RFSCADA32

*Installation, Configuration &
Programming Manual*

TABLE OF CONTENTS

RFSCADA32

Remote Terminal Unit

TERMS & CONDITIONS

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 atCustomer's expense, and a charge made for examination and testing. This Limited Warranty is void if failure of the Products hasresulted 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 MERCHANTABIL-ITY, FITNESS FOR A PARTICULAR PURPOSE, TITLE OR NON-IN-FRINGEMENT 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, RELIABILI-TY, OR OTHERWISE AND DOES NOT WARRANT THAT THE OPER-ATION OF THE PRODUCTS WILL BE UNINTERRUPTED OR ERROR FREE. DDD EXPRESSLY DISCLAIMS ANY WARRANTIES NOT STAT-ED HEREIN.

10. NO LIABILITY FOR CONSEQUENTIAL DAMAGES

The entire liability of DDD and its licensors, distributors, and suppliers (including its and their directors, officers, employees, and agents) is set forth above. To the maximum extent permitted by applicable law, in no event shall DDD and its licensors, distributors, and suppliers (including its and their directors, officers, employees, and agents) be liable for any damages, including, but not limited to, any special, direct, indirect, inci-dental, exemplary, or consequential damages, expenses, lost profits, lost savings, business interruption, lost business information, or any other RTU Manual Version 1.5 damages arising out of the use or inability to use the Products, even if DDD or its licensors, distributors, and suppliers have been advised of the possibility of such damages. Customer acknowledges that the applicable purchase price or license fee for the Products reflects this allocation of risk. Because some states/jurisdictions do not allow the exclusion or limitation of liability for consequential or incidental damages, the above limitation may not apply. If the foregoing limitation of liability is not enforceable because an DDD product sold or licensed to Customer is determined by a court of competent jurisdiction in a final, non-appealable judgment to be defective and to have directly caused bodily injury, death, or property damage, in no event shall DDD's liability for property dam-age exceed the greater of $5,000 or fees paid for the specific product that caused such damage.

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:OUR9X-TREAM 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

RFSCADA32
Remote Terminal Unit

GENERAL SAFETY INSTRUCTIONS

Warnings in this manual appear in either of two ways:

 DANGER

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.

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.

INTRODUCTION

RFSCADA32

Remote Terminal Unit

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 dependent 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.

RFSCADA32

Remote Terminal Unit

SPECIFICATIONS

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.

Specifications

DEVICE UNPACKING & VERIFICATION

RFSCADA32

Remote Terminal Unit

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 & WIRING REFERENCE

RFSCADA32

Remote Terminal Unit

REF	PIN	FUNCTION
J19	1	One positive input
J19	2	One return (connected to ground)
J19	3	Two positive input
J19	4	Two return (connected to ground)
J19	5	Three positive input
J19	6	Three return (connected to ground)
J19	7	Four positive input
J19	8	Four return (connected to ground)

REF	PIN	FUNCTION
J6	1	Five positive input
J6	2	Five return (connected to ground)
J6	3	Six positive input
J6	4	Six return (connected to ground)
J6	5	Seven positive input
J6	6	Seven return (connected to ground)
J6	7	Eight positive input
J6	8	Eight return (connected to ground)

REF	PIN	FUNCTION
J25	1	Thirteen positive input
J25	2	Thirteen return (connected to ground)
J25	3	Fourteen positive input
J25	4	Fourteen return (connected to ground)
J25	5	Fifteen positive input
J25	6	Fifteen return (connected to ground)
J25	7	Sixteen positive input
J25	8	Sixteen return (connected to ground)

