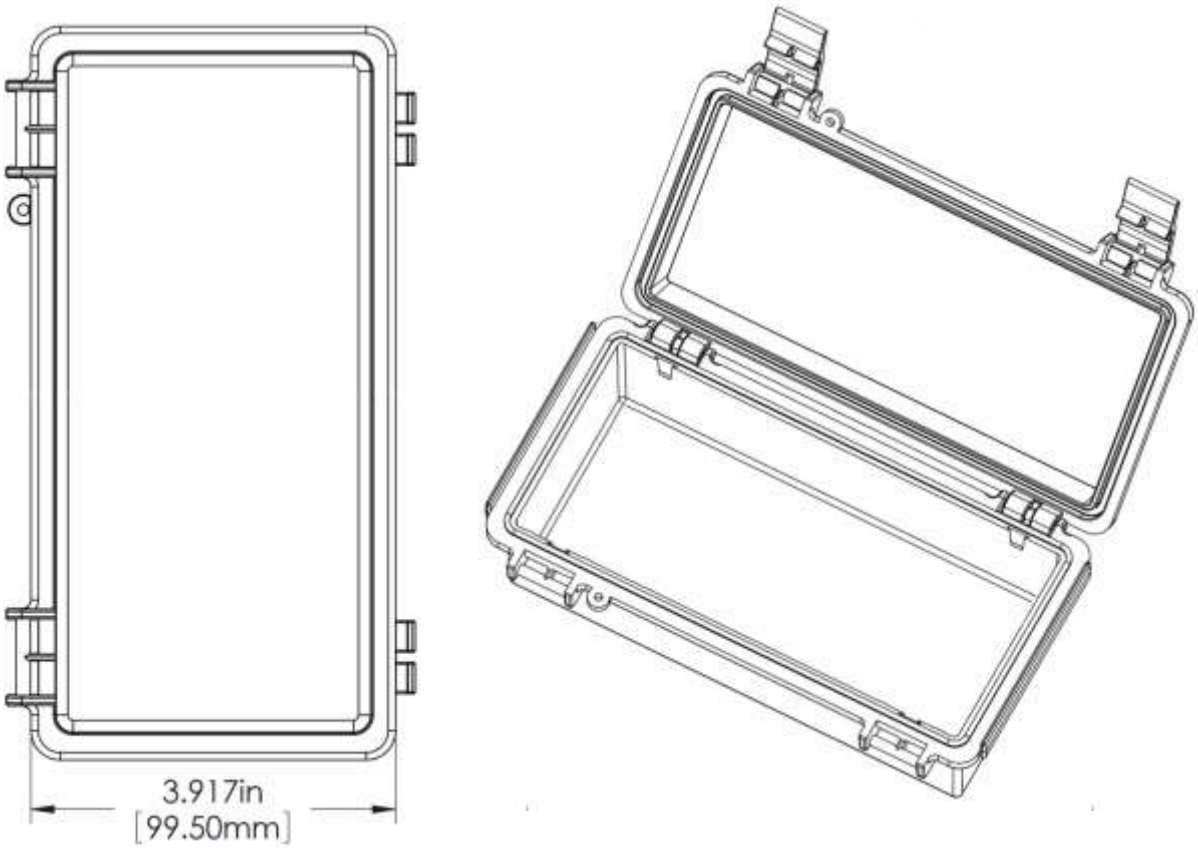
A small whip antenna is included with the cellular modem option. A larger antenna can be connected to the standard SMA connector on the top of the enclosure.

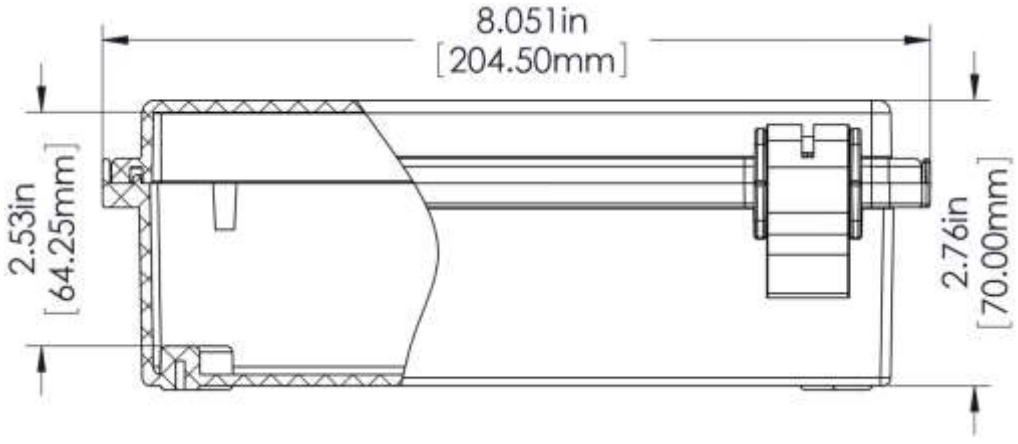
Battery Backup option - Scadaflex II Controllers can be ordered with a built-in rechargeable lithium battery backup option. This can power the controller when external power fails for up to 16 hours of operation. Battery life depends on the system hardware and firmware configuration.

Installation

Enclosures

Scadaflex II controllers, I/O modules and power supplies are housed in a 4”W x 8”H x 3”D (approximately) UV resistant polycarbonate enclosures. The controllers are available with both opaque and clear doors (to be able to see the HMI display with the door closed). I/O modules and the power supply are only available with opaque doors. A ¾” conduit hole is machined into the bottom of the enclosure for external field wiring.



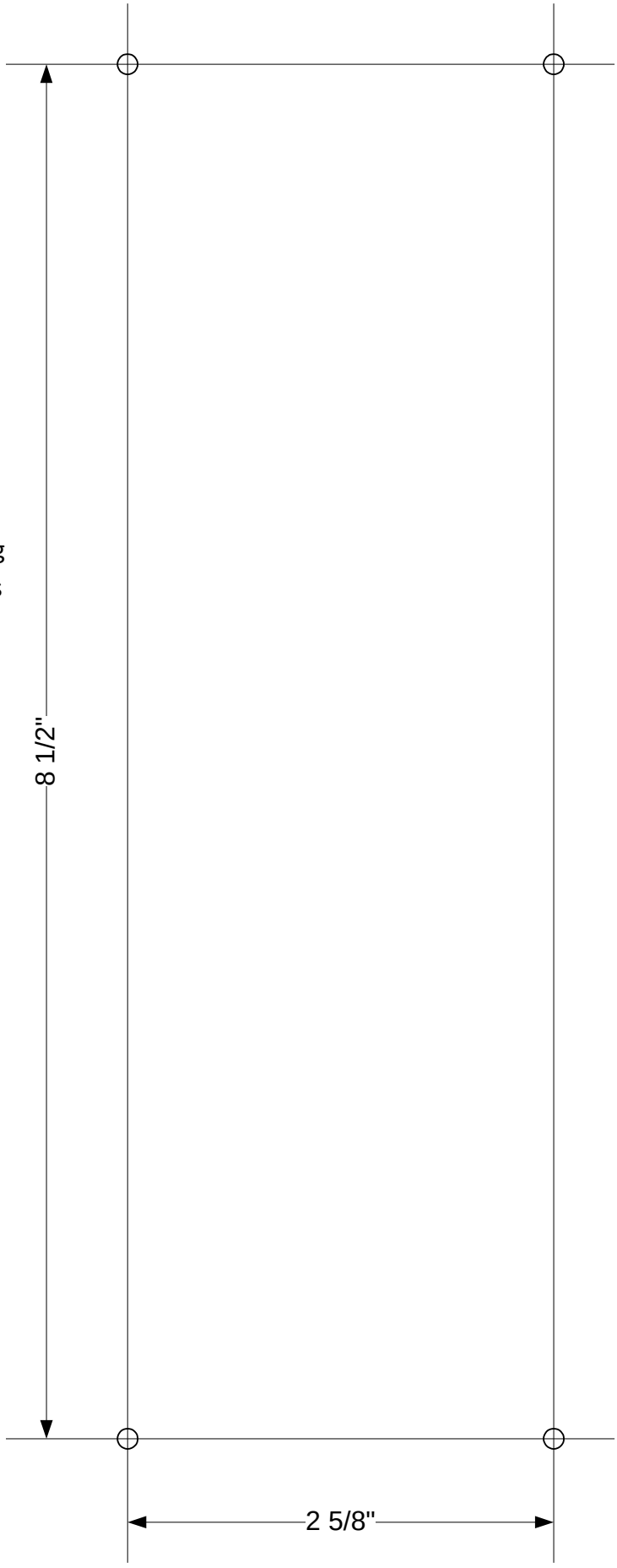


Mounting

Hardware is supplied with Scadaflex II equipment enclosures to simplify mounting to a wall, backboard, panel or post. This hardware consists of brackets that attach to the back of the enclosure.

A mounting hole template is pictured on the right.

Although Scadaflex II controllers are rated for wide temperature range operation, electronics and batteries have a longer life in moderate temperatures. The optional controller backup battery is rated from -20°C to +40°C. The LPR module battery is rated from -40°C to 70°C. Consider shading the Scadaflex II controller and I/O modules in hot environments and avoid extremely low temperatures if possible.



Communications Wiring - General

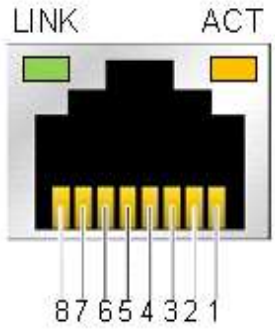
Scadaflex II Controllers have a 10/100 Ethernet port and a combined RS-232/RS-485 serial port. Both the Ethernet port and the serial port utilize RJ-45 modular jack connectors.

A switch located just above the Ethernet connector enables the incoming power to be supplied to Power-Over-Ethernet (POE) devices (up is POE enabled). Be sure that this is OFF for non-POE devices like laptops.

All communications wiring is brought into the Scadaflex II controller through the 3/4" conduit entry at the bottom of the enclosure.

Communications Wiring – Ethernet and POE

Scadaflex II controllers have a standard high-speed 10/100 Base-T RJ-45 Ethernet interface.



The RJ-45 Ethernet jack includes two LED status lights. The left hand GREEN LED is the “LINK” indicator. The right hand ORANGE LED is the “ACTIVITY” indicator.

LINK LED – Illuminates when the controller senses that it is connected to another Ethernet device.

ACTIVITY LED – Flashes ON when a message is passed.

Power-Over-Ethernet (POE) Configuration

Scadaflex II controllers can be configured to supply the controller’s incoming DC power to devices that are plugged into its Ethernet port. The POE switch, when turned ON, connects the incoming controller power (+VEXT) to four Ethernet pins on the RJ-45 Ethernet connector.

Function	Pins
+VEXT	4, 5
Gnd	7, 8

The POE circuitry is fuse protected by the main incoming power fuse for the controller (2A fuse in lower right-hand corner). A high current draw will open the fuse which in turn will power OFF the controller. The POE device must not draw more than 500mA for normal operation.

An example of a POE device is the Wi-Fi Access Point that is offered as an option for the Scadaflex II controllers. The Access Point gets its data and power via a single Ethernet cable to simplify installation.

To enable POE operation, set the POE switch (located above the Ethernet connector) to the UP position (ON). Many devices such as laptop computers are not compatible with POE, so the POE option must be switched OFF (switch in DOWN position) in these cases.

Be careful if you enable the POE (Power-Over-Ethernet) switch. Many Ethernet devices including laptop computers and most Ethernet switches **ARE NOT** compatible with POE and may be damaged if plugged into an Ethernet connector with live power.

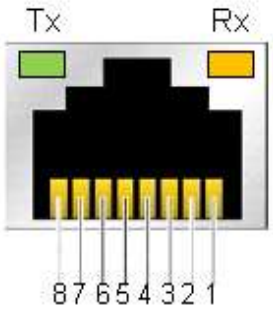
Communications Wiring – Serial Port

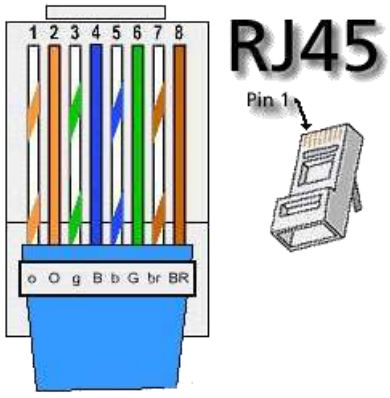
Scadaflex II controllers have a combined RS-232/RS-485 serial port. The serial port connector is an RJ-45 modular jack.

The RJ-45 Ethernet connector includes two LED status lights. The left hand GREEN LED is the Transmit Data indicator. The right hand ORANGE LED is the Receive Data indicator.

The serial port pin assignments are shown below. The wire colors shown are the "normal" colors used for most Ethernet cables which are low-cost and convenient to use and modify as serial cables.

Pin#	RS-232/RS-485 Function	Wire Color
1	RS-485+	Orange/White
2	RS-485-	Orange
3	DTR Out (RTS inverted)	Green/White
4	Gnd	Blue
5	RS-232 Rx In	Blue/White
6	RS-232 Tx Out	Green
7	CTS In (not used)	Brown/White
8	RTS Out	Brown





The RS-485 interface has a built-in series termination circuit that eliminates the need for termination resistors for all but the longest RS-485 wiring runs. We recommend NOT using a termination resistor for cable lengths under 1000 ft.

RS-232 Cabling

By using an RJ-45 "Ethernet" style jack for the serial port connections, low-cost Ethernet cables and DB-9 adapters can be used to easily fabricate serial communications cables without soldering or crimping. A typical RJ-45 to DB-9 adapter is pictured on the right.

If you make up your own RS-232 cables, you should wire them as follows:

RJ-45 Pin#	RS-232/RS-485 Function	DB-9 Male Pin# (to modems & radios)	DB-9 Female Pin# (to DTE devices)	Wire Color
1	RS-485+			Orange/White
2	RS-485-			Orange
3	DTR Out (RTS inverted)			Green/White
4	Gnd	5	5	Blue
5	RS-232 Rx In	2	3	Blue/White
6	RS-232 Tx Out	3	2	Green
7	CTS In (not used)			Brown/White
8	RTS Out	7		Brown

If you want to purchase the cables already made up and tested, here are the part numbers (xx =ft.). Available cable lengths are 1ft., 2ft., 3ft., 5ft., 10ft., 25ft., 50ft., and 100ft.,

RS-232

99-22xx RJ-45 to DB-9M (male) RS-232 Serial Cable Assembly, (xx = length in feet)

99-23xx RJ-45 to DB-9F (female) RS-232 Serial Cable Assembly, (xx = length in feet)

RS-485

99-30xx RJ-45 to tinned wire ends RS-485 Serial Cable Assembly, (xx = length in feet)

RS-232 cable runs of greater than 100ft. are not recommended.

RS-485 Cabling

For RS-485 communications, simply use the Orange/Orange-White pair for the data and the solid Blue wire for ground.

RJ-45 Pin#	RS-232/RS-485 Function	Wire Color
1	RS-485+	Orange/White
2	RS-485-	Orange
3	DTR Out (RTS inverted)	Green/White
4	Gnd	Blue
5	RS-232 Rx In	Blue/White
6	RS-232 Tx Out	Green
7	CTS In (not used)	Brown/White
8	RTS Out	Brown

Wiring - General

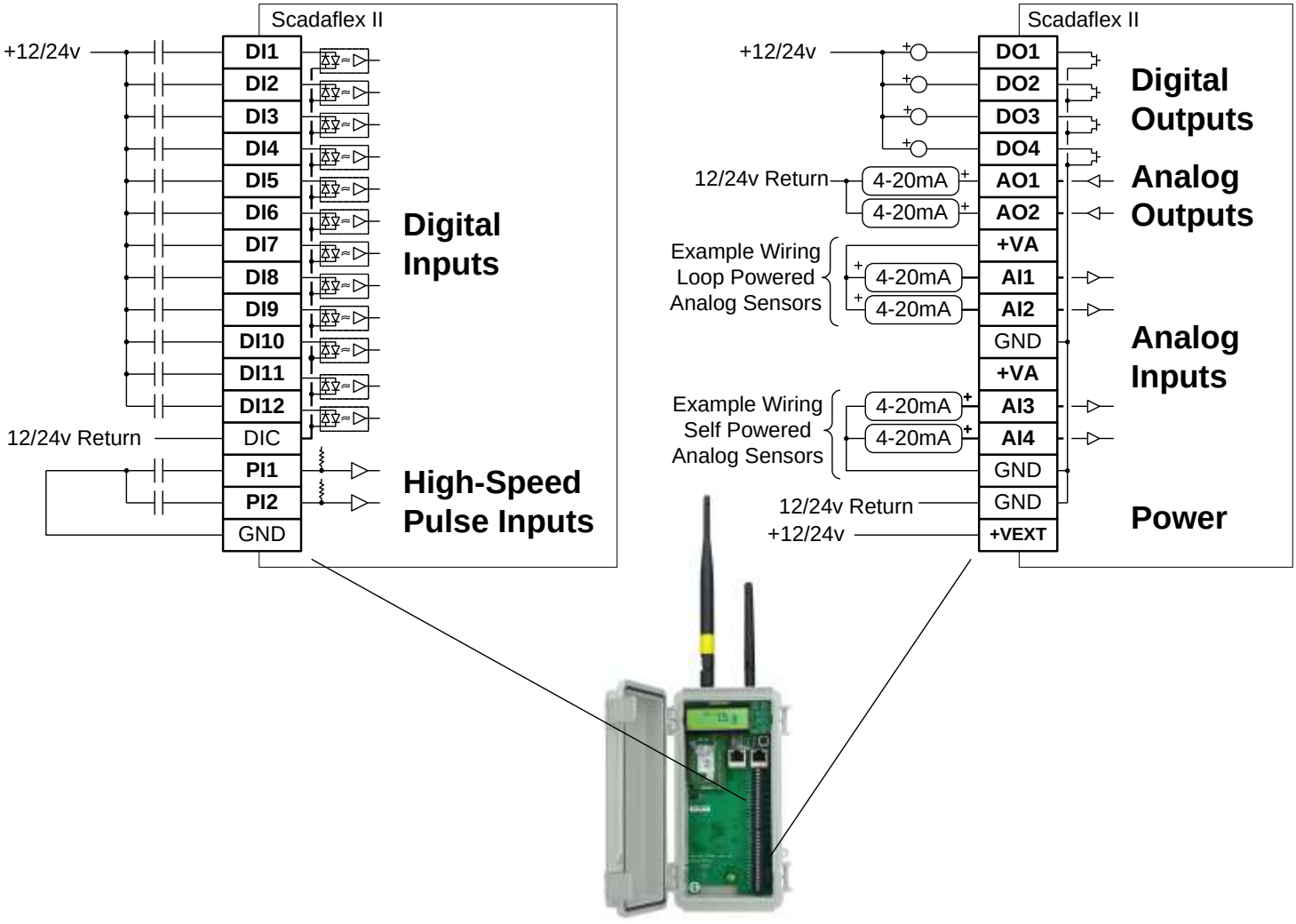
Field wiring is brought into Scadaflex II controllers through a 3/4" conduit entry at the bottom of the enclosure. There are two pluggable 16-position terminal blocks for termination of field wiring and power.

The Scadaflex II terminal blocks will accommodate wires sizes ranging from 28GA to 16GA. **The recommended tightening torque is between 0.22Nm and 0.25Nm.** Wires should have their insulation stripped back approximately 0.25” to 0.30”

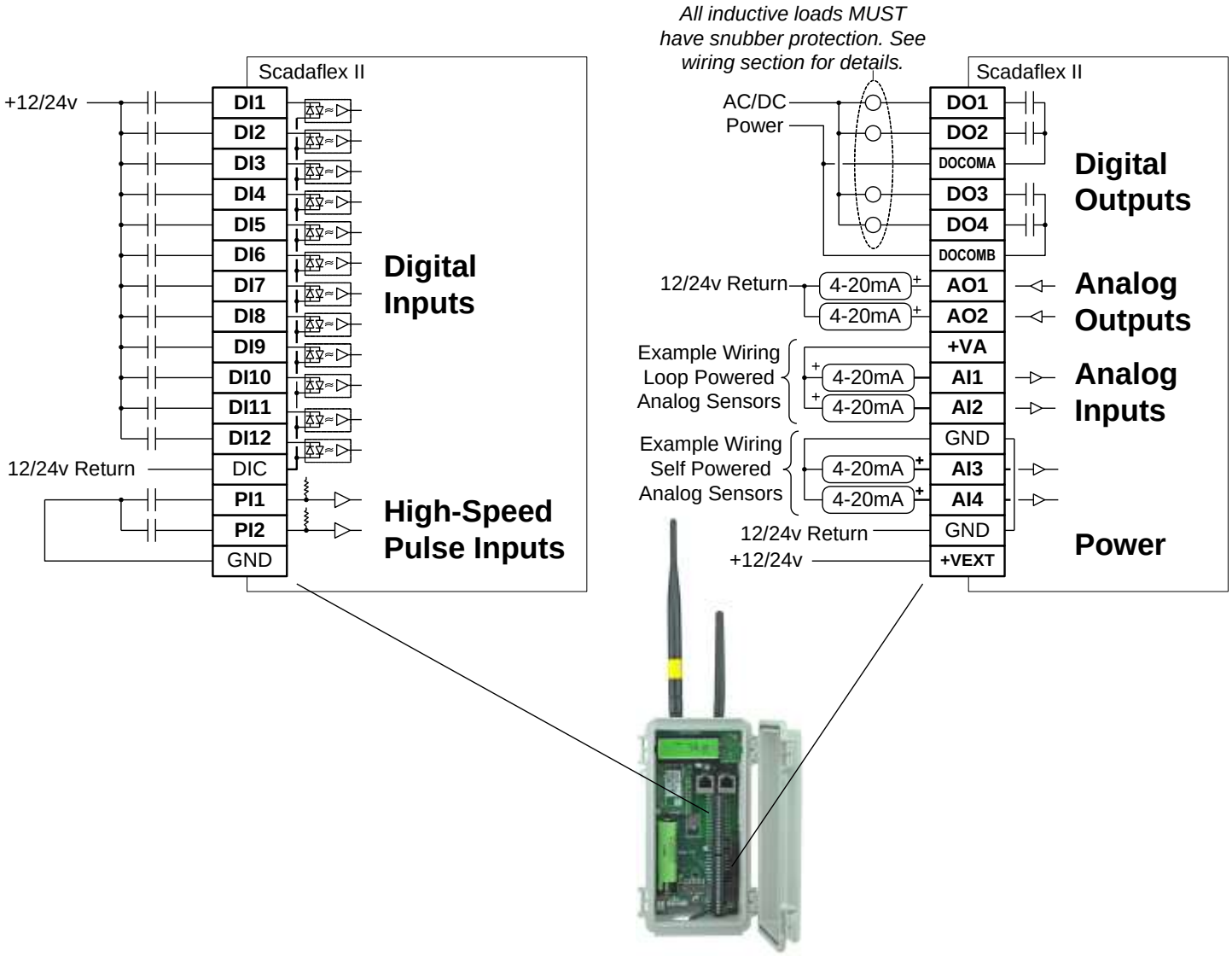
The diagrams below summarize the field wiring to the controller. Note that the discrete output wiring is different between Scadaflex SC1 controllers (FET outputs) and SC-2 controllers (relay outputs). This difference causes the analog inputs and outputs on the lower terminal block to be shifted down one terminal in the SC-2 model compared to the SC-1.

Detailed wiring information is provided on the pages following.

SC-1 Wiring

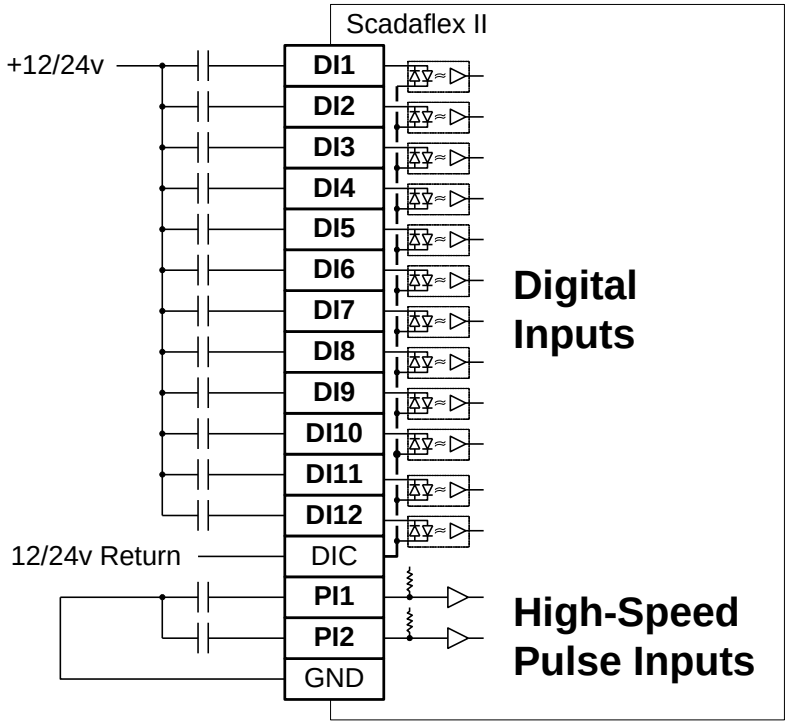


SC-2 Wiring



Wiring – Discrete Inputs

Scadaflex II controllers have twelve optically isolated discrete inputs and two high-speed discrete/pulse inputs. The upper terminal block has the field connection points for these inputs.



Optically Isolated Discrete Input Wiring

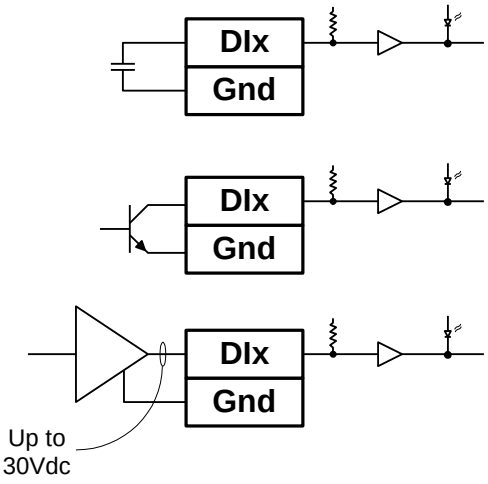
The twelve optically isolated discrete inputs support AC or DC input signals of either polarity. They can also be configured to support contact closures using the controller's power supply or external AC or DC power for "wetting" current. An ON is an input of 9V or more. An OFF is an input of 3V or less. Levels between 3V and 9V are not defined and should be avoided for reliable operation.

High-speed Pulse Input Wiring

The two high-speed pulse inputs are discrete inputs that support contact closures, "open collector" or "open drain" devices, and DC voltages up to 30Vdc. Both high-speed inputs can totalize pulses and compute their input frequency such as for use with flow meters. An ON is a closed contact to ground (Gnd) or an input voltage of less than 1Vdc. An OFF is an open contact or an input voltage greater than 2Vdc. Levels between 1Vdc and 2Vdc are not defined and should be avoided for reliable operation.

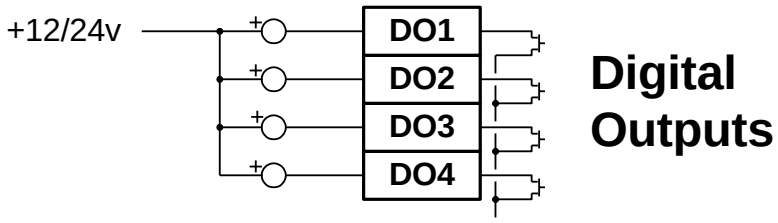
Typical sensor output configurations and how they connect to the Scadaflex II controller are shown in the diagram on the right.

Input devices must switch to ground or pull down below 1Vdc for an "ON" condition, and switch "open" or pull up above 2Vdc for an "OFF" condition.



Wiring – SC-1 Discrete Outputs (FET)

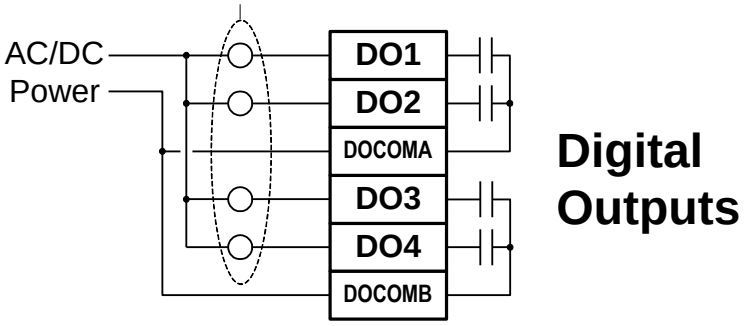
The Scadaflex II SC-1 Controller has four solid-state “open drain” protected FET discrete outputs. The outputs are capable of switching 1A loads (each) up to 30Vdc. They are electronically protected against inductive transients, over-current faults and thermal overloads. The outputs are designed to have one side of their loads connected to the plus side of a 12 or 24Vdc supply (negative side of supply connected to a “ground” terminal on the controller). The outputs switch the other side of the loads to ground.



Wiring – SC-2 Discrete Outputs (Relay)

The Scadaflex II SC-2 controller has four relay discrete outputs grouped as two pairs with shared commons. The outputs are capable of switching up to 3A loads (each), up to 30Vdc or 240 Vac. The outputs are designed to have one side of the loads connected to an external supply. The outputs switch the other side of the supply to the second connection to the loads.

All inductive loads MUST have snubber protection.



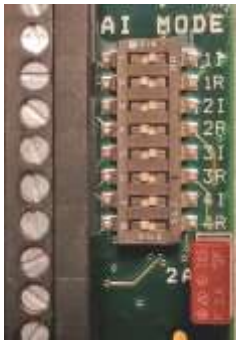
All inductive loads, regardless of their size, must have snubber protection across them. This can be rectifiers for DC circuits, or capacitor/resistor snubber devices for AC circuits. Failure to install snubber will reduce relay contact life and cause elevated radiated electrical noise emissions. Please contact ICL technical support if you need assistance in properly selecting and installing snubber devices for your application.

Wiring – Analog Inputs

Analog Inputs Wiring

Scadaflex II controllers have four analog inputs, each configurable for the following signal types:

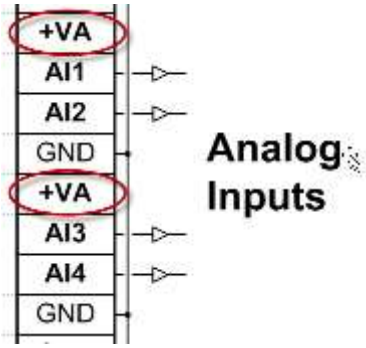
- 20mA
- 5Vdc
- +/-250mVdc
- Ohms, up to 65,535
- Temperature (using 2250 ohm thermistor)



Besides configuration settings in the controller (via the configuration web pages) there are DIP switches that must be set. In the SC-1 controller, these switches are located to the right of the I/O terminal blocks. In the SC-2 controller, these switches are located in the middle of the wiring cavity to the left of the I/O terminal blocks.

For each channel, there is an "I" switch and an "R" switch.

- The I switch must be turned ON (right or up) for current measurements.
- The R switch must be turned ON (right or up) for resistance and temperature sensor measurements.
- Both switches must be OFF (left or down) for voltage and millivolt measurements.
  Both switches should NEVER be ON at the same time.



Device or loop power for sensors can be supplied by either an external supply, or by the +VA terminals on the controller. The +VA terminal power can be set to switch ON only during measurements for low power applications so that the loops are only powered when the sensors are being measured. There is a configurable "warm-up" delay. Using the +VA switched sensor power can significantly reduce power consumption for solar powered and other power sensitive applications by turning off the sensor power between analog readings.

20 mA Sensor Wiring

20mA sensors are available in three basic types; 2-wire or loop powered, 3-wire, and self-powered.

- **Loop powered sensors** are two-wire devices that connect between a positive supply and the analog input. These devices that provide a 4mA to 20mA signals to represent measurement values.

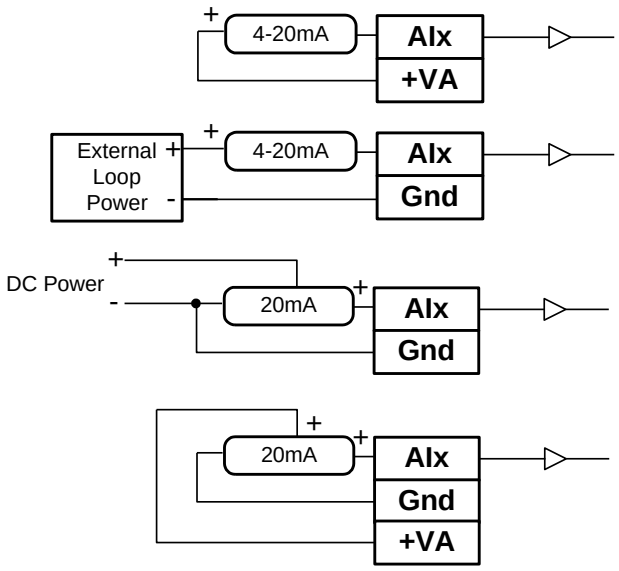
- **3-wire sensors** connect between ground and the analog input, with a third wire going to a DC power source. Three wire sensors frequently consume more power than 2-wire sensors. If you are going to power 3-wire sensors from +VA, be sure to check that the power requirements of all sensors together do not exceed a total load current of 100mA. Consider powering 3-wire sensors from an external DC power supply—possibly the same one that powers the controller.

- **Self Powered sensors** have their own power source (many are AC powered) with separate signal and ground connections that connect to the Scadaflex II controller terminals.

The **+VA** terminal(s) provide 15Vdc loop or sensor power whose level is independent of the controller's input power supply. If the controller includes the internal battery backup option, the +VA power is also backed up and available when external power is lost. The +VA loop/sensor power is typically configured so that it is turned on only when the analog readings are taking place and turned off when not actually needed. There are two +VA terminals in the SC-1 Controller and one +VA terminal in the SC-2 Controller.

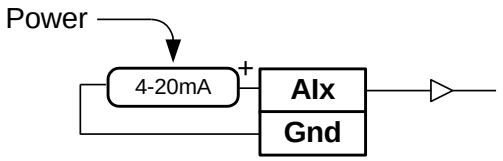
2-wire (20 mA loop powered) sensors can be powered from the switched analog power terminal (+VA) or from an external supply. Note the polarity of the sensor connections with the negative lead connected to the analog input terminal.

3-wire sensors can also be powered from the switched analog power terminal (+VA) as long as the current draw does not exceed 80mA, or from an external supply. The sensors can be milliamp or voltage output devices.



Use the +VA terminals for powering sensors for power sensitive applications, or when sensors will need to still operate when external power is lost (if the controller has the internal battery backup option). When switched sensor power is not needed, using external sensor/loop power is preferable and recommended. In most cases, this will be the same power as the controller input power.

Self-powered sensors are similar to 3-wire devices except that they have their own internal power supply, typically isolated from the signal circuit.



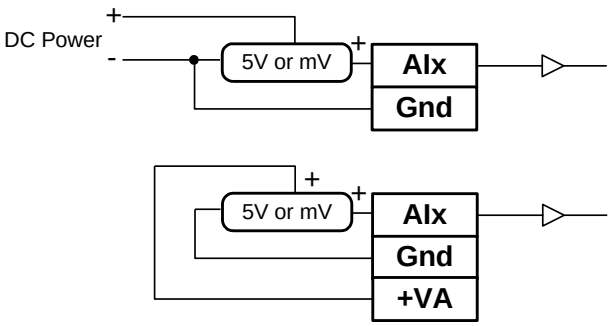
Voltage and Millivolt Sensor Wiring

Voltage and millivolt sensors are available in two basic types; 3-wire, and self-powered.

- **3-wire sensors** connect between ground and the analog input, with a third wire going to a supply voltage. Three wire voltage output sensors are frequently used for low-power applications since their power consumption is typically ¼ or less than 20mA current loop sensors. If you are going to power 3-wire sensors from +VA, be sure to check that the power requirements of all sensors together do not exceed a total load current of 80mA. Consider powering 3-wire sensors from an external DC power supply—possibly the same one that powers the controller.

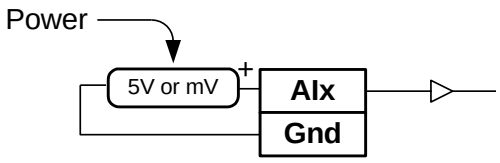
- **Self Powered sensors** have their own power source (many are AC powered) with separate signal and ground connections that connect to the analog input terminals.

3-wire sensors can also be powered from the switched analog power terminal (+VA) as long as the current draw does not exceed 80mA, or from an external supply. The sensors are available as millivolt or voltage output devices.



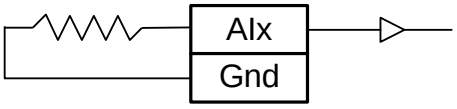
Use the +VA terminals for powering sensors for power sensitive applications, or when sensors will need to still operate when external power is lost (if the controller has the internal battery backup option). When switched sensor power is not needed, using external sensor/loop power is preferable and recommended. In most cases, this will be the same power as the controller input power.

Self-powered sensors are similar to 3-wire devices except that they have their own internal power supply typically isolated from the signal circuit.



Resistance Sensor Wiring

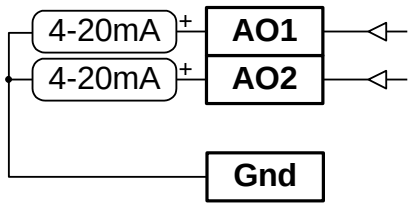
Resistance sensors (like valve position feedback pots) and thermistor temperature sensors are two-wire devices. If there is a third wire for the other end of a potentiometer, it can be left disconnected. These sensors are simply wired between an analog input and ground.



Wiring – Analog Outputs

Scadaflex II controllers have two analog outputs. The outputs provide 0 to 20mA signals and with the addition of an external resistor can be converted to a 0 to 5Vdc or 0 to 10Vdc signals.

Current Loop control devices can be wired as shown below. The Scadaflex II controllers source loop current so no external loop power supply is required

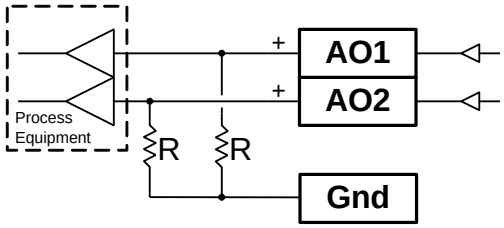


Voltage control devices can be wired as shown below with external resisters converting the controller's current outputs to voltage outputs. The input impedance of the process equipment inputs should exceed 10K ohms with greater than 100K ohms preferred for best accuracy. The following resistance values should be used for 5Vdc and 10Vdc output levels.

"R" resistance values

5Vdc 250 ohms 0.1% 0.25W or more
(Digikey p/n CMF250HD-ND)
(Mouser p/n 71-CMF55250R00BHEK)

10Vdc 500 ohms 1% 0.5W or more
(Digikey p/n CMF500HY-ND)
(Mouser p/n 71-CMF555001%T9)



Digikey contact information:

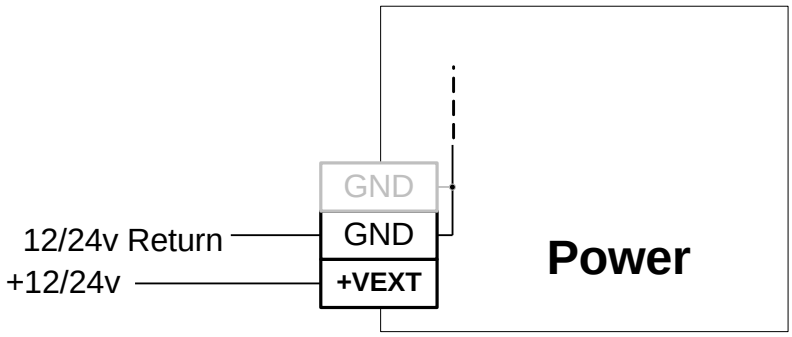
www.digikey.com
800-344-4539

Mouser contact information:

www.mouser.com
(800) 346-6873

Wiring – External DC Power

The Scadaflex II controller requires DC power ranging from 10Vdc to 30Vdc. Power is wired into the +VEXT and Ground terminals as shown below.



