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ScadaBridge

Wireless I/O Bridge and RTU

Installation and Reference Manual



***Wireless I/O
Remote Monitoring
Remote Control***

ScadaBridge



... a wireless I/O Bridge and RTU

- | | |
|-------------------------|---|
| Cost Saving | <ul style="list-style-type: none"> • No Trenching and wire pulling • No Monthly Telephone charges • Pre-engineered integrated RTU and radio |
| Versatile | <ul style="list-style-type: none"> • Supports both RTU Slave and I/O Bridge Operation • Built-in 32-bit Totalizers on Digital Inputs • Built-in 32-bit Runtime "meters" on Digital Inputs • Built-in Pulse Rate measurement on Digital Inputs • Built-in 32-bit Analog Totalizers on analog inputs |
| Easy to Use | <ul style="list-style-type: none"> • Simple Windows point-and-click configuration • No computer or special tools for field installation • All electronic "no pots" calibration • Individual LED Digital I/O Status Indicators • Industry Standard Modbus protocol • Compatible with all popular SCADA/DCS software • Removable Field Wiring Terminal Blocks • Low-power for Battery/Solar Operation |
| High reliability | <ul style="list-style-type: none"> • Wide Operating Temperature: -40°C to 75°C • Dual Watchdog Timers; Communications & CPU |

Specifications (cont.)

Radio

Technology

Operating Frequency

RF Output Power

Range

Data Rate

Receiver Sensitivity

Receiver Selectivity

Spread Spectrum, frequency hopping

902 to 928MHz standard

2.40 to 2.4835GHz (optional)

up to 1.0W (900 MHz), >10Vdc DC power

up to 0.5W (2400 GHz), >10Vdc DC power

up to 20mi, line of sight

up to 115K baud

-108dBm at 10-6 raw BER

40dB at fc+/-230KHz, 60dB at fc +/-460 KHz

General

Input Voltage (power)

Power Consumption

8 to 28Vdc

Measured at 12Vdc in:

Transmit: 2.4W (typ.), 8.0W (max.)

Receive: 0.75W (typ.), 1.5W (max.)

Power Saver: 0.40W (typ.), 0.50W (max.)
(Master Mode)

(supply power measured with no load on analog outputs. Add up to 40mA (0.5W@12Vdc) total for both analog outputs driving at full load)

Operating: -40°C to 75°C

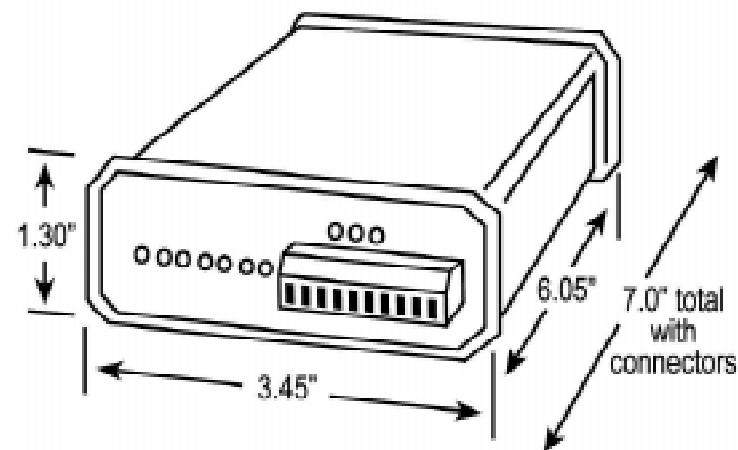
Storage: -40°C to 100°C

10 to 90%, non-condensing

Temperature

Humidity

Dimensions



Specifications

Digital Inputs/Outputs

Quantity	4, user configurable as input or output
Input Type	Contact closure to common
Input current (pullup to input power)	2 mA at 12Vdc power
Input Pulse Totalizers	1 per chan., 50Hz max, up to 4,294,836,200
Input Runtime Accumulation	up to 4,294,836,200 seconds (136 yrs)
Input Rate Totalization	Up to 65,535 counts/gate time

	Gate time = 1 to 65,535 seconds (0=OFF)
Output Type	Open Drain FET, switches to common
Output Rating	0 to 28Vdc, 7.0A peak
	0.25A continuous @ 80°C
	0.50A continuous @ 25°C

Transient/Overload protection	Transorb with self resetting polyfuse
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Analog Inputs

Quantity	2
Resolution	10-bit (1 part in 1024)
Input Levels	0 to 20mA (4 to 20mA)
Input Totalizers	1 per channel, up to 4,294,836,200 total

Analog Outputs

Quantity, type	2, sourcing
Resolution	10-bit (1 part in 1024)
Input Levels	0 to 20mA (4 to 20mA)
Power	From RTU input power, 44mA max.

Alarm Output

Alarm Conditions	3, user configurable: Comm Failure High Internal Temperature Low Input Power
Output Type	Open Drain FET, switches to common
Output Rating	0 to 28Vdc, 7.0A peak
	0.25A continuous @ 80°C
	0.50A continuous @ 25°C
Transient/Overload protection	Transorb with self resetting polyfuse

Communications

Interface	RS-232 and Spread Spectrum Radio
Data Rate	2400, 4800, 9600, 19.2K, 38.4K
Protocol	Modbus RTU

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Overview

Overview

RTUs (Remote Terminal Units) provide access to sensor signals and control devices, typically over a widespread area. They are used in water/wastewater systems, on gas and oil pipelines and by the power utilities.

ScadaBridge RTUs can provide simple wireless I/O in a SCADA (Supervisory Control and Data Acquisition) system, or serve as an I/O bridge that “mirrors” sensor and control signals between two or three locations.

In a SCADA system, a PC computer or a Master RTU communicates with up to several hundred RTUs. ScadaBridge RTUs support the Modbus RTU protocol, an industry standard supported by most SCADA/DCS software packages, PLCs and process controllers. ScadaBridge RTUs are “Plug-and-Play” compatible with Wonderware’s “InTouch”, Intellusion’s “FIX”, and National Instrument’s “Lookout” software.

As an I/O bridge, no other controller hardware or software is needed other than providing DC power and standard antenna system components.

ScadaBridge RTUs combine the remote I/O functions of a traditional RTU with a built-in spread spectrum radio. They have a range of up to 20 miles, or further with repeaters. By using spread spectrum radio technology, ScadaBridge RTUs eliminate government licensing headaches. ScadaBridge RTUs also reduce installation costs with no trenching and less hardwiring. They also provide significant savings and improved reliability over leased telephone lines.

ScadaBridge RTUs are optimized for smaller I/O count applications that, in the past, have carried a high cost per point. Their integrated design minimizes the cost of carrying just a few sensor or control signals.

ScadaBridge RTUs provide a total of eight I/O points:

- **2 Analog Inputs** for level, flow, temperature and pressure.
- **2 Analog Outputs** for controlling variable speed motors and positioners, and driving remote indicators
- **4 Digital Inputs and Outputs** - As inputs, they accept simple contact closure signals, such as from switches, float sensors, relays and auxiliary contacts. As outputs, they can control relays, indicators and annunciators.

In addition, there are two internal analog points that monitor the input power and internal temperature.

InTouch, FIX and Lookout are trademarks of their respective companies above.

Modbus Access (Programmers Reference, continued)

	AO 23	Pulse rate “gate time” (seconds)
	AO 24	AI Totalizer “gate time” (seconds)
Calibration	AO 25	AI #1 Calibration Scale Factor (/10000)
	AO 26	AI #2 Calibration Scale Factor (/10000)
	AO 27	AI #3 Calibration Scale Factor (/10000)
	AO 28	AI #4 Calibration Scale Factor (/10000)
	AO 29	AO #1 Calibration Scale Factor (/10000)
	AO 30	AO #2 Calibration Scale Factor (/10000)
Configuration A	AO 31	AI #1 Calibration Offset
	AO 32	AI #2 Calibration Offset
	AO 33	AI #3 Calibration Offset
	AO 34	AI #4 Calibration Offset
	AO 35	AO #1 Calibration Offset
	AO 36	AO #2 Calibration Offset
Configuration B	AO 37	Cfg A - DI Trigger Mask
	AO 38	Cfg A - AI # 1, Delta for message trigger
	AO 39	Cfg A - AI # 2, Delta for message trigger
	AO 40	Cfg A - Minimum Time between analog samples (.1 sec)
	AO 41	Cfg A - Analog Sensor warm-up time (.1 sec)
	AO 42	Cfg A - Minimum Time between messages (sec)
Alarm Thresholds	AO 43	Cfg A - Maximum Time between messages (sec)
	AO 44	Cfg A - Radio ON (warm-up) Time (10mS)
	AO 45	Cfg A - I/O Mapping to/from Slave #1
	AO 46	Cfg A -I/O Mapping to/from Slave #2
	AO 47	Cfg B - DI Trigger Mask
	AO 48	Cfg B - AI # 1, Delta for message trigger
Misc. Comm	AO 49	Cfg B - AI # 2, Delta for message trigger
	AO 50	Cfg B - Minimum Time between analog samples (.1 sec)
	AO 51	Cfg B - Analog Sensor warm-up time (.1 sec)
	AO 52	Cfg B - Minimum Time between messages (sec)
	AO 53	Cfg B - Maximum Time between messages (sec)
	AO 54	Cfg B - Radio ON (warm-up) Time (10mS)
Slave Mode Sensor Cfg	AO 55	Cfg B - I/O Mapping to/from Slave #1
	AO 56	Cfg B - I/O Mapping to/from Slave #2
	AO 57	Low Power Alarm Threshold
	AO 58	High Temperature Alarm Threshold
	AO 59	Communications Timeout
	AO 60	Communications Retry Count
General	AO 61	Minimum Time between analog samples (.1 sec)
	AO 62	Analog Sensor warm-up time (.1 sec)
	AO 253	Communications Watchdog (seconds)
	AO 254	Baud Rate (0 to 5 = 2.4K to 115K)
	AO 255	Status Bit Map
	AO 256	Reserved for Factory Testing

Modbus Access (Programmers Reference)

The following Modbus “register” addresses are used to access the digital and analog I/O, status and configuration parameters in the ScadaBridge RTU.