J6   J9   J8   J10   J7   J22   J27

J44   J43   J47   J3   J4   J21   J20   J1   J2
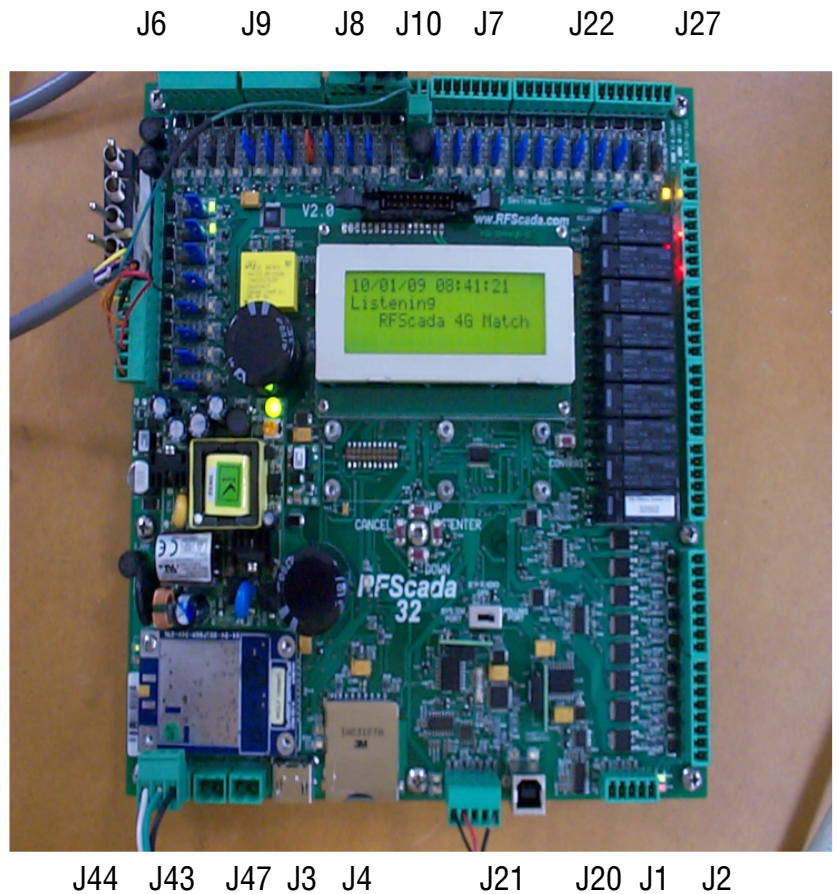
REF	PIN	FUNCTION
J30	1	Nine positive input
J30	2	Nine return (connected to ground)
J30	3	Ten positive input
J30	4	Ten return (connected to ground)
J30	5	Eleven positive input
J30	6	Eleven return (connected to ground)
J30	7	Twelve positive input
J30	8	Twelve return (connected to ground)

REF	PIN	FUNCTION
J46	1	4-20 mA transducer positive power supply output
J46	2	4-20 mA transducer positive power supply output

REF	PIN	FUNCTION
J56	1	Seventeen positive input
J56	2	Seventeen return (connected to ground)
J56	3	Eighteen positive input
J56	4	Eighteen return (connected to ground)
J56	5	Nineteen positive input
J56	6	Nineteen return (connected to ground)
J56	7	Twenty positive input
J56	8	Twenty return (connected to ground)

REF	PIN	FUNCTION
J61	1	Twenty One positive input
J61	2	Twenty One return (connected to ground)
J61	3	Twenty Two positive input
J61	4	Twenty Two return (connected to ground)
J61	5	Twenty Three positive input
J61	6	Twenty Three return (connected to ground)
J61	7	Twenty Four positive input
J61	8	Twenty Four return (connected to ground)

REF	PIN	FUNCTION
J66	1	Twenty Five positive input
J66	2	Twenty Five return (connected to ground)
J66	3	Twenty Six positive input
J66	4	Twenty Six return (connected to ground)
J66	5	Twenty Seven positive input
J66	6	Twenty Seven return (connected to ground)
J66	7	Twenty Eight positive input
J66	8	Twenty Eight return (connected to ground)

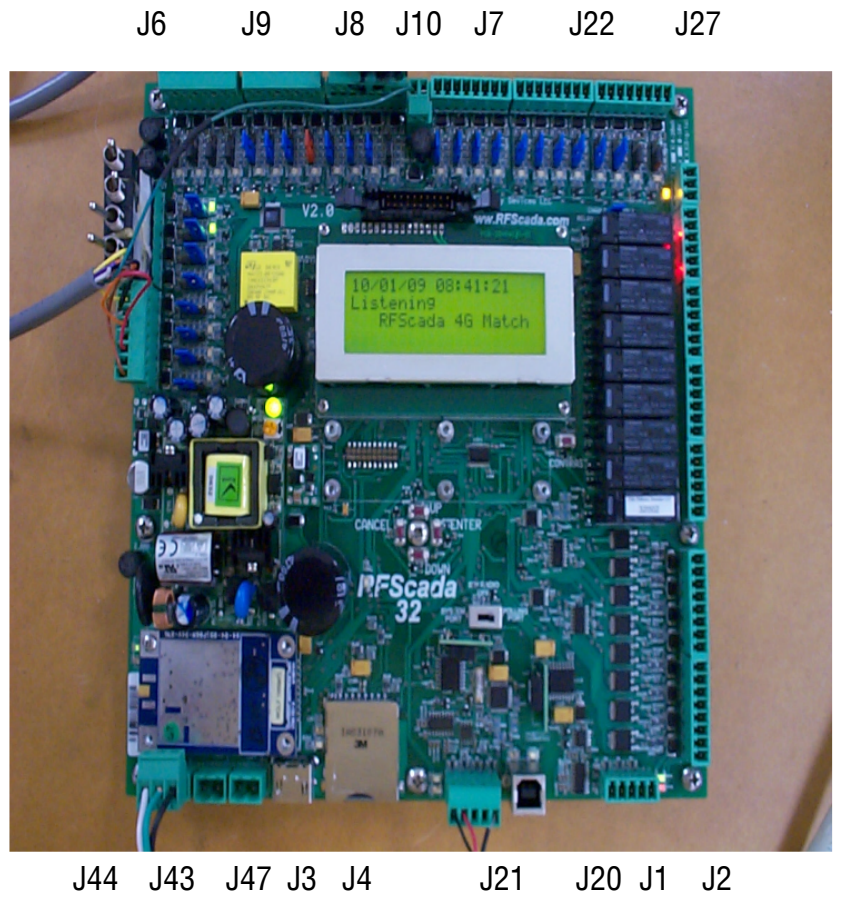| REF	PIN	FUNCTION
J71	1	Twenty Nine positive input
J71	2	Twenty Nine return (connected to ground)
J71	3	Twenty Six positive input
J71	4	Thirty return (connected to ground)
J71	5	Thirty One positive input
J71	6	Thirty One return (connected to ground)
J71	7	Thirty Two positive input
J71	8	Thirty Two return (connected to ground)

