SAGE 1X30 Operations and Maintenance

S1X30-AAA-00001 V**1.1**

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For Reference Only

Manual No. S1X30-AAA-00001

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1.0	2012-10-09	Initial release for secure firmware		N/A	Dan Stark
1.1	2014-08-29	Minor corrections			
				Garry Macejewski, Manager, RTU Engineering	Dan Stark, Manager, RTU S/W Engineering

1 Introduction

Throughout this manual, the term SAGE 1X30 refers to the SAGE 1230, the SAGE 1330 and the SAGE 1430 collectively.

This user manual describes the operation and maintenance of the Telvent SAGE 1X30 Remote Terminal Unit (RTU).

The SAGE 1X30 Remote Terminal Unit is designed to satisfy a limited range of Supervisory Control and Data Acquisition (SCADA) application requirements in harsh environmental conditions.

The SAGE 1X30 Graphical User Interface guides the user through setup and operation while expanding the rich functionality you have come to expect from Telvent RTUs.

The Theory of Operation chapter should be used in conjunction with the schematics and printed circuit assembly drawings, which can be found in the Drawings chapter. The drawings also include bills of material for those users wishing to perform component level repair of failed assemblies.

1.1 Features

The SAGE 1X30 uses the latest electronic technology for reliability, speed and maintainability. It is intended for use where limited on-board I/O is acceptable, yet is capable of polling a wide variety and number of IEDs or other RTUs.

The SAGE 1X30 has the following new features:

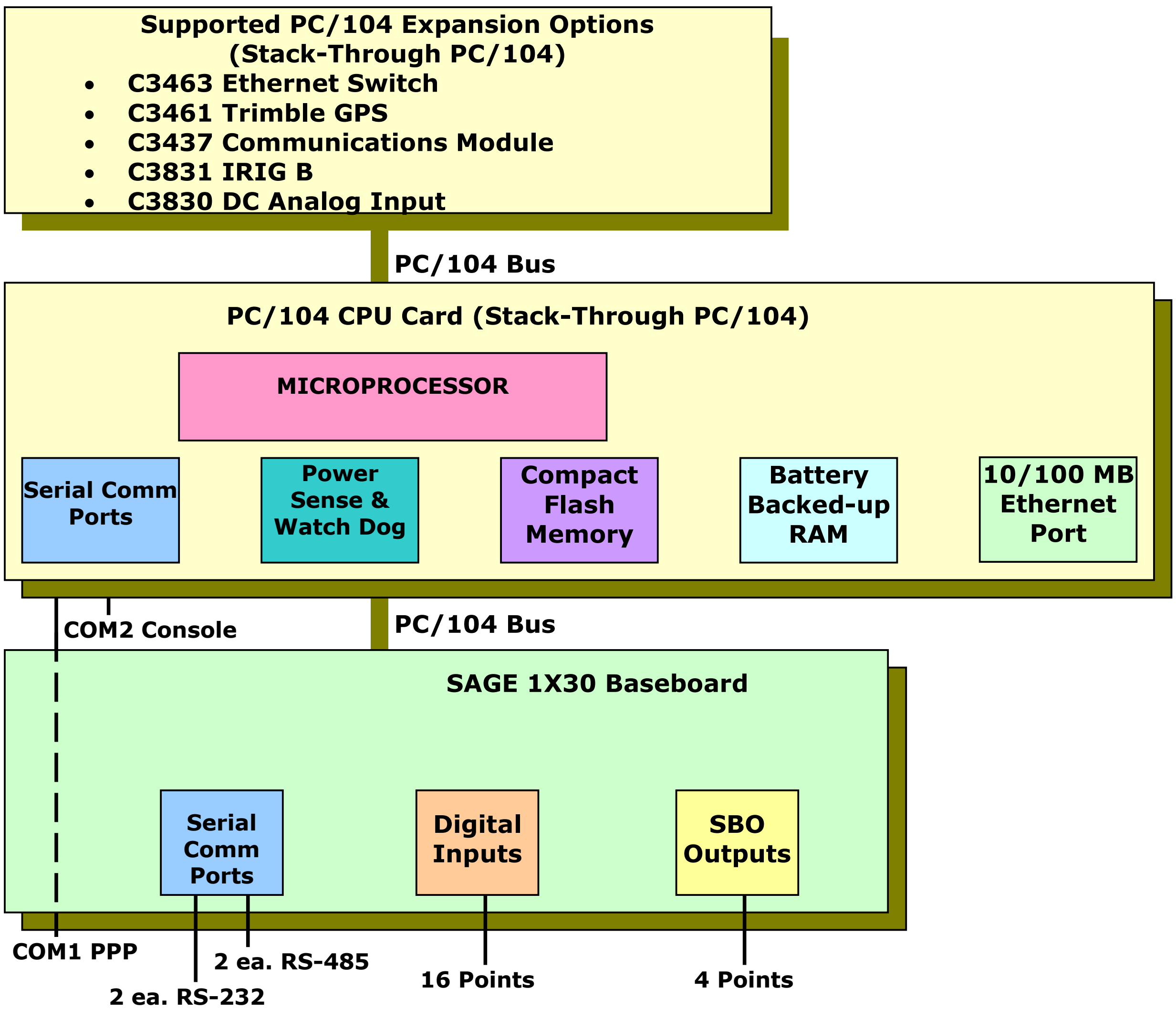
- When used with the secure firmware, the RTU has the following security:
  - Encrypted account file
  - Secure Console
  - Secure Protocols - SSH/HTTPS/IPsec
- Easy-to-use Graphical User Interface (GUI) via Microsoft Internet Explorer
- Embedded web server
- Built-in Ethernet with TCP/IP
- File Transfer Protocol (FTP or SFTP)
- May be configured either locally or remotely
- Point naming (no more counting point numbers to find your point of interest!)
- Point mapping with simple click and drop
- Data concentration – adds data from multiple IEDs to one database for fast polling
- Protocol conversion – convert multiple protocols to a standard protocol
- Built on a widely adopted Real-Time Operating system (RTOS)
- Employs standard PC/104 bus interface for CPU and Communication upgrades
- Relay Ladder Logic capability that supports all five IEC 61131-3 Languages
- 16 digital inputs
- 4 Select Before Operate (SBO) control points.

1.2 Architecture

Figure 1-1 shows a simplified block diagram of the SAGE 1X30 Baseboard that illustrates its general architecture and major components. The basic SAGE 1X30 consists of a Baseboard and a microprocessor daughter board. Terminal block connections are provided for all external I/O lines.

Additionally, the open architecture of the PC/104 interface provides for expanded functions. You may add a PC/104 GPS receiver and/or C3437/C3438 Communication cards that allow up to eight additional Communication ports.

Figure 1-1 SAGE 1X30 Simplified Block Diagram



1.3 Graphical User Interface (GUI)

The SAGE 1X30 is easily configured using the standard web browser, Internet Explorer version 7.0 or later. The physical connection may be made in one of four ways:

- Ethernet connection using an Ethernet crossover cable directly to the CPU card
- Ethernet connection to a network , locally or remotely
- PPP connection using a null-modem cable to the UIF port
- Console – this method commonly used to read and/or change IP address

See Config@WEB Secure Software Users Guide or the Config@WEB Secure Software Users Guide for details on connections.

The GUI is designed around the classical client/server model. A web browser is all you need for your client (PC) and you can browse any RTU product or any version of that product that supports our web interface. All configuration data is stored on the RTU in the form of Extensible Markup Language (XML). XML data is served up to the browser within HTML pages or transformed into HTML via Extensible Stylesheet Language (XSL). In either case data is presented to the user in an intuitive format using common design elements like forms, Radio Buttons, Spin Boxes, Alert Boxes, etc. for much of the data entry.

The GUI supports File Transfer Protocol (FTP) or uses HTTP File Transfer to transfer files to/from the RTU and the client. The file types include RTU applications, Web pages, Configuration files, and the operating system. In short, every file within one RTU can be transferred to another RTU or parts of the RTU file system can be upgraded as needed. This provides a powerful means of performing firmware upgrades or configuration changes.

General Operational Considerations

Note: See Config@WEB Secure Software Users Guide or the Config@WEB Secure Software Users Guide for initial user name and password.

Note: With the release of firmware C0 and later, the initial TCP/IP address is now 172.18.150.50 for standard firmware and 192.168.1.1 for secure firmware.

1.4 Point Mapping

The RTUs of today must interface to a wide Varity of I/O and industry standard IEDs. This creates within the RTU a large database of points that have been acquired by the RTU that must be transferred to one or more master stations.

The SAGE 1X30 GUI supports an intuitive drag and drop point mapping scheme. Each point within the RTU is named and scaled with user definable names and values. Scaling is used for local data display as well as protocol count scaling for conversion of data from one protocol to another.

1.5 Communications

The SAGE 1X30 supports a large suite of communication protocols over many different types of communications media. Ethernet, RS485, and RS232 come as standard hardware. However, installation of media converters allow for just about any physical communications media to be supported.

The UIF is a dedicated RS-232 port that supports a connection to the operating system using a terminal emulation program. It is used to configure the customer RTU IP and to change to safe mode operation.

Diagnostic functions may also be performed using this port. A second RS-232 port is available that supports the Point to Point Protocol (PPP). This port can perform all GUI functions, but at a 38.4kb. Both ports can be used concurrently with the other serial and Ethernet ports.

All Telvent RTU products support multiple RTU and IED protocols. This allows for data to be mapped from IEDs to multiple masters via different RTU protocols. Example: If you were replacing your current master station software that talks Series V protocol with a system that supports DNP, your RTU could talk to both the old master and the new master at the same time. This provides an excellent means of replacing legacy RTU/MTU equipment without interruption to data acquisition.

An emerging need for RTU products is SCADA protocols to communicate over Ethernet all the way down to the RTU. The SAGE 1X30 supports DNP over Ethernet.

1.5.1 PC/104 Communications Expansion

The PC/104 C3437 module, along with the C3438 XT board, expands communication capabilities of the SAGE 1X30 to as many as eight extra comm ports. All RS232 host ports are fully RS232 compliant and can be operated in asynchronous or synchronous modes.

1.6 I/O And Communication Expansion

The SAGE 1X30 is designed to be cost effective where limited on-board I/O is acceptable, yet is capable of polling a wide variety and number of IEDs or other RTUs. The SAGE 1X30 has the following built-in points:

- 16 digital inputs
- 4 Select Before Operate (SBO) control points or 8 digital outputs
- 4 configurable communications ports (expandable to 12)

1.7 Relay Ladder Logic (RLL)

The SAGE 1X30 supports a RLL Runtime Target that accepts applications that can be developed using any one of the five IEC 61131-3 languages plus flow Charting. Programs are developed on an application workbench that runs only on the client. Fully developed/debugged programs can be downloaded into the SAGE 1X30 and activated for execution.

RLL applications have access to all the data within the RTU and make use of the powerful mapping capabilities of the GUI. Output data from RLL applications can be viewed in real time data displays.

1.8 Packaging

The SAGE 1X30 Baseboard is mounted on a flat panel for installation in a NEMA style cabinet for small point count configurations. It also may be mounted on an EIA universal 19-inch rack mountable panel.

1.9 Protection

All terminations contain any transient protection required for the particular input function. In addition to this, relays include matrix and kick-back diodes and digital inputs include current limiting resistors.

2 Specifications

2.1 User Computer Requirement

OPERATING SYSTEM	Windows XP or newer with Internet Explorer Version 6 or above. If using XML to Excel macro, Microsoft Office 2003 or above.

2.2 Environmental

OPERATING TEMPERATURE	–40° to +85° C
RELATIVE HUMIDITY	5% to 95%, non-condensing
TRANSIENT PROTECTION	All user field connections designed to pass: IEEE 472-1974, ANSI C37.90-1979 (R1982) ANSI C37.90.1-1989

2.3 Digital Inputs

2.3.1 Status Inputs

ISOLATION	Optically isolated, 1500VDC
LOOP VOLTAGES	±12VDC
DEBOUNCE	20 msec nominal
CONFIGURATION	1 terminal per point (common ground)
BASEBOARD POINTS	16
POWER	+ and –12V wetting

2.3.2 Accumulator Inputs

ACCUM. FORMATS	FA, FC (1 or 2 counts/cycle)
ACCUM. INPUT RATE	20 pps max.
MAX INPUTS	16

2.4 SBO Control Outputs

DURATION	Software programmable in 5 msec increments
CONTACT FORM	1 Form A (one side common on each two relays)
CONTACT RATINGS	30 VDC @ 2A 120 VAC @ 0.6A 129 VDC @ 500 MA
CONTROL POINTS	4 (from 8 relays)

2.5 Communications

NUMBER OF RS-232C PORTS	1 Console, 1 PPP User Interface, 4 Communications ports on baseboard, up to 8 additional ports with optional C3437 PC/104 cards and C3438 Comm Expansion card
FORMATS	2 each RS-485 (3-wire Phoenix connector), 2 each RS232 (DB9 connector)
SPEEDS	300-9600 bps
PROTOCOLS	Synchronous and asynchronous
ETHERNET	One built-in 10/100BASE-T (RJ45) auto-negotiate (will adjust to the speed and half/full duplex of the connecting device)

2.6 C3463 PCA Ethernet 10/100 5-Port Switching Hub (Optional)

ETHERNET	Five built-in 10/100BASE-T (RJ45) auto-negotiate (will adjust to the speed and half/full duplex of the connecting device)

2.7 Power Requirements

INPUT VOLTAGE	+12VDC, –12VDC, +5VDC
OPTIONAL POWER SOURCES	220VAC (90-250VAC/100-350VDC) 120VAC (90-132VAC/110-175VDC) 48VDC (38-63VDC) 24VDC (10-40VDC) 24VDC (10-33VDC)
INPUT POWER	7 watts maximum
INPUT/OUTPUT ISOLATION	500 VDC
LOOP EXCITATION	±12VDC wetting provided for DIs

2.8 Visual Indicators

BASEBOARD LEDs	RTU PWR LED for +5VDC input power EXE PWR LED for SBO power 5 LEDs per RS232 COMM port (DCD, RX, RTS, TX, CTS) 2 LEDs per RS-485 COMM port (TX, RX)

2.9 Analog Inputs (Optional)

Note: Optional analog inputs requires a C3830 PC/104 card and one or more XT AI card(s) operating on a standard AI bus.