The register numbers below are abbreviations of the actual full Modbus addresses without their numeric prefixes. If you have any questions regarding the Modbus protocol or how these addresses relate to the actual Modbus messages and message types, please contact ICL Technical Support.

Digital Ins

Read prefix = 2

DI 1	DI #1
DI 2	DI #2
DI 3	DI #3
DI 4	DI #4

Digital Outs

Read prefix = 1

Write prefix = 5 or 15

DO 1	DO #1
DO 2	DO #2
DO 3	DO #3
DO 4	DO #4

Analog In Regs

Read prefix = 4

AI 1	AI #1
AI 2	AI #2
AI 3	Input power supply voltage
AI 4	Internal temperature
AI 5	DI #1 Pulse Input Rate
AI 6	DI #2 Pulse Input Rate
AI 7	DI #3 Pulse Input Rate
AI 8	DI #4 Pulse Input Rate
AI 9	Alarm Bitmap
	xxxx xxxx xxxx xx1x Overtemp
	xxxx xxxx xxxx x1xx Low input Power
AI 255	EEROM Rev Level (assumed DP at xx.xx)
AI 255	Firmware Rev Level (assumed DP at xx.xx)
AI 256	Device ID (101)

Analog Out Regs

Read prefix = 3

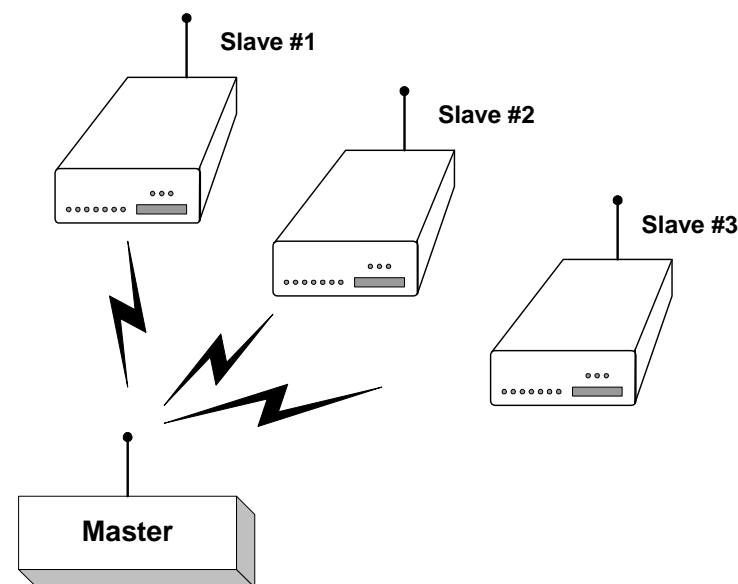
Write prefix = 6 or 16

AO 1	AO #1 (Sourcing, 20mA)
AO 2	AO #2 (Sourcing, 20mA)
AO 3/4	DI #1, 32-bit ON transition counter (high/low)
AO 5/6	DI #2, 32-bit ON transition counter (high/low)
AO 7/8	DI #3, 32-bit ON transition counter (high/low)
AO 9/10	DI #4, 32-bit ON transition counter (high/low)
AO 11/12	DI #1, 32-bit ON runtime (seconds, high/low)
AO 13/14	DI #2, 32-bit ON runtime (seconds, high/low)
AO 15/16	DI #3, 32-bit ON runtime (seconds, high/low)
AO 17/18	DI #4, 32-bit ON runtime (seconds, high/low)
AO 19/20	AI #1, 32-bit Analog Totalizer (high/low)
AO 21/22	AI #2, 32-bit Analog Totalizer (high/low)

Operation

SCADA Slave

In a traditional SCADA application, a single Modbus Master communicates with one or more Slaves. Up to 255 ScadaBridge RTUs can be used with a single Master for this type of operation. The Master may be a “smart” controller (like a ScadaLogic 4300) or a PC computer running standard SCADA, DCS or MMI software.



In Slave mode, the ScadaBridge RTU constantly listens to the messages being sent by the Modbus Master. When a message arrives that has the Slave’s address, proper error validation codes and syntax, the Slave responds. If there is a problem with the received message, the Slave does not respond, the Master “times out”, and either retries the message or goes onto the next.

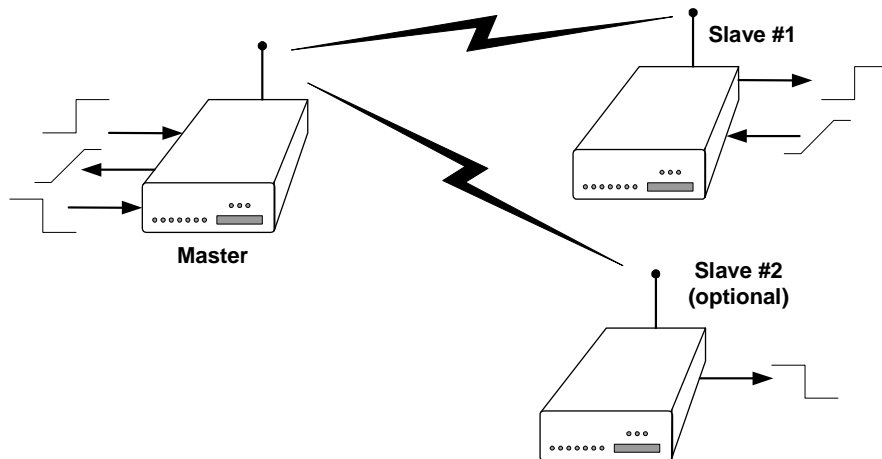
Modbus commands read or set the values of digital (discrete) and analog I/O points (real I/O) or read and set internal register values that represent data that has been collected or that configures the RTUs operation.

Using the ScadaBridge RTU in Slave mode normally only requires setting a unique address that matches the configuration of the SCADA system Master. The address is set with DIP switches on the underside of the RTU. A few less commonly changed Slave Mode configuration parameters can be adjusted by using the ScadaBridge Toolbox software. To access the internal configuration information of the ScadaBridge RTU with the Toolbox software, the RTU must be configured for Slave operation (again by setting DIP switches on the RTUs underside).

Operation (continued)

I/O Bridge

A ScadaBridge RTU can also be configured as a Modbus “Master” that can be used in conjunction with one or two other ScadaBridge RTUs configured as Modbus Slaves. This combination forms a stand-alone system that carries analog and digital sensor and control signals between two (or three) locations like an invisible set of wires. ScadaBridge RTUs “read” analog and digital (ON/OFF) levels at their inputs, exchange these readings, and reconstruct the input states as outputs on the opposite ends.



The ScadaBridge Toolbox software is used to configure the RTUs Master Mode operation, setting the direction and number of I/O points passed between it and one or two Slaves. For example, the two analog inputs of a “Master” can be passed to two outputs of a single “Slave”, or split between two Slaves. Likewise, the “Master” can accept two analog input levels from a single Slave or one input each from two Slaves and “reconstruct” these levels as analog outputs.

The Toolbox software is also used to configure when the data is sent, periodically and/or based on the change of a discrete point or an analog level at the “Master”.

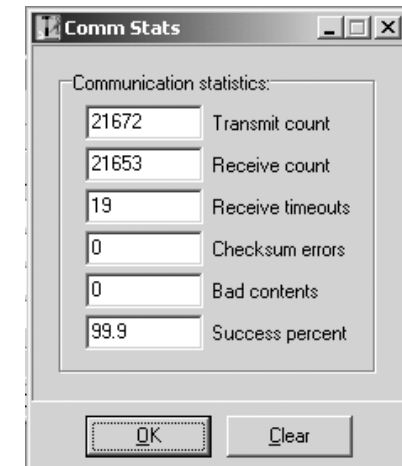
In solar or battery powered applications, the lowest power site should have the “Master”. The “Master” can be configured to switch the radio and/or sensor power ON only when required to take a measurement or send a message, allowing for operation with the lowest possible “idle” current. A Slave can only control the sensor power. The Toolbox software also allows limits to be placed on how often the Master sends messages, further reducing Master RTU power consumption.