The power draw of the Scadaflex II controller during normal operation ranges from 0.5 watts to 3.5 watts depending on the units configuration and in the case of SC-2 controllers whether one or more relay outputs are activated.

Trending Memory Micro SD Card

Scadaflex II controllers can record up to 63 "channels" or "pens" of sensor measurements and other data over a period of many years. The trending functionality utilizes a micro SD memory card (user supplied) similar to those used in many cell phones. Trending in Scadaflex II controllers can replace many mechanical and electronic chart recorders, saving tens of thousands of dollars.

The micro SD card must be installed in the socket indicated in the picture on the right in order to use the trending feature.

The micro SD card should only be inserted or removed with power OFF. This incudes the battery power on units with the backup battery option.

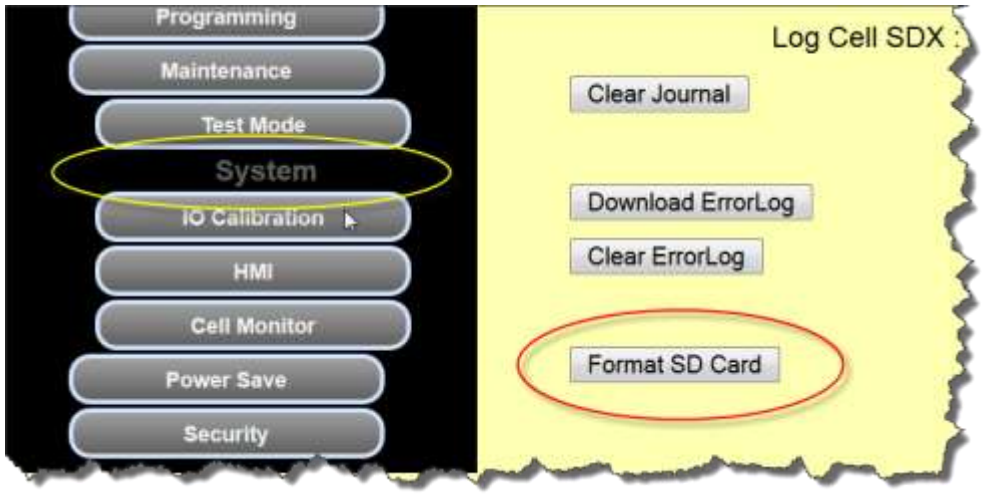
Micro SD cards come in a variety of speeds, identified as a "Class" value. ICL recommends using an SD card with at least a Class 10 rating (48MB/s or faster). Slower cards will affect the retrieval performance of historical trend data.

While many different brands of micro SD cards will work, we recommend using Sandisk Ultra series cards. These are the cards that we test and certify performance with. These cards have an operating temperature rating of -25°C to +85°C, a 10 year warranty, and are readily available. Extended temperature range cards are also available from ICL.

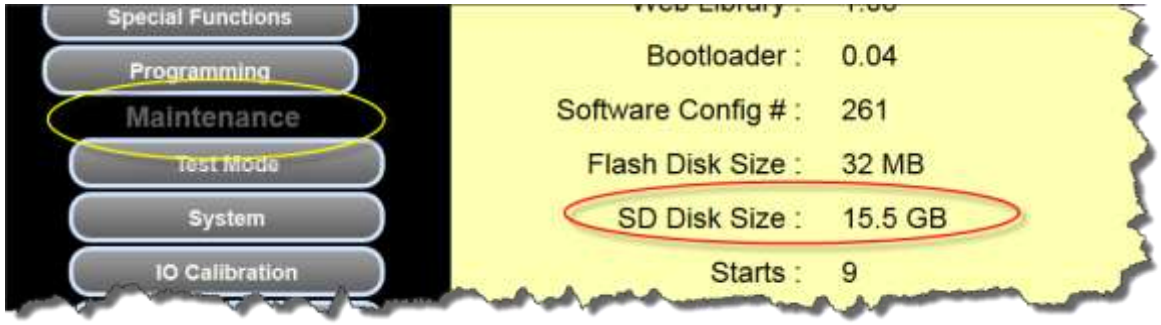
In Scadaflex II Controllers, trending data is recorded at a sampling rate of 1 second or 8 seconds (slow mode). Depending on the selected sampling rate, the approximate storage times for common micro SD memory card sizes, and the recommended Sandisk part numbers are shown in the table below.

Card Capacity	Sampling Rate		Sandisk Micro SD Card Part#s (recommended)		
GB	1 sec	8 sec	USA	Latin America	Canada
8	2 yrs	15 yrs	SDSDQUA-008G-A46A	SDSDQUAN-008G-G4A	SDSDQUAN-008G-C4A
16	4 yrs	30 yrs	SDSDQUA-016G-A46A	SDSDQUAN-016G-G4A	SDSDQUAN-016G-C4A
32	8 yrs	60 yrs	SDSDQUA-032G-A46A	SDSDQUAN-032G-G4A	SDSDQUAN-032G-C4A
64	16 yrs	120 yrs	SDSDQUA-064G-A46A	SDSDQUAN-064G-G4A	SDSDQUAN-064G-C4A

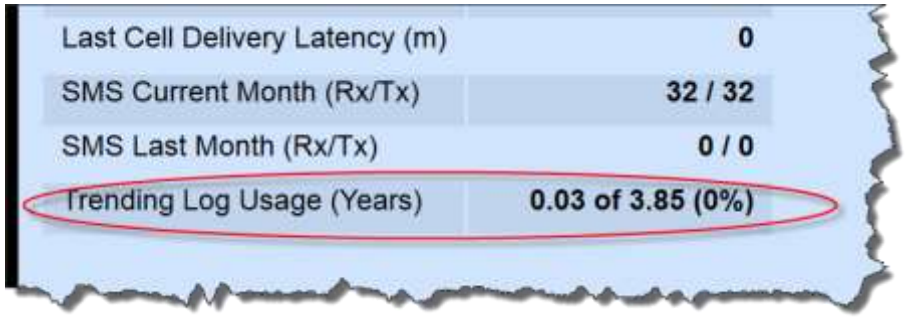
When a new micro SD card is installed in a Scadaflex II Controller, or if you wish to erase and start over using a card that is already installed, you must format it. The easiest way to do this is to go to the bottom of the **CONFIGURATION | MAINTENANCE | SYSTEM** page and click on the "Format SD Card" button.



You can verify that the micro SD card is properly installed and formatted on the MAINTENANCE page.



When a properly formatted micro SD card is installed, the total trending capacity (for the selected recording rate and card size) and the trending space that has been used is shown at the bottom of the user HOME page. The displayed disk size will always be slightly less than the labeled capacity of the card.



Battery Backup Option

Scadaflex II controllers can be ordered with a built-in battery backup option which allows the controller to keep running for up to 16 hours (depending on options and loads) when external input power is lost. The battery backup option uses a rechargeable lithium battery which is installed in a socket located along the left-hand side of the controller. The controllers have a built-in charger to recharge the battery when external power is applied. The battery voltage can be "mapped" to a register on the **CONFIGURATION | I/O CONFIG** page). Note that if the battery is unplugged or switched off, the unloaded output of the charger will be read (about 4.1 volts).

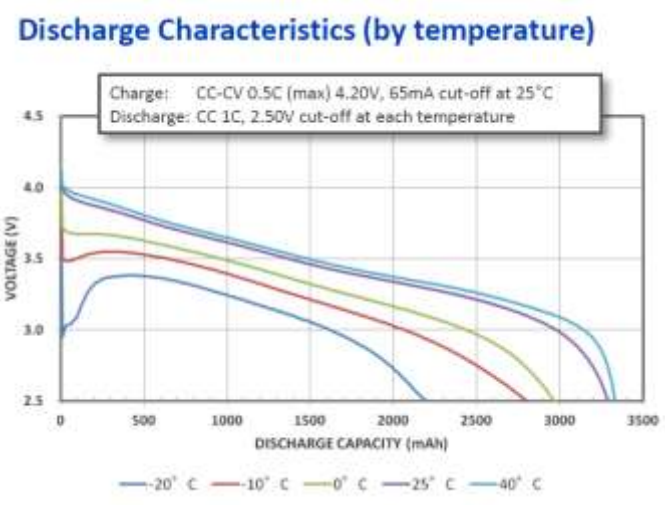
An LED status indicator indicates the status of the internal battery/charger. A missing or switched off battery causes this LED to flash rapidly. The LED is on solid when the battery is charging, and off when the battery is fully charged.

The Scadaflex II Battery Backup Option includes a 3.4AH (typical) lithium battery with a built-in protection circuitry. **The battery must be a protected lithium cell. Do not substitute this battery. Installing any other battery may cause permanent damage to the controller and runs the risk of starting a fire.**

If you do replace the battery, dispose of the old battery properly according to local regulations as it is considered hazardous waste in most locations.

Do not ship the Scadaflex II Controller with the battery installed.

Performance of the backup battery is significantly affected by the ambient temperature. Operation below room temperature will provide shorter battery backup times as shown by the chart on the left. **The minimum operating temperature with the battery backup option is 20ºC.** The controller will operate with battery voltage down to 3.0 volts. For safety, the built-in battery charger is automatically disabled if the temperature in the enclosure exceeds 60 ºC.



Cellular Option

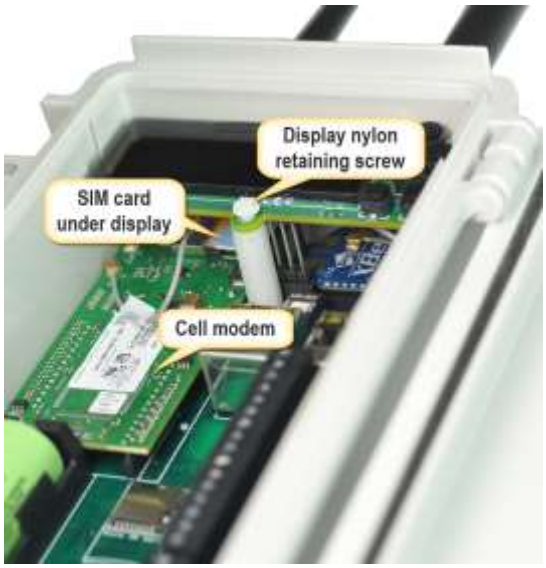
Scadaflex II controllers can be ordered with internal 4G/LTE cellular modems (a 3G modem was available in older units, but is now discontinued). The modems are either ordered for use on the Verizon network in the United States, or the AT&T, T-Mobile, and most international networks. Contact ICL sales to order modems for alternative networks such as Sprint.

The internal cellular modems support both data and text messaging operation but how they can be used is determined by how the account is set up with the cellular carrier. Generally plans with data are billed in tiers by the number of megabytes allotted per month and overage charges are assessed when actual usage exceeds the monthly allotment. Text messaging normally is billed as a base rate plus some amount per text message (both incoming and outgoing). Unlimited data and text messaging plans may also be available from your carrier so that there is no risk of facing overage charges but the base costs are higher.

The internal cellular modem option provides a means to remotely access user web pages and exchange register data. Register data exchange can use both data and/or text messaging and both maybe secured with encryption (text message data exchanges are always encrypted). Data mode must be used to access web pages in the controller and to remotely update the controller firmware. Text messaging may also be used to manually access controller values and parameters including register and I/O information.

Cellular Option - SIM card installation and APN configuration

The Scadaflex II 4G/LTE modem options require installation of a SIM card (provided by the cellular carrier) into a socket on the modem. If the controller has an HMI option, the display must be temporarily unplugged to access the SIM socket beneath it. After the SIM card is installed, generally you will also need to enter an Access Point Name (APN) (also provided by the carrier) on a configuration web page. The APN is only required for data mode operation.



Follow this procedure to install the SIM card and set the APN:

Scadaflex II controllers require a “standard size” SIM card (not “mini” or “micro”)

STEP 1 - Power down – Remove power from your controller. If your controller has battery backup, temporarily remove the lithium backup battery or turn off the battery power switch (older controllers do not have this switch).

STEP 2 - Fully Expose the SIM card socket – If your controller has an LOCAL HMI option (display), you will need to temporarily remove it to access the SIM card on the cell modem. To do so, loosen but save the nylon retaining screw.

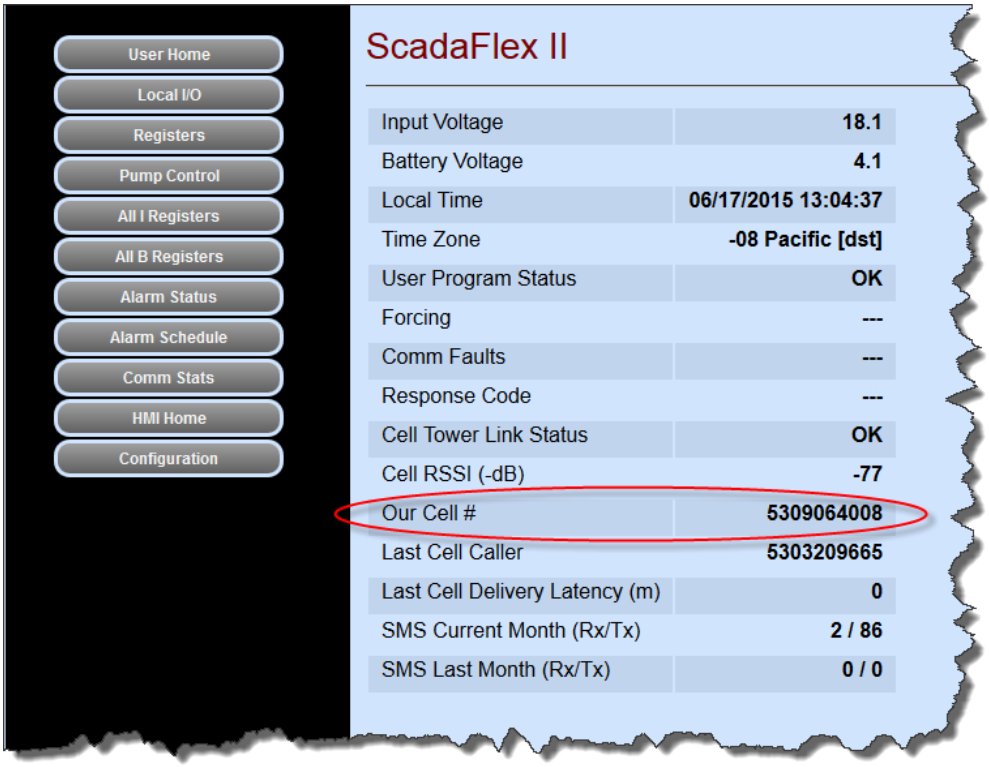
STEP 3 - SIM card installation – With the cell modem fully exposed, you will see the SIM card socket towards the top of the modem. The SIM card plugs into the right hand side with the gold contacts on the card facing the modem (you should be able to read the writing on the card) and the notched corner should be oriented to the upper right-hand side. Be sure that the SIM card is fully seated as shown.

STEP 4 - Re-install the LOCAL HMI– If your controller had an optional LOCAL HMI, re-install it with the side tab slipping into the support slots on either side. Be careful to properly align the 5-pin connector that plugs into the main board. Carefully and gently hand tighten the nylon retaining screw until barely snug.

STEP 5 - Apply Power and Log In– Re-install the backup battery if you removed it earlier or switched it off, and apply power. Log into the controller's main user web page. The default IP address from the factory is **192.168.237.199.**
It should look something like this:

Seconds after booting, you should see an "Our Cell#" which is stored in the SIM card. It may take up to a minute or two to get an "OK" Cell Tower Link Status and Cell RSSI. For reliable operation, you should have an RSSI better than -100dB.

Within 5 minutes or so, if cellular data is enabled and you have good signal strength, the modem should link up with the tower and you should see a cellular IP address.

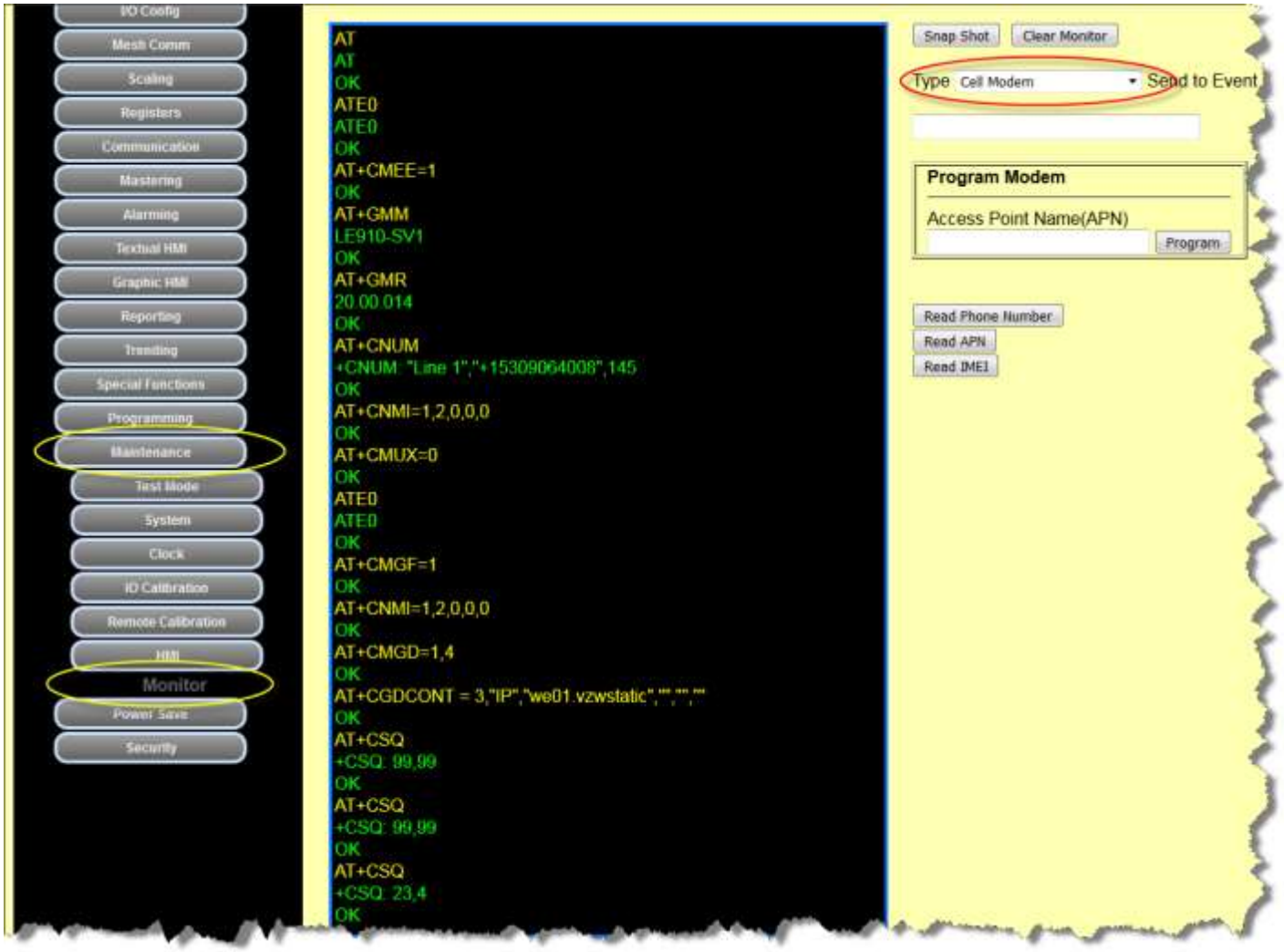


STEP 6 - Set the APN– The controller must have an APN setting to use data mode operation. Sometimes, this will be set automatically from the tower based upon the account plan that you have signed up for from the carrier. Many times though, you will need to manually enter the APN.

Go to: **CONFIGURATION | MAINTENANCE | MONITOR**

In the upper right-hand corner, select "Cell Modem" monitor type.

Reset the controller by cycling power. You will see a dialog like the one below.



The initial transactions displayed are between the controller and the modem (no tower communications yet). This includes the displayed telephone number (in the line starting with +CNUM). This is the number programmed into the SIM card. The +CSQ message is the controller asking for the signal strength from the modem. A value of "99,99" means no tower connection. Once the connection is established, the signal strength readings will change to a new pair of numbers such as the "23,4" shown. The controller interprets these values to display the RSSI value on the main web page.

There are additional command buttons below the monitor mode selector including one to program the APN. Until there is a tower link (+CSQ <> 99,99), none of these will be active. Once you have a tower connection (this can take several minutes in some cases) you can click on the "Read APN" button. In Verizon systems, you will see three APNs. You are only interested in the third one. You will also see a

warning message which can be ignored for now. In AT&T and international systems, you will only see one APN value.

The APN that is displayed may be different from the one required for your account. In this case, data mode will not operate. The correct APN must be programmed into the controller to match your account for data operation. Text messaging operation will not be affected by a bad APN value.

```
+CSQ: 20,2
OK
AT+CSQ

+CSQ: 19,2
OK
AT+CGDCONT?
+CGDCONT: 1,"IPV4V6","vzwims","",0,0
+CGDCONT: 2,"IPV4V6","vzwadmin","",0,0
+CGDCONT: 3,"IP","we01.vzwstatic","",0,0
+Sys : 3017 - Warning - CMUX Packet Dropped (2)
AT+CSQ
+CSQ: 20,4
OK
AT+CSQ
+CSQ: 19,4
OK
```

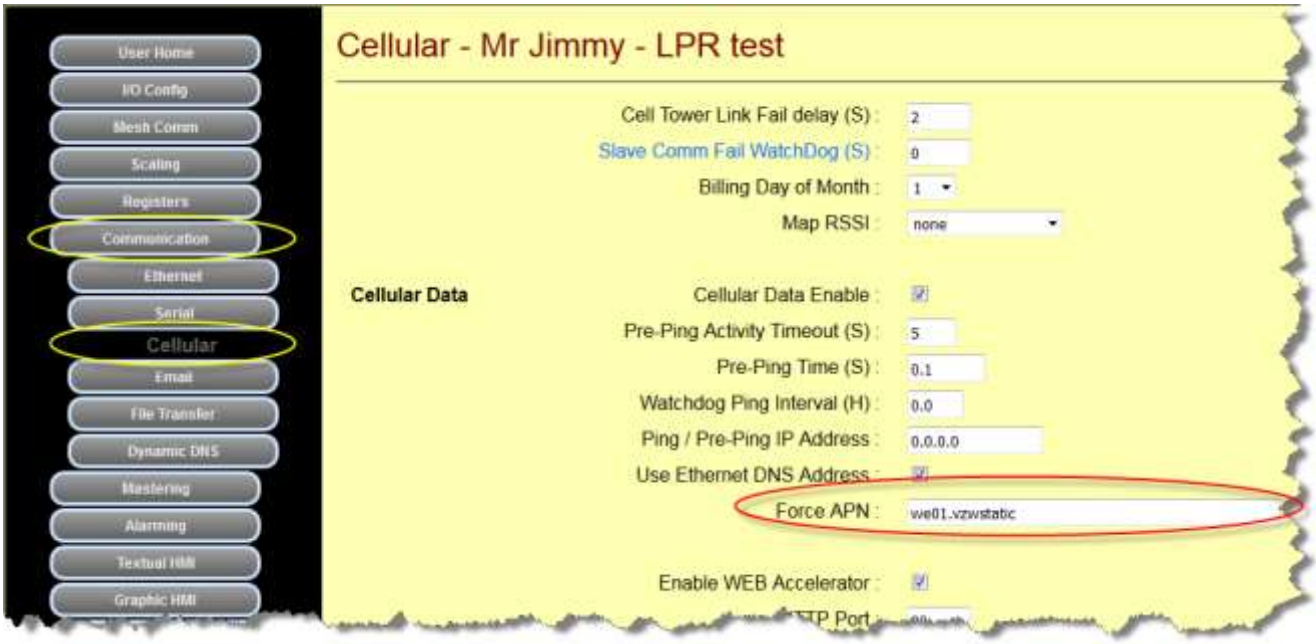
To set the APN, enter it into the field provided and click on "Program APN". Note that you MUST have a tower connection (signal strength) to set the APN. In the above example, the Verizon APN shown is **we01.vzwstatic**. After you program the APN, you should see the command in the monitor screen followed by an OK. You can also click on the "Read APN" button to verify that the APN "took".

STEP 7 - Locking in the APN

In some systems, it's possible for the tower to change the APN setting back to a value which is not correct for your account. This can lock you out from remote access. To prevent this, you can set the controller to force the APN value every time that it is reset. To enter the Force APN value, go to:

CONFIGURATION | COMMUNICATIONS | CELLULAR

and enter the APN in the field provided.



If you find yourself locked out (from web page access via cellular), you can text a "#restart" command to the controller, forcing a reset and re-establishing the proper APN.

I/O Expansion Modules

Scadaflex II controllers support wired and wireless modules to extend their I/O capacity and reach. Of the wireless modules, the Low Power Remote (LPR) module can run for several years powered by a single lithium "D" cell battery (supplied), or from external DC power. The Remote I/O (RIO) module comes in both wireless and wired versions and uses external DC power (only).

Low-Power Remote I/O (LPR)

LPR (**L**ow **P**ower **R**emote) I/O Modules can add widely distributed I/O to Scadaflex II controllers utilizing high-reliability meshing wireless networking. Up to 64 LPR modules can be controlled by a single Scadaflex II controller.

LPR modules are supplied complete, ready-to-run. They are packaged in polycarbonate enclosures with a long-life wide temperature range lithium battery and a weatherproof whip antenna. The modules draw so little power that they can run for several years using a single lithium D cell battery eliminating the cost of running power wiring, installing a power supply or installing and maintaining solar power components.

LPR Modules include internal 900MHz meshing spread spectrum radios that allow them to communicate up to a 1/2 mile to a 1 mile or more between sites with the supplied antennas (depending on elevation above grade and terrain) or further with higher performance antenna systems. Each module can automatically act as a repeater (no manual configuration is required) to extend the reach of a network of modules. The network is “self healing” so that if one unit becomes unavailable as a repeater, the system will automatically try to establish another radio path.

LPR Modules come with a mix of analog inputs, discrete inputs, and discrete outputs. There are four analog inputs for resistive sensors like thermistor temperature sensors and soil moisture sensors. There are also four process analog inputs that can be ordered configured for either 20mA or 5V sensors. A switched sensor/loop power supply is included that can provide up to 50mA 12V device power. There are four discrete inputs that accept contacts closures and "open collector" signals. Two of these can totalize pulses up to 10KHz. There are two latching relay outputs that provide “dry” contact closures. A special input is provided to support a low-power ultrasonic level sensor.

Operation

Scadaflex II LPR Modules are optimized for very low-power operation. They can be powered by either the supplied lithium D cell battery, an external DC power source (10 to 30Vdc), or both utilizing the battery as backup power when external DC power is lost.

To maximize battery life, the LPR module is designed to "sleep" most of the time. The major demands on the battery are the radio transmitting, sensor power consumption, and the microprocessor. Keeping these asleep or powered off as much as possible is critical to long battery life.

The LPR module can be configured to wake up periodically and after a configurable slumber time of up to 18 hours, report back to the master controller then go back to sleep. It can also be configured to wake up when there has been a change in a digital input state or an analog level. This allows for rapid response times while retaining much of its low-power functionality. When ultra low-power operation is not critical--such as when the module is powered from an external DC power source—it can be polled without sleeping.

Configuration

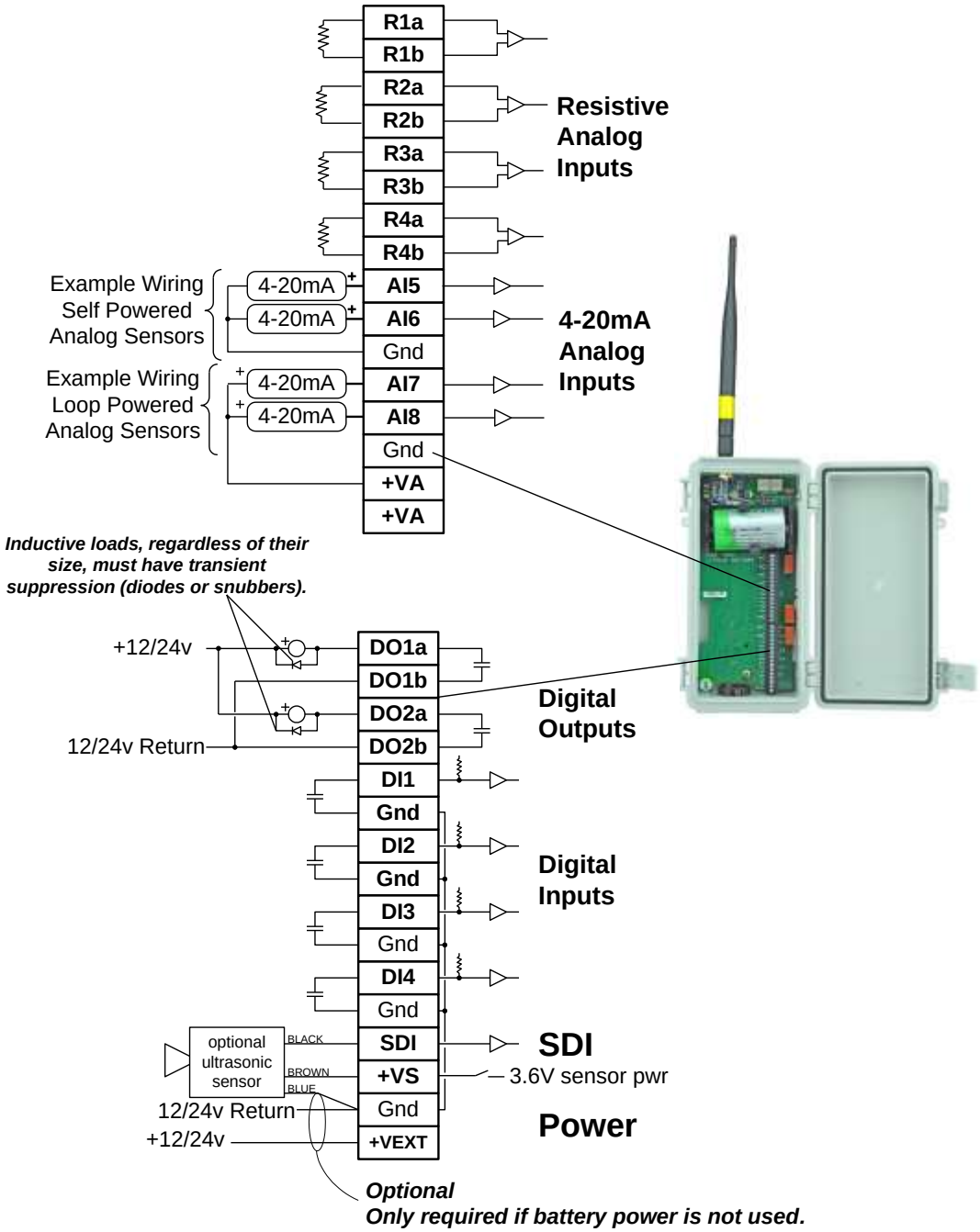
Scadaflex II LPR Modules are configured by filling in information on web pages in the Scadaflex II Controller (SC-1, SC-2) that controls them. The Scadaflex II Controller, operating as a "master", updates the configuration information in the LPR remote modules each time that they communicate with it. The only configuration performed at the remote module is the network address setting and three power configuration DIP switches. All scaling and mapping of I/O is done in the master. If the LPR module is replaced in the field, its configuration is automatically updated when it talks to the master. The master also ensures that the remote module always has the latest firmware. If new firmware is downloaded to the master, it automatically updates the LPR Remotes “over-the-air” the next time they communicate. Calibration is also done “over-the-air” using a built-in maintenance web page. Module calibration information is kept in the remote modules themselves so that they can be easily and quickly swapped in the field without readjustment.

LPR Wiring - General

Field wiring is brought into the LPR module through a 3/4" conduit entry at the bottom of the enclosure. There are two pluggable 16-position terminal blocks for termination of field wiring and power.

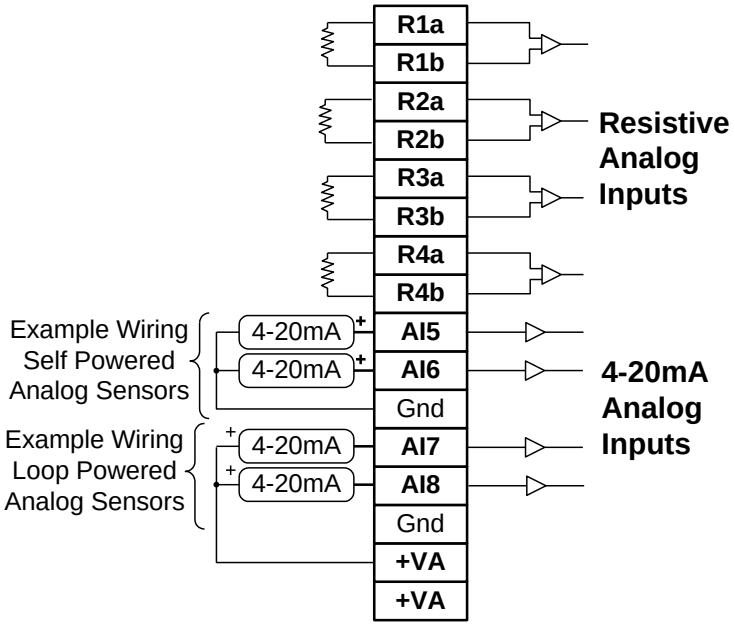
The LPR terminal blocks will accommodate wires sizes ranging from 28GA to 16GA. The recommended tightening torque is between 0.22Nm and 0.25Nm. Wires should have their insulation stripped back approximately 0.25” to 0.30”

The diagram below summarizes the field wiring to the LPR module. Detailed wiring information is provided on the pages following.



LPR Wiring – Analog Inputs

LPR modules have eight analog inputs; four for resistance type sensors, and four for process sensors (may be ordered as 20mA, 5V or 10V full scale).



Resistance Sensor Wiring

The four resistance measurement inputs of the LPR module are at the top of the analog terminal block (the a and b terminals marked R1, R2, R3 and R4), closest to the battery. A resistance sensor is simply wired between the two input terminals for the channel. The resistance measurement range is from 0 ohms to just slightly more than 25,000 ohms. The conversion of resistance to engineering units such as temperature, soil moisture level, position, etc. is done by the master.

Process Sensor Wiring

Process sensors are available in three basic types; 2-wire or loop powered, 3-wire, and self-powered.

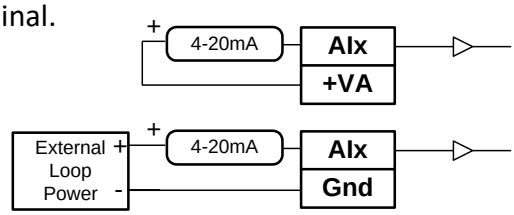
- **Loop powered sensors** are two-wire devices that connect between a positive supply and the analog input. These devices provide 4mA to 20mA signals to represent measurement readings.
- **3-wire sensors** connect between ground and the analog input, with a third wire going to a supply voltage. These sensors can be purchased in different versions that can supply a 4mA to 20mA, 0 or 1 to 5Vdc or 10Vdc signal to represent measurement values. The voltage output version of these sensors are preferred for low-power applications over 20mA sensors (either 2-wire or 3-wire) since their power consumption is typically much less.
- **Self Powered sensors** have their own power source (many are AC powered) with separate signal and ground connections that connect to the LPR module terminals.

The **+VA** terminals below the analog inputs provide regulated loop or sensor power derived from the internal battery or external DC power. The loop/sensor power is supplied only when the analog readings are taking place, and turned off when not actually needed. The current drawn from the +VA terminal should not exceed 50mA (for example, no more than two 20mA loop powered sensors).

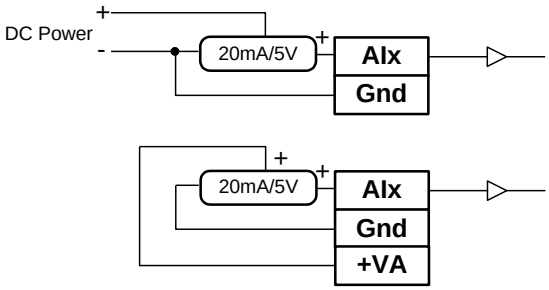
In systems that may use the battery for power, either exclusively or as backup power, do not draw more than 50mA from the +VA terminals. Doing so will exceed the operating rating of the battery and may cause a malfunction, damage to battery, or both.

Whenever possible, select 5Vdc output sensors for low-power applications. The battery in the LPR module will last longer than with 10Vdc and 20mA output sensors.

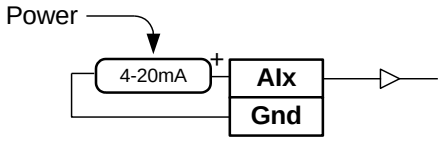
2-wire (loop powered) sensors can be powered from the switched analog power terminal (+VA) or from an external supply. The sensors must be 20mA devices. Note the polarity of the sensor connections with the negative lead connected to the analog input terminal.



3-wire sensors can also be powered from the switched analog power terminal (+VA) or from an external supply. The sensors can be milliamp or voltage output devices.

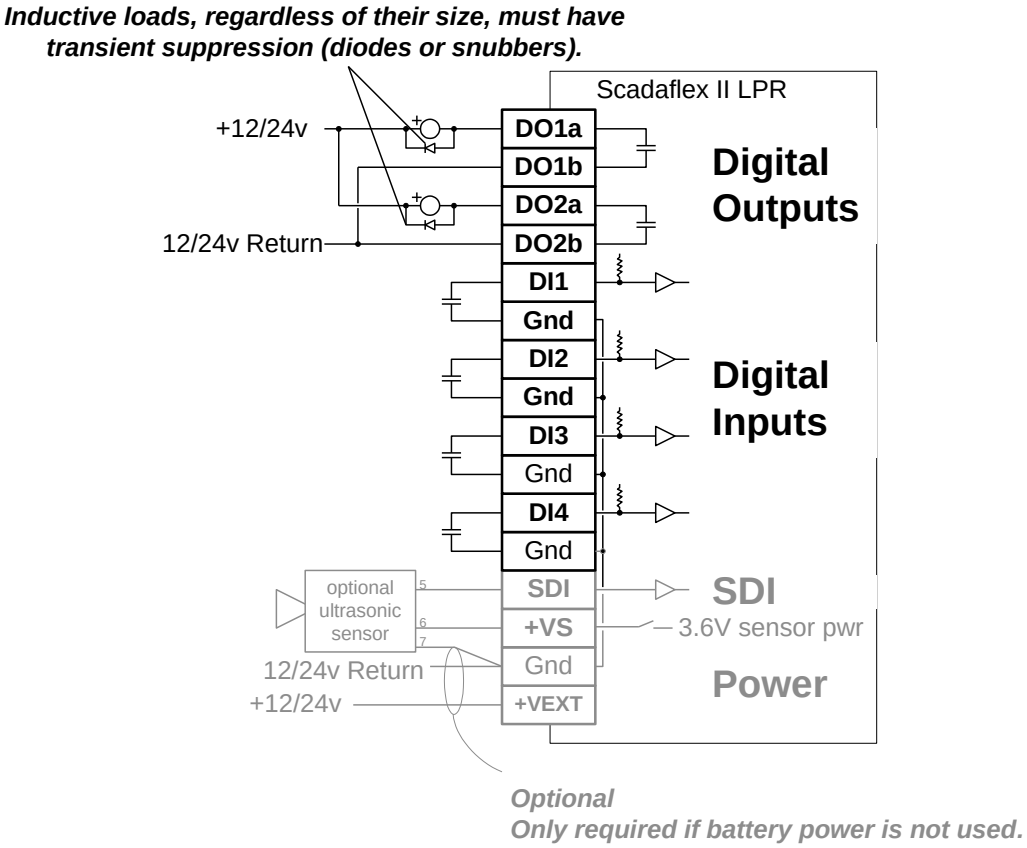


Self-powered sensors are similar to 3-wire devices except that they have their own internal power supply, typically isolated from the signal circuit.