INPUT TYPE	Differential
INPUT RANGES	±5VDC, 0-5VDC, 1-5VDC, ±1mA, 0-1mA, 4-20mA, 10-50mA
RESOLUTION	12 bits (11 bits plus sign)
COMPREHENSIVE ACCURACY	±0.25% FS between –40° and +85°C
REFERENCE VOLTAGES	±4.500V
CONVERSION RATE	All analogs once per second
COMMON MODE RANGE	±10V
COMMON MODE REJECTION	80 dB @ 50/60Hz
NORMAL MODE REJECTION	60 dB @ 50/60Hz
INPUT RESISTANCE	10M ohm or greater
MAX INPUTS	256
XT CONFIGURATION	2 terminals per point (+ and -) with a shared shield ground.

3 Installation

This chapter describes the normal installation and operation procedures for the SAGE 1X30 RTU. Prior to moving the RTU assembly to the installation site, we recommend that you perform a preliminary functional test to verify that the configuration is correct for the intended site and also to check for any undetected shipping damage.

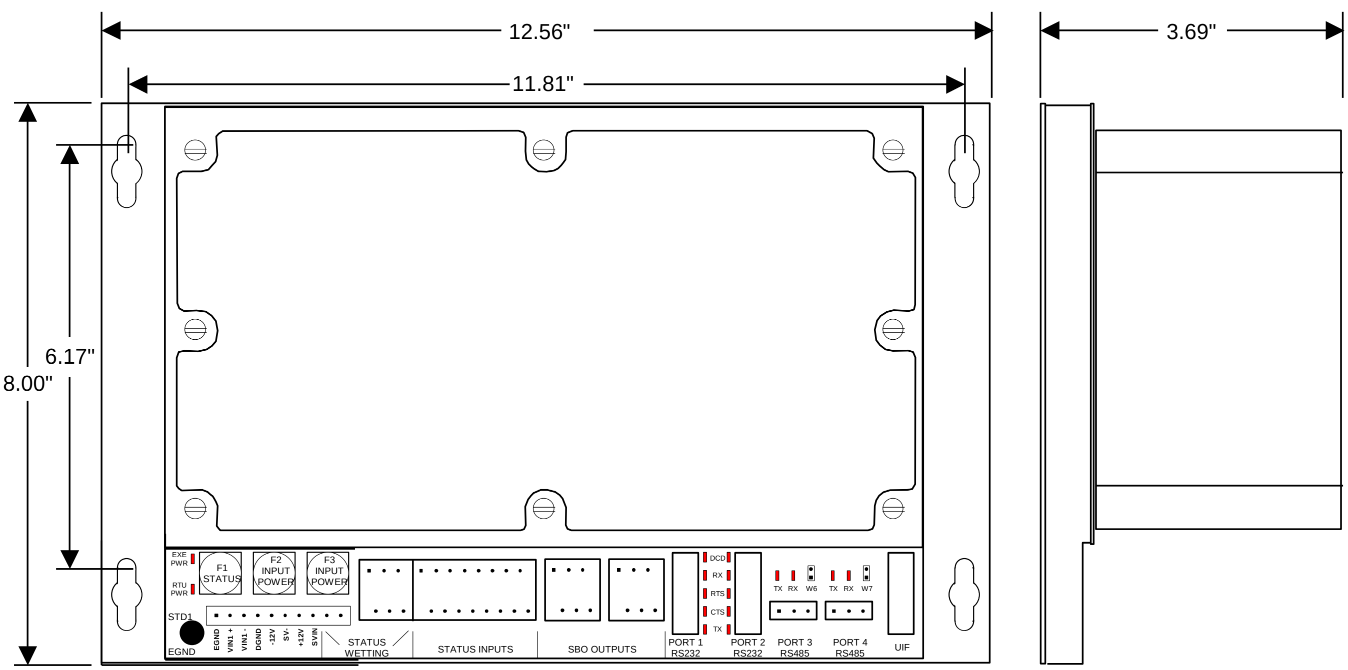
3.1 General Installation Procedure

As shown in Figure 3-1, the SAGE 1X30 is small enough that it usually can be mounted in an existing cabinet. All that is needed is four screws. The entire board consumes less than 7 watts, so no special ventilation is needed.

The procedures for connecting field wiring to the RTU are provided in the following sections.

Caution: The printed circuit assembly contains CMOS devices and is sensitive to static discharge. Boards should be handled only at a grounded workstation. Avoid touching the electronic components, jumpers, connectors, or the exposed etches on the boards when connecting the field wiring.

Figure 3-1 SAGE 1X30 Dimensions



Top View Side View

3.2 Power Terminations

Field input power will vary according to project requirements. The SAGE 1X30 includes fuses (F2, F3) for field power. Figure 3-2 is an overall look at the RTU with an enclosure. The Baseboard can have the power options shown in Figure 3-3.

Refer to your RTU assembly drawing for your particular variance. In all cases, make sure the input power is de-energized before connecting power.

Figure 3-2 SAGE 1X30 RTU (C3500-AXX-10000 Variation)

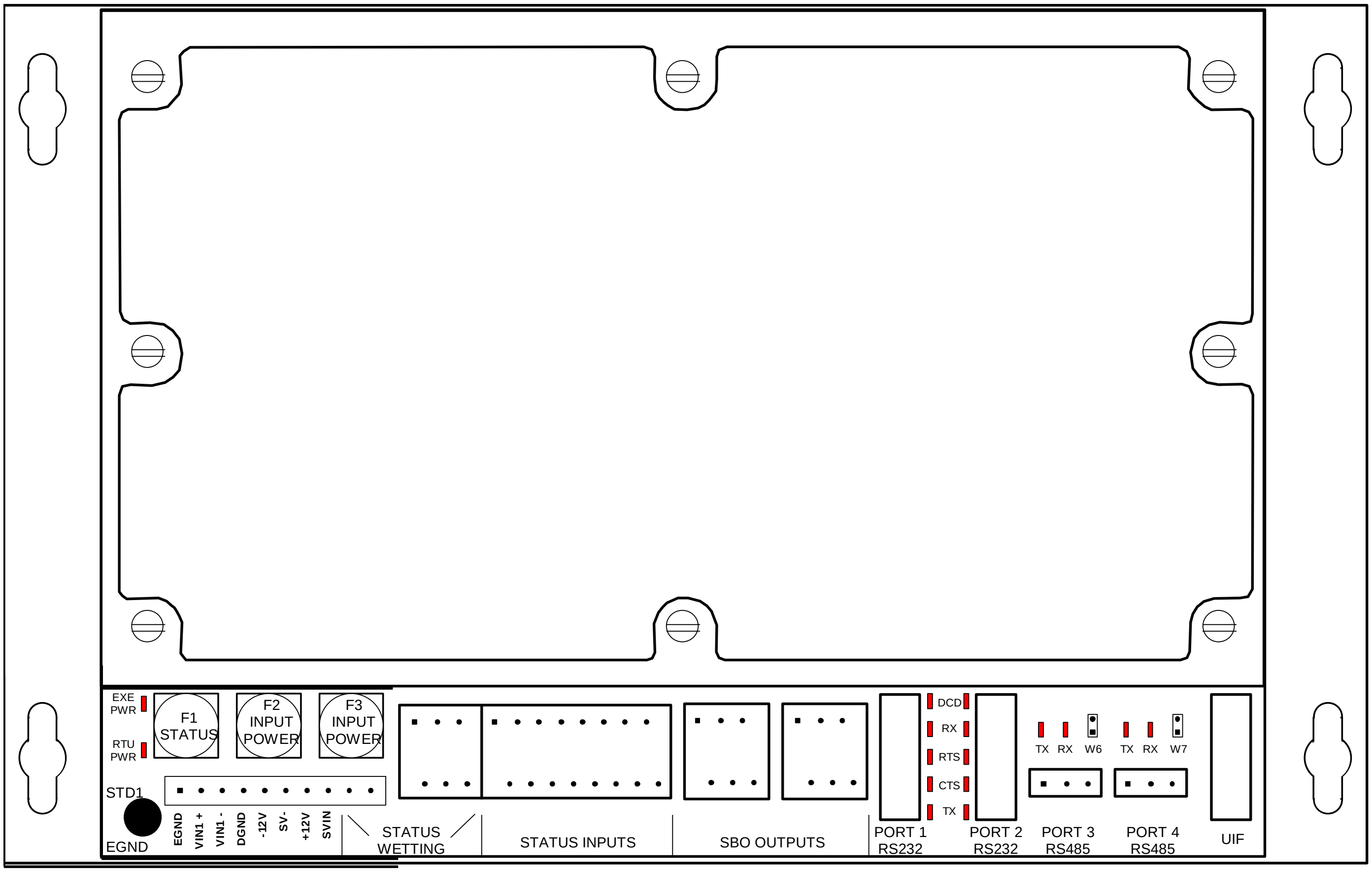
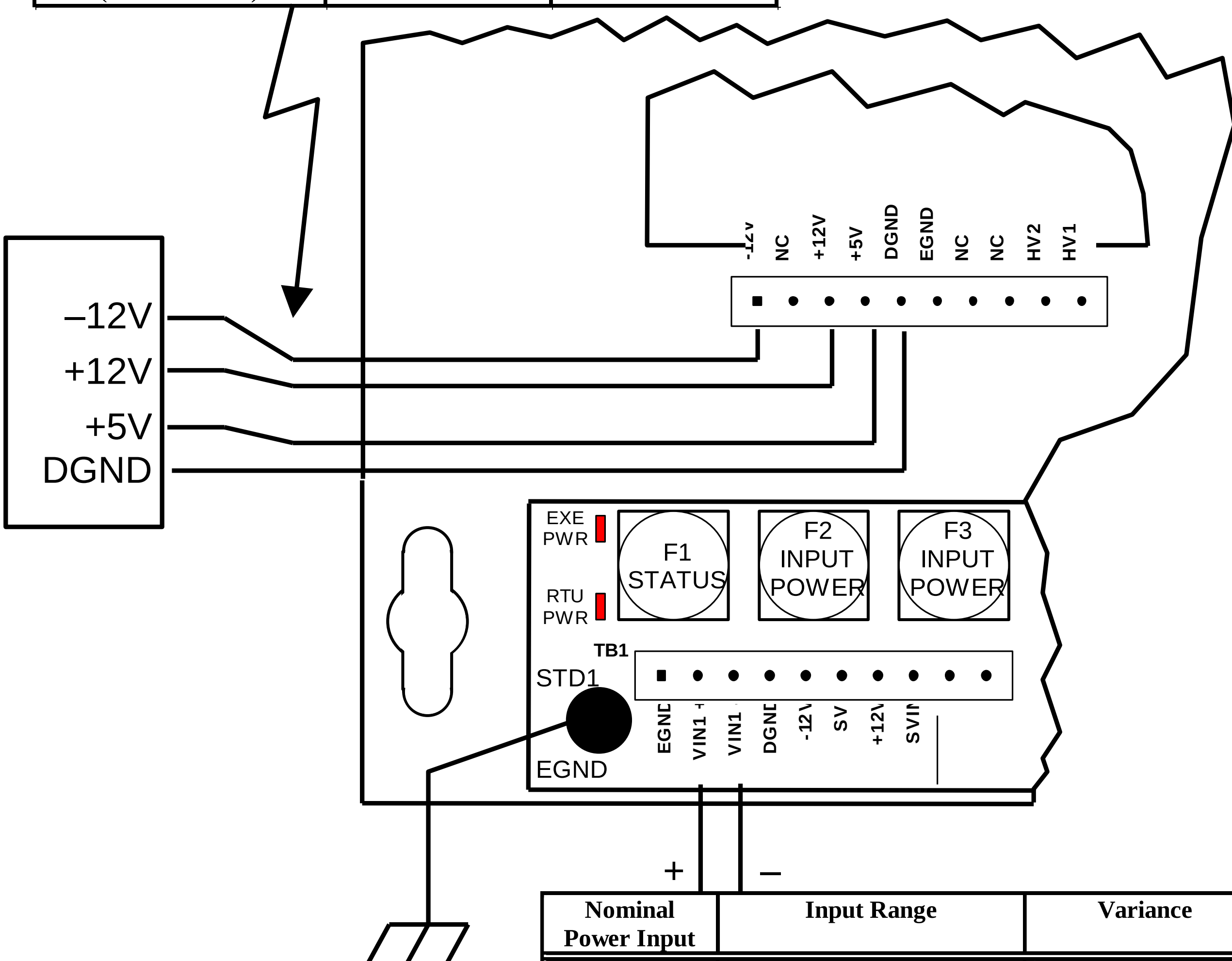


Figure 3-3 Baseboard Power Options (Cover Removed)

Nominal Power Input	**Input Range**	**Variance**
Minimal Configuration (no internal P/S)	±12VDC, +5VDC	C3500-A0X-X0000



Nominal Power Input	**Input Range**	**Variance**
220VAC	90-250VAC/100-350VDC	C3500-A1X-X0000
120VAC	90-130VAC/110-175VDC	C3500-A2X-X0000
48VDC	38-63VDC	C3500-A3X-X0000
24VDC	10-40VDC	C3500-A4X-X0000
24VDC	19-32VDC	C3500-A5X-X0000
24VDC	10-33VDC	C3500-A6X-X0000

3.3 Serial Ports

The SAGE 1X30 baseboard has 5 serial ports. One port is dedicated to the User Interface (UIF). The four other serial ports (1 through 4) use two dual Serial Communications Controllers and may be used for communications with IEDs, MTUs, as a redundant channel to the primary master, or as a data concentrator for other RTUs. Ports 1 & 2 are RS232. Ports 3 & 4 are RS485.