REF	PIN	FUNCTION
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

REF	PIN	FUNCTION
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

REF	PIN	FUNCTION
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

REF	PIN	FUNCTION
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

J6   J9   J8 J10 J7   J22   J27

J44   J43   J47 J3   J4   J21   J20 J1   J2

Component Identification, Signal & Wiring Reference

REF	PIN	FUNCTION
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

REF	PIN	FUNCTION
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

REF	PIN	FUNCTION
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

REF	PIN	FUNCTION
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

REF	PIN	FUNCTION
J20	1	System (Comm1) USB Port
J20	2	System (Comm1) USB Port
J20	3	System (Comm1) USB Port
J20	4	System (Comm1) USB Port

REF	PIN	FUNCTION
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

REF	PIN	FUNCTION
J21		SD/MMC Card Connector

REF	PIN	FUNCTION
J2	4	Comm4 RS-485 Modbus 'A' Transmit / Receive Data
J2	2	Comm4 RS-485 Modbus 'B' Transmit / Receive Data
J2	3	Comm4 RS-485 Modbus Ground
J2	4	RF4G High Speed I/O Bus Ground
J2	5	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

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), 0-5 VDC 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.

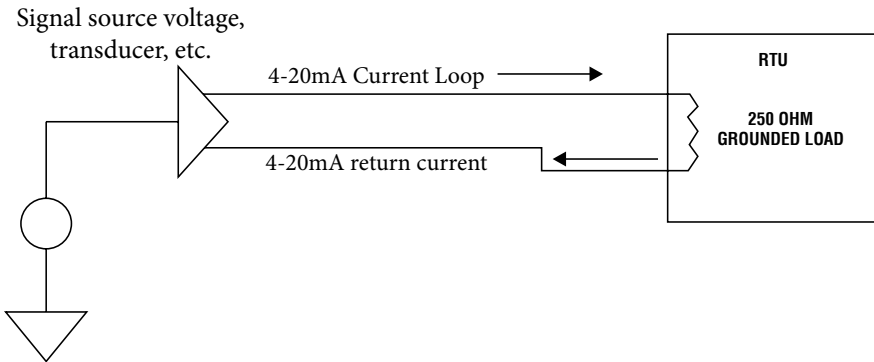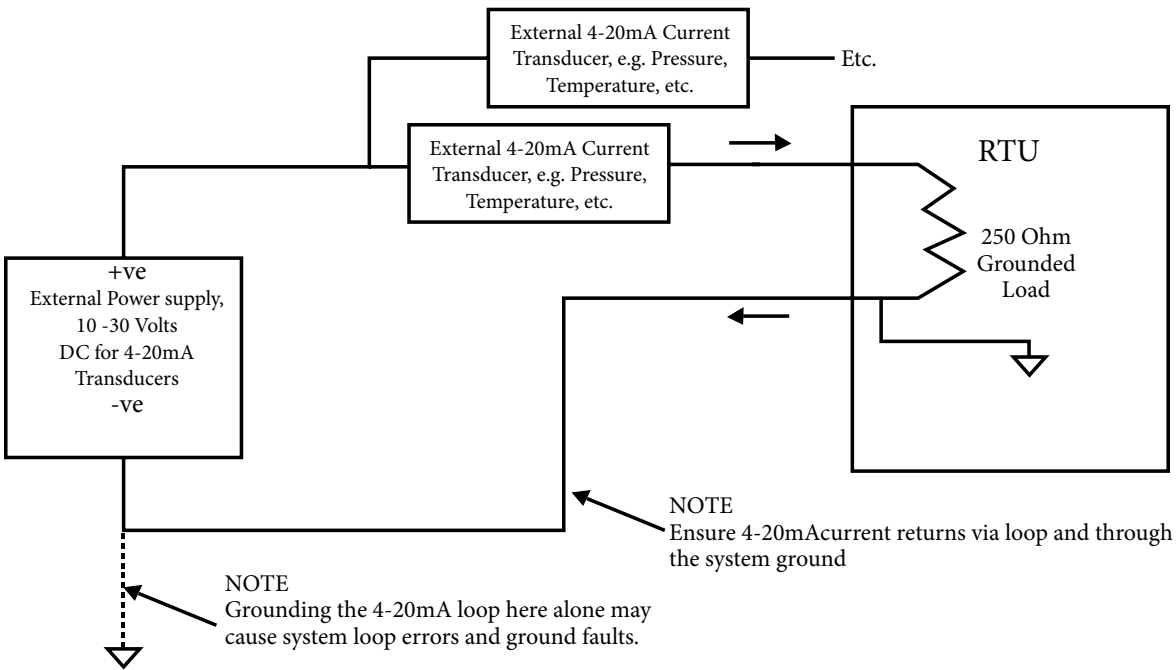## Configuring Inputs for Analog, Digital or Pulse Operation

