

User's Guide



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RTU Series

Radio Telemetry Systems



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WARNING: These products are not designed for use in, and should not be used for, patient-connected applications.

WARRANTY/DISCLAIMER

OMEGA ENGINEERING, INC. warrants this unit to be free of defects in materials and workmanship for a period of 13 months from date of purchase. OMEGA Warranty adds an additional one (1) month grace period to the normal one (1) year product warranty to cover handling and shipping time. This ensures that OMEGA's customers receive maximum coverage on each product.

If the unit malfunctions, it must be returned to the factory for evaluation. OMEGA's Customer Service Department will issue an Authorized Return (AR) number immediately upon phone or written request. Upon examination by OMEGA, if the unit is found to be defective, it will be repaired or replaced at no charge. OMEGA's WARRANTY does not apply to defects resulting from any action of the purchaser, including but not limited to mishandling, improper interfacing, operation outside of design limits, improper repair, or unauthorized modification. This WARRANTY is VOID if the unit shows evidence of having been tampered with or shows evidence of having been damaged as a result of excessive corrosion; or current, heat, moisture or vibration; improper specification; misapplication; misuse or other operating conditions outside of OMEGA's control. Components which wear are not warranted, including but not limited to contact points, fuses, and triacs.

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The purchaser is responsible for shipping charges, freight, insurance and proper packaging to prevent breakage in transit.

FOR **WARRANTY** RETURNS, please have the following information available BEFORE contacting OMEGA:

1. Purchase Order number under which the product was PURCHASED,
2. Model and serial number of the product under warranty, and
3. Repair instructions and/or specific problems relative to the product.

FOR **NON-WARRANTY** REPAIRS, consult OMEGA for current repair charges. Have the following information available BEFORE contacting OMEGA:

1. Purchase Order number to cover the COST of the repair,
2. Model and serial number of the product, and
3. Repair instructions and/or specific problems relative to the product.

OMEGA's policy is to make running changes, not model changes, whenever an improvement is possible. This affords our customers the latest in technology and engineering. OMEGA is a registered trademark of OMEGA ENGINEERING, INC.

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OWNER INFORMATION

FCC REGULATIONS

LICENSING

The FCC requires you to obtain a station license for your **DATAFLOW RTU** system before using it, but does not require an operation license or permit.

The station licensee is responsible for ensuring that the transmitter power, frequency and deviation are within the limits specified by the station license. The licensee is also responsible for the proper operation and maintenance of the radio equipment. This includes checking the transmitter frequency and deviation periodically, using appropriate methods.

You will need to obtain a FCC license to operate the **DATAFLOW RTU**. To get a FCC license for VHF or UHF frequencies, submit FCC application Form 600.

SAFETY STANDARDS

The FCC (with its action in General Docket 79-144, March 13, 1985), has adopted a safety standard for human exposure to radio frequency electromagnetic energy emitted by FCC regulated equipment. OMEGA observes these guidelines, and recommends that you do also:

- DO NOT hold the **DATAFLOW RTU** so the antenna is very close to or touching exposed parts of the body, especially the face or eyes, while transmitting.
 - DO NOT operate radio equipment near electrical blasting caps or in an explosive atmosphere.
 - DO NOT allow children to play with any radio equipment that contains a transmitting device.
- REPAIR of OMEGA products should be performed only by OMEGA authorized personnel.

CAUTIONS

1. ALL DIGITAL INPUTS, ANALOG INPUTS, ANALOG OUTPUTS, AND MEASUREMENTS OF THE **DATAFLOW RTU** ARE REFERENCED TO GROUND. DO NOT USE THE **DATAFLOW RTU** WITH EQUIPMENT THAT REQUIRES COMPLETE ISOLATION.
2. ALL **DATAFLOW RTU** DIGITAL OUTPUTS ARE ISOLATED LATCHING RELAYS. DO NOT EXCEED CONTACT RATINGS OF THESE RELAYS.
3. EXCITATION VOLTAGE AND LOAD DRIVE VARY FROM MANUFACTURER TO MANUFACTURER. CONSULT MANUFACTURER DOCUMENTATION BEFORE CONNECTING THE SENSORS OR INDICATORS TO THE **DATAFLOW RTU**.
4. THE **DATAFLOW RTU** CASE IS CONNECTED TO GROUND.
5. ALL **DATAFLOW RTU** SYSTEMS REQUIRE AN FCC LICENSE
6. THE FREQUENCY DEVIATION IS CONTROLLED BY VARIABLE RESISTOR R131. THIS DEVIATION ADJUSTMENT SHOULD ONLY BE PERFORMED BY AUTHORIZED OMEGA PERSONNEL USING THE APPROPRIATE METHODS AND TEST EQUIPMENT.
7. · DO NOT SHORT THE RED WIRE (PIN 6) OF CONNECTOR J105 TO GROUND.
· DO NOT SHORT THE RED WIRE (PIN 5) OF CONNECTOR J101 TO GROUND.
· IF AN INTERNAL BATTERY IS INSTALLED DO NOT SHORT THE ORANGE WIRE (PIN 7) OF CONNECTOR J105 TO GROUND.
PERFORMING ANY OF THESE ACTIONS WILL DESTROY THE FUSE (F101) LOCATED ON THE **DATAFLOW RTU** CONTROL BOARD.
8. DO NOT OPERATE THE **DATAFLOW RTU** WITHOUT AN ANTENNA OR SUITABLE LOAD. TO DO SO MAY DAMAGE THE TRANSMITTER.

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1. INTRODUCTION

- 1.1 The **DATAFLOW RTU** from OMEGA is a complete wireless telemetry system designed to deliver industrial instrumentation signals from a source to other instruments via radio frequency communications. The **DATAFLOW RTU** allows you to access industrial measuring devices in remote locations without running wires, installing microwave links or leasing a telephone line. OMEGA **DATAFLOW RTU** and MODBUS radio communications equipment replaces these methods.
- 1.2 Manual Part A is intended to provide information needed for the installation and operation of DATAFLOW RTU systems. The intended readers are people familiar with industrial instrumentation. A basic understanding of radio communications is helpful. The included information is valid only for models listed on the cover.

2. OPERATION

- 2.1 **DATAFLOW RTU** is a radio telemetry system. It operates on either 450-470 MHz with a transmitter power of 2 Watts or 5 Watts (UHF-FM), or 136 to 151 MHz, 150 to 165 MHz, 160 to 174 MHz with a transmitter power of 5 Watts (VHF-FM). An RTU system operating in the UHF-FM band at 2 Watts with directional antennas and 50-foot towers has an effective range of 20 to 25 miles over level terrain. Changes in the frequency of operation, transmitter power, terrain and antenna structure will affect the range of the link.
- 2.2 All **DATAFLOW RTU** systems require FCC licensing.

3. MICROPROCESSOR UPDATES

- 3.1 A microprocessor, IC105, the main controlling device of a **DATAFLOW RTU**, is located in a socket on the Control Board. Socket configuration provides ease in replacing or updating microprocessor firmware.
- 3.2 The microprocessor firmware version available when this manual was printed is Version 3.27. (In Version 3.x, "x" represents the [number] designation of a minor revision.)

Installation/Operation

4. PART NUMBER DEFINITION

- 4.1 The following is a list of the part numbers available at the printing of this material.

RTU-X X X - X / / / /	<u>Band Option</u>	
	1 5 0 - E	136-151 MHz. RF Board (OMEGA # DTX-150-E0DD)
	1 5 0 - 0	150-165 MHz. RF Board (OMEGA # DTX-150-00DD)
	1 5 0 - F	160-174 MHz. RF Board (OMEGA # DTX-150-F0DD)
	4 5 0 - 0	450-470 MHz. RF Board (OMEGA # DTX-450-00DD)
	4 0 0 - G	400-430 MHz. RF Board (OMEGA # DTX-150-G0DD)
RTU- / / / - / X / / /	<u>RF Connection</u>	
	U	UHF Connector
RTU- / / / - / / X / /	<u>Enclosure</u>	
	S	Small Enclosure
RTU- / / / - / / / X /	<u>Power Option</u>	
	1	One 8-cell AA battery holders (batteries not included)
	2	Two 4-cell NiCad rechargeable battery packs
	D	No internal power
RTU- / / / - / / / / X	<u>Data Encryption</u>	
	C	Clear

5. ACCESSORIES

- 5.1 The following list reflects available accessories.

<u>OMEGA PART NO.</u>	<u>DESCRIPTION</u>
RTU-06001123	Power/ Serial Cable, 6 foot length for small (S) enclosure
RTU-06001124	User I/O Cable, 6 foot length for small (S) enclosure
RTU-25104600	Mounting Bracket for small (S) enclosure
RTU-25605100	Enclosure Cover Seal
RTU-BATNICD	NiCad Rechargeable Battery Pack
RTU-BATHOLD	Battery Holder
RTU-AFP-150	VHF Flexible Antenna
RTU-AFP-150H	VHF Flexible Antenna for 164-174 MHz
RTU-RYA-15	VHF Directional Antenna, 6.5 dB Gain
RTU-AFP-450	UHF Flexible Antenna
RTU-RYA-45	UHF Directional Antenna, 10 dB Gain
RTU-ROA-45	UHF Omnidirectional Antenna, 2.5 dB Gain
RTU-RAC-05	Coaxial Cable, 50 feet, RG-8A/U w/PL-250 Connectors
RTU-RAC-10	Coaxial Cable, 100 feet, RG-8A/U w/PL-250 Connectors
RTU-9/RTC-PAS	Programming Cable for small (S) enclosure
RTU-PCPC	Programming Cable for small (S) enclosure
RTU-PCPS-3.0	Programming software (Version 3.03 for DOS & Windows PC's on 3.5" disk)
RTU-PCPK	Programming Kit
RTU-PS	1.5 Amp AC-to-DC Power supply
RPS-1	1 Amp AC to DC Power Supply
14800018-0	RTU Series User's Guide

6 SPECIFICATIONS6.1 SYSTEM SPECIFICATIONS

FCC ID:.....	RTU-150 - AIERIT04-150; RTU-450 - AIERIT04-450
Emission designator:	10K8FID
Digital Inputs:.....	Maximum of 6
LOW:	Programmable from 0 to 5 V
HIGH:	Programmable from 0 to 5 V
Digital Outputs:.....	Two (2) isolated latching relays
UL/CSA rating:	2A 30VDC
	0.5A 110VDC
	0.5A 125VAC
Analog Inputs:	Maximum of 6
Voltage Mode Range:	0-5 VDC
Current Loop Mode Range:	0-20 mA
Resolution:	8 bits
Analog Outputs:.....	Maximum of 2
Analog Voltage Mode Range:	0-5 VDC
Current Loop Mode Range:	0-20 mA
Resolution:	8 bits
Radio Communications:.....	FSK, 1200 BPS, proprietary Manchester-Encoded data format
Serial Communications:	RS-485; 1200, 2400, 4800, or 9600 BPS; ModBUS RTU protocol; for programming and external control
Power Requirements:.....	10-16 VDC
	300mA sleep, 100 mA receive
	1.5A low power transmit, 2.5A high power transmit
Housing:.....	Diecast Aluminum, Weather-resistant, (Enclosure S)
Dimensions (L x W x H):.....	4.5" x 3.5" x 2.2" (Enclosure option S)
Weight:.....	1.4 lb. (Enclosure option S)
Operating Temperature:.....	-30 to +60 degrees Centigrade
	-22 to +140 degrees Fahrenheit

6.2 DTX SPECIFICATIONS**TRANSMITTER**

Bandsread:	20 MHz
Freq. Stability:	5 PPM
RF Power Out:	5 W, programmable to 2 W
RF Output Z:	50 Ohms
Mod. Dist.:	less than 4%
Mod. Input Z:	100 K Ohms

RECEIVER

Bandsread:	20 MHz
Freq. Stability:	5 PPM
Sensitivity:	.3 mV
RF Input Z:	50 Ohms
Selectivity:	70 dB @ 30 kHz
	65 dB @ 25 kHz
Audio Dist.:	less than 3%

NOTES

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7.1 The following is the *DATAFLOW RTU* Control Board schematic.



Installation/ Operation

8. CONTROL BOARD LAYOUT

8.1 The following diagram shows the physical layout of the RTU control board

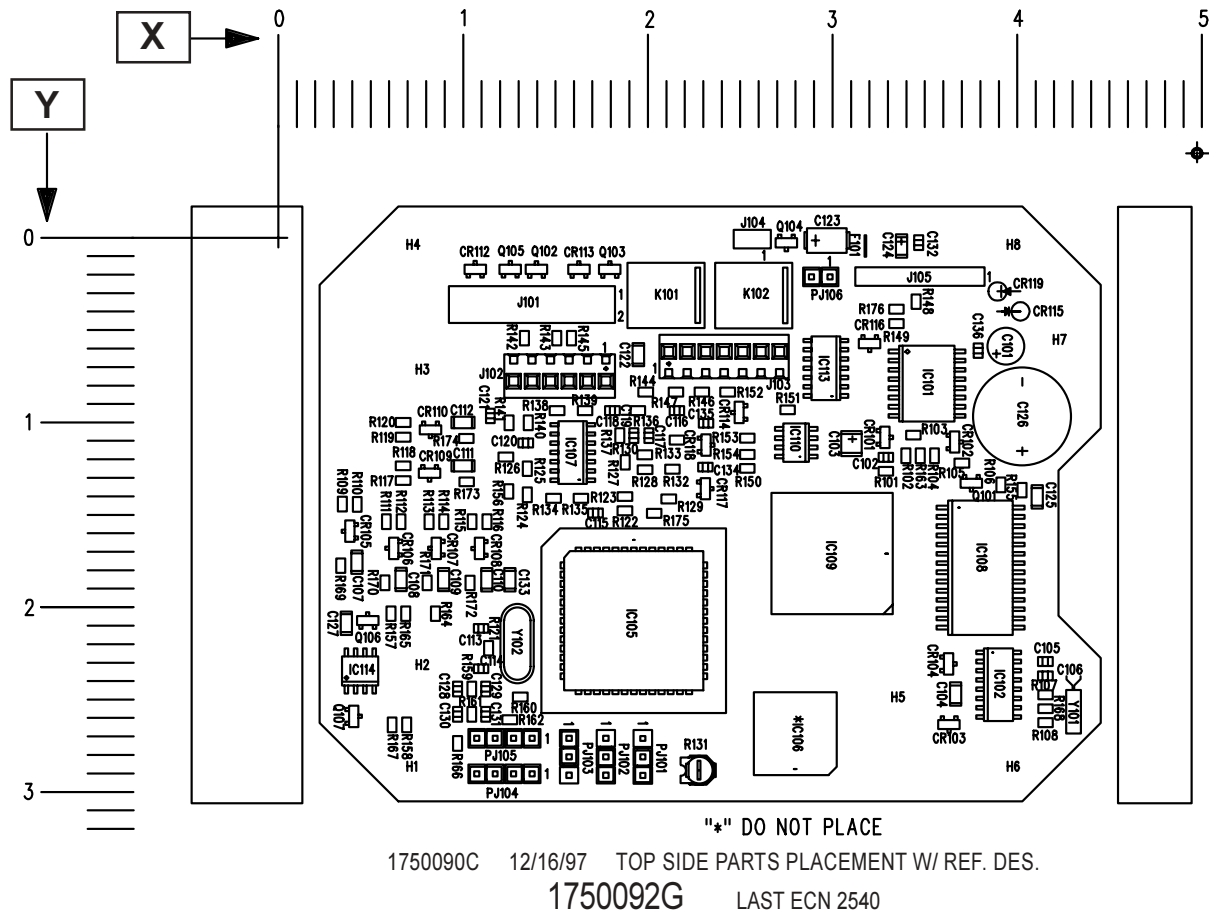


Figure A2 - Control Board top side parts placement with reference deisgnators.

8.2 EXAMPLE: The location of a particular component is given by the following notation - J101 PIN 1 (Y 0.3 - X 1.8). This means the pin 1 of connector J101 is located at a horizontal (X) coordinate of 1.8 inches and a vertical (Y) coordinate of 0.3 inches.

8.3 SCHEMATIC REFERENCE NUMBER PARTS LIST, RTU-CNTL, 03/05/98

REF.	PART NO.	DESCRIPTION	Y	X
CAPACITORS				
C 101	01503021	10uf ELT CAP 50V .1" .2"x.46" r	0.585	3.939
C 102	15111102	.001MF X7R 0805 50V CHIP CAP	1.189	3.291
C 103	152B8106	CAP 10uF 16V 3.4 X 2.8 CHIP TANTALUM	1.113	3.104
C 104	15121104	.1MF X7R 1206 50V CHIP CAP	2.470	3.670
C 105	15110100	10PF NPO 0805 50V CHIP CAP	2.294	4.155
C 106	15110100	10PF NPO 0805 50V CHIP CAP	2.372	4.155
C 107	15121104	.1MF X7R 1206 50V CHIP CAP	1.755	0.428
C 108	15121104	.1MF X7R 1206 50V CHIP CAP	1.849	0.666
C 109	15121104	.1MF X7R 1206 50V CHIP CAP	1.850	0.897
C 110	15121104	.1MF X7R 1206 50V CHIP CAP	1.851	1.130
C 111	15121104	.1MF X7R 1206 50V CHIP CAP	1.234	1.001
C 112	15121104	.1MF X7R 1206 50V CHIP CAP	0.999	1.001
C 113	15110180	18PF NPO 0805 50V CHIP	2.114	1.100
C 114	15110180	18PF NPO 0805 50V CHIP	2.332	1.099
C 115	15111103	.01MF X7R 0805 50V CHIP	1.489	1.719
C 116	15111103	.01MF X7R 0805 50V CHIP	0.935	2.159
C 117	15111103	.01MF X7R 0805 50V CHIP	1.069	2.007
C 118	15111103	.01MF X7R 0805 50V CHIP	0.935	1.810
C 119	15111103	.01MF X7R 0805 50V CHIP	1.069	1.926
C 120	15111103	.01MF X7R 0805 50V CHIP	1.110	1.340
C 121	15111472	.0047MF X7R 0805 50V CHIP	0.964	1.149
C 122	15121104	.1MF X7R 1206 50V CHIP CAP	0.632	1.951