As an option, you may also configure two C3437 PC/104 cards and a C3438 card for an additional eight RS232 ports, as shown in Figure 3-12.

3.3.1 RS232 Connections

For the simplest connection on the RS232 ports, only pins 2, 3, and 5 are actually required. The other pins are used for modem controls as well as synchronous connections. The input pins receive signals from external sources while the output pins supply signals from the RTU. Five signal lines for each channel are supplied with LEDs as indicated in the last column of the table.

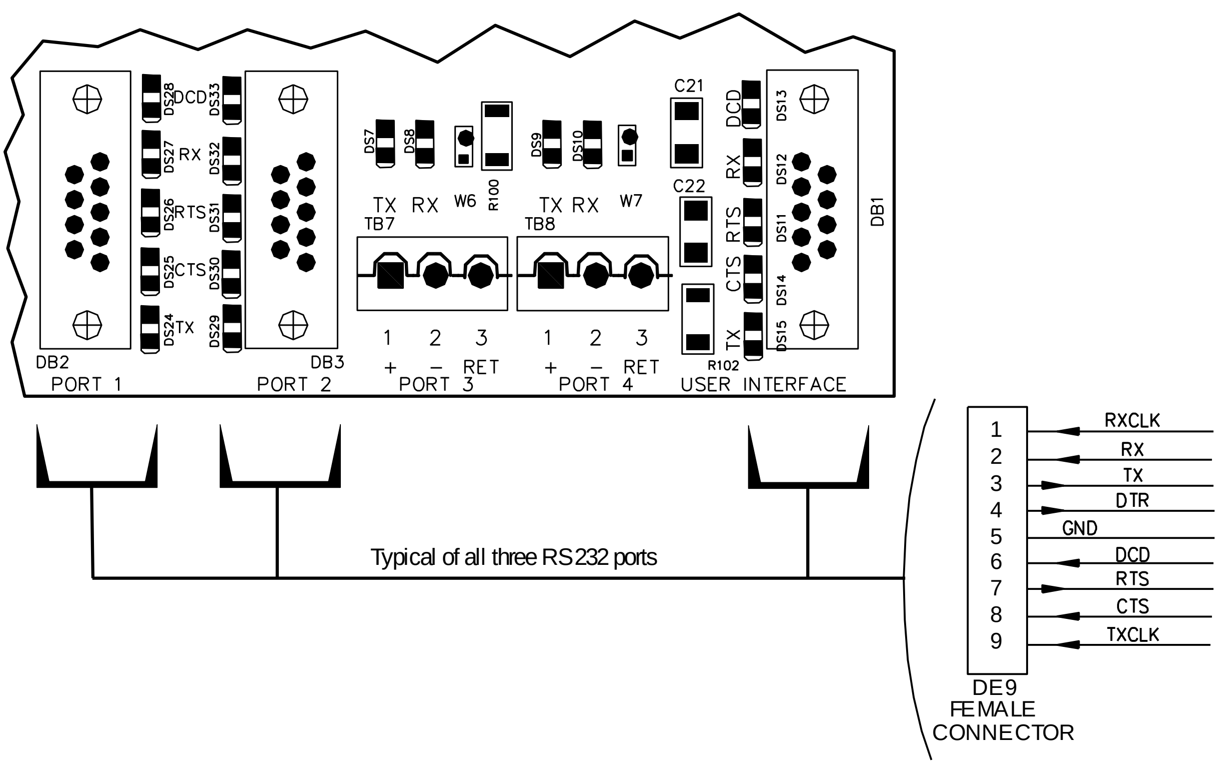
Table 3-1 DB-9/RS232 Connector Pinouts

Baseboard							**C3438**	**LEDs**
SIGNAL	**PIN**	**DESCRIPTION**	**TYPE**	**UIF**	**Port 1-2 RS232**	**Port 3-4 2-wire RS485**	**Port 5-12**	
RXCLK	1	Receive Clock	input		X		X	
RXD	2	Receive data	input	X	X	X	X	X
TXD	3	Transmit data	output	X	X	X	X	X
DTR	4	Data Terminal Ready	output	X	X		X	
GND	5	Ground	n/a	X	X		X	
DCD	6	Data Carrier Detect	input	X	X		X	X
RTS	7	Request to Send	output	X	X		X	X
CTS	8	Clear to Send	input	X	X		X	X
TXCLK	9	Transmit Clock	Input		X		X	

X = Active

As shown in Figure 3-4, both port 1 and port 2 are RS232. The RS232 specification limits the cable length to fifty feet. However, in a substation environment with the possibility of a ground potential difference, it is advisable that both the RTU and the IED be contained within the same enclosure.

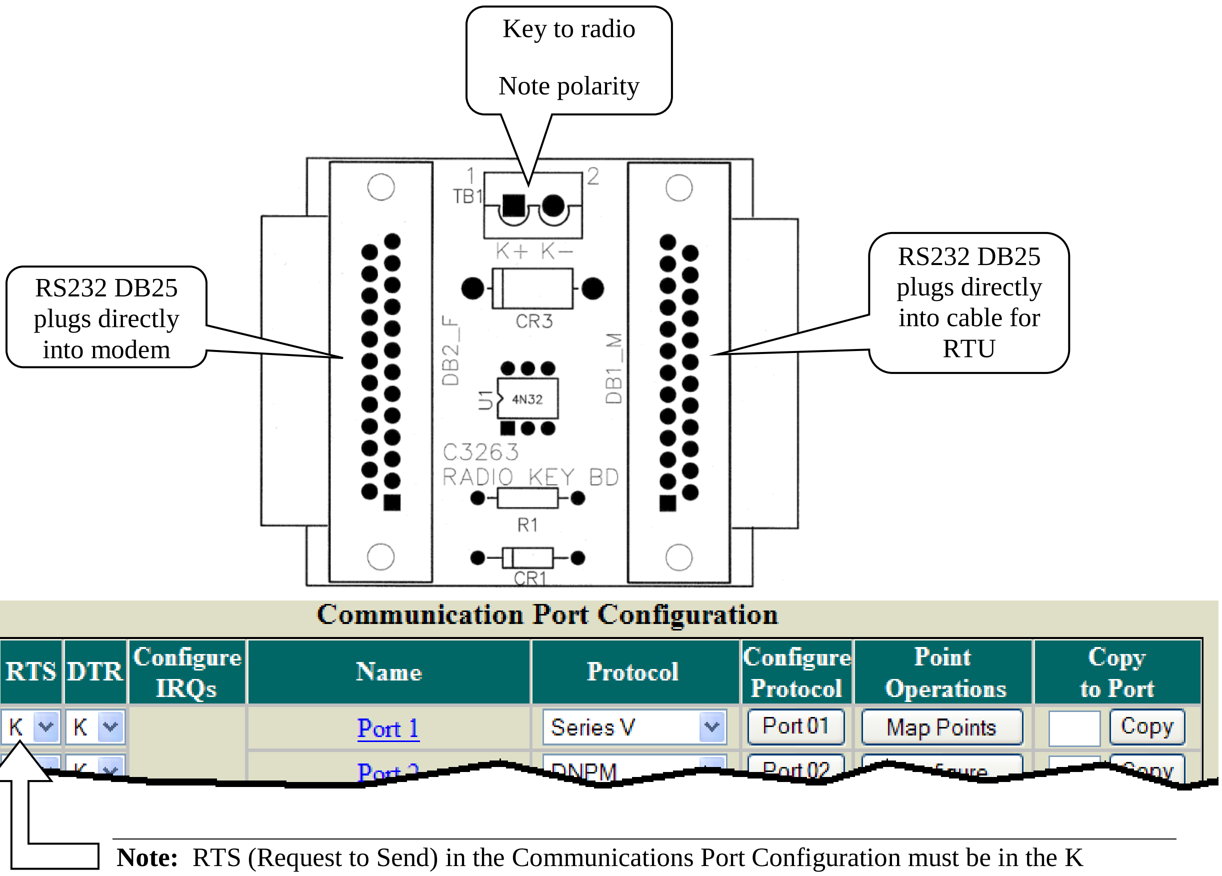
Figure 3-4 Connections for the RS232 Ports



3.3.2 Radio Keying Option

Some communications devices require an open collector output to key the device for data transmission. The config@WEB RTUs do not have this output on their baseboards. The optional C3263 Radio Keying Module provides an optically isolated open collector output to perform this function. Configure the RTS (Request to Send) to K (for Keyed) in the Communications Port Configuration to control this output. The module is installed as shown in the figure below.

Figure 3-5 C3263 Radio Keying Board Installation



Note: RTS (Request to Send) in the Communications Port Configuration must be in the K (Keyed) position for the C3263 Radio Keying Board to work. The RTS time may be controlled with the CTS Delay (no RTU reset required after change) in the Communication Channel Configuration.

3.3.3 RS485 Connections

Ports 3 and 4 of the RTU are designed for a 2-wire RS485 LAN (3-wire, including Return). The RTU can act as either the master or a slave on such an interface.

LEDs are supplied for both Transmit and Receive data. The pinouts for Ports 3 & 4 (RS485) are shown in Table 3-2.

Table 3-2 RS485 Ports 3-4 Connector Pinouts

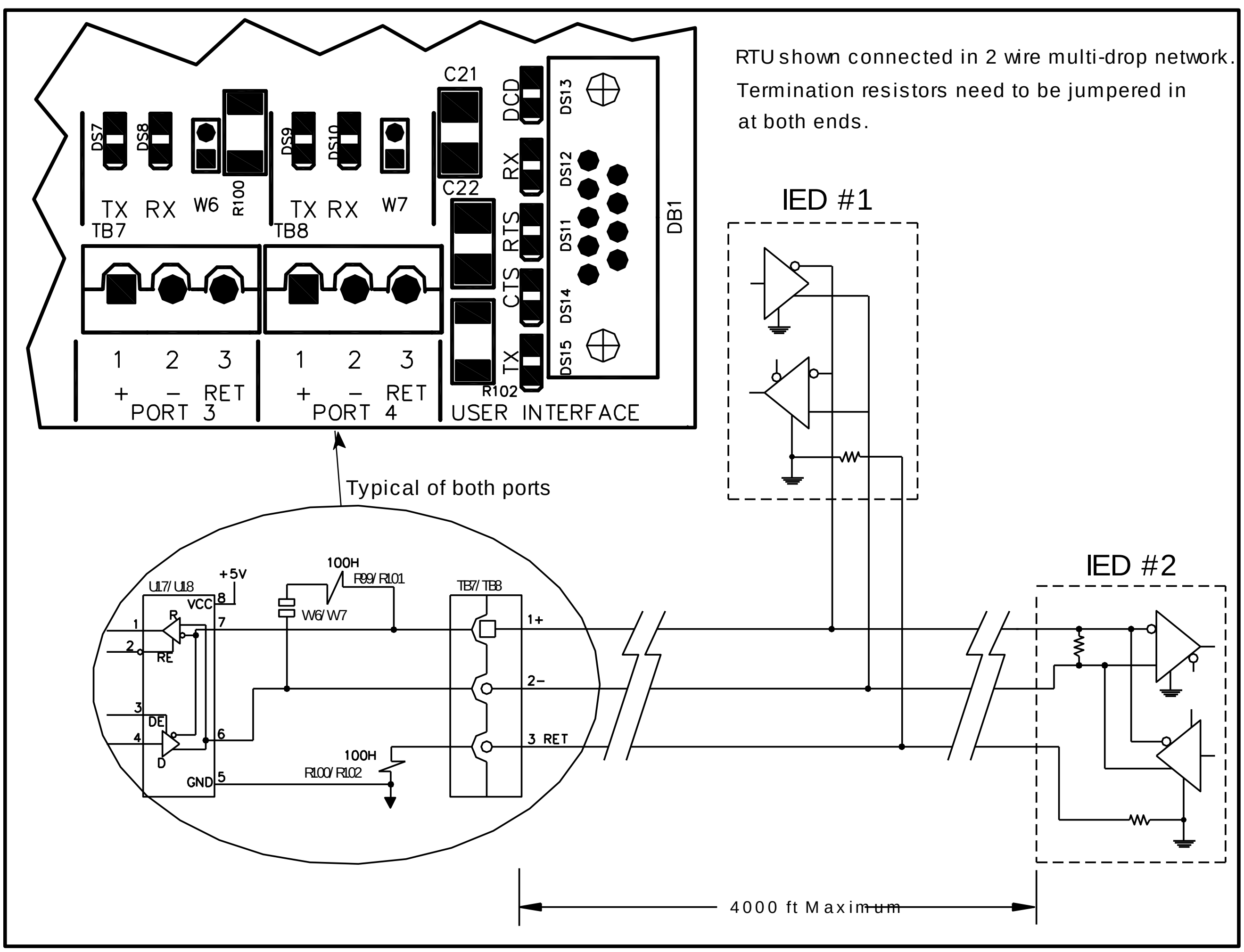
SIGNAL	PIN	DESCRIPTION	TYPE	LEDs
TX	1	Transmit data	output	X
RX	2	Receive data	input	X
RET	3	Ground	n/a	

X = Active

The next figure shows an RS485 2-wire connection with the RTU at one end of the RS485 LAN and IED#2 at the other end. If the run is long, each end of the RS485 LAN must have a termination resistor installed. The termination resistor is approximately 100 ohms and is built-in to the SAGE 1X30. Install jumper W6 for Port 3, and W7 for Port 4. IED#2 must also be terminated. Notice that IED#1 (a "tap off") does not need a termination resistor. This same principle applies to the SAGE 1X30. If the SAGE 1X30 is somewhere in the middle of an RS485 LAN, jumper W6 (or W7) should be removed. A maximum length of 4000 feet should be observed for the RS485 LAN.

