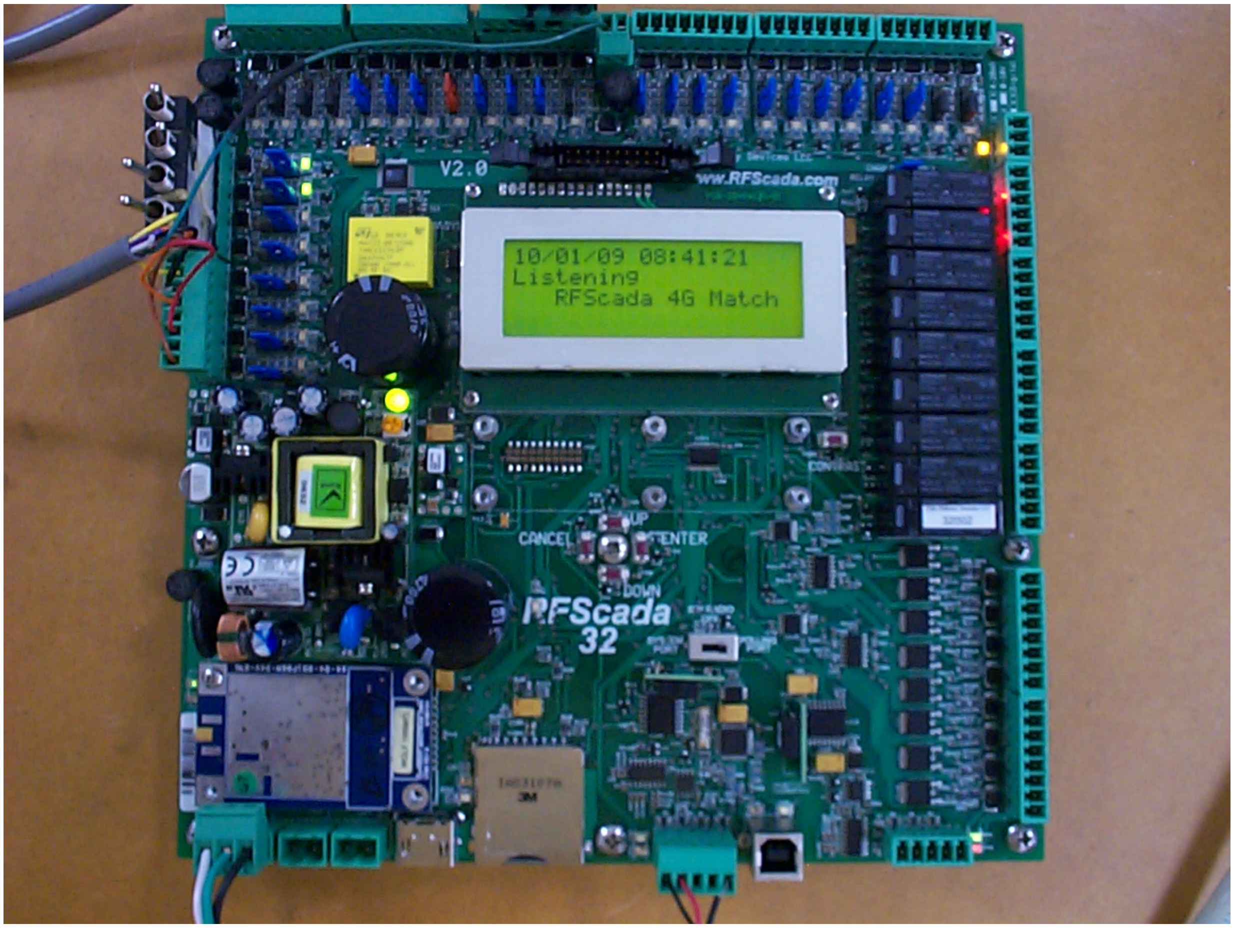
Data Delivery Devices LLC

RFScada32

Remote Terminal Unit



Installation, Configuration and Programming Manual

Data Delivery Devices LLC Terms and Conditions of Sale

Customer and Data Delivery Devices LLC ("DDD") agree that the purchase and sales of DDD hardware and software products ("the Products") are made under these terms and conditions, and that DDD SHALL NOT BE BOUND BY CUSTOMER'S ADDITIONAL OR DIFFERENT TERMS. Customer's order and purchase of the Products shall constitute acceptance of these terms and conditions.

1. TITLE. Title to the Products shall pass at DDD's plant; however, if Customer is the United States or any political subdivision of the United States, title shall pass at Customer's plant. DDD retains a security interest and right of possession in the Products until Customer makes full payment.

2. TAXES. Product prices are exclusive of, and Customer shall pay, applicable sales, use, service, value added or like taxes, unless Customer has provided DDD with an appropriate exemption certificate for the delivery destination acceptable to the applicable taxing authorities.

3. PRICES AND PAYMENT. All quotations shall expire sixty (60) days from date of issuance, unless otherwise set forth on the quotation or agreed in writing. Customer shall make payment in full prior to or upon delivery by cashier's check, credit card, or money order, unless DDD approves Customer for credit terms. If DDD approves Customer's credit application, payment shall be due no later than 30 days from the date of DDD's invoice. All sums not paid when due shall accrue interest daily at the lesser of a monthly rate of 1.5% or the highest rate permissible by law on the unpaid balance until paid in full. Payments for orders shall be made in U.S. Dollars. In the event of any order for several units, each unit(s) will be invoiced when shipped. Exceptions may be made for government purchase orders.

4. ORDERS. All orders are subject to acceptance by DDD. DDD's booking of an order shall constitute its acceptance of an order.

5. DELIVERY. DDD shall deliver the Products to a carrier at DDD's plant and, if the Products are sold to a Customer outside the United States, shall clear the Products for export destined outside the United States. Customer shall pay all freight charges, applicable import duties, and other necessary fees and shall bear the risks of carrying out customs formalities and clearance. Orders are entered as close as possible to the Customer's requested shipment date, if any. Shipment dates are scheduled after acceptance of orders and receipt of necessary documents. Claims for shipment shortage shall be deemed waived unless presented to DDD in writing within twenty one (21) days of shipment.

6. LIMITED WARRANTY. DDD hardware Products are warranted against defects in materials and workmanship for one year from the date DDD ships the Products to Customer. All software Products are licensed to Customer under the terms of the appropriate DDD license. For a period of ninety (90) days from the Delivery Date, DDD software Products (when properly installed) (a) will perform substantially in accordance with the accompanying written materials, and (b) the medium on which the software product is recorded will be free from defects in materials and workmanship under normal use and service. Any replacement of a licensed software product will be warranted for the remainder of the original warranty period or thirty (30) days, whichever is longer. Customer must obtain a Return Material Authorization number from DDD before returning any Products under warranty to DDD. Customer shall pay expenses for shipment of repaired or replacement Products to and from DDD. After examining and testing a returned product, if DDD concludes that a returned product is not defective, Customer will be notified, the product returned at Customer's expense, and a charge made for examination and testing. This Limited Warranty is void if failure of the Products has resulted from accident, abuse, misapplication, improper calibration by Customer, Customer supplied third party software not intended for use with the applicable DDD software, utilization of an improper hardware or software key or unauthorized maintenance or repair.

7. CUSTOMER REMEDIES. DDD's sole obligation (and Customer's sole remedy) with respect to the foregoing Limited Warranty shall be to, at its option, return the fees paid or repair/replace any defective Products, provided that DDD receives written notice of such defects during the applicable warranty period. Customer may not bring an action to enforce its remedies under the foregoing Limited Warranty more than one (1) year after the accrual of such cause of action.

8. RETURN/CANCELLATION/CHANGE POLICY. Customer may return unwanted Products within thirty (30) days of the Delivery Date. Customer shall pay a fifteen percent (15%) restocking charge on any unwanted Products returned to DDD. No returns will be accepted after the thirty (30) day period has expired. Where special equipment or services are involved, Customer shall be responsible for all related work in progress; however, DDD shall take responsible steps to mitigate damages immediately upon receipt of a written cancellation notice from Customer. A Return-Material Authorization number must be obtained from DDD for return of any Products. DDD may terminate any order if any representations made by Customer to DDD are false or misleading. Changes to orders shall not be binding upon nor be put into effect by DDD unless confirmed in writing by DDD's appropriate representative.

9. NO OTHER WARRANTIES. EXCEPT AS EXPRESSLY SET FORTH ABOVE, THE PRODUCTS ARE PROVIDED "AS IS" WITHOUT WARRANTY OF ANY KIND, AND NO OTHER WARRANTIES, EITHER EXPRESSED OR IMPLIED ARE MADE WITH RESPECT TO THE PRODUCTS, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, TITLE OR NON-INFRINGEMENT OR ANY OTHER WARRANTIES THAT MAY ARISE FROM USAGE OF TRADE OR COURSE OF DEALING. DDD DOES NOT WARRANT, GUARANTEE, OR MAKE ANY REPRESENTATIONS REGARDING THE USE OF OR THE RESULTS OF THE USE OF THE PRODUCTS IN TERMS OF CORRECTNESS, ACCURACY, RELIABILITY, OR OTHERWISE AND DOES NOT WARRANT THAT THE OPERATION OF THE PRODUCTS WILL BE UNINTERRUPTED OR ERROR FREE. DDD EXPRESSLY DISCLAIMS ANY WARRANTIES NOT STATED HEREIN.

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11. WARNING: (1) DDD PRODUCTS ARE NOT DESIGNED WITH COMPONENTS AND TESTING FOR A LEVEL OF RELIABILITY SUITABLE FOR USE IN OR IN CONNECTION WITH SURGICAL IMPLANTS OR AS CRITICAL COMPONENTS IN ANY LIFE SUPPORT SYSTEMS WHOSE FAILURE TO PERFORM CAN REASONABLY BE EXPECTED TO CAUSE SIGNIFICANT INJURY TO A HUMAN. (2) IN ANY APPLICATION, INCLUDING THE ABOVE, RELIABILITY OF OPERATION OF THE SOFTWARE PRODUCTS CAN BE IMPAIRED BY ADVERSE FACTORS, INCLUDING BUT NOT LIMITED TO FLUCTUATIONS IN ELECTRICAL POWER SUPPLY, COMPUTER HARDWARE MALFUNCTIONS, COMPUTER OPERATING SYSTEM SOFTWARE FITNESS, FITNESS OF COMPILERS AND DEVELOPMENT SOFTWARE USED TO DEVELOP AN APPLICATION, INSTALLATION ERRORS, SOFTWARE AND HARDWARE COMPATIBILITY PROBLEMS, MALFUNCTIONS OR FAILURES OF ELECTRONIC MONITORING OR CONTROL DEVICES, TRANSIENT FAILURES OF ELECTRONIC SYSTEMS (HARDWARE AND/OR SOFTWARE), UNANTICIPATED USES OR MISUSES, OR ERRORS ON THE PART OF THE USER OR APPLICATIONS DESIGNER (ADVERSE FACTORS SUCH AS THESE ARE HEREAFTER COLLECTIVELY TERMED "SYSTEM FAILURES"). ANY APPLICATION WHERE A SYSTEM FAILURE WOULD CREATE A RISK OF HARM TO PROPERTY OR PERSONS (INCLUDING THE RISK OF BODILY INJURY AND DEATH) SHOULD NOT BE RELIANT SOLELY UPON ONE FORM OF ELECTRONIC SYSTEM DUE TO THE RISK OF SYSTEM FAILURE. TO AVOID DAMAGE, INJURY, OR DEATH, THE USER OR APPLICATION DESIGNER MUST TAKE REASONABLY PRUDENT STEPS TO PROTECT AGAINST SYSTEM FAILURES, INCLUDING BUT NOT LIMITED TO BACK-UP OR SHUT DOWN MECHANISMS. BECAUSE EACH END-USER SYSTEM IS CUSTOMIZED AND DIFFERS FROM DDD'S TESTING PLATFORMS AND BECAUSE A USER OR APPLICATION DESIGNER MAY USE DDD PRODUCTS IN COMBINATION WITH OTHER PRODUCTS IN A MANNER NOT EVALUATED OR CONTEMPLATED BY DDD, THE USER OR APPLICATION DESIGNER IS ULTIMATELY RESPONSIBLE FOR VERIFYING AND VALIDATING THE SUITABILITY OF DDD PRODUCTS WHENEVER DDD PRODUCTS ARE INCORPORATED IN A SYSTEM OR APPLICATION, INCLUDING, WITHOUT LIMITATION, THE APPROPRIATE DESIGN, PROCESS AND SAFETY LEVEL OF SUCH SYSTEM OR APPLICATION.

12. FORCE MAJEURE. DDD shall be excused for any delay or failure to perform due to any cause beyond its reasonable control, including but not limited to acts of governments, natural catastrophes, acts of Customer, interruptions of transportation or inability to obtain necessary labor or materials. DDD's estimated shipping schedule shall be extended by a period of time equal to the time lost because of any excusable delay. In the event DDD is unable to perform in whole or in part because of any excusable failure to perform, DDD may cancel orders without liability to Customer.

13. LIMITED INDEMNITY AGAINST INFRINGEMENT. DDD shall, at its own expense, defend any litigation resulting from sales of the Products to the extent that such litigation alleges that the Products or any part thereof infringes any United States patent, copyright, or trademark, provided that such claim does not arise from the use of the Products in combination with equipment or devices not made by DDD or from modification of the Products, and further provided that Customer notifies DDD immediately upon its obtaining notice of such impending claim and cooperates fully with DDD in preparing a defense. If Customer provides to DDD the authority, assistance, and information DDD needs to defend or settle such claim, DDD shall pay any final award of damages in such suit and any expense Customer incurs at DDD's written request, but DDD shall not be liable for a settlement made without its prior written consent. If the Products are held to be infringing and the use thereof is enjoined, DDD shall, at its option, either (i) procure for the Customer the right to use the Products, (ii) replace the Products with others which do not constitute infringement, or (iii) remove the infringing Products and refund the payment(s) made therefore by Customer. The foregoing states the Customer's sole remedy for, and DDD's entire liability and responsibility for, infringement of any patent, trademark, or copyright relating to the Products provided hereunder. THIS LIMITED INDEMNITY IS IN LIEU OF ANY OTHER STATUTORY OR IMPLIED WARRANTY AGAINST INFRINGEMENT.

14. ACKNOWLEDGMENT/GOVERNING LAW. Customer acknowledges reading these Terms and Conditions, under-stands them and agrees to be bound by them. A waiver of any provision of this agreement shall not be construed as a waiver or modification of any other term hereof. With respect to all orders accepted by DDD, disputes arising in connection with these Terms and Conditions of Sale shall be governed by the laws of the State of Oklahoma without regard to principles of conflicts of laws.

15. APPLICATION LIABILITY. DDD assumes the buyer to be an expert in his intended application of DDD products. DDD claims no special expertise in the application of its products into the buyer’s equipment. DDD accepts no responsibility for the buyer’s selection and use of DDD products. Buyer’s interpretation and implementation of application suggestions and recommendations by DDD, general or specific, transmitted verbally, electronically or in writing, published or unpublished, is strictly at the buyers own risk.

16. FCC COMPLIANCE WARNING. The RTU device may contain a transmitter module FCC ID:OUR9XTREAM or FCC ID:OUR9XTEND. The transmitter module complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) The device may not cause harmful interference, and (2) the device must accept any interference that may cause undesired operation.

17. FCC RF EXPOSURE WARNING. In order to comply with the FCC RF exposure requirements the ISM RTU units may only be used with approved antennas that have been tested with it. A minimum separation distance of 20cm must be maintained from the antenna to any nearby persons. The RTU unit is not classified as a portable device per FCC Section 2.1093

GENERAL SAFETY INSTRUCTIONS

Warnings in this manual appear in either of two ways:

1. *Danger warnings* – The danger warning symbol is an exclamation mark enclosed in a triangle which precedes letters spelling the word “DANGER”. The Danger warning symbol is used to indicate situations, locations and conditions that can cause serious injury or death:

DANGER

2. *Caution Warnings* - The caution warning symbol is an exclamation mark enclosed in a triangle which precedes letters spelling the word “CAUTION”. The Caution warning symbol is used to indicate situations and conditions that can cause operator injury and/or equipment damage:

Other warning symbols may appear along with the Danger and Caution symbol and are used to specify special hazards. These warnings describe particular areas where special care and/or procedures are required in order to prevent serious injury and possible death.

Electrical Warnings – The electrical warning symbol is a lightning bolt mark enclosed in a triangle. The electrical warning symbol is used to indicate high voltage locations and conditions that may cause serious injury or death if proper precautions are not observed:

For the purposes of this manual and product labels, a **Qualified Person** is one who is familiar with the installation, construction, operation and maintenance of the equipment and the hazards involved. This person must:

1. Carefully read and understand the entire manual.
2. Be trained and authorized to safely energize, de-energize, clear faults, ground, lockout and tag circuits and equipment in accordance with established safety practices.
3. Be trained in the proper care and use of protective equipment such as safety shoes, rubber gloves, hard hats, safety glasses, face shields etc. in accordance with established safety practices.
4. Be trained in rendering first aid.

Manual Revisions

0.1 August 2009	First version
0.2 September 2009	Prelim
0.3 January 2010	First publish.
1.1 September 2010	Many additions.
1.5 November 2010	Examples added.

RFScada32 Firmware Versions

0.6 Sept 2009	Functional as polling master & RFScada slave
0.9 January 2010	Polling 4G master functional.
1.0 June 2010	Mixed Polling / advanced 4G functions added.
1.2 November 2010	Addition of sticky registers, toggle functions, local 4G bus functions, bug fix for V2.2 boards with certain brands of SD cards.