LPR Wiring – Discrete Inputs and Outputs

LPR modules have four discrete inputs and two discrete (relay) outputs. The lower terminal block has the field connection points for these I/Os.

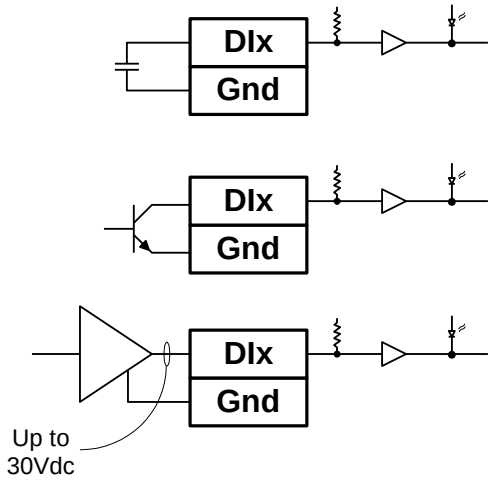


Discrete Inputs Wiring

The four discrete inputs support contact closures, "open collector" or "open drain" devices, or DC voltages up to 30Vdc. An ON is a closed contact to ground (Gnd) or an input voltage of less than 1Vdc. An OFF is an open contact or an input voltage greater than 2Vdc. Levels between 1Vdc and 2Vdc are not defined and should be avoided for reliable operation.

Typical sensor input configurations and how they connect to the Scadaflex LPR module are shown in the diagrams on the right.

Input devices must switch to ground or pull down below 1Vdc for an "ON condition, and switch high or pull up above 2Vdc for an "OFF" condition.



The last two inputs can totalize pulses and compute their input frequency such as required by flow meters. When only one pulse input is needed, DI4 provides for slightly lower power consumption.

LED status indicators are provided for each input. The indicators are automatically switched off to conserve power during battery operation but momentarily re-enabled by a single press of the "SETUP" pushbutton.

Discrete Outputs Wiring

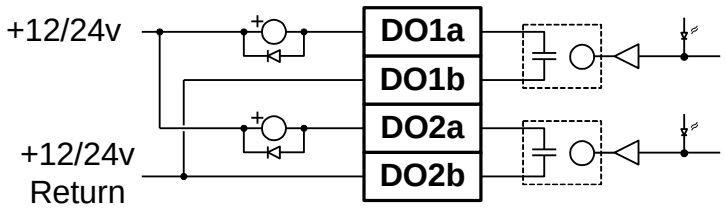
Two discrete outputs provide “dry” contact closures from latching relays. The latching nature of the relays is transparent to the user (they act like "normal" relay outputs) but provides for extremely low power operation since power is only required by the relay when switching states. The outputs can be turned ON or OFF, or pulsed ON for just 1 second, when activated. LED status indicators are provided for each output. The indicators are automatically switched off to conserve power during battery operation but momentarily re-enabled by a single press of the "SETUP" pushbutton.

Be careful when using the discrete outputs to control inductive devices such as relays, motor starters and solenoids of any size. All inductive load devices require the use of some type of surge suppression to protect the relay output contacts and minimize interference. Switching inductive loads without surge suppression can *significantly* reduce the lifetime of relay contacts and cause radiated electrical noise that can interfere with other electronic devices. By adding a suppression device directly across the coil of an inductive device, you will avoid these problems.

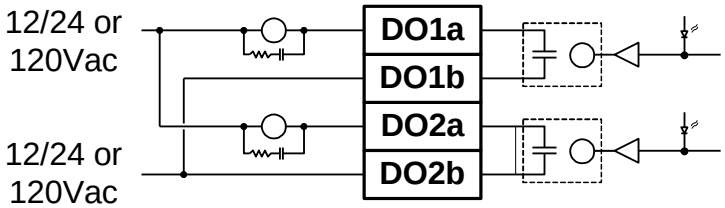
You must use suppression devices whenever the Scadaflex II LPR relays are switching even very small inductive loads such as relays and solenoids.

A diode is frequently used for snubbing DC loads, while a capacitive snubber is typically used for AC loads. Contact ICL technical support if you would like help with suppression implementation.

Example of driving DC inductive loads. Note the use of diode snubbers.



Example of driving AC inductive loads. Note the use of capacitor/resistor snubbers.



Ultrasonic Level Sensor option

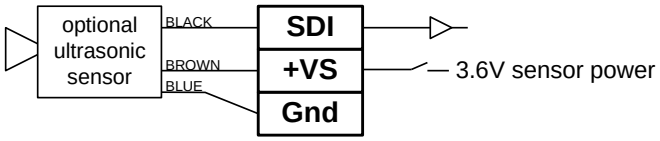
The LPR module supports a very low-power ultrasonic level sensor. The sensor can be ordered to mount "internally" on the bottom of the LPR module enclosure, or externally on a stainless steel bracket with a shielded UV resistant cable. The sensor is powered from the internal power of the module and switched on only when taking readings for ultra low-power operation.

Internal Ultrasonic Sensor Wiring

The internal ultrasonic level sensor option installs in the 3/4" conduit hole in the bottom of the enclosure. Since it uses the same hole that might otherwise be used for field wiring, this option may only be used if there are no other field devices to be used with the LPR module, and the module is only powered from its internal battery.

The sensor is supplied with pre-tinned color-coded "flying" leads labeled with the terminal names that they should be wired to:

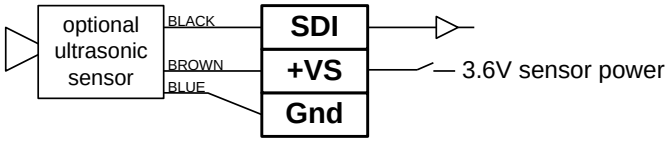
Internal Ultrasonic Sensor Wiring	
Color	***Signal***
Brown	*+VS (3.6V Sensor Power)*
Blue	*Ground*
Black	*Data (SDI)*



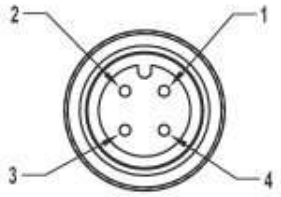
External Ultrasonic Level Sensor Wiring

The external ultrasonic level sensor option comes enclosed and mounted on a stainless steel bracket. The mount is designed for rapid installation on "uni-strut" channel using 1/4-20 screws and channel nuts (not supplied). The cables are shielded and UV resistant with an "M12" type female 4-pin sealed connector. They are available in 5M (16.4ft.) and 10M (32.8ft.) lengths, but longer runs of up to 30M (100ft.) are permissible. The sensors use 3 color-coded wires (the white 4th wire is not used), wired as shown below.

External (M12) Ultrasonic Sensor Wiring		
Pin	**Color**	**Signal**
1	**Brown**	+VS (3.6V Sensor Power)
2	**White**	not used
3	**Blue**	Ground
4	**Black**	Data (SDI)



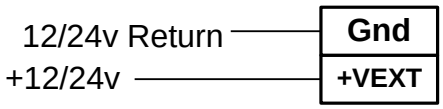
To avoid damage to the sensor and/or the LPR module, be very careful to ensure that the sensor is wired as shown.



KEY
1 = Brown
2 = White
3 = Blue
4 = Black

Wiring – External DC Power

The Scadaflex II LPR module can be powered from its internal battery or from an external DC power source. When using a DC power source, the battery can serve as backup power when the external power is lost. DC input power can range from 10Vdc to 30Vdc. Current draw at 12Vdc power under worst case conditions (radio transmitting) is less than 50mA and less than 5mA when quiescent.



LPR Hardware Configuration - General

The Scadaflex II LPR module has three sets of switches for basic configuration of the modules communications address, power and operation.

Address - The modules unique communications address is set with a pair of rotary DIP switches

Power - The power operating mode is set with a 3-position DIP switch

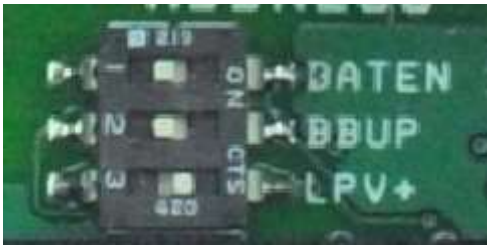
Setup - A small pushbutton switch is used to "link" an LPR module with a "Master" that is to control it as well as to momentarily turn on the discrete input and output LED status indicators under battery power.

Address Configuration

LPR modules must be set to any one of 256 unique addresses via a pair of rotary DIP switches in the upper right-hand corner of the module. Each switch can be set from 0 to F, so a complete 2-digit address can range from 00 to FF. Be sure that each remote module in the field has a unique address that does not conflict with any other module.

Power Configuration

An LPR module can be powered by an internal battery, external DC power or external DC power with battery backup. These three modes are selected by setting a sealed 3-position DIP switch (located just above the battery on the right-hand side) as follows:

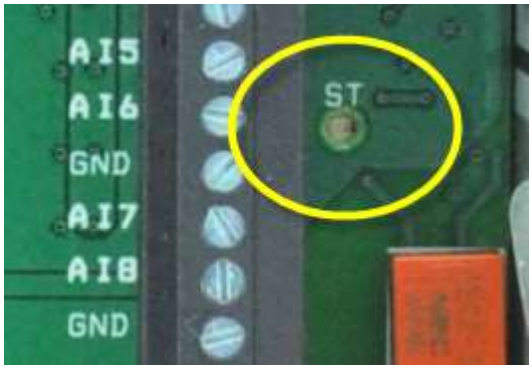


MODE	SWITCHES ON	
Battery Power Only	**BATEN**	Switch **1 ON** (only)
DC Power Only	**LPV+**	Switch **3 ON** (only)
DC Power w/Battery Backup	**BATEN and BBUP**	Switches **1** and **2 ON** (switch **3 OFF**)

Setup Switch

The Scadaflex II LPR module normally "sleeps" in order to conserve power. The setup pushbutton switch can be used to awaken the module so that it will attempt to communicate/synchronize with a master and turn on its LED status indicators at the same time.

Setup Switch Operation



Illuminate Status LEDs - Press the switch briefly

Sync to Master - Press the switch for a couple of seconds until the "ST" LED is lit. When the switch is released, the ST LED will blink every 1.5 seconds until the LPR module is successfully linked to a master. This operation is only required when the module is first put into service or the address of the module is changed. Note that if the ST LED light starts flickering rapidly after linking with a master, the master is updating the firmware in the LPR module and will start normal operation after it is finished in a couple of minutes.

Standard Remote I/O (RIO)

RIO remote I/O modules can add widely distributed I/O to Scadaflex II controllers utilizing either high-reliability meshing wireless networking or hardwired cabling. Up to 64 RIO modules can be controlled by a single Scadaflex II controller.

RIO modules are supplied complete and ready-to-run. They are packaged in polycarbonate enclosures. The wireless version is supplied with a weatherproof whip antenna. The modules require external DC power ranging from 10Vdc to 30Vdc.

Wireless RIO I/O modules include internal 900MHz spread spectrum radios (meshing or standard) that allow them to communicate up to a mile or more between sites with the supplied antennas (depending on elevation above grade and terrain), or further with higher performance antenna systems. Modules with meshing radios can automatically act as repeaters (no manual configuration is required) to extend the reach of a network of modules. The network is “self healing” so if one unit becomes unavailable as a repeater, the system will automatically try to establish another radio path. Modules with standard radios can be manually configured for store-and-forward repeater operation.

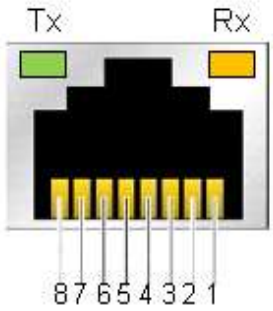
Wired RIO I/O modules use RS-485 Modbus RTU communications back to a master controller (typically a Scadaflex II). The cabling is standard Ethernet cables with RJ-45 connectors for quick low-cost connection between modules and back to the controller. Each RIO module has two RJ-45 connectors bussed together to make it easy to chain a network of RIO modules together.

RIO modules come with a mix of analog inputs, discrete inputs and discrete outputs. There are four analog inputs that are individually software configurable for 20mA, 5V, resistance measurements and temperature sensors. There are ten optically isolated discrete inputs, plus a high-speed discrete input that accepts contact closures or "open collector" signals that can totalize pulses up to 10KHz. There are ten relay outputs that provide “dry” contact closure signals.

RIO Communications Wiring - Wired RIO Modules

Wired RIO modules have an RS-485 serial port with two bussed RJ-45 modular jacks. The pin-out matches that of the serial port in the Scadaflex II controller. Standard Ethernet cables can be used to wire from the controller to the first RIO module and an Ethernet cable from the second jack can be used to wire to the next RIO Module. The communications cabling between hardwired RIO modules can continue to be "daisy chained" in this fashion.

If you are wiring the RIO module to other equipment, use pins 1 and 2 for the RS-485 data terminals, and pin 4 for ground (common)



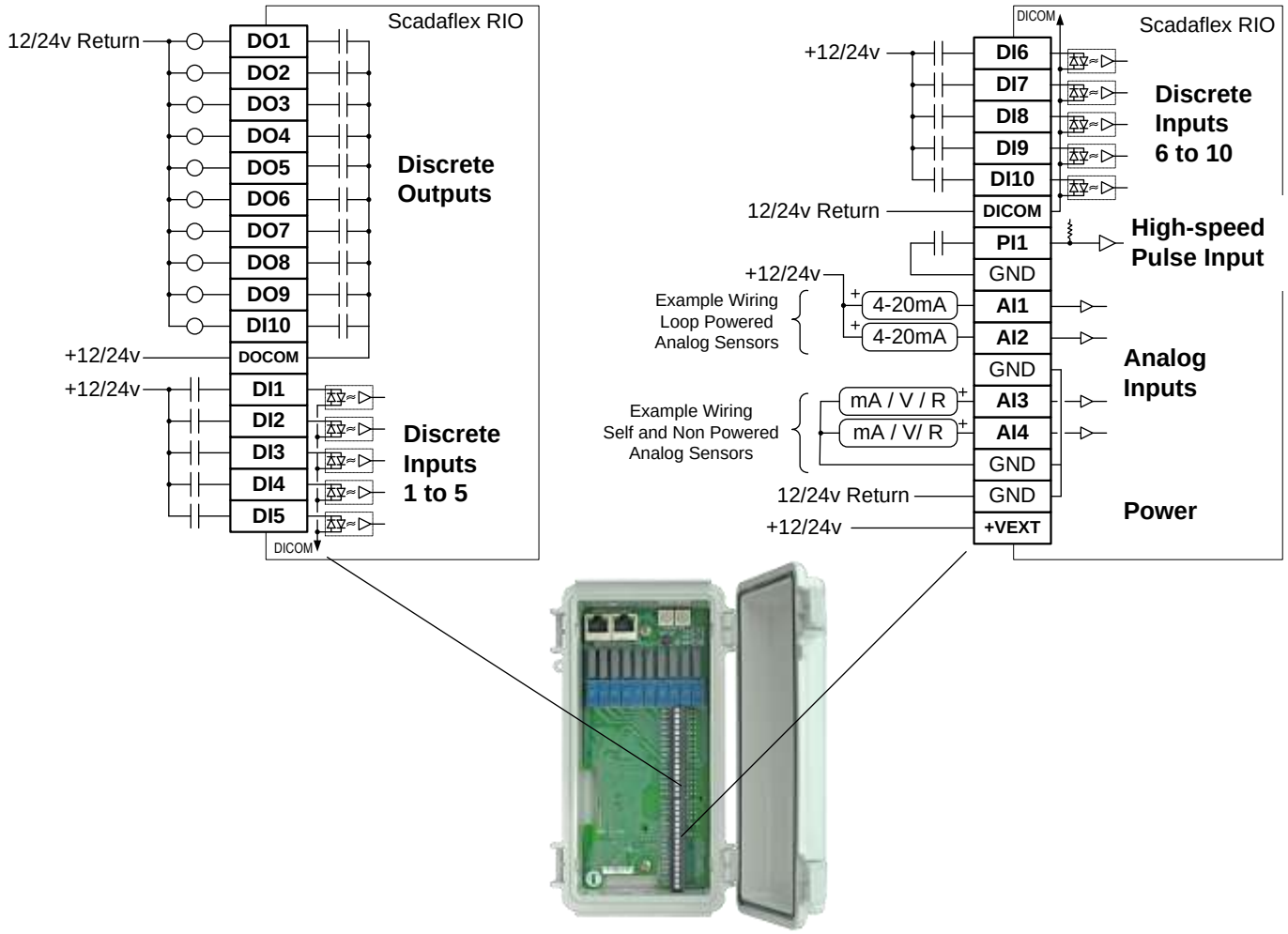
RJ-45 Pin#	RS-232/RS-485 Function	Wire Color
1	RS-485+	Orange/White
2	RS-485-	Orange
3	DTR Out (RTS inverted)	Green/White
4	Gnd	Blue
5	RS-232 Rx In	Blue/White
6	RS-232 Tx Out	Green
7	CTS In (not used)	Brown/White
8	RTS Out	Brown

RIO Wiring - General

Field wiring is brought into the LPR module through a 3/4" conduit entry at the bottom of the enclosure. There are two pluggable 16-position terminal blocks for termination of field wiring and power.

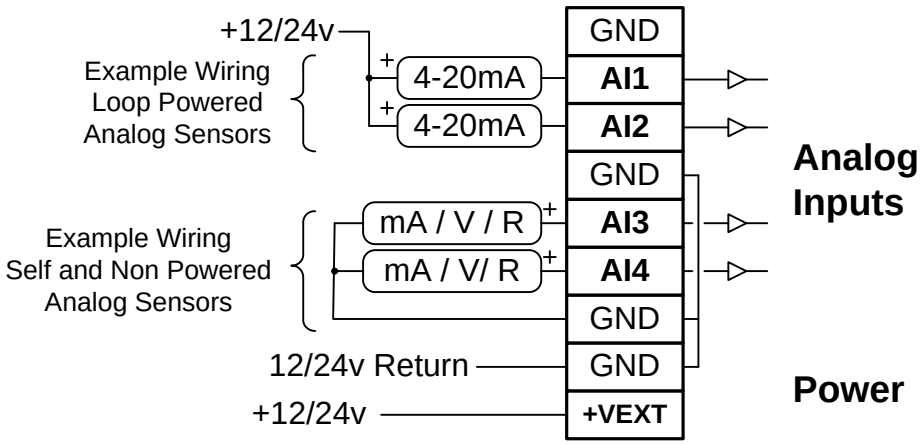
The LPR terminal blocks will accommodate wires sizes ranging from 28GA to 16GA. The recommended tightening torque is between 0.22Nm and 0.25Nm. Wires should have their insulation stripped back approximately 0.25” to 0.30”

The diagram below summarizes the field wiring to the RIO module. Detailed wiring information is provided on the pages following.



RIO Wiring – Analog Inputs

RIO modules have four analog inputs. They may be software configured to accept signals from 20mA, 5V, 65K ohm and thermistor temperature sensors. The diagram below shows how these are wired into the RIO field wiring terminal blocks.

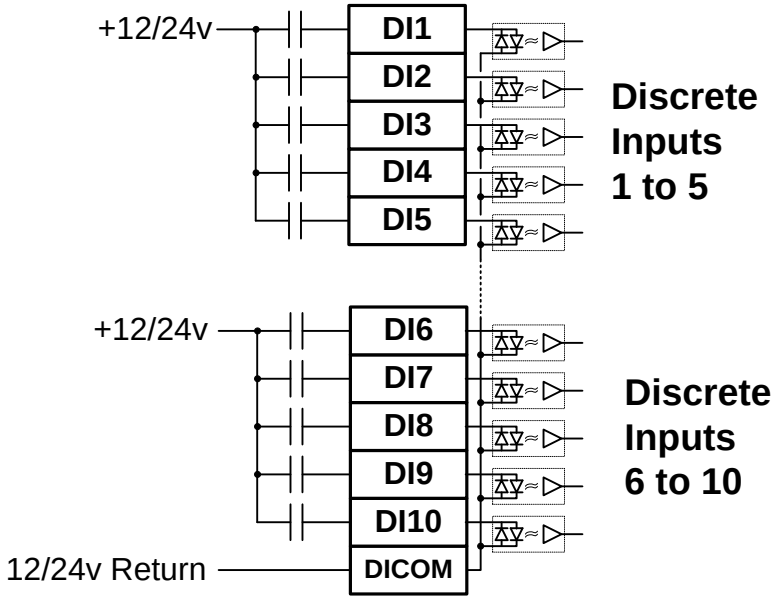


Note that loop powered mA sensors typically use the same power supply that powers the RIO module as the loop power supply. A separate loop power supply can be used as long as its common connection is tied to one of the GND terminals.

Self-powered 20mA sensors as well as voltage, resistance and thermistor sensors have one of their connections tied to a GND terminal while the others are wired into the analog inputs themselves.

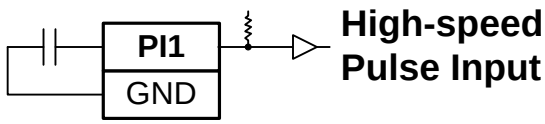
RIO Wiring – Optically Isolated Discrete Inputs

Ten optically isolated discrete inputs are split across the field wiring terminal blocks to support AC or DC input signals of either polarity. They can also be configured to support contact closures using the controller's power supply or external AC or DC power for "wetting" current. The discrete inputs have their own common that is isolated from the rest of the module. An ON is an input of 9V or more. An OFF is an input of 3V or less. Levels between 3V and 9V are not defined and should be avoided for reliable operation.



RIO Wiring – High-speed Pulse Input

RIO has a high-speed discrete input that supports signals from contact closures, "open collector" or "open drain" devices, and DC voltages up to 30Vdc. It can totalize pulses and be used to compute their input frequency (rate) as required by some flow meters. An ON is a closed contact to ground (Gnd) or an input voltage of less than 1Vdc. An OFF is an open contact or an input voltage greater than 2Vdc. Levels between 1Vdc and 2Vdc are not defined and should be avoided for reliable operation.

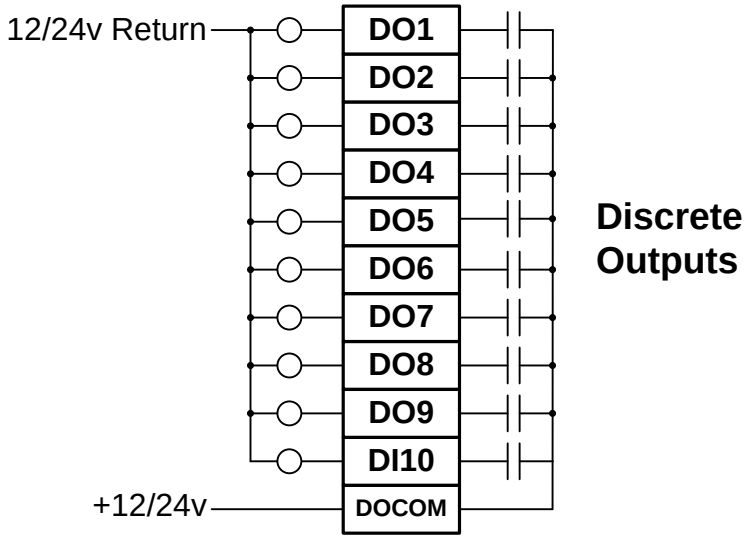


RIO Wiring – Discrete Outputs

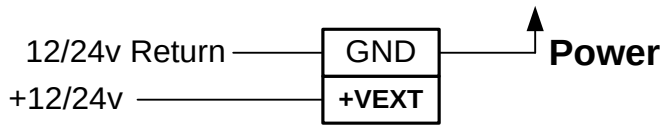
RIO modules have ten relay discrete outputs with shared isolated common. The outputs are capable of switching up to 3A loads (each), up to 30Vdc or 240 Vac.

The total current switched by all of the outputs together must not exceed 8 amps.

The outputs are designed to have one side of the loads connected to an external supply. The outputs switch the supply voltage to the loads, which have their other side tied to the other output of the external supply. The external supply can be the same one that powers the RIO module.



RIO modules can be powered from a DC power source ranging from 10Vdc to 30Vdc. Power is wired into the +VEXT and Ground terminals as shown below.



RIO Hardware Configuration

The RIO module has two sets of switches for basic configuration of the modules communications address and operation. It also has a green ST (Status) LED to indicate the modules current (operating) and communications link status.

Address - The modules unique communications address is set with a pair of rotary DIP switches

Setup - A small pushbutton switch is used to "link" a RIO module with a master that is to control it.

Status (ST) LED - In a wireless RIO module, the Status LED is located just to the right of the Setup Switch. In a wired RIO module, the Status LED is located just to the left of the address switches.

Address Switches

RIO modules must be set to any one of 256 unique addresses via a pair of rotary DIP switches in the upper right-hand corner of the module. Each switch can be set from 0 to F, so a complete 2-digit address can range from 00 to FF (hex). Be sure that each remote module in the field has a unique address that does not conflict with any other module.

Setup Switch and Status LED

In Wireless RIO modules, the Setup Switch is used to cause the module to link up with the Master over the wireless link. The Status (ST) LED provides a visual indication of the attempting and success of linkage with the Master.

In Wired RIO modules, the Setup Switch is used to query, and optionally set, the current communications baud rate of the module. The Status LED is used to indicate the current communications baud rate when queried or set, and running status / communications failure during normal operation.

Setup Switch and ST (Status) LED - Wireless RIO Modules

When the RIO module is first powered ON, it will attempt to link up and start talking with a master configured for its network address. The setup button can also be used to initiate a master connection. When the module is attempting to link up, the Status LED will flash. When successfully linked to a master the LED indicator turns on solid.

Each time that the master talks to the RIO module, it confirms the version of firmware running in the module. If a newer version becomes available, the master will automatically download it to the module. The status light will flicker rapidly when this is happening.

Setup Switch and ST (Status) LED - Wired RIO Modules

When the RIO module is first powered ON, the ST (Status) LED will flash between 1 and 4 times indicating the communications baud rate configuration. The flashes correspond to the following baud rate setting:

1 - 9600 baud
2 - 19.2K baud
3 - 38.4K baud
4 - 115K baud

At any time that the module is operating, the current operating baud rate can be determined by briefly (<200 mS) pressing the Setup Switch. The buad rate can be changed with long presses (>500mS) of the Setup Switch. Each time the switch is released, the Status LED will rapidly flash from 1 to 4 times to indicate the new baud rate setting.

During normal operation, the Status LED will flash at a slow even rate. If no messages are received by the module for a preset time period (5 seconds by default), the module will indicate a communications failure by rapidly flashing the Status LED.

Operation

RIO modules are low-power devices that accept external DC power from 10 to 30Vdc.

The wireless version is network compatible with LPR I/O modules, the mesh radio option in Scadaflex II controllers, and Modulus Mesh Communications modules.

The wired version is compatible with any device capable of being master of a Modbus RTU RS-485 network.

Operation - Wireless RIO Modules

Wireless RIO modules are configured by filling in information on web pages in a master Scadaflex II controller (SC-1 or SC-2) or Modulus Mesh Communications module that controls them. The master updates the configuration information in the RIO remote modules each time that it communicates with them. The only configuration performed at the remote module is the network address setting. All scaling and mapping of I/O is done in the master. If the RIO module is replaced in the field, its configuration is automatically updated when it talks to the master. The master also ensures that every remote module always has the latest firmware. If new firmware is downloaded to the master, it automatically updates all of the RIO remote I/O modules “over-the-air”. Calibration is also done “over-the-air” using a built-in maintenance web page. Module calibration information is kept in the remote modules themselves so that they can be easily and quickly swapped in the field without readjustment.

Operation - Wired RIO Modules

Wired RIO modules operate as conventional Modbus RTU devices. Other than address and baud rate, they are configured by setting values in pre-defined Modbus registers. By default, the analog inputs are configured for 20mA operation.

A list of the most commonly accessed registers are shown on the next page. For a complete list, please contact ICL Technical support.

Status Registers (R)		Coil Registers (R/W)		Input Registers (R)		Holding Registers (R/W)	
Address	Tag	Address	Tag	Address	Tag	Address	Tag
10001	DI1	00001	DO1	30001	UI1 (Analog Input)	30001	
10002	DI2	00002	DO2	30002	UI2 (Analog Input)	30002	
10003	DI3	00003	DO3	30003	UI3 (Analog Input)	30003	
10004	DI4	00004	DO4	30004	UI4 (Analog Input)	30004	
10005	DI5	00005	DO5	30005		30005	
10006	DI6	00006	DO6	30006		30006	
10007	DI7	00007	DO7	30007		30007	
10008	DI8	00008	DO8	30008		30008	
10009	DI9	00009	DO9	30009	Packed Dis	30009	Packed DOs
10010	DI10	00010	DO10	30010		30010	
10011	PI1			30011	PI Interval (mS)- LSB	30011	PI Totalizer - LSB
				30012	PI Interval (mS)- MSB	30012	PI Totalizer - MSB
				30013	PI Rate	30013	Cfg Protect
						30014	UI1 Mode*
						30015	UI2 Mode*
						30016	UI3 Mode*
						30017	UI4 Mode*

* UI Modes: (0=mA, 1=V, 2=mV, 3=R) Can only be changed if Cfg Protect Register is set to 12345

AC Power Supply

Scadaflex II controllers and I/O modules require DC power ranging from 10Vdc to 30Vdc. When DC power is not readily available from other equipment, a Scadaflex II AC Power Supply can be used. The power supply accepts either 110V or 220V AC power and provides regulated 24DC power on its output.

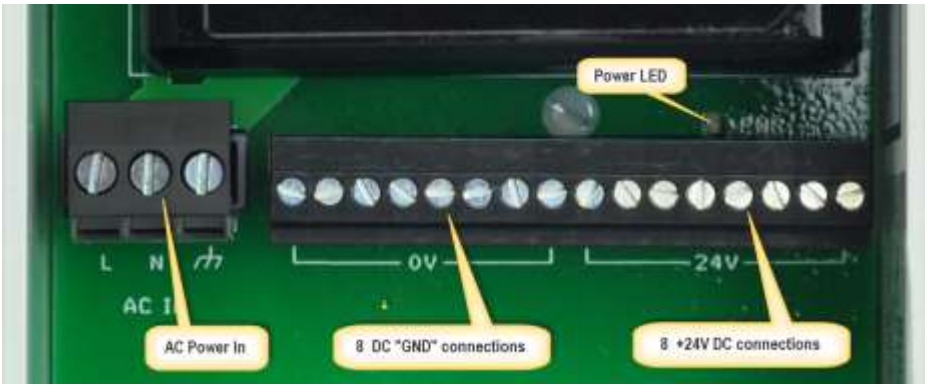
The Scadaflex II Power Supply is packaged in a polycarbonte enclosure identical to the Scadaflex II controllers and I/O modules. It provides a set of teminals to distribute DC power to controllers, I/O modules, and field devices. It also provides a convenience service outlet to power test equipment.

A standard 5mm 10A "slo-blo" user replacable fuse (within the green fuse holder) protects the outlet from overloads. A separate fuse that protects the power supply itself is not user replacable. Note that the power supply has electronic overload protection against short circuits across its DC output.

The service outlet is not GFI protected. The AC power source to the power supply must have GFI protection if there is the potential that the power supply will be used in a damp environment. This will apply to most all outdoor installations, as well as indoors such as in pumping stations.

The power supply terminal blocks will accommodate wires sizes ranging from 28GA to 16GA. The recommended tightening torque is between 0.22Nm and 0.25Nm. Wires should have their insulation stripped back approximately 0.25” to 0.30”

The power supply terminals are wired to as shown in the annotated picture on the right. AC power is brought into the 3 larger terminals on the left (the earth ground terminal provides a safety ground connection for the service outlet).



The "0V" terminals connect to the "GND" terminal on each controller and I/O module. It is recommended that you run a separate 0V ground wire to each piece of equipment ("star configuration") instead of "daisy chaining" from one piece of equipment to the other. The 24V terminals are the (+) power connection to each device. It can also be used to supply loop and device power for sensors.

Controller and Remote I/O - Software Configuration

Web Page Access

Scadaflex II controllers are configured via built-in web pages using standard web browsers such as Internet Explorer, Firefox, Chrome, and Safari. No separate applications are needed or installed. You can use nearly nearly any PC, Apple or Android computing device, including smart phones and tablets.

Besides the configuration web pages, the controllers also have “user” web pages (blue background) for basic interaction during operation but not setting how the controller functions. The controller automatically “morphs” the user web pages based on the controller’s configuration settings. For example, if historical trending is enabled, buttons and web pages for displaying trends are automatically shown.

To start software configuration of the controller hardware, set your browser to access the controllers IP address (factory default IP address is **192.168.237.199**). Make sure that your computer is on a compatible subnet if you are not going through a router.

If your controller has the LOCAL HMI option installed, the IP address shows up on the screen at power-up or after the ESC key is held pressed and then released.

The controller’s User Home Page with a blue background will be shown (similar to the screen capture below). As more features are enabled, the number of selection buttons down the left hand side will grow to provide user access to these features. You will also be able to specify other alternative startup screens such as a custom full graphical interface.

Click on the **CONFIGURATION** button.

The controllers Configuration web pages will be displayed (yellow background). Note that the configuration web pages can be secured as part of the controller’s username/password security scheme. This can be enabled as a selection on the configuration pages.

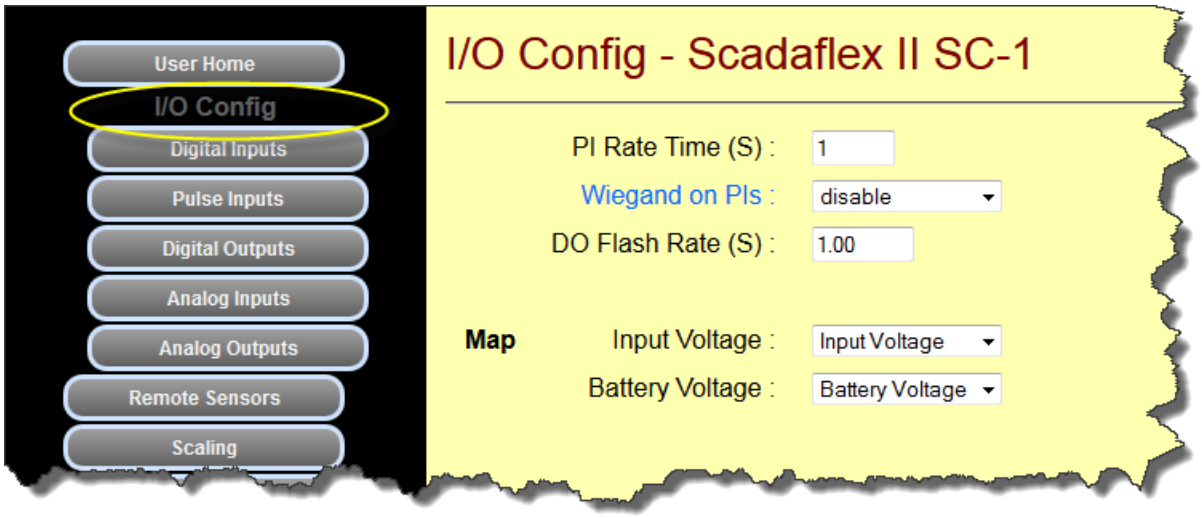
Some configuration information related to the Scadaflex hardware maintenance is contained in the following pages of the next section. For additional detailed information on configuration of the Scadaflex II controller functions, please refer to the *Scadaflex II Configuration Manual*.

Controller Software Configuration

Local I/O Configuration - General

The local input and output points built into Scadaflex II controllers are configured using web pages in the **CONFIGURATION | I/O CONFIG** section.

On the main page shown below, there are several configuration items common to all I/O, not one particular I/O point.



PI Rate Time

The two pulse inputs in the Scadaflex II Controller can measure the incoming pulse rate by counting the number of pulses that occur over the time period specified here. For example, if left at the factory default setting of 1 second the reading represents pulses per second. Changing this parameter to 60 would result in a reading of the number of pulses per minute. The PI Rate Time is also the rate at which the reading is updated.

Wiegand on PIs

Weigand is a two wire data interface that has been used for years by the security and access control industry. The two pulse inputs may be used with Wiegand compatible card readers and keypads by enabling this mode. When enabled, a number encoded in the Weigand standard format will be decoded and placed into the registers mapped in the pulse inputs configuration section. Typical applications include door access control and recording of facility security checks by patrol personnel.

DO Flash Rate

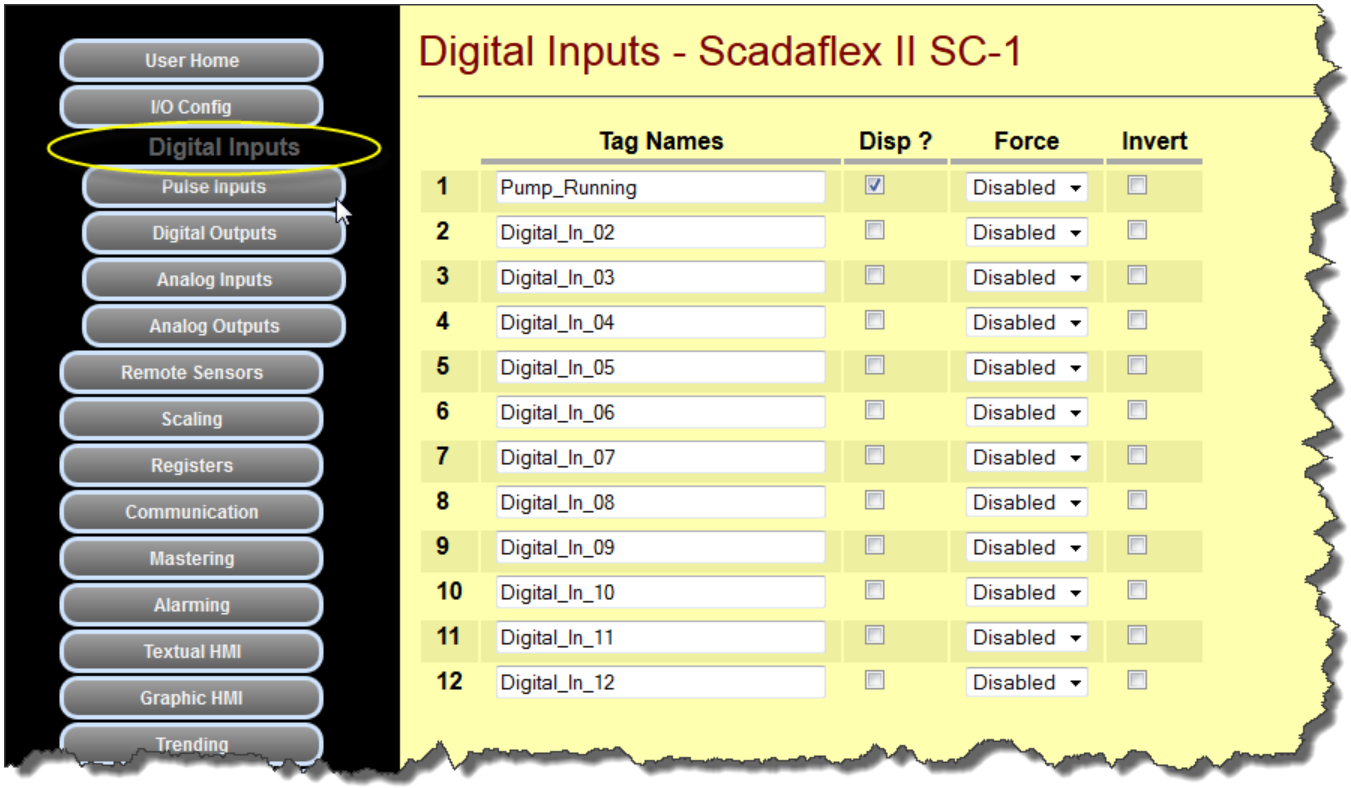
The individual discrete outputs may be configured to flash synchronously with each other. This parameter sets the speed at which they will flash. This is typically used with visual and audible alarm indicators.