Note: The RTS (Request To Send) signal on the 485 port will stay ON unless a non-zero value is entered for CTS (Clear To Send) in the communication interface. This means the RTU will send, but not receive. Always enter a non-zero value for CTS in the 485 port communications user interface. See the appropriate protocol manual.

Figure 3-6 Connections for the RS485 Ports



Notes:
The silkscreen is incorrect for TB7 and TB8 for baseboards C3500-001-REV-A through C3500-001-REV-D.
The correct usage of Pin 1 is "-" and Pin 2 is "+".
The silkscreen is correct for C3500-001-REV-E and newer.

3.3.4 User Interface Connections

There are four physical ways to connect to the SAGE 1X30:

- Ethernet connection to a network using a Straight-through cable to the CPU card
  - Best way to gain remote access
- Ethernet connection locally using an Ethernet crossover cable to the CPU card
  - Best way to gain local access
- PPP (Point-to-Point Protocol) connection using a null-modem cable to the UIF port
  - Moderately slow; can still access RTU locally or even remotely with a dedicated comm. Channel
- Console – this method commonly used to read and/or change IP address

Both the PPP and the Ethernet connections use the same GUI running on Internet Explorer. The difference is that the PPP connection runs at 38,400 baud; the Ethernet connection runs at 10/100MB. When dealing with a GUI, obviously the faster connection is much better. Therefore, the primary connection to the RTU is Ethernet.

3.4 Digital Input Terminations

The SAGE 1X30 uses the same digital input termination hardware for both status and accumulator inputs. The SAGE 1X30 Baseboard is equipped with 16 digital inputs that are accessed at TB3 (see Figure 3-7).

The DI mapping on TB3 is shown in Table 3-3. There is a one-to-one correspondence between TB3 pin number and the DI input, which by initial default power-up are all status points. However, DI points may be remapped so that statuses and accumulators are whatever point number desired. Please see the Config@WEB Secure Software Users Guide and the Config@WEB Secure Software Users Guide for mapping information.

Table 3-3 DI Mapping on TB3

Digital Input Record #	Digital Input #	TB3 Pin #
1	1	1
2	2	2
3	3	3
4	4	4
5	5	5
6	6	6
7	7	7
8	8	8
9	9	9
10	10	10
11	11	11
12	12	12
13	13	13
14	14	14
15	15	15
16	16	16

The Baseboard includes a fuse (F1) to protect the loop power source against shorts in the field wiring. For voltage-free DI contacts, connect the jumpers as shown in Figure 3-7. Devices with voltage outputs can be connected. See Figure 3-8. The device output voltage must match the design voltage for the DI point as defined by the variance structure in Table 3-4.

Table 3-4 Status & Accumulator Input Voltage Variance

Nominal Status Input Voltage	Variance
129VDC	C3500-AX1-X0000
12-24VDC	C3500-AX2-X0000
48VDC	C3500-AX4-X0000
5VDC	C3500-AX5-X0000

Notice that only one pin is used for each DI input on TB3 (unless the input is a Form C accumulator as in the example of Figure 3-8).

In the case of the internal 24V wetting variance, make sure that the factory-installed jumpers are in place on TB1-5 to 6, and TB1-7 to 8. To use external wetting, remove the jumpers (if installed) and connect an external source of the proper voltage to SV– (Return) and SVIN (+). See Figure 3-7. Always observe proper voltage according to the variance of your SAGE 1X30.

Figure 3-7 DI Connections (All Variances)

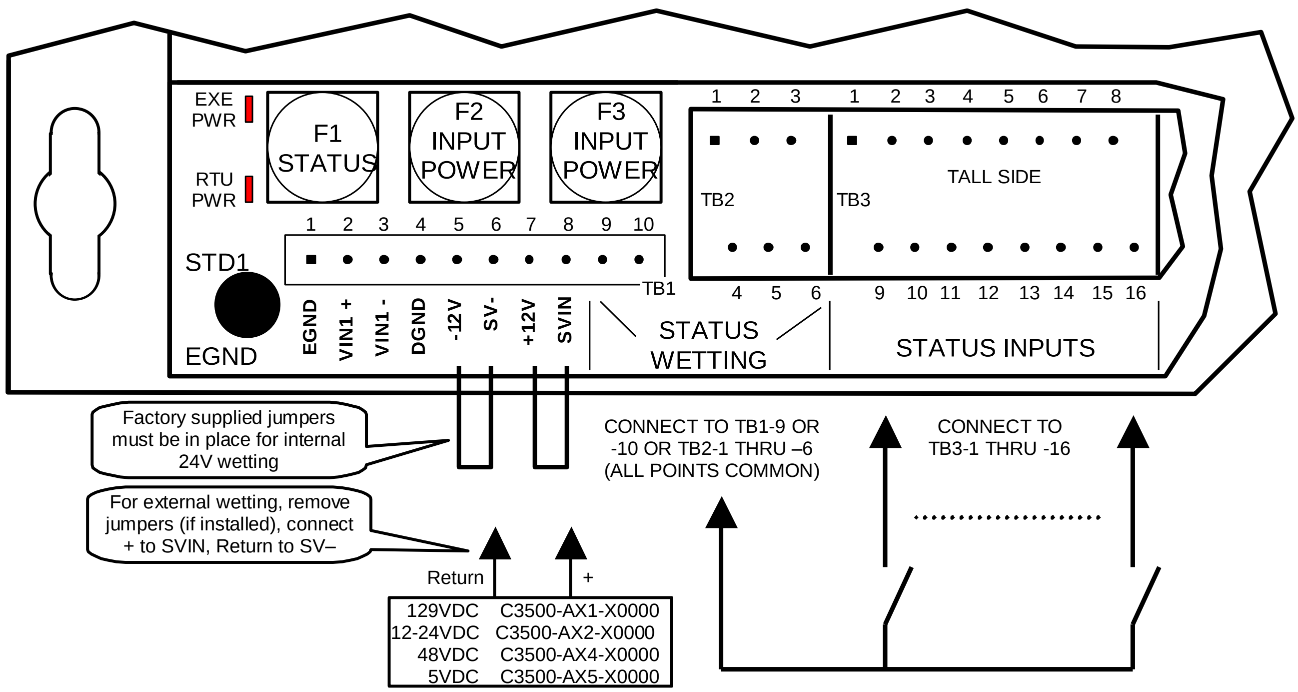
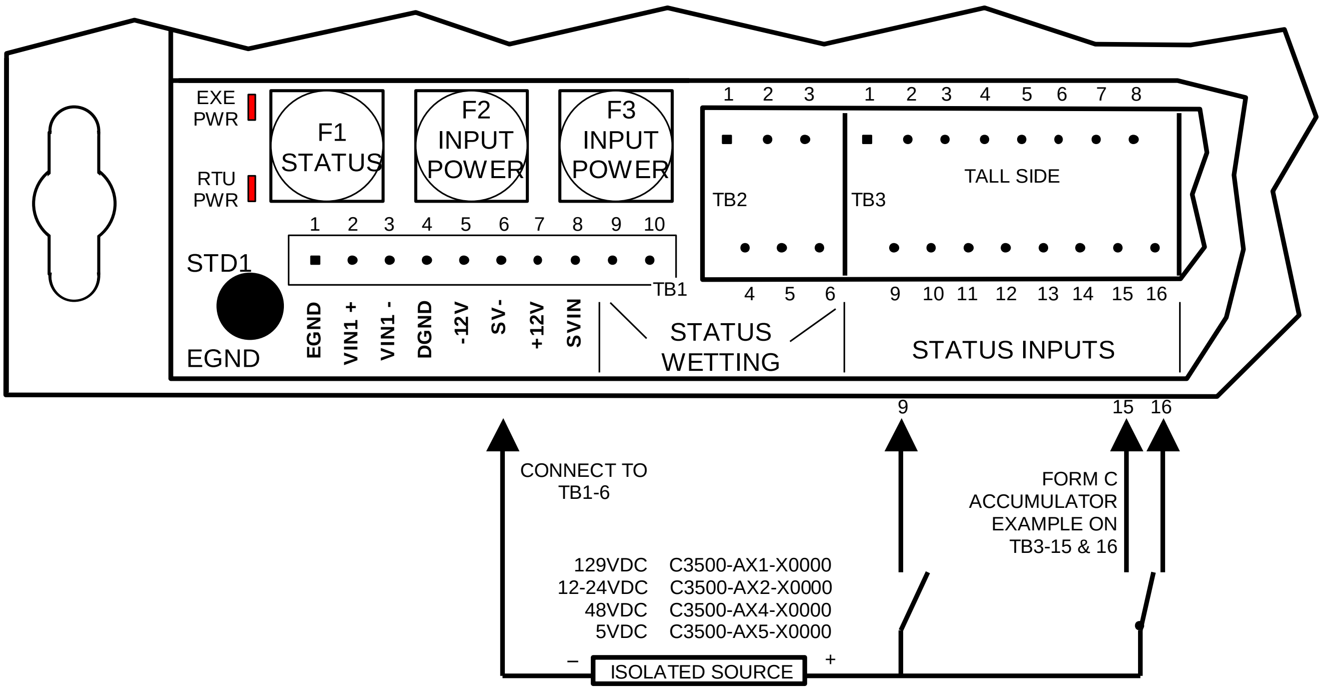


Figure 3-8 shows how to connect isolated self-powered contacts. This may be done in addition to the internal or external wetting supply for other contacts. In all cases, the voltage must match the variance number ordered from the factory or serious RTU damage will occur. Wetting supply voltage and variances are listed in Table 3-4. Figure 3-8 also shows an example of a Form C connection.

Figure 3-8 DI Connections Using Self-Powered Contacts (Isolated Supply)

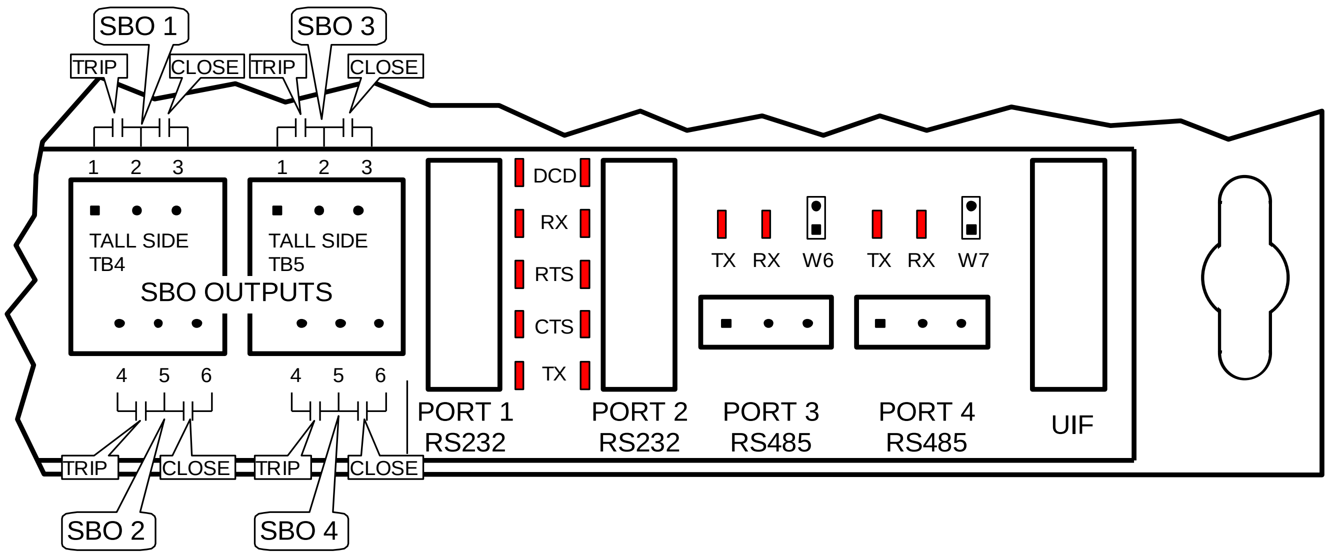


3.5 Control Output Terminations

The SAGE 1X30 Baseboard includes relays and terminations for four SBO (momentary) control points available at TB4 and TB5. The trip and close for each point share a common connection. Refer to Figure 3-9 for connection information.