REF.	PART NO.	DESCRIPTION	Y	X
C 123	152C6226	22uf 10V 6.0 X 3.2 CHIP TANTALUM CAP	0.028	2.955
C 124	152AB334	.33MF 35V "3.2X1.6" CHIP TANTALUM	0.044	3.375
C 125	15121104	.1MF X7R 1206 50V CHIP CAP	1.402	4.111
C 126	01517014	CAPACITOR .047F 5.5V TANTALUM	1.065	4.027
C 127	15121104	.1MF X7R 1206 50V CHIP CAP	2.086	0.369
C 128	15111103	.01MF X7R 0805 50V CHIP	2.442	0.971
C 129	15111103	.01MF X7R 0805 50V CHIP	2.441	1.124
C 130	15111103	.01MF X7R 0805 50V CHIP	2.578	0.971
C 131	15111103	.01MF X7R 0805 50V CHIP	2.579	1.124
C 132	15111102	.001MF X7R 0805 50V CHIP CAP	0.026	3.469
C 133	15121104	.1MF X7R 1206 50V CHIP CAP	1.851	1.255
C 134	15111102	.001MF X7R 0805 50V CHIP CAP	1.241	2.313
C 135	15111102	.001MF X7R 0805 50V CHIP CAP	1.004	2.316
C 136	15111102	.001MF X7R 0805 50V CHIP CAP	0.610	3.791
DIODES				
CR101	48A1005C	MMBD7000 DUAL DIODE SOT-23	1.080	3.285
CR102	48A1005C	MMBD7000 DUAL DIODE SOT-23	1.105	3.664
CR103	48A1005C	MMBD7000 DUAL DIODE SOT-23	2.634	3.633
CR104	48A1005C	MMBD7000 DUAL DIODE SOT-23	2.306	3.630
CR105	48A1005C	MMBD7000 DUAL DIODE SOT-23	1.588	0.388
CR106	48A1005C	MMBD7000 DUAL DIODE SOT-23	1.680	0.626
CR107	48A1005C	MMBD7000 DUAL DIODE SOT-23	1.680	0.857
CR108	48A1005C	MMBD7000 DUAL DIODE SOT-23	1.681	1.090
CR109	48A1005C	MMBD7000 DUAL DIODE SOT-23	1.274	0.820
CR110	48A1005C	MMBD7000 DUAL DIODE SOT-23	1.039	0.825
CR112	48A100A3	MMBD2835, DUAL DIODE SOT-23	0.170	1.067
CR113	48A100A3	MMBD2835, DUAL DIODE SOT-23	0.171	1.629
CR114	48A1005C	MMBD7000 DUAL DIODE SOT-23	0.945	2.496
CR115	04810003	1N4001 DIODE 50 VOLT/1AMP	0.398	4.019
CR116	48B10001	DIODE, ZENER, 6.2V 5% 225MW SOT-23	0.572	3.203
CR117	48B1008W	MMBZ 5245 ZENER DIODE SOT23	1.358	2.313
CR118	48B1008W	MMBZ 5245 ZENER DIODE SOT23	1.121	2.316
FUSE				
F 101	06000040	WIRE; #40AWG TINNED BUS (INCHES)	0.044	3.180
INTEGRATED CIRCUITS				
IC101	31040001	IC, SO-16 WIDE VOLT. REG. LT1020	0.789	3.513
IC102	31130002	CD4060 COUNTER, SO-16, CD4060	2.419	3.901
IC105	314B0005	IC, PLCC-52 MICROPROCESSOR, 68HC705B16	2.073	1.926
IC107	31020324	LMT324AD/NJM324E QUAD OP-AMP	1.162	1.595
IC108	312G0001	IC, SO-28 WIDE 32KB STATIC RAM HM52256	1.785	3.803
IC109	311A0001	IC, PLCC-44, PERIPHERAL INTERFACE 82C55A	1.709	3.000
IC110	31110001	RS-485 TRANSCEIVER, SO-8, MAX487	1.109	2.805
IC112	03131056	IC, TO-220 5 PIN VOLT. REG. MIC29302	BOTTOM SIDE	
IC113	31120001	INVERTER, HEX CD4069	0.706	2.966
IC114	31010008	LMT2904D DUAL OP AMP SO-8	2.345	0.444
JACKS				
J 102	21443061	CONNECTOR; 6 POSITION PC VERT. GOLD		
J 103	21443071	CONNECTOR; 6 POSITION PC VERT. GOLD		
RELAYS				
K 101	04500016	RELAY, SPDT 5V LATCHING	0.161	2.201
K 102	04500016	RELAY, SPDT 5V LATCHING	0.162	2.675
JUMPERS				
PJ101	02100024	3 PIN STRAIGHT HEADER	2.810	1.975
PJ102	02100024	3 PIN STRAIGHT HEADER	2.809	1.775
PJ103	02100024	3 PIN STRAIGHT HEADER	2.809	1.575
PJ104	02100098	4 PIN 0.1" HEADER	2.902	1.375
PJ105	02100098	4 PIN 0.1" HEADER	2.709	1.375
PJ106	02100159	2 PIN .1" HEADER STRIP	0.211	2.888
TRANSISTORS				
Q 101	4801001Q	MMBT-5088 "SOT-23"	1.328	3.754
Q 102	4801001Q	MMBT-5088 "SOT-23"	0.171	1.399
Q 103	4801001Q	MMBT-5088 "SOT-23"	0.171	1.796
Q 104	4801001Q	MMBT-5088 "SOT-23"	0.027	2.752
Q 105	4801001Q	MMBT-5088 "SOT-23"	0.170	1.257
Q 106	4801001Q	MMBT-5088 "SOT-23"	2.071	0.485
Q 107	4801001Q	MMBT-5088 "SOT-23"	2.590	0.409
RESISTORS				
R 101	47403163	316K OHM 1% 0805 CHIP	1.264	3.291
R 102	47403012	30.1K OHM 1% 0805 CHIP	1.180	3.399
R 103	47402873	287K OHM 1% 0805 CHIP	1.068	3.439
R 104	47100103	10K OHM 0805 CHIP RES	1.180	3.554
R 105	47100473	47K OHM 0805 CHIP RES.	1.219	3.702

Installation/ Operation

REF.	PART NO.	DESCRIPTION	Y	X
R 106	47100102	1K OHM 0805 CHIP RES	1.337	3.914
R 107	47100106	RESISTOR, 10M OHM 0805 5% CHIP	2.473	4.155
R 108	47100474	470K OHM 0805 CHIP RES.	2.625	4.155
R 109	47100103	10K OHM 0805 CHIP RES	1.442	0.348
R 110	47402002	20K OHM 1% 0805 CHIP	1.443	0.428
R 111	47100103	10K OHM 0805 CHIP RES	1.537	0.586
R 112	47402002	20K OHM 1% 0805 CHIP	1.537	0.666
R 113	47100103	10K OHM 0805 CHIP RES	1.537	0.817
R 114	47402002	20K OHM 1% 0805 CHIP	1.537	0.897
R 115	47100103	10K OHM 0805 CHIP RES	1.537	1.050
R 116	47402002	20K OHM 1% 0805 CHIP	1.537	1.130
R 117	47100103	10K OHM 0805 CHIP RES	1.314	0.676
R 118	47402002	20K OHM 1% 0805 CHIP	1.234	0.676
R 119	47100103	10K OHM 0805 CHIP RES	1.079	0.676
R 120	47402002	20K OHM 1% 0805 CHIP	0.999	0.676
R 121	47100106	RESISTOR, 10M OHM 0805 5% CHIP	2.222	1.139
R 122	47401003	100K OHM 1% 0805 CHIP	1.477	1.877
R 123	47403163	316K OHM 1% 0805 CHIP	1.400	1.877
R 124	47100682	6.8K OHM 0805 CHIP RES.	1.391	1.350
R 125	47401003	100K OHM 1% 0805 CHIP	1.250	1.350
R 126	47100332	3.3K OHM 0805 CHIP RES.	1.187	1.234
R 127	47402802	28K OHM 1% 0805 CHIP	1.215	1.879
R 128	47402002	20K OHM 1% 0805 CHIP	1.255	1.986
R 129	47402002	20K OHM 1% 0805 CHIP	1.413	2.115
R 130	47100393	39K OHM 0805 CHIP RES.	1.175	1.985
R 131	47270103	VARIABLE RESISTOR 10K SEALED	2.882	2.265
R 132	47100102	1K OHM 0805 CHIP RES	1.252	2.134
R 133	47100682	6.8K OHM 0805 CHIP RES.	1.094	2.159
R 134	47100393	39K OHM 0805 CHIP RES.	1.410	1.491
R 135	47100332	3.3K OHM 0805 CHIP RES.	1.410	1.640
R 136	47100682	6.8K OHM 0805 CHIP RES.	0.935	1.947
R 137	47100682	6.8K OHM 0805 CHIP RES.	1.070	1.850
R 138	47100393	39K OHM 0805 CHIP RES.	0.935	1.510
R 139	47403012	30.1K OHM 1% 0805 CHIP	0.935	1.662
R 140	47403012	30.1K OHM 1% 0805 CHIP	1.002	1.354
R 141	47402002	20K OHM 1% 0805 CHIP	1.002	1.250
R 142	47100752	RESISTOR, 7.5K OHM 0805 CHIP	0.543	1.333
R 143	47100243	24K OHM 0805 CHIP RESISTOR	0.543	1.508
R 144	47401003	100K OHM 1% 0805 CHIP	0.835	1.990
R 145	47402002	20K OHM 1% 0805 CHIP	0.543	1.588
R 146	47100103	10K OHM 0805 CHIP RES	0.835	2.294
R 147	47100103	10K OHM 0805 CHIP RES	0.835	2.154
R 148	47402802	28K OHM 1% 0805 CHIP	0.346	3.455
R 149	47404751	4.75K OHM 1% 0805 CHIP	0.463	3.368
R 150	47401003	100K OHM 1% 0805 CHIP	1.248	2.540
R 151	47401003	100K OHM 1% 0805 CHIP	0.931	2.758
R 152	47100103	10K OHM 0805 CHIP RES	0.835	2.433
R 153	47100270	27 OHM 0805 CHIP RESISTOR	1.084	2.540
R 154	47100270	27 OHM 0805 CHIP RESISTOR	1.172	2.540
R 155	47100102	1K OHM 0805 CHIP RES	1.366	4.028
R 156	47100123	12K OHM 0805 CHIP RES.	1.373	1.249
R 157	47404990	RESISTOR, 499 OHM 1% 0805 CHIP	2.035	0.611
R 158	47404990	RESISTOR, 499 OHM 1% 0805 CHIP	2.636	0.695
R 159	47100334	330K OHM 0805 CHIP RES.	2.442	1.048
R 160	47100334	330K OHM 0805 CHIP RES.	2.485	1.310
R 161	47100334	330K OHM 0805 CHIP RES.	2.579	1.048
R 162	47100334	330K OHM 0805 CHIP RES.	2.608	1.253
R 163	47100103	10K OHM 0805 CHIP RES	1.180	3.477
R 164	47100102	1K OHM 0805 CHIP RES	2.035	0.852
R 165	47404990	RESISTOR, 499 OHM 1% 0805 CHIP	2.035	0.689
R 166	47100102	1K OHM 0805 CHIP RES	2.737	0.971
R 167	47404990	RESISTOR, 499 OHM 1% 0805 CHIP	2.636	0.617
R 168	47100106	RESISTOR, 10M OHM 0805 5% CHIP	2.549	4.155
R 169	47100102	1K OHM 0805 CHIP RES	1.775	0.339
R 170	47100102	1K OHM 0805 CHIP RES	1.868	0.578
R 171	47100102	1K OHM 0805 CHIP RES	1.868	0.807
R 172	47100102	1K OHM 0805 CHIP RES	1.869	1.040
R 173	47100102	1K OHM 0805 CHIP RES	1.321	1.020
R 174	47100102	1K OHM 0805 CHIP RES	1.085	1.019
R 175	47100682	6.8K OHM 0805 CHIP RES	1.492	2.036
R 176	47403012	30.1K OHM 1% 0805 CHIP RES		
CRYSTALS				
Y 101	02300041	32.768 KHz CRYSTAL	2.372	4.344
Y 102	02300058	CRYSTAL 4.000MHZ; AT-49	2.195	1.294

9. RF BOARD SCHEMATIC

9.1 Contact Omega for more detailed information on the DTX RF board schematic.

10. RF BOARD LAYOUT

10.1 Contact Omega for more detailed information on the DTX RF board layout.

11. INTERCONNECTS**C A U T I O N**

On DATAFLOW RTU's shipped before the 2nd quarter of 1998, do not exceed 6 volts referenced to GND on RS-485 connections (the GREEN and BLUE wires of the External Power/Serial Cable: OMEGA Part No. 06001123). Exceeding 6 volts will damage protection circuitry and render the unit's serial link inoperable.

11.1 For a weather-resistant aluminum enclosure for **DATAFLOW RTU**, purchase it in a small (S) enclosure option. This option also provides bulkhead circular connectors and one UHF antenna port. See Figure A3 for pin number designations of the circular connectors.

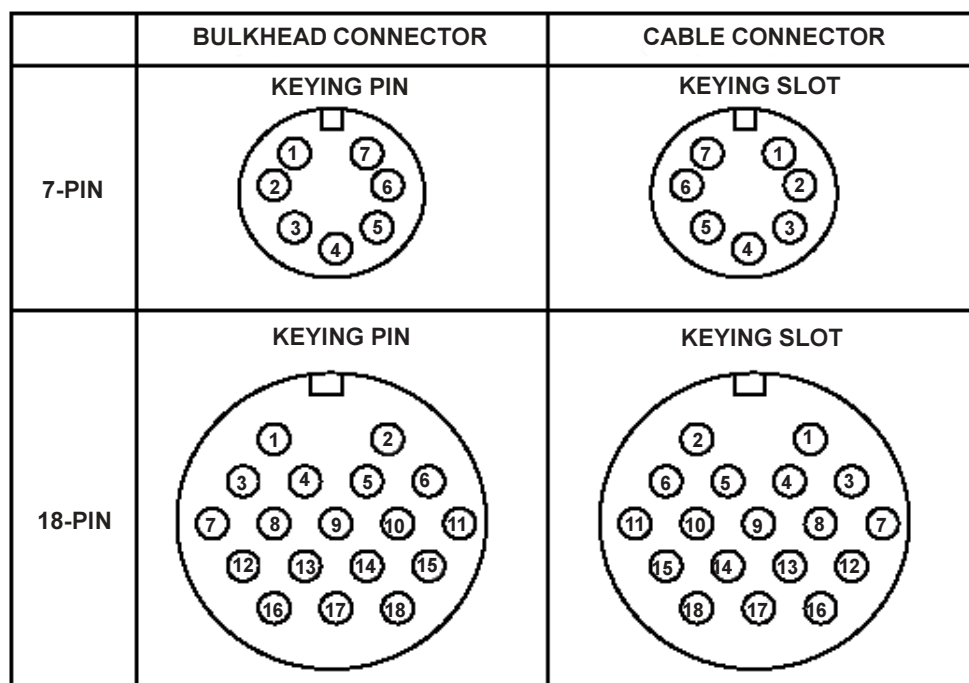


Figure A3 - Circular connector pin designators

11.1.1 BULKHEAD CONNECTORS:

<u>CONNECTOR</u>	<u>PIN</u>	<u>NAME</u>	<u>DESCRIPTION</u>
Ext. Power/ Serial:	1	A	Serial Pair A
	2	B	Serial Pair B
	3	GND	Loader Ground
	4	LDR	Loader Connected/Program Enable
	5	GND	Power Ground
	6	VI	Power In to Controller and Radio
	7	B+	From Internal Battery

Installation/Operation

<u>CONNECTOR</u>	<u>PIN</u>	<u>NAME</u>	<u>DESCRIPTION</u>
User Input/ Output:	1	R11	Relay 1 Contact 1
	2	R12	Relay 1 Contact 2
	3	R21	Relay 2 Contact 1
	4	R22	Relay 2 Contact 2
	5	PWR	Power Out
	6	GND	Power Out Ground
	7	S1	Input 1
	8	GND	Input 1 Ground
	9	S2	Input 2
	10	GND	Input 2 Ground
	11	S3	Input 3
	12	GND	Input 3 Ground
	13	S4	Input 4
	14	GND	Input 4 Ground
	15	S5	Input 5/ Output 1
	16	GND	Input 5/ Output 1 Ground
	17	S6	Input 6/ Output 2
	18	GND	Input 6/ Output 2 Ground

11.1.2 OPTIONAL INTERFACE CABLES, part numbers RTU-06001123 and RTU-06001124, may be purchased for use with the small (S) enclosure. These cables provide the user with 6-foot long, color-coded cables designed specifically for use with **DATAFLOW RTU**.

11.1.3 INTERFACE CABLE CONNECTIONS:

<u>CABLE</u>	<u>PIN</u>	<u>NAME</u>	<u>COLOR CODE</u>	<u>DESCRIPTION</u>
Ext. Pwr./ Serial: Part # 06001123	1	A	GREEN	Serial Pair A
	2	B	BLUE	Serial Pair B
	3	GND	BLACK	Loader Ground
	4	LDR	WHITE	Loader Connected/Program Enable
	5	GND	BROWN	Power Ground
	6	VI	RED	Power In to Controller and Radio
	7	B+	ORANGE	From Internal Battery
User Input/ Output: Part # 06001124	1	R11	WHITE	Relay 1 Contact 1
	2	R12	RED	Relay 1 Contact 2
	3	R21	GREEN	Relay 2 Contact 1
	4	R22	RED	Relay 2 Contact 2
	5	PWR	RED	Power Out
	6	GND	BLACK	Power Out Ground
	7	S1	BROWN	Input 1
	8	GND	BLACK	Input 1 Ground
	9	S2	ORANGE	Input 2
	10	GND	BLACK	Input 2 Ground
	11	S3	YELLOW	Input 3
	12	GND	BLACK	Input 3 Ground
	13	S4	GREEN	Input 4
	14	GND	BLACK	Input 4 Ground
	15	S5	BLUE	Input 5/ Output 1
	16	GND	BLACK	Input 5/ Output 1 Ground
	17	S6	WHITE	Input 6/ Output 2
	18	GND	BLACK	Input 6/ Output 2 Ground

NOTE: The following pin groups are twisted pairs:
1-2, 3-4, 5-6, 7-8, 9-10, 11-12, 13-14, 15-16, 17-18

(A-10(A-3))

11.1.4 CONNECTIONS

<u>CONNECTOR</u>	<u>PIN</u>	<u>NAME</u>	<u>DESCRIPTION</u>
Ext. Power/ Serial: J105 (X3.8 Y0.2)	1	A	Serial Pair A
	2	B	Serial Pair B
	3	GND	Loader Ground
	4	LDR	Loader Connected/ Program Enable
	5	GND	Power Ground
	6	VI	Power In to Controller and Radio
	7	B+	From Internal Battery
User Input/ Output: J101 (X1.8 Y0.3)	1	R11	Relay 1 Contact 1
	2	R21	Relay 2 Contact 1
	3	R12	Relay 1 Contact 2
	4	R22	Relay 2 Contact 2
	5	PWR	Power Out
	6	GND	Power Out Ground
	7	S1	Input 1
	8	GND	Input 1 Ground
	9	S2	Input 2
	10	GND	Input 2 Ground
	11	S3	Input 3
	12	GND	Input 3 Ground
	13	S4	Input 4
	14	GND	Input 4 Ground
	15	S5	Input 5/ Output 1
	16	GND	Input 5/ Output 1 Ground
	17	S6	Input 6/ Output 2
	18	GND	Input 6/ Output 2 Ground

12. HARDWARE CONFIGURATION

12.1 The **DATAFLOW RTU** has six hardware configurable jumpers. Jumper functions are described in the following paragraphs 12.1.1 to 12.1.6. See Figure A2, page A-6, for location references.

12.1.1 **PJ101** (Y 2.8 - X 2.0): This jumper setting determines whether configurable I/O 1 is an input or an analog output. The jumper across pins 1 and 2 configures the pin to be an input. The jumper across pins 2 and 3 configures the pin to be an output, the default setting.

12.1.2 **PJ102** (Y 2.8 - X 1.8): This jumper setting determines if configurable I/O 2 is an input or an analog output. The jumper across pins 1 and 2 configures the pin to be an input. The jumper across pins 2 and 3 configures the pin to be an output, the default setting.

12.1.3 **PJ103** (Y 2.8 - X 1.6): This jumper setting determines how the configurable analog outputs 1 and 2 are powered. The jumper setting is valid only if PJ101 or PJ102 is set for output. The jumper across pins 2 and 3 configures the output to be powered by system power. The jumper across pins 1 and 2 configures the output to be powered by regulated radio power, the default setting.

PJ104 (Y 2.9 - X 1.2): This jumper setting determines if configurable I/O 1 is set for voltage or current loop analog output. This jumper setting is valid only if PJ101 is set for output. With one jumper across pins 1 and 2 and another jumper across pins 3 and 4, the output is configured for voltage, the default setting. Only one jumper across pins 2 and 3 configures the output for current loop.

Installation/Operation

- 12.1.5 **PJ105** (Y 2.7 - X 1.2): This jumper setting determines if configurable I/O 2 is set for voltage or current loop analog output. This jumper setting is valid only if PJ102 is set for output. With one jumper across pins 1 and 2 and another jumper across pins 3 and 4, the output is configured for voltage, the default setting. Only one jumper across pins 2 and 3 configures the output for current loop.
- 12.1.6 **PJ106** (Y 0.2 - X 2.9): This jumper connects the internal battery power to the power input of the control board. This jumper setting is valid only when using the internal battery power. With the jumper installed, the default condition, the internal battery is always connected to control board power, meaning the unit is always ON with the internal batteries installed.
13. **SOFTWARE CONFIGURATION**
- 13.1 All **DATAFLOW RTUs** contain identical hardware; the software configuration of a unit makes it perform a particular task. This programmable configuration can be changed using any PC compatible computer, **DATAFLOW RTU** Programming Software and a **DATAFLOW RTU** Programming Cable.
14. **MOUNTING INFORMATION**
- 14.1 To provide **DATAFLOW RTU** with an aluminum enclosure, it may be purchased with the small enclosure (S). The S enclosure has four pilot holes drilled into the back corners of the case; the holes are tapped with four (4) #6 - 32 x 3/8 thread-forming screws. The **DATAFLOW RTU** is shipped with these screws installed in the case. A T-15 Torx® drive tool is required to remove the screws.
- 14.1.1 You can use the holes in the back of the enclosure to mount the **DATAFLOW RTU** directly to a surface, using the recommended hole pattern shown in Figure A4. The four thread-forming screws can be used to secure the case to the surface, if desired, by removing the screws and reusing them. Alternately, four #6 - 32 machine screws may be used; ensure they do not extend more than 5/16" into the case.