Map

Internal voltage measurements of Input Voltage (power) and Battery Voltage (if the battery backup option is installed) can be “mapped” to any of the Integer (“I”) registers for communications, programmable logic and display with an HMI.

Discrete Inputs Configuration

Scadaflex II controllers have 12 optically isolated discrete inputs. Each input can be assigned a Tag Name, forced to a value (over-ride the actual input level), inverted, and marked to be included in the response to a text message or e-mail "?" command.



Tag Names

Every digital input can be named with a user friendly name of up to 23 characters. The names can include any upper and lower case alphanumeric characters, numbers and underscores.

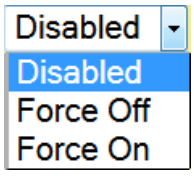
Do not use punctuation characters other than underscores ("_") in a tag name. Do not use a number as the first character or any spaces if the digital input is to be used in the programming section or if it is to be used in text message and e-mail commands.

Disp ?

Check this box for every digital input that is to be displayed in a text message or e-mail response to a "?" command.

Force

Over-rides the actual state of the physical input for testing and temporary maintenance purposes.

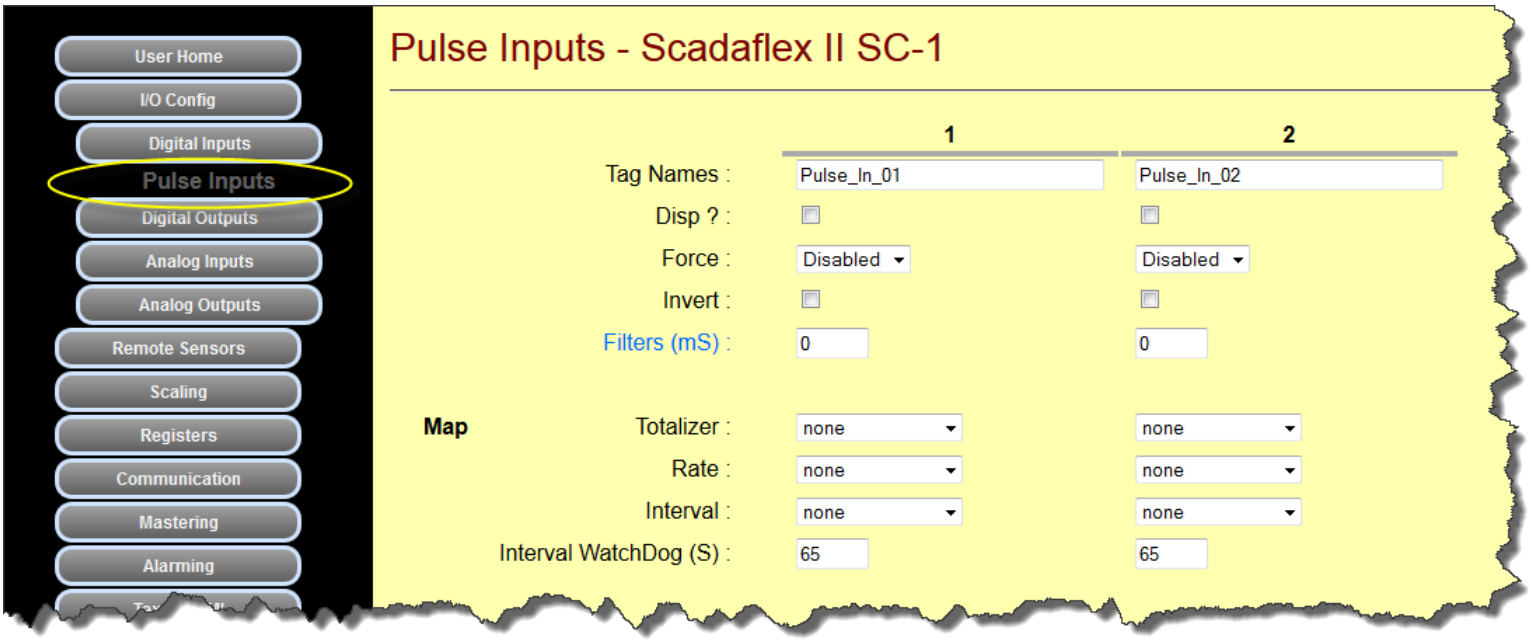


Invert

Inverts the logical state of the digital input.

Pulse Inputs Configuration

Scadaflex II controllers have two high-speed pulse inputs that can also be used as simple “contact closure” discrete inputs. These inputs have the same functions and configuration items as the discrete inputs but also have programmable filtering, built-in hardware Totalizers, Rate and Interval measurement.



Tag Names

Every pulse input can be named with a user friendly Tag Name of up to 23 characters. The names can include any upper and lower case alphanumeric characters, numbers and underscores.

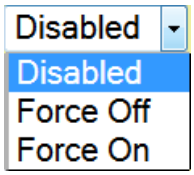
Do not use punctuation characters other than underscores (“_”) in a tag name. Do not use a number as the first character or any spaces if the digital input is to be used in the programming section or if it is to be used in text message and e-mail commands.

Disp ?

Check this box for every pulse input that is to be displayed in a text message or e-mail response to a “?” command.

Force

Over-rides the actual state of the physical input for testing and temporary maintenance purposes.



Invert

Inverts the logical state of the pulse input.

Filter (mS)

The pulse inputs are very fast (> 10KHz), so they can be more susceptible to noise and contact bounce. To mitigate this, a digital filter value may be set for each input individually. For example, if a pulse input is being used with a mechanical contact closure device, a filter of 30mS to 50mS will filter out contact bounce.

Map

Mapping links a measurement value to a register that has been configured in the **CONFIGURATION | REGISTERS** section. Using a 10-digit format (such as ##########) as a "Scale" selection links two 16-bit integer registers together to form a 32-bit register (such as for totalizers). Check the “Retain” box if you want the register to be non-volatile. To make the register show up in a selection list for mapping or for use by the programming or Web User Interface section, check the “Visible” box.

Map - Totalizer

Each pulse input has a hardware totalizer that can be mapped to an integer register. Typically this register is configured as a 32-bit non-volatile register (maximum value of 4,294,836,225 counts instead of 65,535 for a 16-bit register).

Map - Rate

Each pulse input has a hardware rate measurement capability that can be mapped to an integer register. Rate is measured by counting the number of pulses that occur in the measurement period specified on the main **CONFIGURATION | I/O CONFIG** page. The factory default rate period is 1 second.

Map - Interval

Each pulse input has a hardware interval measurement capability that can be mapped to an integer register (usually 32-bit). Interval is measured by counting the number of milliseconds from leading edge to leading edge of two successive pulses. Interval measurement is an effective way to measure and calculate the rate of very slow pulse rates such as from larger municipal flow meters. The update rate and resolution will be much better than the conventional rate technique (counting the number of pulses in a measurement period) for pulse rates slower than around 10 pulses per second.

To convert interval to frequency, use the following formula in the Programming Section:

Frequency (x .000001 Hz) = 1,000,000,000 / Interval(mS) ‘Frequency is calculated to 0.000001 Hertz

For example, an interval measurement from a large flow meter of 10,000 (mS) is calculated as:

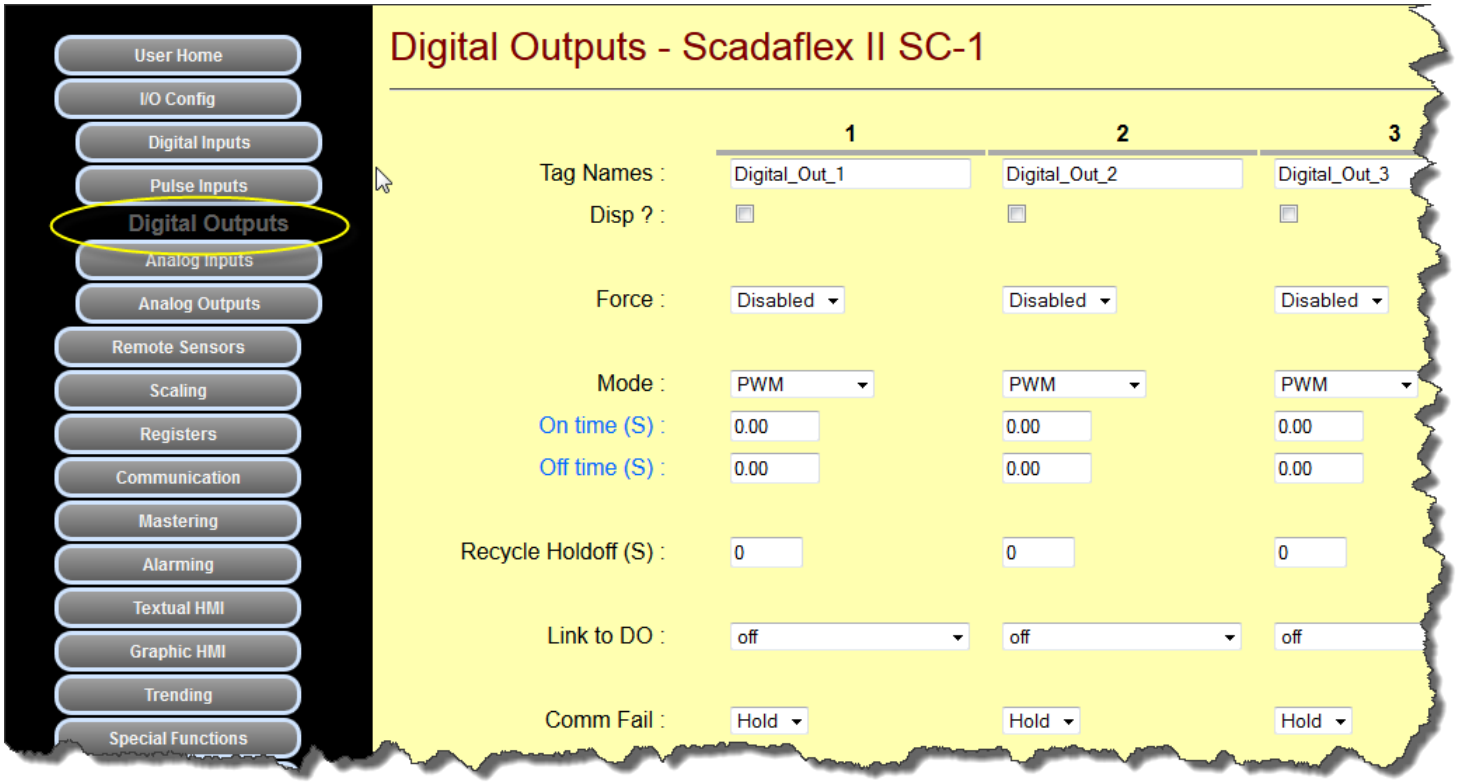
1,000,000,000 / 10,000 = 100,000

With a decimal place of 6 positions set in the scaling selection reads as **0.100000 Hz**

You can use further scaling to convert this frequency to flow rate using the meters K factor in the programming section.

Discrete Outputs Configuration

Scadaflex II controllers have 4 discrete outputs. Each output can be assigned a Tag Name, forced to a value (over-ride the actual output level), inverted, and marked to be included in the response to a text message or e-mail "?" command. Each output can also be assigned a unique attribute to flash (synchronized 50% duty cycle), PWM (programmable duty cycle pulse), toggle (flip-flop) and one-shot pulse, as well as specify its state when a communications failure occurs.



Tag Names

Every digital output can be named with a user friendly name of up to 23 characters. The names can include any upper and lower case alphanumeric characters, numbers and underscores.

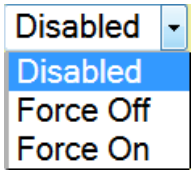
Do not use punctuation characters other than underscores ("_") in a tag name. Do not use a number as the first character or any spaces if the digital input is to be used in the programming section or if it is to be used in text message and e-mail commands.

Disp ?

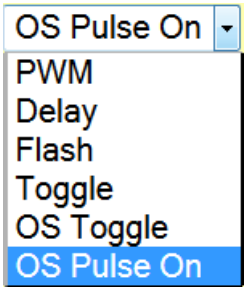
Check this box for every digital output that is to be displayed in a text message or e-mail response to a "?" command.

Force

Over-rides the state of the physical output for testing and temporary maintenance purposes.



Mode



Sets the operating Mode of a digital output to flash (synchronized 50% duty cycle), PWM (programmable duty cycle pulse), toggle (flip-flop) and one-shot toggle or pulse when the output is activated.

PWM Mode The output turns ON and OFF based on the "ON Time" and "OFF Time" values below the mode setting.

Delay Mode The output turns ON after a delay set by the "ON Time" value below the mode setting.

Flash Mode The output turns ON and OFF at the rate specified by the "DO Flash Rate" time on the main **CONFIGURATION | I/O CONFIG** page

Toggle Mode The output changes state each time the output is written to.

OS Pulse ON One-shot Pulse mode - The output turns ON based on the "ON Time" and then resets back to OFF each time the output is written to. This mode is ideal to reset remote equipment by SCADA command.

Recycle Holdoff

This function prevents an output from turning ON immediately after being turned OFF (rapid cycling). This function can be used to protect large pumps and motors. When this parameter is set to a non-zero value, the output will be held off from turning ON for the specified time period in seconds after it has been turned off. This protection is also in effect just after a power failure so that pumps will not slam ON after a power glitch.

Link to DO

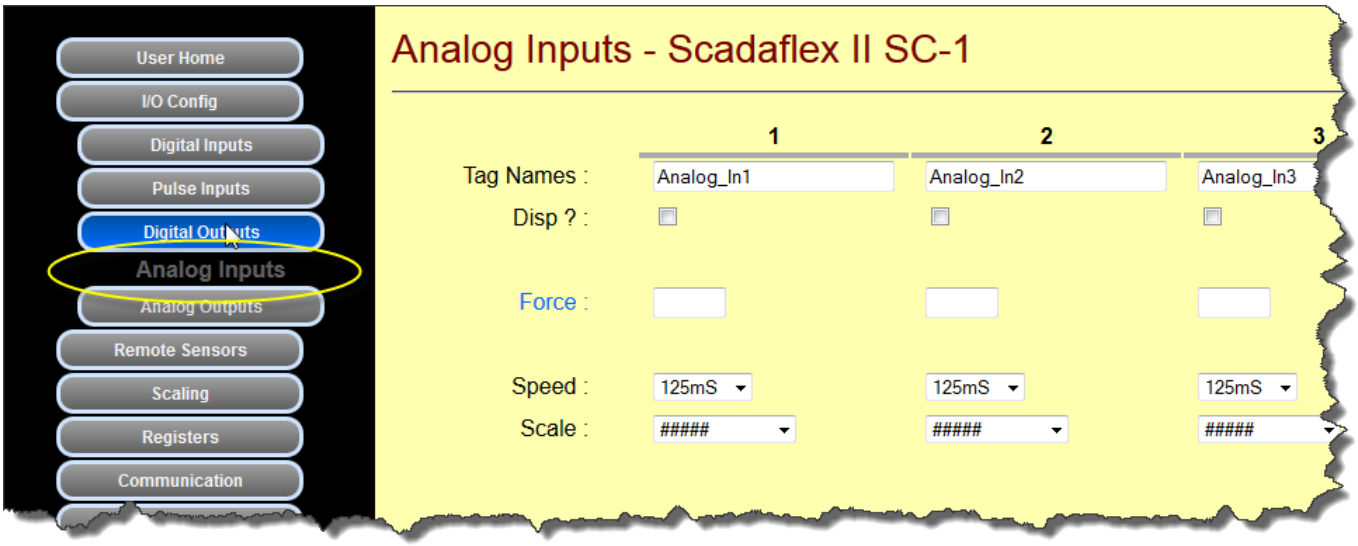
This function lets a Bit register or control function output (like PID) to be linked to a physical digital output.

Comm Fail

This setting determines how a digital output should react to a communications failure. The output can be set to either HOLD the last state, or turn OFF or ON. The MODE setting can be used in conjunction with the COMM FAIL setting. For example, if the COMM FAIL setting is set to "ON" and the MODE setting is set to "FLASH", the digital output can be used to flash a light or horn when there is a communications failure.

Analog Inputs Configuration

Scadaflex II controllers have 4 analog inputs. Each input can be assigned a Tag Name and forced to a value (over-ride the actual input level). Each input can also have its own conversion speed to balance between update rate and suppression of noise, etc.



Tag Names

Every analog input can be named with a user friendly name of up to 23 characters. The names can include any upper and lower case alphanumeric characters, numbers and underscores.

Do not use punctuation characters other than underscores ("_") in a tag name. Do not use a number as the first character or any spaces if the digital input is to be used in the programming section or if it is to be used in text message and e-mail commands.

Disp ?

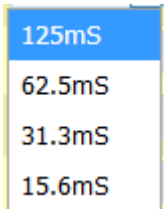
Check this box for analog inputs to be displayed in a text message or e-mail response to a "?" command.

Force

Over-rides the actual reading of the analog input for testing and temporary maintenance purposes. If blank, forcing is disabled. To force an input to a specific level, set the value in micro amps (uA) from 0 and 20000 (0mA to 20mA)

Speed

Sets the rate at which analog conversions are performed, from 8 (125mS) to over 64 (15.6mS) times per second. If high-speed is required, set this parameter to a lower value. For better noise rejection when speed is not critical set this parameter to a higher value.

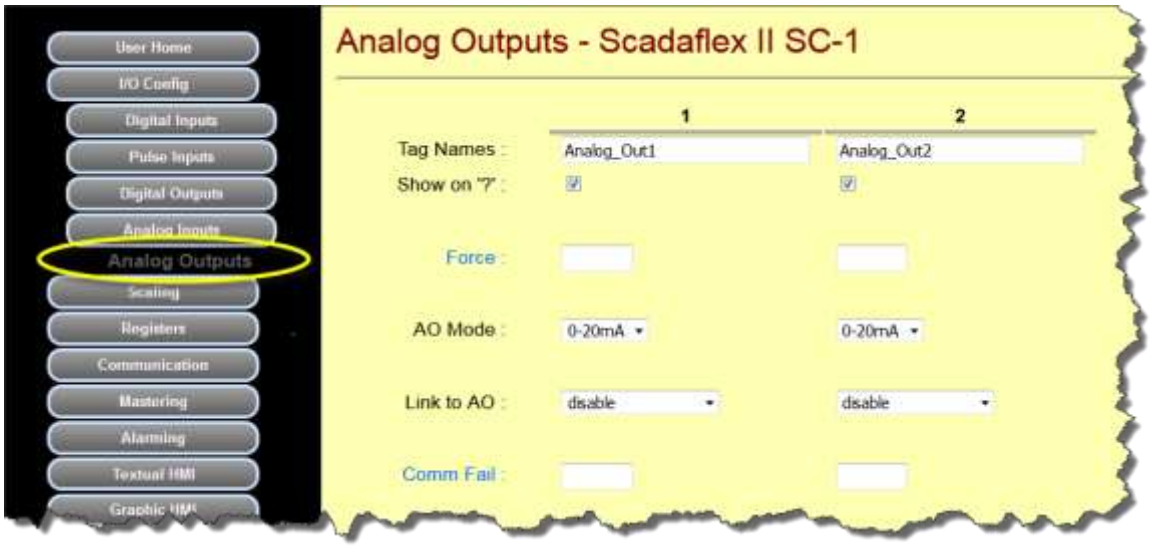


Scale

This parameter selects a formatting or scaling to be applied to the raw analog reading. Without scaling, the analog readings read in micro amps, or 0 to 20,000 for 0mA to 20mA.

Analog Outputs Configuration

Scadaflex II controllers have two 20mA analog outputs. Each output can be assigned a Tag Name, forced to a value (over-ride the output level), and marked to be included in the response to a text message or e-mail "?" command. The output level of each output can be preset for when a communications failure occurs.



Tag Names

Every analog output can be named with a user friendly name of up to 23 characters. The names can include any upper and lower case alphanumeric characters, numbers and underscores.

Do not use punctuation characters other than underscores ("_") in a tag name. Do not use a number as the first character or any spaces if the digital input is to be used in the programming section or if it is to be used in text message and e-mail commands.

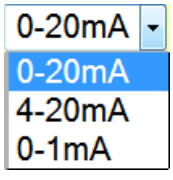
Disp ?

Check this box for analog outputs to be displayed in a text message or e-mail response to a "?" command.

Force

Over-rides the "normal" analog output value for testing and temporary maintenance purposes. If blank, forcing is disabled. To force an output to a specific level set the value from 0 and 20000 (0mA to 20mA).

AO Mode



Sets the full scale range of an analog output; 0 to 20mA, 4 to 20mA, or 0 to 1mA.

Link to AO

This function lets an Integer register or control function output (like PID) to be linked to a physical analog output.

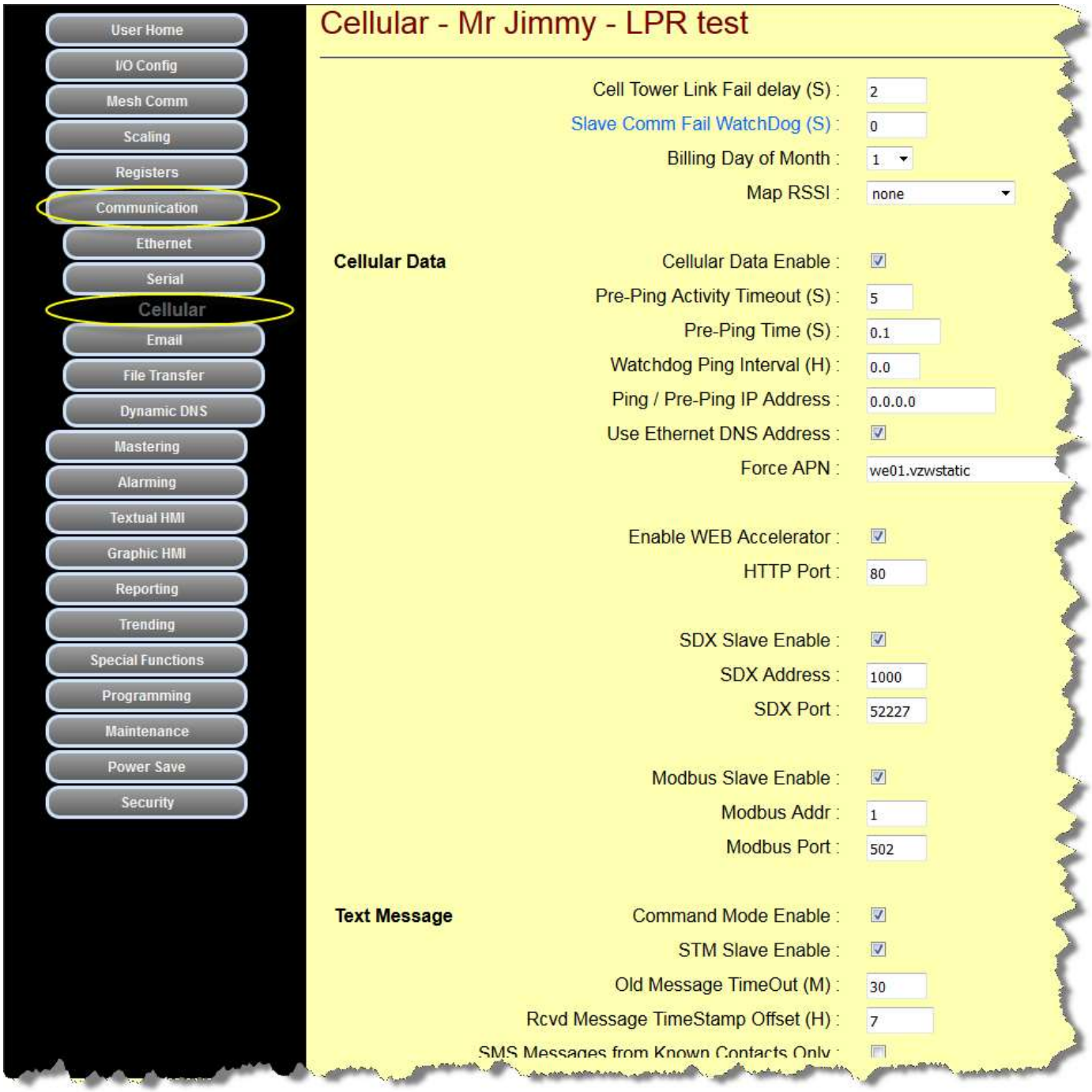
Comm Fail

This setting determines how an analog output should react to a communications failure. The output can be set to either HOLD the last value (blank) or go to a specified value in micro amps (uA) from 0 to 20000 for 0mA to 20mA.

Cellular Option – Software Configuration

The functionality of data and text message operation for the Cellular Option is configured in the Cellular portion of the Communications section under Configuration.

Go to: **CONFIGURATION | COMMUNICATIONS |CELLULAR**



The items at the top of the page are common to both data and text message operation.

Cell Tower Link Fail Delay (S)

This setting delays the link status failure indication. It is primarily used to prevent false alarms since in some areas, it is normal to have occasional drop outs in the link with the tower.

Slave Comm Fail Watchdog (S)

Set this to a non-zero value to detect if a remote communications master has stopped sending register access messages (via cellular). The resulting status bit can be used to log and/or alarm if it occurs.

Billing Day of Month

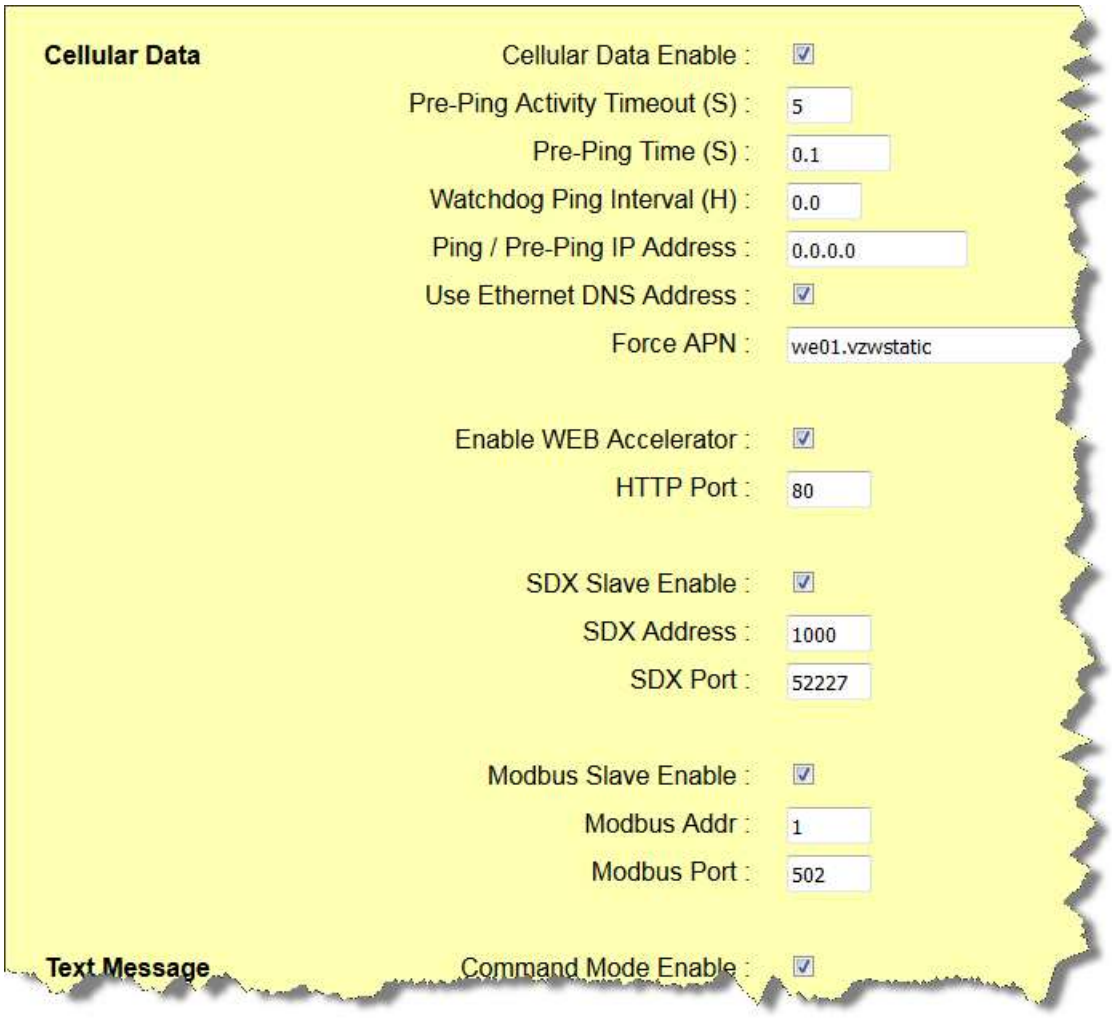
The Scadaflex II controller keeps track of the number of bytes and text messages sent and received within the current and previous billing cycle. Set this value to configure when your billing cycle starts every month to align the collected counts with your bill from the carrier.

Map RSSI

The Receive Signal Strength from the cell tower can be "mapped" to a numeric register for display, trending and alarming purposes. Be sure to set the format to a signed value since the signal strength is always a negative value in dB.

Cellular Option – Data Mode Configuration

The Cellular Data section controls whether data mode operation is enabled, provides a watchdog mechanism to ensure that an Internet connection is maintained, has settings to improve cellular communications success percentages, and protocol controls for security.



Cellular Data Enable

Check or uncheck this box to enable or disable data operation via the internal cellular modem. When data operation is disabled, the controller is effectively "disconnected" from the Internet (via cellular) for maximum security. Cellular data support can be enabled and disabled by a text message command so when data access for web pages is required, data mode can be turned on for just the time required to work on the unit remotely. It can then turned off again for maximum security. If cellular data operation is disabled, but the controller needs to send a message out on the Internet via cellular (such as report-by-exception operation), the controller will momentarily enable data mode on its own, link up with the tower, complete the transaction, then turn data mode back off again.

The cellular data mode makes the controller accessible to the Internet. There are significant security concerns associated with such access. Most people limit what actions can be taken through the HMI interfaces and enable the security controls (**CONFIGURATION | SECURITY**) to reduce their risk. You may also want to consider arranging for a private network (with VPN access) through your cellular carrier.

Unless you have an "unlimited data plan", every byte that is received or transmitted by the controller is a byte that you pay for, including spam, web crawlers, etc. Consider arranging for a private network (with VPN access) through your cellular carrier to avoid this.

Pre-ping Time and Activity Timeout

Some cellular networks (such as Verizon) will frequently drop the first packet of a data message if there has been no data traffic for a while. Even though the controller will time out and retry the message, this wastes data and causes delays. To avoid this, the controller will send out a very short "pre-ping" message ahead of the "real" message (as set by the Pre-ping Time) if there has been no data message traffic for the period of time set by the Pre-ping Activity Timeout. Recommended starting settings for these values are 2 seconds for the Pre-ping Time and 5 seconds for the Pre-ping Activity Timeout.

Watchdog Ping Interval

To ensure that the controller has a link to the Internet (via cellular), the controller can be set to periodically send out a ping message to test the link. If the test fails, the controller will reset the cellular modem and re-establish the connection to the tower.

Ping/Pre-ping IP Address

This sets the IP address to be used for the pre-ping and ping watchdog functions. Choose an address that should always be available such as Google at IP address 8.8.8.8

Use Ethernet DNS address

Check this box if are using names instead of IP addresses (such as for e-mail) and you want to use the DNS server configured in the Communications | Ethernet section.

Force APN

The Access Point Name (APN) is a setting that must match the account with your cellular carrier. It is normally set when the controller is first installed, but can also be altered by the carrier from the cellular.

Occasionally, the APN can get accidently (?) changed, usually from a static IP machine-to-machine account to a consumer account APN. By entering the correct APN here, the controller will re-establish the correct APN whenever it is reset.

Enable Web Accelerator

ICL provides a server "in the cloud" that can offload some of the task of file downloads required for web access to the controller. This can sometimes improve web page access speeds as well as reduce the amount of data charged to your cellular plan. **It is recommended that you enable this feature unless you are on a private cellular network that restricts access to the public Internet.**

HTTP Port

The cellular IP port normally used for serving web pages is port 80. This can be changed here if desired.

SDX Slave Enable

Checking this box enables the controller to respond to SDX data commands and requests via the cellular interface. Since SDX is a secure protocol (with AES-128 encryption), it is generally OK to leave this enabled if you have customized the encryption key, but if the key in your controller becomes known to someone on the "outside", you will have a security hole that allows access to most all settings.

Whenever SDX Slave protocol access is enabled, we recommend setting the SDX encryption key to a unique value for the customer. This is done on the **CONFIGURATION | SECURITY** page.

SDX Address

This sets the controller address when using the SDX protocol. It is a 16-bit value that can range from 1 to 65535.

SDX Port

The SDX TCPIP port is traditionally port 52227. This can be changed here if desired.

Modbus Slave Enable

Checking this box enables the controller to respond to Modbus data commands and requests via the cellular interface. Since Modbus is not a secure protocol. Do not enable Modbus slave operation unless you are specifically using Modbus communications over the cellular interface and the controller needs to respond to Modbus messages from a remote master.

Nearly every parameter within the controller is accessable as a Modbus register. This a potential security problem. There is some protection available to prevent unauthorized CHANGES to parameters via Modbus. This is discussed under the SECURITY section in the Scadaflex II Configuration Guide.

Modbus Address

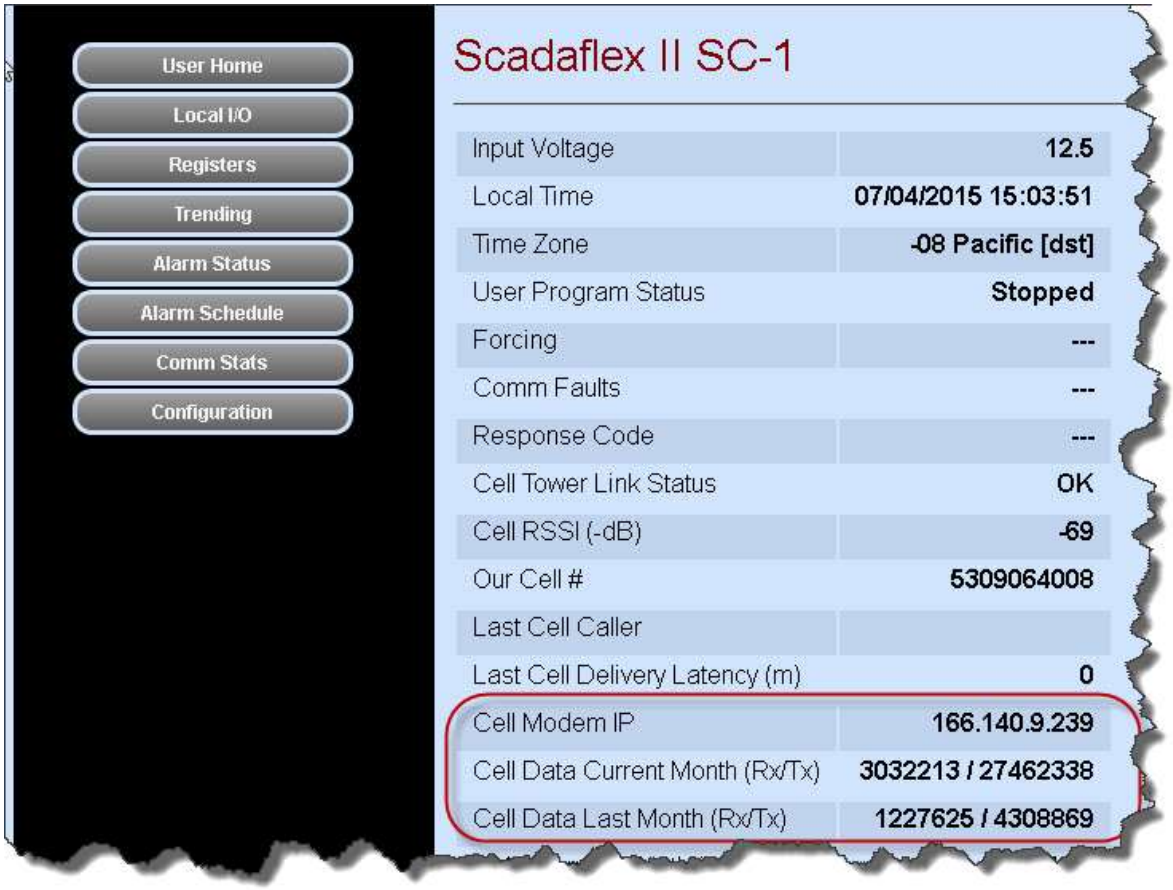
This value represents the Slave Address of the cellular port for Modbus data communications.

Modbus Port

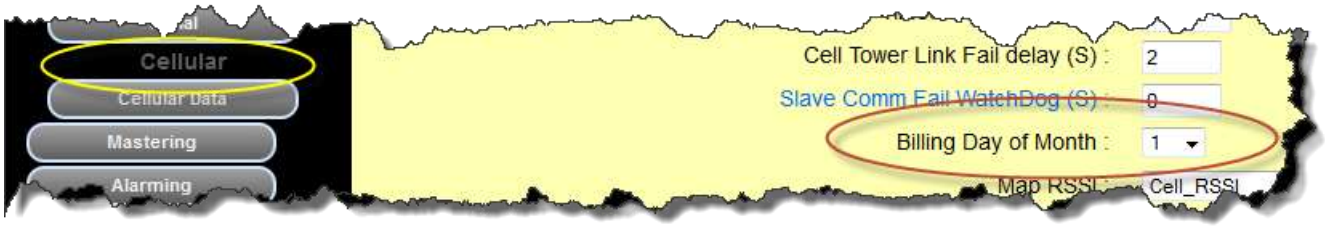
The Modbus TCPIP port is traditionally port 502. This can be changed here if desired.

User Home Page with Cellular Data Enabled

With Cellular Data Enabled, the User Home web page displays the controllers IP address on the cellular network, as well as the number of bytes transmitted and received this month and the previous month.



For billing verification, be sure to set the Billing Date on the **CONFIGURATION | COMMUNICATIONS | CELLULAR** page to correspond to the billing cutoff date used by the cellular carrier.



Cellular Option – Text Messaging Configuration

Cellular Text Messaging can be used for three purposes in the Scadaflex II controller:

HMI - As an HMI interface (user interface) that enables a user to access information in the controller and optionally make setpoint and other setting changes from their cell phone. Access can be password protected and limited to "friendly" cellular telephone numbers.

Alarming – Text messaging can be used to send both SMS and e-mail alarms

Communications – Text messaging can be used to send small packet data between ICL controllers and RTUs.

Regardless of the usage, almost every transaction requires at least two text messages. For example, when used as an HMI, the user texts a request or command and the system responds. Longer responses (multiple variables) may span multiple text messages.

For alarms, an alarm is sent out to a group of users and at least one person normally responds to acknowledge the alarm. Then, a message is sent out to all people currently on call to tell them that the alarm was acknowledged and who acknowledged it.