CAUTION: The miniature momentary relays should not be used to switch 125VDC devices, even if the current is significantly less than 10A. The contact rating of these relays is greatly reduced at such high DC voltages and the relay is subject to failure if the maximum current is exceeded. Consult the factory if you are unsure of the suitability of the relays.

Figure 3-9 SBO XT Field Wiring



3.6 Jumpers

All jumper designations and functions for the Baseboard are found in the Maintenance chapter of this manual. It is important that the jumper configurations are properly set to prevent the RTU from malfunctioning. Please check the jumper settings whenever an addition or change is made to the RTU configuration.

3.7 PC/104 Expansion Installation

The PC/104 interface provides for expanded functionality. The PC/104 expansion cards are described in the following sections. PC/104 expansion cards are optional.

3.7.1 C3461 Trimble GPS Receiver

The C3461 PC/104 Trimble GPS Receiver consists of the SATPAK Carrier Board and the Trimble GPS Receiver Board riding piggy-back.

Caution: The SATPAK Carrier Board and the Trimble GPS Receiver Board are permanently joined. Do NOT attempt to separate the two. Also take care to avoid bending any pins on the C3461 or the PC/104 assembly on which it is mounted.

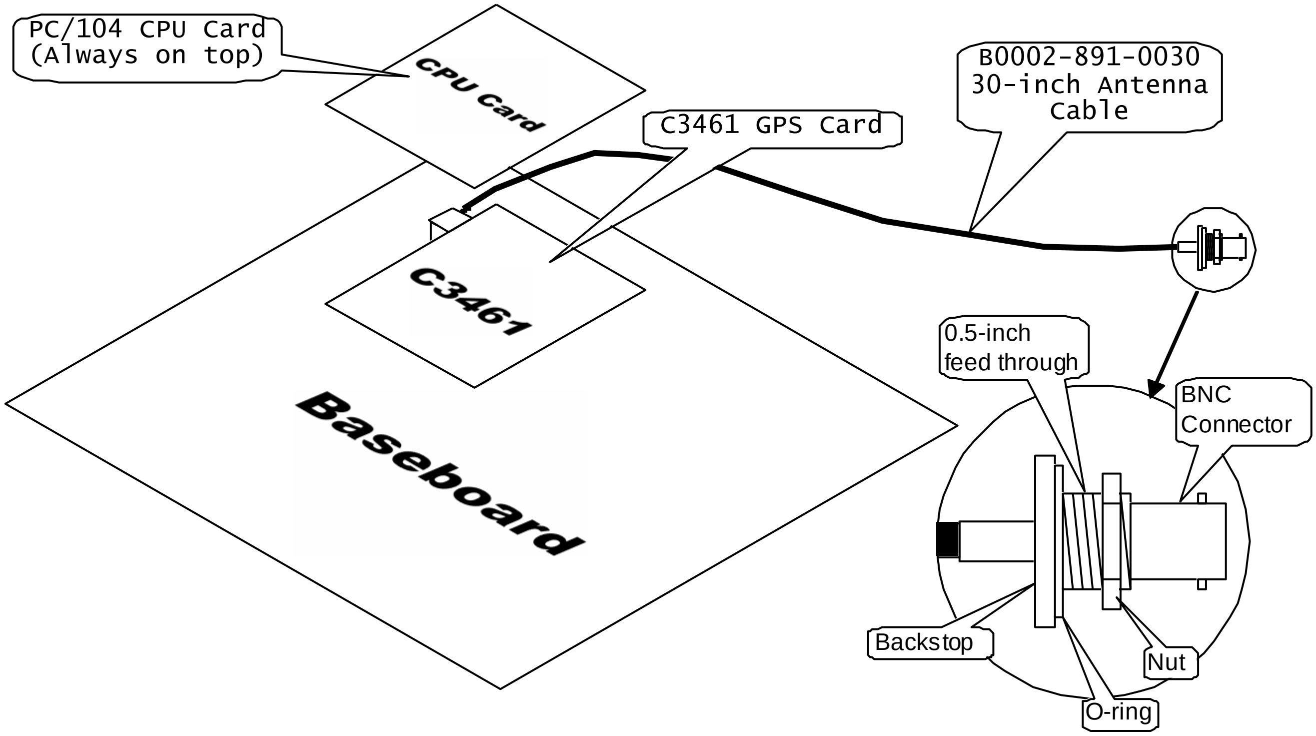
As shown below, the C3461 requires only a few steps for physical installation:

1. Unplug the CPU card.
2. Plug the C3461 into the baseboard.
3. Plug the CPU card into the top of the C3461. The CPU card must always be on top.
4. There is a 30-inch thin coax cable that attaches to the C3461 card. The BNC end may be mounted through a 0.5-inch hole in the cabinet or other barrier. The assembly comes with a built-in O-ring to afford some weather protection.
5. Mount the GPS antenna in an elevated, clear area outside the building.

6. Connect a suitable length of BNC cable* from the antenna to the cabinet-mounted BNC connector.

Note: Telvent supports a maximum length of 50 foot of RG-58 coaxial cable.

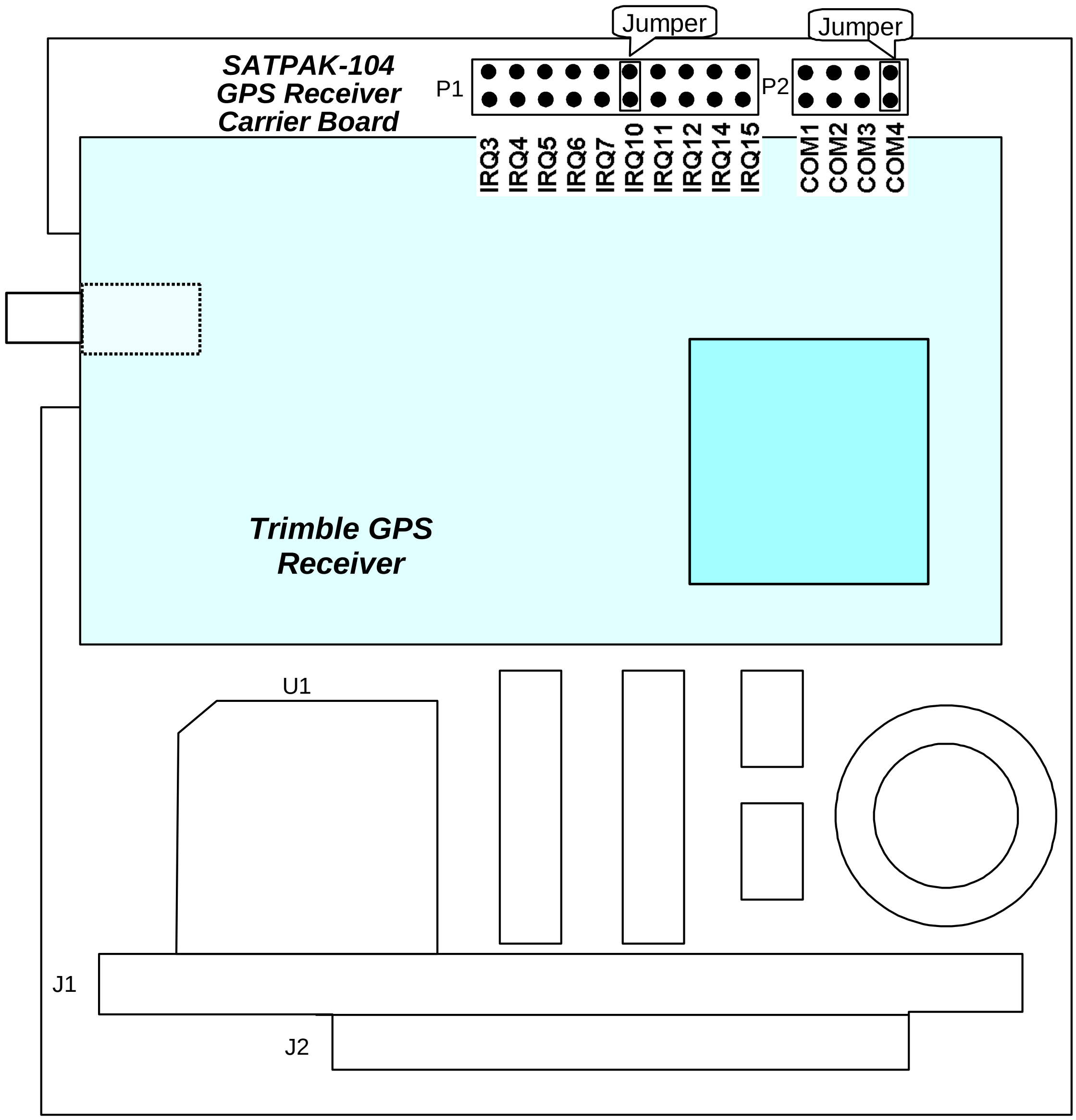
Figure 3-10 C3461 PC/104 Trimble GPS Receiver



3.7.1.1 C3461 GPS Jumper Configuration for P1 & P2

P1 and P2 should have the jumpers and wire connection as shown below.

Figure 3-11 C3461 Board Layout

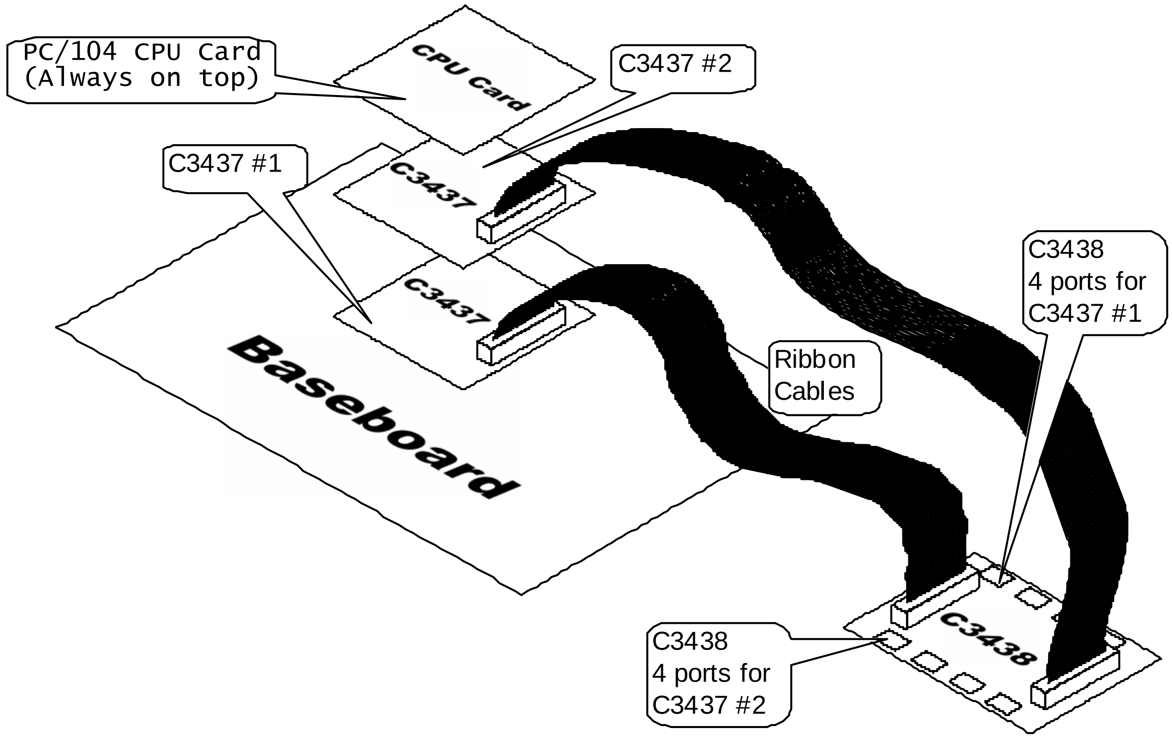


3.7.2 C3437 Comm Expansion & C3438 RS-232 Port Card

3.7.2.1 Introduction

The C3437 is a PC/104 card that is plugged into the baseboard on the PC/104 bus beneath the CPU card. One C3437 will service four ports on a C3438 (see Figure 3-12). Another C3437 is required to support the remaining four ports on the C3438.

Figure 3-12 Installing the C3437/C3438 Communications Expansion Cards



3.7.2.2 C3437 IRQ (Interrupt) Selection

The C3437 must be version B or above.

	Board 1	**Board 2**
IRQ9	OUT	OUT
IRQ3	OUT	OUT
IRQ6	IN	IN
IRQ7	OUT	OUT
PD (Pull Down)	OUT	OUT
BOARD1	IN	OUT

3.7.2.3 C3438-002-REV-X, XT Board

The XT board is used to provide 8 DB-9F terminations for two C3437 4 channel communications boards. All signals in the DB-9F connector are RS-232 levels and are configured as DTE (Data Terminal Equipment).

Two ribbon cable connectors are provided to accept signals from the C3437 boards.

Connect the C3437 board(s) to the XT as follows:

C3438 Connector	C3437
J1	Board 1
J2	Board 2

The DB-9F connectors are configured as follows:

C3437	C3437Channel	C3438 Port	RTU Channel
Board 1	1	1	5
Board 1	2	2	6
Board 1	3	3	7
Board 1	4	4	8
Board 2	1	5	9
Board 2	2	6	10
Board 2	3	7	11
Board 2	4	8	12

The pins in the DB-9F are used as follows:

Pin	Signal	Direction
1	RXCLK	Input
2	RX#	Input
3	TX#	Output
4	DTR	Output
5	DGND	
6	DCD	Input
7	RTS	Output
8	CTS	Input
9	TXCLK	Input

3.7.3 C3463 PCA Ethernet 10/100 5-Port Switching Hub

The optional C3463 5-Port Ethernet switching hub expands the number of Ethernet ports to five. There is no special software needed, but because of clearance restrictions, the card must be installed on top.