Toolbox Setup Software (continued)

Stats Tab

As a system test and troubleshooting aid, the Toolbox maintains statistics on communications between the PC and the RTU.

A typical set of statistics is captured below:

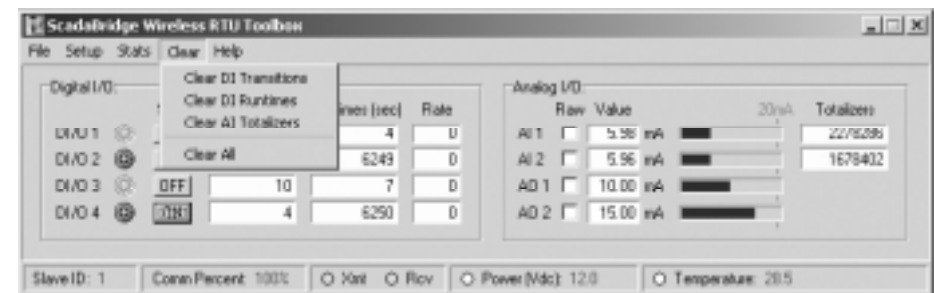


Clear Tab

The toolbox Clear Tab is used to clear the RTUs:

- Analog Input Totalizers
- Digital Input Totalizers
- Digital Input Runtime Totals

These elements may be cleared (reset) in groups or all together (Clear All). The Clear Tab pull-down menu is pictured below:



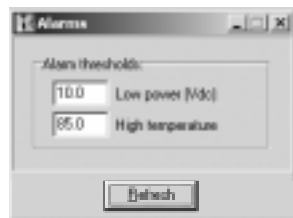
Toolbox Setup Software (continued)

Alarms

The RTU senses two types of *internal* alarm conditions:

- Internal high temperature
- Low input voltage (power)

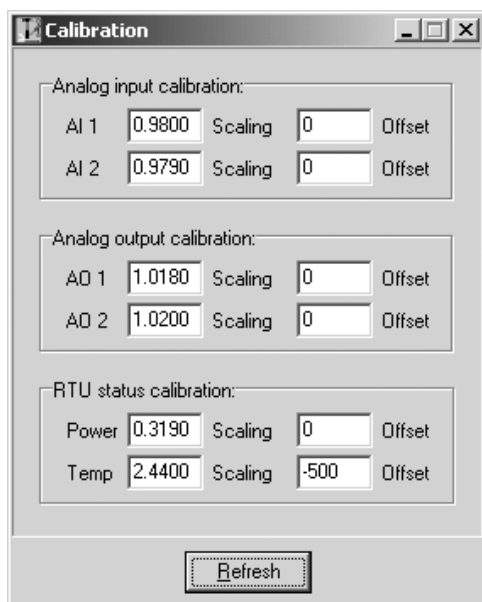
In the Alarms Screen, the High Temperature and Low Power thresholds can be set.



Calibration

Each of the RTUs analog inputs and outputs are factory calibrated to ensure that the RTUs are interchangeable in the field without requiring system readjustments. The calibration effectively scales each analog point to a span of 0 to 1000 for an input of 0 to 20mA.

The RTU scales analog values by multiplying the reading from the A/D converter hardware by the scaling value, and then adding the offset value. The calibration values can be readjusted to effectively “rescale” the analog channels for specific user applications. Typically though, the calibration values are only adjusted for periodic calibration and certification of a facilities instrumentation.



Operation (continued)

Digital I/O

The RTUs digital I/O points can be used as any combination of inputs and outputs. A digital I/O point starts out as an input until a command is received to turn it ON. Turning the point OFF again restores it as an input. A one or ON is represented as a LOW or contact/switch closure to the digital I/O common.

The digital I/O points are protected from overloads by transient suppressors and self-resetting polyfuses. If an overload occurs, the polyfuse limits the current flow to a safe level. When the fault is cleared, the connection is automatically reestablished.

Analog I/O

The ScadaBridge RTU has two analog inputs and two analog outputs which support 0 to 20mA current operation (voltage type analog inputs are available as an option). ICL Controllers and most SCADA software can be configured to allow for the 20% offset of 4 to 20mA devices using a 0 to 20mA reading. Otherwise, the RTUs calibration facilities may be used to “scale” the readings for a 4 to 20mA span.

Input sensors must SOURCE current into the analog inputs of the RTU (analog common is negative). The analog outputs SOURCE current to their loads (no external loop power supply is required).

The analog inputs and outputs are protected from overloads by transient suppressors and self-resetting polyfuses. If an overload occurs, the polyfuse limits the current flow to a safe level. When the fault is cleared, the connection is automatically reestablished.

The resolution of the analog inputs and outputs is 10 bits, a range of 0 to 1023. The RTU has Modbus accessible calibration registers. The RTUs are shipped from the factory with the analog I/O calibrated so that a span of 0 to 20mA is represented as values from 0 to 1000 (not 1023) or 0 to 100.0%. The user can change the calibration settings back to their raw analog values by setting a calibration multiplier of 1.0000, or set to some other value to provide a simple means of scaling the readings to engineering units. Beware though that changing these values may affect your ability to swap RTUs without adjusting sensor and control device settings.

Besides the two pairs of external analog inputs and outputs, ScadaBridge RTUs have a pair of internal temperature and input power monitoring points. The RTU is shipped with the temperature sensor calibrated for direct Celsius readout, although it can be “rescaled” for Fahrenheit readings. The power supply voltage monitor reads the input power to tenths of a volt, ideal for solar/battery powered applications.

Operation (continued)

Totalization, Rate and Runtime	<p>Besides simple analog and digital I/O, ScadaBridge RTUs perform some data collection functions.</p> <p>For each digital I/O point, the RTU totalizes ON transitions and runtime, and computes an input pulse rate.</p> <p>Counting ON transitions keeps track of the number of times that a piece of equipment has been cycled, or totalizes flow or power usage for meters or sensors with pulse type outputs.</p> <p>Pulse rate is frequently used to indicate instantaneous flow or power usage. The period over which the pulses are totalized to compute the rate is user configurable with the ScadaBridge Toolbox software.</p> <p>Runtime tracks the number of seconds that an input point has been turned ON. This feature is frequently used to support a preventive maintenance program for pumps and motors.</p> <p>For each analog input, the RTU totalizes periodic samples of the analog input readings. The sampling period is user configurable in seconds. The totalizers can be used with analog (4 to 20mA) flow meters to provide an indication of total flow.</p>
Radio Features	<p>ScadaBridge RTUs have a smart microprocessor controlled spread spectrum radio with additional features that enhance it's operation under adverse conditions. Examples include:</p> <p><i>Store & Forward:</i> The radio is capable of serving as a repeater, effectively extending the range of the system and enabling outlying sites to be reached, even around obstacles.</p> <p><i>Security:</i> The radio may be configured to reject interference from other radios within the same system, from other nearby systems or other control equipment.</p> <p>To implement these features, please refer to the:</p> <p><i>SSR-900/2400 Technical Reference Manual</i></p> <p>or contact ICL Technical support.</p>

Toolbox Setup Software (continued)

Radio Setup	<p>As shipped from the factory, Scadabridge RTUs are configured as one Master and the rest Slaves. Note that the terms "Master" and "Slave" have a somewhat different meaning for the radios than a SCADA system (for example, the "Master" radio does not need to be at a central site).</p> <p>The radio section of the RTUs are shipped from the factory pre-configured for the most common applications, but the user may need to adjust this configuration based on specific system requirements. Please refer to the <i>SSR-900 and SSR-2400 Technical Reference</i> manual for detailed information on configuration of the radio section.</p>	
Factory Settings	The following is the ScadaBridge RTU factory radio configuration	
<i>Operation Mode</i>	1st RTU/radio is set to 2 (Point-to-Multipoint MASTER). All other RTUs are set to Mode 3 (Point-to-Multipoint SLAVE).	
<i>Baud Rate</i>	Modem Baud Rate:	38,400
	Modem Data/Parity:	0 (No parity, 8 data bits)
	Modbus RTU:	1 (enabled)
<i>Call Book</i>	not used	
<i>Transmission Char.</i>	FreqKey:	5
	Max Packet Size:	8
	Min Packet Size:	9
	Xmit Rate:	1
	RF Data Rate:	3
	RF Xmit Power:	9
	Slave Security:	0
	RTS to CTS:	0
	Retry Timeout:	255
	Low Power Mode:	0 (disabled)
<i>Multipoint Parameters</i>	Number Repeaters:	0
	Master Packet Repeat:	2
	Max Slave Retry:	9
	Retry Odds:	9
	DTR Connect:	0
	Repeater Frequency:	0
	Network ID:	1
	MultiMaster Sync:	0
	1 PPS Enable/Delay	255
	Slave/Repeater:	0
	Diagnostics	0
	Subnet ID:	disabled
	Radio ID:	not set

Toolbox Setup Software (continued)

Terminal Mode (Radio Setup)

The Radio Section of the ScadaBridge RTU has it's own control microprocessor and system of configuration menus built into it. Accessing these menus requires a simple terminal emulation program which is incorporated into the ScadaBridge RTU Toolbox.