Input Connectors
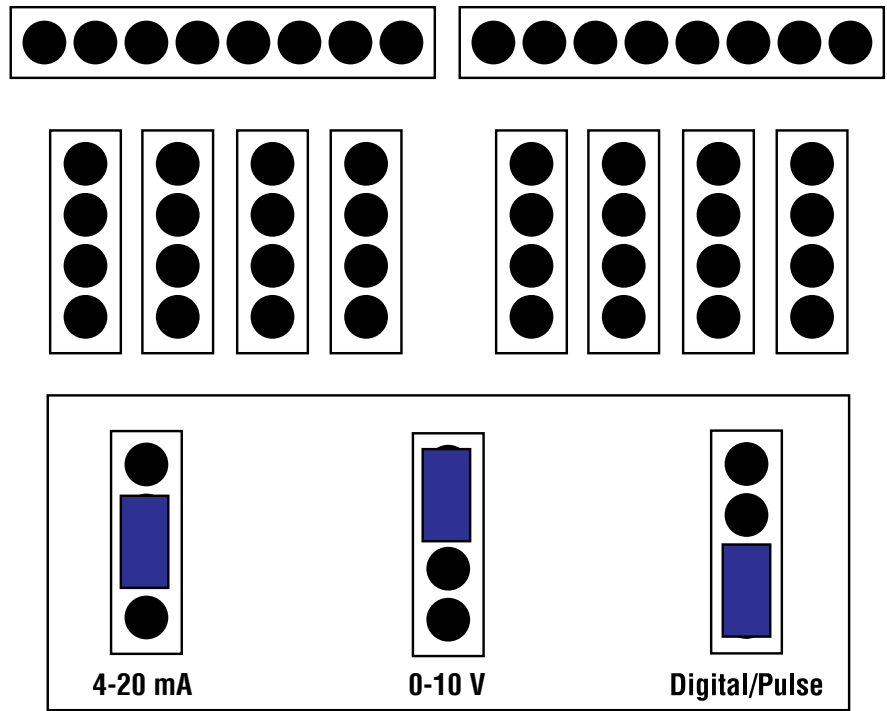
When configured for 4-20 mA each of the inputs presents a load of 250 Ohms to ground for the external circuit, so each input may also be used for a 0 to 5 Volt DC input providing the external circuit is capable of driving the load. Each analog input is protected against overloads to approximately 14 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.
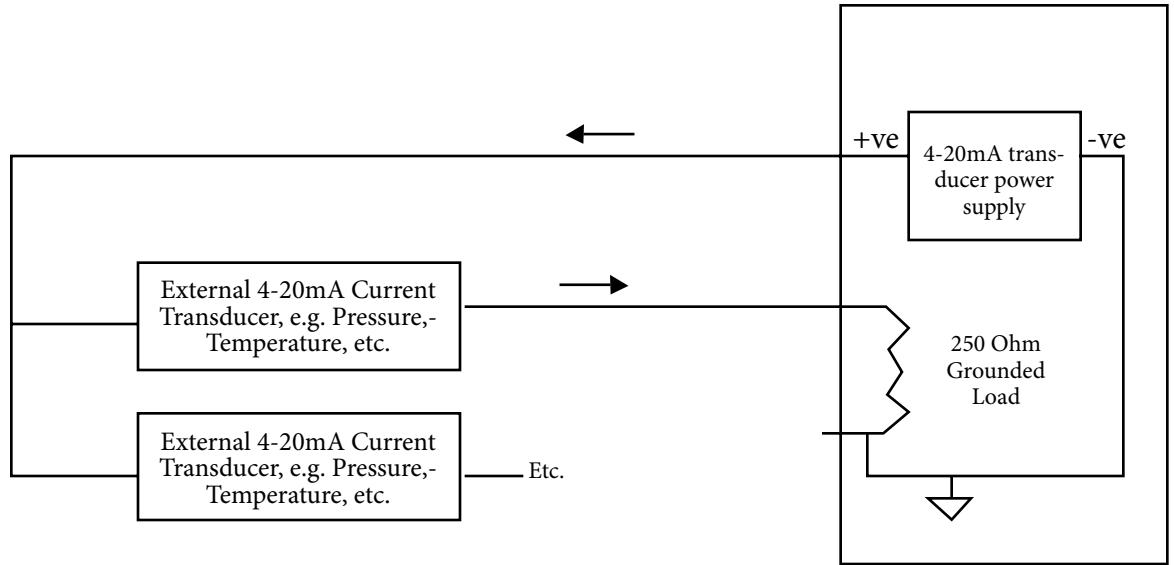
Component Identification, Signal & Wiring Reference