Figure 3-13 C3463 5-Port Ethernet Switching Hub

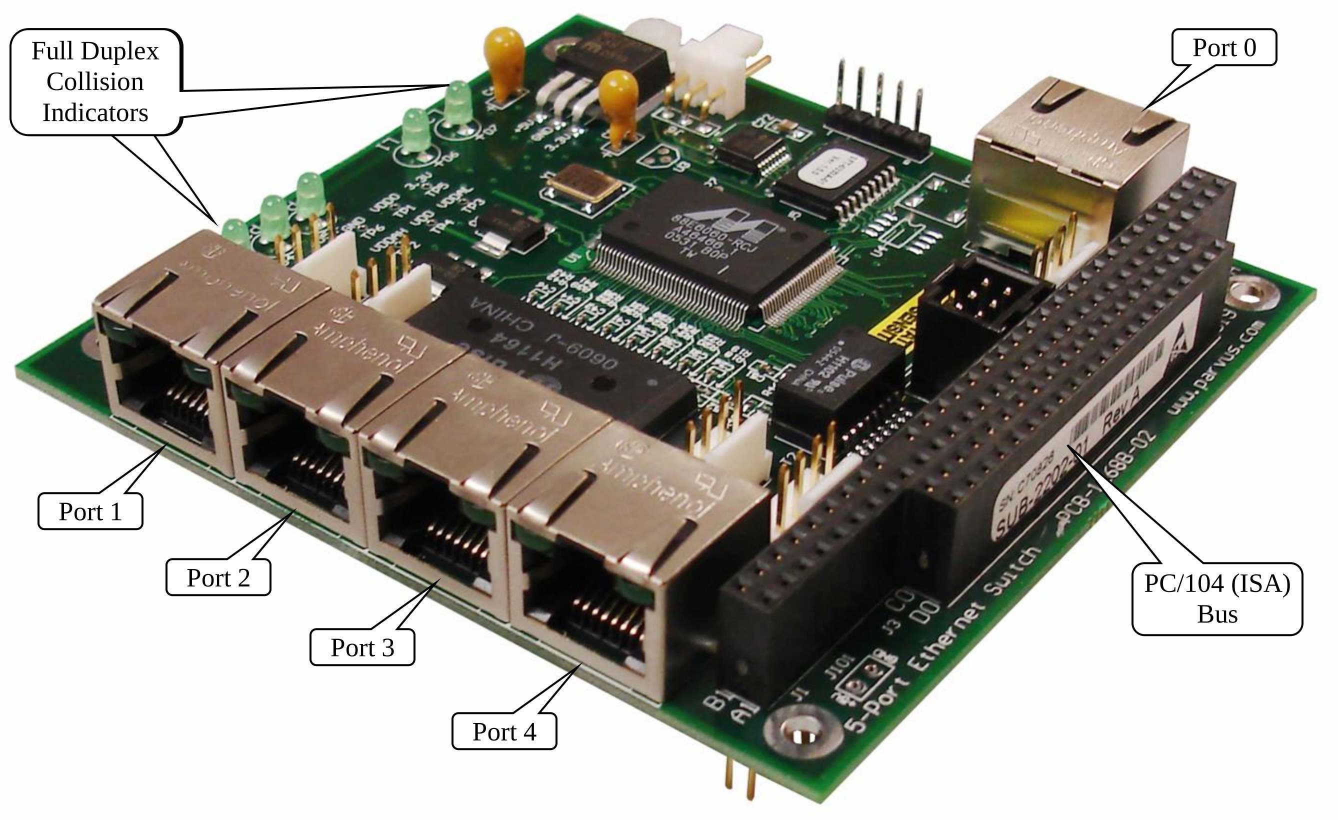
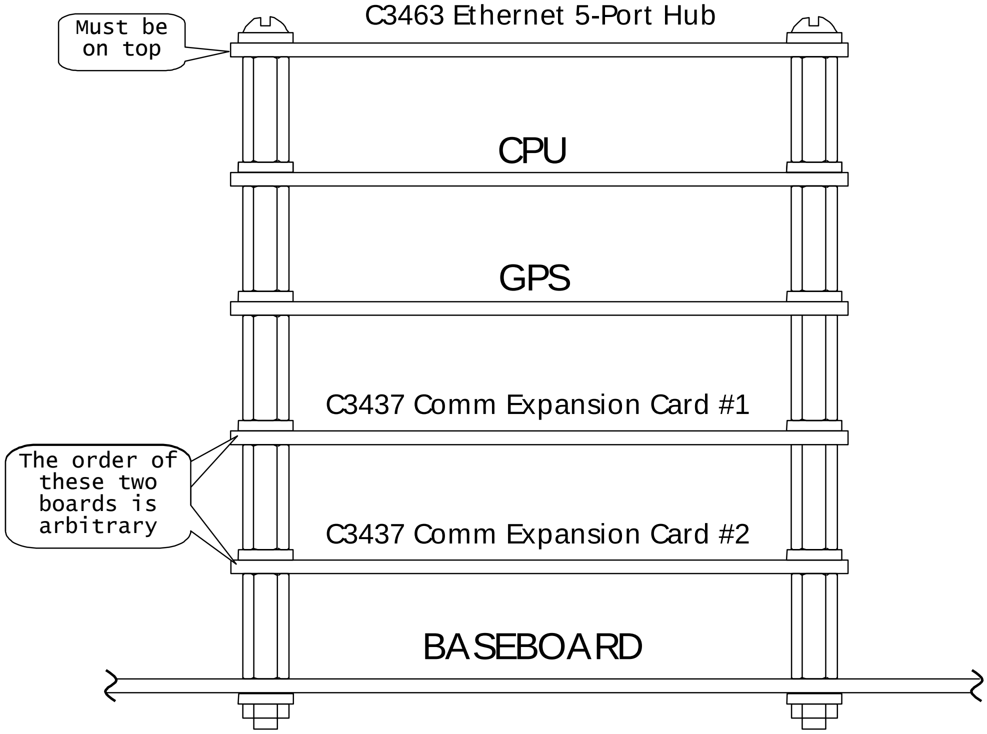


Figure 3-14 PC/104 Card Stacking



3.7.4 C3830 PC/104 AI Card

The PC/104 Analog Input Module is an option that can be used with the SAGE 1X10, 1X30, 1X50 or 3030/3030M models. It adds traditional DC analog inputs to the I/O capabilities of the base unit. The PC/104 Analog Input module is easy to add by simply plugging it into the PC/104 bus. It is added in the same way that a Serial Communication Expansion module or GPS Module is added to the PC/104 stack. Once the card is added, a ribbon cable connects it to the first SAGE Analog Input XT card. Additional modules then connect together in a daisy chain fashion.

- Add up to 256 analog input points
- All Standard input ranges supported

Figure 3-15 C3830 PC/104 AI Card

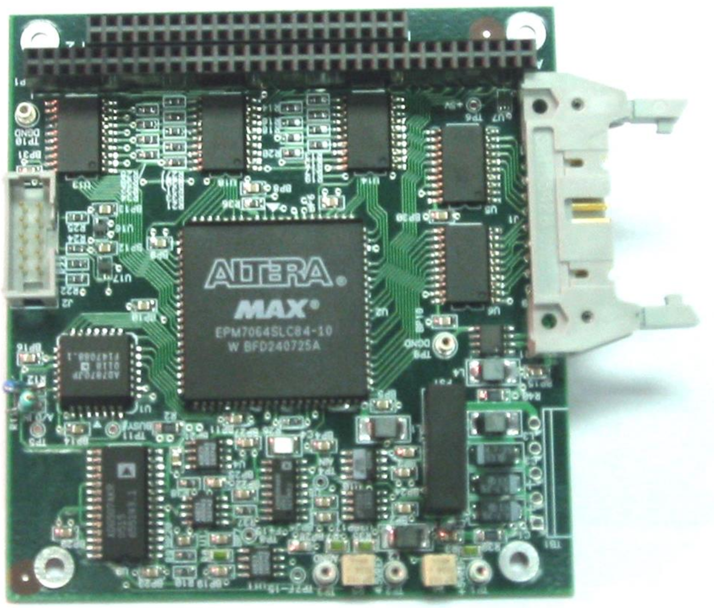
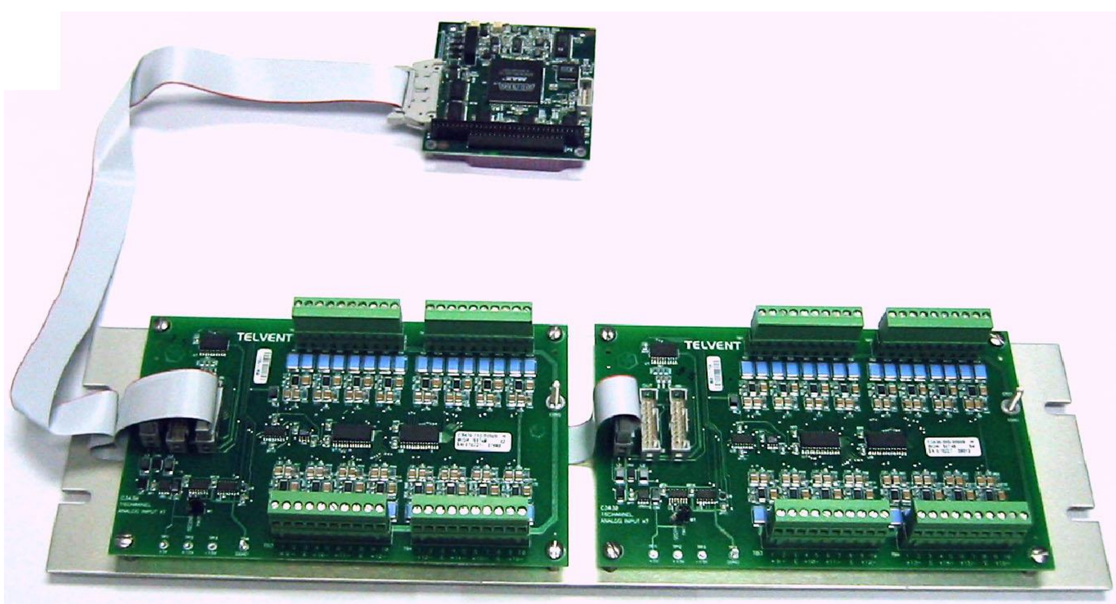


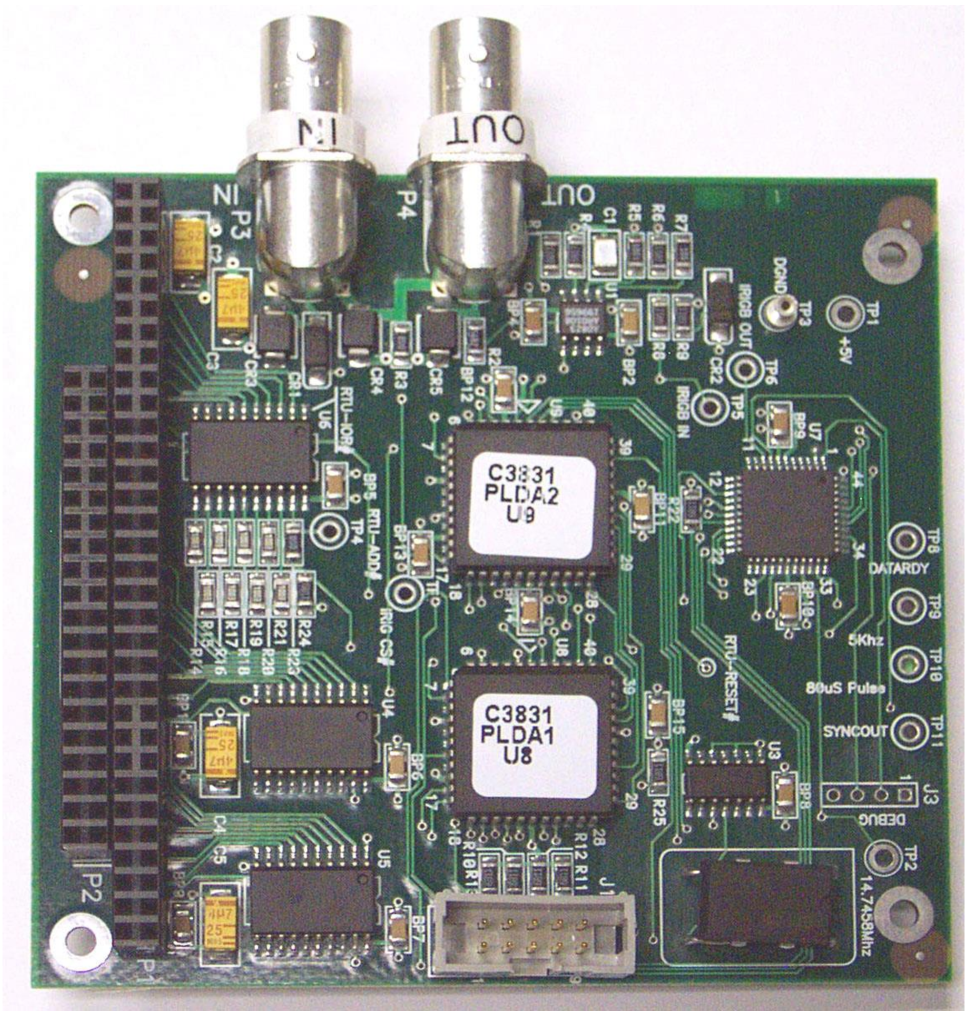
Figure 3-16 C3830 PC/104 AI Card w/XTs



3.7.5 C3831 PC/104 IRIG-B Card

The IRIG-B card pictured below is available for all SAGE RTUs except the S3030/3030M, which have built-in IRIG-B.