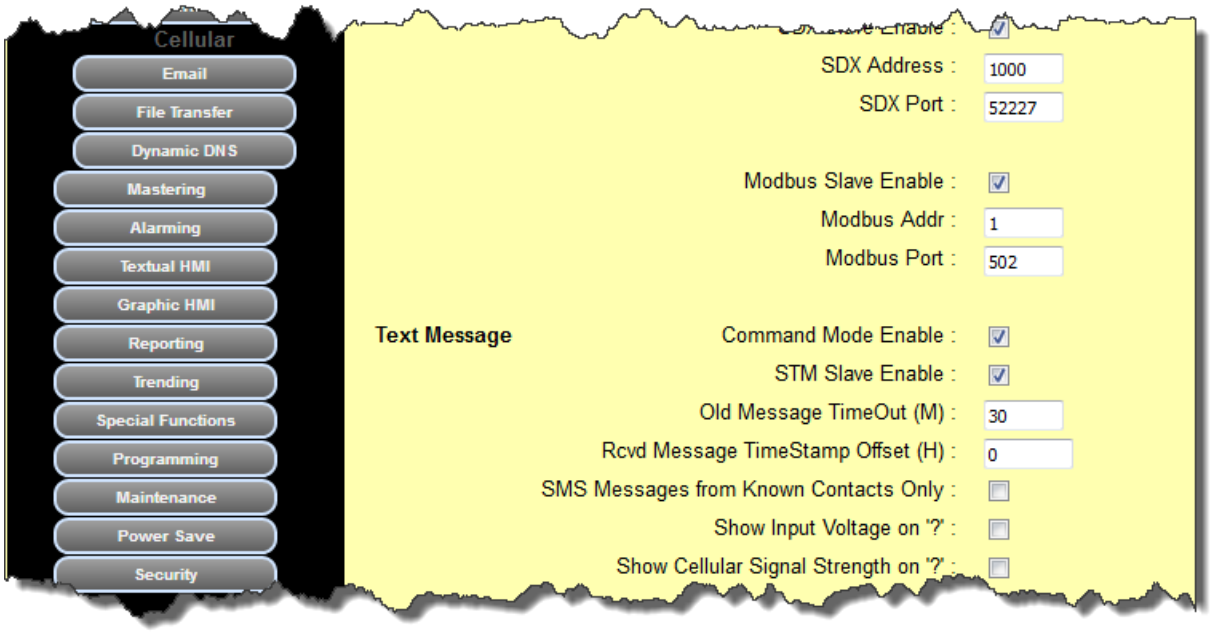
For data communications, a command is sent to send or receive data and the unit responds. Since text messages are limited to about 140 characters, some transactions may span additional text messages.

Most cellular carriers charge for each text message or have a certain monthly allowance after which there is a per text message charge. Some carriers though do offer unlimited text messaging as part of some of their plans. In the United States and Canada, unlimited plans are available "off-the-rack" ranging from $10 to $25 per month. Per text message plans tend to start at about $0.01 per message.

Text Messaging Setup

Most of the basic configuration for Text Messaging is done under **CONFIGURATION | COMMUNICATIONS | CELLULAR** (shown below). Items specific to HMI, alarming and communications are set up in their own specific sections and are covered in detail in the *Scadaflex II Configuration Manual*.

This page is only visible and accessible if an internal cellular modem (option) is installed.



Command Mode Enable

Check this box to enable the controller to accept and respond to commands via text messaging.

STM Slave Enable

STM is an encrypted protocol used by ICL controllers and RTUs to communicate with each other using text messaging. The protocol provides data encryption (AES-128) to secure data transfers since text messaging only permits the transfer of “readable” ASCII text characters. Encryption makes the messages look like gibberish until the receiving unit decrypts them.

Old Message Timeout (M)

Occasionally, text messages can get “hung up” within a cellular system so that their delivery can be significantly delayed. If the text message is a control command (either as an HMI action or by protocol communications), you may not want the controller to take action on the command if it arrives hours or days late. This setting limits how late a control command can be and still be accepted.

Rcv’d Message Timestamp Offset (H)

Cellular carriers timestamp messages to the controller. Some cellular carriers report the time as local time while others (such as Verizon) report GMT time. Some systems are also on time zone borders so that the controller may talk to a tower across a time zone boundary. This parameter can be used to correct for this situation. For example, on Verizon systems in California, we have to set this value to -8 for our Pacific Time zone in the United States.

SMS Messages from Known Contacts Only

The Scadaflex II controller can have a list (address book) of up to 32 known contacts. The list is maintained under the Alarming Section (**CONFIGURATION | ALARMING | ADDRESS BOOK**). If this box is checked, SMS messages will only be accepted from contacts in that Address Book.

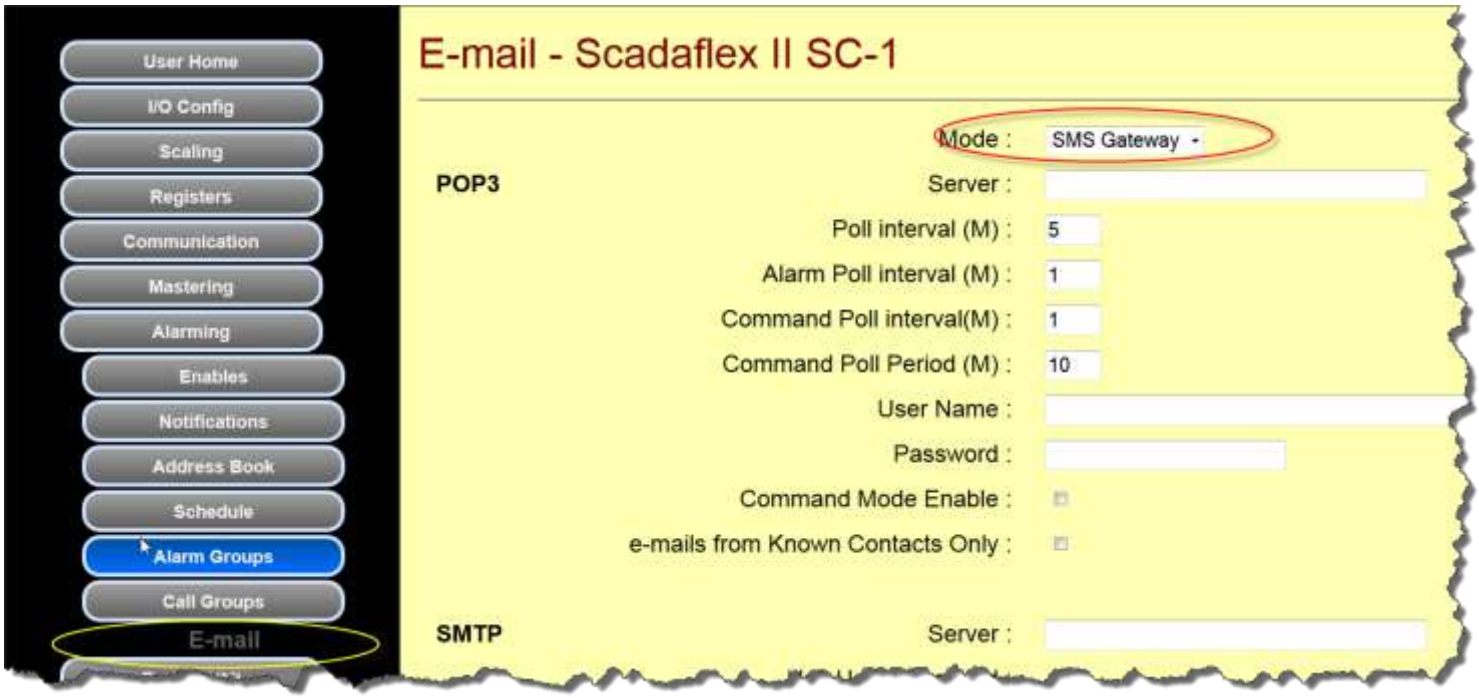
Show Input Voltage and Signal Strength on "?"

Check these boxes if you wish for the Input Voltage and Cellular Signal Strength (RSSI) to be returned for a "?" text message inquiry.

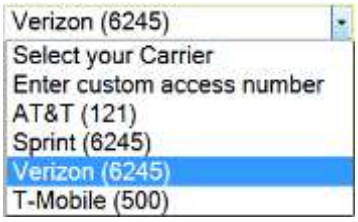
E-mail via Text Messaging Setup

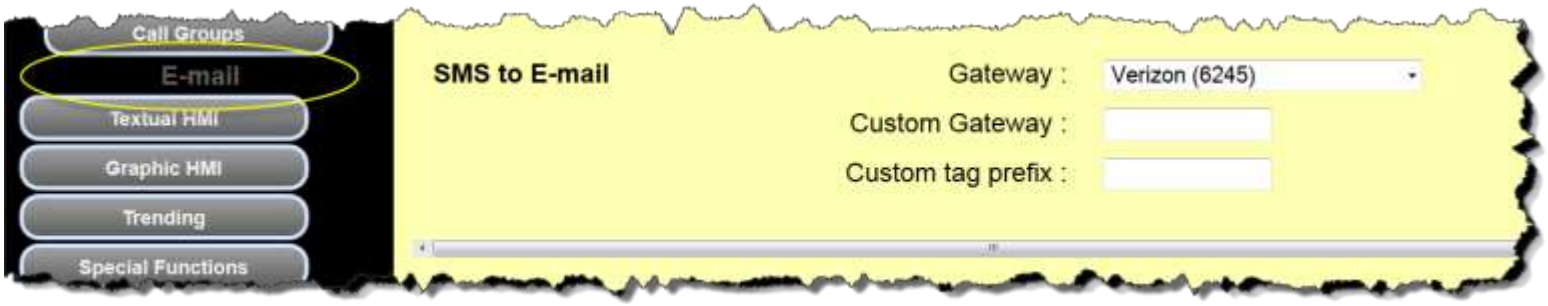
Many cellular carriers, including all of the major carriers in the United States, provide a facility for sending e-mails translated from text messages. This can eliminate the need for paying the monthly fees for a data plan for systems whose primary functions are alarming and/or text message/email HMI. To use this feature, it is necessary to configure the controller to use a cellular carrier's text message to email gateway (server). This is done on the email configuration page under **CONFIGURATION | ALARMING | E-MAIL**.

STEP 1 - At the top of this page, set the Mode to **SMS Gateway**



STEP 2 - At the bottom of this page, set the Gateway to the cell carrier that you are using or to "custom access number" if your carrier is not listed. The numbers in parenthesis are the tag prefixes for the carriers

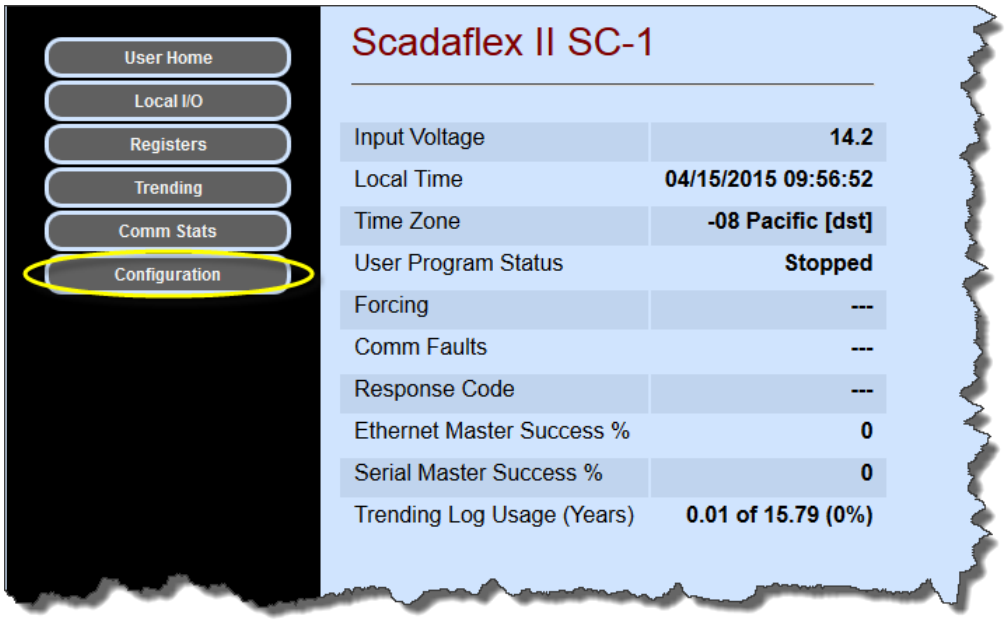


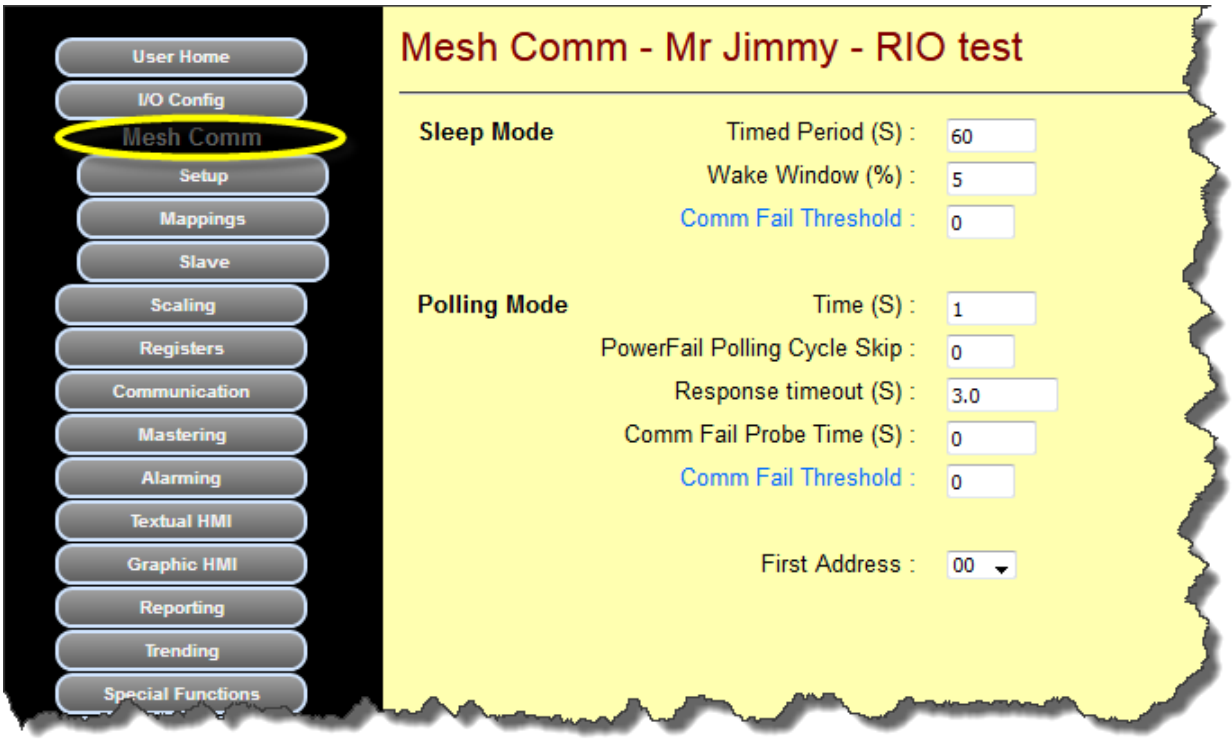


STEP 3 - If you selected "custom access number", enter the Custom Gateway and Tag Prefix information (available from your carrier) in the spaces provided.

Wireless I/O Software Configuration

Wireless LPR and RIO modules are configured using web pages built into Scadaflex II controllers under "Configuration |Mesh Comm". Here you will define how the Scadaflex II master communicates with individual remotes, what information is gathered and saved to registers, and how it is scaled.





LPR modules support several modes of operation with are optimized for:

- Least power draw (sleep mode)
- Low power draw and fast response time (transmit on change)
- Polled mode (fast response time but higher power draw)

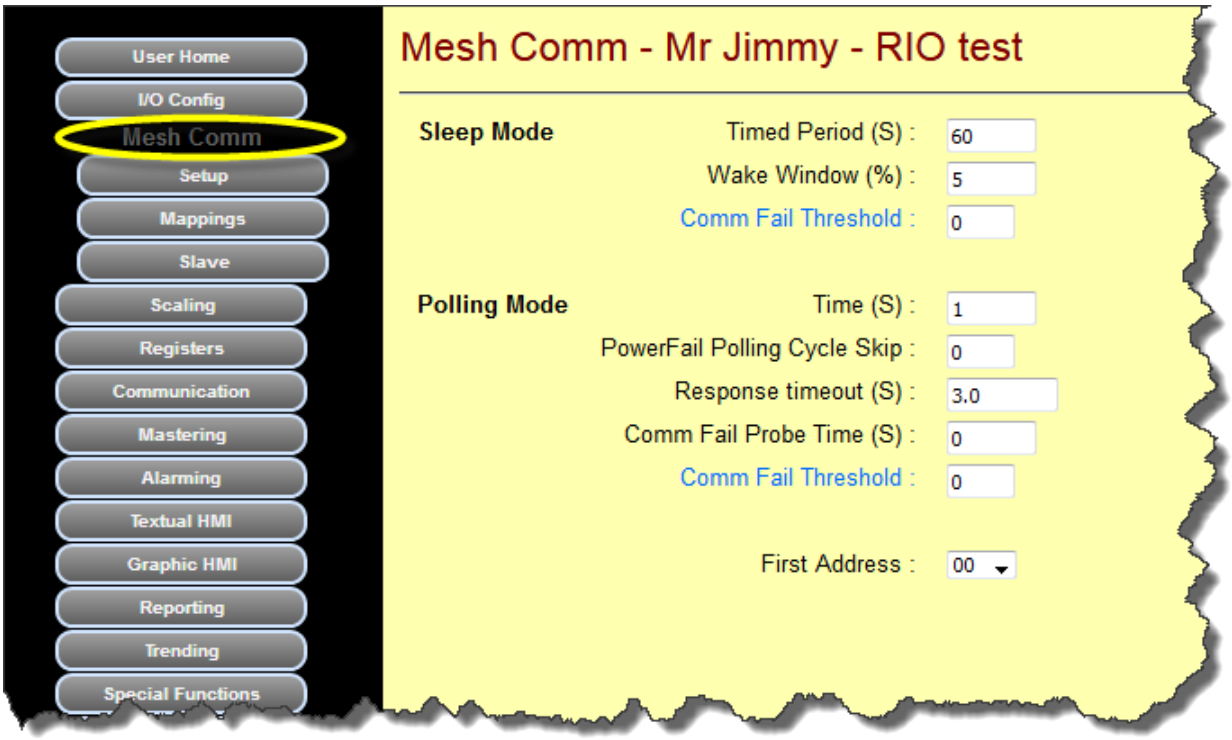
The operating modes may be used in combination with each other.

RIO modules are always powered so they use Polled Mode and also support Transmit-on-Change.

The first configuration items that show up under the Mesh Comm tab are the items that affect all of the remote modules and their sensors. For example, sleep times and polling times apply to all modules. The configuration items for individual remote modules are found under “Setup” and “Mappings”. For example, mapping of individual sensors to their registers, on-change thresholds, transmit power, etc.

Mesh Communications

To configure the general parameters that affect all of the remote modules, navigate to **Configuration | Mesh Comm**.



Sleep Mode

Time Period This sets the amount of time in seconds that any remote mode set to use “sleep mode” will go to sleep between readings and transmissions. When a remote is asleep, no measurements are taken and the radio is completely powered down. Longer sleep times provide longer battery life but less frequent data updates. Sleep mode is ideal when the module is battery powered and measurements need to be taken infrequently for data such as soil moisture and lake levels.

Wake Window

When the remote modules go to sleep, they use a very low-power clock to wake them up at the “Sleep Time Period” interval. Modules configured as "sleeping repeaters" to set when they wake up must wake up a little earlier and stay awake a little later than the sleep interval setting to ensure that they are awake to repeat the messages from other units (only radios that are awake can repeat messages).

The Wake Window setting also allows for slight variations in clock operation, which with their ultra low-power operation and temperature variation over several hours could shift by as much as 1% or so. Normally, you will want to change the value of the Wake Window setting to 2% after the system is installed and checked out. Since this setting also affects the power utilization and therefore battery life of units configured as sleeping repeaters, longer values may not be desirable.

ComFail Threshold

This parameter sets the number of failed communications attempts that will be tolerated before a communications failure is sensed and alarmed for remote units using sleep mode (note that there is a separate parameter like this one used for polled mode). A value of zero (factory default) means that any failure to communicate with a site will cause a communications failure alarm for that site. A value of one will allow for another attempt before alarming the failure. Higher and higher values (up to 255) allow for additional consecutive failed attempts before a failure for that unit is flagged. Note that low-level message retry and recovery is built into the module communications, so a failed attempt is a severe failure where the low-level protocol was not able to get through with its retries. The disadvantage of setting higher values for this parameter is that the time required to detect a failed unit could become very long. For example, if the sleep time is set to 4 hours so communications is only attempted every 4 hours, a ComFail Threshold of 2 would require a total of three communications attempts or 12 hours before a communications failure is annunciated.

Sleep Mode

Time

This parameter sets the polling rate (in seconds) for remote modules that are configured for polled operation. Note that the speed of polling affects the power draw. For each poll, the unit will power up the analog sensors, take readings, and transmit the values back to the Scadaflex II Controller. Some remote modules, even if they are not running from the internal D cell battery built into the remote module, may still be power sensitive (such as solar powered sites). Slower polling rates may be best for these types of systems.

PF Polling Cycle Skip

LPR remote modules can be externally powered, but set to use their internal battery if external power is lost (battery backup). If polling is being used, it may be OK to poll frequently when externally powered but the polling rate should be dialed back when the unit is powered from the internal battery. This parameter facilitates this type of fallback operation. For example, if the polling time is set to 10 seconds and the Power

Fail Polling Cycle Skip value is set to 12, then when external power is lost at a remote site, the polling rate for that site will be extended from 10 seconds to 2 minutes.

Response Timeout This parameter sets the length of time in seconds that the Scadaflex II Controller will wait for a response to a message sent to a remote site. Sites that require more repeater “hops” will require longer timeout settings. The factory default of 3 seconds will handle most situations but if one or more remote sites are not responding, a long timeout can adversely affect overall system responsiveness. A shorter time may be better especially in systems with larger numbers of remote units.

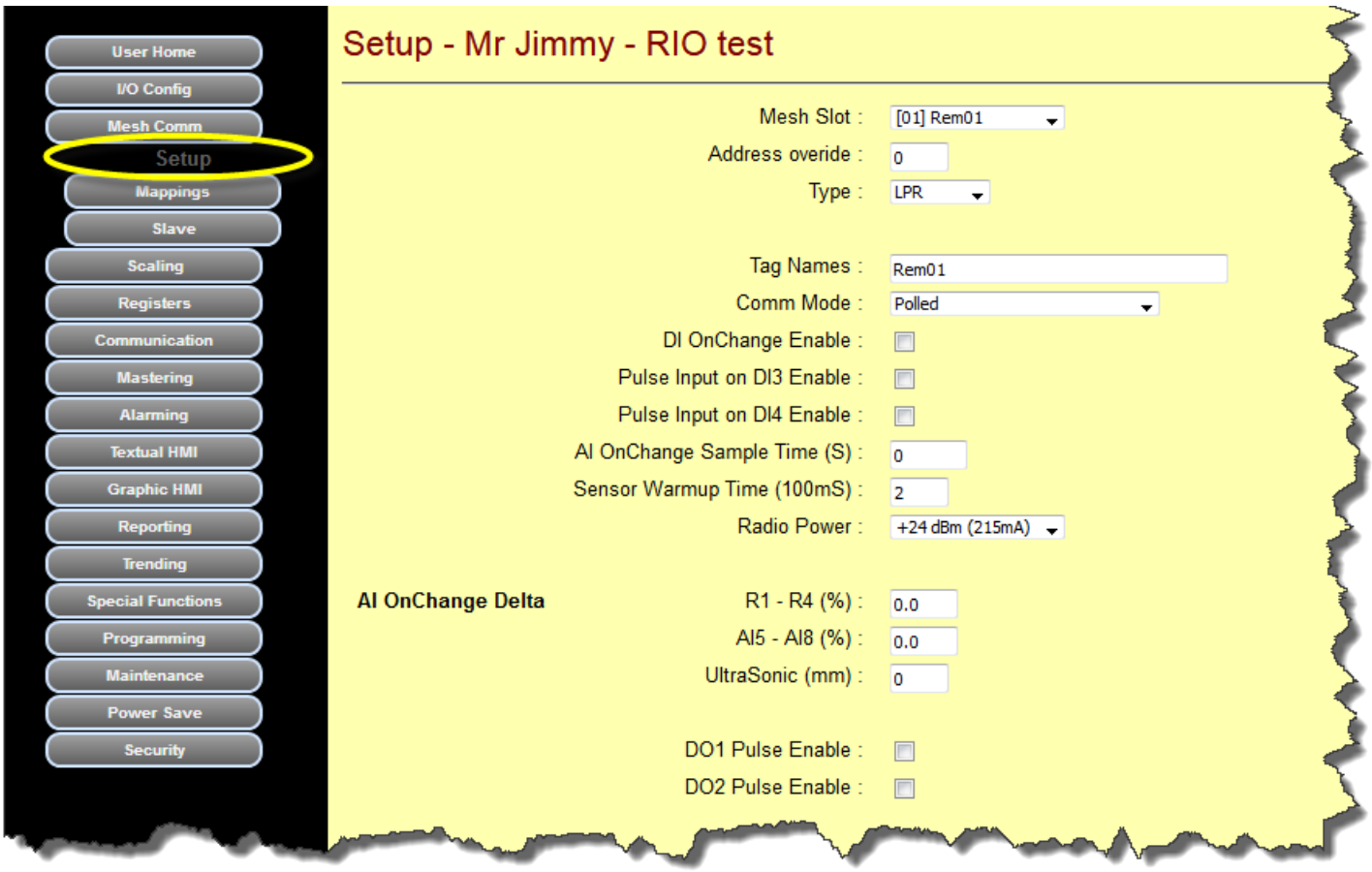
ComFail Probe Time If a remote module goes into comm fail, the Scadaflex II Controller can be configured to check for it to come back up at a slower rate than the normal poll time. This will reduce the impact of down units on overall system responsiveness.

ComFail Threshold This parameter sets the number of failed communications attempts that will be tolerated before a communications failure is sensed and alarmed for remote units using polled mode (note that there is a separate parameter like this one used for sleep mode). A value of zero (factory default) means that any failure to communicate with a site will cause a communications failure alarm for that site. A value of one will allow for another attempt before alarming the failure. Higher and higher values (up to 255) allow for additional consecutive failed attempts before a failure for that unit is flagged. Note that low-level message retry and recovery is built into the module communications so a failed attempt is a severe failure where the low-level protocol was not able to get through with its retries.

First Address A single Scadaflex II Controller can support up to 64 LPR remote modules. Individual LPR remote modules can be addressed to any one of 256 addresses so multiple masters can service an area with many remotes. Masters must be configured with the address of the first remote module that they will service. The modules that it will access will range from the First Address to the First Address + 63.

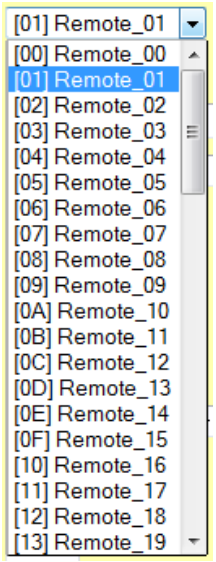
Remote Module Setup - General

To configure the operating parameters for individual remote modules, navigate to **Configuration | Mesh Comm| Setup**.



Mesh Slot

This selects the remote module that is being viewed/configured. It is a pull-down selection list with the number of remotes listed as were configured on the main Remote Sensors page described above. The information below this selection list will change to reflect the information for the selected module. The default module names are *Remote_00* through *Remote_nn*, but they can be changed with meaningful site names (see "Tag Names" below) and these names will show up in the Mesh Slot selection list. The module's address switch setting is included in parentheses to the left of the name.



Address Overide

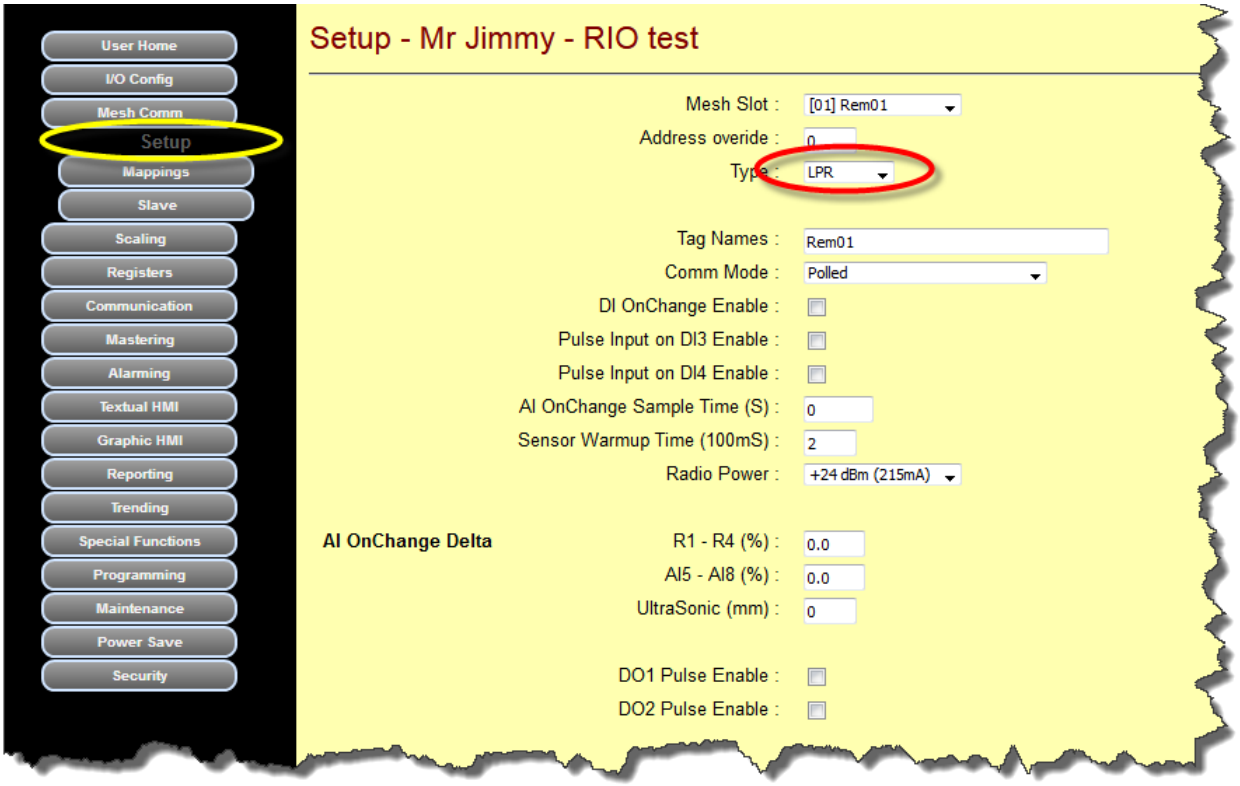
The address overide settings are exposed to the programming and HMI sections. If they are set to a non-zero value for a remote I/O device, they will overide the "hard" settings on the configuration pages. This allows address changes to be made "on-the-fly".

Type This is a selection list of possible remote I/O devices, including

- LPR Low Power Remote I/O
- SC1, SC2 and SC3 controllers (SC3 is discontinued but still supported)
- RIO Standard Remote I/O

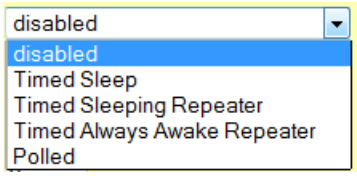
Based on the type that is chosen, the rest of the page "morphs" with the configuration information for that type of device.

LPR Remote I/O - Setup



Tag This is a 24 character text field that lets you give a meaningful name to the remote unit. That name will show up on the user web pages.

Comm Mode This is a selection list that determines how the master will communicate with the LPR module (sleep mode or polled). If a sleep mode is selected, the module will also serve as a repeater. A sleeping repeater goes to sleep like the rest of the sleeping modules but wakes up a little early at the start of the wake window to be available when the sleeping modules start to wake up and try to talk to the master. It also stays awake until all of the modules have reported in to the master or the wake window ends. As the name implies, a non-sleeping repeater serves as a repeater to the rest of the sleeping nodes but never goes to sleep itself.

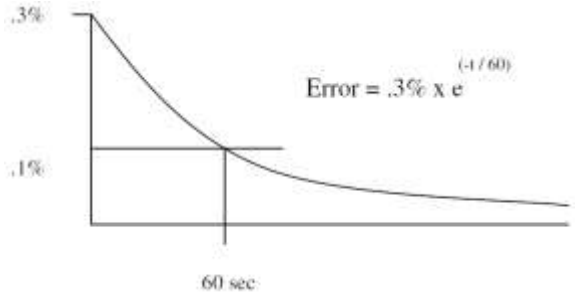


DI OnChange Enable Check this box if you want the remote module to send an I/O status message back to the master whenever there is a state change on any of the discrete inputs. Enabling this function will slightly increase the amount of power draw whenever a digital input is ON since it causes the current sources for the discrete inputs to be turned ON at all times instead of being switched ON only when the discrete inputs are being read periodically after a sleep period expires or a poll occurs.

DI3/4 is pulse input Checking these boxes DISABLES DI3 and/or Di4 from being used for on-change transmissions. Enable it when you want to connect a pulse type flow meters to either of these two discrete inputs.

AI On Change Sample Time This box configures how often the analog inputs are sampled (in seconds) for detecting changes. When set to a non-zero value, the remote module will periodically enable the sensor power, wait for the period of time specified below (Sensor Warm-up Time), take analog readings then turn off the sensor power. Since this parameter affects how often the sensor power is turned ON, it can have a significant effect on overall power consumption. Using Analog On Change reporting is still more power efficient than continuous polling and more responsive than just sleep mode operation since it only powers up the radio and transmits when a significant change in analog level occurs. Setting this value is always a compromise between responsiveness and power consumption. For example, if you want to monitor a tank level using On Change operation, you might determine that the level only needs to be checked once every 10 minutes for the worst case possible drawdown or pump up. This means that the sensor power will only be on for less than a few seconds every 10 minutes which will greatly reduce power consumption. Even if the overall module is using sleep mode, sleeping for several hours, tank level updates will never be slower than every 10 minutes if the level is actually changing.

Sensor Warm-up This parameter sets how long the sensor power is turned ON before taking an analog reading. Most sensors have a warm-up time to stabilize. Setting this parameter can be a compromise between power consumption and measurement accuracy. Generally, the longer the sensor warm-up time, the greater the accuracy but at the expense of greater power consumption. An example is the curve pictured here supplied by GEMS, a sensor manufacturer. In this case, for ultimate conservation of power, you might choose to accept up to a 3% error and use a very short sensor warm-up time. On the other hand, if you need at least 1% accuracy, then you will have to set the sensor warm-up time to 60 seconds and accept that you will need to change batteries more frequently. They show how the reading accuracy from their sensors will vary depending on how much warm-up time is

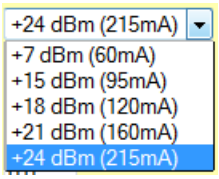


allowed. Check with the manufacturer of the sensors that you are using for your specific application.

The sensor warm-up time also affects the +VS power to the optional low-power ultrasonic level sensor. A warm-up time of 0.5 seconds or more is recommended for LPR modules that do include this sensor.

Radio Power

The radio can be one of the largest power draws in the LPR module. Depending on the distance that you are trying to cover, you may want to reduce the transmit power of the radio to extend the battery life. The selection list shows 5 different transmit power levels and their corresponding current draw from the battery. The factory default is the highest power.



Be careful when you are adjusting the radio power remotely. Start with the highest power first, then drop the power down one setting at a time while watching the RSSI level reading change each time the remote talks to the master. If you adjust it too quickly you may be cut off from communicating with the module in order to adjust the power back up!

AI On Change Delta

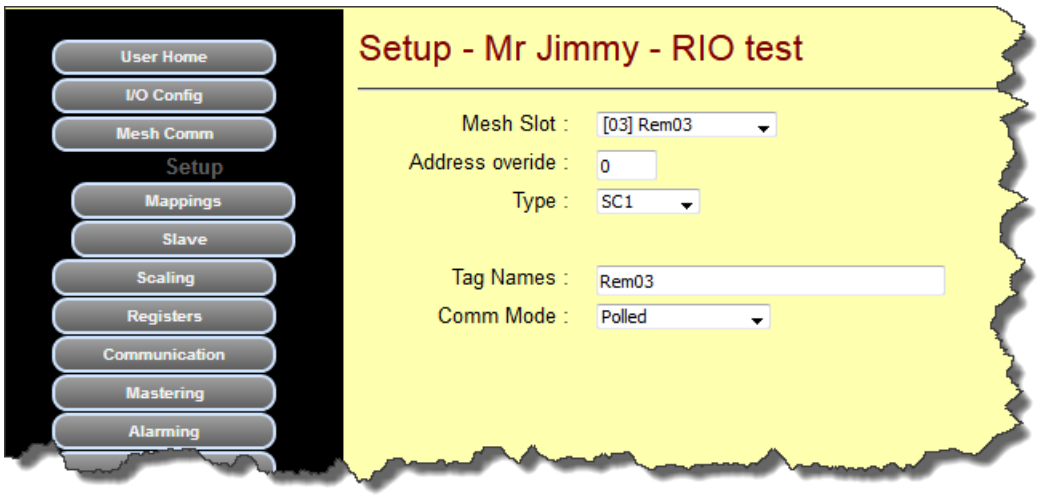
These parameters set the amount of change required to initiate a transmission to the master. There is one for the four resistance analog inputs and one for the four process analog inputs. These values are in percent of full-scale. For example, setting the delta to 0.1% on a 35ft. tank level sensor would cause the remote module to report level changes of 0.42 inches (35 / 1000 = 0.35ft = 0.42 inches).

DO Pulse Enables

Check these boxes if you want to modify the operation of the DO relays so that any time that an ON is written to them, they will pulse on for one second and then turn OFF ("one-shot" operation).

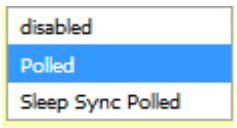
Controller to Controller- Setup

The mesh radio system can be used to facilitate communications between controllers as well as remote I/O. In this case, most of any configuration is done in the controllers themselves. The master just needs to know the communications mode to use.