Setup

DIP switches on the bottom of the RTU case set the communication routing within the RTU. To configure the Radio Section, switches 1 and 2 of the four position DIP switch must be set to 1-ON, 2-OFF.



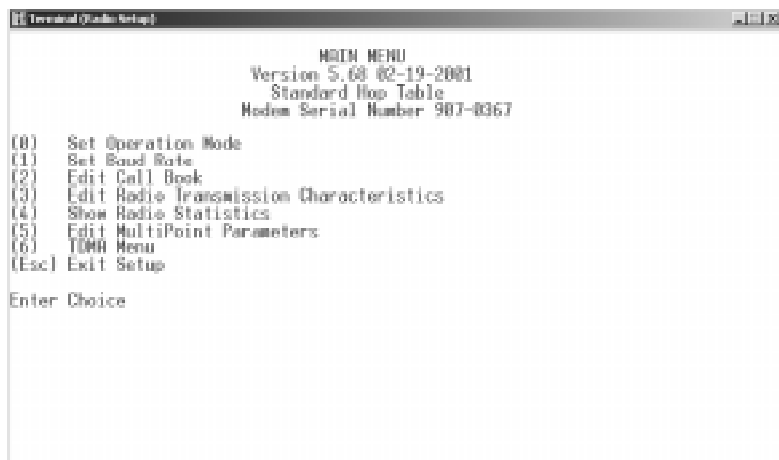
RS-232 port to Radio

(switches 3 and 4 are ignored in this mode). This “connects the RS-232 port to the radio microprocessor so that the Toolbox terminal emulation software can communicate with it. When the DIP switches have been set, press the radio setup pushbutton located behind the access hole on one end of the case.

Pushbutton behind
this hole activates
radio setup menu



A “menu” like the one below will be displayed and all three radio status lights (CTS, TX and CD) will glow green.



Rear Panel

Rear Panel

The rear panel of the ScadaBridge RTU includes the:

- RS-232 Communications Connector (9-pin D, female)
- Antenna Connector (TNC female)
- Power & alarm terminal block



RS-232 Connector The RS-232 “comm” connector is used to:

- configure the RTU and radio sections of the ScadaBridge with a PC and Windows based ScadaBridge Toolbox software.
- provide data access to the radio section for connection to external equipment (RTU not used)
- provide I/O expansion and access to the Modbus message stream so that an external Modbus device can share the spread spectrum radio while “connected” to the RTU
- support on-line radio network diagnostics during Master Mode operation when the RTU is being used as an I/O bridge (contact ICL technical support for details)

Antenna

The ScadaBridge RTU provides a TNC female antenna connection (the antenna cable should have a TNC male connector).

Power & Alarm

A five position removable terminal block provides:

- a “fail-safe” open-collector alarm output connection which is normally ON (pulled low) and opens for an alarm condition.
- switched 14Vdc power for analog (4 to 20mA) sensors
- DC input power, 8 to 28Vdc

Front Panel

Front Panel

The front panel of the ScadaBridge RTU includes LED status indicators for both the RTU and radio sections, and a removable terminal block for wiring to sensors and control devices:



RTU Status LED

The Status LED provides local RTU status as well as the status of the remote Slave RTU(s) when the local RTU is configured as a "Master". The indicator is turned on solid when the RTU powers down the radio and flashes pairs of codes "Morse-Code" style to indicate local and remote alarm conditions when they occur. The indicator is flashed in two closely spaced sequences as follows:

The first set of flashes indicates the unit:

- 1 flash *local*
- 2 flashes *Slave #1 (Master Mode only)*
- 3 flashes *Slave #2 (Master Mode only)*

The second set of flashes indicates the alarm code:

- 1 flash *communications failure alarm*
- 2 flashes *high temperature alarm*
- 3 flashes *low input voltage (power) alarm*

The following summarizes the nine possible alarm indications:

<i>Local Alarm</i>	✱	✱	Comm failure (Slave mode only)
	✱	✱ ✱	High internal temperature
	✱	✱ ✱ ✱	Low input voltage (power)
<i>Slave #1</i>	✱ ✱	✱	Comm Failure (Master mode only)
	✱ ✱	✱ ✱	High internal temperature
	✱ ✱	✱ ✱ ✱	Low input voltage (power)
<i>Slave #2</i>	✱ ✱ ✱	✱	Comm Failure (Master mode only)
	✱ ✱ ✱	✱ ✱	High internal temperature
	✱ ✱ ✱	✱ ✱ ✱	Low input voltage (power)

Toolbox Setup Software (continued)

Min. time between messages

As a "Master", the RTU will send a message to the slave(s) each time a digital input or analog input level changes. This parameter places a limit, in seconds, on the minimum time between messages to avoid "flooding" the network or taxing the available power resources when the RTUs inputs are changing frequently. An example is wave action in a tank which could trigger a flurry of messages due to apparent rapid "level" changes. The value of this parameter may range from 0 (no limit) to 65,535 seconds.

Max. time between messages

As a "Master", the RTU may go for long periods of time without sending a message to the slave(s) because none of it's digital or analog inputs change state or level significantly. This parameter "forces" the RTU to send a message periodically indicating that it's silence is due to a lack of input activity, not an untimely death or power failure. Likewise, the communications watchdog timer(s) in the slave RTU(s) can be set to expect a message from the Master within the watchdog time period. This will ensure that equipment controlled by Slave outputs (such as pumps) is not left running with a communications or power failure. It is important to set the watchdog time in the slave(s) to a longer time that this parameter in the Master, otherwise outputs (both analog and digital) will be cycled OFF and then turned back ON as the slave times out, and then receives an update.

Radio warm-up

As a "Master", the RTU may be configured for extremely low power operation, turning ON the radio power only when it is needed to send a message to the slave(s). This switched mode of operation is enabled by setting a nonzero warmup time. The time period sets the delay from powering ON the radio to sending a message. It should be set long enough to allow the radio to power up and synchronize with the slave(s). Typically, this is about 5 seconds. To disable powering off the radio, set this parameter value to 0.

Sampling Period

Sensors with 4 to 20mA outputs are popular, but can consume a significant amount of power compared to the low idle state power requirements of the RTU. To reduce power usage in solar powered or battery backed applications, the RTU can be configured to only periodically sample the analog signal levels and to power OFF the sensors between samples. This parameter sets the time period between samples, ranging from 0 (continuous sampling without turning loop power OFF) to 65,535 seconds (a little over 18 hours!).

Sensor Warmup

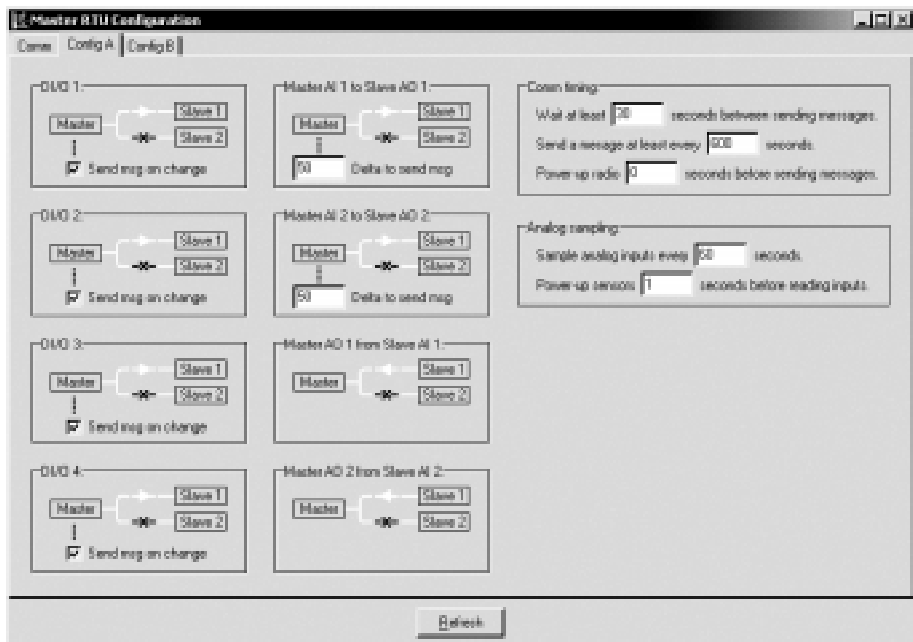
When a sensor has been powered OFF, there is a certain time required to allow the sensors internal electronic circuits to stabilize after reapplying power. This parameter is used to set the sensor "warm-up" time; ranging from 0 (no delay, not recommended) to 65,535 seconds (probably a little long).