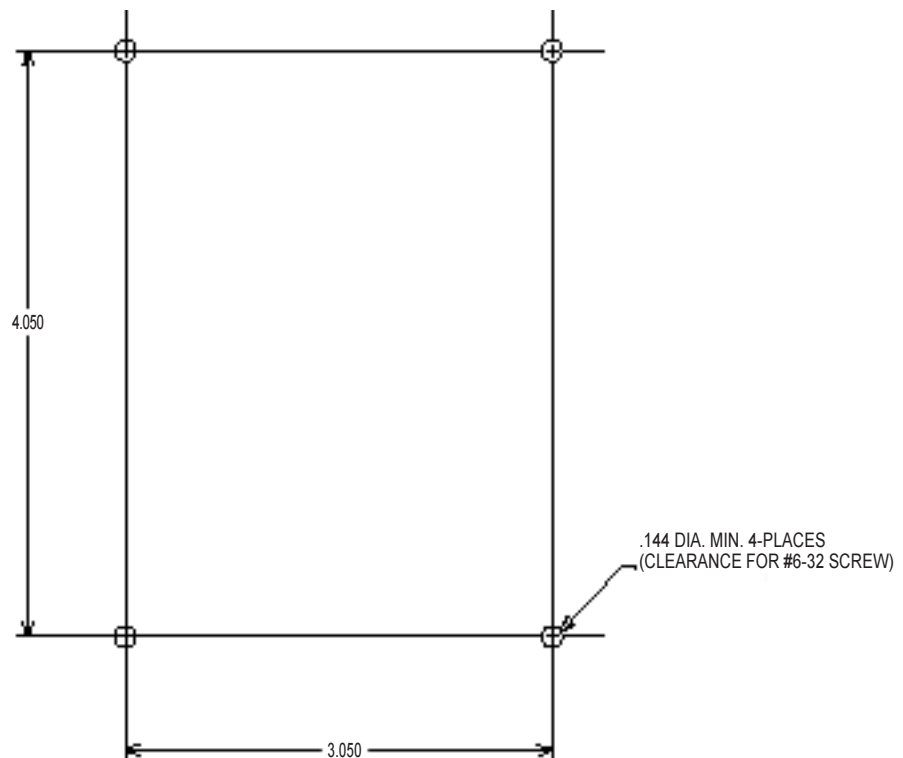


Figure A4 - Mounting hole pattern for fastening directly to the **DATAFLOW RTU** case

- 14.1.2 Optional mounting bracket OMEGA part number RTU-25104600 is available for **DATAFLOW RTU**. To install this bracket to the case, remove and save the four thread-forming screws described in paragraph 14.1 to attach the mounting bracket to the case. Be sure the narrow portion of the keyhole is positioned towards the top (UHF antenna connector) of the **DATAFLOW RTU**. Use the recommended hole pattern for the optional mounting bracket shown in Figure A5.

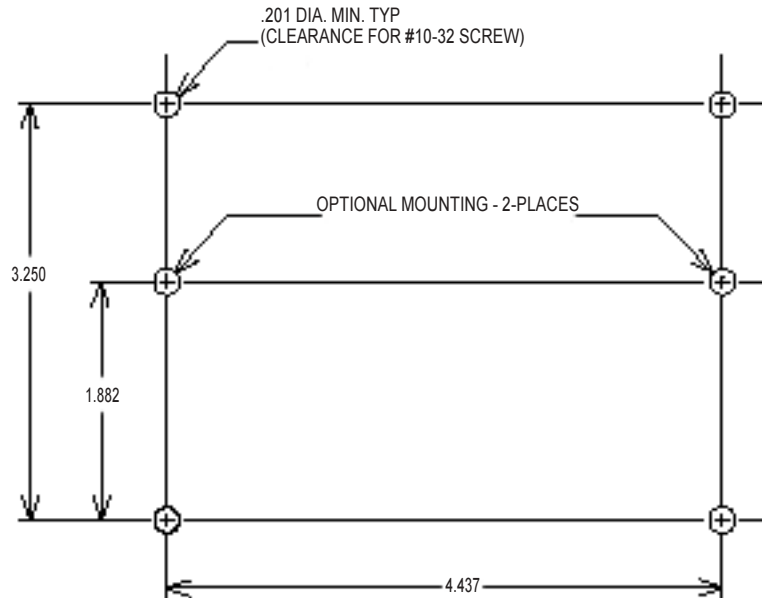


Figure A5 - Mounting hole pattern for use with optional mounting bracket

14.2 Reassembling **DATAFLOW RTU** Cover/ Waterproofing the Antenna Connection

14.2.1 **The DATAFLOW RTU is weather-resistant if it has been properly sealed.** If you have opened or disassembled the device, refer to the following instructions.

14.2.2 Sealing the Housing Cover: Inspect the seal and mating surfaces for flaws (tears, gaps, dents, etc.). Repair the surface or replace the part as necessary. Purchase replacement cover gaskets through Omega: Part No. RTU-25605100.

Insert the seal in the cover. Thread the four (4) screws through the cover, into the housing; **do not tighten the screws**. Snug down the screws in an “X” sequence; i.e.: top left, then bottom right, then top right, then bottom left. Then fully tighten the screws in this same sequence.

14.2.3 Replacing Connectors: OMEGA discourages the practice of removing and discarding the protective cap from the connectors. Doing this may reduce the water-resistance of the unit. If you must remove a connector for any reason, make sure it has been retightened properly — **“finger-tight” connector nuts will not provide an effective water barrier.**

14.2.4 Connecting the Antenna: Seal screws are used to secure the antenna to the housing. **Always replace with a new seal screw, not a common screw.**

Do not remove the antenna connector from the housing; doing so will destroy the silicone rubber seal in the interface. The screw securing the ground strap inside the housing must be fully tight.

14.2.5 **If this device is to be used in a wet environment**, use seal tape around the antenna connection. Use Archer Connector Sealant, Radio Shack Number 278-1645 or an equivalent. Wrap the connection with the sealant tape and press it securely in place.

Installation/Operation

15. POWER

- 15.1 The **DATAFLOW RTU** small enclosure (S) may be purchased with the delete internal power (D) option. The RTU power source is a user-provided external power supply meeting the following criteria:

- Between 10 VDC and 16 VDC with 12 VDC nominal;
- Has less than 1 V peak-to-peak of ripple;
- Provides 1.5 A with the transmitter in low power setting;
- Provides 2.5 A with the transmitter in high power setting.

- 15.1.1 Connect the positive side of the power supply to J105 pin 6. Connect the negative side of the power supply to J105 pin. The negative side of the power supply is considered to be GROUND and is the REFERENCE to which all inputs, outputs and measurements are to be made. GROUND is connected to the enclosure.

- 15.2 You can purchase the **DATAFLOW RTU** with an eight-cell internal battery holder (power option 1). In this option, internal AA batteries are used as the power source.

CAUTION: When installing the batteries, be sure to match polarities of the batteries with the battery holder. Not matching polarities can damage the RTU.

- 15.2.1 The negative side of the battery assembly is considered to be GROUND and is the REFERENCE by which all inputs, outputs, and measurements are to be made. GROUND is connected to the case.
- 15.2.2 The battery voltage appears at pin 8 of J105 pin 8, and is not connected directly to the input power of the RTU control board. With jumper PJ106 installed, the battery is jumpered to the input power. With jumper PJ106 not installed, an external connection is required between pin 6 and 7, which allows the user to install an external ON/OFF switch to the RTU while using internal power.
- 15.3 J101 pin 5 is connected to the RTU power source, and J101 pin 6 is connected to GROUND. This power supply provides excitation voltage to external equipment with maximum current draw of .25 A.
- 15.4 Fuse F101 (X3.2 - Y0.1) is a 40-gauge tinned wire designed to open at 2.5A. If this fuse is destroyed, replace it with nothing larger than 40-gauge wire.
- 15.5 Optional Internal Battery Back-up (Refer to 11.1.3 for the appropriate pin numbers.)
Either of the following two options may be used as an optional internal battery back-up:
- a. A two 4-cell battery pack (OMEGA Part No. RTU-BATNICD), OR
 - b. An 8-cell AA battery holder (OMEGA Part No. RTU-BAT/HOLD).

- 15.5.1 Connect the battery as shown in Figure A6:

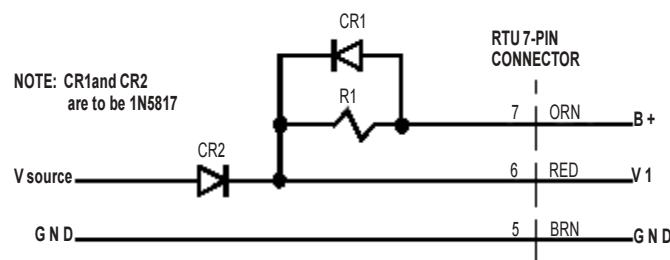


Figure A6 - Battery Connection Wiring Diagram

- 15.5.2 The following equations define the values required for R1.

$$R1 = (V_{source} - V_{diode} - V_{battfull}) / I_{charge}$$

$$PR1 = (V_{source} - V_{diode} - V_{battempty})^2 / R1$$

WHERE: R1 is the value of R1 in Ohms —

V_{source} is the input voltage to the RTU.

V_{diode} is the voltage drop of the diode (CR1).

V_{battfull} is the fully charged voltage of the internal battery.

I_{charge} is the charge current to the battery.

PR1 is the power rating of R1 in Watts.

V_{battempty} is the empty voltage of the internal battery.

(A-14)

15.5.3 The following calculations apply to RTU-BATN1CD, using a 14V source.

$$R1 = (14 - 0.4 - 12) / .05 = 32 \text{ W}$$

$$PR1 = (14 - 0.4 - 8)^2 / R1 = 0.98 \text{ W}$$

15.5.4 For RTU-BATHOLD, use a rechargeable battery type. Confirm the manufacturer's specification for full charge voltage, empty voltage, and "trickle" charge current.

16. SERIAL LINK

16.1 J105 pins 1 and 2 comprises the pair of differential lines used for the RS-485 link. This link provides the user access to change the software configuration, and allows the RTU to be controlled by an external computer via MODBUS RTU Protocol. The baud rate of this link is programmable between 1200, 2400, 4800, and 9600 BPS.

17. I/O MAPPING

17.1 I/O mapping is the connection of one **DATAFLOW RTU** input to (another) **DATAFLOW RTU** input via radio communication. The current mapping scheme allows any input of any **DATAFLOW RTU** to be sent to any output of any other **DATAFLOW RTU**.

17.2 A digital output used as a warning indicator is not available for mapping to an input of another unit. Because of this, a **DATAFLOW RTU** having a digital output used as a warning indicator can have only one digital signal sent to it.

17.3 Using the analog output as a warning indicator is not recommended. If used in this way, it is not available to be mapped to an input of another unit, meaning a **DATAFLOW RTU** having an analog output used in this manner can have only one analog signal sent to it. NOTE: Be sure to not exceed the load drive capability if an analog output is used as a warning indicator.

18. DIGITAL INPUTS

18.1 The (up to) six digital inputs are pins 7, 9, 11, 13, 15 and 17 of J101. (NOTE: Pins 15 and 17 are inputs only if jumpers PJ101 and PJ102 are configured as inputs.)

Inputs are to be considered either HIGH or LOW. The following table defines the characteristics of the input pin. The absolute limits are the safe operating region. Operation outside of this region can damage the device. A HIGH state may be obtained by letting the input pin float, and a LOW state may be obtained by connecting the input pin to GROUND. The threshold level between HIGH and LOW is programmed with **DATAFLOW RTU** Programming Software.

PARAMETER	MINIMUM	MAXIMUM
HIGH	programmable V programmable k Ω	5 V infinite Ω
LOW	0 V 0 Ω	programmable V programmable k Ω
ABSOLUTE LIMITS	-2 V	7 V

You can invert the input state of an RTU unit, which will cause a **DATAFLOW RTU** reading a switch as HIGH to transmit the switch status as LOW to another **DATAFLOW RTU**. Inversion allows a NORMALLY OPEN switch to control a NORMALLY CLOSED relay output without external circuitry.

Installation/Operation

19. DIGITAL OUTPUTS

- 19.1 The two digital outputs are defined to be pins 1-3 and 2-4. These outputs are two dry-contact closure-latching relays. They are controlled by the **DATAFLOW RTU** software, and are either OPEN or CLOSED. The following table defines the characteristics of the relay. The UL/ CSA power rating is the safe operating region. Operation outside of this region can damage the device.

PARAMETER	MINIMUM	MAXIMUM
OPEN	1 M Ω	1 Ω
CLOSED		2A 30VDC
UL/ CSA POWER RATING		.5A 110VDC .5A 125VAC

- 19.1.1 The relays can be programmed to have both initial and fail-safe conditions. The initial condition forces the relays to a desired state at power on of the device. The fail-safe condition forces the relays to a desired state if a RF data link problem is detected. For details on how to set these conditions, see the **DATAFLOW RTU** Software/Programmers Manual.
- 19.2 If a digital output is used for a warning indicator, it is not available to be mapped to the corresponding digital input of the other unit. This means that if a digital output is used for a warning indicator, only one digital signal may be sent to that **DATAFLOW RTU**.
- 19.3 Because the relays are latching relays, they retain the state they are in if power to the **DATAFLOW RTU** is lost; they will not go to OPEN state during power outage.

20. ANALOG INPUTS

- 20.1 The (up to) six analog inputs are defined as pins 7, 8, 11, 13, 15 and 17. (NOTE: Pins 15 and 17 are inputs only if PJ101 and PJ102 are configured as inputs.)

These inputs can be of two types: voltage or current loop. These inputs are used to digitize the analog signal and transmit it to another **DATAFLOW RTU**.

20.1.1 If the signal to be read is a voltage source, the input pin is ready as is. The following table defines the characteristics of the input pin working as voltage input. Absolute limits define the safe operating region; operating outside this region can damage the device.

PARAMETER	MINIMUM	MAXIMUM
INPUT RANGE	0 V	5 V
SOURCE IMPEDANCE		1000 Ω
ABSOLUTE LIMITS	-2 V	7 V

- 20.1.2 If the signal to be transmitted is a 0 - 20mA current source, the input pin must have a 250W resistor placed between the pin and GROUND. The following table defines the characteristics of the input pin working as a current input. Absolute limits define the safe operating region. Operating outside this region can damage the device.

See Figure A7, below, for an example of connecting a current loop sensor to the **DATAFLOW RTU**.

PARAMETER	MINIMUM	MAXIMUM
INPUT RANGE	0 mA	20 mA
SOURCE IMPEDANCE	(Ev-5) / .02 Ω	
ABSOLUTE LIMITS	-8 mA	28 mA

NOTE: "Ev" is excitation voltage

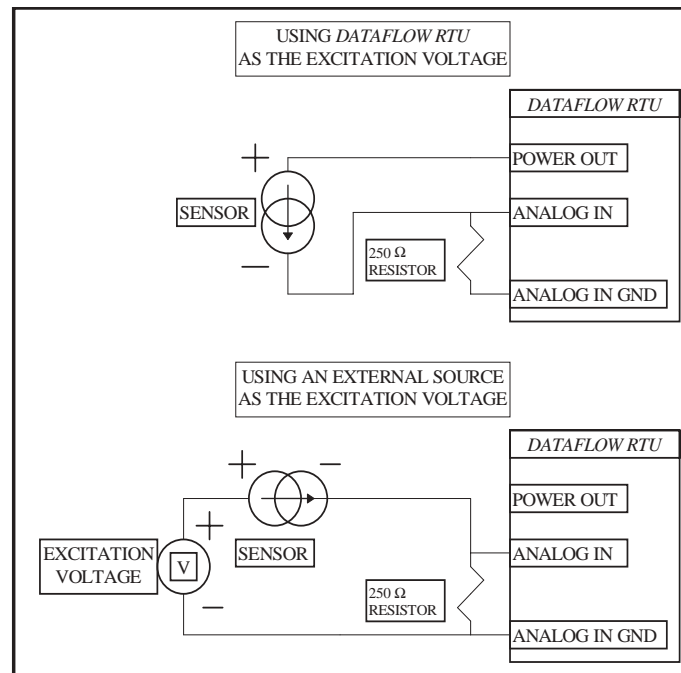


Figure A7 - Connecting a Current loop sensor to a *DATAFLOW RTU* analog input.

- 20.2 All analog inputs are non-isolated. All analog measurements are referenced to GROUND. Take care when connecting the *DATAFLOW RTU* to external sensors.
- 20.3 The user can invert the input state of a *DATAFLOW RTU* if desired, which will cause a *DATAFLOW RTU* that reads an analog signal as full scale to transmit the signal status as zero scale to another *DATAFLOW RTU*. This inversion allows a positive transfer function signal to control a negative transfer function signal without external circuitry.
- 20.4 Sensor excitation voltage may be supplied by the *DATAFLOW RTU*, using the J101 Power Out pin. For this configuration, make sure to not exceed the maximum current drive of the pin, and ascertain your sensor will operate on a supply voltage of $V_{supply}-5\text{Volts}$.
21. ANALOG OUTPUTS
- 21.1 The two analog outputs are defined to be pins 15 and 17. (NOTE: Pins 15 and 17 are outputs only if PJ101 and PJ102 are configured as outputs.)
- These outputs are two low power outputs hardware configured as either a voltage source or a current sink. All analog outputs are referenced to GROUND.
- 21.1.1 If the output pin is desired to be a voltage source, correctly set the hardware configuration. The pin is to be hardware-configured as an output and as a voltage source. The following table defines the characteristics of the output pin set as a voltage source. Attempting to drive a load less than the minimum will cause incorrect output and can possibly damage the device.

PARAMETER	MINIMUM	MAXIMUM
OUTPUT RANGE	0 V	5 V
LOAD RESISTANCE	1000 Ω	

Installation/Operation

- 21.1.2 If the output pin is to be a current sink, correctly set the hardware configuration. The pin is to be hardware configured as an output and as a current source. The following table defines the characteristics of the output pins set as a current sink. Attempting to drive a load less than the minimum will cause incorrect output and possibly can damage the device.

See Figure A8, below, for an example of how to connect a current loop meter to the **DATAFLOW RTU**.

PARAMETER	MINIMUM	MAXIMUM
OUTPUT RANGE	0 mA	20 mA
LOAD RESISTANCE	$(E_v - 5.5) / .02 \Omega$	

NOTE: "Ev" is excitation voltage

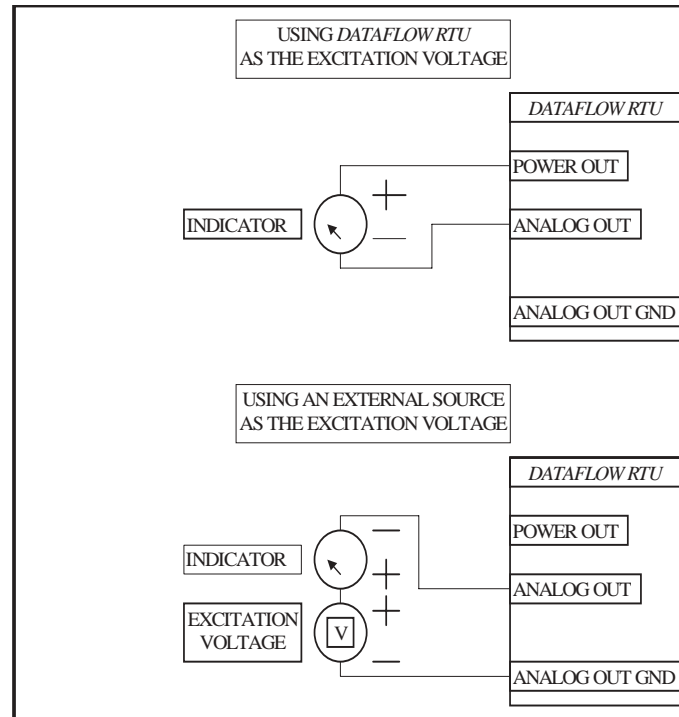


Figure A8. - Connecting a Current loop indicator to a DATAFLOW RTU analog output

- 21.2 The analog outputs can be programmed to have both initial and fail-safe conditions. The initial condition forces the output to a desired state at power ON of the device. The fail-safe condition forces the output to a desired state if an RF data link problem is detected. Refer to **DATAFLOW RTU Software/Programmers Manual** for details on setting these conditions.
- 21.3 Meter excitation voltage may be provided by the **DATAFLOW RTU** using the Power Out pin of connector J101. If the Power Out pin is used as the excitation supply make sure that the maximum current drive of the pin is not exceeded and that your indicator will operate on a supply voltage of $V_{supply} - 5.5\text{Volts}$.
- 21.4 It is not recommended to use the analog output as a warning indicator. If used, it is not available to be mapped to the corresponding analog input of the other unit; meaning that a **DATAFLOW RTU** having an analog output used in this manner can have only one analog signal sent to it. NOTE: Be sure to not exceed the load drive capability if an analog output is used for a warning indicator.

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1. INTRODUCTION

- 1.1 The **DATAFLOW RTU** from OMEGA is a complete wireless telemetry system designed to deliver industrial instrumentation signals from a source to other instruments via radio frequency communications. The **DATAFLOW RTU** allows you to access industrial measuring devices in remote locations without running wires, installing microwave links or leasing a telephone line. OMEGA **DATAFLOW RTU** and MODBUS radio communications equipment replaces these methods.
- 1.2 Manual Part B is intended to provide information needed for the programming and MODBUS™ control of OMEGA **DATAFLOW® RTU** systems. The intended readers are people familiar with industrial instrumentation. A basic understanding of radio communications is helpful. The included information is valid only for models listed on the cover.