Figure 3-17 C3831 PC/104 IRIG-B Card



3.7.5.1 IRIG-B signal as a Input to the RTU

If the RTU IRIG-B system is connected to an IRIG-B source, it must provide a B 0 2 X or B 1 2 X Time Code Format signal to the RTU.

Modulation/Frequency (First Digit of IRIG-B Time Code Format)

0 - Pulse Width Code

1 - Sine Wave, Amplitude Modulated

Frequency/Resolution (Second Digit of IRIG-B Time Code Format)

2 - 1kHz/1ms

Coded Expressions (Third Digit of IRIG-B Time Code Format)

0 through 7 is acceptable. The RTU IRIG-B system uses only the BCDtoy (Binary-Coded-Decimal time-of-year) Coded Expressions part of the IRIG-B data stream. The BCDtoy is included in Coded Expressions 0 to 7 of the IRIG-B data stream.

3.7.5.2 IRIG-B signal Output from the RTU

If the RTU IRIG-B system is driven by a time source in the RTU, the Time Code Format is B 0 2 2.

Modulation/Frequency (First Digit of IRIG-B Time Code Format)
0 - Pulse Width Code

Frequency/Resolution (Second Digit of IRIG-B Time Code Format)
2 - 1kHz/1ms.

Coded Expressions (Third Digit of IRIG-B Time Code Format)
2 - BCDtoy

3.7.5.3 IRIG-B Reference

The following is a link to the IRIG Standard 200-04 document for IRIG Serial Time Code Formats.

https://wsmrc2vger.wsmr.army.mil/rcc/manuals/200-04/TT-45.pdf

4 Maintenance

This chapter describes maintenance procedures for the SAGE 1X30. Those users who desire a more thorough technical understanding of the SAGE 1X30 should refer to the Theory of Operation chapter which contains detailed descriptions of each module, and to the Drawings chapter, which contains complete schematics, bills of materials, and printed circuit board assembly drawings.

The following equipment is recommended for performing routine maintenance and repair on SAGE 1X30 RTUs:

- General-purpose 3-1/2 digit DMM
- General-purpose oscilloscope

The SAGE 1X30 requires no routine adjustments.

4.1 Comm Port Diagnostics

The RTU includes a built-in test routine that allows limited testing of the communication ports. Click the Command tab, then click Serial Comm. You will see a screen similar to Figure 4-1.

Figure 4-1 Command Communications Port Data

Command Communication Port Data

Port Number	RTS	DTR	Name	Protocol	Command Port Data	Test Mode
Port #1	K	K	Series V to Master	Series V	Port Data	Normal
Port #2	K	K	Port 2	DNPM	Port Data	Normal
Port #3	K	K	Port 3	Series V	Port Data	Normal
Port #4	K	K	Port 4	None	Port Data	Normal
Port #5	K	K	Port 5	None	Port Data	Normal
Port #6	K	K	Port 6	None	Port Data	Normal
Port #7	K	K	Port 7	None	Port Data	Normal
Port #8	K	K	Port 8	None	Port Data	Normal
Port #9	K	K	Port 9	None	Port Data	Normal
Port #10	K	K	Port 10	None	Port Data	Normal
Port #11	K	K	Port 11	None	Port Data	Normal
Port #12	K	K	Port 12	None	Port Data	Normal

Back

Under the Test Mode heading, select the type of test you wish from the pull-down menu for the port of interest. The choices and the meaning of each type of test are listed below. See Figure 4-3 for the expected results for each test.

Normal

In the normal mode, the selected comm channel functions normally. Each channel will be in this mode when the display is called up. Each channel is automatically restored to this mode when you exit from the display or the RTU is reset.

Mark

In the mark mode, the selected comm channel outputs a continuous stream of ones. Marks for the RS-232 channel are low (negative) voltage pulses, and low frequency (1,200Hz) for any attached 202 modem.

Space

In the space mode, the selected comm channel outputs a continuous stream of zeros. Spaces for the RS-232 channel are high (positive) voltage pulses, and high frequency (2,200Hz) for any attached 202 modem.

Alt

In the Alt mode, the selected comm channel outputs a continuous stream of alternating ones and zeros at the baud rate originally selected for the channel.

You may use a scope to see the outputs on the ports under test as shown in Figure 4-3. Notice that the test mode will terminate and return to Normal mode if you leave this screen with the pull-down menus in anything other than Normal, as shown in Figure 4-2.

Figure 4-2 Clicking the Back Button While in Test

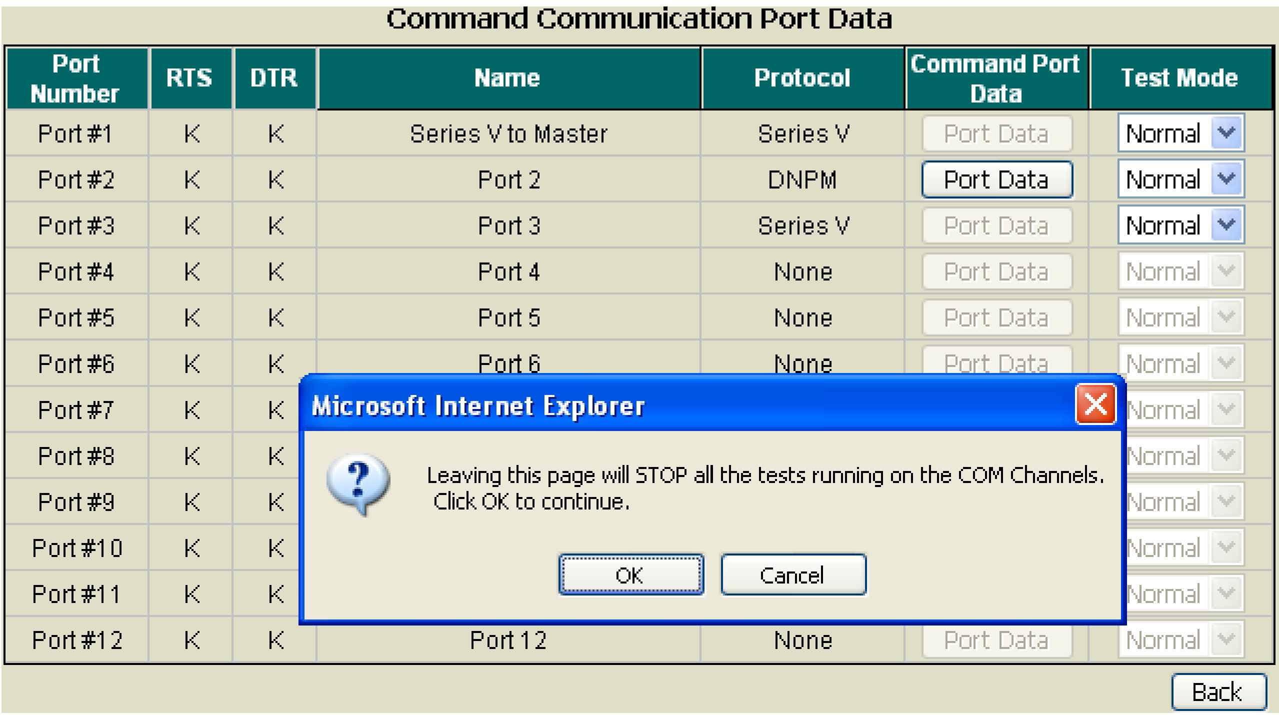
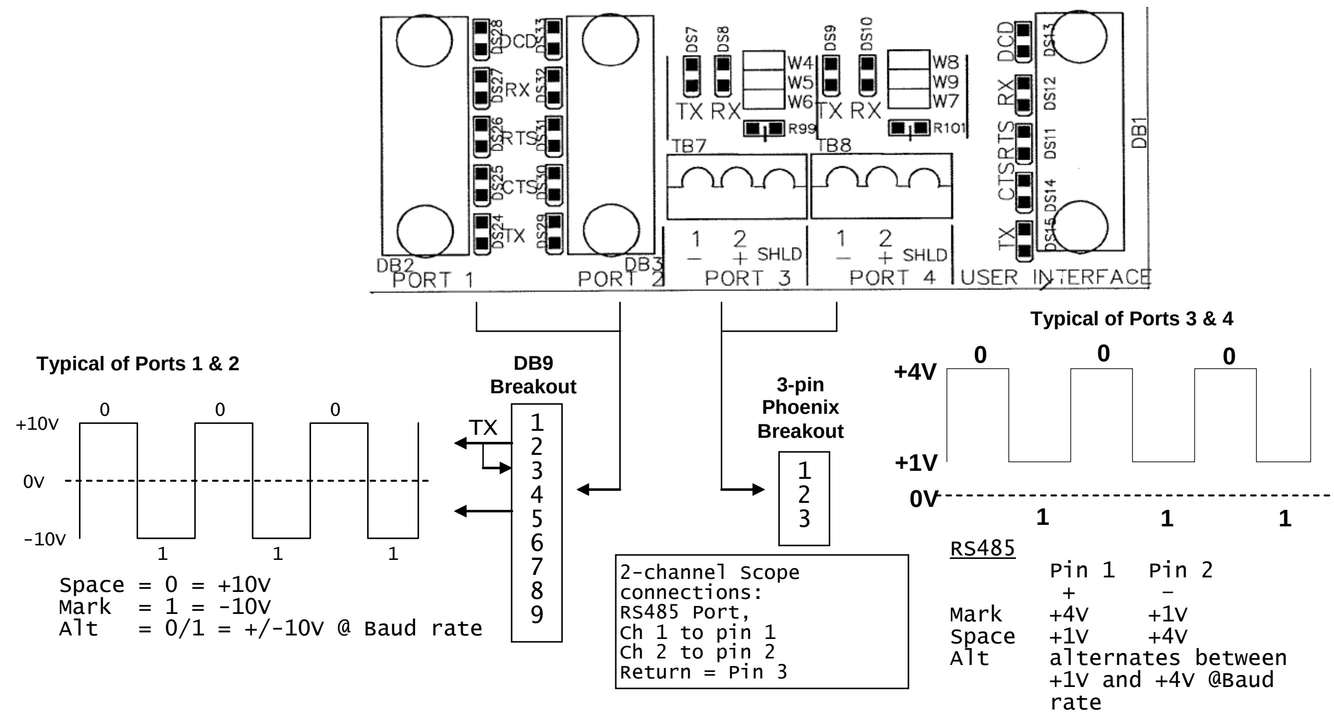


Figure 4-3 Comm Port Test



Note: A protocol must be assigned to the port undergoing Port Test

Note: Measure the RS485 pins with either two scope channels (pins 2 to 3) for a differential, or one scope channel displaying pin 1 then pin 2 with pin 3 as the common.

4.2 Troubleshooting

This section includes a brief guide to troubleshooting some of the more common problems that could occur in the SAGE 1X30. If you are troubleshooting to the component level, the use of the Theory of Operation chapter and the Drawings chapter will be helpful.

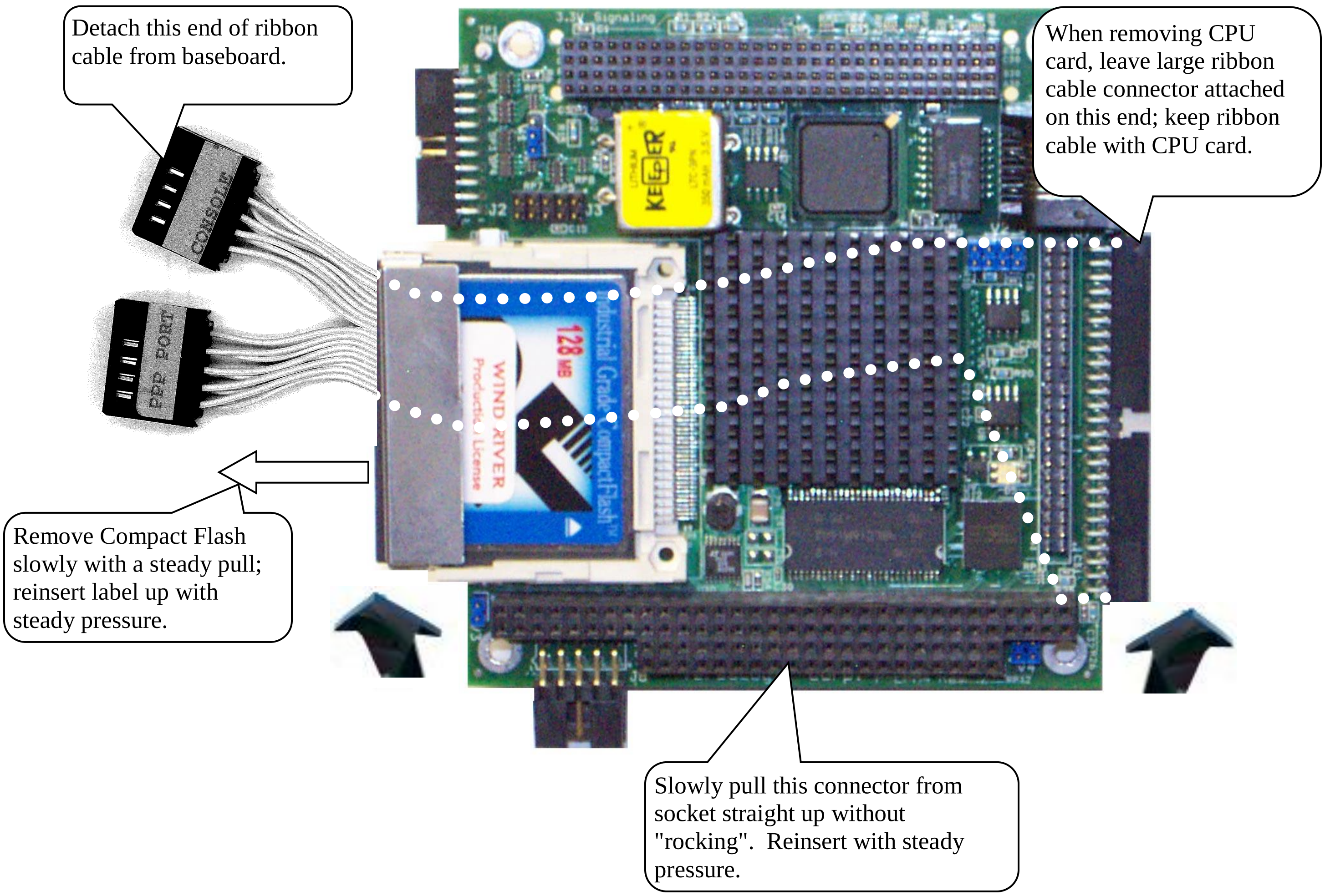
4.2.1 Removing PC/104 CPU Card or Compact Flash

If you determine that the PC/104 CPU card or the Compact Flash must be removed or reinserted for any reason, follow the directions below.