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

Signal source voltage,
transducer, etc.

4-20mA Current Loop

RTU

250 OHM
GROUNDED LOAD

4-20mA return current

External DC power supply and 4-20mA transducers

External 4-20mA Current
Transducer, e.g. Pressure,
Temperature, etc.

Etc.

External 4-20mA Current
Transducer, e.g. Pressure,
Temperature, etc.

RTU

250 Ohm
Grounded
Load

+ve
External Power supply,
10 -30 Volts
DC for 4-20mA
Transducers
-ve

NOTE
Ensure 4-20mAcurrent returns via loop and through
the system ground

NOTE
Grounding the 4-20mA loop here alone may
cause system loop errors and ground faults.

Component Identification, Signal & Wiring Reference

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

4-20mA trans-
ducer power
supply

+ve

-ve

External 4-20mA Current
Transducer, e.g. Pressure,-
Temperature, etc.

External 4-20mA Current
Transducer, e.g. Pressure,-
Temperature, etc.

Etc.

250 Ohm
Grounded
Load

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

Examples of digital signal input methods

Relay Contacts

Relay Coil Power

Open Collector

Switch

RTU
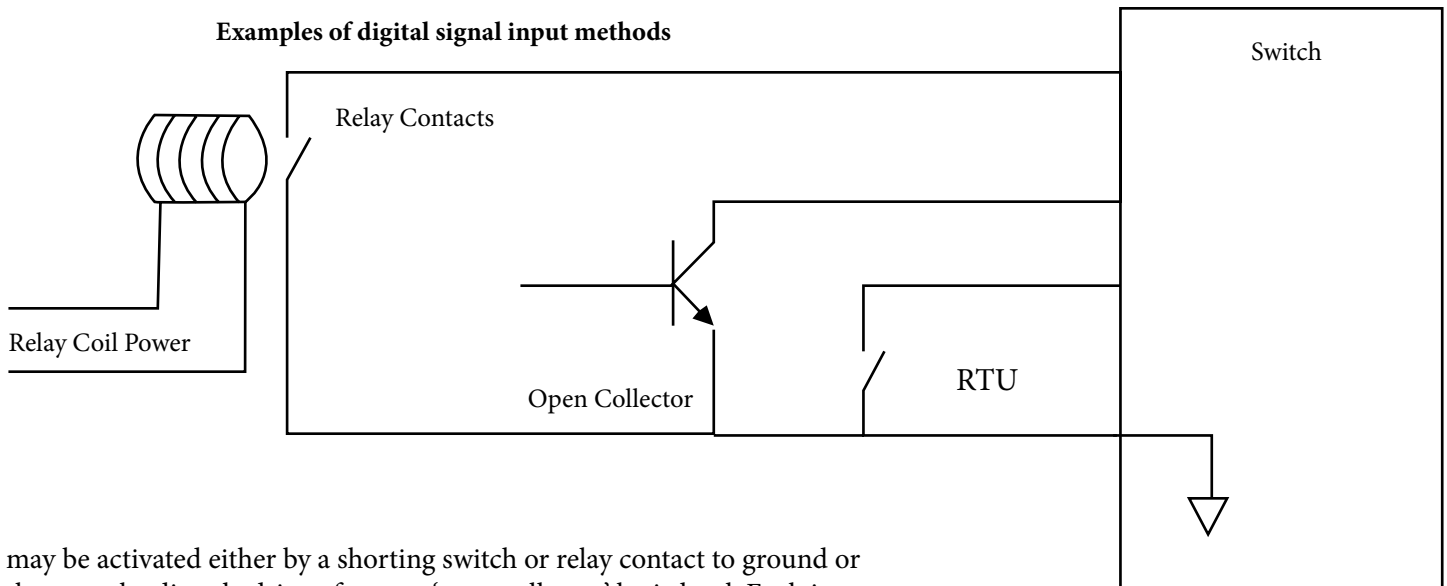
may be activated either by a shorting switch or relay contact to ground or they may be directly driven from an 'open collector' logic level. Each input connection has a corresponding ground connection on the connectors, but it is permissible for these switch inputs to share a common ground connection 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 mayrequest 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 otherunits. 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.