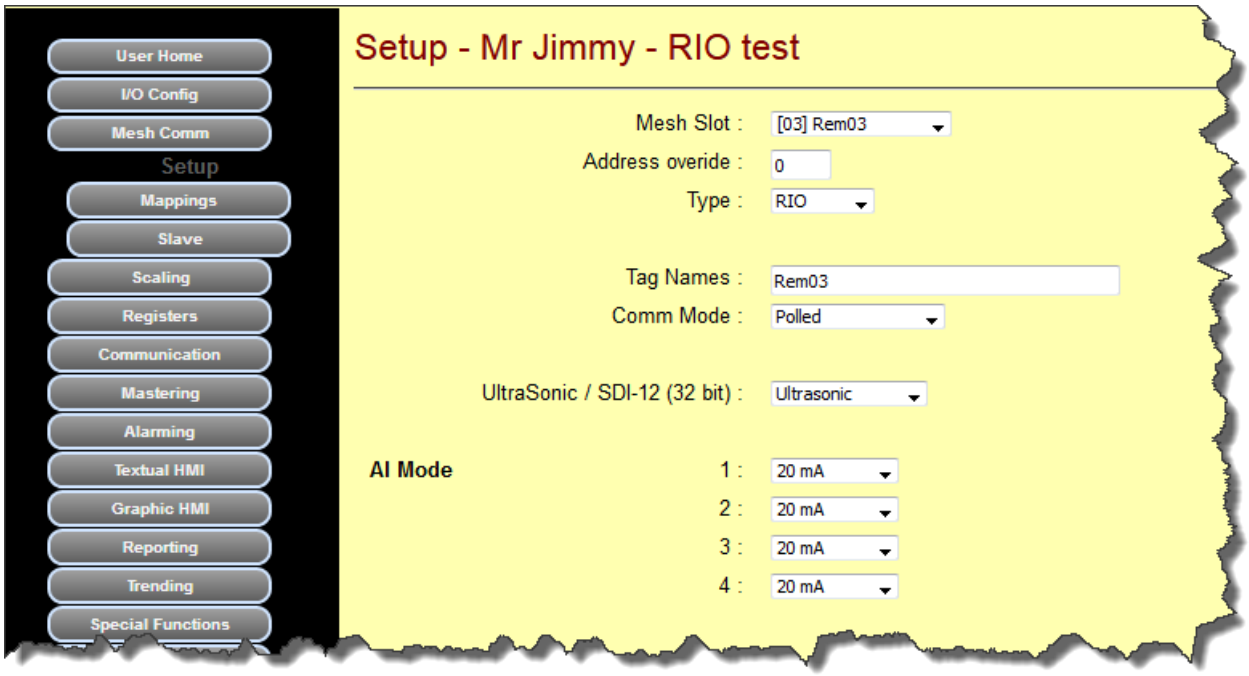
Tag This is a 24 character text field that lets you give a meaningful name to the remote unit. That name will show up on the user web pages.

Comm Mode This is a selection list that determines how the master will communicate with the other controller. Polling is always used but that polling can just use the polling timer cycle or be synchronized with the wake cycle of the sleep mode modules.



RIO - Setup

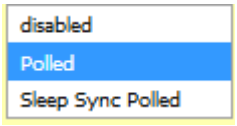
RIO is the best remote I/O solution when power is available at the location. It does consume very little power for solar and similar applications, but requires more than the battery powered LPR module.



RIO configuration is very simple. RIO modules are always polled for discrete and analog I/O, although discrete input changes are reported instantly on status changes. Besides the polling mode, the only other configuration is the type of analog signals on each analog input.

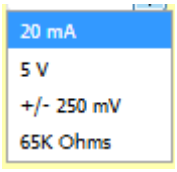
Tag This is a 24 character text field that lets you give a meaningful name to the remote unit. That name will show up on the user web pages.

Comm Mode This is a selection list that determines how the master will communicate with the other controller. Polling is always used but that polling can just use the polling timer cycle or be synchronized with the wake cycle of the sleep mode modules.



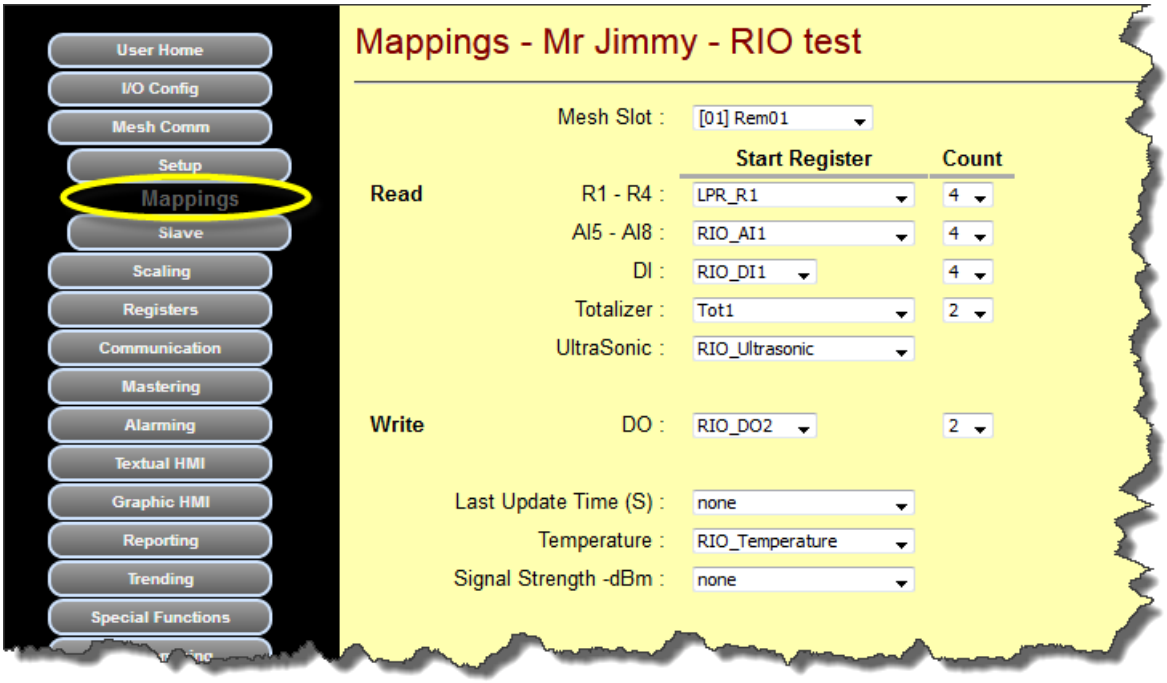
Ultrasonic/SDI-12 Not currently supported. Contact technical support if needed.

AI Mode A selection list to set the signal type and range of each individual analog input.

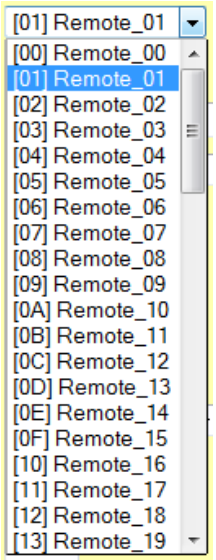


Mappings - General

To “map” the data between the remote I/O and the internal registers of the Scadaflex II Controller, navigate to **Configuration | Mesh Comm| Mappings**.

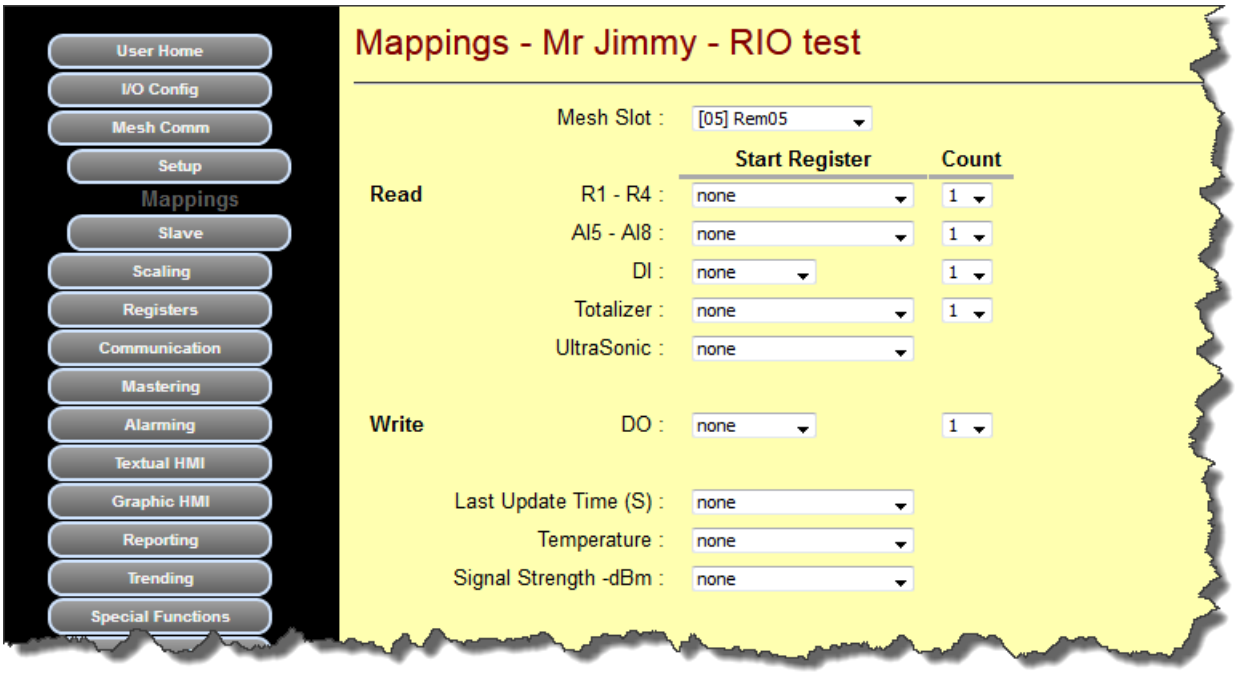


I/O points in the remote modules are mapped to registers in the Scadaflex II controller on the web page. The remote unit that is being configured must be selected in the “Mesh Slot” pull-down menu. Note that the name of the remotes can be changed to more meaningful names than "Remote_xx" by setting the Tag name in the Mesh Comm |Setup section.



The layout and information configured on a mappings page depends on the type of module configured for the selected Mesh Slot. LPR, RIO and controllers all have difference configuration settings.

LPR Remote I/O - Mappings

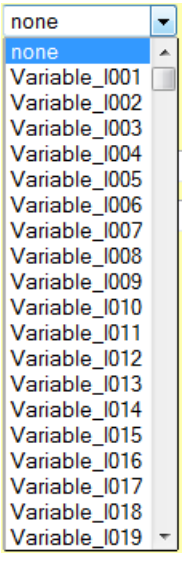


Mappings

I/O data from an LPR module is mapped in blocks to I (Integer) and B (Boolean) registers in the master. An LPR remote I/O Module has the following:

R1-R4	Resistance analog inputs	(4)
AI5 – AI8	Process analog inputs	(4)
DI1 – DI4	discrete inputs	(4)
DO1 – DO2	digital outputs	(2)
Ultrasonic	Ultrasonic Level Sensor	(1)

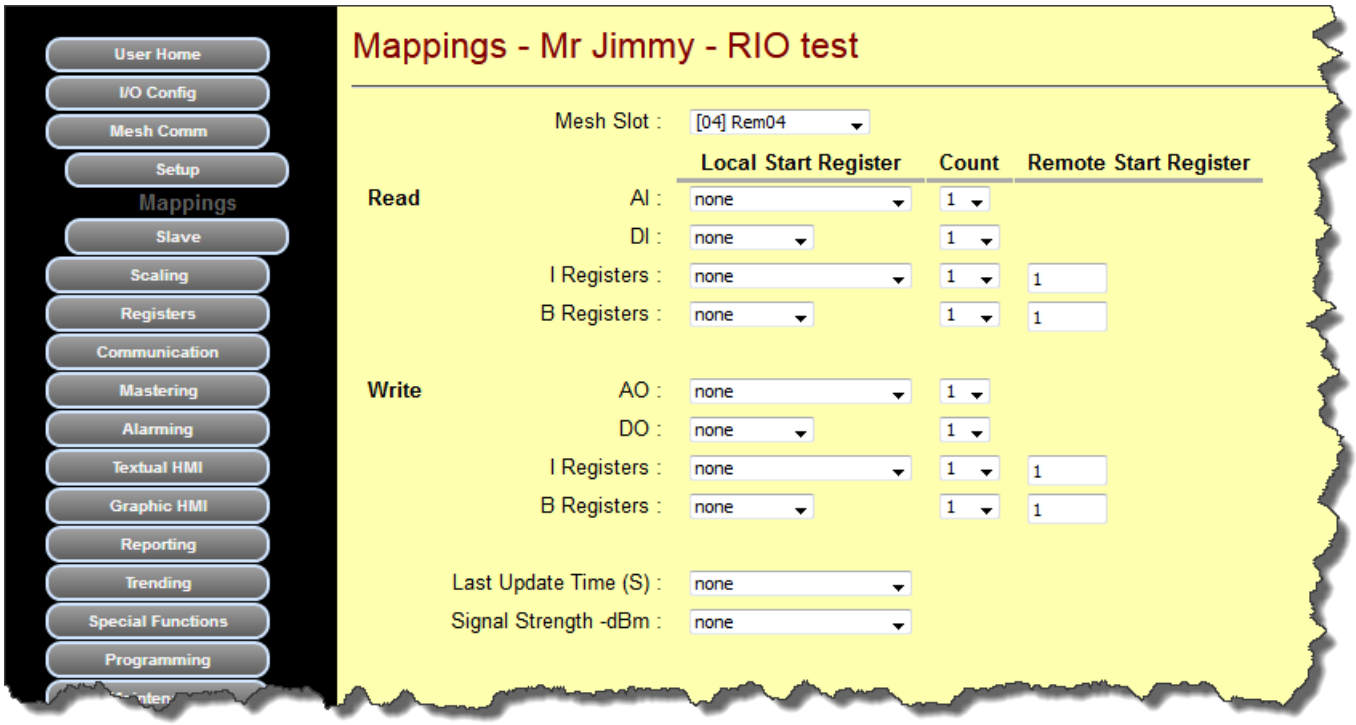
There are also two 32-bit totalizers which are fed from DI3 and DI4, a timer that keeps track of the time for the last complete reading cycle (for rate calculation), the local temperature, and the last received radio signal strength.



These points can be mapped to registers which have been made "visible" in the "Registers" section. The registers can also be named in that section so that they are more user friendly than being called "Variable_xxxx".

Mappings consist of a starting register and a count (number of registers) for each type of data. So for example, if a count is set to 3, a type of data from the remote module will be placed in the “Start Register" and the next two successive registers.

Controller to Controller - Mappings



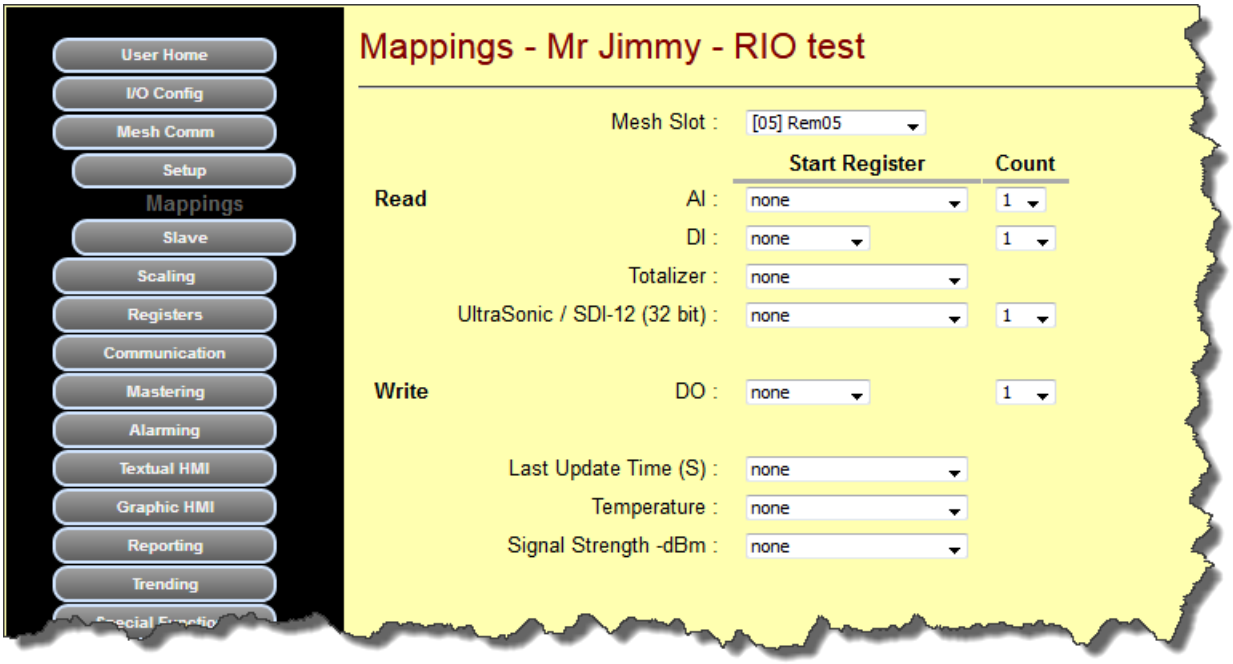
Mappings

I/O and register data can be mapped from other controllers. The maximum block size for register data (to I (Integer) and B (Boolean) registers) is 64 each.

Mappings consist of a starting register and a count (number of registers) for each type of data. Registers transfers have an additional parameter to specify the starting register address in the remote controller.

There is also a timer that keeps track of the time for the last complete reading cycle and the last received radio signal strength.

RIO Remote I/O - Mappings



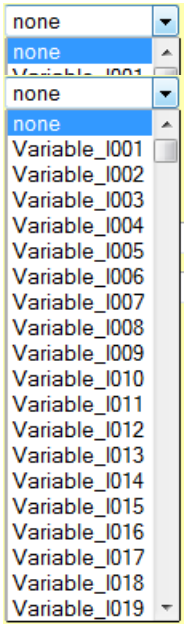
Mappings

I/O data from a RIO module is mapped in blocks to I (Integer) and B (Boolean) registers in the master. A RIO remote I/O Module has the following:

AI1– AI4	Process analog inputs	(4)
DI1 – DI11	discrete inputs	(11) (includes high-speed DI as DI11)
DO1 – DO10	digital outputs	(10)

The Ultrasonic level sensor/SDI12 data is not currently supported.

There is also a 32-bit totalizer which is fed by the high-speed discrete input (DI11), a timer that keeps track of the time for the last complete reading cycle (for rate calculation), the local temperature, and the last received radio signal strength.

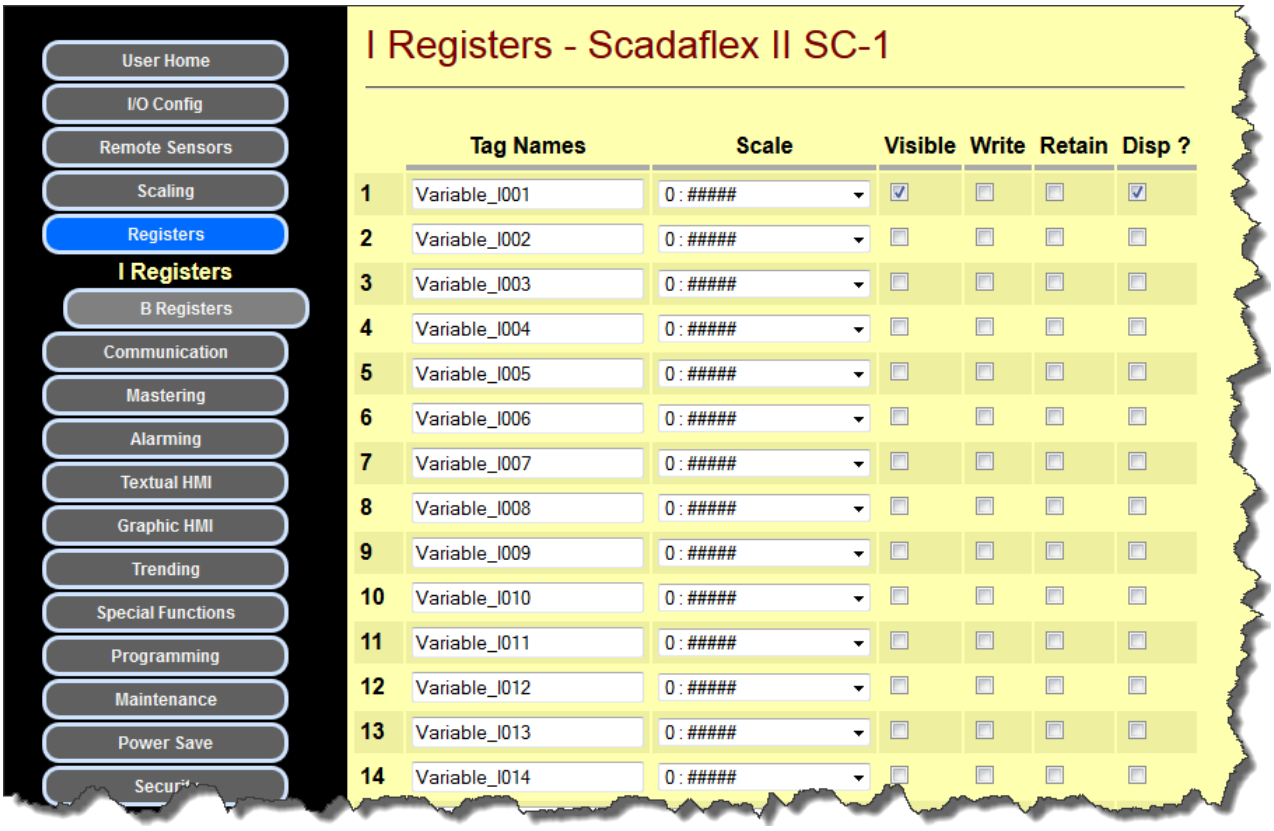


These points can be mapped to registers which have been made "visible" in the "Registers" section. The registers can also be named in that section so that they are more user friendly than being called "Variable_xxxx".

Mappings consist of a starting register and a count (number of registers) for each type of data. So for example, if a count is set to 3, a type of data from the remote module be placed in the “Start Register" and the next two successive registers.

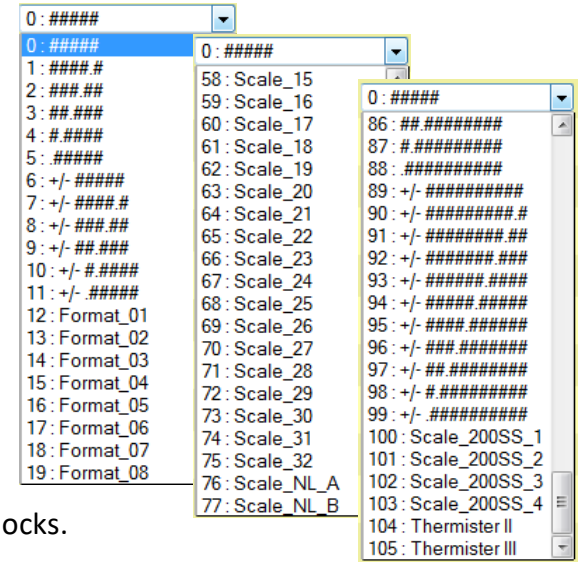
Registers Configuration

The data from remote modules is mapped to registers within the master controller. As the information comes into the controller registers, scaling and formatting is applied "on-the fly". The names, scaling and attributes of individual registers can be set under **Configuration | Registers.** There are a 504 Integer (I) and 504 Boolean (B) registers.



Tag Names This is a 24 character text field for each register that lets you give it a meaningful name. That name will show up on the user web pages. For Boolean registers, the name is also the alarm text if the Boolean is enabled as an alarm.

Scale Under "Scale", you can select simple formatting (with a decimal point), custom scaling and formatting, or pre-made sensor scaling (i.e. temperature and soil moisture sensors). As data is read into a register the scaling is applied. Pairs of 16-bit I registers can be treated as 32-bit values by choosing the larger 32-bit formatting shown on the right-hand side. Custom scaling is set up in the scaling section. There are 34 user definable scaling blocks including two non-linear scaling blocks.



Visible Only registers that have been marked as "Visible" are included in selection lists for HMIs and Trending. This reduces the size of the selection lists to only actively used registers. Registers are accessible to communications including sensor mapping regardless of being visible or not.

Write Only registers that have been marked as "Write" enabled may be written to from the simple textual HMIs (has no effect on the Graphical HMI). Registers mapped to Remote I/O will be overwritten even if you do write to them from the textual HMIs. Since read operations can happen fairly slowly or be disabled, you may want to enable writing to Remote I/O mapped registers for your testing.

Retain Registers that have been marked as "Retained" will have their contents saved during a power failure. This is not normally used for registers mapped to remote I/O unless you really want to preserve the last I/O value unless read in before the controller was powered down.

Disp ? Registers that have been marked as "Disp ?" will be included in a response to a text message or e-mail "?" command". This can be a simple way to provide information from the Remote I/O such as levels and flows to users.

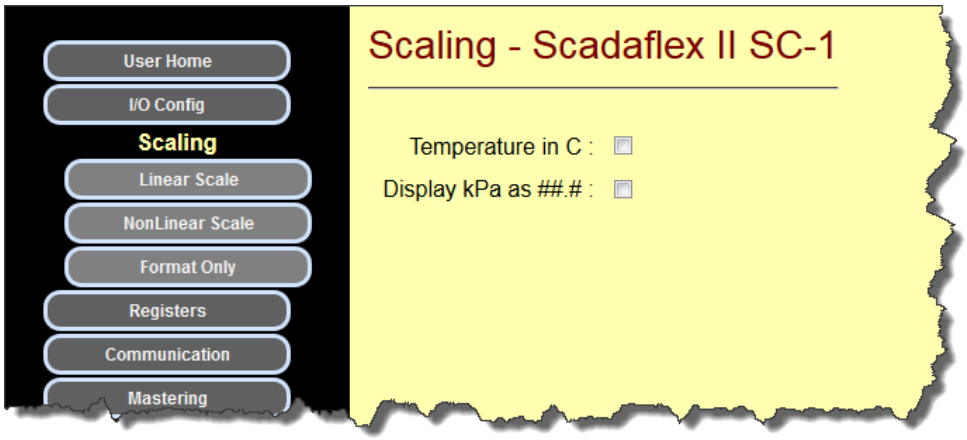
Scaling and Formatting

Scaling and formatting is applied to readings from the remote I/O modules "on-the-fly". Scaling converts the raw analog readings (typically in volts or milliamps) to engineering units that represent level, flow, temperature, soil moisture, etc. The raw I/O values from the LPR modules are 0 to 50000 for 5Vdc inputs and 0 to 20000 for 20mA inputs. A facility is provided for non-linear scaling by user entered table. This is useful for indicating level in odd shaped tanks, or calculating flow in open-channel weirs.

Formatting just adds a decimal point for visual displays, and can be used to logically combine two 16-bit registers into a single 32-bit register.

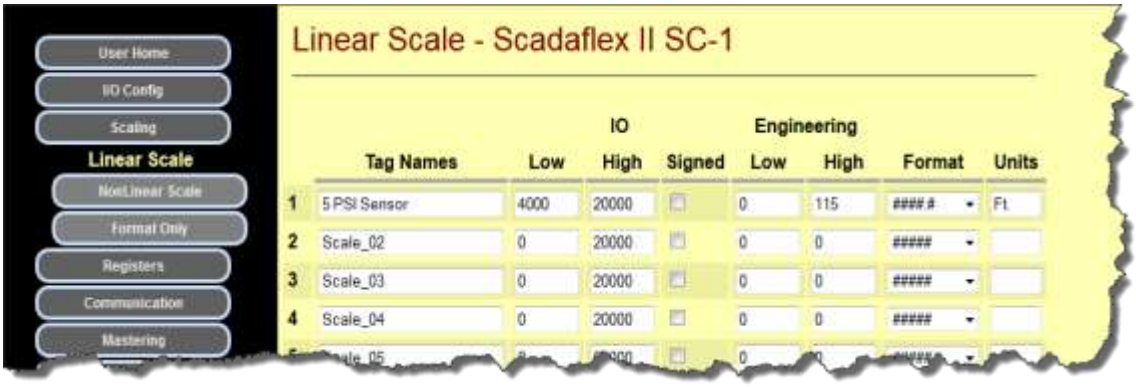
Scaling and formatting records are first "created" and named in the scaling section then applied to individual registers in the Registers section described previously.

To set up scaling and formatting records navigate to **Configuration | Scaling**. On the first page are the general system-wide settings that define the temperature measurement system usage (C or F) and the resolution of soil moisture readings from LPR modules (one or no decimal places; no decimal places is the default unless the box is checked).



Linear

Linear Scaling takes a pair of I/O Low and High settings and linearly scales them between a pair of Low and High Engineering values then applies a decimal point format and units tag. I/O readings outside of the low and high values are clamped to the low and high settings. The tag names should be selected to be descriptive when they are included in a list for applying to registers. The example shown below scales a 4 to 20mA reading (4000 to 20000) from the I/O to a 0 to 11.5ft level reading; this is appropriate for a 5PSI level sensor.

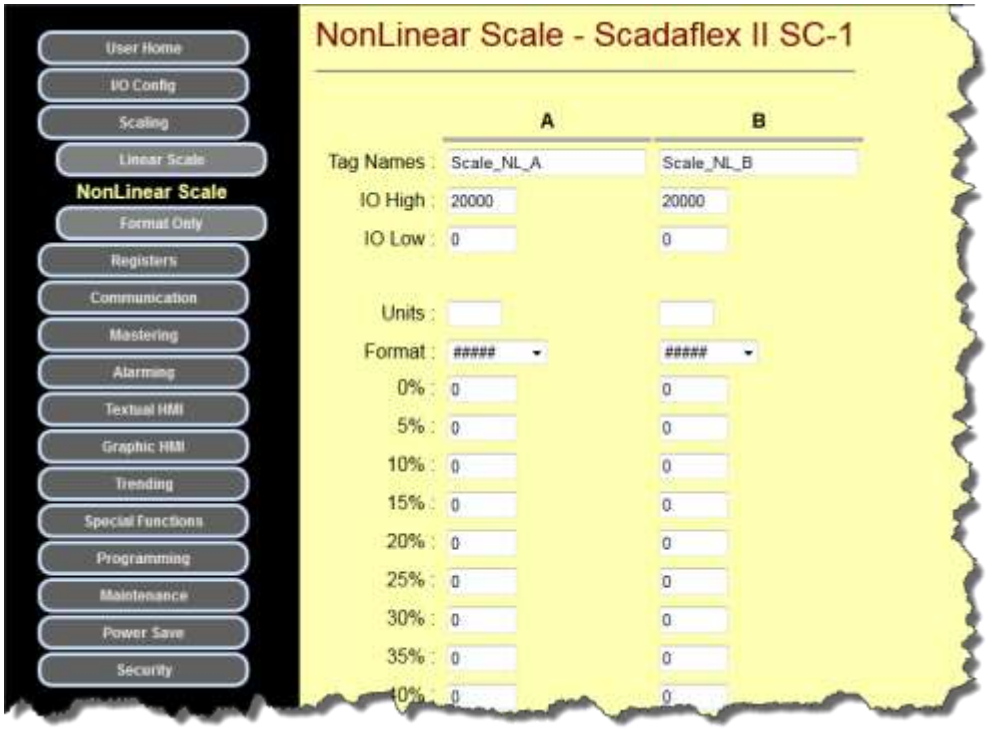


Non-linear Scaling

Non-linear Scaling takes a pair of I/O Low and High settings and uses a user entered table to convert the reading to engineering units then applies a decimal point format and units tag. The table defines any shape curve as a set of 20 points at 5% intervals. The Controller interpolates between the entered points in the table for readings that fall between a pair of points. There are two user definable non-linear scaling records.

I/O readings outside of the low and high values are clamped to the low and high settings. The tag names should be selected to be descriptive when they are included in a list for applying to registers.

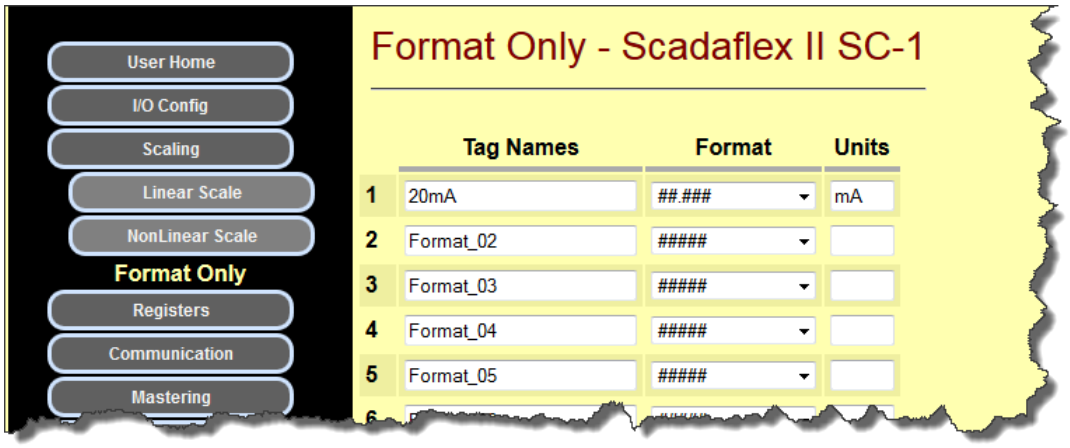
For example, if the I/O low and high values are 0 to 20mA (0 to 20000), then a reading of 10mA will use the value in the table specified as the 50% point. If the reading is slightly higher than 10mA but less than the next 5% step (10.5mA), the controller will extrapolate the value.



Formatting

Some readings do not need to be scaled, but simply formatted. For example, input voltage and temperature readings come in from the I/O modules as tenths of volts and tenths of degrees. In this case, a simple formatting record can be applied to registers that have these kinds of values. Formatting records not only apply a decimal point, but also a "units" tag name.

In the example below, a formatting record has been defined that takes the 0 to 20000 raw I/O reading from an LPR module and converts it to read 0 to 20.000 mA.



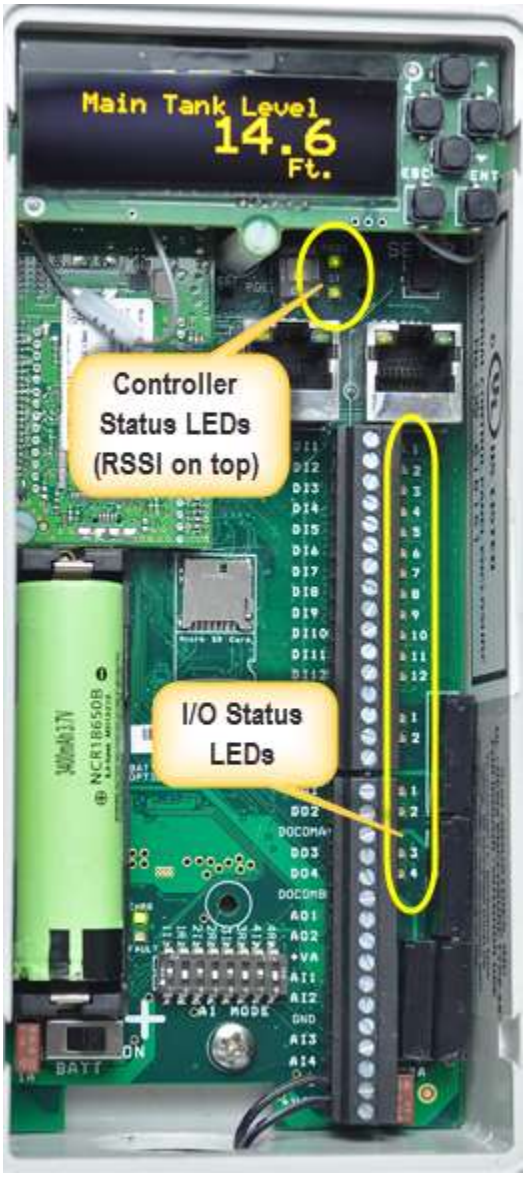
Operation

Status LEDs

The Scadaflex II controller has 21 status LEDs to indicate digital I/O status as well as operating status and error conditions if the occur.

ST LED – The main Controller Status LED is labeled ST.

On initial boot-up, the ST LED can indicate if there is a problem detected by internal controller diagnostics. The LED will flash periodically as follows:



ST LED Blink Status – Controller booting:

OFF	= File System OK and we can Boot (LED Off)
1 flash	= Bad Ethernet circuitry
2 flashes	= Flash disk not found (defective?)
3 flashes	= SFS (operating program) not found in Flash Disk
4 flashes	= SFS (operating program) is corrupt

ST LED Blink Status – Operating

ON	Normal Operation
Slow Blink	One or more I/O points are FORCED
Fast Blink	Comm Failure or SD Card needs formatting

RSSI LED – When an internal cellular modem is installed, the RSSI (Receive Signal Strength Indicator) gives a visual indication of the signal strength of the connection to the cell tower.

>-60dB	LED on solid
-60 to -100dB	Proportional to signal strength (<-100 = OFF)

I/O Status LEDs – These LEDs show the current real state of the discrete inputs and outputs (inputs not affected by forcing).

Setup Pushbutton

The Setup pushbutton is used to force specific configuration settings manually. Its operation is different during boot-up (i.e. just after cycling power) and during normal operation. Selections are made by holding in the button for certain ranges of times.

SETUP Pushbutton Switch Operation – Controller booting (after initial status check):

The ST and RSSI LEDs blink alternately at ever increasing rates to provide a visual indication of the setup pushbutton mode operation.

<5 sec	BOOTLOADER MODE (let go when the LEDs start to blink together) This will keep the controller in Boot loader Mode.
5 to 14 sec	Reset Ethernet IP address to 192.168.237.199 and force stop user program.
15 to 29 sec	Reset security and set HTTP port to port 80
30+ sec	Restore factory defaults or saved image (if previously saved)

SETUP Pushbutton Switch Operation – Controller Running

3 to 10 sec	Format the SD card. The card must be inserted and not already formatted (to avoid accidently destroying existing recorded data)
> 10 sec	Reset Ethernet IP address to 192.168.237.199

Local HMI (Option)

The Local HMI (Human Machine Interface) is an option that provides access to registers and alarms within the Scadaflex II controller in addition to firmware version, IP address and cell# information (if a cellular option is installed).

The HMI consists of a four line alphanumeric display and a 6-key simplified keypad.

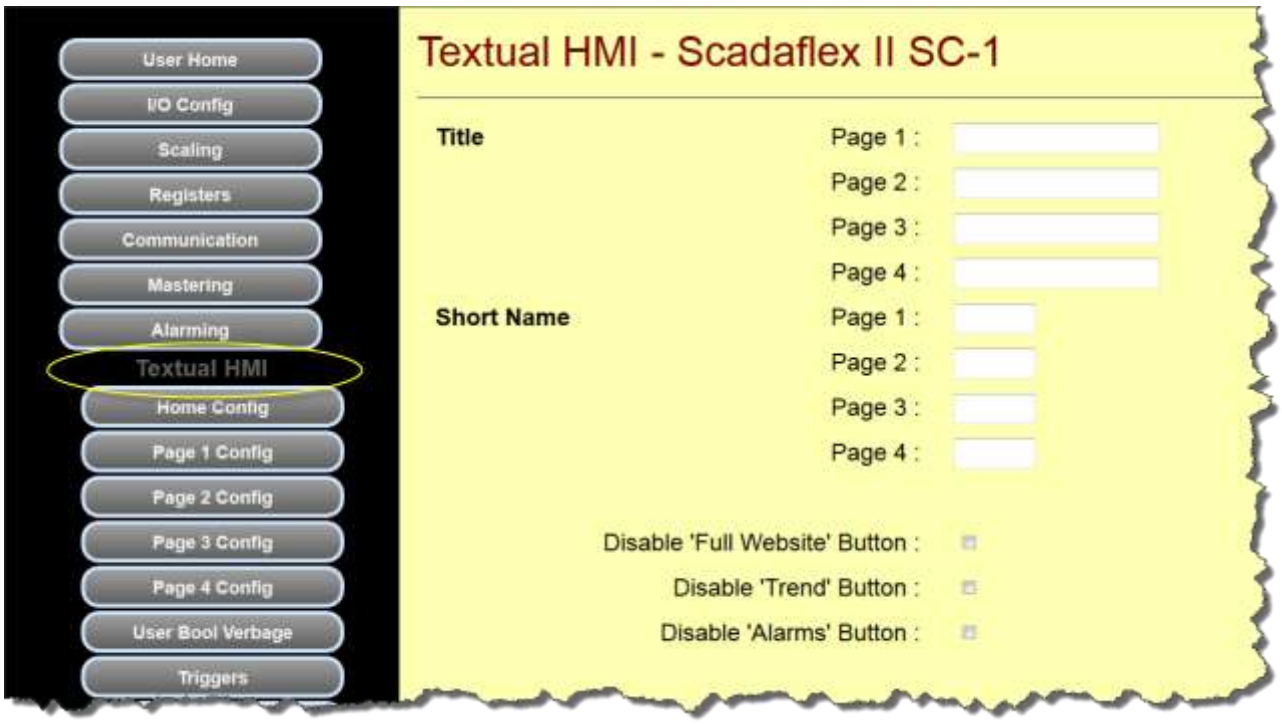
Initial IP Address(es) and Cell# Display

When the controller is first powered up, the display shows the software version and Ethernet IP address of the controller. In addition, if a cellular modem is installed, the lower half of the display shows the cellular IP address (if data mode is enabled) and the telephone number (used for text messaging).