Table of Contents

Introduction

The RFScada32 remote terminal unit from Data Delivery Devices LLC (DDD) is a very high performance, highly integrated general purpose RTU and data logger. It is a fourth generation (4G) device in the RFScada product family, will communicate with any of the other RFScada products, along with virtually any brand of PLC, PC etc. Primarily designed to interface with the DDD range of RFScada products it is also capable of acquiring data from virtually any third party device that supports an analog, digital or Modbus connection (hardwired or wireless). Acquired data may be stored using removable data cards and/or transmitted to other remote devices using the Modbus and RFScada protocols. Support for an on board or remote display for all remote signals and locally connected signals allows for easy data display and control entry. The RTU may be configured using the keypad and LCD, a PC either locally (via built in USB, RS-232 or RS-485 ports, all optically isolated), remotely using a serial link or radio connection, or using the SD card interface to store or load configurations. The RTU has a built in interface to accommodate a 1 Watt 900 MHz spread spectrum radio module; it may also use virtually any commercial radio modem connected via a second set of RS-232 and RS-485 ports (both optically isolated).

All analog signals are acquired, processed and output at a minimum resolution of 16 bits and Modbus support includes acquiring 32 bit resolution data from other devices. There are 32 inputs, each may be configured as analog 4-20mA, 0-10VDC, 0 to 5 VDC, digital (dry contact) or pulse. The 8 4-20mA analog outputs may be driven by any local or remote signal source, and the flexible scaling scheme covers virtually any field application. Nine relays on the board may also be driven by multiple sources, so for example tank control with adjustable hysteresis or control of oilfield pumps dependant of well pressure may easily be configured. An optional board plugs directly to the RFScada32 that adds an additional 24 relays. This manual covers installation and operation of the RTU, plus basic operation of the PC configuration and display software.

DDD RTU Specifications

Due to continual improvements all published specifications are subject to change.

AC Operating voltage	85 - 140 VAC 48 – 62 Hz (85 – 264 VAC 48 – 62Hz if protective MOV changed)
AC Power supply certification	UL, CE, CISPR/FCC Class B
DC Input Operating voltage (note 2)	14 to 28 Volts DC
DC Output Power (note 3)	24 Volts DC 0.5 Amp (for 4-20mA transducers)
DC Output Power (note 3)	12 Volts DC 1 Amp Intermittent (for 5 Watt external radio)
AC Power consumption	<0.5 Amp
DC Power consumption (at 24VDC)	0.1 Amp to 2 Amps depending on active input / output loads and option boards.
On board AC input fuse rating	Field replaceable 2 Amp 115 VAC
AC Input transient protection	Yes, 10,000A 120 Joule 150 V MOV on board
DC Input transient protection	Yes, field replaceable 2A fuse and 1500W MOV on board
Dimensions	9 x 8.5 inches
Weight	1 Pound
Storage temperature rating	-40°C to +85 °C
Operating temperature rating	-10°C to +75 °C (0 to 40 °C for AC powered version)
Humidity	15-95% non-condensing
Analog Input channels	16 plus PCB temperature, DC Voltage and radio signal strength (with ISM radio)
Analog Input resolution	16 bit
Analog Input signal type	0-20 mA grounded, 0-5 Volt DC, 0-10 Volt DC
Analog Input transducer power source	May be external or use on board supply
Analog Input transient protection	600W TVS surge and RF filters
Analog Input transducer on board power supply	On board 24 VDC with AC power or ~1 Volt below DC supply Voltage.
Digital Input channels	16
Digital Input channel signal type	Low voltage (5V) contacts or logic level
Digital Input signal voltage required	None
Digital Input signal transient protection	600W TVS surge and RF filters
Digital Input signal status indication	On board LED’s, one per channel.
Digital Input signal cable length	Maximum 50 feet recommended
Digital Input signal de-bounce time	Approximately 0.2 second
Analog Outputs channels	8
Analog Outputs resolution	16 bit
Analog Outputs signal source	Each output may be driven by any register in the RTU
Analog Output Scaling	Fully configurable by user
Relay output channels	9
Relay contact ratings	SPDT 10 Amp at 115 VAC, 5 Amp at 30 VDC
Relay output signal indication	9 on board LED’s, one per channel, show relay states
Relay control source	Any RTU register
Relay control method	Approx. 40 relay control methods
Modbus Slave connections (data retrieval and RTU config)	RS-232, RS-485 and USB. All may be used simultaneously.
Modbus Master connections (for polling remote devices)	RS-232, RS-485. Both may be used simultaneously.
Number of remote Modbus devices that may be polled	256
Remote device baud rates	1200, 2400, 4800, 9600, 19200, 38400. Each device may be different
On board radio option	Maxstream XTend 900MHz 1 Watt ISM Module plugs in. (note 2)
Transducer on board power supply protection	Yes, current limited with electronic fuse
Inputs that may be monitored by Modbus	Every analog input, digital input, temperature and DC voltage
Outputs that may be controlled by Modbus	Every analog output and digital output
Time to default outputs after signal loss	User adjustable, 20 seconds to over 7 days
Additional status LED’s	7, two each for data transmission/ reception plus one for Modbus / system activity

Notes:

1. Output power will vary depending on external and on board options.
2. Either the master or slave Modbus port may also be shared with the on board radio (if installed).
3.

Device Unpacking & Verification.

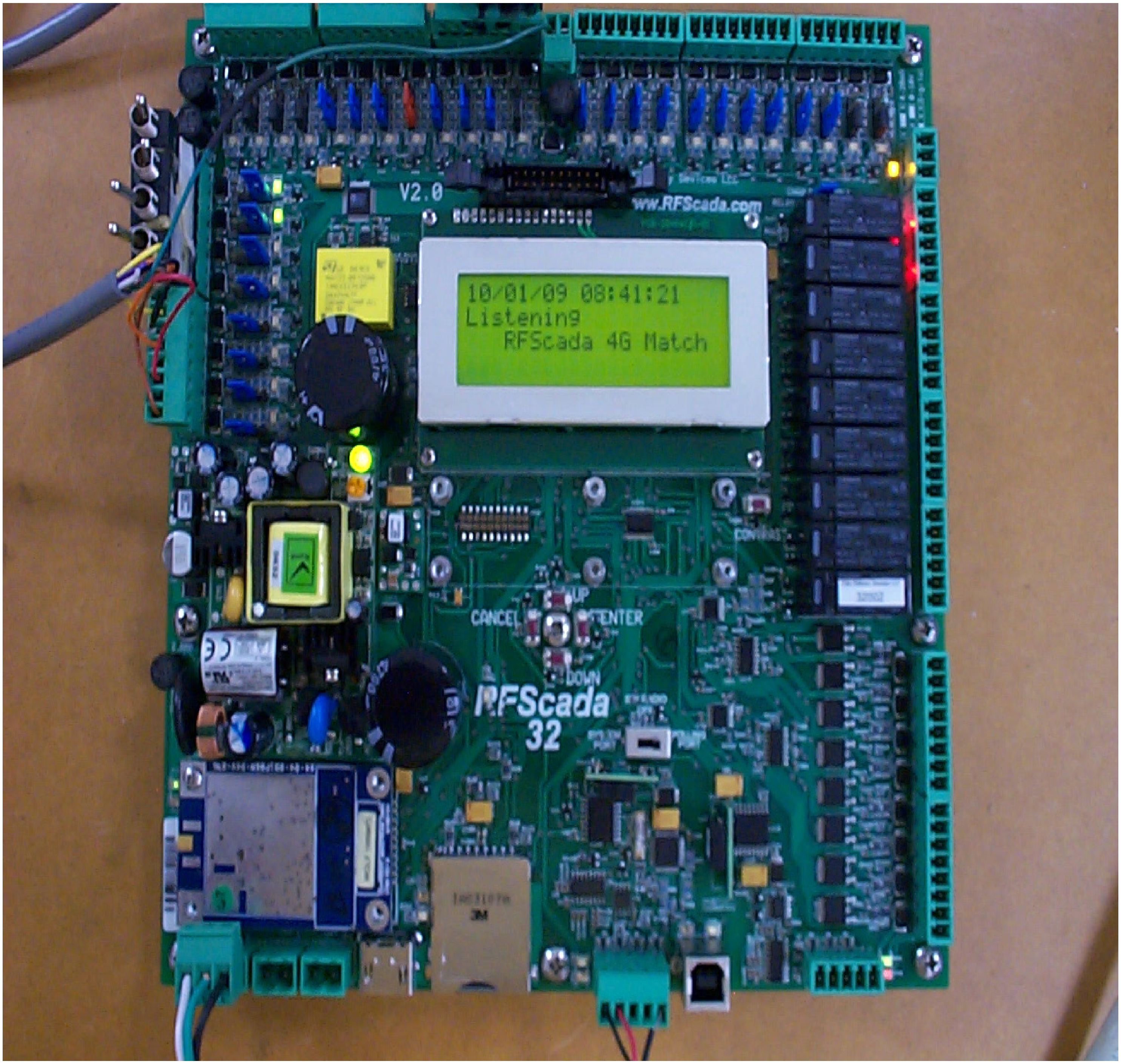
Unpacking:

First carefully unpack the units and verify all the contents are complete, intact and match the items ordered. (Note that the OEM versions may differ from the table below). If there are any discrepancies then please contact the vendor for assistance.

Qty.	Description
1	RFScada32 assembly.
2	2-conductor Phoenix/Sauro connector for DC power in and DC power out
1	3 conductor Phoenix/Sauro connector for AC power in
1	2-conductor Mini Phoenix/Sauro connector for 4-20 mA transducer power source
1	3-conductor Mini Phoenix/Sauro connector for system status output relay
2	5-conductor Mini Phoenix/Sauro connector for RS-232 / RS-485 ports
4	6-conductor Mini Phoenix/Sauro connectors for 8 output relays.
10	8-conductor Mini Phoenix/Sauro connector for analog and digital input/output signals
2	2 Amp 250 V fuses (spare).
1	2GByte SD/MMC data card.
1	RTU Configuration Software and Manual (provided on above SD/MMC data card)

Component Identification, Signal and Wiring Reference.

J6 J9 J8 J10 J7 J22 J27



J44 J43 J47 J3 J4 J21 J20 J1 J2

The following chart lists the connections and basic functions of all pins.

Ref	Pin	Function
J19	1	Input Channel One positive input.
J19	2	Input Channel One return (connected to ground)
J19	3	Input Channel Two positive input
J19	4	Input Channel Two return (connected to ground)
J19	5	Input Channel Three positive input
J19	6	Input Channel Three return (connected to ground)
J19	7	Input Channel Four positive input
J19	8	Input Channel Four return (connected to ground)
J6	1	Input Channel Five positive input
J6	2	Input Channel Five return (connected to ground)
J6	3	Input Channel Six positive input
J6	4	Input Channel Six return (connected to ground)
J6	5	Input Channel Seven positive input
J6	6	Input Channel Seven return (connected to ground)
J6	7	Input Channel Eight positive input
J6	8	Input Channel Eight return (connected to ground)
J30	1	Input Channel Nine positive input
J30	2	Input Channel Nine return (connected to ground)
J30	3	Input Channel Ten positive input
J30	4	Input Channel Ten return (connected to ground)
J30	5	Input Channel Eleven positive input
J30	6	Input Channel Eleven return (connected to ground)
J30	7	Input Channel Twelve positive input
J30	8	Input Channel Twelve return (connected to ground)
J25	1	Input Channel Thirteen positive input
J25	2	Input Channel Thirteen return (connected to ground)
J25	3	Input Channel Fourteen positive input
J25	4	Input Channel Fourteen return (connected to ground)
J25	5	Input Channel Fifteen positive input
J25	6	Input Channel Fifteen return (connected to ground)
J25	7	Input Channel Sixteen positive input
J25	8	Input Channel Sixteen return (connected to ground)
J56	1	Input Channel Seventeen positive input
J56	2	Input Channel Seventeen return (connected to ground)
J56	3	Input Channel Eighteen positive input
J56	4	Input Channel Eighteen return (connected to ground)
J56	5	Input Channel Nineteen positive input
J56	6	Input Channel Nineteen return (connected to ground)
J56	7	Input Channel Twenty positive input
J56	8	Input Channel Twenty return (connected to ground)
J61	1	Input Channel Twenty One positive input
J61	2	Input Channel Twenty One return (connected to ground)
J61	3	Input Channel Twenty Two positive input
J61	4	Input Channel Twenty Two return (connected to ground)
J61	5	Input Channel Twenty Three positive input
J61	6	Input Channel Twenty Three return (connected to ground)
J61	7	Input Channel Twenty Four positive input
J61	8	Input Channel Twenty Four return (connected to ground)

J66	1	Input Channel Twenty Five positive input
J66	2	Input Channel Twenty Five return (connected to ground)
J66	3	Input Channel Twenty Six positive input
J66	4	Input Channel Twenty Six return (connected to ground)
J66	5	Input Channel Twenty Seven positive input
J66	6	Input Channel Twenty Seven return (connected to ground)
J66	7	Input Channel Twenty Eight positive input
J66	8	Input Channel Twenty Eight return (connected to ground)
J71	1	Input Channel Twenty Nine positive input
J71	2	Input Channel Twenty Nine return (connected to ground)
J71	3	Input Channel Thirty positive input
J71	4	Input Channel Thirty return (connected to ground)
J71	5	Input Channel Thirty One positive input
J71	6	Input Channel Thirty One return (connected to ground)
J71	7	Input Channel Thirty Two positive input
J71	8	Input Channel Thirty Two return (connected to ground)
J46	1	4-20 mA transducer positive power supply output
J46	2	4-20 mA transducer positive power supply output
J40	1	Network status (relay thirty three) contact normally closed
J40	2	Network status (relay thirty three) contact normally open
J40	3	Network status (relay thirty three) contact common
J36	1	Relay one contact normally closed
J36	2	Relay one contact normally open
J36	3	Relay one contact common
J36	4	Relay two contact normally closed
J36	5	Relay two contact normally open
J36	6	Relay two contact common
J37	1	Relay three contact normally closed
J37	2	Relay three contact normally open
J37	3	Relay three contact common
J37	4	Relay four contact normally closed
J37	5	Relay four contact normally open
J37	6	Relay four contact common
J38	1	Relay five contact normally closed
J38	2	Relay five contact normally open
J38	3	Relay five contact common
J38	4	Relay six contact normally closed
J38	5	Relay six contact normally open
J38	6	Relay six contact common
J39	1	Relay seven contact normally closed
J39	2	Relay seven contact normally open
J39	3	Relay seven contact common
J39	4	Relay eight contact normally closed
J39	5	Relay eight contact normally open
J39	6	Relay eight contact common
J32	1	Analog Output 1
J32	2	Analog Output 1 Ground
J32	3	Analog Output 2
J32	4	Analog Output 2 Ground
J32	5	Analog Output 3

J32	6	Analog Output 3 Ground
J32	7	Analog Output 4
J32	8	Analog Output 4 Ground
J33	1	Analog Output 5
J33	2	Analog Output 5 Ground
J33	3	Analog Output 6
J33	4	Analog Output 6 Ground
J33	5	Analog Output 7
J33	6	Analog Output 7 Ground
J33	7	Analog Output 8
J33	8	Analog Output 8 Ground
J1	1	Polling port (Comm2) RS-485 & RS-232 Modbus Common
J1	2	Polling port (Comm2) RS-485 Modbus 'A' Transmit / Receive Data
J1	3	Polling port (Comm2) RS-485 Modbus 'B' Transmit / Receive Data
J1	4	Polling port (Comm2) RS-232 Modbus Receive Data
J1	5	Polling port (Comm2) RS-232 Modbus Transmit Data
J20	1-4	System (Comm1) USB Port
J7	4	System port (Comm1) RS-485 & RS-232 Modbus Common
J7	2	System port (Comm1) RS-485 Modbus 'A' Transmit / Receive Data
J7	3	System port (Comm1) RS-485 Modbus 'B' Transmit / Receive Data
J7	4	System port (Comm1) RS-232 Modbus Receive Data
J7	5	System port (Comm1) RS-232 Modbus Transmit Data
J21		SD/MMC Card Connector
J2	6	Comm4 RS-485 Modbus 'A' Transmit / Receive Data
J2	4	Comm4 RS-485 Modbus 'B' Transmit / Receive Data
J2	5	Comm4 RS-485 Modbus Ground
J2	2	RF4G High Speed I/O Bus Ground
J2	3	RF4G High Speed I/O Bus 'A' Transmit / Receive Data
J2	1	RF4G High Speed I/O Bus 'B' Transmit / Receive Data
J2	8,11, 17	4G Ground
J2	18,19	4G 5Volt Supply
J47	1	Fused DC Supply Output positive (for external radio, 12 VDC)
J47	2	DC Supply Output negative (connected to ground, for external radio)
J43	1	External DC Voltage input positive 10 to 28 Volts DC
J43	2	External DC Voltage input negative (connected to ground)
J44	1	117 VAC Line Hot AC power in
J44	2	Ground In
J44	3	117 VAC Line Neutral AC power in
J5		Socket for spread spectrum ISM radio module.
J49		Expansion connector.
J48		LCD / remote keypad connector

All signals are identified by the preceding diagram and chart. Note that not all the connections need to be used; these will vary depending on the application.

J44, AC Line Input

This is 115 VAC line power and ground connection to the unit. Note, depending upon local electrical codes grounding may also need to be provided from any steel plate or enclosure which supports the main board.