2. OPERATION

- 2.1 **DATAFLOW RTU** is a radio telemetry system that operates on either UHF-FM (450-470 MHz with transmitter power of 2 Watts or 5 Watts); or VHF-FM (150 - 165 MHz, 136 - 151 MHz, 160 - 174 MHz with transmitter power of 5 Watts). An RTU system operating in the UHF-FM band at 2 Watts with directional antennas and 50-foot towers has an effective range of 20 to 25 miles over level terrain. Changes in the frequency of operation, transmitter power, terrain and antenna structure will affect the range of the link.
- 2.2 All **DATAFLOW RTU** systems require FCC licensing.

3. MICROPROCESSOR UPDATES

- 3.1 A microprocessor, the main controlling device of a **DATAFLOW RTU**, is located in a socket on the Control Board. Socket configuration provides ease in replacing or updating microprocessor firmware.
- 3.2 The microprocessor firmware version available when this manual was printed is Version 3.27. (In Version 3.x, "x" represents the [number] designation of a minor revision.) OMEGA User's Guide for **DATAFLOW RTU** is written for all 3.2 minor designation number **DATAFLOW RTU** microprocessors.
- 3.3 Custom software is also available. Call OMEGA for help in determining if custom software is cost-effective for you.

4. PROGRAMMING KIT

- 4.1 A programming kit for user configuration, OMEGA part number RTU-PCPK, is available on separate purchase. It is for connecting and providing power to the **DATAFLOW RTU**, and for connecting a MODBUS PC controller to the **DATAFLOW RTU**.
- 4.2 The programming kit RTU-PCPK, consists of:
- (1) AC Power Supply, OMEGA part number RTU-PS
 - (1) Computer Cable, OMEGA part number RTU-9/RTC-PAS
 - (1) **DATAFLOW RTU** Cable, OMEGA part number RTU-PCPC
 - (1) RTU Programming Software Disk, OMEGA part number RTU-PCPS-3.05

NOTE: You can download the RTU-PCPS-3.05 software from the OMEGA website at
<www.dasieee.com/>

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- 4.2.1 The AC Power Supply, OMEGA part number RTU-PS, converts 110 Volts AC to a DC voltage for use by the **DATAFLOW RTU**. The power supply provides power to the RTU when RTU programming software is being used, and also provides power to the RTU, if it is to be connected to a MODBUS PC controller.

CAUTION:

Plug the power supply only into a 110 VAC outlet. AC Power Supply, OMEGA part number RTU-PS **is intended** only for indoor use at normal room temperatures. It is **not intended** to provide protection from water or any other contaminants; it is **not intended** to function over the full temperature range of the **DATAFLOW RTU**. **To correctly use the power supply**, plug the two-pronged end into a 110 VAC 50-60 Hz wall outlet. Plug the 2.1 mm power jack into the 2.1 mm power receptacle of the RTU-PCPC cable.

NOTE: The AC Power Supply furnished with the programming kit is not guaranteed to provide adequate current to the RTU in HIGH (5W) power mode. When the transceiver is operating in the HIGH power mode, DC power supply of 12 Volts and 2.5 Amps minimum is required. For external power supply connection, mate the coaxial power connector of the RTU-PCPC cable to a coaxial power connector, Radio Shack part number 274-1569 or equivalent, having an outer diameter of 5.5 mm and an inner diameter of 2.1 mm.

- 4.2.2 The Computer Cable, OMEGA part number RTU- 9/RTC-PAS, connects the 25-pin PC compatible COM port to the RTU-PCPC cable. Plug the 25-pin connector into the computer port and the modular telephone jack into the RTU-PCPC.

CAUTION:

Computer Cable, OMEGA part number RTU-9/RTC-PAS **is intended** to operate at normal room temperatures; it is **not intended** to function over the full temperature range of the **DATAFLOW RTU**.

NOTE: If the COM port has a 9-pin connector, a 9-pin to 25-pin serial port adapter is required. The adapter is not included with the programming kit.

- 4.2.3 **DATAFLOW RTU** Cable, OMEGA part number RTU-PCPC is used to connect the RTU to the power supply and the computer cable. Plug the 7-pin circular connector of the RTU-PCPC into the 7-pin connector of the RTU.

CAUTION:

DATAFLOW RTU Cable, OMEGA part number RTU-PCPC **is intended** to operate at normal room temperatures, it is **not intended** to function over the full temperature range of the **DATAFLOW RTU**.

- 4.2.4 RTU Programming Software Disk, OMEGA part number RTU-PCPS-3.0, provided with the programming kit to facilitate configuration of a **DATAFLOW RTU** is version 3.0. To install it on the computer hard drive, insert the 3.5" diskette into the floppy drive, select that drive and type INSTALL.EXE. Follow the instructions on the computer monitor screen to load the software onto the hard drive. **DATAFLOW RTU** programming software is not copy-protected; it may be copied, or loaded onto more than one computer.
5. **DATAFLOW RTU PROGRAMMING SOFTWARE**
 - 5.1 The **DATAFLOW RTU** programming software is a DOS-based executable program. System requirement is a PC-compatible computer with a serial port. The availability of a mouse and a printer is helpful, but not required.
 - 5.2 Menus and function keys are used for program navigation. Execute menu choices by pressing the key of the corresponding menu choice number or by clicking the mouse on the menu choice. Function key commands are executed when they are displayed by pressing the corresponding function key or by clicking the mouse on the command.
 - 5.3 The user interfaces the programming software by modifying highlighted fields of the monitor screen display. Position the cursor in the chosen highlighted field, then type in the desired text. The cursor can be moved using the mouse, or shifted to the next field by pressing the <TAB> key. Press <SHIFT> <TAB> to shift the cursor to the previous field. The <ENTER> key, the arrow keys and page control keys can also be used to move the cursor.

Press the <F1> FIELD HELP key at any time. A Help dialog box will appear on the monitor screen with a brief explanation of the selected field.
 - 5.4 The <F3> and <F4> function keys are used in several fields of the programming software. The <F3> UPLOAD key transfers configuration data from the **DATAFLOW RTU** to the computer. The <F4> DOWNLOAD key transfers configuration data from the computer to the **DATAFLOW RTU**. UPLOADED and DOWNLOADED data is transferred over the serial link.
 - 5.4.1 The <F3> UPLOAD key executes the upload function by causing the computer to read the RTU configuration from the **DATAFLOW RTU**. When the configuration is successfully read, all programming field values are updated to the current RTU configuration.

NOTE: If an upload is unsuccessfully attempted, none of the field values will update. The computer indicates an unsuccessful upload by displaying a message in the lower right corner of the monitor screen and by sounding a two-tone beep.
 - 5.4.2 The <F4> DOWNLOAD key executes the download function by causing the computer to write all current field values to the **DATAFLOW RTU** by sending 16 sequential messages.

NOTE: If one or more of these messages is unsuccessfully sent, the RTU configuration may be corrupted. The computer indicates an unsuccessful download by displaying a message in the lower right corner of the monitor screen and by sounding a two-tone beep.

When these signals of an unsuccessful download are given, attempt the download operation again. When the download is successful, the current field values are successfully written so the RTU's configurations are the same as the computer field values.

- 5.5 The <F5>, <F6> and <F9> function keys are used in several fields of the programming software to perform file functions. The <F5> READ DISK key transfers file data from the computer hard disk to the computer screen field values. The <F6> WRITE DISK key transfers file data from the computer-screen field values to the computer hard disk. The <F9> DIR key displays all files of the proper type that are on the computer hard disk.

CAUTION:

To prevent loss of configuration data, save all RTU configuration files to the hard disk.

NOTE: Selecting a file with the <F9> DIR key DOES NOT LOAD the file. Use the <F5> READ FILE key after the <F9> DIR key to load the selected file.

- 5.6 If a printer is connected to the computer system, press the <PRINT SCREEN> key at any time during the operation of the programming software to generate a hard copy of the current configuration data.
- 5.7 A Help file is available for several areas of the programming software. The user can display, read and close the Help text file while running and programming the software. A copy of the Help text is included in this manual on pages B-5 to B-10.

NOTE: In the event of a difference between the included text of this file and the actual file in the software, the computer file supersedes.

- 5.8 Software Utilities Menu: refer to UTILITIES, Item 3, for system diagnostics and remote monitoring, which is also covered on pages B-9 - B-10 of this manual.

>>> RTU PROGRAMMER VERSION 3.03 960724 HELP FILE <<<

1.0 RTU System Configuration Screen:

The system configuration screen provides an area for the user to configure system parameters, send list, repeat list, and fail-safe states. It allows access to RTU configuration and disk files. It also provides access to the input/output configuration and the SCADA configuration.

1.1 System Parameters:

The frequency must be the same for all RTU's in a system. The frequency must be a multiple of the channel spacing. The standard channel spacing for UHF channels (RTU-450's) is 12.5kHz. VHF radios (RTU-150's) may operate at either 5 kHz or 12.5 kHz channel spacing. UHF RTU's can be programmed to operate on either high or low power. High power is approximately 5 Watts. Low power is approximately 2 Watts. VHF RTU's can only operate on high power.

The ID must be unique for each RTU in the system. Other MODBUS devices in the system must each also have a unique ID. All RTU's which communicate together must have the same group number. For version 3.27 firmware, the group is limited to 1. Multiple groups will be supported in a later version of the firmware.

Each RTU can send periodic status messages that are not triggered by a change on the inputs. The time between these periodic check-ins is variable from 1 second to 48 days. A check-in time of zero indicates that the periodic check-in is not used, and messages will be sent on input change only. The check-in interval must be larger than the number of message attempts times the transmit time (about 180 ms) plus the listen time. If an acknowledge is not received, the sending RTU tries to send the message again until the number of message attempts has been exhausted. If, at the end of these attempts, an acknowledge has not been received, the unit will set its fail-safe condition.

Some of the variables particular to the radio operation of the RTU are displayed on the System configuration screen. These values include the carrier detect level, back-off time, cold start time, and attack time. These values are preset and should not be altered without consultation with the factory.

The serial port baud rate is selectable between 1200, 2400, 4800, and 9600. Version 3.0 software locks the baud rate at 9600 baud. The radio communicates at a constant 1200 baud. This RF data rate is not selectable.

The RTU can be programmed to operate in sleep mode. In this mode, the RTU acts as an input device only. The RTU's radio receiver is turned off during normal operation. The RTU transmits only on status change or at a set check-in interval. After message transmission, the RTU turns on the receiver and waits for an acknowledge. It then turns off the receiver and goes back to sleep. The maximum time that the sleeping unit's receiver stays on is equal to the awake time.

>>> RTU PROGRAMMER VERSION 3.03 HELP FILE <<<(continued)

Enabling RF spy mode on one RTU allows that RTU to report all incoming RF messages over the serial link. These messages can be displayed using the RF Spy screen available from the Utilities menu. While the RF Spy feature is enabled, the unit will only operate in RF Spy mode and will not respond to the RF messages.

1.2 Send List:

The send list indicates up to four other RTU's to which this RTU can send its status. All inputs will be sent to each of the units on the list. Enter an ID of 0 (zero) for any unused entries. If any of these listed units fail to acknowledge the message, the fail-safe state indicated by the letter next to that unit's ID will be set. The lettered fail-safe states are listed in the lower right corner of the system configuration screen.

1.3 Repeat List:

When this unit receives a message from another unit, it can use the message AND send it along to other RTU's. This information is configured in the repeat list. Each incoming message can be repeated to up to four RTU's. The first column indicates the unit that originates the message and the next four columns show the ID's of the units which will receive the message.

1.4 Fail-Safe States:

If a unit fails to receive an acknowledge a fail-safe condition can be set. Each of the four outputs can be set to a distinct fail-safe condition. The analogs can be set to any value from 0% to 100%. A "no change" option is also available. For the analog outputs, the "no change" is indicated by a 999%. Any number over 101% will be interpreted as a "no change". The programmer will automatically replace this number with "999%" when it downloads the information to the RTU. For the digital outputs, the choices are: open on fail, close on fail, or no change on fail. The R column indicates whether the output should revert to its initial condition when the signal is re-acquired. The choices for the field are yes or no.

Example 1: Revert to initial condition is selected for a digital output.
 The initial condition for this output is relay open.
 The fail-safe condition for this output is relay closed.
 This output is not actively controlled by any other RTU.
 The relay will be open when the system is started.
 The relay will close when the RF link is lost.
 The relay will open when the RF link is regained.

Example 2: Revert to initial condition is NOT selected for digital output.
 The initial condition for this output is relay open.
 The fail-safe condition for this output is relay closed.
 This output is not actively controlled by any other RTU.
 The relay will be open when the system is started.
 The relay will close when the RF link is lost.
 The relay will remain closed after the RF link is regained.

>>> RTU PROGRAMMER VERSION 3.03 HELP FILE <<<(continued)

1.5 Message Line

The third line from the bottom of the RTU system configuration screen is the message line. This line displays important information about the status of uploads, downloads, disk reads, and disk writes.

1.6 Function Keys

The last two lines of the RTU system configuration screen form the function key menu. To perform one of the listed tasks either press the related function key or click the command with your mouse. Field help will display a short help message for the field where the cursor is. Full help will display this text file.

Upload will read the contents of the RTU currently connected to the serial programming cable and display the configuration on the screen. Download will cause the currently displayed configuration to be written to the RTU. Read disk will get the configuration stored in the file named in the file name field at the top of the screen and display this configuration on the screen. Write disk will save the currently displayed configuration to the file named at the top of the screen.

Selecting I/O CONFIG will display the RTU input/output configuration screen. SCADA CONFIG will display the RTU SCADA configuration screen. Press F9 to display a list of .USR files which you can select. F10 will return the program to the main screen.

2.0 RTU Input/Output Configuration Screen:

The input/output screen allows the user to edit the configuration of the RTU connected to the serial programming cable. Inputs will be sent to any RTU on send list. Outputs are controlled by the RTU listed under each output number. You must also be certain that the unit which has the input controlling this output has its inputs and send list properly configured.

2.1 Inputs:

There are six EXTERNAL analog inputs to the RTU. Although these inputs are all analog, they can be treated as digital by the microprocessor. The battery voltage is a seventh INTERNAL input to the RTU.

An eight character long name may be used to identify each of the inputs (i.e.: TANK1LVL, PUMP2PWR). These tag names will be stored in the configuration files when they are saved to disk, but they will not be stored in the RTU due to EEPROM space limitations.

All inputs to the RTU are read by the microprocessor as analogs. The microprocessor converts the input to a value between 0 and 255 (8-bit resolution). Inputs can be treated as digital inputs by taking their analog value and comparing it to a digital threshold or set point to determine whether it is a high or low. Digital inputs cause a message to be created only when they cross the set point in either direction. Analog inputs cause a message to be created whenever they change from the previously reported value by a certain amount. This amount is called the dead zone.

>>> RTU PROGRAMMER VERSION 3.03 HELP FILE <<<(continued)

If this input is selected as a Digital input, the value in this field will be a threshold. Any value above this threshold will be a 1 and any value below this threshold will be a zero. A message is created only when the input crosses from one side of the threshold to the other. If the input type is analog, the value in this field is a dead zone. The dead zone is minimum change necessary to initiate a message.

Digital and analog inputs can be inverted. Inverting a digital value will cause a closed contact to be transmitted as closed contact and vice versa. Inverting an analog input will cause a full scale reading to be transmitted as a zero. A zero reading will translate to a full scale output at the receiver.

All input values are sent when a message is created. You can select which inputs will trigger a message. If "no" is selected, changes on this input will not cause a message to be sent. The status of this input will only be sent if an active input changes or it is time for the unit to check-in. If "yes" is selected, changes on this input will cause a message to be sent.

The time delay is the length of time a signal must change before it is processed as a valid change. A momentary change with a duration less than the time delay will be ignored.

2.2 Outputs:

The RTU has two digital outputs and two analog outputs. These two analog outputs share their external connection with two of the inputs. They are hardware selectable between inputs and analog outputs.

An eight character long name may be used to identify each of the outputs(i.e.: TANK1LVL, PUMP2PWR). These tag names will be stored in the configuration files when they are saved to disk, but will not be stored in the RTU due to EEPROM space limitations.

A used output is controlled by another RTU's input. When this RTU receives a message from the other RTU, it sets its corresponding output to the same value. The from ID is the ID number of the RTU which has the input controlling this output. The from location is the input number of the input which controls this output. This input number corresponds to the input number in the top half of the screen for the RTU listed in the from ID field.

Example 3: RTU #1 has 1 digital input and 1 analog input which must be transmitted to RTU #2. The digital input must be inverted. The threshold between a high and a low value is half scale. The digital input is a noisy signal and we do not want a momentary glitch to trigger a false alarm. However, we want any state which persists for more than 5 seconds to be treated as a true signal. The analog input is a 0 (zero) V to 5 V input. We do not want to receive a status report unless the input changes by more than 0.5 V. Typical entries on the input configuration of RTU # 1 would be:

>>> RTU PROGRAMMER VERSION 3.03 HELP FILE <<<(continued)

Input	# 1	# 2	# 3	# 4	# 5	# 6	BATTERY
Tag Name							
Initiate Xmit	YES	YES	NO	NO	NO	NO	NO
Type	D	A	D	D	D	D	A
Invert	YES	NO	NO	NO	NO	NO	NO
Threshold /	50 %	10 %	50 %	50 %	50 %	50 %	1.00 V
Dead Zone							
Time Delay	5.00 S	0.25 S	0.25 S	0.25 S	0.25 S	0.25 S	0.25 S

D=Digital, A=Analog

The corresponding entries for the output configuration of RTU # 2 would be:

Output	Digital 1	Digital 2	Analog 1	Analog 2
Tag Name				
Used	YES	NO	YES	NO
Init Condition	OPN	CLO	0 %	0 %
From ID	1	0	1	0
From Location	INPUT 1	INPUT 1	INPUT 2	INPUT 1
Rcv Check-In	0: 0: 0: 0	0: 0: 0: 0	0: 0: 0: 0	0: 0: 0: 0
Fail-Safe State	E	F	G	H

When the RTU is turned on, the outputs will be set to the initial conditions. These values will remain on the outputs until an incoming message changes the outputs or until a fail-safe condition is set. Both used and unused outputs can have an initial condition and a fail-safe state.

This RTU can be programmed to expect a check-in from other units. If this check-in message is jammed or the other RTU fails to respond, this RTU can set a fail-safe condition. The value in this field is the amount of time this RTU must go without receiving a message from the other RTU before it can set its fail-safe state. Each From ID can have only one receive check-in time. Place this check-in time in the first column which contains the appropriate From ID.

The letter in the fail-safe state field indicates which fail-safe state will be used upon loss of signal from the unit listed in From ID. The fail-safe states are listed in the lower right corner of the system configuration screen.

2.3 Function Keys

The bottom two rows of the RTU input/output configuration screen form the function key menu. Select an input field and press F1 to display help for the selected field. Press F2 to display this full help document. Press F10 to return to the RTU system configuration screen.

3.0 RTU SCADA Configuration Screen

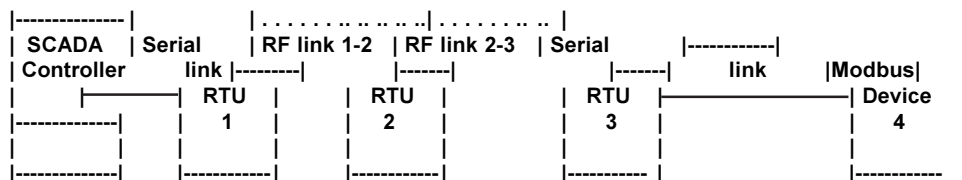
The SCADA configuration screen lists four SCADA points which can be stored in the RTU EEPROM. The function key menu provides access to the full SCADA configuration. SCADA configuration allows the user to connect one RTU to a supervisory control and data acquisition program and poll remote RTU's over RF. The SCADA program must use the MODBUS protocol. The SCADA configuration must reside in the one RTU connected directly to the SCADA program. That RTU uses the routing information in the SCADA configuration to send an RF message to the addressed RTU.

>>> RTU PROGRAMMER VERSION 3.03 HELP FILE <<<(continued)

3.1 EEPROM SCADA Points

Four SCADA points can be stored in EEPROM. If power to the RTU is temporarily lost and then returns, the EEPROM points will not be lost. The repeater columns list, in order, the repeaters between this RTU and the End RTU. The To ID is the RTU or other MODBUS device which the SCADA program will request information from. If the To ID is an RTU, the To ID and End RTU will be identical. If the To ID is another MODBUS device, the End RTU must be directly connected to the MODBUS device by a serial link.