This same screen can be brought up at any time by pressing and holding the ESC key for a couple of seconds and then releasing it.

Register Access

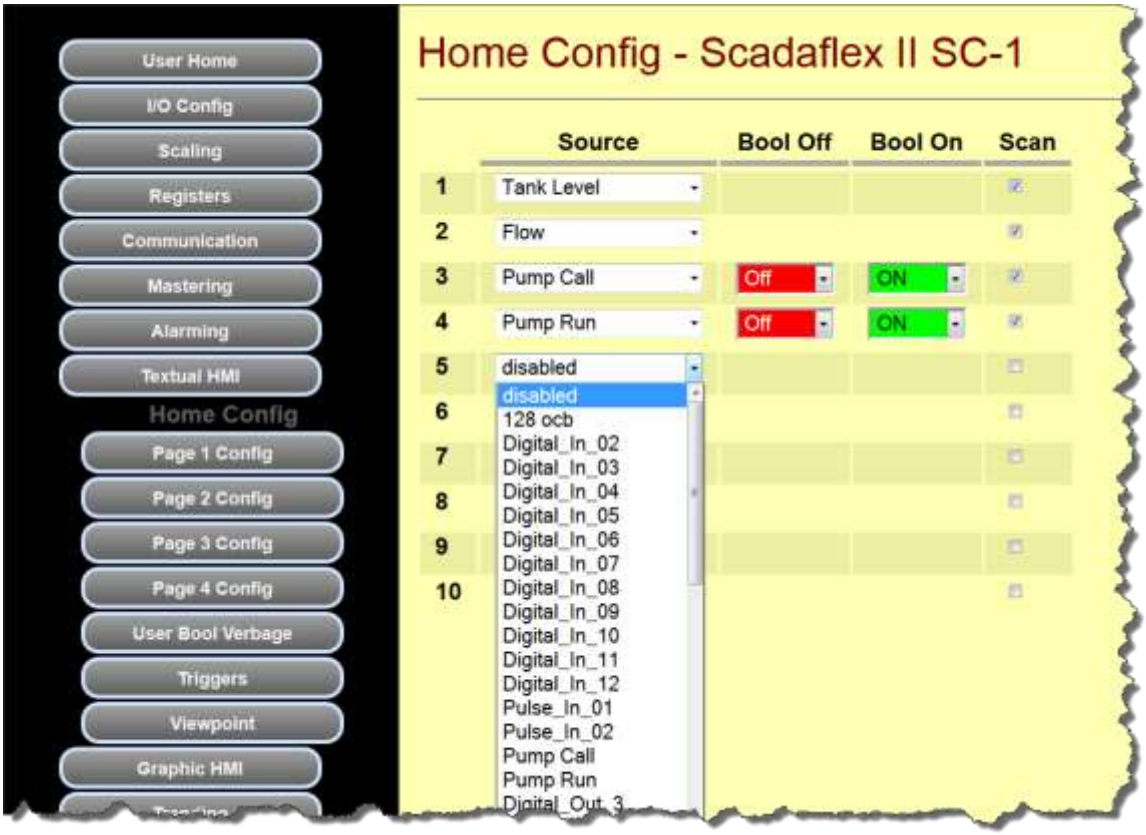
Register access is configured in the Textual HMI section of the Configuration pages. There are a total of 5 pages (the Home page and pages 1 through 4), each with up to 10 registers. On the first configuration page you can assign Titles to pages 1 through 4. The “Short Names” and disable buttons lower on the page are not used by the local HMI (they are used by the Mobile Textual HMI).



Registers to be accessed are selected on the “Home Config” and “Page n Config” pages. Any I/O point or register that has been marked as “visible” (in the I/O Config and Registers sections) will show up in a selection list in the “Source” column for the 10 items to be accessed on that page.

Boolean items have selectors for selecting the text to be displayed for Boolean states (i.e. “on”, “off”, “running”, “stopped”, etc). The Boolean State verbage can be configured as described later in this section. The color selectors are not used by the local display (mobile web page access only).

The HMI can be configured to automatically cycle through display of registers whose “scan” check boxes have been checked.



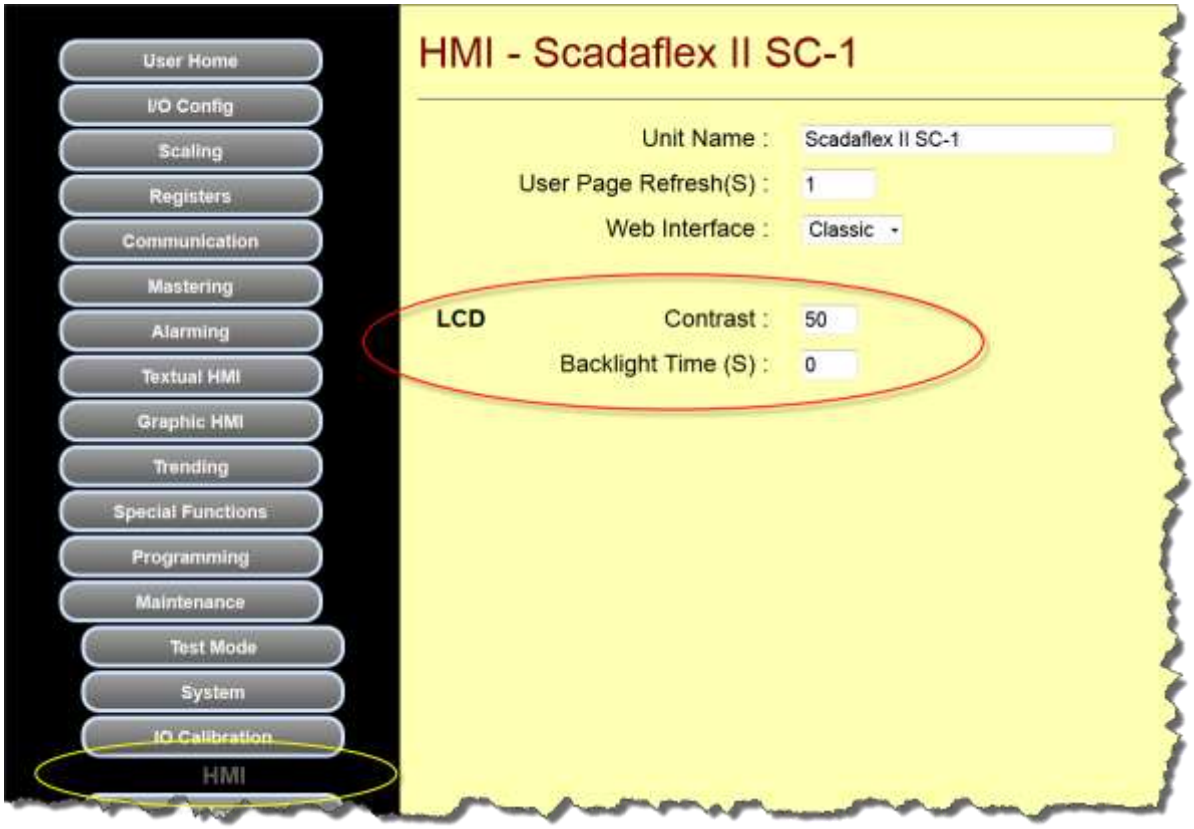
Using the Local HMI

One register at a time is displayed on the Local HMI. The **LEFT** and **RIGHT** keys are used to select pages. The **UP** and **DOWN** keys select individual registers on a page. Holding down the **DOWN** key for a couple of seconds enables the HMI scan mode to cause the sequential display of any registers that have their “scan” checkbox checked. Press the **ESC** key to stop the register auto scan operation.

Any registers marked as “Write Enabled” in the Register configuration section can have their values changed through the Local HMI. Writable registers are indicated with an underline beneath their value. To change the value of a register, press the **ENT** key. Use the **UP** and **DOWN** keys to raise or lower the value. Use the **LEFT** and **RIGHT** keys to select individual digits. When finished, press the **ENT** key to lock in the change. If you don’t want the change to take effect, press the **ESC** key before the final **ENT** press.

Backlight Control

The operation of the Local HMI backlight is controlled by settings on the main **CONFIGURATION | MAINTENANCE** page. The contrast can be adjusted from 0 to 100 percent to accommodate various viewing angles. The original Scadaflex II controllers used LCD displays with LED backlights. The Backlight Time set how long the backlight is turned ON after a key press. For the OLED display, this control simply turns the display on and off. Also, the contrast adjustment has only a slight affect on display brightness. The contrast is always very high by nature. OLED displays do have a finite life, so turning the display off when it is not used is a good idea. If there is no keyboard activity, the backlight/display is turned OFF after the number of seconds specified in order to conserve power. Setting the Backlight Time to 0 leaves the backlight/display ON all the time.



For the older **LCD displays**, the additional power consumption attributed to the LOCAL HMI with the backlight ON or OFF is shown in the table below:

		Average Power Draw			
Controller	**Test Conditions**	**12V (mA)**	**24V (mA)**	**12V (W)**	**24V (W)**
HMI Display	LED backlight OFF	**8**	4	**0.10**	0.10
	LED backlight ON	**35**	17	**0.42**	0.41

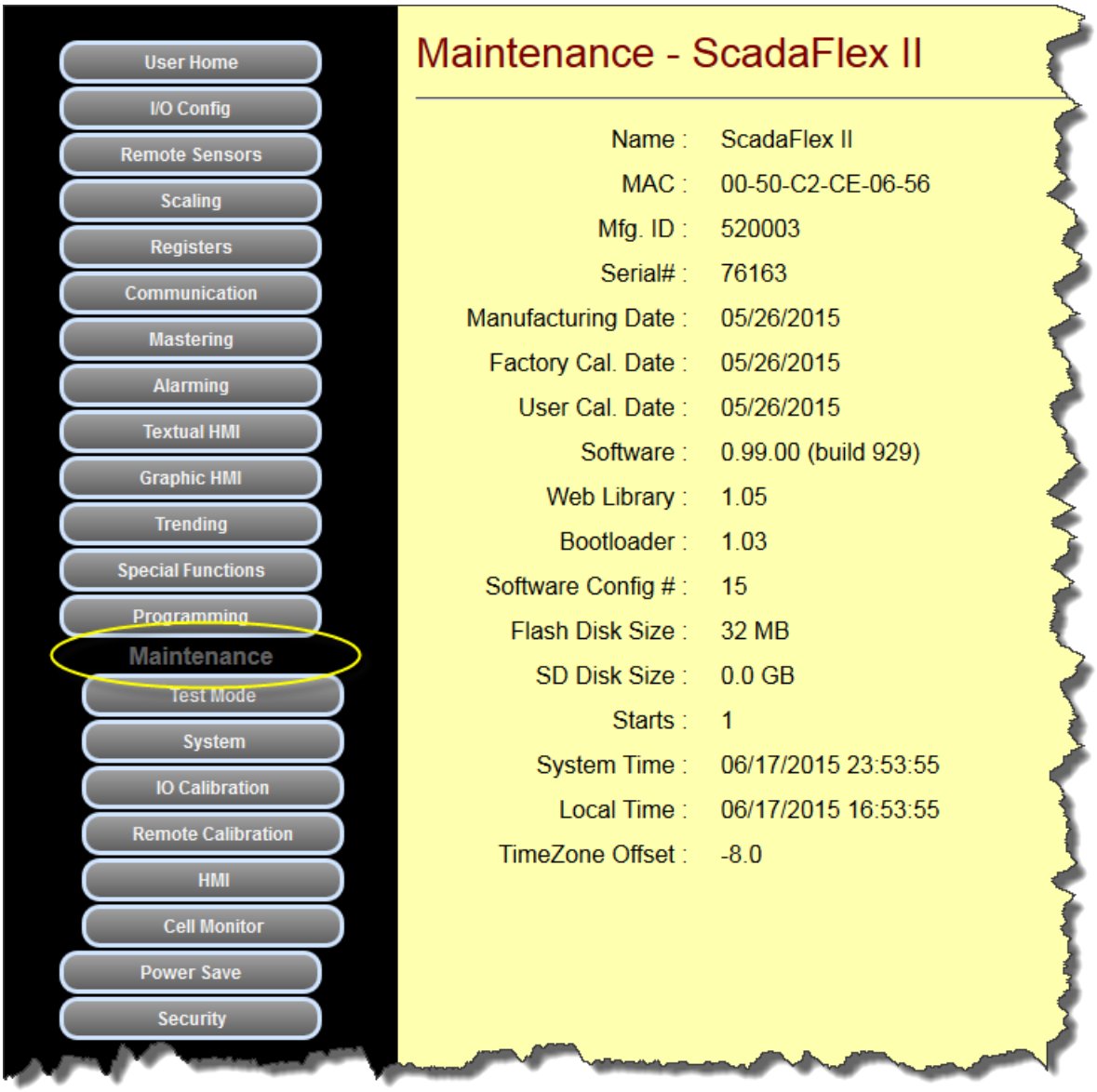
For the newer **OLED displays**, there is negligible difference in power consumption when the display is on or off.

Maintenance

General

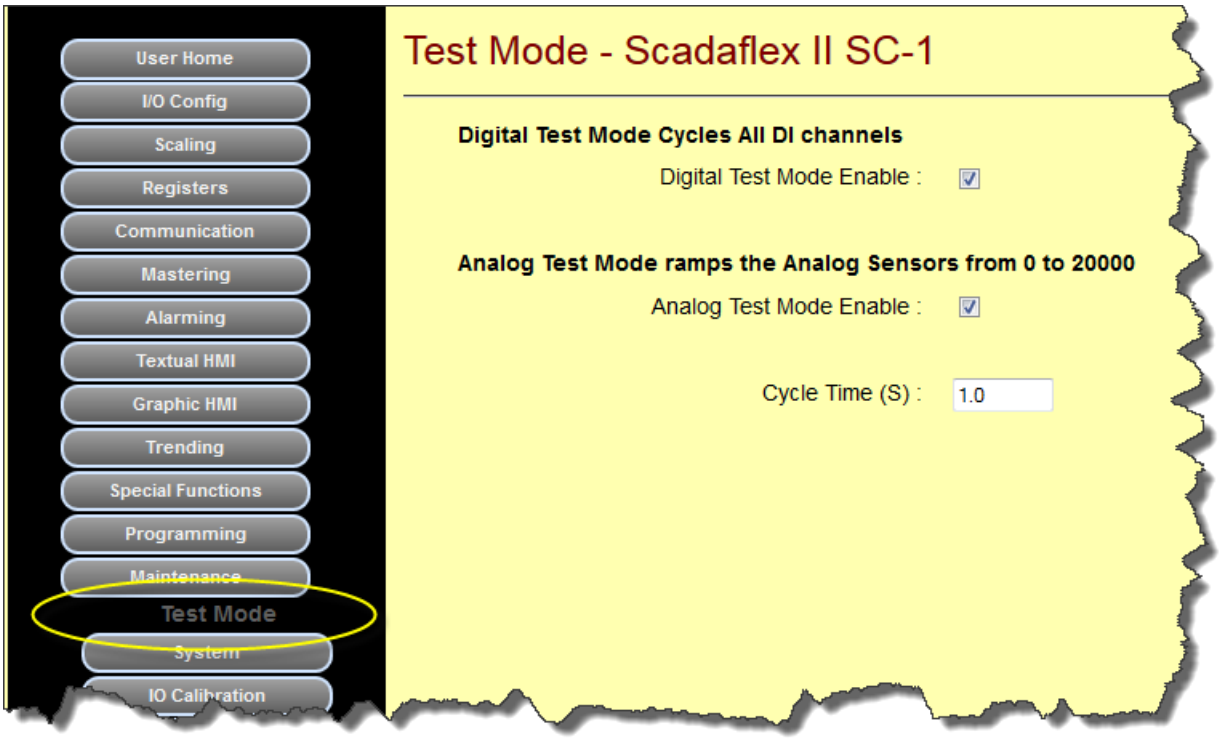
On the Configuration pages, there is a section entitled “Maintenance” (near the bottom of the menu on the left-hand side). This section has functions useful for installation, support (such as backup and restore) and I/O calibration.

The main Maintenance web page (sample shown below) gives basic hardware and software information for the controller. You may be asked to relay some of this information to technical support if you are receiving help from them.



Test Mode (I/O Simulation)

Scadaflex II controllers have a built-in I/O simulator. This test function can simulate ramping analog inputs and cycling discrete inputs. The ramping and cycling rate are adjustable in 0.1 second increments.

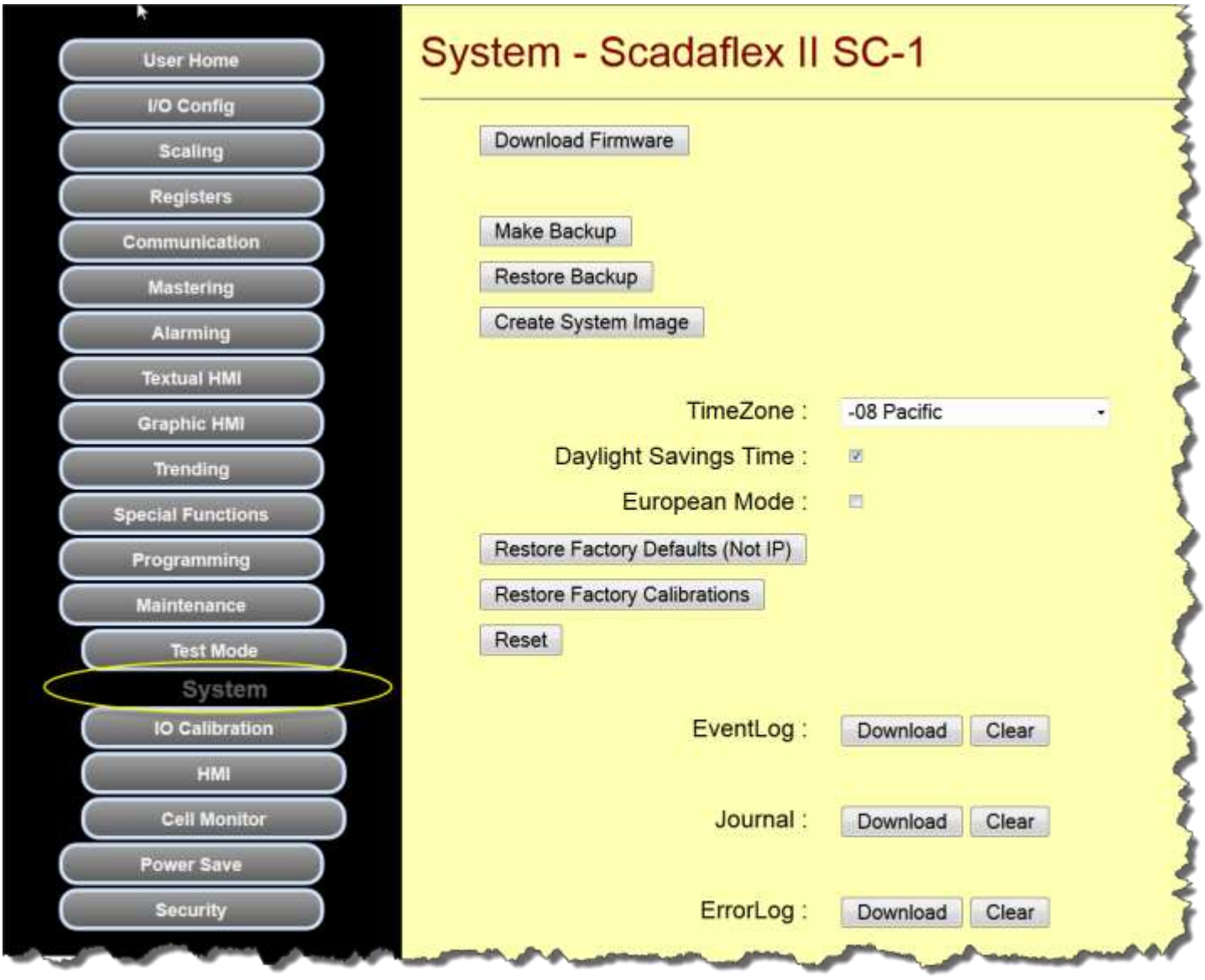


The test mode functionality is especially useful during system startups, where not all of the sensors may be installed at remotes sites and a second person is not available to force I/O values. By enabling the simulation of analog and discrete inputs, the other portions of the system including the communications links, trending and control configuration can be tested.

System Maintenance Functions

A collection of system maintenance functions are supported on the **CONFIGURATION | MAINTENANCE | SYSTEM** page. These functions include:

- Installation of software updates
- Creating and Restoring configuration backup files to/from your computer
- Creating a backup system image in the controller
- Setting the local time zone, daylight savings and local numbering system mode
- Restoring Factory Default Settings
- Restoring Factory Default Calibration Values
- Resetting the Controller (same as cycling power)
- Retrieving and Clearing System Log files
- Formatting the historical trending micro SD memory card



Installation of Software Updates

The firmware of the Scadaflex II controller is contained within two files:

- scadafx2.sfsxxxxx Main system firmware file (xxxxx is the version number)
- IclMagic.wfsxxx Graphical components file (xxx is the version number)

Before doing a firmware update, always back up your configuration as described in the next section.

Installing firmware updates requires no external program. The same tool is used to update both the main firmware and the IclMagic (graphics) file. Simply . . .

1. Click on the “Download Firmware” button, and the downloader pop-up window will appear.
2. Use the “Browse” button to navigate to the new firmware file on your computer or "drag" the file onto the browse button.
3. Click on the “Download Firmware” button to start the download process

The downloading of the main system file is a 4-step process . . .

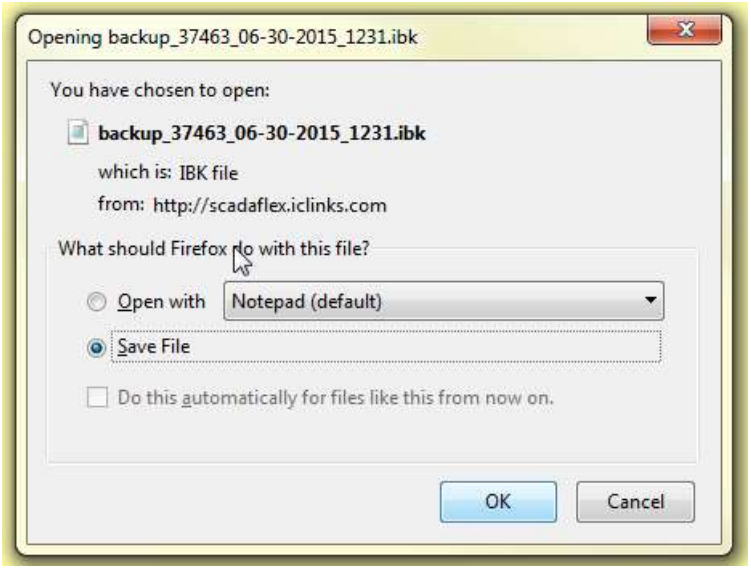
1. Downloading – transfers file to the Controllers internal disk drive
2. Unpacking – decompresses the file
3. Verifying – Verifies the file integrity
4. Installing – Replaces the existing system firmware with the new code

If the new firmware requires an update of the graphics file, you will see a pop-up error message on the User Home Page.

Installation of the IclMagic file is only a two-step process; downloading and installing.

Creating and Restoring configuration backup files to/from your computer

You can make a backup of a controller configuration by simply clicking on the "Make Backup" button. A dialogue box will appear to prompt you as to where you want to save the backup on your disk.



The backup file is named:

backup< date stamp >.ibk

This file is largely a text file (yes, you can edit it in a text editor if you choose to).

If you want to rename the file, please keep the beginning of the name ("backup") and the extension (.ibk) intact.

To restore a backup file, simply . . .

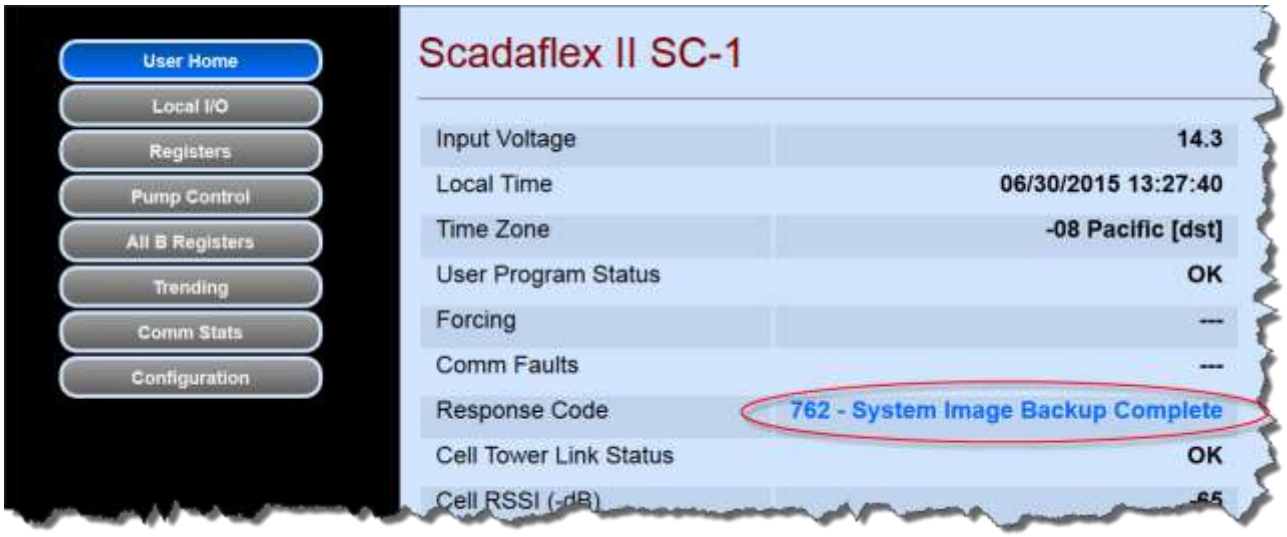
1. Click on the "Download Firmware" button, and the downloader pop-up window will appear.
2. Use the "Browse" button to navigate to the backup file on your computer.
3. Click on the "Download Backup File" button to start the download process

Creating a backup system image in the controller

A system image is a backup that is retained on the flash disk in the controller. The system image can be restored at any time without a computer so this capability is useful to support less technical customers in the field.

To create a system image, simply click on the “Create System Image” button. The system imaging process can take a few minutes so it is done in the background of all other operations. When the imaging process starts, a status message and progress (percent done) value is displayed on the User Home Page.

When imaging is complete, the status is updated:

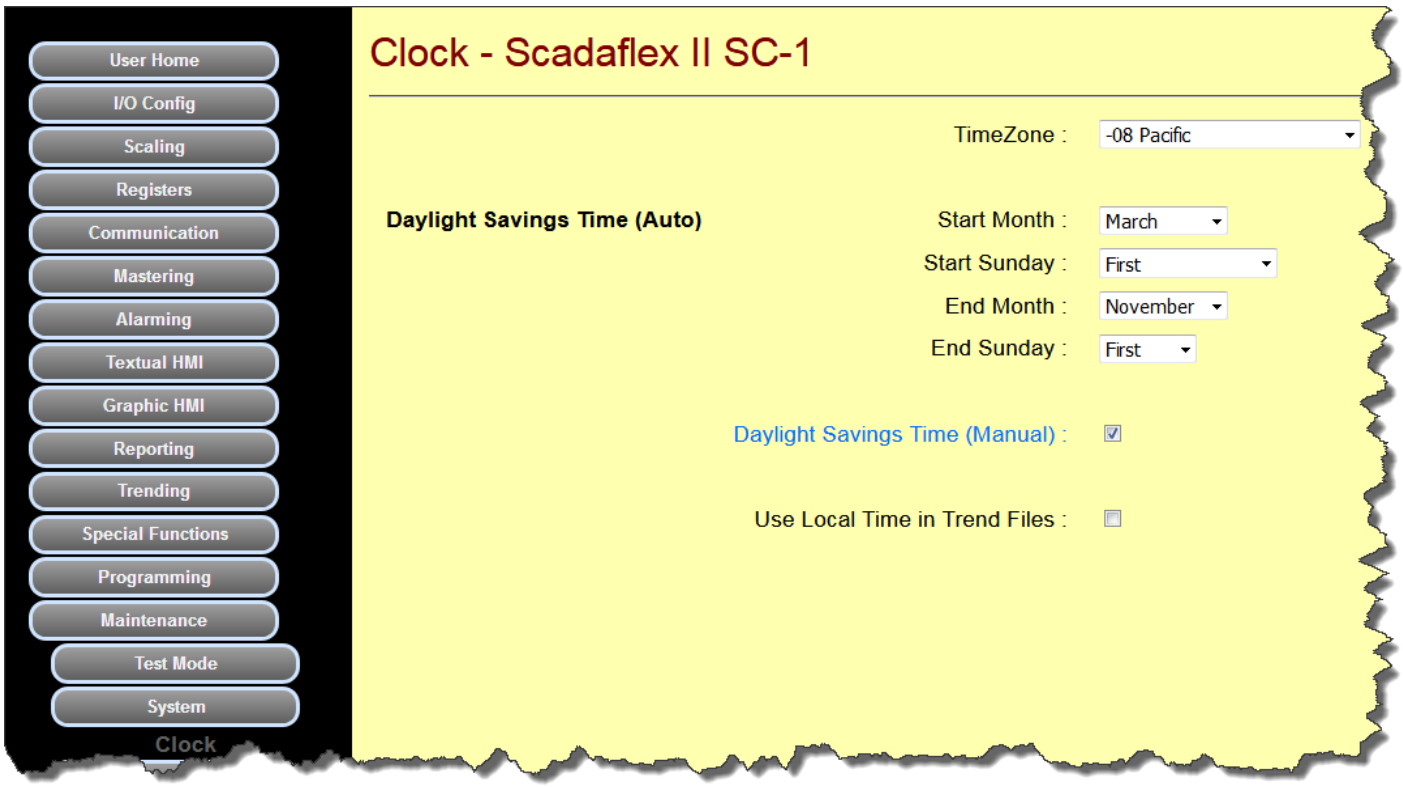


Restoring from a backup system image in the controller

To restore from an internal system image, cycle the controller power while holding in the Setup button for 30 seconds (remember to disable the battery on battery backed units). The ST and RSSI LEDs will blink alternately at ever increasing rates the longer the button is pressed. At the highest rate (after 30 seconds) the image is restored and the LED indicators will resume normal operation (see OPERATION section).

Setting the local time zone, daylight savings

The Scadaflex II has a built-in clock and calendar. The clock/calendar can be updated either manually or automatically in several ways (via the Internet or from a cell tower). Daylight savings can be set automatically by defining when it should start and stop. Checking the "Daylight Savings Time (Manual)" box forces daylight savings to be turned on. This checkbox is also available as a system variable that can be accessed by the HMIs and programming environment.



European Mode

Great Britain and the United States are two of the few places in the world that use a period to indicate the decimal place. Many other countries use a comma instead. The decimal separator is also called the **radix** character. Likewise, while the U.K. and U.S. use a comma to separate groups of thousands, many other countries use a period instead. Some countries separate thousands groups with a thin space. The table below shows some commonly used numeric formats.

Locale	Large Number
Canadian (English and French)	4 294 967 295,000
Danish	4 294 967 295,000
Finnish	4 294 967 295,000
French	4 294 967 295,000
German	4 294 967.295,000
Italian	4.294.967.295,000
Norwegian	4.294.967.295,000
Spanish	4.294.967.295,000
Swedish	4 294 967 295,000
GB-English	4,294,967,295.00
US-English	4,294,967,295.00
Thai	4,294,967,295.00

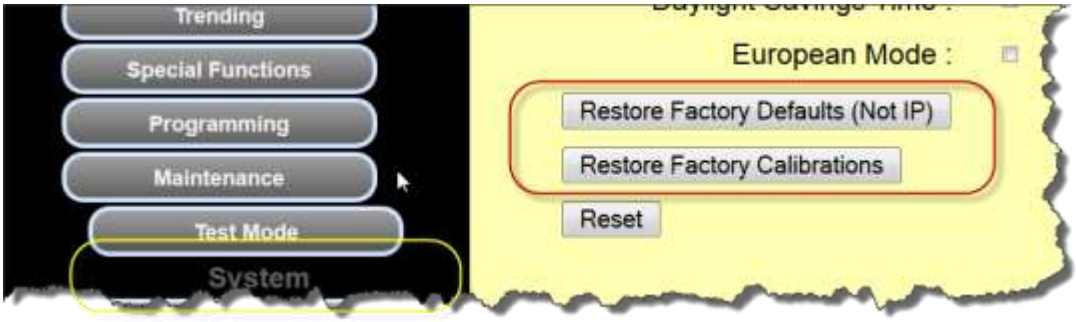
Also, outside of the United States and Great Britain, semicolons are frequently used to delimit spreadsheet files.

To support numeric displays and proper formatting of sheet files extracted from the controller in other countries, select the “European Mode” checkbox on the **CONFIGURATION | MAINTENANCE | SYSTEM** page.

Restoring Factory Default Settings (Not IP)

Restoring Factory Default Calibration Values

Two buttons on the **CONFIGURATION | MAINTENANCE | SYSTEM** page are used to restore the controller configuration back to the values set by the factory. The “Restore Factory Defaults (Not IP)" button clears out any user entered configuration other than the IP address (so you don’t get cut off from the controller when operating remotely) and the I/O calibration. Likewise the “Restore Factory Calibrations" button independently restores the I/O calibration values originally set by the factory.



Reset

Clicking on the “Reset” button duplicates cycling power on the unit. Some configuration changes require a controller reset which may not be practical when supporting a controller remotely.

Retrieving and Clearing System Log files

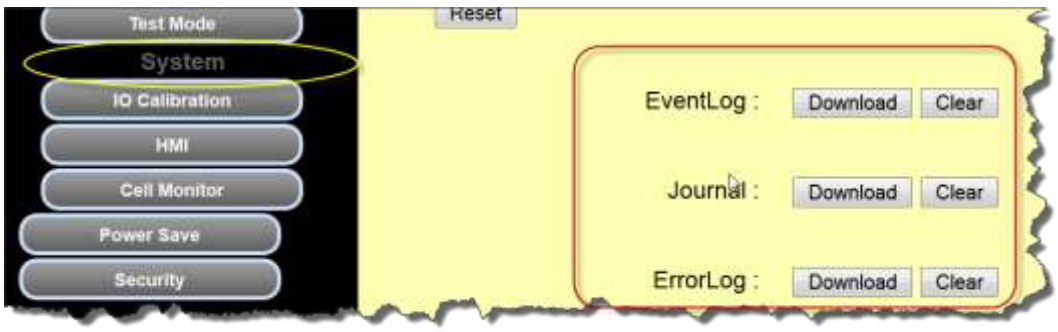
The Scadaflex II controller maintains three different types of logs on its internal disk drive (separate from any historical trending operations). They are:

Event Log A user driven log with entries made from a Scadaflex II user program.

Journal A log that records cellular transactions, alarm activity and responses.

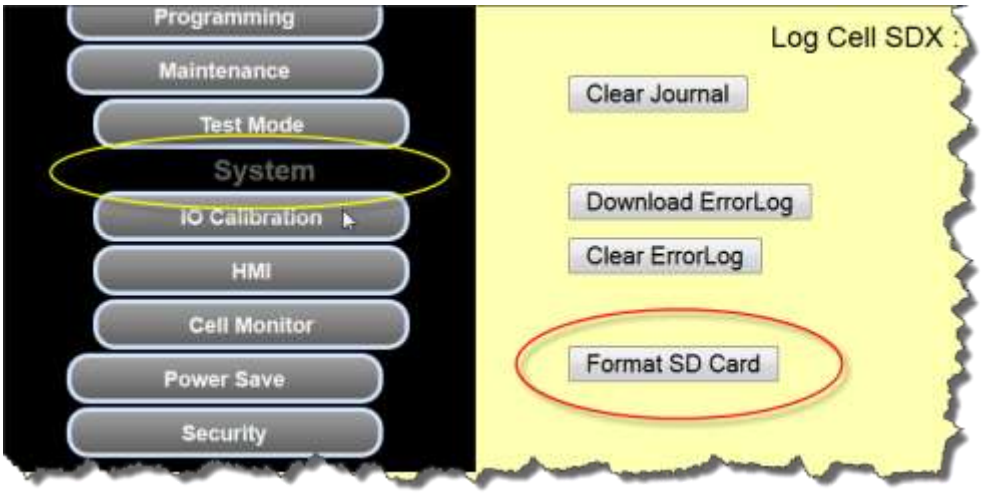
Error Log A log that records hardware related errors and maintenance activity including radio and modem errors and recovery, firmware updates, backups, etc.

All logs are in CSV spreadsheet format and can be downloaded and cleared by clicking on the appropriate buttons. The logs are “circular” overwriting the oldest data when they become full.

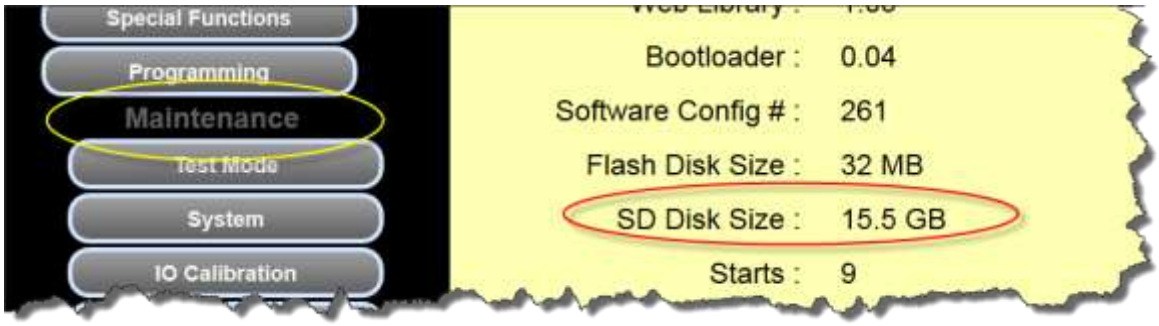


Format SD Card

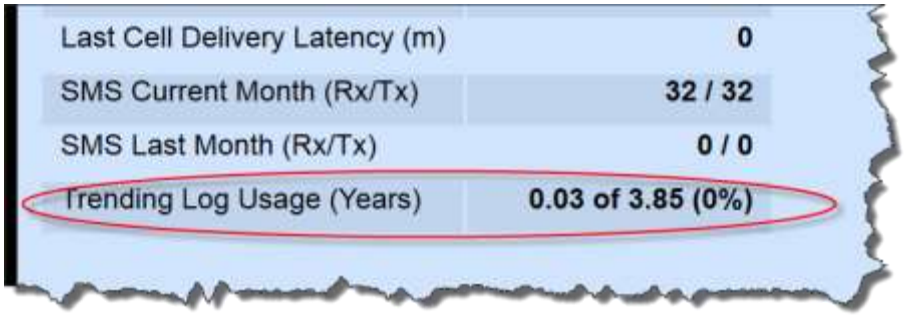
When a new micro SD card is installed in a Scadaflex II Controller, or if you wish to erase and start over using a card that is already installed, you must format it. The easiest way to do this is to go to the bottom of the **CONFIGURATION | MAINTENANCE | SYSTEM** page and click on "Format SD Card".