DANGER

Possibly lethal line voltages will be present on the RTU's circuit board when connected to AC line power. Before attempting to gain access, test or modify connections refer to a qualified electrician for assistance, instructions on safe operation and to ensure that connections meet all applicable safety procedures, standards and codes.

If the RTU unit is operating from an external DC supply this connecter may not be used. Note that when the connector is plugged in it prevents access to the units AC fuse; AC power must be removed to change the fuse. The RTU has extensive AC and DC surge and lightning protection, including 150 VAC MOV protection across the AC input after the main fuse. 150 Volt devices are used instead of the more common 130 Volt devices to prevent nuisance trips that may be caused by unstable power surges, weak power systems, operation from generators etc. The RTU may operate either from 115 AC power or low Voltage DC, both may be safely connected at the same time. The AC power supply is capable of operating from 85 to 264 VAC, however the 150V AC MOV is normally installed across the AC line input. If operation at higher than 140 VAC is required please contact the factory for information on ordering a unit with a higher voltage rating or for information on installing a higher rated MOV in the field. The AC supply installed will provide enough power for most applications. However, for systems using many 4-20mA inputs and outputs where the RTU provides power and all the relays the on board power supply may not be powerful enough. If this is the case an external 12-30 VDC power supply may be used to provide the additional power required. Both the standard AC and an external DC power supply may be safely connected at the same time.

J43, External 10 to 28 Volt DC Input

This is the low voltage input power connector, and if used may be connected to a 10 to 28 Volts DC external power source. Note that pin 2 is connected to ground on the circuit board and is common to all the other pins that connect to ground. If an external ground is not connected via the 115 VAC power connector (J1), then an external ground should be connected to this pin. Note, depending upon local codes grounding may also need to be provided from any steel plate or enclosure which supports the main board. The RTU is diode protected from reverse polarity, has a fuse protecting the on board components, a mechanical (2A 250VDC) fuse protecting the 'pass thru' external radio connection and is also protected by a TVSS surge protectors (33 Volt rating) so care should be taken to prevent exceeding the DC Voltage rating.

The RTU may operate either from 115 Volts AC power or low Voltage DC, both may be safely connected at the same time. Note that some 4-20mA transducers and some external radios will not operate if the DC Voltage is less than 12 Volts.

J46, 4-20mA Transducer Power Supply Output

This connector provides a DC power supply for external 4-20mA transducers that require power. The DC voltage is approximately 23 Volts DC when the RTU device is operating from AC power, and approximately 1 Volt less than the DC input Voltage if operating from DC power. This supply is protected on the RTU board with a field replaceable fuse located next to the transducer power connector. The transducer power supply output is fused by a 2Amp fuse T2.

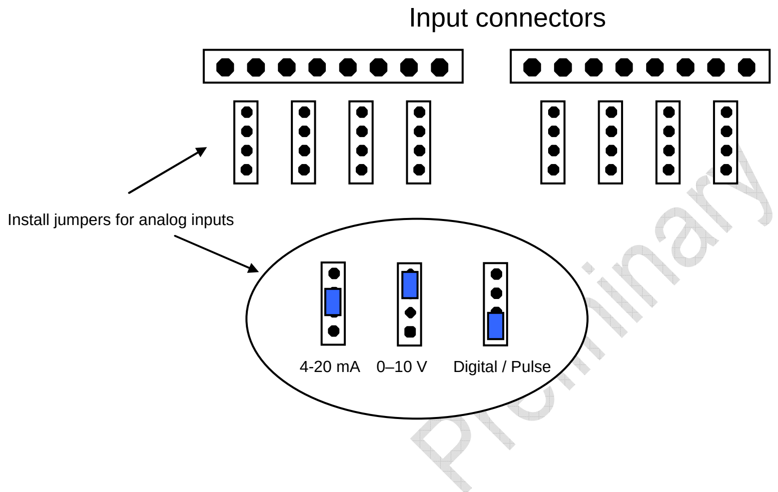
J46, 12 V DC External Radio Power Supply Output

This connector provides regulated 12 Volts DC power supply typically used for external radios that require DC power. If the RTU is operating on DC input power note that this output is only valid when the supply Voltage exceeds approximately 14 Volts DC. The DC output Voltage is fused with a field replaceable 2Amp fuse, T4.

J19, J6, J30, J25, J56, J61, J66 & J71 Signal Inputs

There are thirty two field configurable inputs on the RTU. By moving jumpers at the inputs each may be individually configured for analog 0-20mA (typically used for 4-20mA transducers), 0-5VDC analog, 0-10VDC analog or dry-contact switch / logic level digital inputs. When configured for digital an input may then be used for simple open / closed status reporting or may also be configured for pulse counting.

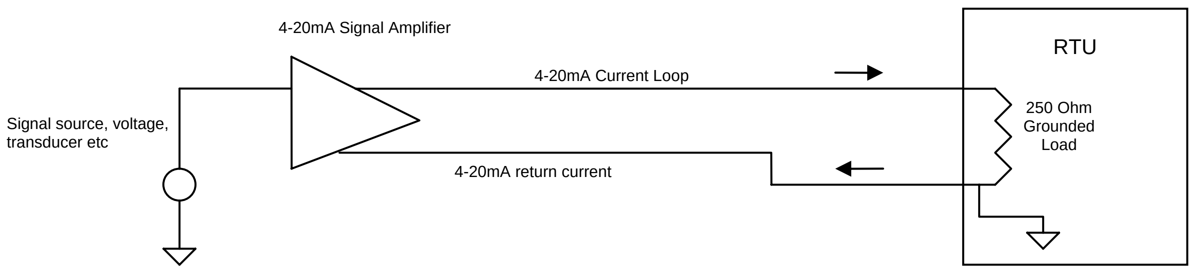
Configuring Inputs for Analog, Digital or Pulse Operation



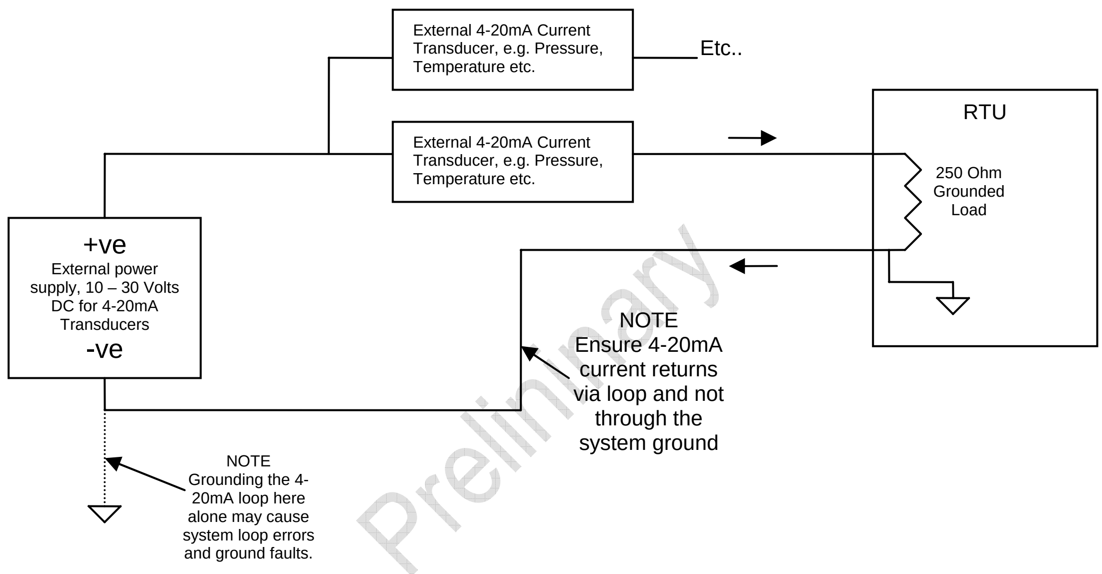
When configured for 4-20 mA each of the inputs presents a load of 250 Ohms to ground for the external circuit, so each input may also be used for a 0 to 5 Volt DC input providing the external circuit is capable of driving the load. Each analog input is protected against overloads to approximately 14 Volts DC by TVSS devices on the board that will clamp signals above that level. Permanent damage to the external or input circuitry may occur above these levels. If possible a current limited power supply, or even a resistor in series with each current loop, may be used to limit current in case the external 4-20mA transducer is accidentally shorted or fails. The full scale reading will occur at 20mA input current, so no indication will occur if the input current limit is exceeded. The RTU units have a built in power supply specifically for external 4-20 mA transducers, or external signal sources may supply the 4-20mA power required. Note that all references to 4-20mA input actually allow accurate signal measurements from 0 to 20mA, so broken 4-20mA ‘loops’ may be reliably detected. See the following examples for some connection possibilities.

When the units are configured for 0-10VDC each analog input presents a load of 2KOhms to the applied signal.

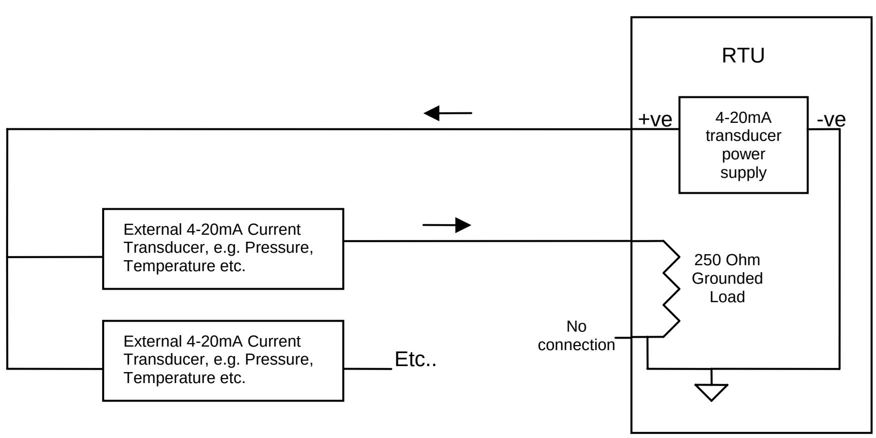
External signal amplifier, PLC or PC with analog 4-20mA output



External DC power supply and 4-20mA transducers



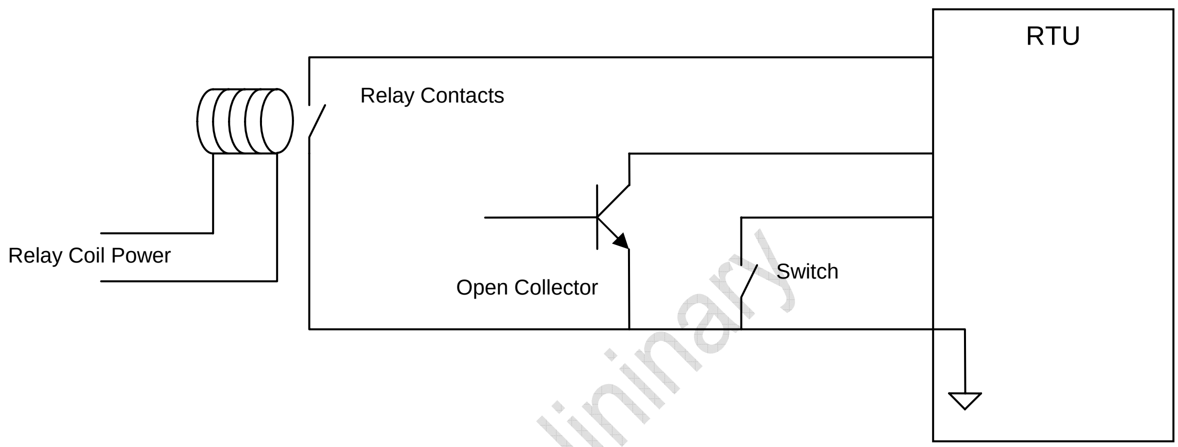
External transducers using RTU's built in 4-20mA transducer power source



If possible each input should have its own current return (the even numbered pins on these connectors) to maintain highest accuracy, however they may share ground connections in some cases to save wiring. Do not use the system ground as a return for the current loops when using an external supply, as it may cause errors and external 'ground fault' protectors may trip. Since each input is grounded the RTU unit must be the only 'grounded' part of the current loop if several devices are in series in a 4-20mA loop. The hardware converter for each analog input measures at 16 Bit accuracy, representing 0.000305mA per bit. There are several ways to supply 4-20mA signals and power to the RTU units, the previous diagrams shows some possibilities.

If configured for digital input switch the input presents transient protected, dry-contact switch or logic level inputs to the RTU device. Each of the inputs is pulled up to 5 Volts DC via a 1K Ohm resistor, so the inputs may be activated either by a shorting switch or relay contact to ground or they may be directly driven from an 'open collector'

Examples of Digital Signal Input Methods



logic level. Each input connection has a corresponding ground connection on the connectors, but it is permissible for these switch inputs to share a common ground connection to save on wiring. Note that each of these inputs is protected from Voltage surges and impulses by individual TVSS surge protectors, which short-out negative Voltages and clip any Voltage spikes above approx 6 Volts DC, preventing damage to the RTU unit. **Under no circumstances should any external voltage be applied to these connectors, as damage may occur**. Since these inputs are protected from Voltage spikes and surges the input signals may be run substantial distances without risk of damage. When each input is 'active', i.e. shorted to ground, a corresponding green LED will illuminate next to the active input. If a TVSS input protection device had been damaged due to excessive input current the LED may remain on and the input appear to be active all the time, even with no input switch or signal connected.

Output Relay Contacts

J40 is connected to the contacts of a single-pole double-throw relay (relay 33), which typically is configured to reflect the current operating state. Usually this relay and LED will be continually energized (yellow LED on) when all remote devices are successfully operating and communicating with the RTU. If the relay and LED are slowly toggling on and off it indicates some but not all remote devices are successfully communicating, If this relay and LED are continually off it indicates that no remote devices are communicating with the RTU. The relay function may be set for any other mode using the setup configuration. For some solar powered applications where power consumption is important this relay may be disabled simply by moving a jumper (J51), so saving power (approx. 30mA on 12 VDC systems). All the software settings are unaffected by this jumper; it merely physically disables power to the relay and LED. Once the system has been verified fully operational the jumper may be placed in the power save position; of course it may be placed back in the normal position to verify correct operation at any time.

J36, J37, J38, J39 & J40 Output Relay Contacts

The first four connectors connect to the contacts of eight single-pole double-throw relays, with each relay driven depending on software configuration. Each relay has a corresponding red status LED by the connector, for visual indication of the output state. Each relay contact is rated for 8 Amps at 115 VAC, or 5 Amps at 30 V DC. If loads greater than this are to be controlled a suitable larger capacity relay could be driven from these.

Relay thirty three, connected to J40 is typically used to reflect polled device network status although it may be programmed for other uses. It is the only relay that may be manually disabled using a jumper on the RTU board located by the relay connector.

System Modbus Connector J7 RS-232, RS-485

This connector brings out the Modbus, or configuration communications signals from the RTU unit at both RS-232 levels and RS-485 levels on the same connector. This port is typically used for RTU configuration or connection to upstream devices that may request RTU data, such as a satellite modem, an internet connection or a PC. There are just three connections needed, common and depending on the interface level (RS-232 or RS-485) two other pins. Note that the RTU board has an RS-232, RS-485 and USB system interface built in, along with the option of an ISM radio module; and all of these may actually be used at the same time. An incoming data request may arrive at any of these ports, and the response from the RTU is sent out to all ports simultaneously; the changeover between different communication ports is automatic. As is normal with Modbus protocol, any device or similar master that is connected simply ignores responses they did not originate or expect. Refer to the configuration section for further details on RTU programming and connection. Note that the RS-232, RS-485 and USB connection although electrically connected to each other are completely electrically isolated from ground and the rest of the RTU, to eliminate any ground loop or induced Voltage surges that could damage the ports especially when using long cable runs. Pins 2 & 3 duplicates the system Modbus except at RS-485 (two wire) levels.

System Modbus USB Connection, J20

This connector duplicates the system Modbus RS-232/485 signals, except at USB levels. When connected to a PC for the first time a suitable USB driver may be installed on the PC, this is usually done automatically and the PC will appear to have gained an additional COMM port that may be used to communicate with the RTU.

Polling Port Device Connection RS-232, RS-485 J1

This connector brings out the communications signals from the RTU unit to other devices at RS-232 and RS-485 levels. This port is typically used to ‘poll’ or receive commands from external devices using Modbus or RFScada protocols. There are just three connections needed, common, and depending on the interface level (RS-232 or RS-485) two other pins. Note that the RTU board has an RS-232 and RS-485 interface built in for polling remote devices, along with the option of an ISM radio module; and all of these may actually be used at the same time. When the RTU issues a data request it is sent out to all ports simultaneously; the response may come back on any of these ports; the changeover between different communication ports is automatic. So for example one device may be connected by RS-232, some by RS-485 and some by radio; all could communicate correctly. Refer to the configuration section for further details on RTU programming and connection.

On Board ISM Spread Spectrum Radio Option, J5

The system and ‘polling’ ports may also use the ISM spread spectrum radio option. When installed this radio option may be used by either the system or ‘polling ports’ but not both. A switch T13 controls which port (or neither if it is set to the center position) will utilize the radio. If the switch is to the right it will connect to the ‘polling’ ports, or to the left for connection with the system ports. Note that the ISM radio module is typically set for 9600 baud only. An external ISM radio may also be used at the same time as the on board radio by simply connecting it to the RS-232 or RS-485 port either for the remote device or system ports.