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.

ISM High Power Radio 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 Transmit / Receive LED's

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.

System / Modbus LED

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.

F1, AC Power Fuse

⚠️ **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.

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 reconnected.

RFSCADA32

Remote Terminal Unit

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

**Configuration / Data Access
Communication Ports (cont.)**

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.

*System Configuration & Programming*

⚠️ **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.
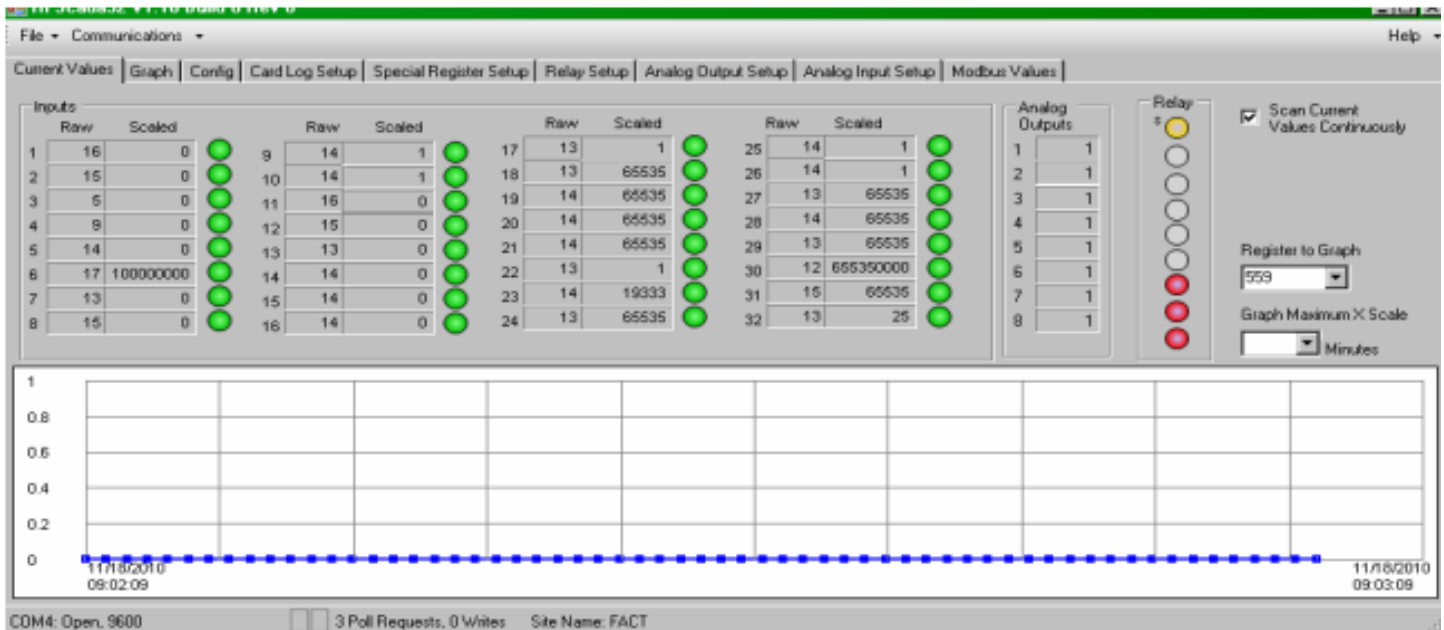