You can verify that the micro SD card is properly installed and formatted on the **CONFIGURATION | MAINTENANCE** page:

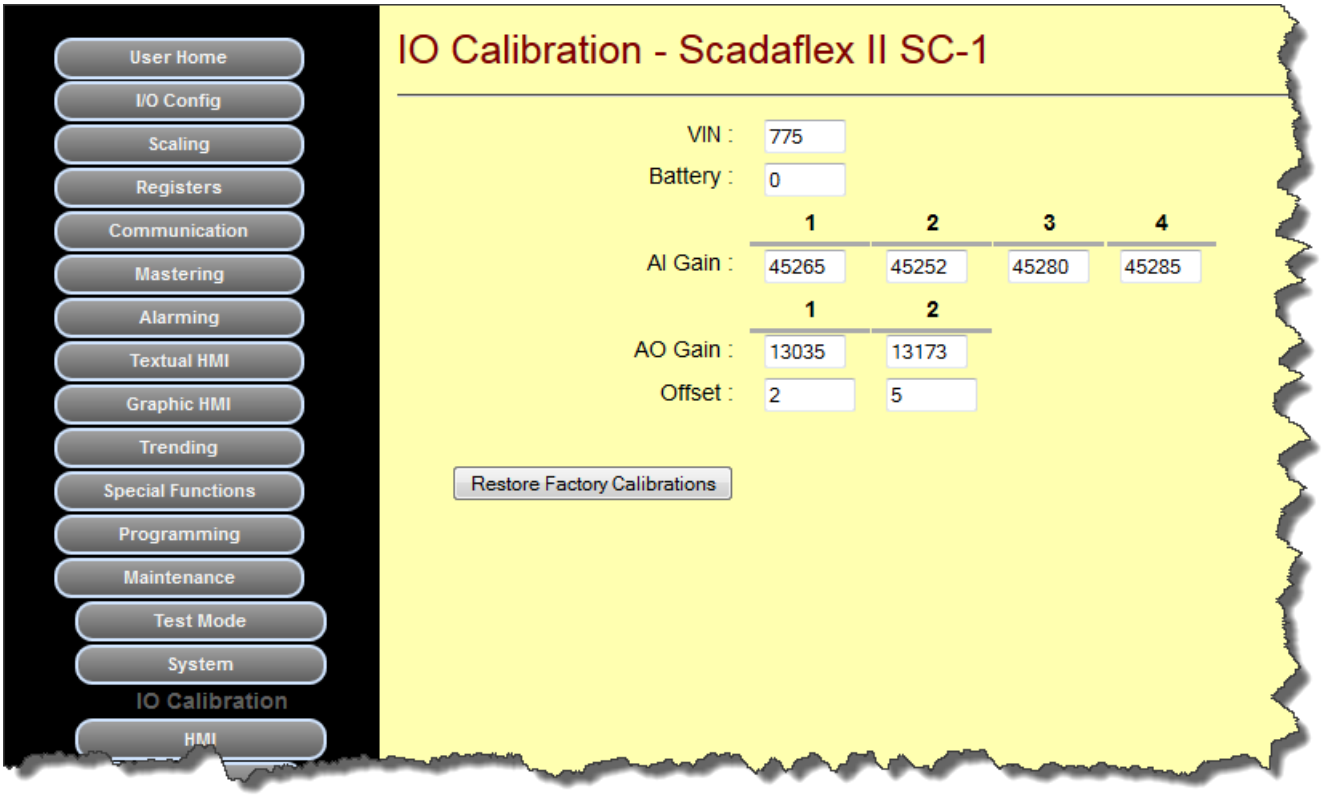


When you have trending enabled the total trending capacity (for the selected recording rate and card size) and the trending space that has been used is shown at the bottom of the user HOME page.



I/O Calibration

Scadaflex II controllers are shipped with their local I/O fully calibrated. This calibration should be checked (and adjusted if needed) at least once every year. If any calibration needs to be adjusted, the **CONFIGURATION | MAINTENANCE | IO CALIBRATION** page provides calibration access. There is also a button to restore the original factory calibration.

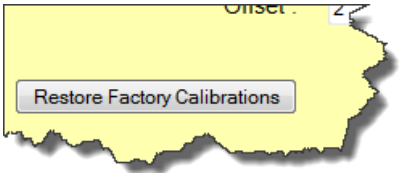


Calibration - General

Calibration is best done by opening two separate browsers; one to display the measured levels (for Input Power (Vin), Backup Battery Voltage, and the analog inputs) or to set the outputs (for analog outputs); the other for accessing the calibration web page (**CONFIGURATION | MAINTENANCE | IO CALIBRATION**). As adjustments are made on the calibration page the results can be seen on the User pages.

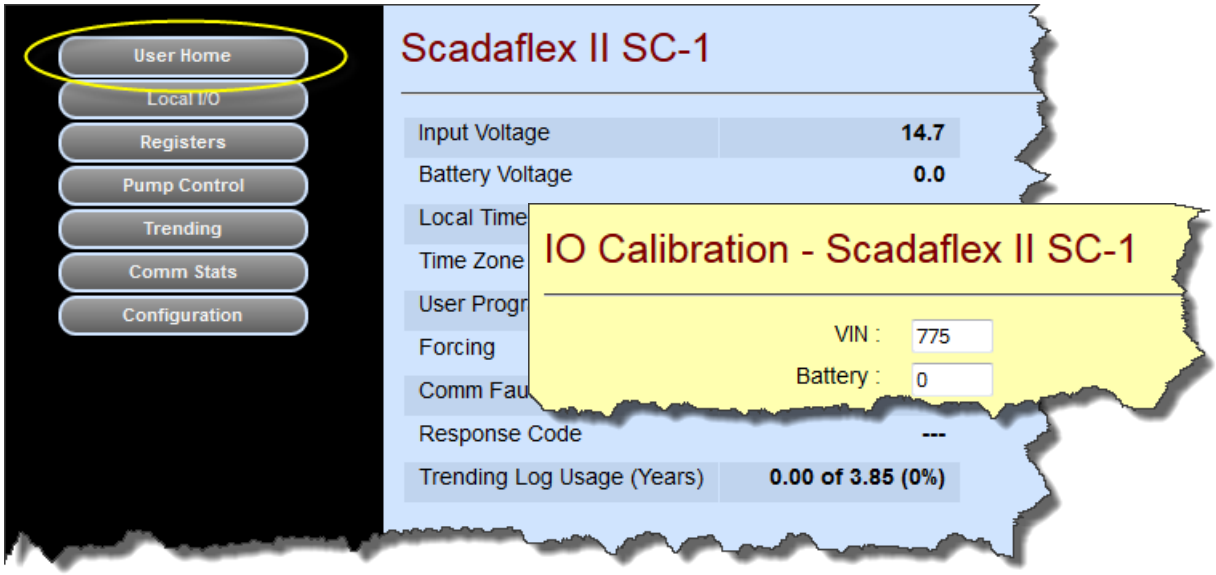
Calibration - Restoring Factory Values

The remainder of this section describes how to change the calibration of a Scadaflex II controller I/O. If you make a mistake while making these changes and need to get back to the original factory settings you can click on the Restore Factory Calibrations button.



Vin and Battery Voltage Calibration

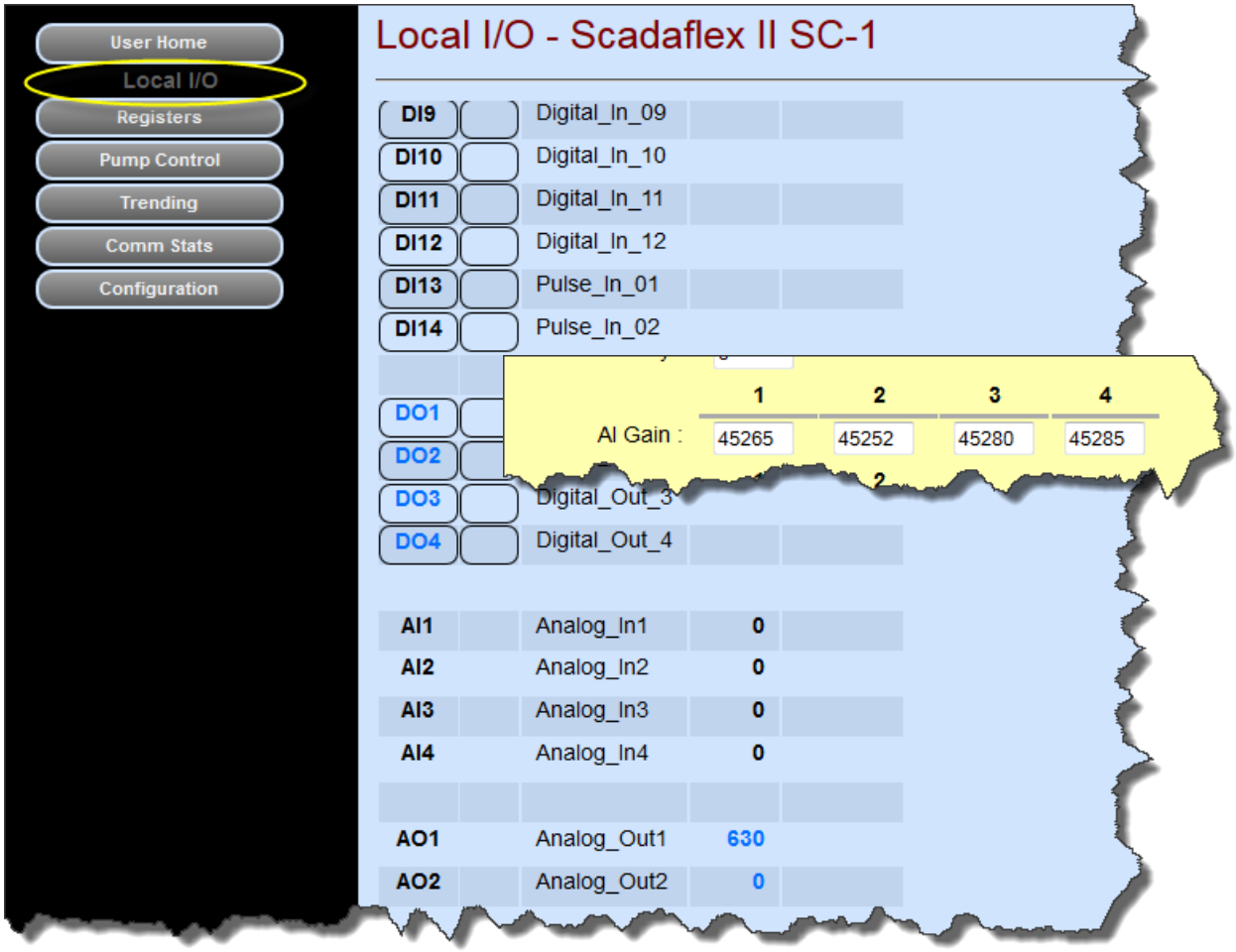
The Input Voltage and Battery voltage can be seen on the User Home Page:



For calibration verification and adjustment, measure the Input Voltage or Battery Voltage. If needed, adjust the calibration values (**CONFIGURATION | MAINTENANCE | IO CALIBRATION** page) to get the correct readings on the Home Page. Battery calibration is not required if the backup battery option is not installed.

Analog Input Calibration

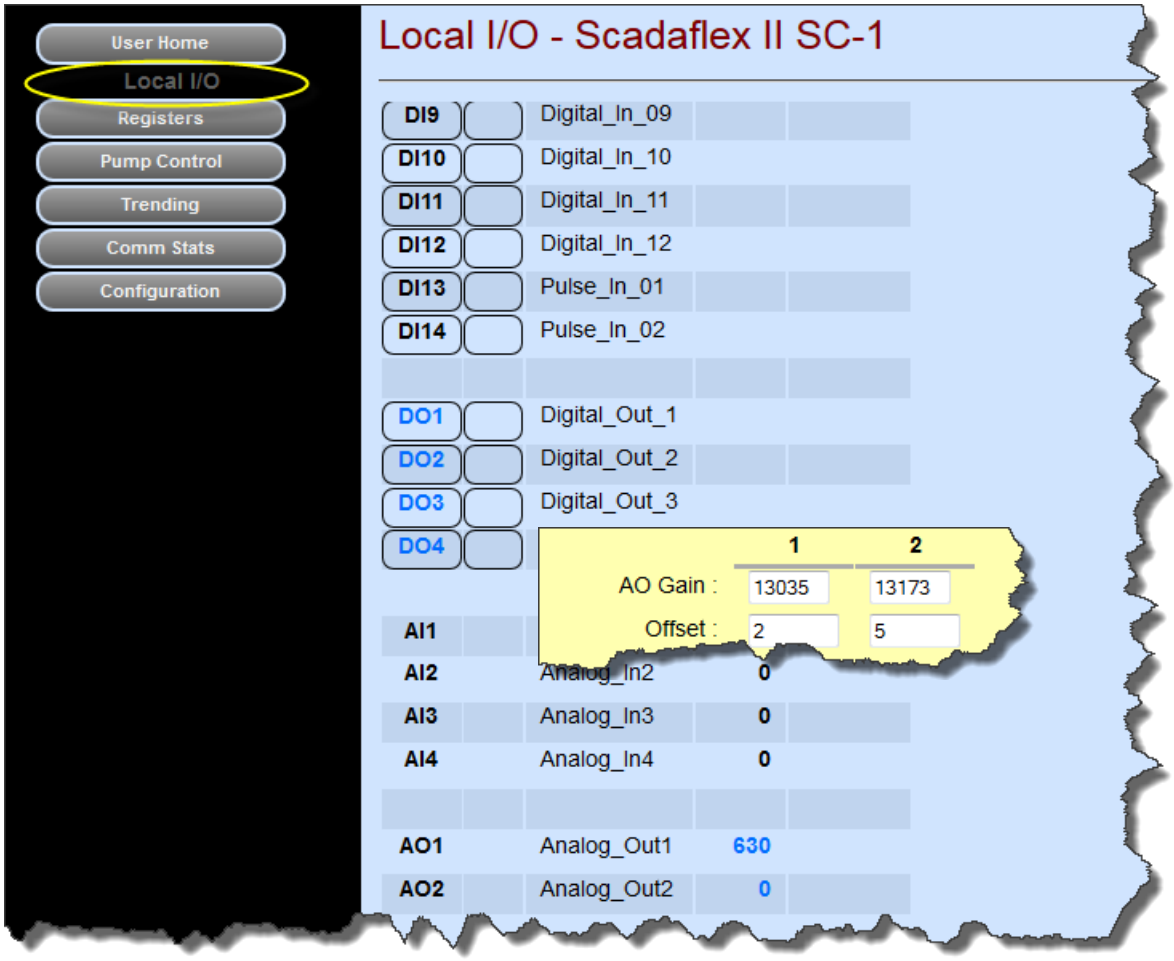
The analog input readings can be seen near the bottom of the User Local I/O page:



For calibration verification and adjustment, apply a known input from a 20mA loop calibrator on each channel one at a time. If needed, adjust the calibration values (**CONFIGURATION | MAINTENANCE | IO CALIBRATION** page) to get the correct readings on the Local I/O Page. The readings are in micro amps; 4mA should read as 4000, half scale (12mA) should read 12000 and full scale (20mA) should read as 20000.

Analog Output Calibration

The analog output settings can be seen at the bottom of the User Local I/O page:



For calibration verification, connect a digital meter to the analog outputs. You can click on the blue analog output settings to change them. Be sure that nothing else in the controller is trying to set them at the same time (such as a user program).

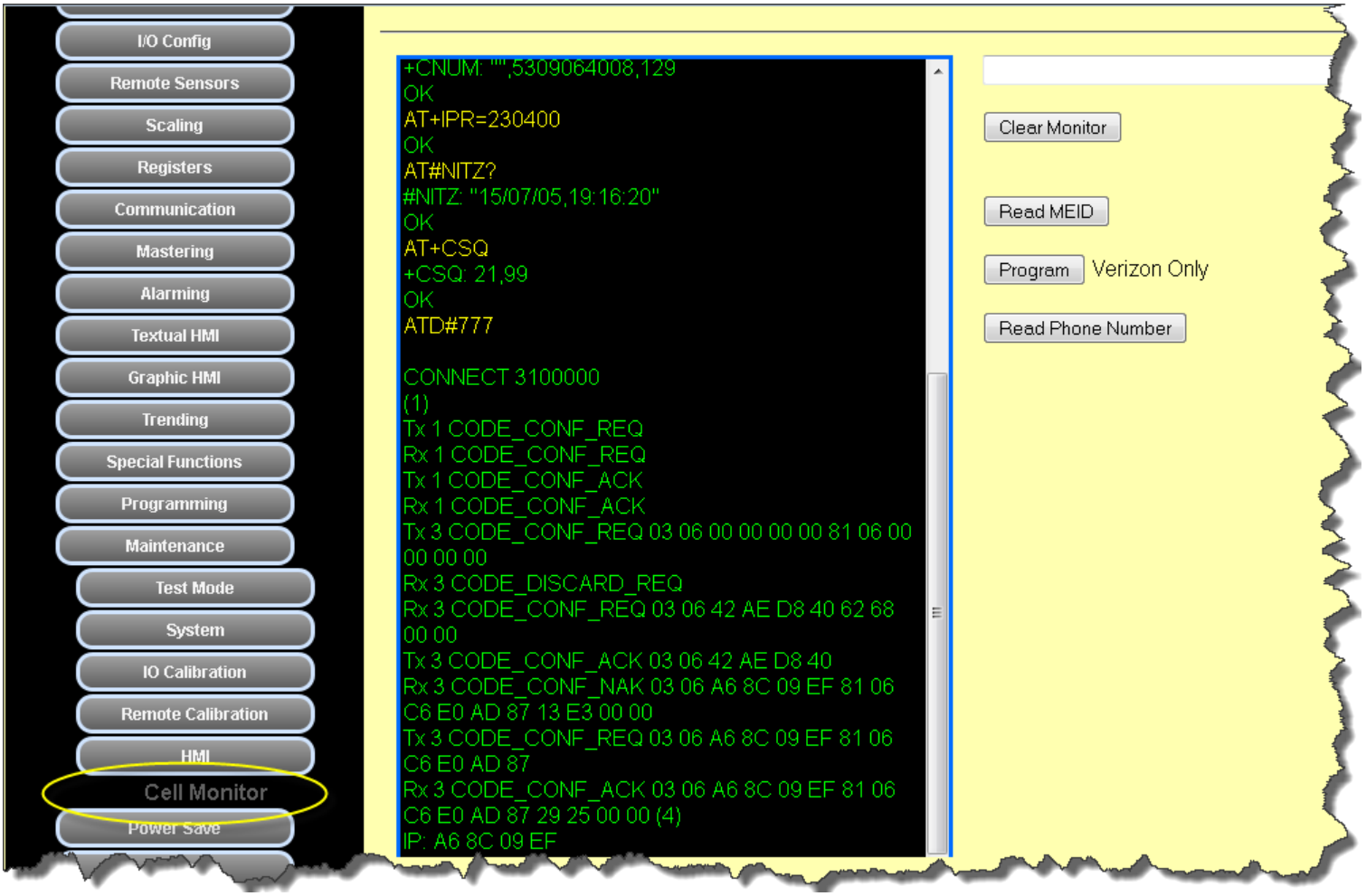
With the analog outputs set to 0, verify that your meter reads 0uA. Adjust the Offset values if they do not read 0.

For analog output (AO) gain calibration, check the outputs at three points; 4000 for 4mA, 12000 for 12mA and 20000 for 20mA. If needed, adjust the AO Gain calibration values (**CONFIGURATION | MAINTENANCE | IO CALIBRATION** page) to get the correct readings on the digital meter.

Cellular Data Monitor

There is a cellular data monitor that can be used to troubleshoot cellular link and modem issues on the **CONFIGURATION | MAINTENANCE | CELL MONITOR** page. You may be asked by Technical Support to capture (screen print) some of this traffic to help troubleshoot unusual cellular link problems.

The monitor window in the center of the page shows the ASCII message traffic between the controller and the cellular modem; the yellow text is message traffic to the modem and the green text is message traffic from the modem. Low level AT commands may be inserted into the message stream to the modem using the entry field at the upper right-hand corner.

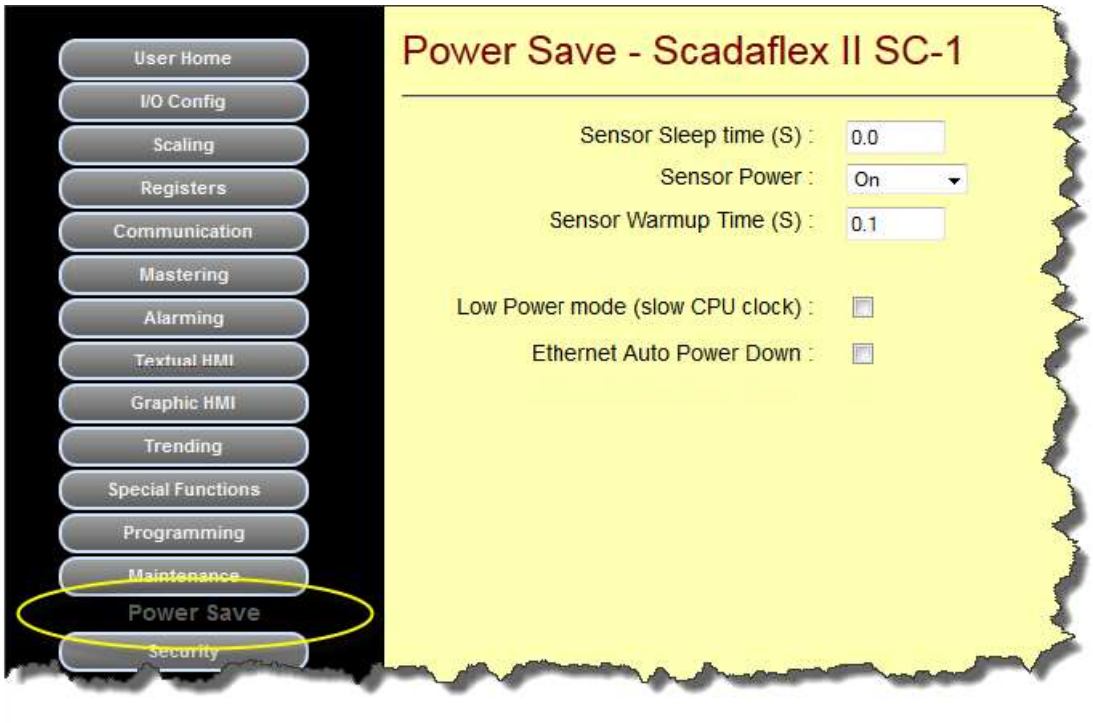


Power Management

Scadaflex II controllers can be configured to operate with less system power consumption. This is accomplished by managing the power supply that powers the sensors, reducing the speed of the internal microprocessor, and configuring the Ethernet port to automatically power down when not connected to an Ethernet device.

The controller power consumption under various operating settings is detailed in a table at the end of this manual (after the specifications).

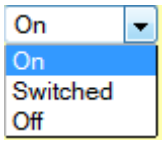
These functions are configured under **CONFIGURATION | POWER SAVE**.



Sensor Sleep Time (S)

Setting this parameter causes the analog inputs to be sampled at a reduced rate. The time value specified is the "sleep" (inactive) time between measurements. While sleeping, the sensor power is turned off if the Sensor Power control (below) is set to "switched".

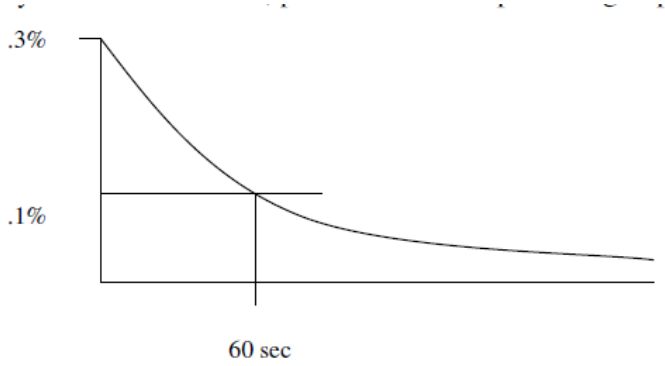
Sensor Power



This setting controls the sensor power output that is used to provide regulated loop and sensor device power (+VA). The setting may be set to ON, SWITCHED or OFF. ON leaves the sensor power output energized at all times. OFF leaves the output disabled for maximum power savings when it is not needed. SWITCHED turns the sensor power ON only when required to briefly power the sensor(s) and take a reading. Between readings, the output is de-energized.

Sensor Warm-up Time

Most sensors require a little time to stabilize when powered on. This setting represents the amount of time that the controller will turn ON the sensor power ahead of sampling the analog inputs. There is usually a tradeoff between sensor warm-up time and reading accuracy. For example, the curve on the right was supplied by Gems, a sensor company.



For this particular sensor, the readings will be within about 3% accuracy if read immediately after being powered on, but about 3 times better than that with a 60 second Sensor Warm-up Time.

Managing sensor power with the above three settings can significantly reduce system power consumption. For example, let's say that we need to keep track of a tank level that won't change much between readings taken every 15 minutes. The sensor power output (+VA) of the controller provides 15Vdc. A current loop device left ON continually will consume as much as 20mA (full output) or 0.3 watts per hour (per sensor). That's the same amount of power required by the entire controller (without using Ethernet)! If the Sensor Powered is switched ON say for just 2 seconds per reading every 15 minutes, that consumption figure drops to 0.00067 watts per hour (per sensor)—a 450x improvement!

Low Power Mode (slow CPU clock)

Slowing the operating speed of the controller's CPU can reduce the overall power consumption by as much as 10%. Be careful as web page responsiveness, trend report generation and user program scan time will be severely degraded with a slower CPU clock.

Ethernet Auto Power Down

Ethernet support consumes a significant amount of power. If this box is checked, the controller will put the Ethernet section to sleep when an Ethernet device is not connected. When an Ethernet device is reconnected, the Ethernet section is automatically powered up.

Some other devices besides the controller (such as many laptops) support Ethernet Auto Power Down. When they don't detect an Ethernet connected device, they put their own Ethernet section to sleep. That can be a problem if Ethernet Auto Power Down is also enabled in the controller since both the controller and the device will put the Ethernet sections to sleep because the other end is not active. To avoid this situation, the controller briefly turns on its Ethernet interface when first powered ON or when the "Setup" pushbutton is pressed even if this check box is selected.

Appendix A - Antenna Hardware

Antenna Installation and Considerations

Scadaflex II controllers with cellular or 900Mhz radio options, and wireless I/O modules come with omni-directional whip antennas. The antennas screw into sealed connectors at the top of the enclosure. The antenna connectors are polarity encoded; RPSMA (Reverse Polarity SMA) for 900Mhz standard and meshing radios and SMA for the cellular modem.

900MHz Radio antennas - The supplied antennas are appropriate for radio ranges of up to about a 1/2 mile for the meshing radio and about a mile for the standard radio if the controller elevation is 6 feet (or higher) above grade. Mounting the enclosure or extending an antenna to about 12 ft. or more above grade, or on a rise or other elevated location, will increase the range to several miles. ICL offers software based radio path studies to confirm radio system operation to help in designing your system. Keep in mind that other nearby radio signal sources will degrade radio system performance. Be especially aware of nearby cellular towers, municipal VHF and UHF radio systems (such as police and fire), as well as TV and radio broadcast antennas.

To achieve longer distances, a higher gain and higher elevation antenna may be installed and wired into the SMA connector on the top of the enclosure. As a rule of thumb, the higher the antenna elevation the better the radio performance. The optimum antenna elevation for a specific application should be determined by a software-based radio path study based on site GPS coordinates.

Cellular Modem antenna - Although less frequently required, an external antenna system can be used in areas with weak cellular performance. Since a SCADA system is typically stationary, a directional antenna can be pointed at the nearest cellular tower to improve link strength and quality. Contact ICL technical support if you would like help determining the optimum configuration for an external antenna system.

External Antenna System Configuration

When a more advanced antenna system is used with the Scadaflex II controller and wireless I/O modules, but sure to:

- Use a lightning arrestor and be sure that it is properly grounded (dedicated ground rod).
- Use low-loss antenna cables for runs greater than a few feet. LMR-400 is strongly recommended for exterior cables over 10 feet. Do not go over 100 feet.
- Be sure to weatherproof all exterior connectors after fully testing the system.
- Keep in mind that in a 900Mhz radio system that uses meshing technology that each node may be used as a repeater so they should be "reachable" by the other units. They typically use omni-directional antennas. Non meshing 900MHz radio systems will typically use directional antennas pointed back to the master which will typically have an omni-directional antenna.

High-quality compatible pre-tested antenna system components are available from Industrial Control Links and can be ordered as a "ready-to-install" kit shipped with your Scadaflex II equipment.

Antenna hardware for 900Mhz Radios (standard and meshing):

INTERNAL ANTENNA CABLES

98-6536 36” Internal Antenna Cable: RPSMA-Male (socket) to N-Male, other lengths: p/n 98-65xx (xx = inches)

EXTERNAL ANTENNA CABLES (direct connection to Scadaflex II controllers and remote I/O , 25ft. or less)

98-42xx External Antenna Cable: RPSMA-Male (socket) to N-Male (xx = ft.) Example 98-4210 = 10ft.

ANTENNAS

98-3103 3dB OMNI "Salt Shaker" Transit Antenna, Type-N Female, 902 to 928 MHz

98-3106 6dB OMNI Fiberglass Antenna, Type-N Female, 896 to 940 MHz, w/mtg hardware

98-2106 6dB YAGI Directional Antenna, Type-N Female, 896 to 940 MHz, w/ mtg hardware

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Antenna hardware for cellular modems:

INTERNAL ANTENNA CABLES

98-6136 36" Internal Antenna Cable: SMA Male to N-Male, other lengths: p/n 98-61xx (xx = inches)

EXTERNAL ANTENNA CABLES (direct connection to Scadaflex controllers and remote I/ O , 25ft. or less)

98-43xx External Antenna Cable: SMA-Male to N-Male (xx = ft.) Example 98-4310 = 10ft.

ANTENNAS

98-3402 3dB “Salt Shaker” Low Profile Dual-band Cellular Antenna 850MHz/1900MHz

98-3409 9dB Yagi Directional Antenna, Type-N Female, 700 to 2400 MHz (with radome cover and mtg h/w)

For all Radio and Cellular Systems:

EXTERNAL ANTENNA CABLES (cabinet lightning arrestor or bulkhead connector to antenna

98-40xx External Antenna Cable, LMR-400, N Male to N-Male connectors (xx = ft.) Example 98-4010 = 10ft.

LIGHTNING ARRESTORS

98-8011 Lightning Arrestor, 150MHz – 2.7GHz, bulkhead mount, N-Female to N-Female

98-8012 Lightning Arrestor, 150MHz – 2.7GHz, bulkhead mount, N-Male to N-Female

WEATHERPROOFING KIT

98-9002 Weatherproofing Kit, exterior connector weatherproofing kit for up to 10 sites

Appendix B - Specifications

Scadaflex II Controller Specifications

Scadaflex II Controllers		
Analog Inputs:	**4**	16-bit: individually settable as 20mA, 5V, +/- 250mV, or 65K ohms ranges
Analog Outputs:	**2**	12-bit: 20mA (standard) [5Vdc or 10Vdc w/external precision resistor] Loop power is from input power
Discrete Inputs:	**12**	Optically Isolated, 12/24V AC/DC (30Vdc/Vac max)
Pulse Inputs:	**2**	Contact closure or 0 to 30Vdc, up to 10Khz each, Weigand support
Discrete Outputs:	**4**	**SC-1**: Protected FET, up to 30Vdc, 1A each
		SC-2: Relays with shared common, up to 30Vdc/250VAC, resistive, 3A each, 8A total maximum
Ethernet Ports:	**1**	10/100 Base-T, RJ-45 connector
Serial Ports:	**1**	RS-232/RS-485, RJ-45 connector
Internal Radio Option:	**1**	License-free 900MHz, up to +24dBm (1/4 W) maximum TX power, up to -110 dBm sensitivity (standard, 9600 baud), -100dBm (mesh), with 2dB whip antenna, RP SMA connector for external antenna
Cellular modem Option	**1**	4G/LTE data and/or SMS – Verizon, AT&T, T-Mobile, most all International, SMA connector for external antenna
Configuration:		By built-in web pages
Battery Backup:		3.4Ah rechargeable lithium, charge/discharge fault protected, up to 16 hours runtime, built-in trickle charger

General Specifications		
Wiring Termination:	**2**	16 position pluggable terminal blocks, 3.5mm, 22 to 14GA wires for power and field wiring
Field Wiring Entry:	**1**	Pre-drilled for ¾" conduit
Input Power:		10Vdc to 30Vdc
		WITHOUT local HMI, cellular or mesh radio **Enet** = Ethernet **no Enet** = disconnected w/auto power down
@10Vdc in		relays OFF or FET (SC1), **no Enet**: **22mA** All relays ON, **no Enet**: **102mA** All relays ON, **plus Enet**: **160mA**
@12Vdc in		relays OFF or FET (SC1), **no Enet**: **19mA** All relays ON, **no Enet: 88mA** All relays ON, **plus Enet**: **134mA**
@24Vdc in		relays OFF or FET (SC1), **no Enet**: **17mA** All relays ON, **no Enet**: **54mA** All relays ON, **plus Enet**: **77mA**
		WITH local HMI + cellular + mesh radio options **Enet** = Ethernet **no Enet** = disconnected w/auto power down
@10Vdc in		relays OFF or FET (SC1), **no Enet**: **160mA** All relays ON, **no Enet**: **240mA** All relays ON, **plus Enet**: **300mA**
@12Vdc in		relays OFF or FET (SC1), **no Enet**: **120mA** All relays ON, **no Enet**: **210mA** All relays ON, **plus Enet**: **260mA**
@24Vdc in		relays OFF or FET (SC1), **no Enet**: **80mA** All relays ON, **no Enet**: **120mA** All relays ON, **plus Enet**: **140mA**
Sensor Power Output (+VA):		Switched 15Vdc out, up to 80mA. Additional input current with +VA output power draws of 20 / 40 / 60 / 80mA are:
		@10Vdc in: 43 / 86 / 129 / 172 mA **@12Vdc in:** 36 / 72 / 108 / 144 mA **@24Vdc in:** 18 / 36 / 54 / 72 mA
Temperature:		**WITHOUT battery backup option:**-40°C to 70°C (operating), -40°C to 85°C (storage)
		WITH battery backup option (battery installed):-20°C to 40°C (operating), -20°C to 50°C (storage - 1 month)
Humidity:		<90% RH (non-condensing)
Enclosure:		8" (H) x 4"(W) x 3"(D), Polycarbonate, wall-mounting hardware provided

Scadaflex II Power Supply Specifications

Scadaflex II 12W External Power Supply		
Output Power:		24Vdc 0.5A (12watts), 240mVp-p ripple, electronic overload and over voltage protected
Wiring Termination:	**2**	16 position pluggable terminal blocks, 3.5mm, 22 to 14GA wires
Field Wiring Entry:	**1**	Pre-drilled for ¾" conduit
AC Power In:		100 to 132Vac, 47 to 440Hz
Service Outlet:		10A maximum, fuse protected (outlet source is line input)
Temperature:		-40°C to 60°C (operating), -40°C to 85°C (storage)
Humidity:		<90% RH (non-condensing)
Enclosure:		8" (H) x 4"(W) x 3"(D), Polycarbonate, wall-mounting hardware provided

LPR Remote I/O Specifications

Scadaflex II LPR Remote I/O Module		
Analog Inputs:	**8**	16-bit: 4 x 5Vdc or 20mA (order choice), 4 x 25,000 ohms (i.e. for position, temperature and soil moisture)
Discrete Inputs:	**4**	Contact closure or 0 to 30Vdc. Two inputs include 32-bit totalizers
Digital Outputs:	**2**	Latching relay contacts, 1A, 220Vdc or 250Vac maximum (60W, 125VA maximum switching power)
Ultrasonic Sensor Support	**1**	Range: 50 to 1000mm range (32.8 ft.), Resolution: 1mm
Internal Radio:	**1**	License-free 900MHz, up to +24dBm (1/4 W) maximum TX power, -100 dBm sensitivity, with 2dB whip antenna, RP SMA connector for external antenna
Configuration:		By web pages in master, automatic update upon communications

General Specifications		
Wiring Termination:	**2**	16 position pluggable terminal blocks, 3.5mm, 22 to 14GA wires for power and field wiring
Field Wiring Entry:	**1**	Pre-drilled for ¾" conduit
Internal Battery Power:		3.6V 19AH Lithium "D" cell (included)
Power:		10Vdc to 30Vdc, external power Sensor Power Load = 50mA Transmit power is short bursts w/50mA sensor power
@10Vdc in		Sleeping: **<1mA** Awake w/Sensor Pwr OFF: **17mA** Awake w/Sensor Pwr ON: **96mA** Transmitting: **25mA**
@12Vdc in		Sleeping: **<1mA** Awake w/Sensor Pwr OFF: **15mA** Awake w/Sensor Pwr ON: **78mA** Transmitting: **24mA**
@24Vdc in		Sleeping: **0.5mA** Awake w/Sensor Pwr OFF: **7mA** Awake w/Sensor Pwr ON: **41mA** Transmitting: **12mA**
Temperature:		-40°C to 70°C (operating), -40°C to 85°C (storage)
Humidity:		<90% RH (non-condensing)
Enclosure:		8" (H) x 4"(W) x 3"(D), Polycarbonate, wall-mounting hardware provided

RIO Remote I/O Specifications

Scadaflex II RIO Remote I/O Module		
Analog Inputs:	**4**	16-bit: , individually selectable ranges: 20mA, 5V, +/- 250mV, 65K ohms
Discrete Inputs:	**10**	Optically Isolated, 12/24V AC/DC (30Vdc/Vac max)
Pulse Inputs:	**1**	Contact closure or 0 to 30Vdc, up to 10Khz
Discrete Outputs:	**10**	Relays with shared common, up to 30Vdc/250VAC, resistive, 3A each, 8A total maximum
Serial Ports (wired model):	**1**	RS-485, 2 x RJ-45 connectors (bused together)
Internal Radio models	**1**	License-free 900MHz, up to +24dBm (1/4 W) maximum TX power, up to -110 dBm sensitivity (standard, 9600 baud), -100dBm (mesh), with 2dB whip antenna, RP SMA connector for external antenna
Configuration:		By web pages in master, automatic update upon communications

General Specifications		
Wiring Termination:	**2**	16 position pluggable terminal blocks, 3.5mm, 22 to 14GA wires for power and field wiring
Field Wiring Entry:	**1**	Pre-drilled for ¾" conduit
Power:		10Vdc to 30Vdc
@10Vdc in		All relays OFF (idle/transmitting): **20/28 mA** All relays ON (idle/transmitting): **151/160 mA**
@12Vdc in		All relays OFF (idle/transmitting): **17/26 mA** All relays ON (idle/transmitting): **126/136 mA**
@24Vdc in		All relays OFF (idle/transmitting): **10/15 mA** All relays ON (idle/transmitting): **66/70 mA**
Temperature:		40°C to 70°C (operating), -40°C to 85°C (storage)
Humidity:		<90% RH (non-condensing)
Enclosure:		8" (H) x 4"(W) x 3"(D), Polycarbonate, wall-mounting hardware provided

Revision History

V1.00 First Release

V1.01 Corrected wrong factory default IP from 192.168.1.199 to 192.168.237.199

V1.01a Typo fix – Setup Pushbutton Operation header

V1.02 Combined SC-1 , SC-2, and remote I/O manuals and updated

V1.03 Refresh manual for latest hardware and firmware updates

V1.04 Enhanced description of Wired RIO module