Auxiliary Modbus RS-485 Port & RFScada 4G I/O port J2
This single connector, similar in style to a video HDMI port, contains two separate high speed serial ports. The first port would typically be used for local connection to a flat panel display via Modbus (the RTU being a Modbus slave). It has access to all RTU Modbus registers, supports the same Modbus protocols as the system port but is completely separate (electrically and software wise) from it. It has a single three wire RS-485 connection that is not electrically isolated form ground. It is recommended to leave this port at the 38400 baud rate for maximum performance, and is typically used for a remote flat panel display that may interface to the RTU. The second port contained in the same connector supports the high speed 4G interface port allowing the RTU to connect to 4G peripherals such as the optional 24 relay output board. All 4G peripherals such as the relay board have two HDMI style connectors in parallel to allow daisy chaining the signals from one device to another. The interconnect between 4G peripherals may be made using standard HDMI cables. *Note - Do not connect the RFScada 4G I/O port to any HDMI devices!*

RTU Network Transmit / Receive LED's
These two LED's (green receive, red transmit) illuminate each time the unit transmits data or receives data from another device. Normally the two LED's will be flashing in sequence as the unit communicates with other units. If the unit receives data not intended for it the green LED may flash but not the red. If the receive LED flashes quickly but the transmit LED never flashes it is possible this unit is configured not to communicate with remote devices. If the transmit LED flashes but not the receive LED it indicates that this unit is the network master but no slaves are responding to the transmitted data. These two LED's give a quick indication of communications, and are very useful in the case of marginal data communications, configuration setup or antenna adjustments. Typically the yellow 'network state' LED and relay will also give indication of the network status at all times although this may be re-programmed by the user for other functions.

ISM High Power Radio Transmit / Receive LED's
These two LED's (green receive, red transmit) illuminate each time data is transmitted or received from the ISM spread spectrum high power radio transceiver. Depending on the mode it is programmed to operate in the LED's may flash multiple times for each transmission and reception. These LED's are not used with any other radio option.

System Transmit / Receive LED's
These two LED's (red receive, green transmit) illuminate each time the unit completes a data transmission or verified data reception with a PC or other connected device via Modbus. If the unit receives data not intended for it or does not understand the data then the red LED may flash but not the green.

System / Modbus LED
This blue system / Modbus LED indicates system activity, such as during a power up, each Modbus or configuration data reception. It will also flash quickly for a few seconds when configuration settings are being stored in the non volatile memory.

F1, AC Power Fuse
A user replaceable fuse and a transient arresting MOV protect the board. The fuse is located by the AC input power connector J44; note that the AC power connector must be unplugged before the fuse may be removed.

DANGER

Possibly lethal line voltages will be present on the unit's circuit board when connected to AC line power. Before attempting to gain access, test or modify connections refer to a Qualified Person for assistance, instructions on safe operation and to ensure that connections meet all applicable safety procedures, standards and codes.

The fuse will blow if there is a malfunction in the circuit, or a voltage greater than the board rating is applied to the AC line input. If it has failed discard and replace with a spare 2 Amp 250VAC fuse that is supplied with the unit. Do not use a fuse with any other rating. To check AC operation any external DC supply, if connected, must also be removed. If the unit does not power up correctly please contact DDD for assistance. Once correct operation has been verified the DC supply, if used, may be re-connected.

System Configuration & Programming.

The RTU is a very complex device with many settings. Being far more capable than previous RFScada devices it is also a little more complex to program, however most applications may still be configured very quickly. Before details of operation are explained a general overview of how it operates may be beneficial. In normal operation the RTU continually gathers data from its own signal inputs, such as the analog inputs, the PCB temperature etc. This data is stored in volatile (RAM memory, i.e. contents are lost if the power is removed) local memory and may also be stored in a removable memory card. The RTU controls the local outputs such as the relays and analog outputs in many different ways. It responds to Modbus commands that arrive via one of the four available ‘system’ serial ports. It may poll remote devices for data via the three possible ‘remote device’ serial ports or it may act as a 'slave' device to other RFScada devices. It will respond to key presses and, if installed, will display configuration and live data on the LCD display. The RTU has thousands of user adjustable non-volatile settings instructing it how to do all of these things, and another 1000 or so volatile registers that contain the result of various inputs or calculations. All of these registers may be read and written to by the user, to effectively configure and take data from the device. All of these registers may be accessed by serial (Modbus) commands coming into the system serial ports or by using the SD card interface to read or write the registers. Most (but not all) may also be accessed by using the keypad and LCD display. The RTU stores all of its settings inside non volatile memory on the PCB (not in the removable memory card) where they will remain until the unit is reconfigured. Connection to power is not required to maintain these settings; there are no batteries or similar volatile devices required for configuration storage. The RTU also contains a real time clock; this has its own battery and so the time and date is retained without external power.

Any general purpose Modbus master program (such as QuickMod by Azeotech) may be used to configure the device. However, because of the complexity a custom PC program called RFScada32 is provided by DDD that allows user friendly configuration of the RTU; it may also be used to display the current RTU inputs and display logged data files that have been saved to the SD memory cards. However the configuration is changed the net result is the same, registers inside the RTU memory will have been changed and the RTU will now operate using the latest settings. The full Modbus ‘map’ is given which identifies every register inside the device; note that many registers are just described once, as for example there may be 256 polled devices so the related group of registers is repeated 256 times. The more common registers and settings may be accessed using the LCD and keypad; for example every remote device may be fully configured from the keypad. This would be a long and tedious process however, so for occasional use the keypad may be used for device configuration but the PC configuration software would be a much faster way to accomplish the task for multiple devices. If a PC with suitable interfacing cables were not available another method would be to save the existing configuration to the SD card, edit the configuration file with a computer, then load the new configuration file into the RTU form the memory card.

All features and functions will be described in terms of physical signals and Modbus registers, rather than menu descriptions, PC software configuration screens or data files.

Configuration / Data Access Communication Ports.

The three (four if the onboard radio is also configured for this port) system communication ports have several configuration settings. The baud rate, Modbus ‘gap’ time and Modbus address may all be changed. Common settings may be entered from the keypad; non standard values are also supported and may be entered using Modbus commands or from the SD card. If any of the Modbus parameters are changed they will become effective immediately; so if a Modbus master is communicating with the RTU it will need to change its own communication parameters to match the RTU’s new ones.

The Modbus specification has very strict definitions for the time a slave device should take to respond to commands from a Modbus master and the time that a gap between successive bytes in a packet may be. In ideal circumstances these definitions may work, but in real applications where the RTU may be used with phone modems, data radios, leased line connections, pc’s, ‘hardware automatic’ RS-232 to RS-485 data converters, internet connections etc they may not always work.

The Modbus ‘gap time’ allows adjustments to enable communications via various pieces of equipment that may introduce delays. Modbus RTU messages start and end with a silent interval of at least 3.5 character times, which for a baud rate of 9600 bps is approximately 4mS. The RTU is capable of reading a Modbus message, acting on the message, formulating a reply, then start transmitting it back to the Modbus master device as soon as this 4mS time expires. The RTU is also capable of monitoring the Modbus data and detecting a gap between bytes in a message that is 4 mS in length for example. Normally Modbus messages from a Master, such as from a local PC with a built in serial port will usually have correctly formed data packets without any gaps between bytes. However, if there are gaps between bytes of more than 4mS the RTU units may assume the packet has ended, process it and since the packet is not complete the RTU unit ignores the packet and does not reply. The Modbus master then indicates an error reporting that the RTU device did not reply to a Modbus message, when in fact a legal Modbus packet was not presented to the RTU device. This type of error seldom occurs on modern PC systems with a hardwired local connection; however they will occur when a telephone modem, radio or similar device is between units on a Modbus network. Even short packets of data sent directly between two telephone modems often result in smaller bursts of data at the receiving modem, separated by gaps of several milliseconds. The problem may also occur when some RS-485 interface devices are used that incorporate ‘automatic transmit enable’ circuits; these devices often use simple RC timing circuits to enable the driver output, with the result being they may still be driving the Modbus connection and corrupting data several milliseconds after the bus should have been released, when the RTU unit is trying to send a reply.

To overcome these problems the user may set the gap time in mS. Extending the gap time will delay a response to the Modbus master, so it should not be extended too long, or the Modbus masters own timeout settings may need to be extended.

Warning !

If this delay is set to very small values Modbus communication problems may occur, especially with remote modems and similar devices. ***It is possible to completely lose remote Modbus communications, and lose the capability to change the configuration back!*** If this occurs a direct serial connection may be required to regain Modbus control or the settings restored with either the SD card or keypad, and return modified registers such as the gap time, back to values that allow functionality with connected equipment.

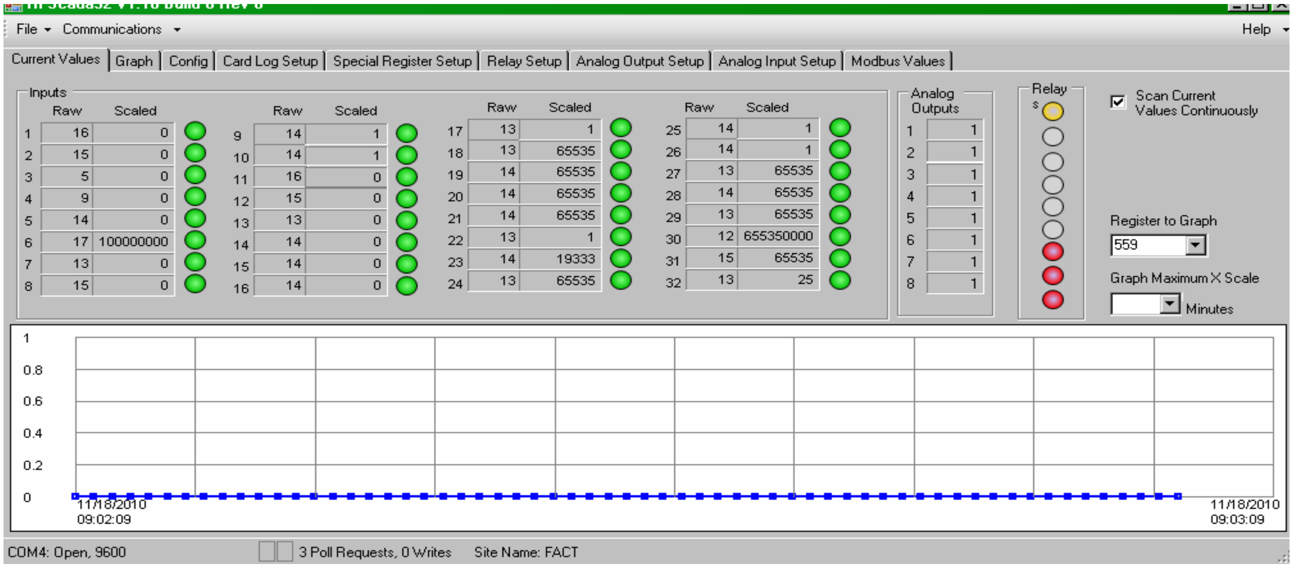
For this reason if an RTU device is accessed via Modbus address 170 (0x55 Hex) it will ignore the users silent time setting and use a very slow setting of 100mS, therefore allowing communication with most standard devices including remote modems. This gives the user (and the RTU configuration program) a means to restore settings that have been changed to inoperative ones. Therefore, if changes in the gap time are required a Modbus address other than 170 must be used.

If this register is adjusted from a remote location use caution as communications may be lost and a site visit may be required to restore operational settings.

The USB connector allows communication with most modern PC’s without requiring any special cables or adapters. If the RTU is powered up and connected via the USB port to a PC a ‘new device found’ window should appear on the PC. The RTU does not require any special software drivers to use this connection, and the PC should be able to configure what appears to be a new ‘Comm Port’ on the PC. Any device files needed should already be installed on most modern PC’s running Windows. If for some reason the device is nt installed automatically the device driver files are available on the SD card provided with the RFScada32. When the PC software is running it will allow the connection to be made via the USB Comm port; which is physically on the RTU board.

Inputs.

There are thirty two inputs on the RTU. Each may be configured for analog (0-20mA, 0 to 10 Volts DC, 0 to 5 Volts DC), or digital (dry contact closures, switches, relay contacts, open collector transistors, pulses) by moving a jumper located by each input. The RTU is not aware of the actual signal type being used; the jumper location simply changes the load resistance and input type. They will be described in the two modes.



Analog: When set to any of the analog modes the inputs will be constantly read to sample the incoming analog signal levels, and the (16 bit) 'raw' result of these reads are placed directly into 32 Modbus registers starting at address 800. Also, at the end of each sample, a scaling conversion will be performed and the scaled values (engineering units) will be placed into Modbus registers starting at 768.

Typically engineering unit values are much more useful, for example a tank level of 0 to 20 FT, or a pressure of 500 to 2500 PSI. The RTU may scale the raw values, and the scaled values will then be placed in the scaled analog input registers starting at 768. The operator may then use either raw or scaled (or both) values for various control and logging functions. To generate scaled values five scaling parameters need to be entered. The following example may help explain the procedure. We will use a 4-20mA type flow transducer that has 100 bbl / day maximum corresponding to 20mA, and a 4mA output when the flow is 0 bbl / day. At full scale, (20mA input) the raw result (input high setting) should be 65535, a full scale 16 bit reading. At minimum scale, 0 bbl/d the transducer does not output 0mA but rather 4mA. This corresponds to (4/20) * 65535 = 13207, which is entered as the 'input low setting'. These two settings are the basis for the scaling calculation inside the RTU, they define the high and low input points for the incoming signal. Now the two 'out settings' may be entered. These correspond to the desired output reading when the input is at its minimum (in this case 0 bbl/d) which is entered as the 'scale output low'. Next the 'scale output high' value is entered, in this case 150. Now as the input signal varies from 4mA to 20mA (0 to 150 bbl/d) the scaled analog Modbus register will reflect that, and may also be observed on the LCD or used for other purposes, such as logging.

The Modbus values are all integer and do not contain decimal places. However another set of configuration registers (starting at 6608) contain information on displaying a decimal point or multiplying the result by powers of 10, If for example the bbl/d reading was needed with 2 decimal places simply change the scale output high from 150 to 15000 and set * 0.01 in the format setting, and it will be displayed as 0.00 to 150.00 This scaling method provides flexibility and makes it easy to correct for scaling errors, for example due to density of a fluid not be being 1 such as saltwater. The RTU will report values such as 'SCALE ERR' if values have been entered that are illegal, such as input high and low points being the same.

Whether the inputs are set for 0-20mA, 0-10Volts or 0-5 Volts the scaling process is exactly the same.

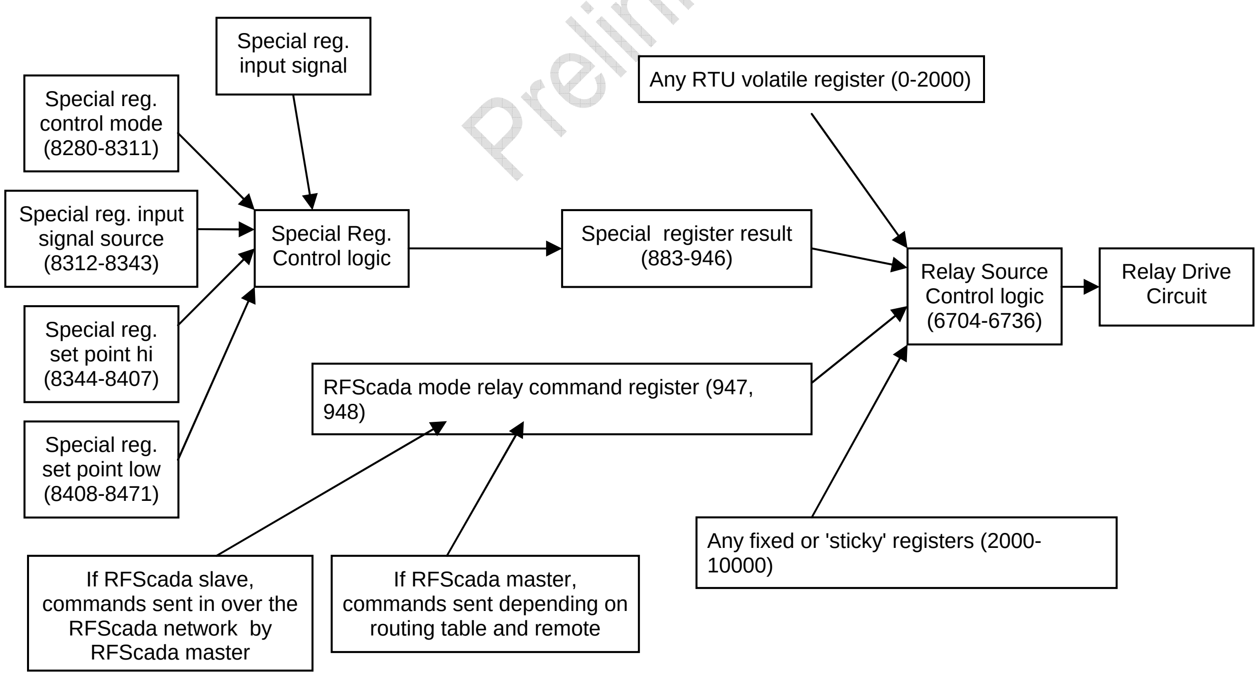
When physically configured as digital inputs or for pulse counting applications a pullup resistor supplies a current limited 5 Volt signal source to the relevant connector pin. As the input is shorted to ground by an external circuit, switch or dry contact a green LED will illuminate by the input indicating an 'active' digital input. When a digitally configured input is open circuit (i.e. 'OFF') the LED will be extinguished and the value read for that 'raw' analog input will be approximately 48000, this will drop to approximately zero when the input is shorted or 'active'. If the scaling factor is set for pulse counting mode then the scaled value will be a count of the number of pulse edges. This will continue to 4095 then wrap back to zero. (It does not wrap at 65536 to maintain 4G protocol compatibility).