Example 4:



The SCADA controller is directly connected to RTU 1 by a serial link. The SCADA controller polls RTU 1, RTU 2, RTU 3, and MODBUS Device 4. The EEPROM configuration for RTU 1 should be:

	Repeaters				End RTU	TO
	1	2	3	4	ID	ID
EEPROM Point # 1	0	0	0	0	2	2
EEPROM Point # 2	2	0	0	0	3	3
EEPROM Point # 3	2	0	0	0	3	4
EEPROM Point # 4	0	0	0	0	0	0

In the previous example, there are no repeaters between RTU 1 and RTU 2. If the SCADA controller polls RTU 2, the last RTU in the path is RTU 2. If the SCADA controller polls RTU 3, then RTU 2 acts as a repeater. The last RTU is RTU 3. Entry number 3 is the same as entry number 2 except that the final address is MODBUS device 4. RTU 3 is the end RTU. It transmits the message to the MODBUS device serially.

6. MODBUS MEMORY MAP

6.1 The **DATAFLOW RTU** supports three types of MODBUS messages; it will recognize:

- READ OUTPUT REGISTER function code 03
- PRESET SINGLE REGISTER function code 06
- PRESET MULTIPLE REGISTER function code 10 (hexadecimal).

All other messages will be ignored.

6.2 The **DATAFLOW RTU** operates in the MODBUS RTU mode with 8 data bits, 1 stop bit and no parity bit.

6.3 The **DATAFLOW RTU** accesses MODBUS information by two different methods:

- Direct data access, which involves direct polling of the RTU's registers. When this method is used, RTUs not directly connected to the MODBUS controller are polled via the RF link. NOTE: Direct data access can result in unacceptably high levels of RF traffic.
- Stored data method, in which copies of the current state of each RTU in the system is stored in the memory of the RTU connected to the MODBUS controller. Having current data stored eliminates the need to poll RF.

NOTE: For a more detailed explanation of these two methods, refer to Examples 6 and 7 in the following section of this manual.

6.3.1 Following is a MODBUS memory map of the **DATAFLOW RTU** for direct data access.

<u>RTU REGISTER</u>	<u>RTU ADDRESS (HEX)</u>	<u>DATA RANGE</u>
INPUT 1	0050	00H to FFH
INPUT 2	0051	00H to FFH
INPUT 3	0052	00H to FFH
INPUT 4	0053	00H to FFH
INPUT 5	0054	00H to FFH
INPUT 6	0055	00H to FFH
INPUT VOLTAGE	0056	00H to FFH
RSSI	0057	07H to 50H
ANALOG OUTPUT 2	009C	00H to FFH
ANALOG OUTPUT 1	009D	00H to FFH
DIGITAL OUTPUTS	009E	00H to 03H
DIGITAL 1 OUTPUT OPEN		000000X0 B
DIGITAL 1 OUTPUT CLOSED		000000X1 B
DIGITAL 2 OUTPUT OPEN		0000000X B
DIGITAL 2 OUTPUT CLOSED		0000001X B
XMIT CONTROL	00C5	
XMIT OFF		01 to FF H
XMIT ON		00 H
XMIT TEST	00C2	00H to 0FH
IP CHECKSUM	005F	
SELFTEST REGISTER	00C8	
CLOCK TEST FAIL		1XXXXXXXX B
CLOCK TEST PASS		0XXXXXXXX B
RAM TEST FAIL		X1XXXXXXXX B
RAM TEST PASS		X0XXXXXXXX B

Software/Programming

6.3.2 DECIMAL MODBUS MEMORY MAP AND TABLES

6.3.2.1 Decimal MODBUS memory map for stored data access:

RTU ID	InputVoltage	Input 6	Input 5	Input 4	Input 3	Input 2	Input 1	Message Counter
0	4104	4105	4106	4107	4108	4109	4110	4111
1	4168	4169	4170	4171	4172	4173	4174	4175
2	4232	4233	4234	4235	4236	4237	4238	4239
3	4296	4297	4298	4299	4300	4301	4302	4303
.
.
.
253	20296	20297	20298	20299	20300	20301	20302	20303
254	20360	20361	20362	20363	20364	20365	20366	20367
255	20424	20425	20426	20427	20428	20429	20430	20431

6.3.2.2 Decimal equation table for calculating addresses:

Input Voltage Address	=	RTU ID × 64 + 4104	Input 3 Address	=	RTU ID × 64 + 4108
Input 6 Address	=	RTU ID × 64 + 4105	Input 2 Address	=	RTU ID × 64 + 4109
Input 5 Address	=	RTU ID × 64 + 4106	Input 1 Address	=	RTU ID × 64 + 4110
Input 4 Address	=	RTU ID × 64 + 4107	Message Counter Address	=	RTU ID × 64 + 4111

6.3.2.3 Equation table to convert decimal register values to voltage and current values:

Register	Voltage Conversion (Volts)	Current Conversion (mAmps)
Input 1 to	(DATA ÷ 255) × 5	(DATA ÷ 255) × 20
Input Voltage (i.e.: Battery)	(DATA ÷ 255) × 5 × (416 ÷ 100)	N/A
Analog Output 1 and 2	(DATA ÷ 255) × 5	(DATA ÷ 255) × 20

6.3.3 HEXADECIMAL MODBUS MEMORY MAP AND TABLES

6.3.3.1 Hexadecimal MODBUS memory map for stored data access:

RTU ID	InputVoltage	Input 6	Input 5	Input 4	Input 3	Input 2	Input 1	Message Counter
00	1008	1009	100A	100B	100C	100D	100E	100F
01	1048	1049	104A	104B	104C	104D	104E	104F
02	1088	1089	108A	108B	108C	108D	108E	108F
03	10C8	10C9	10CA	10CB	10CC	10CD	10CE	10CF
.
.
.
FD	4F48	4F49	4F4A	4F4B	4F4C	4F4D	4F4E	4F4F
FE	4F88	4F89	4F8A	4F8B	4F8C	4F8D	4F8E	4F8F
FF	4FC8	4FC9	4FCA	4FCB	4FCC	4FCD	4FCE	4FCF

6.3.3.2 Hexadecimal equation table for calculating addresses:

Input Voltage Address	=	RTU ID × 40 + 1008	Input 3 Address	=	RTU ID × 40 + 100C
Input 6 Address	=	RTU ID × 40 + 1009	Input 2 Address	=	RTU ID × 40 + 100D
Input 5 Address	=	RTU ID × 40 + 100A	Input 1 Address	=	RTU ID × 40 + 100E
Input 4 Address	=	RTU ID × 40 + 100B	Message Counter Address	=	RTU ID × 40 + 100F

6.3.3.3 Equation table to convert hexadecimal register values to voltage and current values:

Register	Voltage Conversion (Volts)	Current Conversion (mAmps)
Input 1 to 6	(DATA H ÷ FF H) × 5	(DATA H ÷ FF H) × 20
Input Voltage (i.e.: Battery)	(DATA H ÷ FF H) × 5 × 416 ÷ 100	N/A
Analog Output 1 and 2	(DATA H ÷ FF H) × 5	(DATA H ÷ FF H) × 20

- 6.4 Load the FULL SCADA CONFIG, using RTU Programming Software. The configuration is stored in RTU RAM, which has a large capacitor to hold the information in memory for an extended period of time — 3 months or longer. If the stored configuration is lost, reload it with the RTU Programming Software.
- 6.4.1 If the application requires a MODBUS controller to download the FULL SCADA CONFIG, consult OMEGA for the proper procedure. This procedure varies depending on the type of MODBUS controller you are using.

CAUTION:

For Firmware Versions earlier than 3.25 (released in the 2nd quarter of 1998), in a SCADA system, use unit ID's or MODBUS addresses from 40 to 255 only. Communication errors may result from using ID's and addresses from 1 to 39.

7. TECHNICAL NOTES

- 7.1 CLEARING SERIAL RESPONSE DELAY for Firmware Version 3.27 or later: this note explains how to set the **DATAFLOW RTU** serial response delay to 0 (zero). **DATAFLOW RTU** configuration can be changed either before or after programming the serial delay. (Any other aspect of Configuration, except Serial Response Delay, is accessed from the Configuration Screen.)
- 7.1.1 From the Main Screen, press "3" to select Utilities.
- 7.1.2 From the Utilities Menu, press "1" to select EEPROM Block Edit.
- 7.1.3 Press "3" to Upload.
- 7.1.4 Type the hexadecimal value "00" (zero, zero) into Location 01A6. See Figure B1, below.
- 7.1.5 Press "F4" to download the data to the **DATAFLOW RTU**.
- 7.1.6 Press F10" to Exit the EEPROM block edit screen.
- 7.1.7 Press "R" to return to the Main Screen.

***** RTU EEPROM CONFIGURATION SCREEN *****								
Device ID: 01			File Name: DEFAULT.cnf					
Address	-0-1	-2-3	-4-5	-6-7	-8-9	-A-B	-C-D	-E-F
\$0100	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
\$0110	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX

\$0120	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
\$0130	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
\$0140	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
\$0150	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
\$0160	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
\$0170	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
\$0180	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
\$0190	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
\$01A0	XXXX	XXXX	XXXX	00XX	XXXX	XXXX	XXXX	XXXX
\$01B0	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
\$01C0	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
\$01D0	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
\$01E0	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
\$01F0	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX

"00" programmed into Location 01A6

Figure B1 - Configuration Screen

Software/Programming

- 7.2 COPYING CONFIGURATION between **DATAFLOW RTU** Units: This note explains how to preserve programmed default settings.
- TO COPY CONFIGURATION FROM AN OLDER-FIRMWARE **DATAFLOW RTU** TO A NEWER-FIRMWARE **DATAFLOW RTU**, while preserving the default settings of additional programmable features:
- 7.2.1 Connect older-firmware unit to the serial cable and power supply.
 - 7.2.2 From the Programmer Main Screen, press "2" to select **DATAFLOW RTU** configuration.
 - 7.2.3 Press "F3" to Upload.
 - 7.2.4 Enter a filename in the "File Name" field.
 - 7.2.5 Press "F6" to write this configuration to the (named) file.
 - 7.2.6 Disconnect the older-firmware unit from the serial cable and power supply.
 - 7.2.7 Connect the newer-firmware unit to the serial cable and power supply
 - 7.2.8 Press "F3" to Upload from the new unit.
 - 7.2.9 Enter the filename from Step 4 in the "File Name" field.
 - 7.2.10 Press "F5" to Read the (named) file.
 - 7.2.11 Press "F4" to download the configuration to the newer-firmware unit.
 - 7.2.12 Press "F10" to Return to the Programmer Main Screen.
- 7.3 TO COPY ALL INFORMATION from source-configuration **DATAFLOW RTU** to same-version target **DATAFLOW RTU**:
- 7.3.1 Connect older-firmware unit to the serial cable and power supply.
 - 7.3.2 From the Programmer Main Screen, press "2" to select **DATAFLOW RTU** configuration.
 - 7.3.3 Press "F3" to Upload.
 - 7.3.4 Disconnect the source-configuration unit from the serial cable and power supply.
 - 7.3.5 Connect the (same-version) target unit to the serial cable and power supply.
 - 7.3.6 Press "F4" to download the configuration to the target unit.
 - 7.3.7 Press "F10" to Return to the Programmer Main Screen.
8. APPLICATION EXAMPLES
- 8.1 The following examples provide demonstrations of OMEGA **DATAFLOW RTU** operation. All examples are included and can be loaded as Software Programming configuration files on the accompanying programming disk.
- 8.1.1 These are not "stand alone" examples. Examine and understand each example in sequence before proceeding to the next. These illustrations and demonstrations have been designed to run in a laboratory environment using dummy loads for antennas.
 - 8.1.2 The frequency programmed into the configuration files is 460 MHz. If your RTU system does not operate in this band, change the configuration file frequency to reflect a value you can use.
 - 8.1.3 UPLOAD or DOWNLOAD commands that change RTU configuration also disable the transmitter. Cycle the RTU by turning it OFF then ON to re-enable the transmitter and re-establish normal RTU operation.

EXAMPLE 1

- 8.2 **EXAMPLE 1** is a pair of **DATAFLOW RTU**s having two digital channels and two analog channels in each direction; each RTU is configured for a maximum of five (5) message attempts. If an RTU detects loss of RF link, both relay outputs close, and both analog outputs are driven to full scale. The inputs and outputs are mapped to each other as shown in the following table:

RTU ID 1	RF LINK	RTU ID 2
Input 1	connected to	Digital Output 1
Input 2	"	Digital Output 2
Input 3	"	Analog Output 1
Input 4	"	Analog Output 2
Digital Output 1	"	Input 1
Digital Output 2	"	Input 2
Analog Output 1	"	Input 3
Analog Output 2	"	Input 4

- 8.2.1 RTU ID 1 SETUP: Example 1 requires one **DATAFLOW RTU** to be wired and its hardware configured according to Figure B2 - EXAMPLE 1 RTU ID 1 Wiring Diagram, shown on page B-26. Load Software Programming configuration file **EXP1ID1.USR** into RTU ID 1.
- 8.2.2 RTU ID 2 SETUP: Example 1 requires the other **DATAFLOW RTU** to be wired and its hardware configured according to Figure B3 - EXAMPLE 1 RTU ID 2 Wiring Diagram, shown on page B-27. Load Software Programming configuration file **EXP1ID2.USR** into RTU ID 2.
- 8.2.3 EXPLANATION: Example 1 illustrates basic RTU operation. Examine the configuration files of the RTU's to understand the following items before advancing to Example 2:
- (RTU) ID
 - SEND LIST
 - FAIL-SAFE STATE
 - I/O CONFIG

- 8.2.3.1 (RTU) ID is a unique address given to each RTU in a system. Example 1 uses ID numbers 1 and 2. The ID number is compared to the ID number of every incoming message. When the ID number on an incoming message matches the (unit) ID number, the RTU processes the message and sends an acknowledgment. The RTU ignores the message if the ID number does not match.

NOTE: Use any unique number(s) from 1 to 255 to assign ID numbers.

- 8.2.3.2 SEND LIST is the list of ID's used by the RTU when transmitting messages. Each outgoing message has "to ID n" attached to it. In Example 1, RTU ID 1 has "to ID 2" in its SEND LIST and RTU ID 2 has "to ID 1" in its SEND LIST. Hence, RTU ID 1 transmits messages intended only for RTU ID 2, and RTU ID 2 transmits messages intended only for RTU ID 1. Because each RTU in Example 1 sends information to only one ID, other SEND LIST values are set for 0.

NOTE: The maximum number of ID entries in the SEND LIST is four.

(Example 1 continued on next page)

EXAMPLE 1 (continued)

8.2.3.3 The FAIL-SAFE STATE table controls RTU outputs when the RTU detects a loss of RF link. Because Example 1 has only one entry in the SEND LIST of each RTU, only FAIL-SAFE STATE A is used. If RTU ID 1 detects loss of RF link, RTU ID 1 outputs are controlled according to its FAIL-SAFE STATE A; if RTU ID 2 detects loss of RF link, RTU ID 2 outputs are controlled according to its FAIL-SAFE STATE A.

8.2.3.3.1 The loss of RF link is detected by a RTU according to the following process: After a RTU transmits a message, it waits for acknowledge.

- If acknowledge is received, the RF link is good and the process ends.
- If acknowledge is not received, the RTU retransmits the message, repeating the sequence until reaching the maximum number of retransmit attempts. The process ends with the RTU detecting loss of RF if the last (maximum number) retransmit is made with no acknowledge being received.

8.2.3.4 I/O CONFIG is Input/ Output control of the RTU displayed in the Programming Software I/O configuration screen. Examine the following items for Example 1:

8.2.3.4.1 Inputs 1 and 2 are configured to be inverted digital inputs.

NOTES: Set digital inputs INVERT to YES to make an open digital input produce an open relay output and a closed digital input produce a closed relay output.

Set the INVERT for analog inputs 3 and 4 to NO to produce a positive transfer function on an output.

8.2.3.4.2 All four outputs are used. The initial condition — the state an output is forced to upon power-on — is set for relays to be open and analog outputs to be forced to 0 scale.

8.2.3.4.3 FROM ID is the transmitting RTU ID number; FROM ID numbers are listed in the following chart:

	FROM ID (RTU ID #)
RTU ID 1	2
RTU ID 2	1

8.2.3.4.4 FROM LOC is the number of the input that controls the output; FROM LOC numbers are listed in the following chart:

	FROM LOC (INPUT #)
Digital Output 1	1
Digital Output 2	2
Analog Output 1	3
Analog Output 2	4

EXAMPLE 2

- 8.3 **EXAMPLE 2** configures three **DATAFLOW RTU's** with one connected to two others. RTU ID 1 has two digital inputs, two digital outputs and two analog outputs. RTU ID 2 and RTU ID 3 each have one digital input, one digital output and one analog input. The inputs and outputs are mapped to each other as shown in the following tables:

RTU ID 1	RF LINK 1	RTU ID 2
Input 1	connected to	Digital Output 1
Input 2		
Input 3		
Input 4		
Digital Output 1	connected to	Input 1
Digital Output 2		
Analog Output 1	connected to	Input 2
Analog Output 2		
RTU ID 1	RF LINK 2	RTU ID 3
Input 1	connected to	Digital Output 1
Input 2		
Input 3		
Input 4		
Digital Output 1	connected to	Input 1
Digital Output 2		
Analog Output 1	connected to	Input 2
Analog Output 2		

- 8.3.1 RTU ID 1 SETUP: Example 2 requires one **DATAFLOW RTU** to be wired and its hardware configured according to Figure B4 - EXAMPLE 2 RTU ID 1 Wiring Diagram, shown on page B-28. Load Software Programming configuration file **EXP2ID1.USR** into RTU ID 1.
- 8.3.2 RTU ID 2 SETUP: Example 2 requires one **DATAFLOW RTU** to be wired and its hardware configured according to Figure B5 - EXAMPLE 2 RTU ID 2 Wiring Diagram, shown on page B-29. Load Software Programming configuration file **EXP2ID2.USR** into RTU ID 2.
- 8.3.3 RTU ID 3 SETUP: Example 2 requires one **DATAFLOW RTU** to be wired and its hardware configured according to Figure B6 - EXAMPLE 2 RTU ID 3 Wiring Diagram, shown on page B-30. Load Software Programming configuration file **EXP2ID3.USR** into RTU ID 3.
- 8.3.4 EXPLANATION: Example 2 illustrates point-to-multipoint RTU operation. Examine the configuration files of these three RTU's. Be certain to understand the following items before advancing to Example 3:
- SEND LIST
 - FAIL-SAFE STATE
 - I/O CONFIG

The following text provides detailed descriptions of the above items.

- 8.3.4.1 SEND LIST is the list of ID's used by the RTU when transmitting messages. Each outgoing message has "to ID n" attached to it. In Example 2, RTU ID 1 has "to ID 2" and "to ID 3" in its SEND LIST. RTU ID 1 transmit messages first to RTU ID 2. When an acknowledge is received from RTU ID 2 or when the maximum number of attempts is reached, the message is then transmitted to RTU ID 3.