Toolbox Setup Software (continued)

Configuration A & B

The Configuration A and B parameters are two identical sets of values that control the RTUs operation as a “Master”; each with its own identical configuration window. On the underside of the RTU, DIP switches select Master or Slave operation, and if “Master” operation is selected, then whether the “A” or “B” set of configuration parameters is used.

Other than the basic communications speed and timeouts parameters, ALL of the configuration parameters that control the RTUs operation as a Master are contained in these two windows.



I/O Bridge I/O Map

As a Master Mode I/O bridge, the “Master” ScadaBridge RTU is configured to exchange a mixture of digital and analog I/O between the Master and the Slave(s), triggered by changes in their states or levels. Clicking on the “connection points” in this window alternately sets the data direction and/or disconnects the links. A slave is accessed only if at least one “connection” exists to it.

Each of the digital I/O points in the Master may be individually configured to “trigger” a message that updates the slave(s) by checking the appropriate box. Likewise, the amount of change in an analog input level required to initiate a message update is configurable by setting “delta” values in the analog input boxes.

Front Panel (continued)

RTU Comm LEDs The RTU has two green status LED labeled “RXD” and “TXD”. These LEDs flash whenever data is received or transmitted (respectively).

RTU DIO LEDs These four yellow LEDs indicate the state of the digital I/O points.

Radio Status LEDs The pattern, color and brightness of these LEDs provides detailed status information on the radio. Each indicator can display two colors at one of two brightness levels, as well as flashing. The combination of color, brightness and flashing provide diagnostic and status information for troubleshooting. The following tables should be used to interpret the LED status information.

Legend:	BR	Blinking Red	SD	Solid Red, Dim	FO	Flashing Orange
	SG	Solid Green	IF	Int. Flashing Red	SR	Solid Red, Bright
	-	Off				
LEDs	CD	Carrier Detect	CTS	Clear to Send	TR	Transmit

POINT-TO-POINT * Condition	Master			Slave			Repeater		
	CTS	TR	CD	CTS	TR	CD	CTS	TR	CD
Powered, disconnected	SR	SR	SR	SR	-	BR	SR	-	BR
Connected, no repeater, sending sparse data	IF	IF	SG	SG	IF	IF			
Master calling slave through repeater	SR	SD	SR	SR	-	BR	SR	-	BR
Master connected to repeater, not to slave	SR	SD	FO	SR	-	BR	SR	SD	SR
Repeater connected to Slave	IF	IF	SG	SG	IF	IF	SG	IF	IF
Mode 6, disconnected	BR	-	SR	SR	-	BR			
Setup Mode	SG	SG	SG	SG	SG	SG	SG	SG	SG

MULTIPOINT Condition	Master			Slave			Repeater		
	CTS	TR	CD	CTS	TR	CD	CTS	TR	CD
Powered, disconnected	-	SD	SR	BR	-	SR	BR	-	SR
Repeater and Slave connected to Master, no data	-	SD	SR	SR*	-	SG	SR*	SD	SG
Repeater and Slave connected to Master, sending data to Slave	-	SD	SR	SR*	-	SG	SR*	SD	SG
Repeater and Slave connected to Master, Slave sending data to Master	IF	SD	SG/SR	SR*	IF	SG	SR*	SR	SG

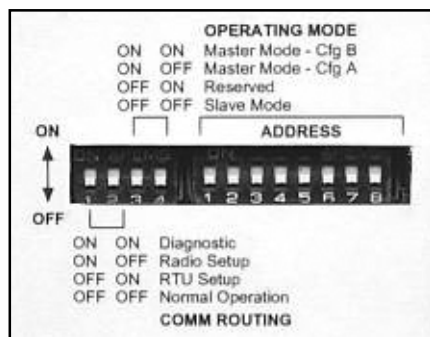
* Note: ScadaBridge RTUs are normally used with the radios configured for Point-to-Multipoint operation.

Configuration DIP Switches

DIP Switches

The ScadaBridge RTU uses 12 DIP switches on its underside for basic field selection of its operating mode and network address. Although detailed configuration of the RTU and radio requires a PC, usually all of the RTUs in a system can be “cloned”, sharing a common configuration so that their field installation requires only setting a few switches without a PC.

The configuration DIP switches are pictured below:



4 Pos. DIP Switch The ScadaBridge RTU consists of two distinct “sections”; the radio and the RTU. Both sections are intelligent with their own microprocessor controllers and both are configurable using a PC through the RS-232 port. The four position DIP switch (on the left hand side) is used to configure the routing of communications within the ScadaBridge and to select the operating mode of the RTU section as follows:

Comm Routing	Switch#	1	2	
		ON	ON	RS-232 port <-> Radio Diagnostics Port
		ON	OFF	RS-232 port <-> Radio (only)
		OFF	ON	RS-232 port <-> RTU (only)
		OFF	OFF	Normal Operation (RS-232 is I/O expansion)

RTU Mode	Switch#	3	4	
		ON	ON	Master Mode using “B” Configuration
		ON	OFF	Master Mode using “A” Configuration
		OFF	ON	Reserved
		OFF	OFF	Slave Mode

Note that there is only one Slave Mode setting but two Master Mode settings (A & B). The actual configuration of each of these modes is user configurable with the ScadaBridge Toolbox software.

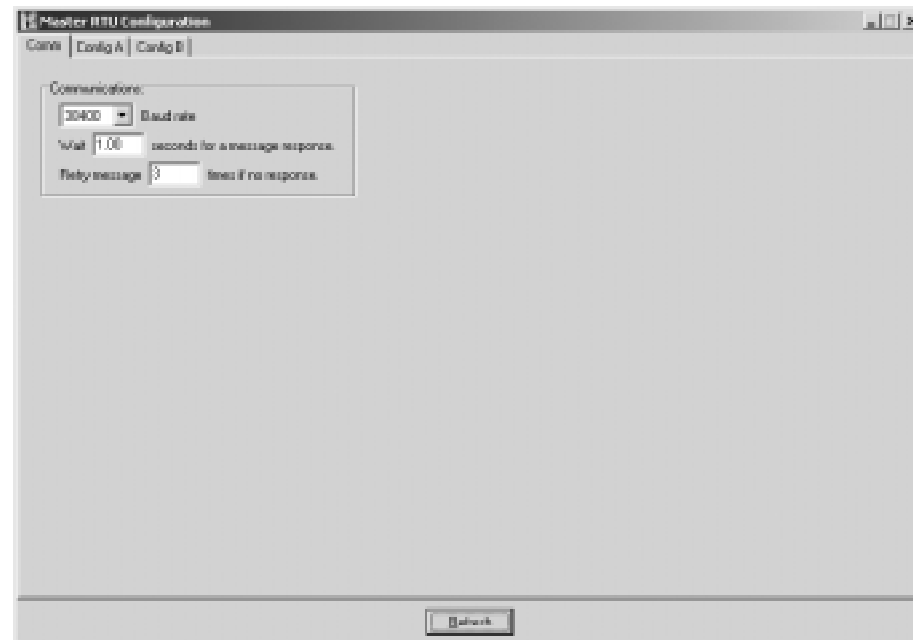
Toolbox Setup Software (continued)

Master Config.

The Master Mode configuration windows contain all of the parameters that control the operation of the RTU running in either of two (A or B) Master Mode configurations. There are a total of three Master Mode configuration windows; one that deals with the communications configuration which is common to both Master Mode configurations, and the remaining two screens that configure the specific items for each Master Mode Configuration.

Master Comm.

The communications configuration window is pictured below:



Baud Rate

This parameter sets the RTUs communications data rate. The RTU baud rate must match the baud rate configuration of the Radio Section. Note that RTU baud rate changes take effect only after the RTU is powered OFF and ON. The factory setting is 38400 baud. This parameter can also be set in the Slave Mode configuration window.

Resp. Timeout

Sets the maximum time that the RTU will wait for a response to a message before “giving up” and retrying. This parameter is used for Master Mode only.

Resp Retry Count

Sets the maximum number of times that the RTU will attempt to resend a message that is not acknowledged before “giving up”.

Toolbox Setup Software (continued)

Slave Config.

The Slave Mode configuration window contains all of the parameters that control the operation of the RTU running in Slave mode:

- Baud Rate
- Comm Watchdog Time
- Analog Sampling rate (used to reduce power consumption)
- DI Gate Time (sampling interval for digital input rate calculation)
- AI Gate Time (sampling interval for analog input totalization)



Baud Rate

This parameter sets the RTUs communications data rate. The RTU baud rate must match the baud rate configuration of the radio section. RTU baud rate changes take effect only after the RTU is powered OFF and ON. The factory setting is 38400 baud.

Comm Watchdog

If this parameter is set to a non-zero value, the RTU will expect to receive a valid message within the specified time period (in seconds), otherwise it will turn OFF all digital and analog outputs. After a communications watchdog failure, any outputs which were turned OFF must be restored with new output commands.