Analog Outputs,

There are 8 analog outputs o the RTU board. Each output is capable of driving a signal from 0 to 20mA. The RTU provides the source current, there is no need for an external supply and the negative side of the load is connected to ground at the RTU. The logical signal that drives each analog output may be any Modbus register in the RTU, so the analog outputs may reflect any data that the RTU is aware of. The analog outputs may also be scaled for both ‘input hi/lo’ and ‘output hi/lo’ set points, so virtually any field application may be accommodated. There are several registers that need to be configured for the analog outputs to operate. @@@

Digital (Relay) Outputs

There are nine SPDT relays on the RTU board, and another 24 on an optional board that can be controlled with the RFScada32. There are many ways the each relay may be controlled. The diagram below shows the options possible for controlling each of the 33 relays. Each relay has a relay source control register which points to a memory location controlling when the relay is active. Typically if this unit is to be used as an RFScada ‘slave’ each register is aimed at the ‘RFScada mode register’ which is controlled by the polling master RFScada unit or PC, this is the default setting. In this case the relays are driven via a Modbus register that is controlled by the RFScada



‘master’. However each relay may also be assigned (locally, in this RFScada) to be controlled by any register in this device. So as an example the first 4 relays could be controlled by a polling master but the remaining ones may be controlled by any register in the RFScada. If the control register that a relay is aimed at contains 0 the relay is inactive (ie off, the same state as if the board is not powered), and any other value turns the relay active (on). For very simple applications a relay control register may be aimed directly at a suitable control register. E.g setting register 6709 to contain 848 means relay 6 will be driven by Modbus register 848, which happens to contain the seconds count from the real time clock. This value will change from 0 to 59 then start again at 0. Therefore the relay will be on when the seconds count is 1 to 59, but will turn off for 1 second when the seconds are at zero; so the relay will turn off briefly once per minute. Most relay controls are more complicated than this, and may require setpoints, hysteresis etc. The RFScada32 contains ‘special’ registers that may be configured for complex control purposes; and of course relays may then be aimed at the special registers for applications such as tank level control, relay activation on transducer out of bounds alarms etc. See the section on ‘special registers’ for a full explanation.

Special Registers

The 32 special control registers may be programmed to contain the results of certain parameters. These would typically be used to drive relays but may be used for other applications as well, allowing great flexibility for special control routines such as tank level controls, alarm outputs etc. They may be combined with other control routines such as the toggle functions to provide multiple complex controls that will often replace extensive programming in a typical PLC. Note that the control results will be stored in the special register ‘results’, not assigned to specific relays, so to use them for relay control the respective relay needs to be 'aimed' at the specific special register ‘result’. There are many modes that can be used, some will require additional register pointers to use data sources, for example a register that may contain a tank level or user set points such as trip levels. First of all the control routines have to be set to an operating mode via the control register, there are over 40 modes available. Setting the control register to 0 effectively disables the special register ‘result’ and it will always be turned off. Setting it to 1 turns on the ‘result’ and it will remain on whenever the RTU is powered up. A setting of 2 invokes ‘drain level control’ for the respective ‘result’. In this mode a 16 bit Modbus register will be monitored (specified by control source pointers, 8312 to 8343). When this signal level exceeds the ‘high’ trip point (specified by every second register 8344 to 8407) the ‘result’ will be energized. When this signal level is below the ‘low’ trip off point (specified by every second register 8408 to 8471) the ‘result’ will turn off. This is effectively a tank level control system with hysteresis where the ‘result’ controls a pump that drains the tank. Once the level is above the high trip point the pump starts, and remains on until the level drops below the low trip off point. It may of course be used for many other applications such as an alarm when a pressure is too high. If the control mode is set to 3 then 16 bit ‘fill‘ level control is invoked. This is identical to drain level control except the ‘result’ is energized when the control level falls below the low trip point, and turns off when the control signal is above the ‘high’ trip point. It is typically used where a pump fills a tank, or an alarm is activated when levels become too low. These two modes both use 16 bit registers for the signal level and the set points. Since many registers in the RTU may be 32 bits in size two other modes perform the same function but use 32 bits registers, these are activated by setting the control mode to 38 and 39.

If the control byte is set to 4 then the ‘result’ will be on if the Modbus source register is not equal to zero, it will be off if the source register is any other value. If the control byte is set to 5 then the ‘result’ will be off if the Modbus source register is not equal to zero, it will be on if the source register is any other value.

The ‘result’s may also be controlled using individual bits in source registers. To activate a ‘result’ when a certain bit is set use control types 6 to 21 (for bits 0 to 15). Enter the Modbus source register and then the ‘result’ will be active when the respective bit in the source register is set. For example enter a control value of 9 into 8281 (‘result’ 2 active when source register bit 3 is set), and a source value of 848 (the real time clock seconds) into 8313. Result 2 (register 884) will now toggle every 8 seconds. Control modes 22 to 37 are similar to modes 6 – 21 but the ‘result’ becomes active when respective bits are clear rather than set.

The final ‘result’ control mode is used to indicate polled device network status, and is set by entering a control type of 40. The ‘result’ will then be continually energized when all remote devices are successfully operating and communicating with the RTU. If some, but not all remote devices are successfully communicating this ‘result’ will slowly toggle on and off. If no remote devices are communicating with the RTU the ‘result’ will be off.

There are an additional 32 reserved registers that may be used for general purpose functions, these are not normally modified directly by the RTU (some may be modified by the toggle functions). They are in RAM memory so the contents will be lost upon power fail, they will however be loaded with zero's upon power up.

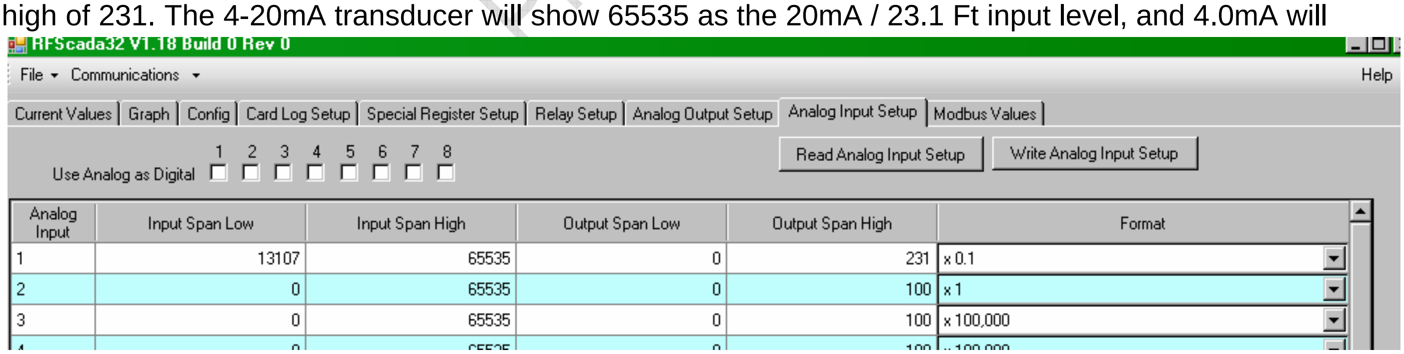
Toggle Registers and Routines

Often it is desirable to toggle certain registers depending on events. This capability is frequently used for dual pumps, where redundancy and equal wear is required. There are four sets of toggle functions that may be used, they are all used in a similar manner. The 'outputs' will be sent to the toggle results, which are the first 8 of the reserved special registers (915 to 922). The toggle functions operate by copying the contents of any two preset registers in the RTU to two toggle result registers. When the value in the first preset register drops to zero the two toggle result register contents will be 'swapped', ie the contents of the first preset will go to the second toggle result, and the contents of the second preset will be copied to the first toggle result. This signal 'routing' will remain that way until the preset register 1 contents changes to a non zero value and back to zero again. This method allows for easy lead / lag pump swapping, although it may be used for other purposes; note that the signal sent to the two toggle results may be any 16 bit value, not just on / off control commands.

Special Register Example - Lead / Lag Tank Level Control.

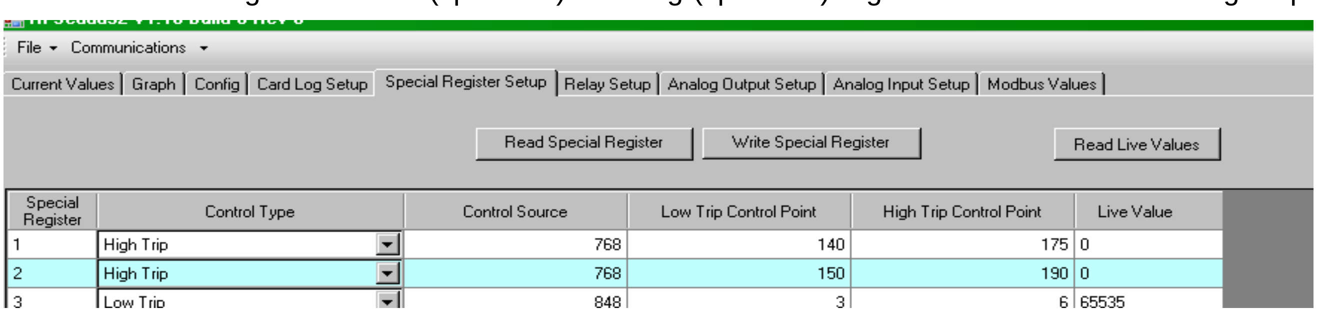
This example shows how a common application for tank level control may be set up, with a 'lead' and 'lag' pump output relay. This example will be for pumps that drain the tank; a tank fill version is almost identical with reversed on / off set points. Typically these systems have a 'lead' pump that comes on first when the process level reaches a user preset high 'turn on' trip point. If the fluid continues to rise it may reach a second 'trip point' when the 'lag' pump will turn on. When the fluid level recedes to the respective 'trip off' points each pump will shut down. Although the lead and lag pump typically use the same process variable (fluid level) as the source, each has independent 'trip on' and 'trip off' set points.

First set up the analog input to be used for the level control. We will use a 4-20mA 0 to 10 PSI transducer, which with water will correspond to a full scale height of 23.1 Ft. We will display the level on the LCD with a resolution of 0.1Ft., so the format multiplier will be set to 0.1 with an output span high of 231. The 4-20mA transducer will show 65535 as the 20mA / 23.1 Ft input level, and 4.0mA will

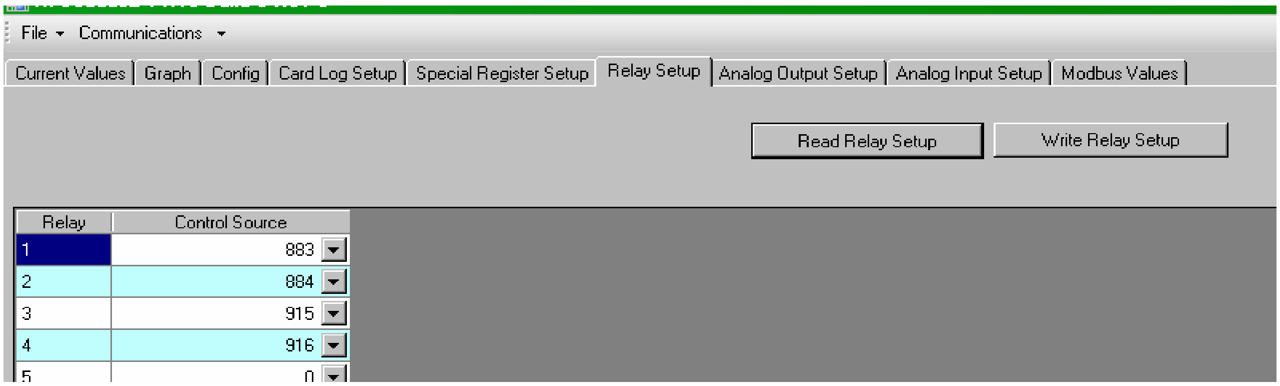


correspond to 13107 or 0 Ft.

Next to configure the lead (special 1) and lag (special 2) registers. Set them both to high trip



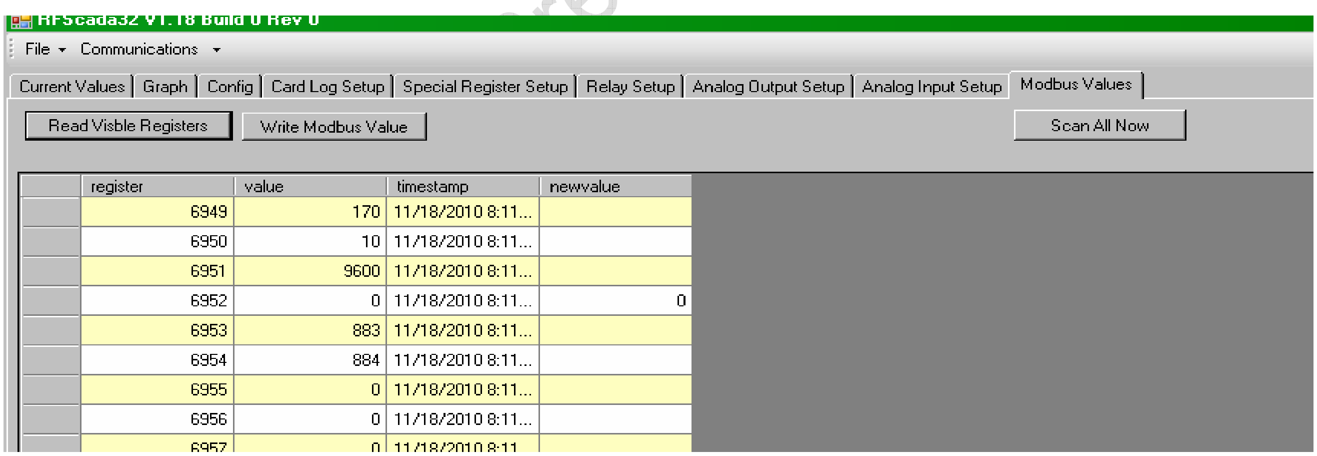
for tank drain applications. They will both use control source of 768, which is the scaled register for analog input 1 (un-scaled is 800). The value in 768 will vary between 0 (0Ft.) and 231 (23.1Ft.). If the value goes above the high trip control point (17.5 Ft for the lead, 19.0 Ft. for the lag) the respective outputs will turn on, ie special registers 1 (883) & 2 (884) will then contain 65535. They will remain that way until the control source drops below the low control trip point when they will revert to containing 0. Any relays that are aimed at 883 and 884 will then be driven by these special registers



as shown for the first two relays. By setting these parameters the level control can quickly be implemented. The high / low trip points may be changed be any local or remote Modbus device, typically a flat panel display.

Toggle Example – Adding pump switching to the example above.

In the above lead / lag example one pump would perform most of the pumping. It is easy to add duplex switching capability by using the toggle function. Assume the lead / lag example above is already set up. We will drive relays 3 and 4 in a lead / lag in sync with the first two relays, however relays 3 & 4 will toggle the lead routing at the end of every lead call, this way the wear and run times will be spread between the two pumps connected to relays 3 and 4. As shown above Relays 3 & 4 will be aimed at the first two toggle output registers 915 & 916. Next using the Modbus Values tab change the contents of the toggle lead register (6953) to 883 (special register 1 output, ie the lead call) and



toggle lag register (6954) to 884 (special register 2 output, ie the lag call). Now the toggle function will automatically switch the routing as needed every time a lead call ends, sending the results to the two registers 815 and 816. Since relays 3 & 4 are aimed at 883 and 884 they will perform the same lead / lag output as relays 1 & 2 but with the lead call switching between relays 3 & 4. Note that the toggle routines are called about every second to reduce relay chatter if incorrectly programmed or fast changing signals area applied. To disable the toggle function write a 0 or 65535 to either of the toggle source registers.

Sticky Registers

Sometimes control registers are used that need to retain contents during power cycles. For example, a cyclic satellite may transmit periodic commands to the RTU such as a VSD speed control.

The satellite typically comes by every 1 ½ hours, and if the RTU power is cycled during that time the most recent speed command should be restored by the RTU upon power up. There are 256 sticky registers in the RTU that are available for general purpose use, starting at 8664. The registers are stored in EEPROM so are not dependant upon power, like all the EEPROM registers they do however have a limited write capability (typically 100,000 to 1,000,000 writes). The RTU contains intelligent routines that attempt to limit over writing to the memory. When a write is made it will not be saved for a second or so (the blue 4G led will flash quickly) in case the user immediately changes the value. Also the RTU will not write the same value to an existing value in EEPROM, it will simply be ignored, so it is safe to continually write the same value to the EEPROM.

"Polling" Port Device Setup - Master & Slave Configuration.

The RTU may be set up in two basic modes, each with many permutations available. The first main mode is as a 'slave' device, where other devices may poll this RTU requesting data and sending commands to it. This would typically be used if this RTU were to be accessed via a SCADA system or PC, another RFScada RTU that was the system 'master', or another third party device that could poll this RTU. In the slave configuration the RTU may be set to respond to Modbus commands or RFScada 4G commands, so can operate in a mixed system. It may also be set to emulate two smaller RFScada units using an older RFScada protocol for compatibility with legacy systems.