(Example 2 continued on next page)

EXAMPLE 2 (continued)

- 8.3.4.2 The FAIL-SAFE STATE table controls the RTU outputs when the RTU detects a loss of RF link. Because Example 2 has two entries in the SEND LIST, both FAIL-SAFE states A & B are used. If RTU ID 1 detects a loss of RF link from RTU ID 2, outputs are controlled according to FAIL-SAFE STATE A. If RTU ID 1 detects a loss of RF link from RTU ID 3, outputs are controlled according to FAIL-SAFE STATE B.
- 8.3.4.3 I/O CONFIG is Input/ Output control of the RTU displayed in the Programming Software I/O configuration screen.
- 8.3.4.3.1 In Example 2, RTU ID 1, Input 1 and Input 2; RTU ID 2, Input 1 and RTU ID3, Input 1 are configured to be inverted digital inputs.
- 8.3.4.3.2 In Example 2, all four outputs of RTU ID 1 are used, RTU ID 2, Digital Output 1 is used, and RTU ID 3, Digital Output 1 is used. The initial condition — the state an output is forced to upon power-on — is set for all relays to be open and all analog outputs to be forced to 0 scale.
- 8.3.4.3.3 In Example 2, FROM ID is the ID number of the transmitting RTU; FROM ID numbers are listed in the following 2 charts:

RTU ID 1	FROM ID (Transmitting RTU ID)
Digital Output 1	2
Analog Output 1	2
Digital Output 2	3
Analog Output 2	3
RTU ID 2 & RTU ID 3	FROM ID (Transmitting RTU ID)
Digital Output 1	1

- 8.3.4.3.4 FROM LOC is the number of the input controlling the output; FROM LOC numbers are listed in the following chart:

RTU ID 1	FROM LOC (Controlling Input)
Digital Output 1	1
Digital Output 2	1
Analog Output 1	2
Analog Output 2	2

EXAMPLE 3

- 8.4 **EXAMPLE 3** configures **DATAFLOW RTU** inputs to illustrate THRESHOLD, DEAD ZONE and TIME DELAY. The configuration includes Digital Input 1 having a 25% Threshold and Digital Input 2 having a 75% Threshold and a 5-second Time Delay; Analog Input 3 having a 10% Dead Zone and Analog Input 2 having a 20% Dead Zone. The configuration of Example 3 is similar to that of Example 1.
- 8.4.1 RTU ID 1 SETUP: Example 3 requires one **DATAFLOW RTU** to be wired and its hardware configured according to Figure B2 - EXAMPLE 1 RTU ID 1 Wiring Diagram, shown on page B-26. Load Software Programming configuration file **EXP3ID1.USR** into RTU ID 1. Replace the switches connected to Input 1 and Input 2 with a 100 kOhm potentiometer. Connect a multimeter to measure voltage across the potentiometer.
- 8.4.2 RTU ID 2 SETUP: Example 3 requires the other **DATAFLOW RTU** to be wired and its hardware configured according to Figure B3 - EXAMPLE 1 RTU ID 2 Wiring Diagram, shown on page B-27. Load Software Programming configuration file **EXP1ID2.USR** into RTU ID 2.
- 8.4.3 EXPLANATION: THRESHOLD/ DEAD ZONE is a value that differs depending on the type of Input.
- For a DIGITAL Input, the value is THRESHOLD, the border between a digital HIGH and LOW. Any value above the border as decoded by the RTU is a HIGH; any value below the border as decoded by the RTU is a LOW.
 - For an ANALOG Input, the value is DEAD ZONE, the amount of change the Input must incur to transmit a message.
- 8.4.3.1 The THRESHOLD of RTU ID 1, Input 1 is programmed to be 25%, the value relating to 1.25 Volts on the multimeter. RTU ID 2, Digital Output 1 opens with a multimeter reading above 1.25 Volts; RTU ID 2, Digital Output 1 closes with a multimeter reading below 1.25 Volts. NOTE: Because of the internal 20 kOhm resistor, the highest voltage possible across the 100 kOhm potentiometer on Input 1 is 4.2 Volts.
- 8.4.3.2 The THRESHOLD of RTU ID 1, Input 2 is programmed to be 75%, the value relating to 3.75 Volts on the multimeter. RTU ID 2, Digital Output 2 OPENS when the multimeter reading is above 3.75 Volts; RTU ID 2, Digital Output 2 CLOSES when the multimeter reading is below 3.75 Volts. NOTE: See Paragraph 7.4.4 for details of the TIME DELAY programmed into Input 2.
- 8.4.3.3 The DEAD ZONE of RTU ID 1, Input 3 is programmed to be 10 %. Cycle the power of the RTU (turn the RTU power OFF, then ON) to ensure the current source for Input 3 is 10 mA. Change the value of the current source to Input 3. RTU ID 2, Analog Output 1 should not change until RTU ID 1, Input 3 changes to over 11 mA or under 9 mA.
- 8.4.3.4 The DEAD ZONE of RTU ID 1, Input 4 is programmed to be 20 %. Cycle the power of the RTU to ensure the voltage value for Input 3 is 2 Volts. Change the value of the voltage source to Input 3. RTU ID 2, Analog Output 2 should not change until RTU ID 1, Input 4 changes to over 2.4 Volts or under 1.6 Volts.
- 8.4.4 EXPLANATION: TIME DELAY is the amount of time an input must remain changed before the RTU will consider the change valid — Digital Input 2 must remain changed for at least 5 seconds. If the current state of this input is LOW, changing the state to HIGH for less than 5 seconds then returning the state to LOW will not cause the RTU to transmit a message. TIME DELAY is used to ignore false activation and “glitches” on an input.

EXAMPLE 4

8.5 **EXAMPLE 4** configures two RTU's to illustrate XMIT CHECK-IN and RCV CHECK-IN intervals, and R (Revert) FAIL-SAFE STATE of the **DATAFLOW RTU**. RTU ID 1 sends one contact closure to RTU ID 2. All Digital Outputs are OPEN at power-on.

- When RTU ID 1 detects a loss of RF link, both Digital Outputs close. When the RF link is re-established, Digital Output 1 opens and Digital Output 2 remains closed.
- When RTU ID 2 detects a loss of RF link, Digital Output 1 will open and Digital Output 2 will close. When the RF link is re-established, Digital Output 1 produces the proper status from RTU ID 1 and Digital Output 2 opens.
- The RF link is tested at least every 10 seconds.

NOTE: Example 4 uses a XMIT CHECK-IN interval of 10 seconds, purposely a short interval for demonstration purposes. In real applications, use longer check-in intervals to help maintain the life span of the RTU — the longer the check-in interval, the fewer transmissions the RTU makes.

8.5.1 RTU ID 1 SETUP: Example 4 requires one **DATAFLOW RTU** to be wired and its hardware configured according to Figure B7 - EXAMPLE 4 RTU ID 1 Wiring Diagram shown on page B-31. Load Software Programming configuration file **EXP4ID1.USR** into RTU ID 1.

8.5.2 RTU ID 2 SETUP: Example 4 requires the other **DATAFLOW RTU** to be wired and its hardware configured according to Figure B8 - EXAMPLE 4 RTU ID 2 Wiring Diagram shown on page B-32. Load Software Programming configuration file **EXP4ID2.USR** into RTU ID 2.

8.5.3 EXPLANATION:

- RTU ID 1 XMIT CHECK-IN is set to 10 seconds.
- RTU ID 2 RCV CHECK-IN is set to 12 seconds.

NOTE: The difference in the XMIT CHECK-IN and RCV CHECK-IN times allows for tolerance differences in the two RTU's.

8.5.3.1 RTU ID 1 sends a message (XMIT CHECK-IN) every 10 seconds whether or not a change occurs on the input. If a valid response is not received within 12 seconds, FAIL-SAFE STATE A is executed. This ensures that 10 seconds is the longest period of time RTU ID 2 can be inactive before RTU ID 1 determines the RF link has failed.

8.5.3.2 RTU ID 2 requires a valid message (RCV CHECK-IN) from RTU ID 1 every 12 seconds or less. If a valid message is not received within 12 seconds, FAIL-SAFE STATE E is executed. This ensures that 12 seconds is the longest period of time RTU ID 1 can be inactive before RTU ID 2 determines the RF link has failed.

8.5.3.3 The R (Revert) columns of the FAIL-SAFE STATE table determines the state of an output when RF link is re-established.

- With R (Revert) setting "Y", the output is forced to its initial condition. With R (Revert) setting "N", the output remains in its current state.
- If the output is controlled by another RTU, the controlling input state determines the state of the output; R (Revert) setting is not valid.

EXAMPLE 5

- 8.6 **EXAMPLE 5** illustrates a **DATAFLOW RTU** system with one RTU configured as a repeater. Connect the RTU's according to the following 2 tables:

RTU END 1	RF LINK 1	RTU END 2
Input 1 Input 2 Input 3 Input 4 Digital Output 1 Digital Output 2 Analog Output 1 Analog Output 2	connected to	Digital Output 1
	connected to	Input 1
RTU END 1	RF LINK 2	RTU END 3
Input 1 Input 2 Input 3 Input 4 Digital Output 1 Digital Output 2 Analog Output 1 Analog Output 2	connected to	Digital Output 1
	connected to	Input 1

NOTE: In Example 5:

- RTU ID 1 has line of sight with RTU ID 2, and RTU ID 2 has line of sight with RTU ID 3.
- RTU ID 1 DOES NOT HAVE line of sight with RTU ID 3.
- RTU ID 2 is configured as a repeater between RTU ID 1 and RTU ID 3.

- 8.6.1 RTU ID 1 SETUP: Example 5 requires one **DATAFLOW RTU** to be wired and its hardware configured according to Figure B9 - EXAMPLE 5 ID 1 Wiring Diagram on page B-33. Load Software Programming configuration file **EXP5ID1.USR** into RTU ID 1.
- 8.6.2 RTU ID 2 SETUP: Example 5 requires one **DATAFLOW RTU** to be wired and its hardware configured according to Figure B10 - EXAMPLE 5 ID 2 Wiring Diagram on page B-34. Load Software Programming configuration file **EXP5ID2.USR** into RTU ID 2.
- 8.6.3 RTU ID 3 SETUP: Example 5 requires one **DATAFLOW RTU** to be wired and its hardware configured according to Figure B11 - EXAMPLE 5 ID 3 Wiring Diagram on page B-35. Load Software Programming configuration file **EXP5ID3.USR** into RTU ID 3.
- 8.6.4 EXPLANATION: Using an RTU as a digital repeater can increase **DATAFLOW RTU** range. This RTU performs both repeating and normal Input/ Output functions.

Examine the configurations of the three RTU's. Notice the fail-safe performance of each unit.

- RTU ID 1 — send list contains only ID 2.
- RTU ID 2 — first line of the REPEAT LIST contains FROM ID 1 and TO ID 3; second line of the REPEAT LIST contains FROM ID 3 and TO ID 1.
- RTU ID 3 — send list contains only ID 2.

NOTE: You must extend the listen time of ID1 and ID3 to .8 seconds to allow for the repeat function.

EXAMPLE 6

- 8.7 **EXAMPLE 6** demonstrates the **DATAFLOW RTU** as a MODBUS device using direct data access. The configuration consists of a remote RTU with another RTU connected to a MODBUS controller, utilizing RTU Programming Software as the MODBUS controller. Each RTU has five digital inputs and one analog input.

NOTE: In real applications the MODBUS controller is a PLC or a SCADA program operating with a MODBUS driver.

- 8.7.1 RTU ID 1 SETUP: Example 6 requires one **DATAFLOW RTU** to be wired and its hardware configured according to Figure B12 - EXAMPLE 6 ID 1 Wiring Diagram on page B-36. Load Software Programming configuration file **EXP6ID1.USR** into RTU ID 1.

When configuration of RTU ID 1 is completed, turn the RTU power OFF then back ON to ensure the RTU microprocessor addressing data is updated. Refer to the NOTE with 8.7.4 for further details.

- 8.7.2 RTU ID 2 SETUP: Example 6 requires the other **DATAFLOW RTU** to be wired and its hardware configured according to Figure B13 - EXAMPLE 6 ID 2 Wiring Diagram on page B-37. Load Software Programming configuration file **EXP6ID2.USR** into RTU ID 2.

- 8.7.3 EXPLANATION: Although the RTU can operate in two different MODBUS modes, Example 6 demonstrates direct access only. In this mode, the remote RTU is polled by RF whenever data is required, generating a large amount of RF traffic.

NOTE: This configuration is recommended only for applications having long polling intervals (over 2 minutes) and few RTU's (fewer than 5).

- 8.7.4 Examine the configuration of RTU ID 1 and RTU ID 2. Because the RTU's are no longer in control of the process and are simply MODBUS devices under control of the MODBUS controller:

- XMIT CHECK IN is set to 0.
- SEND LIST is all 0's.
- REPEAT LIST is all 0's.
- All inputs have INITIATE XMIT set to NO.
- All outputs have USED set to NO.

NOTE: Examine the SCADA CONFIG. screen display for RTU ID 1, containing four SCADA points stored in EEPROM. The four points load into FULL SCADA list at power ON. Cycling the power updates data for this screen. In Example 6, the END RTU ID and the TO ID are the same ID because an RTU is the MODBUS device being controlled.

(Example 6 continued on next page)

EXAMPLE 6 (continued)

8.7.5 Execute the SYSTEM MONITOR - UTILITIES screen to view two ID fields:

The top left field on the UTILITIES screen selects which RTU is active when polling inputs or setting outputs. This field is the only field used in Example 6 configuration.

- Set this ID to 1, then execute the SINGLE POLL command. The current input status of RTU ID 1 displays on the screen.
- Change the ID to 2, then execute the SINGLE POLL command. The current input status of RTU ID 2 displays on the screen.
- Execute the START POLL command to cause continuous polling at 5-second intervals. (If RTU ID 1 Inputs are changed, the changes are reflected in screen updates.)
- Execute STOP POLL command to stop polling.

NOTE: The lower left ID field is used to select which RTU is active when a transmitter test is requested — not needed for Example 6 configuration.

EXAMPLE 7

- 8.8 **EXAMPLE 7** demonstrates the **DATAFLOW RTU** as a MODBUS device using stored data access. The configuration consists of a remote RTU with another RTU connected to a MODBUS controller. Example 7 uses RTU Programming Software as the MODBUS controller. The remote RTU and the RTU connected to the MODBUS controller each have five digital inputs and one analog input.

NOTE: In real applications the MODBUS controller is a PLC or a SCADA program operating with a MODBUS driver.

- 8.8.1 RTU ID 1 SETUP: Example 7 requires one **DATAFLOW RTU** to be wired and its hardware configured according to Figure B12 - EXAMPLE 6 ID 1 Wiring Diagram on page B-36. Load Software Programming configuration file **EXP7ID1.USR** into RTU ID 1.
- 8.8.2 RTU ID 2 SETUP: Example 7 requires the other **DATAFLOW RTU** to be wired and its hardware configured according to Figure B13 - EXAMPLE 6 ID 2 Wiring Diagram on page B-37. Load Software Programming configuration file **EXP7ID2.USR** into RTU ID 2.

NOTE: Except the configuration files, these two setups are identical to Example 6.

- 8.8.3 EXPLANATION: Although the RTU can operate in two different MODBUS modes, Example 7 deals with stored access only. In this mode, only the RTU connected to the MODBUS controller is polled, eliminating the need for RF polling.
- 8.8.4 Examine the configuration of RTU ID 1. It is no longer in control of the process and is simply a MODBUS device controlled by the MODBUS controller:
- XMIT CHECK IN is set to 0.
 - SEND LIST is all 0's.
 - REPEAT LIST is all 0's.
 - All inputs have INITIATE XMIT set to NO.
 - All outputs have USED set to NO.

Examine the configuration of RTU ID 2. It controls activation of RTU ID 1.

- XMIT CHECK IN is set to 30 seconds.
- SEND LIST is set to 1.
- REPEAT LIST is all 0's.
- All inputs have INITIATE XMIT set to YES.
- All outputs have USED set to NO.

NOTE: Examine the SCADA CONFIG screen display for RTU ID 1. All entries in the list are 0 because no RF polling is taking place.

- 8.8.5 Example 7 demonstrates polling by stored access, using the RTU Programming Software as the MODBUS controller. To examine the polling method, execute the EXTERNAL BLOCK EDIT option from the UTILITIES screen.
- Set the ID to 01 and the PAGE ADDRESS to 10. Execute the UPLOAD command. Examine memory locations 1089 to 108E. These values are the current state of RTU ID 2 inputs 6 to 1.
 - Memory location 108F is a message counter. This value is incremented every time RTU ID 1 receives a valid message from RTU ID 2.

Change the inputs on RTU ID 2 while continuously executing the UPLOAD command. Watch the 1089 to 108F memory locations update each time.

EXAMPLE 8

- 8.9 **EXAMPLE 8** illustrates the **DATAFLOW RTU** performing a MODBUS modem function. Configuration files **EXP8ID1** and **EXP8ID2** allow two MODBUS devices to communicate with each other by RF. This configuration can connect two PLC's (MODBUS protocol) to communicate with each other over RF, as long as one PLC is a master and the other is a slave with an ID of 3.
- No set-up or wiring diagram is provided with this example.
- 8.9.1 These files configure one RTU to be ID 1 and the other RTU to be ID2. These two RTU's will take MODBUS commands generated on the RS-485 link and transmit them over RF. When this RF message is received by the other RTU, the message is sent out the RS-485 link. Because this message traffic is in both directions, either RTU may be connected to

NOTES

This image shows a full page of white paper with horizontal blue or grey ruling lines. The lines are evenly spaced and run across the width of the page. There are approximately 20 lines visible. The paper appears to be a standard notebook or composition paper.