Sampling Period

4 to 20mA sensors are popular, but consume a significant amount of power. To reduce power consumption, the RTU can periodically sample analog signals, powering OFF the sensors between samples. This parameter sets the time period between samples, ranging from 0 (always ON) to 65,535 seconds.

Sensor Warm-up

Most sensors have a warm-up time that they require after being powered OFF. This parameter sets the sensor "warm-up" time delay; ranging from 0 to 65,535 seconds.

DI Gate Time

This parameter sets the time period over which the digital input pulses will be totalized to compute an input rate. This feature is normally used with pulse type flow meters to indicate a flow rate, or watt meters to indicate electrical power usage.

AI Gate Time

This parameter sets the period of time between analog samples for analog input totalization. Each time period, the current value of the analog input is added into a 32-bit accumulator. This feature is normally used with analog flow meters to accumulate total flow.

Configuration DIP Switches (continued)

8 Pos. DIP Switch

The eight position switch sets the RTUs network address. The switches are labeled 1 through 8. Switch 1 (far left) is the Most Significant Bit of the 8-bit "address". Any address other than 0 can be used, providing a total of 255 possible valid addresses.

Example switch settings are:

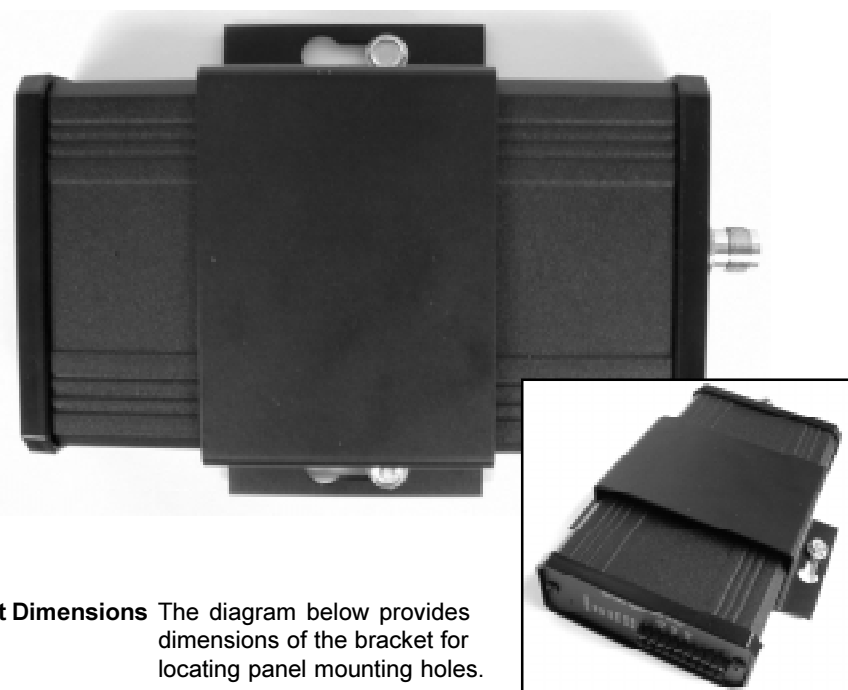
Switch#								RTU Address		
1	2	3	4	5	6	7	8	hex	decimal	
OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	00	000	(Do NOT use)
OFF	OFF	OFF	OFF	OFF	OFF	OFF	ON	01	001	
OFF	OFF	OFF	OFF	OFF	OFF	ON	OFF	02	002	
OFF	OFF	OFF	OFF	OFF	OFF	ON	ON	03	003	
OFF	OFF	OFF	OFF	OFF	ON	OFF	OFF	04	004	
OFF	OFF	OFF	OFF	OFF	ON	ON	OFF	05	005	
OFF	OFF	OFF	OFF	OFF	ON	ON	ON	06	006	
OFF	OFF	OFF	OFF	ON	OFF	OFF	OFF	07	007	
OFF	OFF	OFF	OFF	ON	OFF	OFF	OFF	08	008	
OFF	OFF	OFF	OFF	ON	OFF	OFF	ON	09	009	
OFF	OFF	OFF	OFF	ON	OFF	ON	OFF	0A	010	
OFF	OFF	OFF	OFF	ON	OFF	ON	ON	0B	011	
OFF	OFF	OFF	OFF	ON	ON	OFF	OFF	0C	012	
OFF	OFF	OFF	OFF	ON	ON	OFF	ON	0D	013	
OFF	OFF	OFF	OFF	ON	ON	ON	OFF	0E	014	
OFF	OFF	OFF	OFF	ON	ON	ON	ON	0F	015	
OFF	OFF	OFF	ON	OFF	OFF	OFF	OFF	10	016	
OFF	OFF	OFF	ON	OFF	OFF	OFF	ON	11	017	
OFF	OFF	OFF	ON	OFF	OFF	ON	OFF	12	018	
OFF	OFF	OFF	ON	OFF	OFF	ON	ON	13	019	
OFF	OFF	OFF	ON	OFF	ON	OFF	OFF	14	020	
OFF	OFF	OFF	ON	OFF	ON	OFF	ON	15	021	
OFF	OFF	OFF	ON	OFF	ON	ON	OFF	16	022	
OFF	OFF	OFF	ON	OFF	ON	ON	ON	17	023	
OFF	OFF	OFF	ON	ON	OFF	OFF	OFF	18	024	
OFF	OFF	OFF	ON	ON	OFF	OFF	ON	19	025	
OFF	OFF	OFF	ON	ON	OFF	ON	OFF	1A	026	
OFF	OFF	OFF	ON	ON	OFF	ON	ON	1B	027	
OFF	OFF	OFF	ON	ON	ON	OFF	OFF	1C	028	
OFF	OFF	OFF	ON	ON	ON	OFF	ON	1D	029	
OFF	OFF	OFF	ON	ON	ON	ON	OFF	1E	030	
OFF	OFF	OFF	ON	ON	ON	ON	ON	1F	031	
.
ON	OFF	OFF	OFF	OFF	OFF	OFF	OFF	80	128	
.
ON	ON	ON	ON	ON	ON	ON	OFF	FE	254	
ON	ON	ON	ON	ON	ON	ON	ON	FF	255	

Note that in an I/O Bridge configuration, the "Master" and the first "Slave" must be set to the same address (usually "1"). The second slave (if used) must be set to one more (usually "2") than the Master and first slave addresses.

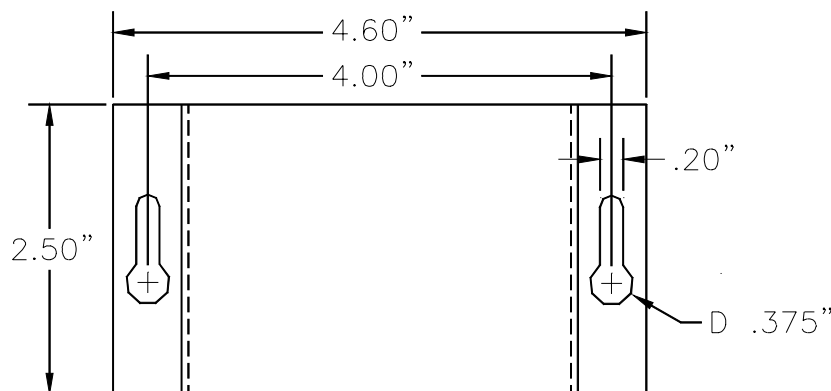
Mounting

Mounting

The ScadaBridge RTU comes with a bracket for panel mounting. Two keyhole slots in the bracket simplify rapid field installation. A foam insert on the inside of the bracket helps keep a snug fit against vibration.



Bracket Dimensions The diagram below provides dimensions of the bracket for locating panel mounting holes.



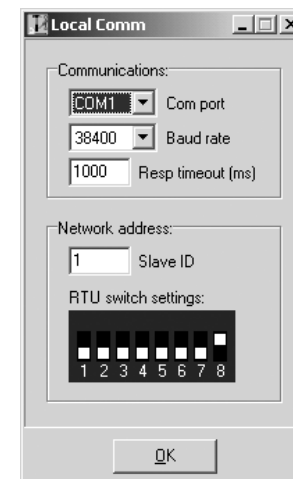
Toolbox Setup Software (continued)

Local Comm.

The Local Communications Setup window is used to configure the PC's serial port for communications with the ScadaBridge RTU. The configuration choices include:

- Com(munications Port): COM1 through COM4
- Baud Rate: 2400 through 115K baud
- Slave Address: 1 through 255
- Resp(onse) Timeout: 1 to 65,535mS (65.5 seconds)

The Local Communications Setup window is pictured below.



Comm Port

PCs typically come with 1 or 2 serial ports (used for connecting to communications devices such as modems) although add-on cards can extend the number of ports to four or more. This parameter specifies which PC serial port is connected to the RTU.