If configured as a 'Master' the RTU may poll many types of device, such as other RFScadas using the 4G protocol and almost any Modbus device.

Polled Device Setup - Slave Configuration.

In this mode the RTU will be assigned an address that will be unique to the 'network', ranging from 1 to 255. The protocol used to communicate with the RTU also needs to be defined, and typically this will be RFScada 4G mode or Modbus. Note that 4G and Modbus protocols can co-exist on the same network, so 4G and Modbus devices may have the same ID's if needed since each will only answer to their own protocols. The RFScada Classic mode may also be selected, in this case the RTU will emulate 2 RFScada 16 channel boards for compatibility with legacy systems. The communications port baud rate will need to be defined, and is typically the same for the whole network although in some cases the baud rates may be mixed. When the PC software is used to configure the RTU after slave mode has been selected in the @@@ configuration tab (or read from the connected RTU) several of the tabs not relevant to slave operation for this RTU will disappear. When the RTU is set in RFScada slave mode the relays may be placed in RFScada default mode by selecting the default setup button @@@, which will assign the relays and analog outputs to be controlled by commands arriving from the polling port. Of course any of the relays or analog outputs may be assigned for local control regardless of the polling commands. If the RTU is set to respond as a Modbus device then the polling Modbus master will be able to query and write any registers in the RTU. The action of the analog outputs and relays will be governed by the RTU control settings which may be set to respond to remote Modbus commands.

Polled Device Setup - Master Configuration.

The RTU may be configured to poll up to 255 various remote devices, accumulate data from them and send data to certain types of device. Each ‘device’ is actually a Modbus register in some physical unit which may be accessed via a wired or wireless connection using one of the polling ports connections. Each device is configured with many individual parameters, so mixed types and brands of equipment may easily be polled. Each device parameter will be explained.

The first selection enables or disables the device; if disabled it will not be polled at all and the device value will change to the devices ‘default’ setting. The Modbus ID needs to be set for each device, this will range from 0 to 255. Note that multiple devices may have the same Modbus ID if multiple registers from the same physical device are required. The device baud rate may be set to any standard value using the keypad, non standard values may also be set using the configuration program. Note that most radio modems (including the optional on board Maxstream Xtend radio) are configured to operate at a single baud rate, so it may not be possible to communicate with devices over radios if they have different baud rates.

The function code for the device is the Modbus command that will be used to access the device, either command 3 or 4 (read single register or input). Note that these commands are essentially the same but either one may be selected since some brands of equipment support just one or the other. The Modbus register address to be read is a 16 bit number from 0 to 65535. Note that many Modbus maps show addresses starting at 30001 or 40001; these are usually translated to ‘real’ addresses starting at 0 or 1 by the Modbus host software. The RTU will directly transmit whatever address is programmed without adding or removing any offsets to allow full coverage of the whole address range.

The type of register to be accessed also needs to be specified. The most common type is a 16 bit integer, however some equipment has values stored in 32 bit format. To further complicate the matter some equipment stores results in high 16 bits then low 16 bits order, while other equipment has the order reversed. Three settings in the RTU allow any of these configurations to be polled. For 32 bit registers the RTU will order the pair correctly in the results table; note that the results are always stored in high/low order. The Modbus specification has strict definitions for the times Modbus devices should take to reply to Modbus commands (see the section on configuration / data access communication ports for further details). However, when devices with different baud rates and communication methods are used it may be necessary to insert delays before and/or after Modbus data polls. For example, polling a device at 9600 baud the Modbus specification requires a response within ~4mS from the end of the Modbus request; this is impossible with most modems which may take 100mS just to transmit the command to the polled device. Therefore the RTU ‘post poll’ time may be set in mS; after the command has been transmitted from the RTU it will wait this long to inspect the reply (if any) from the remote device. Typically this value may be 50 to 500mS with directly connected devices; it may be several seconds if an internet connected device is being polled. The RTU also supports a ‘pre-poll’ delay, a delay between processing a reply from the last command and issuing the next command. It is not normally required but is available if needed when operating for example with older radio modems that take a substantial time to ‘key down’ after transmitting data.

The display format may be set in a similar manner to the analog inputs, it allows a decimal point or multiplier to be used for display and storage of the polled results.

If a polled device does not respond to data requests for a preset time the RTU will change the polled result in the result table to a default value. This allows alarms or similar actions to occur if communications are lost to a remote device. The timeout may be set in 10 second increments up to about 7 days. Communication status of all devices may be monitored using registers 571 to 586, they may also be used to drive any relay alarm or for other purposes.

Each device can also be assigned a text name of us to 8 characters, this will be shown next to the device values on the LCD display.

Memory Card Operations.

The RTU supports removable SD/MMC type memory cards for both data logging and configuration changes. The card socket is located on the bottom edge of the board, to remove a card push it in slightly then it will pop out. The RTU supports cards with a size up to 2GByte that use the FAT16 or FAT32 format standard; both of which are commonly used on modern PC’s. Larger capacity SDHC type cards are not compatible with the RTU. Once a card is inserted the RTU will inspect the data on the card, then after a few seconds either the blue LED by the card will briefly flash or the red LED will continually flash indicating an error. Any time the red LED flashes there is a card error of some sort, such as the write protect tab on the card being set or the card may be full. If this occurs remove the card and try to correct the problem with a PC; nothing will be written to the card if the red LED is flashing.

Card operations require a valid 4 character ‘site name’ to have been set in the RTU; as the data files will use the site name as the first 4 letters of each data file. The site name may be entered from the miscellaneous menu or using the PC configuration software, only valid characters will be accepted. Also required is a valid date and time in the RTU, as memory card writes cannot occur if the correct date and time are unknown. This time can easily be set using the PC configuration software or from the miscellaneous menu. When a card is inserted the RTU will place a small file called xxxxSOFT.VER on the card that contains the current software version of the RTU. Use the card log setup screen in the configuration software to instruct the RTU of which items to log and the logging frequency. Note that logging at the fastest rates will cause the RTU to buffer data then write it intermittently to the card, to prevent card burnout from too frequent writes. Once configured the RTU will write to the card at each logging point, every line in the log file will contain the sitename, date, time then each reading all separated by commas, such as…..

DDD3,01/30/09,07:12:08,1464.3,40.0,185.2,1.03,1459

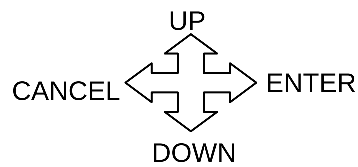
The file name will be xxxxABCD.csv where xxxx will be the sitename and ABCD will be the current month and day. At midnight each day the current file will be closed and a new one started, so the card will fill with a separate file for each day of the year. These files may be imported and viewed with the configuration software or they may be imported with programs such as Excel.

The current RTU configuration may also be loaded from and saved to the memory card. It will take several seconds to save the configuration, but just a couple of seconds to load the configuration. This is the quickest way to configure an RTU, as a standard configuration file may be quickly loaded into the RTU then any site specific settings may be changed. The configuration files are text files containing the Modbus address and contents separated by a comma, such as

2000,34453
2001,256
2002,4096
Etc.

LCD And Keypad Operation.

The RTU has an LCD display installed directly on the RTU, and menu navigation pushbuttons in the center of the circuit board. Not that a duplicate LCD display and navigation switches may be remotely mounted and connected with a ribbon cable to connector J48. In this case both displays and buttons may be used. The chart below shows the navigation structure; after some period of inactivity the display will revert to status screen and turn off the LCD backlight. The contrast key should be held down to modify the LCD contrast which may need adjusting due to extreme temperature changes, releasing it and pressing it again will cause the contrast to change in the opposite direction.



Status	Monitor RTU Inputs	Input 1 Input 2 “ “ “ “ “ “ Input 31 Input 32	
	Monitor Devices	Configured Device 1 Configured Device 2 “ “ Configured Device 255 Configured Device 256	
	Monitor Analog Outputs	Display Analog Output 1 Display Analog Output 2 “ “ Display Analog Output 7 Display Analog Output 8	
	Monitor Relays	Display Relay 1 State “ “ Display Relay 8 State	
	Polled Device Setup	Select Device 1 – 255	Enabled / Disabled Device Modbus ID Device Baudrate Device Modbus Function Code Device Modbus Register Device Register 16 / 32 bit selection Device Modbus Pre-Poll Time (mS) Device Modbus Post-Poll Time (mS) Device Display Format Device Default Value Device Timeout (seconds) Device Text Name
	Communication Port 1 Setup	Baudrate Modbus Slave ID Modbus Gap Time (mS)	
	SD Card Functions	Save Rate (seconds) Load Configuration Save Configuration	
	Miscellaneous	Set Sitename Firmware Version Power On Time PCB Serial Number Factory Access Set Time and Date	

RTU Modbus Map.

All registers may be read with Modbus Command 3 or Command 4. Starting address 30001 for Command 4, 40001 for Command 3 is the same as 00000. If the RTU gets an address between 30001 and 39999 it will subtract 30001; between 40001 and 49999 it will subtract 40001. It is recommended to use addresses starting at 0000 since there are more than 10,000 consecutive registers in the RTU and those above the 3xx and 4xx offsets are not accessible if offsets are used. The registers may also be written using commands 6 (write single register) or 16 (write multiple registers). Note that the RTU will process a maximum of 32 registers in a single command. The first 2000 registers are volatile and may change back to other values.

Warning !

The RTU stores configuration settings in non volatile memory which has a finite lifetime, limited by the number of writes (typically a million writes). Software which writes to the RTU configuration registers (2000 – 10,000+) should prevent continuous writes to the RTU memory.

Following may be read with Cmd 03 or Cmd 4. Starting address 30001 for Cmd4, 40001 for Cmd3 is the same as 0000. If the RTU gets an address between 30001 and 39999 it will subtract 30001; between 40001 and 49999 it will subtract 40001.

0	Polled Device 1 Value - high 16 bits	Both hi/lo used if 32 bit register. Just second low 16 bits used if a 16 bit device.
1	Polled Device 1 Value - low 16 bits	
2	Polled Device 2 Value - high 16 bits	Second polled device result
3	Polled Device 2 Value - low 16 bits	Second polled device result
4	Polled Device 3 Value - high 16 bits	Third polled device result
5	Polled Device 3 Value - low 16 bits	Third polled device result
6	Polled Device 4 Value - high 16 bits	
7	Polled Device 4 Value - low 16 bits	
8	Polled Device 5 Value - high 16 bits	
9	Polled Device 5 Value - low 16 bits	
10	Polled Device 6 Value - high 16 bits	
11	Polled Device 6 Value - low 16 bits	
12	Polled Device 7 Value - high 16 bits	
13	Polled Device 7 Value - low 16 bits	
	etc…..	
510	Polled Device 255 Value - High 16 bits	
511	Polled Device 256 Value - Low 16 bits	
512	Polled Device 1 Scaled Value 16 bits	POLLSCALED. Made by (raw * mult) / divisor
513	Polled Device 2 Scaled Value 16 bits	
514	Polled Device 3 Scaled Value 16 bits	
	etc…..	
767	Polled Device 256 Scaled Value 16 bits	
768	Analog In 1 scaled value 16 bits	ANINSCALED
769	Analog In 2 scaled value as above	

770	Analog In 3 scaled value as above	
771	Analog In 4 scaled value as above	
772	Analog In 5 scaled value as above	
773	Analog In 6 scaled value as above	
774	Analog In 7 scaled value as above	
775	Analog In 8 scaled value as above	
776	Analog In 9 scaled value as above	
777	Analog In 10 scaled value as above	
778	Analog In 11 scaled value as above	
779	Analog In 12 scaled value as above	
780	Analog In 13 scaled value as above	
781	Analog In 14 scaled value as above	
782	Analog In 15 scaled value as above	
783	Analog In 16 scaled value as above	
784	Analog In 17 scaled value as above	
785	Analog In 18 scaled value as above	
786	Analog In 19 scaled value as above	
787	Analog In 20 scaled value as above	
788	Analog In 21 scaled value as above	
789	Analog In 22 scaled value as above	
790	Analog In 23 scaled value as above	
791	Analog In 24 scaled value as above	
792	Analog In 25 scaled value as above	
793	Analog In 26 scaled value as above	
794	Analog In 27 scaled value as above	
795	Analog In 28 scaled value as above	
796	Analog In 29 scaled value as above	
797	Analog In 30 scaled value as above	
798	Analog In 31 scaled value as above	
799	Analog In 32 scaled value as above	
800	Analog In1 un-scaled raw 16 bit value	Analog In Raw from this unit. ANIN contains all polled units analog ins
801	Analog In2 un-scaled raw 16 bit value	
802	Analog In3 un-scaled raw 16 bit value	
803	Analog In4 un-scaled raw 16 bit value	
804	Analog In5 un-scaled raw 16 bit value	
805	Analog In6 un-scaled raw 16 bit value	
806	Analog In7 un-scaled raw 16 bit value	
807	Analog In8 un-scaled raw 16 bit value	
808	Analog In9 un-scaled raw 16 bit value	
809	Analog In10 un-scaled raw 16 bit value	
810	Analog In11 un-scaled raw 16 bit value	
811	Analog In12 un-scaled raw 16 bit value	
812	Analog In13 un-scaled raw 16 bit value	
813	Analog In14 un-scaled raw 16 bit value	
814	Analog In15 un-scaled raw 16 bit value	
815	Analog In16 un-scaled raw 16 bit value	
816	Analog In17 un-scaled raw 16 bit value	
817	Analog In18 un-scaled raw 16 bit value	
818	Analog In19 un-scaled raw 16 bit value	
819	Analog In20 un-scaled raw 16 bit value	
820	Analog In21 un-scaled raw 16 bit value	
821	Analog In22 un-scaled raw 16 bit value	

822	Analog In23 un-scaled raw 16 bit value	
823	Analog In24 un-scaled raw 16 bit value	
824	Analog In25 un-scaled raw 16 bit value	
825	Analog In26 un-scaled raw 16 bit value	
826	Analog In27 un-scaled raw 16 bit value	
827	Analog In28 un-scaled raw 16 bit value	
828	Analog In29 un-scaled raw 16 bit value	
829	Analog In30 un-scaled raw 16 bit value	
830	Analog In31 un-scaled raw 16 bit value	
831	Analog In32 un-scaled raw 16 bit value	
832	Analog Output 1 current value, 16 bit integer	ANOUT1VAL
833	Analog Output 2 current value, 16 bit integer	
834	Analog Output 3 current value, 16 bit integer	
835	Analog Output 4 current value, 16 bit integer	
836	Analog Output 5 current value, 16 bit integer	
837	Analog Output 6 current value, 16 bit integer	
838	Analog Output 7 current value, 16 bit integer	
839	Analog Output 8 current value, 16 bit integer	
840	Digital 1 to 16 inputs packed as 1x 16 bit integer. Lsb = Digital in 1	DIGINIMAGE1
841	Digital 17 to 32 inputs packed as 1x 16 bit integer. Lsb = Digital in 17	DIGINIMAGE2
842	Relay outputs 1 to 9 current state packed as 16 bit integer. bit0 = relay 1, bit 8 = comms relay.D116	RELAYIMAGE
843	RTC Year (required for leap year calcs).	RTCYEAR See preload registers for setting the RTC
844	RTC Month 1 to 12	
845	RTC Day 1 to 31	
846	RTC Hour 0 to 23	
847	RTC Minute 0 to 59	
848	RTC Second 0 to 59	
849	RTU Temperature	RTUTEMP PCB temperature
850	DC Voltage into RTU	RTUVOLT
851	Signal Strength for Xtend radio module	RTURSSI
852	Test register. Slow ramp up over several seconds	TESTREG
853	Test register. Slow ramp down over several seconds	
854	Test register. Slow ramp up over several minutes.	
855	Test register. Slow ramp down over several minutes.	
856	Test register. Quickly ramps up.	
857	Test register. Quickly ramps down.	
858	Performance Monitor lower 16 bits	PERFORM Count of main loop excursions per second
859	Comm state summary of all enabled devices.	COMMSTATEGLOBAL. Comm state of all devices. 0 = no response, 1= some OK, 2 = All OK
860	Packed Comm state of devices 1 to 16	COMMSTATE e.g. 0x000E indicates devices 2,3 and 4 are responding.
861	Packed Comm state of devices 17 to 32	
862	Packed Comm state of devices 33 to 48	
863	Packed Comm state of devices 49 to 64	
864	Packed Comm state of devices 65 to 80	
865	Packed Comm state of devices 81 to 96	
866	Packed Comm state of devices 97 to 112	