Analog: When set to any of the analog modes the inputs will be constantly read to sample the incoming analog signal levels, and the (16 bit) 'raw' result of these reads are placed directly into 32 Modbus registers starting at address 800. Also, at the end of each sample, a scaling conversion will be 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
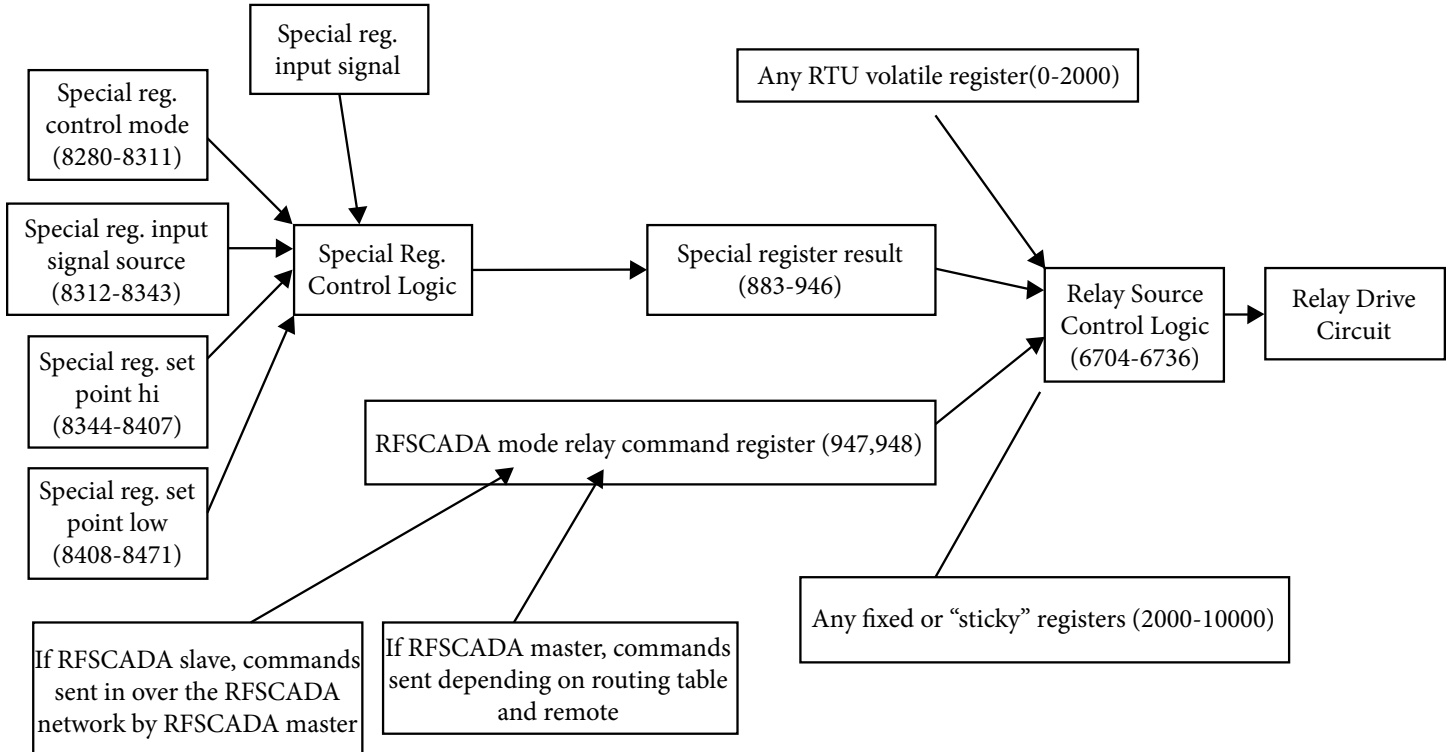
setting. In this case the relays are driven via a Modbus register that is controlled by the RFScada 'master'. However each relay may also be assigned (locally, in this RFScada) to be controlled by any register in this device. So as an example the first 4 relays could be controlled by a polling master 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.