Baud Rate

The link between the PC and the RTU can operate at any of 5 speeds; 2400, 4800, 9600, 19200, 38400 baud. The baud rate must match the speed that the RTU has been configured for. The factory setting for the RTU is 38400 baud.

Resp Timeout

The toolbox software will wait the specified amount of time for a response from the RTU before "giving up" and retrying a message. The lack of a timely response generally means that the RTU detected an error in the message that it received. Because of the natural delay in radio communications, be sure to allow at least 1000mS (1 second) plus an extra 1000mS per repeater "hop".

Slave Address

The RTU can be set to any one of 255 Modbus network addresses. Each address must be unique within the system and must match the address set into the 8-position DIP switch on the underside of the RTU.

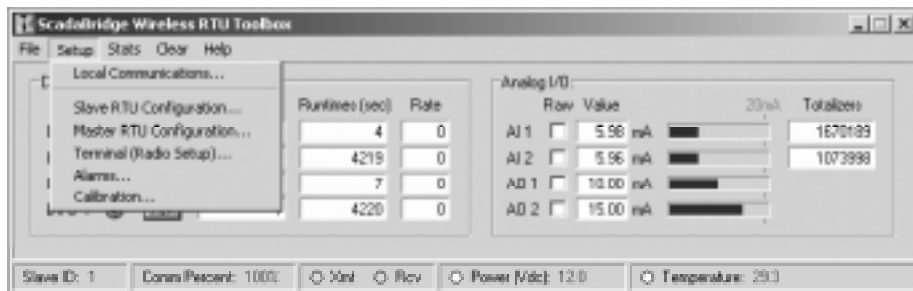
Toolbox Setup Software (continued)

Setup

The Setup Tab is used to access the individual screens for configuring the:

- local PC communications Port
- RTUs Slave Mode operation
- RTUs Master Mode operation (A or B config.)
- internal spread spectrum radio
- internal power and temperature alarm thresholds
- calibration of the analog inputs and outputs.

The Setup Tab choices are pictured below:

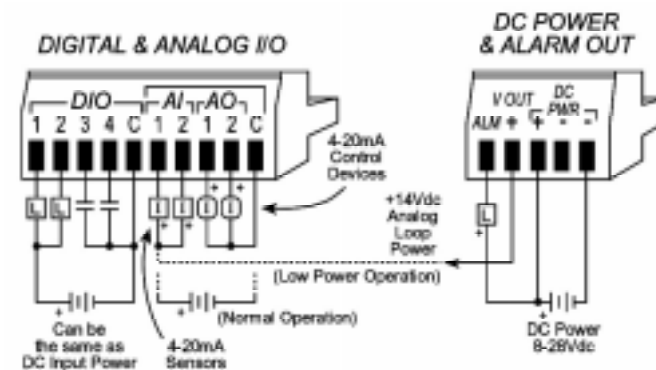


Selecting any one of these choices leads to a window or set of windows for that function as described in the following pages.

I/O & Power Wiring

RTU I/O and Power Wiring

The diagram below shows the typical RTU I/O and power wiring to sensors and control devices. Note that the digital I/Os can be any mix of inputs and outputs (2 each are shown here) and both switch to the Common when ON. Analog sensors must source current to the two analog inputs. The analog outputs source current to the devices that they control.



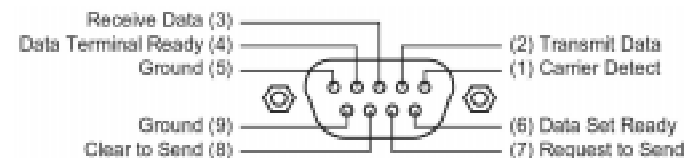
Analog sensors connected to the ScadaBridge RTU can be powered from an external loop supply, or from the +Vout terminal on the back of the ScadaBridge RTU. The latter can reduce system power requirements when the ScadaBridge is configured to only power the sensors ON when taking analog readings.

The alarm output of the ScadaBridge RTU operates as a "fail-safe" signal. The output is Normally ON and turns OFF (opens) to signal an alarm condition.

RS-232 Port Wiring

The ScadaBridge RTU has a single RS-232 port, primarily used for configuration. The port is wired like a PC compatible modem (DCE device) with the full complement of modem control signals using an IBM/PC 9-pin "D" standard pinout.

The pinout of the RS-232 connector is pictured below:



Antenna Installation

Antenna System

The ScadaBridge RTU should be used with an external antenna and all outdoor connections must be weatherproofed. Antennas, cables, accessories and installation kits are available from ICL.

To ensure reliable data transmission, it's best if the target site is visible from the antenna of the originating site. Any obstacles will degrade signal strength. The distance between sites will determine how much impact these obstacles have. An extra foot or two of elevation can also make a big difference in performance.

A properly installed (well grounded) lightening arrestor must be used between the antenna and RTU. The antenna boom and lightening arrestor must be connected by at least a #8 ground wire to an 8ft. x 5/8" ground rod. Use a continuous one-piece wire clamp on the ground rod (not the style that uses two bolts to hold the halves together).

To minimize RF power loss, keep the length of cabling from the RTU to the antenna as short as possible and use a good quality cable and antenna. The antenna connector on the RTU is a female TNC (the cable should have a male TNC).

Recommended antennas are:

	Gain	Manufacture	Model Number
900MHz Directional	10dB	Mobile Mark	YAG10-915N
	10dB	Larsen	YA0006
	6dB	Mobile Mark	YAG6-915N
	6dB	Larsen	YA6-900
900MHz Omnidirectional	5dB	Antennex	EB8965C
		Maxrad	BMEFC8985HD
	3dB	Maxrad	MAX-9053
	0dB	JEMA	JA900SS
	0dB	Mobile Mark	PSTG0-915FW
	0dB	Mobile Mark	PSTN3-915S
	0dB	Mobile Mark	PSTG0-915SE
2.4GHz Directional	14dB	Mobile Mark	SCR14-2400
2.4GHz Omnidirectional	5dB	Maxrad	MAXC24505
	0dB	Mobile Mark	PSTN3-2400N

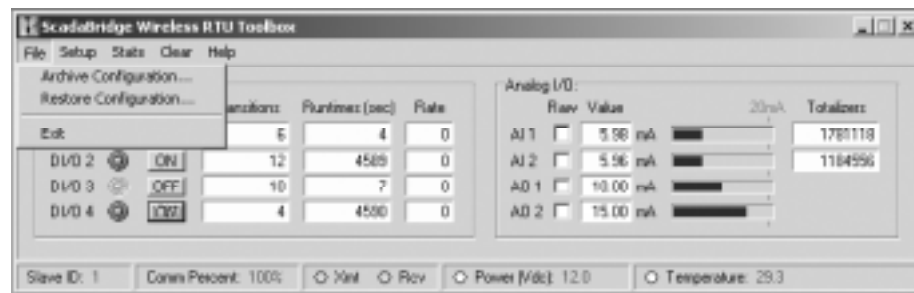
The gain of the antenna system must be limited so as not to exceed FCC regulations. In addition, the gain of the antenna effects the coverage pattern; for example, a lower gain antenna may actually perform better in hilly terrain because of it's lobe pattern. For additional information on configuring an antenna system, please refer to the *SRRi 900/2400 Spread Spectrum Technical Reference* or contact ICL technical support.

Toolbox Setup Software (continued)

File Operations

The Toolbox program can save and retrieve configurations for backup as well as "cloning" RTU setups. The files are human readable in Windows ".INI." format so that they may be loaded into a text editor program for documentation and printing.

The File Operations pull-down choices are pictured below.



Archive

Saves complete configuration from RTU to a disk file.

Restore

Restores (or clones) the configuration on an RTU from a disk file.

Exit

Quit the Toolbox program

A portion of a typical configuration file is shown below:

```
[Rtu_Cfg_Info]
Product=ScadaBridge
Version=100
[Rtu_Cfg_Vals]
DIGateTime=0
AIGateTime=0
AI1CalNum=9880
AI2CalNum=9870
AI3CalNum=3450
AI4CalNum=7070
AO1CalNum=9670
AO2CalNum=9540
AI1CalOff=0
AI2CalOff=0
AI3CalOff=0
AI4CalOff=65036
AO1CalOff=0
```


Toolbox Setup Software (continued)

Main Screen

The Main Screen of the Toolbox displays all analog and digital Input and output states and values, the RTUs incoming power (voltage) and internal temperature, as well as the transition counts, runtimes and rate counts for the four digital I/O points and totalizer values for the two analog inputs.

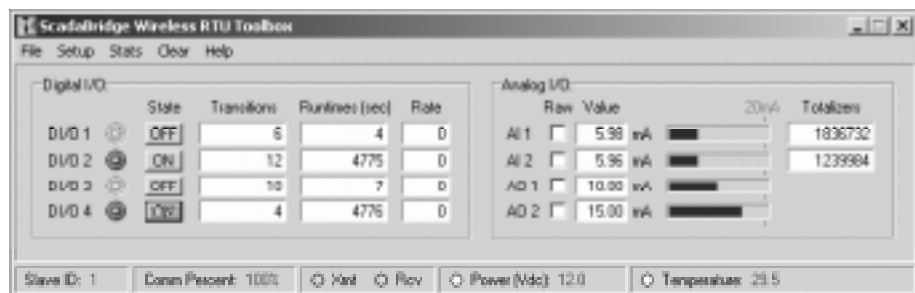
The current address of the slave RTU being “talked to” is shown in the lower left hand corner. The address can be changed by clicking on it which brings up a pop-up change window.