867	Packed Comm state of devices 113 to 128	
868	Packed Comm state of devices 129 to 144	
869	Packed Comm state of devices 145 to 160	
870	Packed Comm state of devices 161 to 176	
871	Packed Comm state of devices 177 to 192	
872	Packed Comm state of devices 193 to 208	
873	Packed Comm state of devices 209 to 224	
874	Packed Comm state of devices 225 to 240	eg 0x8001 indicates devices 225 and 240 are responding.
875	Packed Comm state of devices 241 to 256	
876	RTC Year Pre load	RTCPRELOAD Load these regs with desired time, then write to 54321 to FACTORYLOCK to set clock
877	RTC Month Pre load	
878	RTC Day Pre load	
879	RTC Hour Pre load	
880	RTC Minute Preload	
881	RTC Second Preload	
882	Factory lock. Write various values, nothing stored.	FACTORYLOCK Write FACTORYKEY to unlock locked regs, such as S/N
883	Special register 1	Special register results. These volatile registers 1 to 32 contain the results generated by the special control routines (see regs 8280-8471).
884	Special register 2	
885	Special register 3	
886	Special register 4	
887	Special register 5	
888	Special register 6	
889	Special register 7	
890	Special register 8	
891	Special register 9	
892	Special register 10	
893	Special register 11	
894	Special register 12	
895	Special register 13	
896	Special register 14	
897	Special register 15	
898	Special register 16	
899	Special register 17	
900	Special register 18	
901	Special register 19	
902	Special register 20	
903	Special register 21	
904	Special register 22	
905	Special register 23	
906	Special register 24	
907	Special register 25	
908	Special register 26	
909	Special register 27	
910	Special register 28	
911	Special register 29	
912	Special register 30	
913	Special register 31	
914	Special register 32	

915	Special register 33	Volatile registers available for general use; eg for remote control of relays or analog outputs. Registers 33 to 64 are not assigned to special control routines, but they will always contain 0 upon RTU power up. Registers 33 to 40 may be written to by Toggle() functions.
916	Special register 34	May be written to by Toggle 1 function.
917	Special register 35	May be written to by Toggle 2 function.
918	Special register 36	May be written to by Toggle 2 function.
919	Special register 37	May be written to by Toggle 3 function.
920	Special register 38	May be written to by Toggle 3 function.
921	Special register 39	May be written to by Toggle 4 function.
922	Special register 40	May be written to by Toggle 4 function.
923	Special register 41	
924	Special register 42	
925	Special register 43	
926	Special register 44	
927	Special register 45	
928	Special register 46	
929	Special register 47	
930	Special register 48	
931	Special register 49	
932	Special register 50	
933	Special register 51	
934	Special register 52	
935	Special register 53	
936	Special register 54	
937	Special register 55	
938	Special register 56	
939	Special register 57	
940	Special register 58	
941	Special register 59	
942	Special register 60	
943	Special register 61	
944	Special register 62	
945	Special register 63	
946	Special register 64	
947	Written to if we are RFScada slave 1	DIGCOMMAND1
948	Written to if we are RFScada slave 2	DIGCOMMAND2
949	Written to if we are RFScada slave1 (Aout 1)	RFSLAVEANALOG
950	Written to if we are RFScada slave1 (Aout 2)	
951	Written to if we are RFScada slave1 (Aout 3)	
952	Written to if we are RFScada slave1 (Aout 4)	
953	Written to if we are RFScada slave1 (Aout 5)	
954	Written to if we are RFScada slave1 (Aout 6)	
955	Written to if we are RFScada slave1 (Aout 7)	
956	Written to if we are RFScada slave1 (Aout 8)	
957	Reflect input state in RFScada classic mode	RF4GOPTIONS
958	Raw Analog Input Table. Start Unit 0, Input 1	ANIN 32*32 = 1024 length. Table only used if polling any 4G devices
959	Analog Unit 0 In 2 un-scaled raw 16 bit value	
960	Analog Unit 0 In 3 un-scaled raw 16 bit value	
961		
	etc..	
	Analog Unit 31 In 30 un-scaled raw 16 bit value	

1981	Raw Analog Input Table End. Unit 31, Input 32	
1982	Image of relays 17 to 32	RELAY1732IMAGE
1999		MBRAMSIZE Limit of mbRam array

	2000 to ~8000 are configuration settings all stored in EE.	
	Following are 'Poll device' configuration registers. 32 registers for each poll device.	
2000	Device 1 Baud Rate	MBCONFIGTABLE In actual baud eg 9600 = 9600 baud. 0 = default baud rate of channel
2001	Device 1 ID	Modbus ID RF32 ID is unit number
2002	Device 1 Register	Modbus Register
2003	Device 1 Function	Modbus Function Code (3 or 4 presently supported)
2004	Device 1 Pre Poll	Modbus pre-poll time. In milliseconds time before transmitting serial packet 1 to 65535
2005	Device 1 Post Poll	Modbus poll response time. In milliseconds time to wait before processing response 1 to 65535
2006	Device 1 Register Format	Bits 0-2 determine poll type. 0 = MB 16, 1= 32, 2 = 32 rev, 3 = RFG3, 4 = RF3G16, 5 = RF4G24, 6 = RF4G32; 7=TBD. Bits 3-6 determine dec place. Bit 7 spare. Bits 8-15 = 0xAB if unit enabled - anything else disabled.
2007	Device 1 Dropout Time	In 10 second increments. Time without a valid comm response before setting device reading back to 'default'. 1 to 65535 gives 10 seconds to 7.5 days time.
2008	Device 1 Default Value Upper 16 bits	Default value. Device value if time without a valid comm response expires.
2009	Device 1 Default Value Lower 16 bits	Default value. Device value if time without a valid comm response expires.
2010	Device 1 Text 1 & 2	Text name characters 1 & 2. Stored as 2 ASCII bytes in each 16 bit register, eg 'GR' = 0x4752 = 18258 decimal.
2011	Device 1 Text 2 & 3	Text name characters 3 & 4. Stored as above.
2012	Device 1 Text 3 & 4	Text name characters 5 & 6. Stored as above.
2013	Device 1 Text 5 & 6	Text name characters 7 & 8. Stored as above.
2014	Multiplier	raw val is multipled by this to get scaled
2015	Devisor	raw val is divided by this to get scaled
2016	Device 1	Spare 1
2017	Device 1	Spare 2
2018	Device 2	Repeat as above for devices 2 to 256
	repeat to……	repeat to……
	repeat to……	repeat to……
	repeat to……	repeat to……
6606	Device 256	Spare 1
6607	Device 256	Spare 2
6608	Decimal point location for scaled Analog In 1.	ANINDISPRES If num = 12345 13 = 0.00012345; 6= 1.2345; 5 = 12345; 0 = 1234500000, 14 = pulse counting. If >14 returns ERR1
6609	Decimal point location for scaled Analog In 2.	
6610	Decimal point location for scaled Analog In 3.	

6611	Decimal point location for scaled Analog In 4.	
6612	Decimal point location for scaled Analog In 5.	
6613	Decimal point location for scaled Analog In 6.	
6614	Decimal point location for scaled Analog In 7.	
6615	Decimal point location for scaled Analog In 8.	
6616	Decimal point location for scaled Analog In 9.	
6617	Decimal point location for scaled Analog In 10.	
6618	Decimal point location for scaled Analog In 11.	
6619	Decimal point location for scaled Analog In 12.	
6620	Decimal point location for scaled Analog In 13.	
6621	Decimal point location for scaled Analog In 14.	
6622	Decimal point location for scaled Analog In 15.	
6623	Decimal point location for scaled Analog In 16.	
6624	Decimal point location for scaled Analog In 17.	
6625	Decimal point location for scaled Analog In 18.	
6626	Decimal point location for scaled Analog In 19.	
6627	Decimal point location for scaled Analog In 20.	
6628	Decimal point location for scaled Analog In 21.	
6629	Decimal point location for scaled Analog In 22.	
6630	Decimal point location for scaled Analog In 23.	
6631	Decimal point location for scaled Analog In 24.	
6632	Decimal point location for scaled Analog In 25.	
6633	Decimal point location for scaled Analog In 26.	
6634	Decimal point location for scaled Analog In 27.	
6635	Decimal point location for scaled Analog In 28.	
6636	Decimal point location for scaled Analog In 29.	
6637	Decimal point location for scaled Analog In 30.	
6638	Decimal point location for scaled Analog In 31.	
6639	Decimal point location for scaled Analog In 32.	
6640	Analog Output 1 source MB register pointer.	ANOUTSPANTABLE Start of config table for analog outputs.
6641	Analog Output 1 source MB register type.	0 = 16 bit, 1 = 32 bit high word first, 2 = 32 bit low word first
6642	Analog Output 1 source high span point high 16 bits	
6643	Analog Output 1 source high span point low 16 bits	
6644	Analog Output 1 source low span point high 16 bits	
6645	Analog Output 1 source low span point low 16 bits	
6646	Analog Output 1 scaled output span high	Output must be 16 bit
6647	Analog Output 1 scaled output span low	Output must be 16 bit
6648	Analog Output 2 source MB register pointer.	
6649	Analog Output 2 source MB register type.	0 = 16 bit, 1 = 32 bit high word first, 2 = 32 bit low word first
6650	Analog Output 2 source high span point high 16 bits	
6651	Analog Output 2 source high span point low 16 bits	
6652	Analog Output 2 source low span point high 16 bits	
6653	Analog Output 2 source low span point low 16 bits	
6654	Analog Output 2 scaled output span high	Output must be 16 bit
6655	Analog Output 2 scaled output span low	Output must be 16 bit
6656	Analog Output 3 source MB register pointer.	

6657	Analog Output 3 source MB register type.	0 = 16 bit, 1 = 32 bit high word first, 2 = 32 bit low word first
6658	Analog Output 3 source high span point high 16 bits	
6659	Analog Output 3 source high span point low 16 bits	
6660	Analog Output 3 source low span point high 16 bits	
6661	Analog Output 3 source low span point low 16 bits	
6662	Analog Output 3 scaled output span high	Output must be 16 bit
6663	Analog Output 3 scaled output span low	Output must be 16 bit
6664	Analog Output 4 source MB register pointer.	
6665	Analog Output 4 source MB register type.	0 = 16 bit, 1 = 32 bit high word first, 2 = 32 bit low word first
6666	Analog Output 4 source high span point high 16 bits	
6667	Analog Output 4 source high span point low 16 bits	
6668	Analog Output 4 source low span point high 16 bits	
6669	Analog Output 4 source low span point low 16 bits	
6670	Analog Output 4 scaled output span high	Output must be 16 bit
6671	Analog Output 4 scaled output span low	Output must be 16 bit
6672	Analog Output 5 source MB register pointer.	
6673	Analog Output 5 source MB register type.	0 = 16 bit, 1 = 32 bit high word first, 2 = 32 bit low word first
6674	Analog Output 5 source high span point high 16 bits	
6675	Analog Output 5 source high span point low 16 bits	
6676	Analog Output 5 source low span point high 16 bits	
6677	Analog Output 5 source low span point low 16 bits	
6678	Analog Output 5 scaled output span high	Output must be 16 bit
6679	Analog Output 5 scaled output span low	Output must be 16 bit
6680	Analog Output 6 source MB register pointer.	
6681	Analog Output 6 source MB register type.	0 = 16 bit, 1 = 32 bit high word first, 2 = 32 bit low word first
6682	Analog Output 6 source high span point high 16 bits	
6683	Analog Output 6 source high span point low 16 bits	
6684	Analog Output 6 source low span point high 16 bits	
6685	Analog Output 6 source low span point low 16 bits	
6686	Analog Output 6 scaled output span high	Output must be 16 bit
6687	Analog Output 6 scaled output span low	Output must be 16 bit
6688	Analog Output 7 source MB register pointer.	
6689	Analog Output 7 source MB register type.	0 = 16 bit, 1 = 32 bit high word first, 2 = 32 bit low word first
6690	Analog Output 7 source high span point high 16 bits	
6691	Analog Output 7 source high span point low 16 bits	
6692	Analog Output 7 source low span point high 16 bits	
6693	Analog Output 7 source low span point low 16 bits	

6694	Analog Output 7 scaled output span high	Output must be 16 bit
6695	Analog Output 7 scaled output span low	Output must be 16 bit
6696	Analog Output 8 source MB register pointer.	
6697	Analog Output 8 source MB register type.	0 = 16 bit, 1 = 32 bit high word first, 2 = 32 bit low word first
6698	Analog Output 8 source high span point high 16 bits	
6699	Analog Output 8 source high span point low 16 bits	
6700	Analog Output 8 source low span point high 16 bits	
6701	Analog Output 8 source low span point low 16 bits	
6702	Analog Output 8 scaled output span high	Output must be 16 bit
6703	Analog Output 8 scaled output span low	Output must be 16 bit
6704	Relay 1 control source address.	RELSOURCE eg set to 525
6705	Relay 2 control source address.	
6706	Relay 3 control source address.	
6707	Relay 4 control source address.	
6708	Relay 5 control source address.	
6709	Relay 6 control source address.	
6710	Relay 7 control source address.	
6711	Relay 8 control source address.	
6712	Relay 9 control source address.	
6713	Relay 10 control source address.	
6714	Relay 11 control source address.	
6715	Relay 12 control source address.	
6716	Relay 13 control source address.	
6717	Relay 14 control source address.	
6718	Relay 15 control source address.	
6719	Relay 16 control source address.	
6720	Relay 17 control source address.	
6721	Relay 18 control source address.	
6722	Relay 19 control source address.	
6723	Relay 20 control source address.	
6724	Relay 21 control source address.	
6725	Relay 22 control source address.	
6726	Relay 23 control source address.	
6727	Relay 24 control source address.	
6728	Relay 25 control source address.	
6729	Relay 26 control source address.	
6730	Relay 27 control source address.	
6731	Relay 28 control source address.	
6732	Relay 29 control source address.	
6733	Relay 30 control source address.	
6734	Relay 31 control source address.	
6735	Relay 32 control source address.	
6736	Relay 33 control source address.	
6737	Card logging parameter 1, pointer to MB register.	CARDCONFIG eg load with 848 and first parameter logged in each line will be RTC seconds. If it contains 0xFFFF there are no more items to log in each data file line.
6738	Card logging parameter 1 dec. loc. and 16-32 bit selection.	Bit 4 set for 32 bit register, clear for 16 bit register. Bit 5 indicates 32 bit word order, if 0 then high word first. Bits 0-3 used for precision. eg If num = 12345; 13 = 0.00012345; 6= 1.2345; 5 = 12345; 0 = 1234500000. If >13 returns FORM ERR.

6739	Card logging parameter 2, pointer to MB register.	eg load with 772 and second parameter logged in each line will be raw 16 bit analog in 5.
6740	Card logging parameter dec. loc. and 16-32 bit selection.	
6741	Card logging parameter 3, pointer to MB register.	
6742	Card logging parameter dec. loc. and 16-32 bit selection.	
6743	Card logging parameter 4, pointer to MB register.	
6744	Card logging parameter dec. loc. and 16-32 bit selection.	
6745	Card logging parameter 5, pointer to MB register.	
6746	Card logging parameter dec. loc. and 16-32 bit selection.	
6747	Card logging parameter 6, pointer to MB register.	
6748	Card logging parameter dec. loc. and 16-32 bit selection.	
6749	Card logging parameter 7, pointer to MB register.	
6750	Card logging parameter dec. loc. and 16-32 bit selection.	
6751	Card logging parameter 8, pointer to MB register.	
6752	Card logging parameter dec. loc. and 16-32 bit selection.	
6753	Card logging parameter , pointer to MB register.	
6754	Card logging parameter dec. loc. and 16-32 bit selection.	
6755	Card logging parameter , pointer to MB register.	
6756	Card logging parameter dec. loc. and 16-32 bit selection.	
6757	Card logging parameter , pointer to MB register.	
6758	Card logging parameter dec. loc. and 16-32 bit selection.	
6759	Card logging parameter , pointer to MB register.	
6760	Card logging parameter dec. loc. and 16-32 bit selection.	
6761	Card logging parameter , pointer to MB register.	
6762	Card logging parameter dec. loc. and 16-32 bit selection.	
6763	Card logging parameter , pointer to MB register.	
6764	Card logging parameter dec. loc. and 16-32 bit selection.	
6765	Card logging parameter , pointer to MB register.	
6766	Card logging parameter dec. loc. and 16-32 bit selection.	
6767	Card logging parameter , pointer to MB register.	
6768	Card logging parameter dec. loc. and 16-32 bit selection.	
6769	Card logging parameter 16, pointer to MB register.	
6770	Card logging parameter dec. loc. and 16-32 bit selection.	
6771	Card logging parameter , pointer to MB register.	
6772	Card logging parameter dec. loc. and 16-32 bit selection.	
6773	Card logging parameter , pointer to MB register.	
6774	Card logging parameter dec. loc. and 16-32 bit selection.	
6775	Card logging parameter , pointer to MB register.	