<div style="text-align: right">Special Registers</div>

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

Special Registers (cont.)

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.
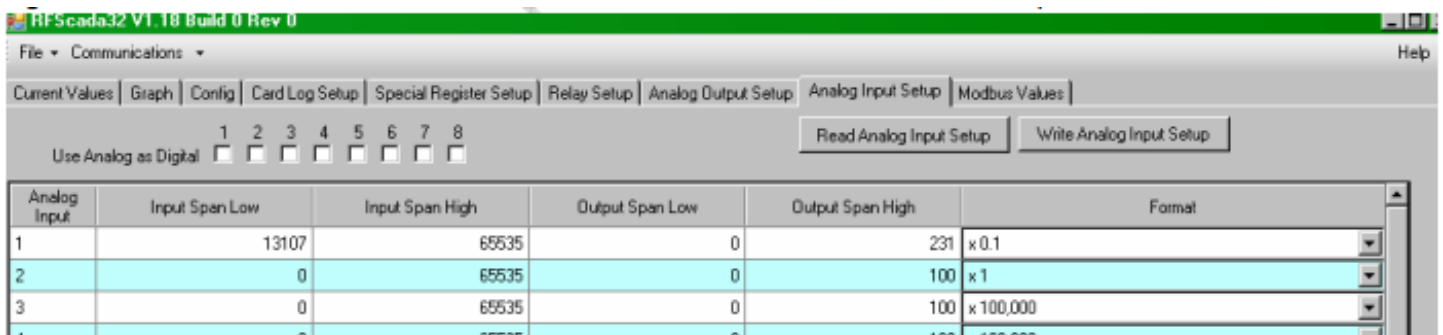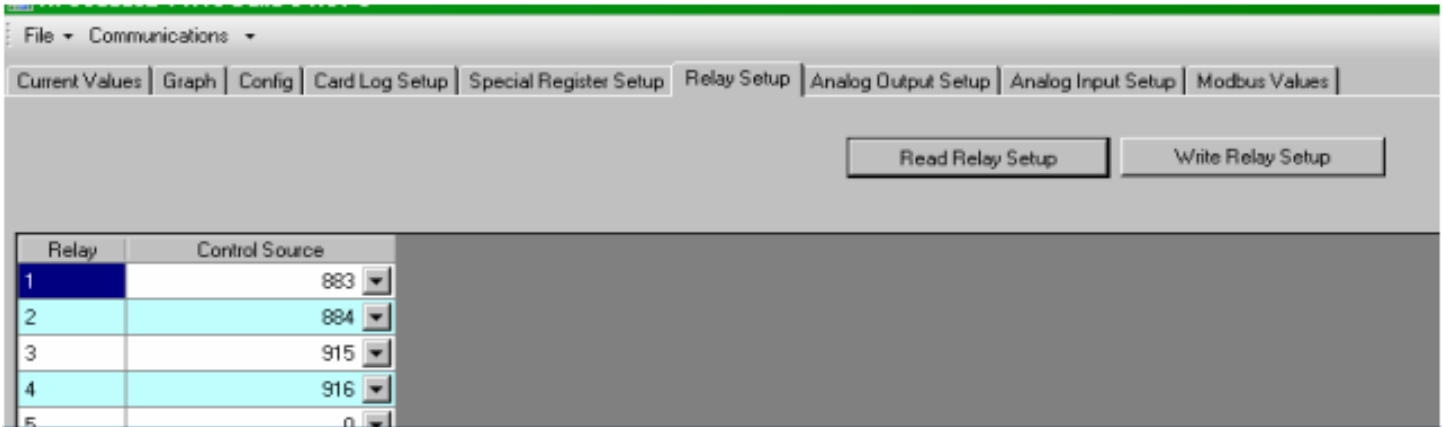
Often it is desirable to toggle certain registers depending on events. This capability is frequently used for dual pumps, where redundancy and equal wear is required. There are four sets of toggle functions that may be used, they are all used in a similar manner. The 'outputs' will be sent to the toggle 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.

Analog Input	Input Span Low	Input Span High	Output Span Low	Output Span High	Format
1	13107	65535	0	231	x 0.1
2	0	65535	0	100	x 1
3	0	65535	0	100	x 100,000

File ▾   Communications ▾

Current Values | Graph | Config | Card Log Setup | Special Register Setup | Relay Setup | Analog Output Setup | Analog Input Setup | Modbus Values |

Read Relay Setup   Write Relay Setup

Relay	Control Source
1	883 ▾
2	884 ▾
3	915 ▾
4	916 ▾
5	0 ▾

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.

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 - Slave 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.

Polled Device Setup - Master Configuration

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.

System Configuration & Programming

Polled Device Setup - Master Configuration (cont.)

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.

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 & KEYPAD OPERATION

RFSCADA32

Remote Terminal Unit

LCD & 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

UP

CANCEL ◁▷ ENTER

DOWN
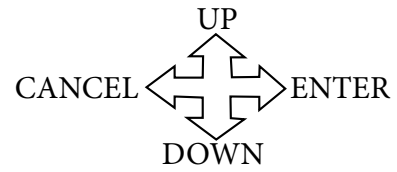
	Monitor Devices	Configured Device 1 Configured Device 2 " " Configured Device 255 Configured Device 256

	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 ModbusPre-Roll Time (mS) Device Modbus Post-Roll Time (mS) Device Display Format Devices 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 PCD Serial Number Factory Access Set Time and Date

RTU MODBUS MAP

RFSCADA32
Remote Terminal Unit

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.	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
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.	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	COMMSTATE e.g. 0x000E indicates devices 2,3
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)		May be written to by Toggle 2 function.
951	Written to if we are RFScada slave1 (Aout 3)		May be written to by Toggle 3 function.
952	Written to if we are RFScada slave1 (Aout 4)		May be written to by Toggle 3 function.
953	Written to if we are RFScada slave1 (Aout 5)		May be written to by Toggle 4 function.
954	Written to if we are RFScada slave1 (Aout 6)		May be written to by Toggle 4 function.
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.**

FIRMWARE UPGRADES

RFSCADA32
Remote Terminal Unit

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.