All analog and digital output levels can be changed from the Main Screen; digital outputs by clicking on the check boxes to the right of the “indicators”, analog outputs by clicking on their value and entering a new value in a pop-up window.

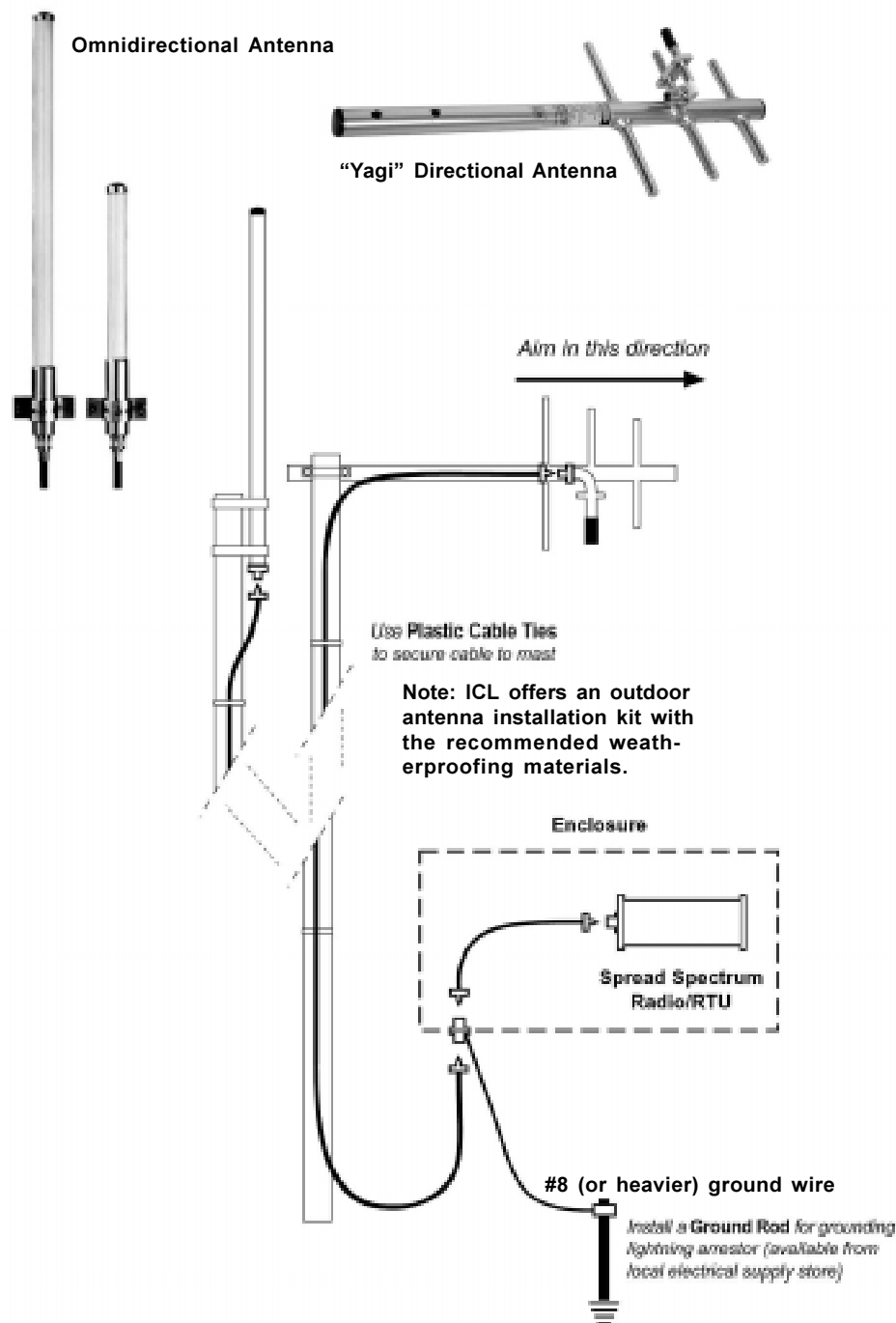
The analog inputs and outputs have bar graph indicators as well as a numeric display of the levels. All “raw” analog levels are factory calibrated to read from 0 to 1000 full scale (0 to 100.0%) for a 0 to 20mA span. It is also possible, using the calibration facilities in the Toolbox software, to “rescale” the analog inputs and outputs. For example, the analog inputs and outputs can be rescaled so that 0 to 1000 represents a 4 to 20mA span instead of 0 to 20mA. Note that this does not improve the actual accuracy or resolution of the analog channels but simply changes their readings.

Under the Main Screen are tabs for:

- File Operations (save/retrieve RTU configuration)
- Setup (RTU and Radio Configuration)
- Stats (communications statistics)
- Clear (totalizers, counts and runtimes)
- Help



Antenna Installation (continued)



Toolbox Setup Software

Toolbox Software The ScadaBridge RTU Toolbox Software is a Windows program used to configure the ScadaBridge RTU. The program is supplied as part of the ScadaBridge RTU starter kit that includes the software, a PC to RTU cable and documentation.

Connecting Up The RS-232 port of the ScadaBridge RTU is wired like a PC modem. The cable required (and supplied with the starter kit) is a "straight through, 9-pin, male-female" modem cable. If you are building your own cable, the transmit, receive and ground pins (2, 3 and 5) are the only connections actually required for communications with the ScadaBridge RTU.

RTU Setup A four position DIP switch on the underside of the RTU case sets the communication routing between the RS-232 port, the radio and the RTU, as well as the RTUs operating mode. To configure the RTU locally, the four position DIP switch must be set to:



RS-232 port to RTU, RTU Slave Mode

This "connects" the RS-232 port to the RTU microprocessor so that the Toolbox software can communicate with it. For RTU configuration, you can leave the 8-position switches as they are as long as you configure the Toolbox software for the network address that they are set to.

Radio Setup To configure the radio, the RS-232 communications must be routed to the radio section. To do so, the four position DIP switch must be set to:



RS-232 port to Radio

For radio configuration, the 8-position switches have no effect and can be left unchanged.

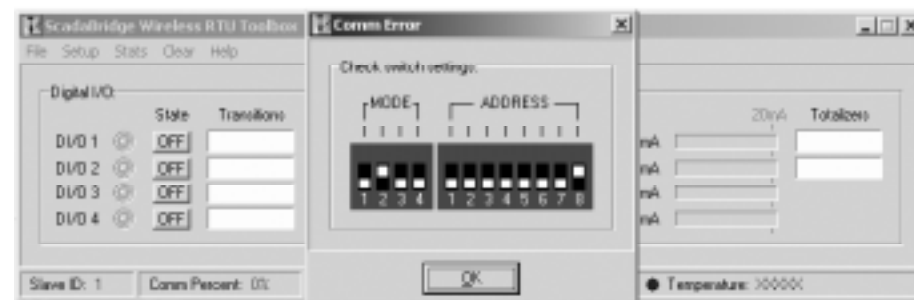
Toolbox Setup The ScadaBridge RTU Toolbox software is supplied on CD ROM, or it may be downloaded from the ICL web site (www.iclinks.com). The program is installed like any other Windows program.

To use the Toolbox software, you will need to know the identity of the RS-232 port that you are connecting to the RTU (COM1, COM2, etc.) and will need to configure the Toolbox software accordingly. In addition, you will need to know the current baud rate setting of the RTU (the factory default is 38400 baud) and the address setting of the DIP switches on the bottom of the RTU.

Toolbox Setup Software (continued)

Getting Started

The initial display of the Toolbox software provides an overview of the RTUs I/O and communications status. If the PC and the RTU are not connected properly or their communication configurations do not match, they will not be able to "talk" together. A pop-up screen will be displayed (as pictured below) with the recommended RTU switch settings (to match the Toolbox configuration).



If this occurs, check the following:

- Is the RTU powered (radio/RTU status LEDs lit on front face)?
- Are the RTUs comm configuration switches set as shown?
- Are you using a "null modem" cable (from the "starter" kit)?
- Are you connected to the correct PC serial port? COM1 is the default for the Toolbox software, but it can be changed.
- Does the PCs baud rate match the RTU (default is 38,400)?

If you need to change the communications settings for the Toolbox software, pull down the Setup menu. Select "Local Communications" and check the port, baud rate and slave address settings.

When connected and working properly, you'll see 100% communications at the bottom of the screen, both "Xmt" and "Rcv" green indicators "lit" and the current data from the RTU displayed.