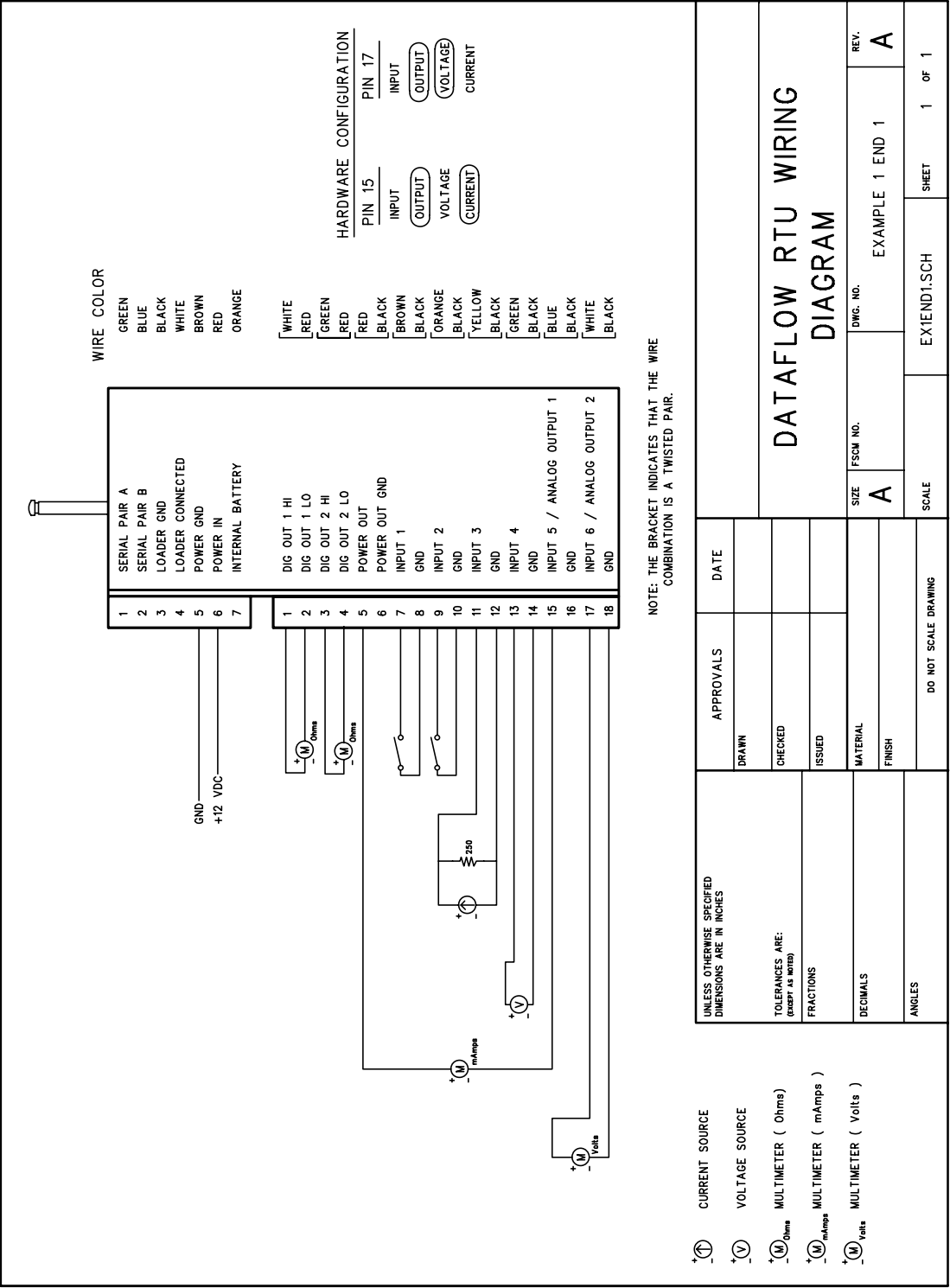


Figure B1 - EXAMPLE 1 RTU ID 1 Wiring Diagram

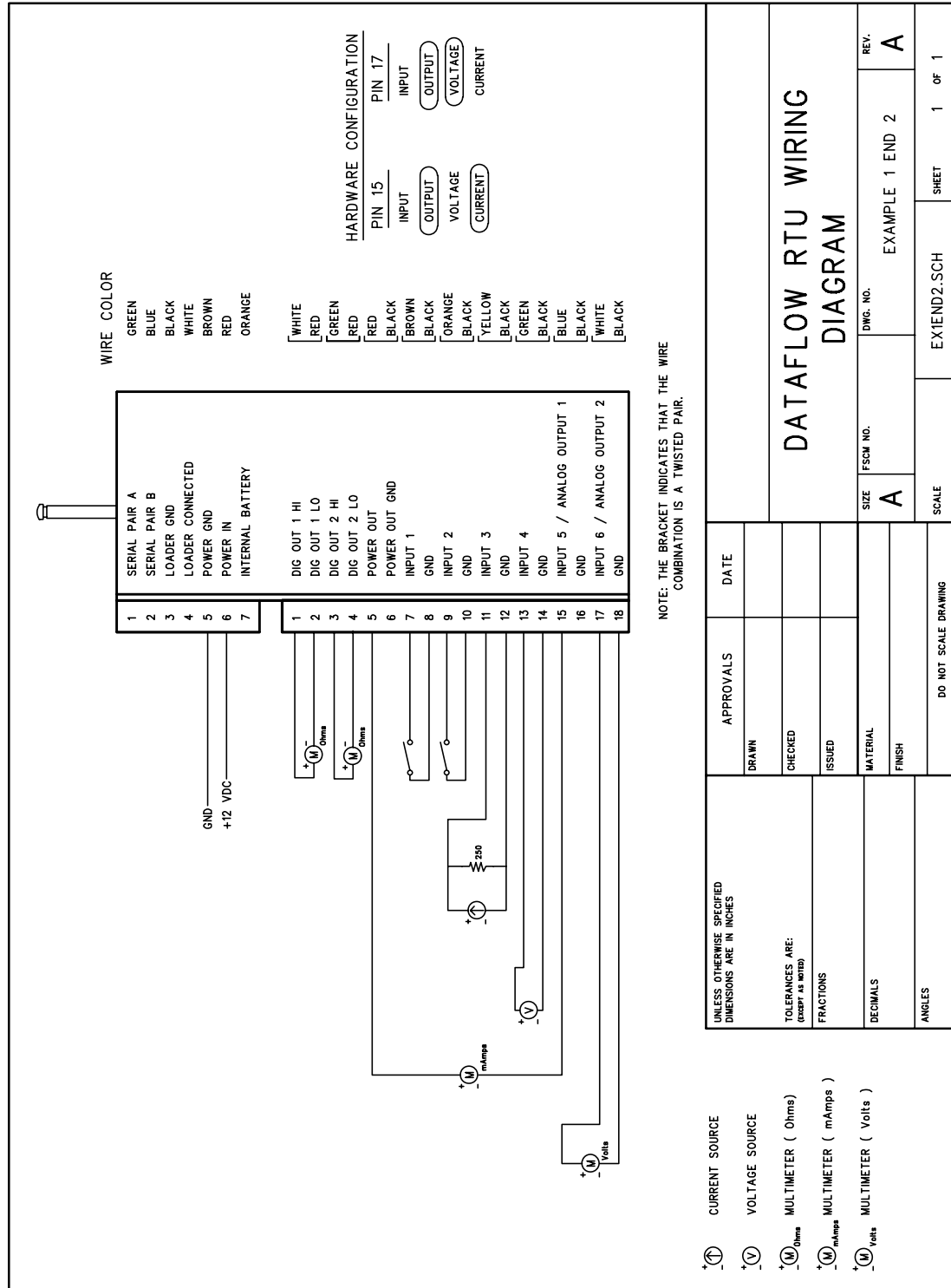


Figure B2 - EXAMPLE 1 RTU ID 2 Wiring Diagram

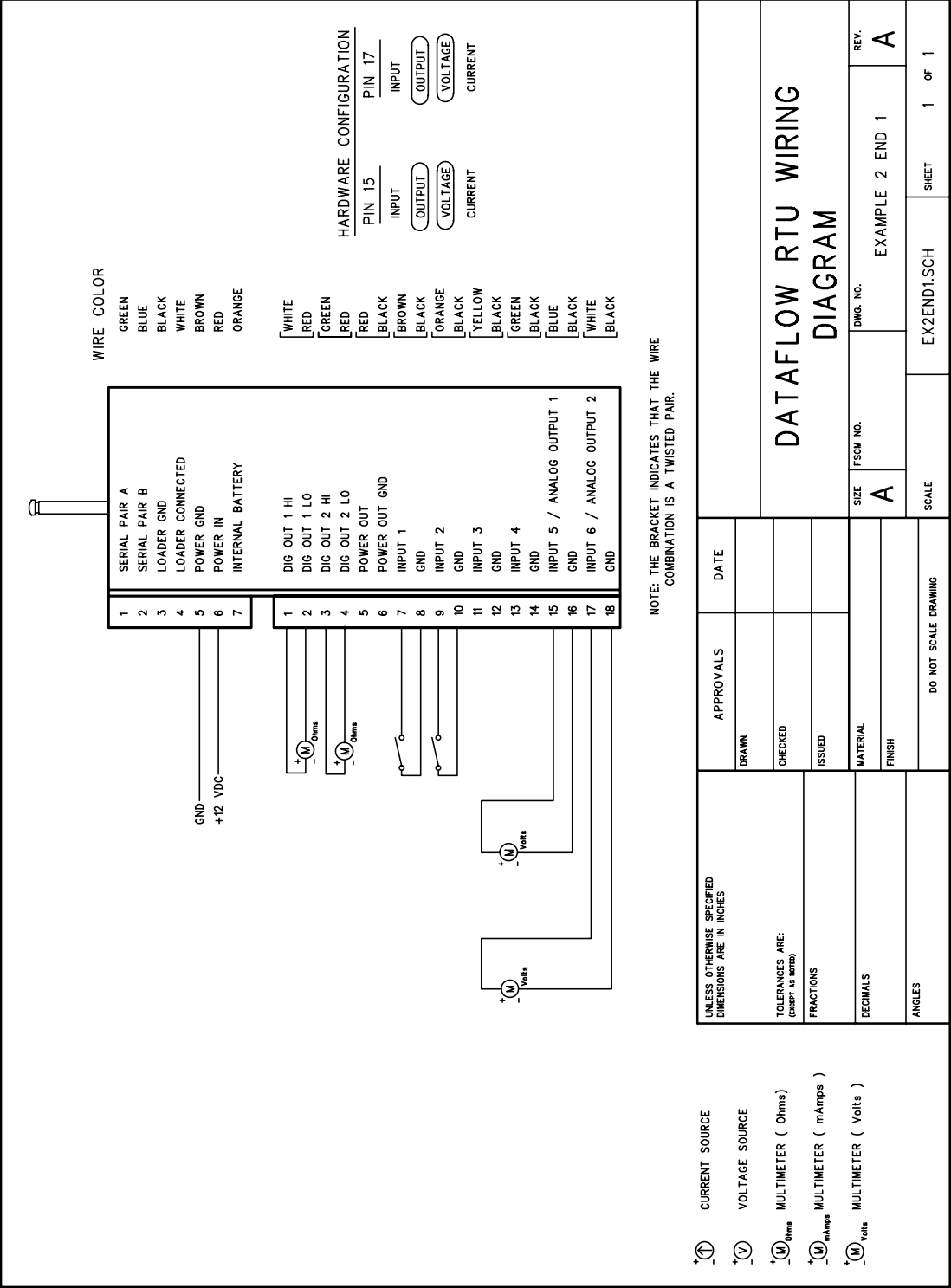


Figure B3 - EXAMPLE 2 RTU ID 1 Wiring Diagram

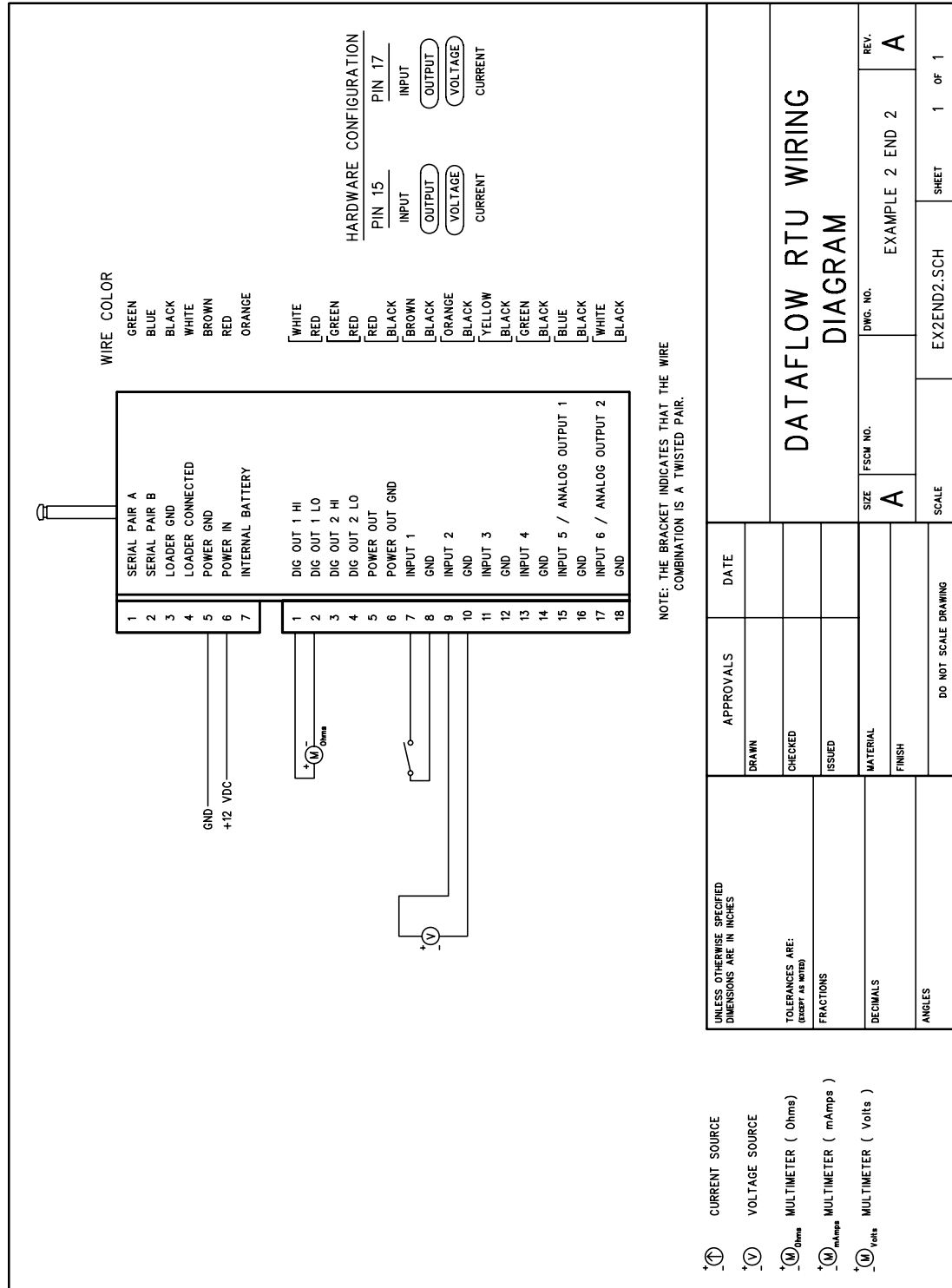


Figure B4 - EXAMPLE 2 RTU ID 2 Wiring Diagram

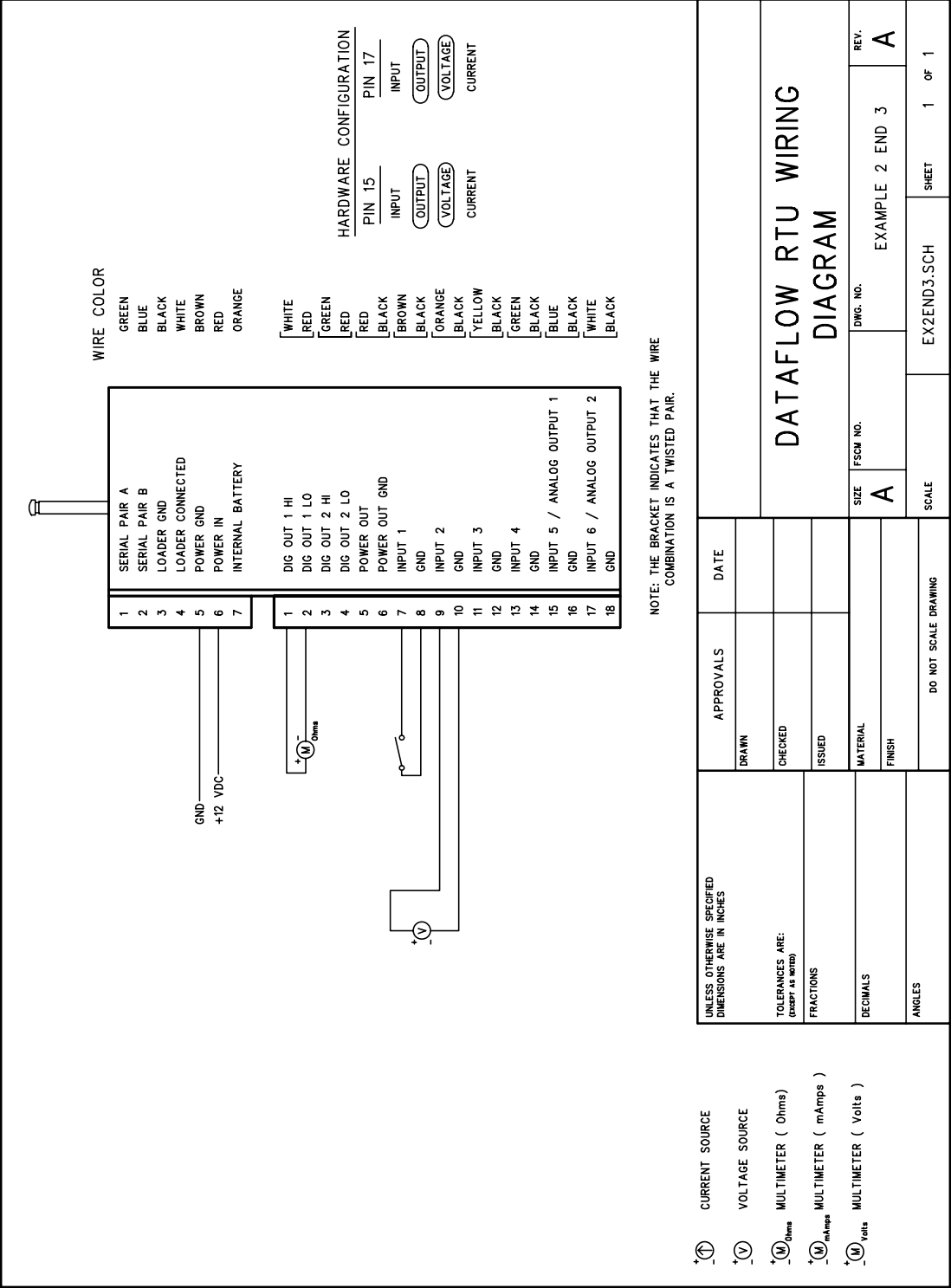


Figure B5 - EXAMPLE 2 RTU ID 3 Wiring Diagram

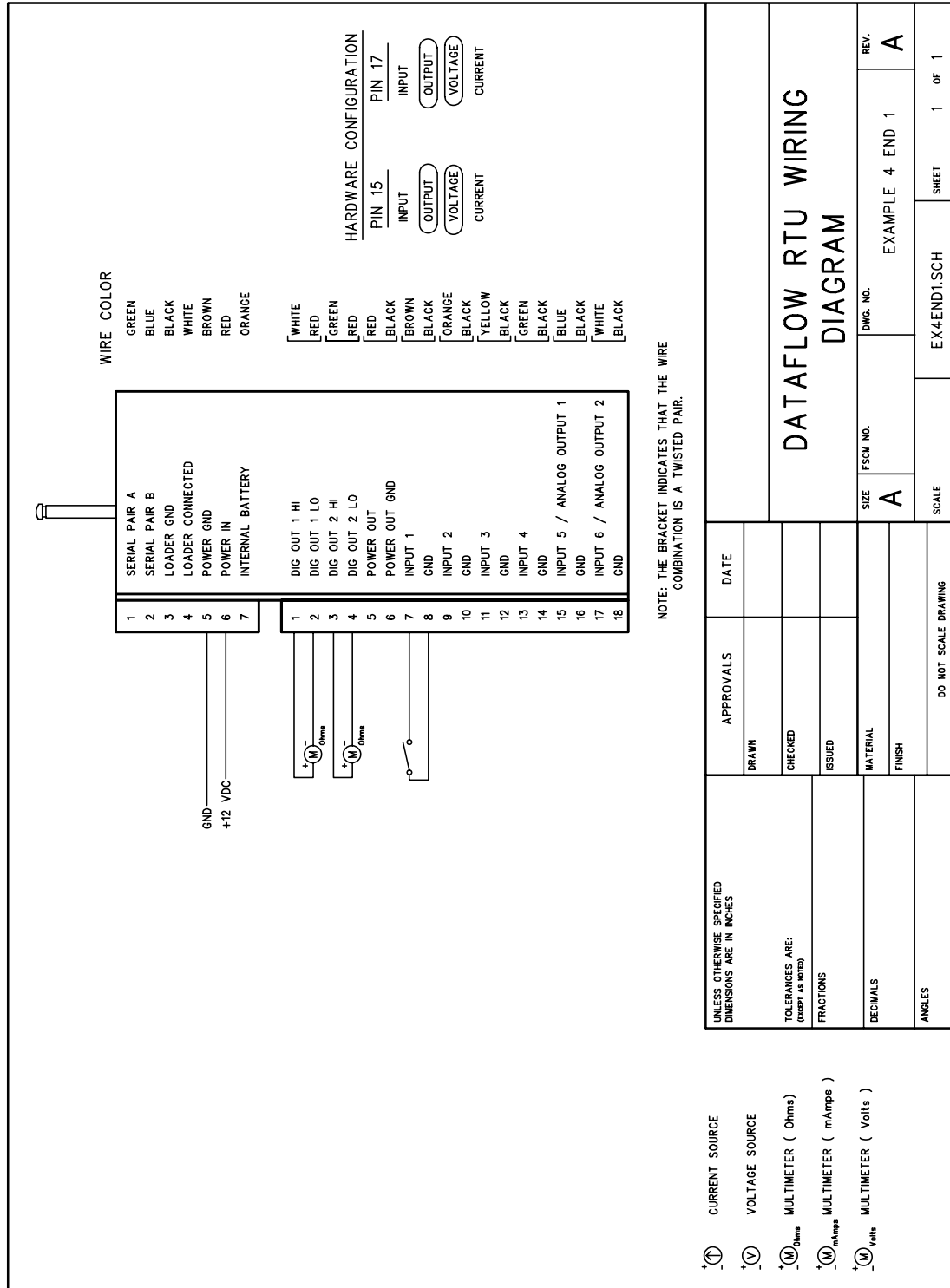


Figure B6 - EXAMPLE 4 RTU ID 1 Wiring Diagram

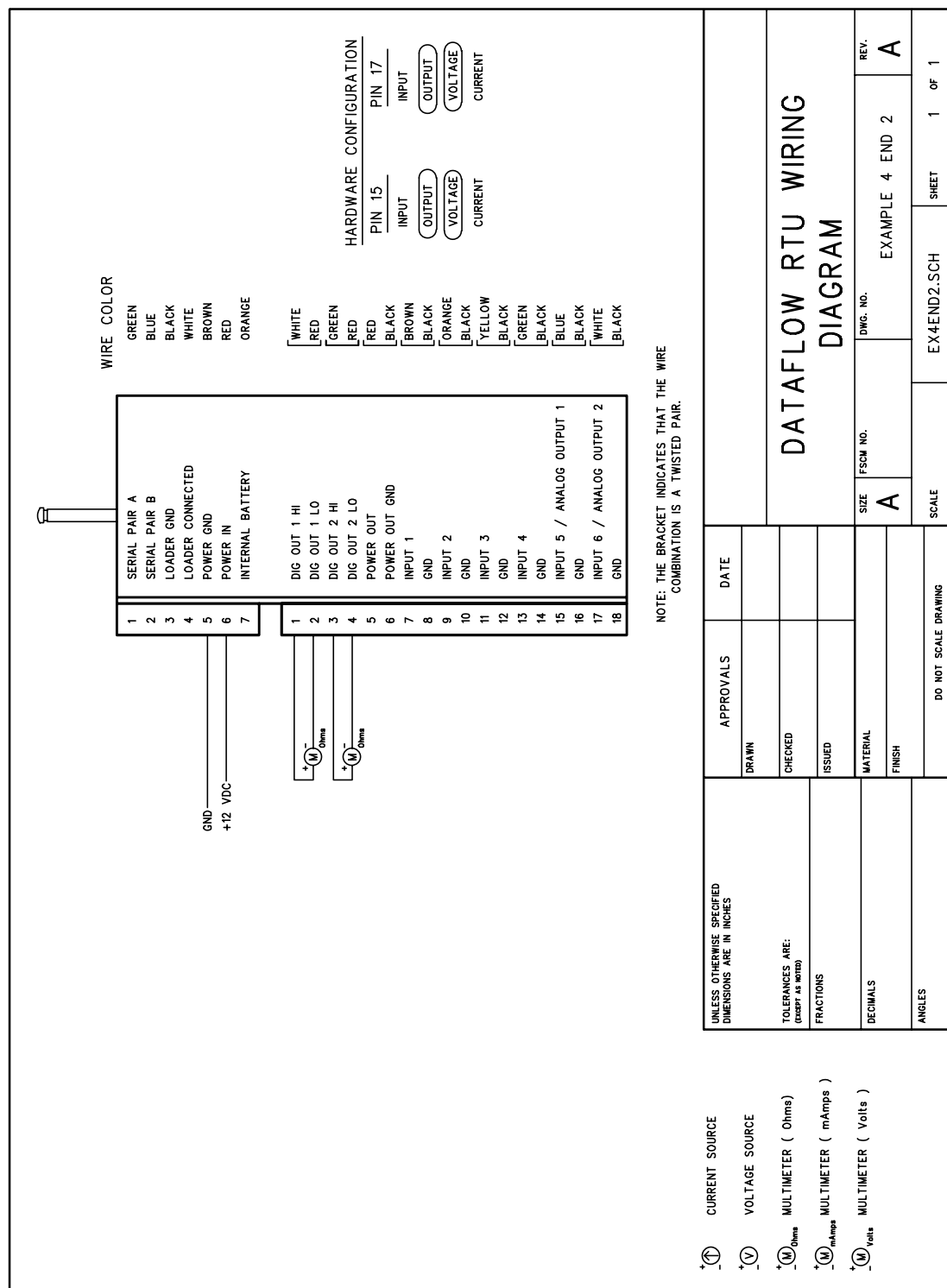