6776	Card logging parameter dec. loc. and 16-32 bit selection.	
6777	Card logging parameter , pointer to MB register.	
6778	Card logging parameter dec. loc. and 16-32 bit selection.	
6779	Card logging parameter , pointer to MB register.	
6780	Card logging parameter dec. loc. and 16-32 bit selection.	
6781	Card logging parameter , pointer to MB register.	
6782	Card logging parameter dec. loc. and 16-32 bit selection.	
6783	Card logging parameter , pointer to MB register.	
6784	Card logging parameter dec. loc. and 16-32 bit selection.	
6785	Card logging parameter , pointer to MB register.	
6786	Card logging parameter dec. loc. and 16-32 bit selection.	
6787	Card logging parameter , pointer to MB register.	
6788	Card logging parameter dec. loc. and 16-32 bit selection.	
6789	Card logging parameter , pointer to MB register.	
6790	Card logging parameter dec. loc. and 16-32 bit selection.	
6791	Card logging parameter , pointer to MB register.	
6792	Card logging parameter dec. loc. and 16-32 bit selection.	
6793	Card logging parameter , pointer to MB register.	
6794	Card logging parameter dec. loc. and 16-32 bit selection.	
6795	Card logging parameter , pointer to MB register.	
6796	Card logging parameter dec. loc. and 16-32 bit selection.	
6797	Card logging parameter , pointer to MB register.	
6798	Card logging parameter dec. loc. and 16-32 bit selection.	
6799	Card logging parameter 32, pointer to MB register.	
6800	Card logging parameter 32 dec. loc. and 16-32 bit selection.	Note Card logging table for another 96 items continued at 8472
6801	Analog In 1 Source High span point INH	Scaled analog input values are calculated as follows. Result = OL + (input - INL) * (OH - OL) / (INH - INL). Illegal values in equation result in 0 for the answer. Default INH = 0xFFFF
6802	Analog In 1 Source Low span point INL	Default 0x0000
6803	Analog In 1 Scaled High span point OH	Default 0xFFFF
6804	Analog In 1 Scaled Low span point OL	Default 0x0000
6805	Analog In 2 Source High span point INH	
6806	Analog In 2 Source Low span point INL	
6807	Analog In 2 Scaled High span point OH	
6808	Analog In 2 Scaled Low span point OL	
6809	Analog In 3 Source High span point INH	
6810	Analog In 3 Source Low span point INL	
6811	Analog In 3 Scaled High span point OH	
6812	Analog In 3 Scaled Low span point OL	
6813	Analog In 4 Source High span point INH	
6814	Analog In 4 Source Low span point INL	
6815	Analog In 4 Scaled High span point OH	

6816	Analog In 4 Scaled Low span point OL	
6817	Analog In 5 Source High span point INH	
6818	Analog In 5 Source Low span point INL	
6819	Analog In 5 Scaled High span point OH	
6820	Analog In 5 Scaled Low span point OL	
6821	Analog In 6 Source High span point INH	
6822	Analog In 6 Source Low span point INL	
6823	Analog In 6 Scaled High span point OH	
6824	Analog In 6 Scaled Low span point OL	
6825	Analog In 7 Source High span point INH	
6826	Analog In 7 Source Low span point INL	
6827	Analog In 7 Scaled High span point OH	
6828	Analog In 7 Scaled Low span point OL	
6829	Analog In 8 Source High span point INH	
6830	Analog In 8 Source Low span point INL	
6831	Analog In 8 Scaled High span point OH	
6832	Analog In 8 Scaled Low span point OL	
6833	Analog In 9 Source High span point INH	
6834	Analog In 9 Source Low span point INL	
6835	Analog In 9 Scaled High span point OH	
6836	Analog In 9 Scaled Low span point OL	
6837	Analog In 10 Source High span point INH	
6838	Analog In 10 Source Low span point INL	
6839	Analog In 10 Scaled High span point OH	
6840	Analog In 10 Scaled Low span point OL	
6841	Analog In 11 Source High span point INH	
6842	Analog In 11 Source Low span point INL	
6843	Analog In 11 Scaled High span point OH	
6844	Analog In 11 Scaled Low span point OL	
6845	Analog In 12 Source High span point INH	
6846	Analog In 12 Source Low span point INL	
6847	Analog In 12 Scaled High span point OH	
6848	Analog In 12 Scaled Low span point OL	
6849	Analog In 13 Source High span point INH	
6850	Analog In 13 Source Low span point INL	
6851	Analog In 13 Scaled High span point OH	
6852	Analog In 13 Scaled Low span point OL	
6853	Analog In 14 Source High span point INH	
6854	Analog In 14 Source Low span point INL	
6855	Analog In 14 Scaled High span point OH	
6856	Analog In 14 Scaled Low span point OL	
6857	Analog In 15 Source High span point INH	
6858	Analog In 15 Source Low span point INL	
6859	Analog In 15 Scaled High span point OH	
6860	Analog In 15 Scaled Low span point OL	
6861	Analog In 16 Source High span point INH	
6862	Analog In 16 Source Low span point INL	
6863	Analog In 16 Scaled High span point OH	
6864	Analog In 16 Scaled Low span point OL	
6865	Analog In 17 Source High span point INH	
6866	Analog In 17 Source Low span point INL	
6867	Analog In 17 Scaled High span point OH	

6868	Analog In 17 Scaled Low span point OL	
6869	Analog In Source High span point INH	
6870	Analog In Source Low span point INL	
6871	Analog In Scaled High span point OH	
6872	Analog In Scaled Low span point OL	
6873	Analog In Source High span point INH	
6874	Analog In Source Low span point INL	
6875	Analog In Scaled High span point OH	
6876	Analog In Scaled Low span point OL	
6877	Analog In Source High span point INH	
6878	Analog In Source Low span point INL	
6879	Analog In Scaled High span point OH	
6880	Analog In Scaled Low span point OL	
6881	Analog In Source High span point INH	
6882	Analog In Source Low span point INL	
6883	Analog In Scaled High span point OH	
6884	Analog In Scaled Low span point OL	
6885	Analog In Source High span point INH	
6886	Analog In Source Low span point INL	
6887	Analog In Scaled High span point OH	
6888	Analog In Scaled Low span point OL	
6889	Analog In Source High span point INH	
6890	Analog In Source Low span point INL	
6891	Analog In Scaled High span point OH	
6892	Analog In Scaled Low span point OL	
6893	Analog In Source High span point INH	
6894	Analog In Source Low span point INL	
6895	Analog In Scaled High span point OH	
6896	Analog In Scaled Low span point OL	
6897	Analog In Source High span point INH	
6898	Analog In Source Low span point INL	
6899	Analog In Scaled High span point OH	
6900	Analog In Scaled Low span point OL	
6901	Analog In Source High span point INH	
6902	Analog In Source Low span point INL	
6903	Analog In Scaled High span point OH	
6904	Analog In Scaled Low span point OL	
6905	Analog In Source High span point INH	
6906	Analog In Source Low span point INL	
6907	Analog In Scaled High span point OH	
6908	Analog In Scaled Low span point OL	
6909	Analog In Source High span point INH	
6910	Analog In Source Low span point INL	
6911	Analog In Scaled High span point OH	
6912	Analog In Scaled Low span point OL	
6913	Analog In Source High span point INH	
6914	Analog In Source Low span point INL	
6915	Analog In Scaled High span point OH	
6916	Analog In Scaled Low span point OL	
6917	Analog In Source High span point INH	
6918	Analog In Source Low span point INL	
6919	Analog In Scaled High span point OH	

6920	Analog In Scaled Low span point OL	
6921	Analog In Source High span point INH	
6922	Analog In Source Low span point INL	
6923	Analog In Scaled High span point OH	
6924	Analog In Scaled Low span point OL	
6925	Analog In 32 Source High span point INH	
6926	Analog In 32 Source Low span point INL	
6927	Analog In 32 Scaled High span point OH	
6928	Analog In 32 Scaled Low span point OL	
6929	Comm 1 Mode	COMM1MODE Unused at present
6930	Comm 1 Modbus Baud rate, e.g. 38400 = 38400	COMM1BAUD
6931	Comm 1 Modbus ID 1 to 254.	COMM1ID The RTU will also always respond to ID address 250 (0xFA). It will also always respond at 9600 Baud for 30 seconds after power on; this allows access in case Modbus parameters have been changed to illegal or unknown values.
6932	Comm 1 Mobus silent time.	COMM1GAP Time in mS it will wait for gaps between bytes in packets.
6933	Comm 2 Mode	COMM2MODE Slave or polling master. 0 = Master, 1=RF4G slave, 2= RFClassic slave only, 3 = MB slave only.
6934	Comm 2 Modbus Baud rate, e.g. 38400 = 38400	COMM2BAUD Only applicable in Slave mode (in master baud changes on fly)
6935	Comm 2 Modbus ID 1 to 254.	COMM2ID Only applicable in Slave mode. ID is also first RFScada slave ID
6936	Comm 2 Mobus silent time.	COMM2GAP Time in mS it will wait for gaps between bytes in packets. Only applicable in Slave mode.
6937	Users ID of device, first 2 characters.	MBSITENAME Also used as the logging file name. See text name of devices for storage details.
6938	Users ID of device, second 2 characters	Also used as start of logging file name. See text name of devices for storage details
6939	F/W version of the board. 16 bit integer divided by 10 e.g. 0x0015 = V2.1 Hardcoded in firmware (SWVERSION)	MBFIRMWARE
6940	S/N of the board. Stored in EEPROM. Factory write permitted after unlocking by writing access code to FACTORYLOCK, which unlocks for 30 seconds.	MBSERIALNUM
6941	Power on time in hours. Factory write permitted after unlocking by writing access code to 406, which unlocks for 30 seconds.	MBPOWERTIME
6942	Display contrast.	MBCONTRAST
6943	Memory card storage rate.	CARDRATE In seconds, minimum value = 10
6944	Comm2 Hop Pattern	0 to 9. Set to 10 to disable Xtend initialiazation string
6945	Comm2 fail time seconds.	Time is 10* this value. Used when in RFScada mode
6946	Comm2 RFScada ID	1-255 4G mode, 1 to 30 in Classic (since will be 2 units)
6947	Comm2 comm fail override	1 = enabled
6948	FlipTime	Seconds between screen changes
6949	Modbus ID of COMM4	COMM4ID
6950	Gap time for COMM4	COMM4GAP
6951	Baud rate for COMM4	COMM4BAUD
6952	Input 1-8 4G Mode	IN18MODE. Bit = 0 inputs reported as normal, 1 input 'flipped'. 1 to 8 only
6953	Toggle 1 Lead register pointer	Set to 0 or 0xFFFF to disable toggle 1 function
6954	Toggle 1 Lag register pointer	Set to 0 or 0xFFFF to disable toggle 1 function
6955	Toggle 2 Lead register pointer	Set to 0 or 0xFFFF to disable toggle 2 function
6956	Toggle 2 Lag register pointer	Set to 0 or 0xFFFF to disable toggle 2 function
6957	Toggle 3 Lead register pointer	Set to 0 or 0xFFFF to disable toggle 3 function
6958	Toggle 3 Lag register pointer	Set to 0 or 0xFFFF to disable toggle 3 function

6959	Toggle 4 Lead register pointer	Set to 0 or 0xFFFF to disable toggle 4 function
6960	Toggle 4 Lag register pointer	Set to 0 or 0xFFFF to disable toggle 4 function
7000	Start of RF4G Map Table Unit0, Relay 1	RF4GMAP Table 1280 regs long for Relay and Analog Outputs.
7001	Unit0 Relay 2 Map	
7002	Unit0 Relay 3 Map	
7003	Unit0 Relay 4 Map	
7004	Unit0 Relay 5 Map	
	""	
	""	
7031	Unit0 Relay 31 Map	
7032	Unit0 Analog Out 1 Map	
7033	Unit0 Analog Out 2 Map	
7034	Unit0 Analog Out 3 Map	
7035	Unit0 Analog Out 4 Map	
7036	Unit0 Analog Out 5 Map	
7037	Unit0 Analog Out 6 Map	
7038	Unit0 Analog Out 7 Map	
7039	Unit0 Analog Out 8 Map	
7040	Unit1 Relay 1 Map	
7041	Unit1 Relay 2 Map	
	"	
	"	
	"	
8279	Unit31 Analog 8 Map	
8280	Special Register 1 Control type	SPECCTLTYPE length 32
8281	Special Register 2 Control type	
8282	Special Register 3 Control type	
8283	Special Register 4 Control type	
8284	Special Register 5 Control type	
8285	Special Register 6 Control type	
8286	Special Register 7 Control type	
8287	Special Register 8 Control type	
8288	Special Register 9 Control type	
8289	Special Register 10 Control type	
8290	Special Register 11 Control type	
8291	Special Register 12 Control type	
8292	Special Register 13 Control type	
8293	Special Register 14 Control type	
8294	Special Register 15 Control type	
8295	Special Register 16 Control type	
8296	Special Register 17 Control type	
8297	Special Register 18 Control type	
8298	Special Register 19 Control type	
8299	Special Register 20 Control type	
8300	Special Register 21 Control type	
8301	Special Register 22 Control type	
8302	Special Register 23 Control type	
8303	Special Register 24 Control type	
8304	Special Register 25 Control type	

8305	Special Register 26 Control type	
8306	Special Register 27 Control type	
8307	Special Register 28 Control type	
8308	Special Register 29 Control type	
8309	Special Register 30 Control type	
8310	Special Register 31 Control type	
8311	Special Register 32 Control type	
8312	Special Register 1 Source	SPECSOURCE length 32
8313	Special Register 2 Source	
	"	
	"	
8343	Special Register 32 Source	
8344	Special Register 1 Trip High Upper 16 bits	SPECTRIPHIGH length 64 (may be 32 bit trips)
8345	Special Register 1 Trip High Lower 16 bits	
8346	Special Register 2 Trip High Upper 16 bits	
8347	Special Register 2 Trip High Lower 16 bits	
8348	Special Register 3 Trip High Upper 16 bits	
8349	Special Register 4 Trip High Lower 16 bits	
	"	
	"	
8406	Special Register 32 Trip High Upper 16 bits	
8407	Special Register 32 Trip High Lower 16 bits	
8408	Special Register 1 Trip Low Upper 16 bits	SPECTRIPLOW length 64 (may be 32 bit trips)
8409	Special Register 1 Trip Low Lower 16 bits	
8410	Special Register 2 Trip Low Upper 16 bits	
8411	Special Register 2 Trip Low Lower 16 bits	
	"	
	"	
	"	
8470	Special Register 32 Trip Low Upper 16 bits	
8471	Special Register 32 Trip Low Lower 16 bits	
8472	Card logging parameter 33, pointer to MB register.	CARDCONFIG2 Second card config table 192 long
8473	Card logging parameter 33 dec. loc. and 16-32 bit selection.	
8474	Card Logging parameter 34, MB Reg.	
8475	Card logging item 34, format and selection	
8476	Card Logging parameter 35, MB Reg.	
8477	Card logging item 35, format and selection	
8478	Card Logging parameter 36, MB Reg.	
8479	Card logging item 36, format and selection	
8480	Card Logging parameter 37, MB Reg.	
8481	Card logging item 37, format and selection	
8482	Card Logging parameter 38, MB Reg.	
8483	Card logging item 38, format and selection	
8484	Card Logging parameter 39, MB Reg.	
8485	Card logging item 39, format and selection	
8486	Card Logging parameter 40, MB Reg.	
8487	Card logging item 40, format and selection	
8488	Card 41	
8489	""	
8490	Card 42	

8491	""	
8492	Card 43	
8493	""	
8494	Card 44	
8495	""	
8496	Card 45	
8497	""	
8498	Card 46	
8499	""	
8500	Card 47	
8501	""	
8502	Card 48	
8503	""	
8504	Card 49	
8505	""	
8506	Card 50	
8507	""	
8508	Card 51	
8509	""	
8510	Card 51	
8511	""	
8512		
8513	etc..	
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8663		
8664	Sticky register array start	
8665	Sticky Register 1	
8666	Sticky Register 2	
	""	
	""	
	""	
	""	
8919	Sticky Register 256	
8920	Spare2 array (~80)	
8921		
8922		
8999		
9000	EESIZE / EECRC	

RFScada32 Firmware Upgrades

From time to time new features will be added to the RFScada32 firmware, and the newest firmware may be installed in field units. The latest firmware available and the program required to install it may be downloaded from www.rfscada.com. The currently installed firmware version may be viewed in the 'Miscellaneous' menu. To upgrade the field firmware proceed as follows.

1. Install the bootloader program in the PC. First ensure that the file RFScada32BL.msi is not 'blocked' by Windows, look at the file properties and select 'Unblock' if it is blocked. Then double-click on the RFSCada32BL.msi file which should install the program.
2. Start the RFScada32BL program, then select 'file' then navigate to and load the new firmware file, which will be named something like RF32Vxx.hex where xx is the version number, eg xx = 11 indicates version 1.1 Using the menus set the 'compatibility delay' to 3 which should be suitable for most modern PC's. (1 is the fastest, it may need to be set slower if problems occur with older PC's)
3. Set the ISM radio switch to the center 'off' position. The bootloader can connect via the RS-232 COM1 (easiest method) or the USB COM1 port. It *cannot be done using the RS-485 port*. If using RS-232 proceed to step 4; if using USB go to step 5.
4. If using the RS-232 port proceed as follows: Connect the cable. Select the appropriate COM port for the PC in the bootloader program. Turn off power to the RFScada32 device. Click on the 'connect' button in the bootloader program. Now hold down the 'Enter' key on the RFSCada32 and turn on power to the RFScada32. The bootloader program should show 'connected' and the blue LED on the RFScada32 should flash rapidly; the 'Enter' key may now be released. Go to step 6
5. If using the USB connection proceed as follows: Connect the USB cable between the PC and the RFScada32, power on the RFScada32. The PC may display a message that it has found a new serial port. Select the appropriate USB COM port for the PC in the bootloader program. Using the RFScada32 keypad navigate to Miscellaneous->Factory Access. Enter the password ABCD then navigate to Upgrade Firmware but do not press Enter key yet. Click on the 'connect' button in the PC bootloader program. Now press and hold down the 'Enter' key on the RFScada32. The bootloader program should show 'connected' and the blue LED on the RFScada32 should flash rapidly; the 'Enter' key may now be released. Proceed with step 6.
6. Click on the 'write device' button to start the firmware upgrade, it will take a minutes or so to complete.
7. Once completed a message saying verify correct should appear; if a verify error occurred then the compatibility delay may be increased and the process repeated from step 2.
8. Cycle power to the RFScada32 and verify the new firmware is displayed in the miscellaneous menu.
9. Note – It is possible after a firmware upgrade that the LCD display may appear blank. This is due to the contrast setting being changed after the upgrade, hold the contrast key down until text is visible then release the contrast key.