Figure B7 - EXAMPLE 4 RTU ID 2 Wiring Diagram

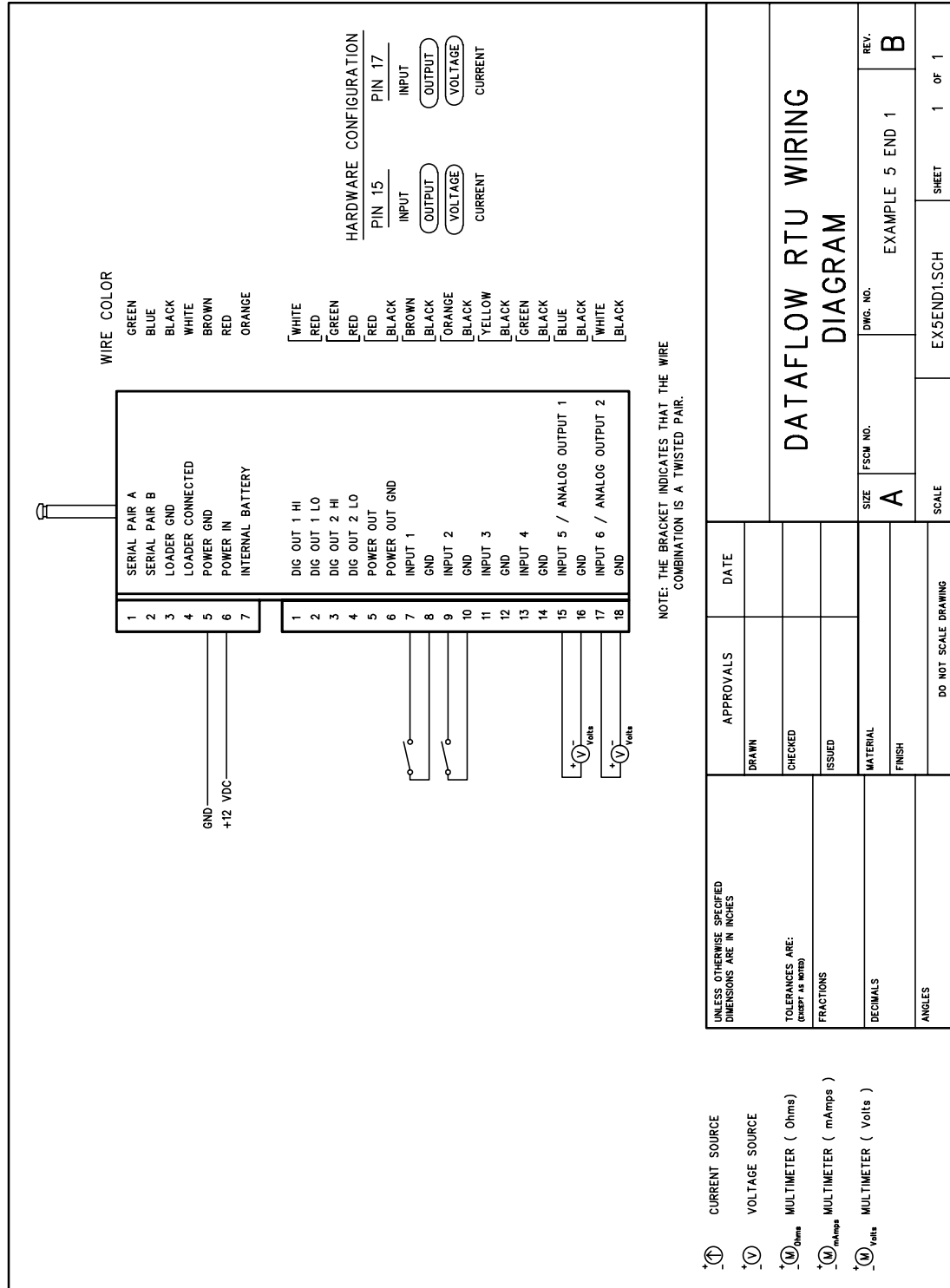


Figure B8 - EXAMPLE 5 RTU ID 1 Wiring Diagram

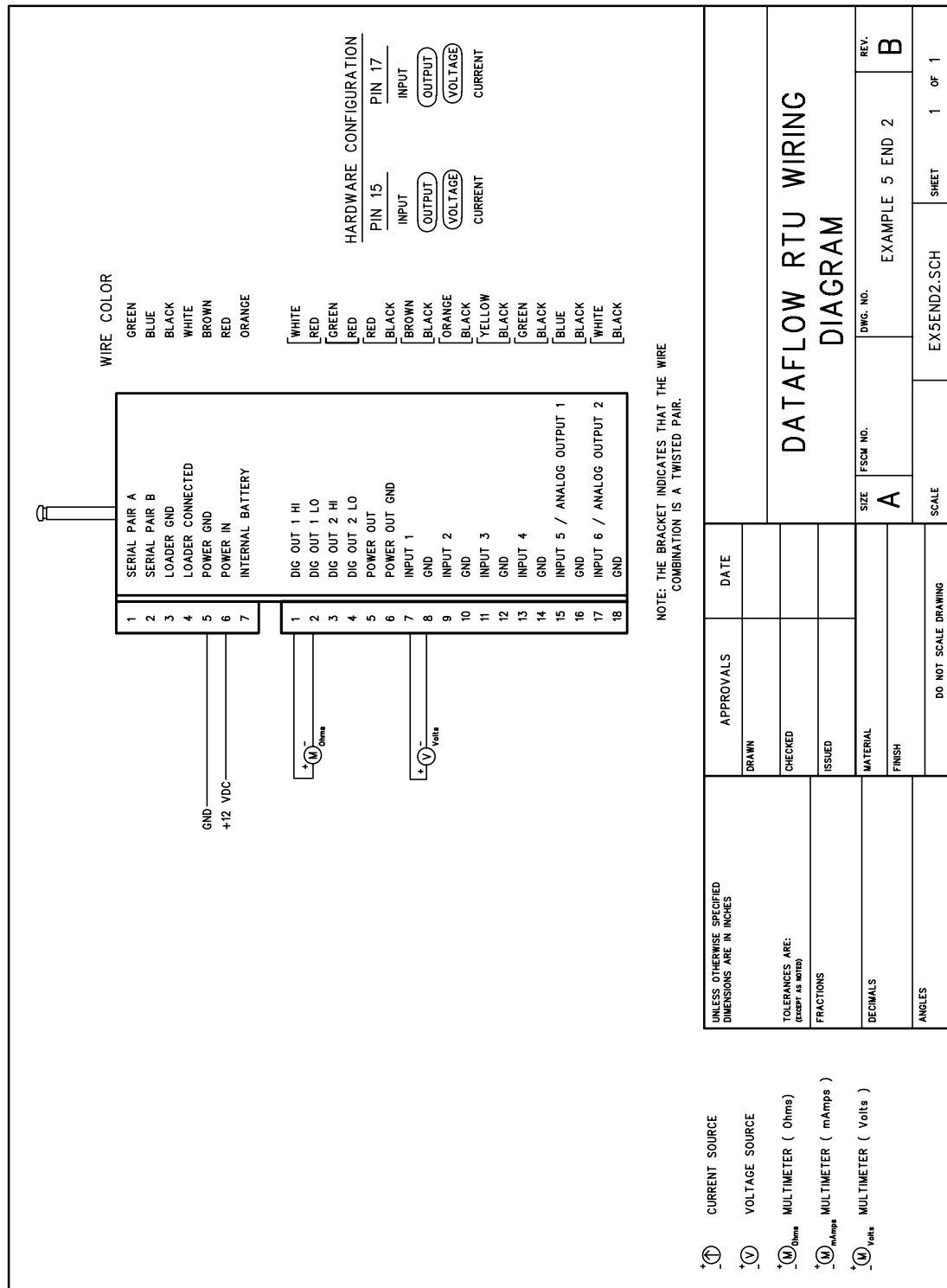


Figure B9 - EXAMPLE 5 RTU ID 2 Wiring Diagram

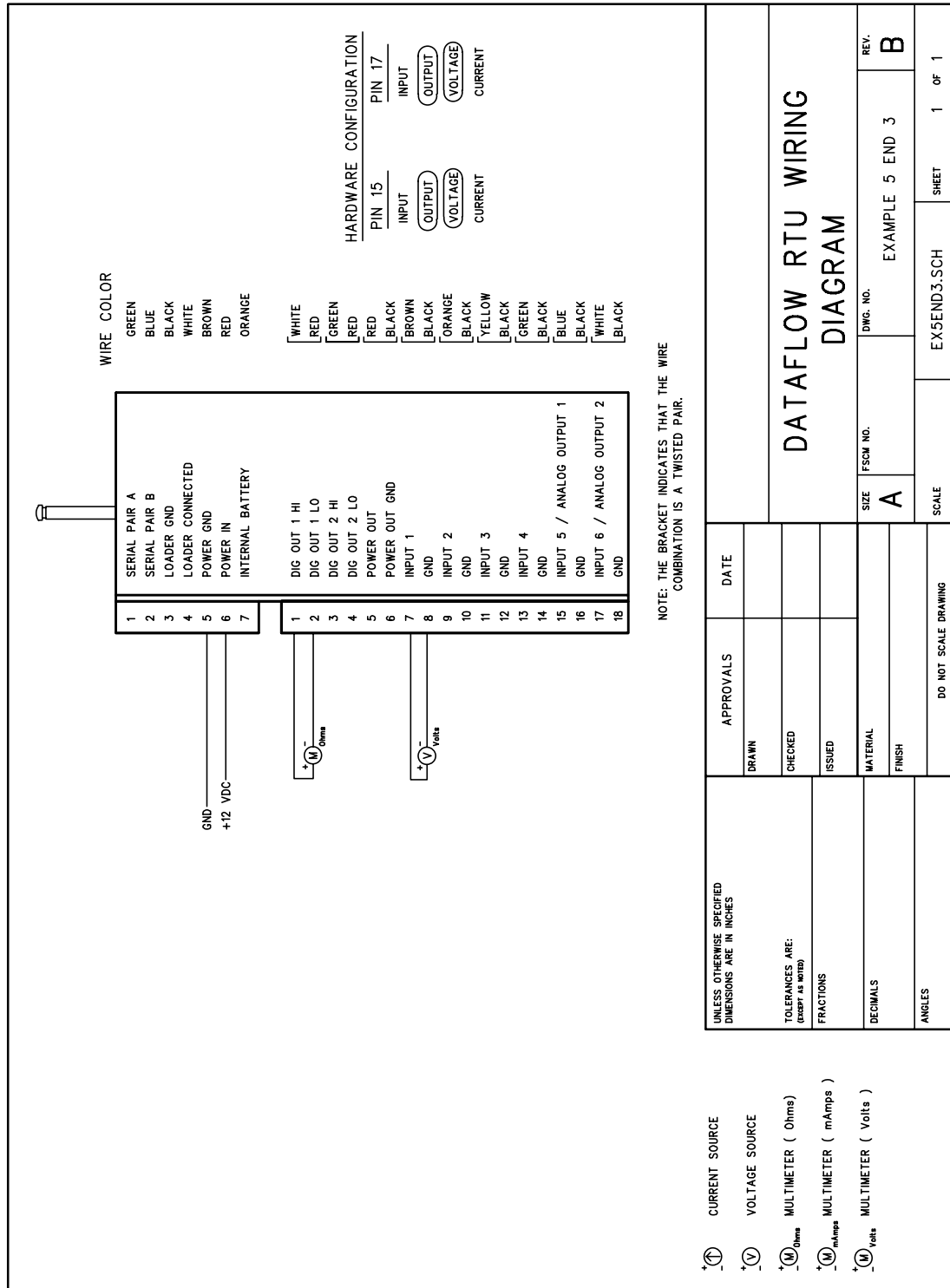


Figure B10 - EXAMPLE 5 RTU ID 3 Wiring Diagram

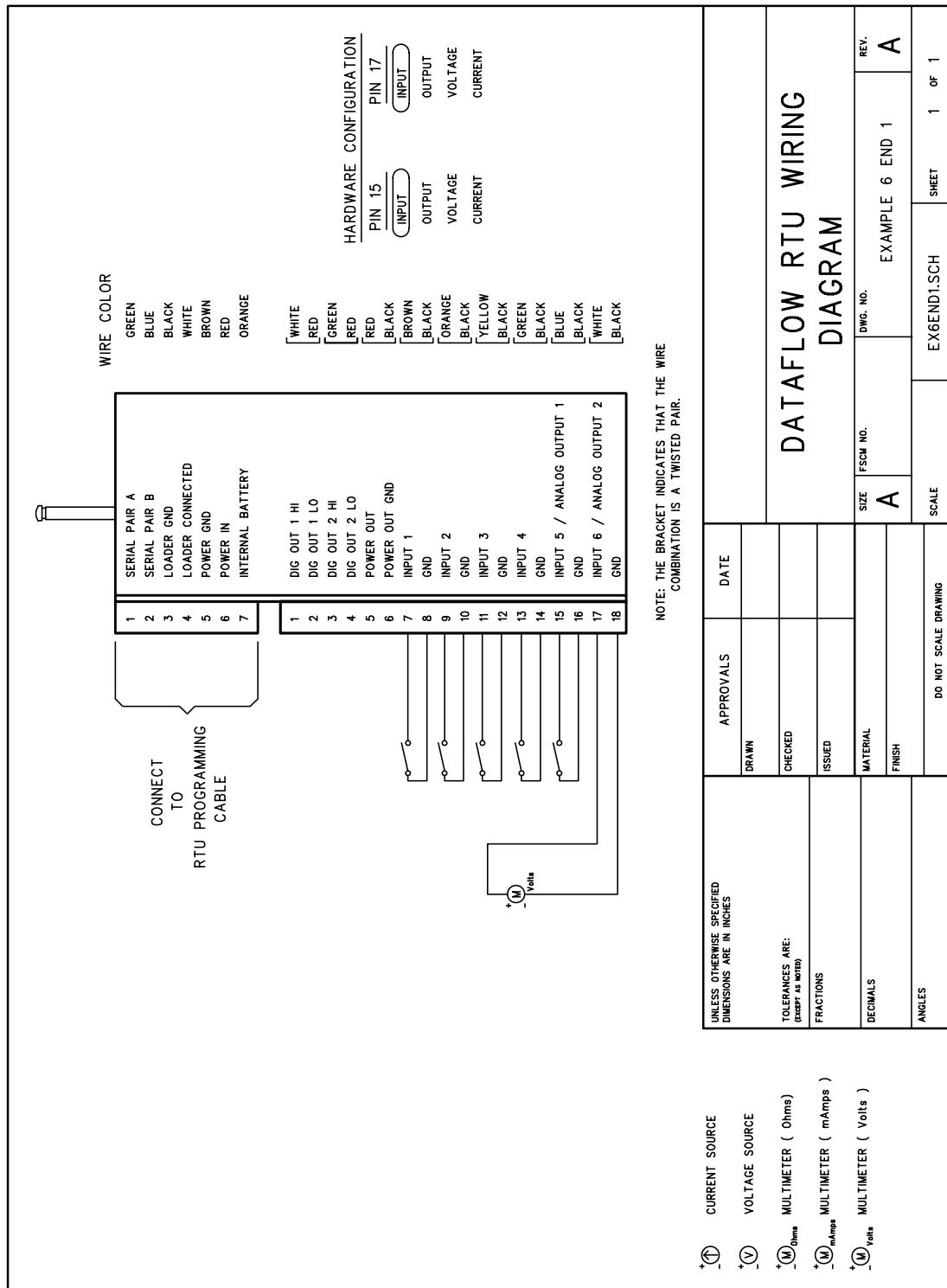


Figure B11 - EXAMPLE 6 RTU ID 1 Wiring Diagram

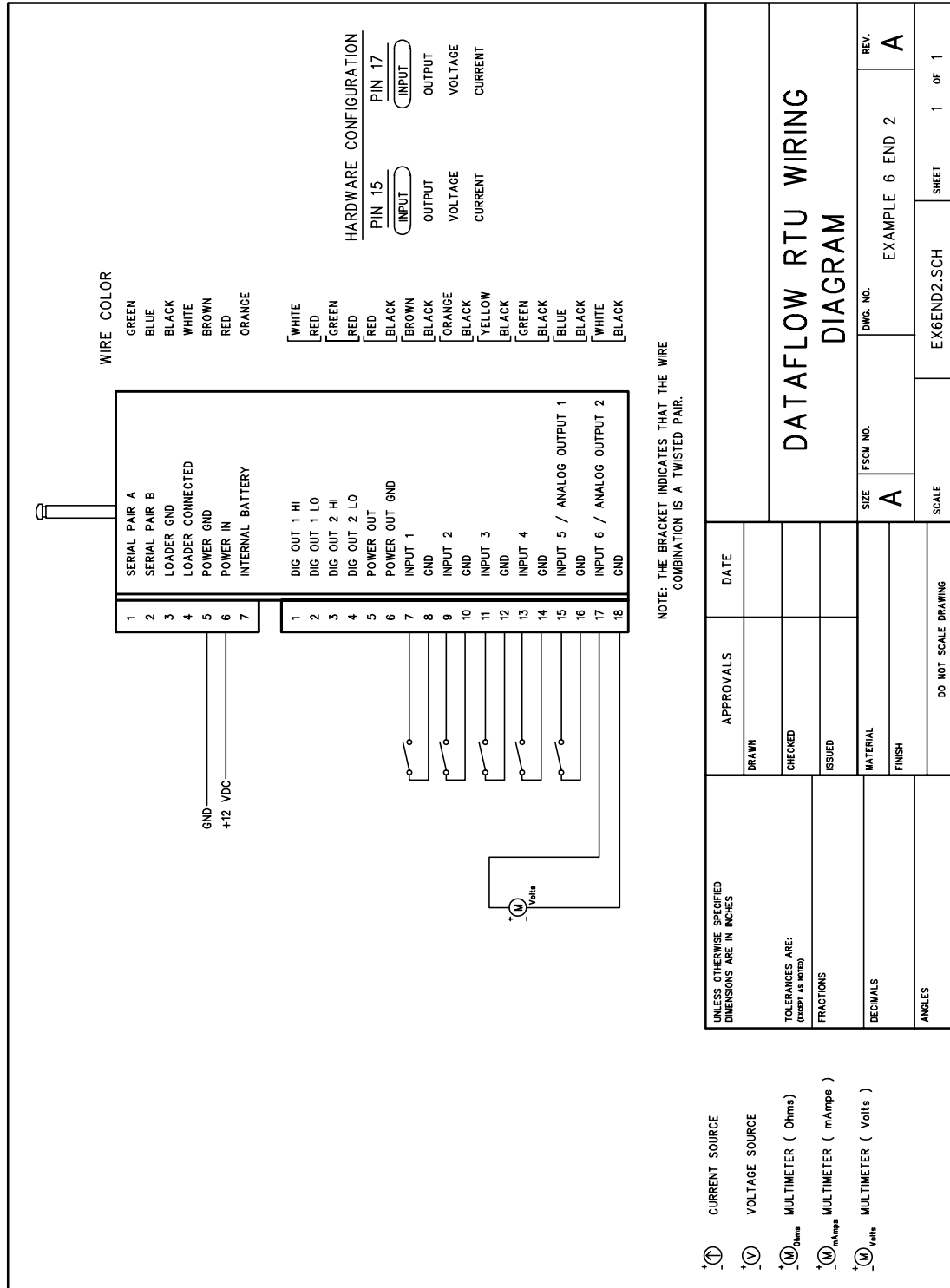


Figure B12 - EXAMPLE 6 RTU ID 2 Wiring Diagram

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