Note: Ensure power is OFF before disconnecting anything on the RTU.

Note: For those Compact Flashes that have a retaining clip, remove the clip carefully because if the clip springs out of its holder, it can damage small parts on the CPU card.

Figure 4-4 Green PC/104 CPU Card with Ribbon Cable & Compact Flash



The newest PC/104 CPU card is shown in Figure 4-5. Note that the newer card has a red printed circuit board rather than green. Although the compact flash and the ribbon cable are not shown, all the rules of handling that apply to the green card apply to the red card. Also note that the red card has two Ethernet ports.

Note: You must have the red card in your RTU to use the secure firmware. This firmware is designated C3414-500-S02YZ (YZ represents the firmware level). The red card has a secure operating system that supports the secure firmware. Please see the Config@WEB Secure Software Users Guide.

Figure 4-5 Red PC/104 CPU Card

4.2.2 Visual Inspection

A visual inspection of the equipment is often a good place to start the troubleshooting process. Look for frayed or loose connections, blown fuses, and any indications of damage or excessive wear. Check that switches and jumpers are in the right position and that input power is being supplied to the RTU. Verify that the LEDs are providing expected indications compared to the present status conditions.

4.2.3 Data Display

You can use the Data Display Menu to monitor the operation of input and output devices. The Data Display can be compared to the LEDs as a means of status verification.

4.2.4 LED Indicators on Baseboard

Refer to Figure 4-10 for the location of LEDs, Test Points, and jumpers on the Baseboard, and to Figure 4-6 for the location of LEDs on the C3438 Communications Expansion Card. The SAGE 1X30 has been designed with enough LEDs to provide the operator an indication of the activities being performed by the RTU.

RTU Power

The RTU Power LED (DS2) illuminates when +5V is present on the Baseboard. The RTU Power LED is located at the lower left on the board and on Figure 4-10.

EXE Power (Relay Power)

The EXE Power LED (DS1) illuminates when there is power available to the SBOs. SBO Power (and the illumination of DS1) depend on full power to the baseboard and valid logic being present at U7, the SBO EPLD. The EXE Power LED is located at the lower left on the board.

Communication
RS232

Each of the RS232 communications ports, both on the baseboard and on the C3438, are indicated by 5 LEDs as noted in Table 4-1. The LEDs for Ports 1 & 2 are located next to the ports at the lower right on the SAGE 1X30.

Table 4-1 RS232 Communication LEDs

Signal	Baseboard			C3438 Communications Expansion Card							
	UIF	CH-1	CH-2	CH-1	CH-2	CH-3	CH-4	CH-5	CH-6	CH-7	CH-8
TX	DS15	DS24	DS29	DS5	DS10	DS15	DS20	DS25	DS30	DS35	DS40
CTS	DS14	DS25	DS30	DS4	DS9	DS14	DS19	DS24	DS29	DS34	DS39
RTS	DS11	DS26	DS31	DS3	DS8	DS13	DS18	DS23	DS28	DS33	DS38
RX	DS12	DS27	DS32	DS2	DS7	DS12	DS17	DS22	DS27	DS32	DS37
DCD	DS13	DS28	DS33	DS1	DS6	DS11	DS16	DS21	DS26	DS31	DS36

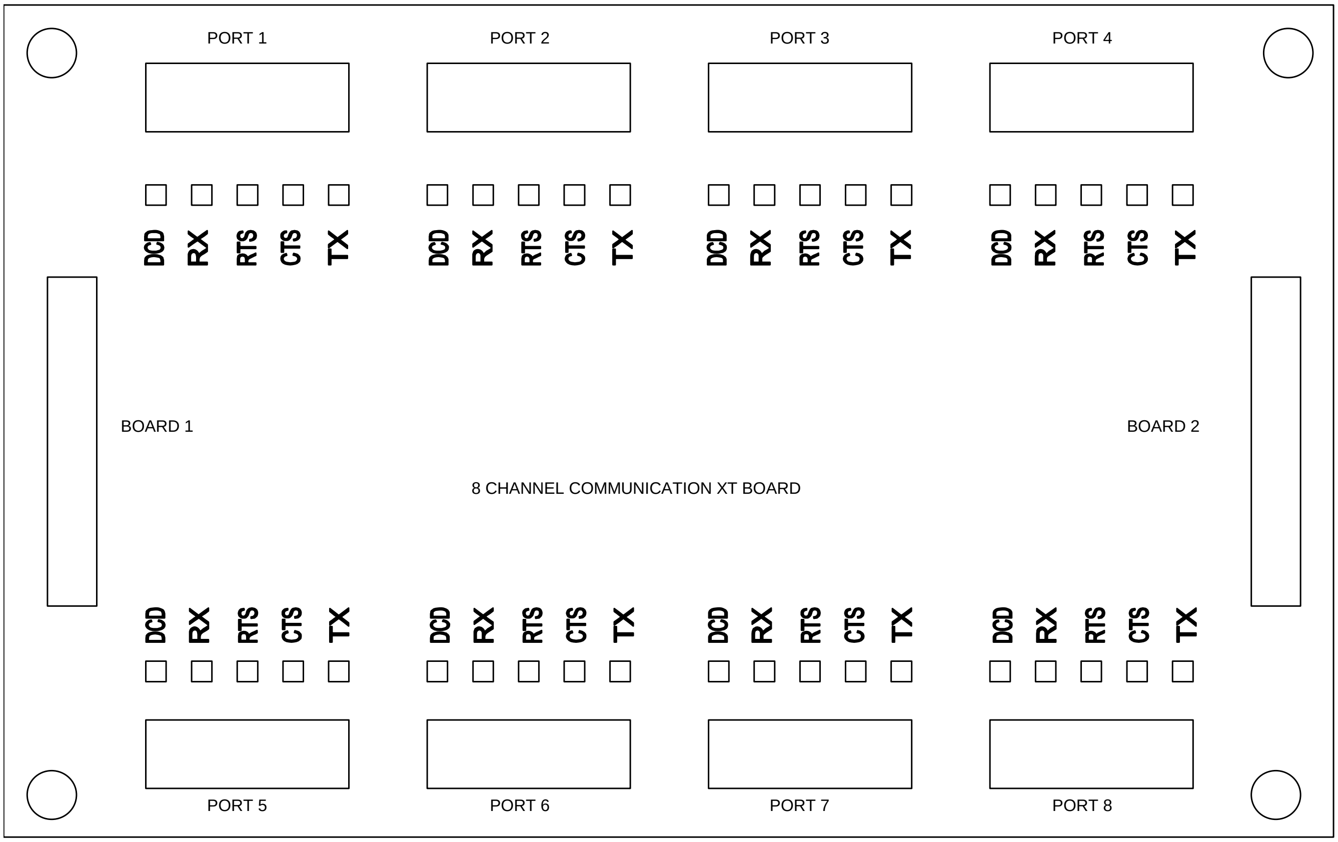
Communication
RS485

Both RS485 communications ports are indicated by 2 LEDs as noted in Table 4-2. The LEDs for Ports 3 & 4 are located next to the ports at the lower right on the SAGE 1X30.

Table 4-2 RS485 Communication LEDs

Signal	CH-3	CH-4
TX	DS7	DS8
RX	DS9	DS10

Figure 4-6 C3438 Board Layout

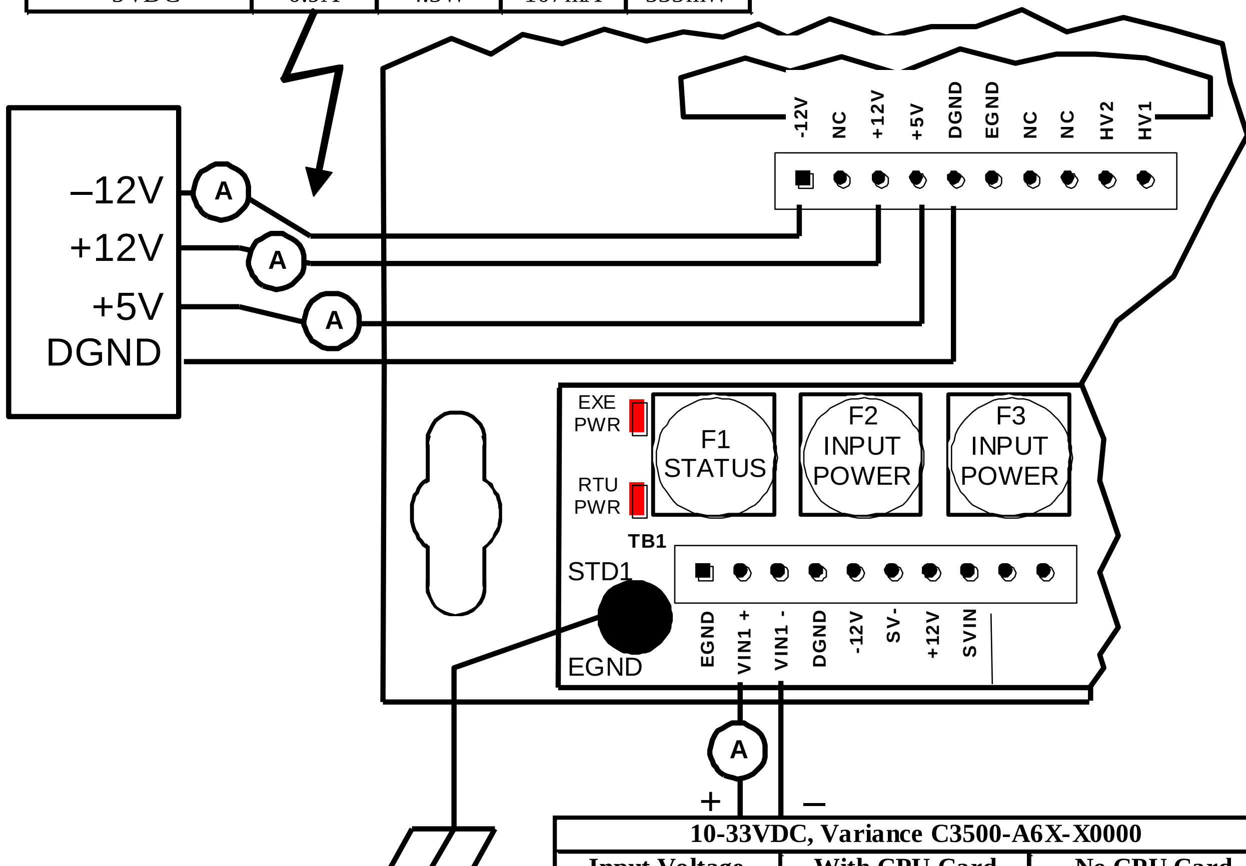


4.2.5 Power Consumption Test

If you suspect that the internal power supply is not performing properly, or that the board is drawing more power than it should, then check the power consumption of the board (unloaded; no I/O). The following tests were done with variance C3500-A0X-X0000 (no internal P/S) and with variance C3500-A6X-X0000, 10-33VDC P/S option. The test was done with, and without, a CPU card for troubleshooting comparisons of a normal unit.

Figure 4-7 Power Consumption Tests

No internal P/S, Variance C3500-A0X-X0000				
Input Voltage	With CPU Card		No CPU Card	
	I	P	I	P
–12VDC	1.2mA	14.4mW	1.52mA	18.2mW
+12VDC	4.0mA	48mW	3.92mA	47mW
+5VDC	0.9A	4.5W	107mA	535mW



10-33VDC, Variance C3500-A6X-X0000				
Input Voltage	With CPU Card		No CPU Card	
	I	P	I	P
10VDC	615mA	6.2W	115mA	1.15W
15VDC	411mA	6.2W	75.7mA	1.14W
33VDC	398mA	13.1W	36.1mA	1.20W

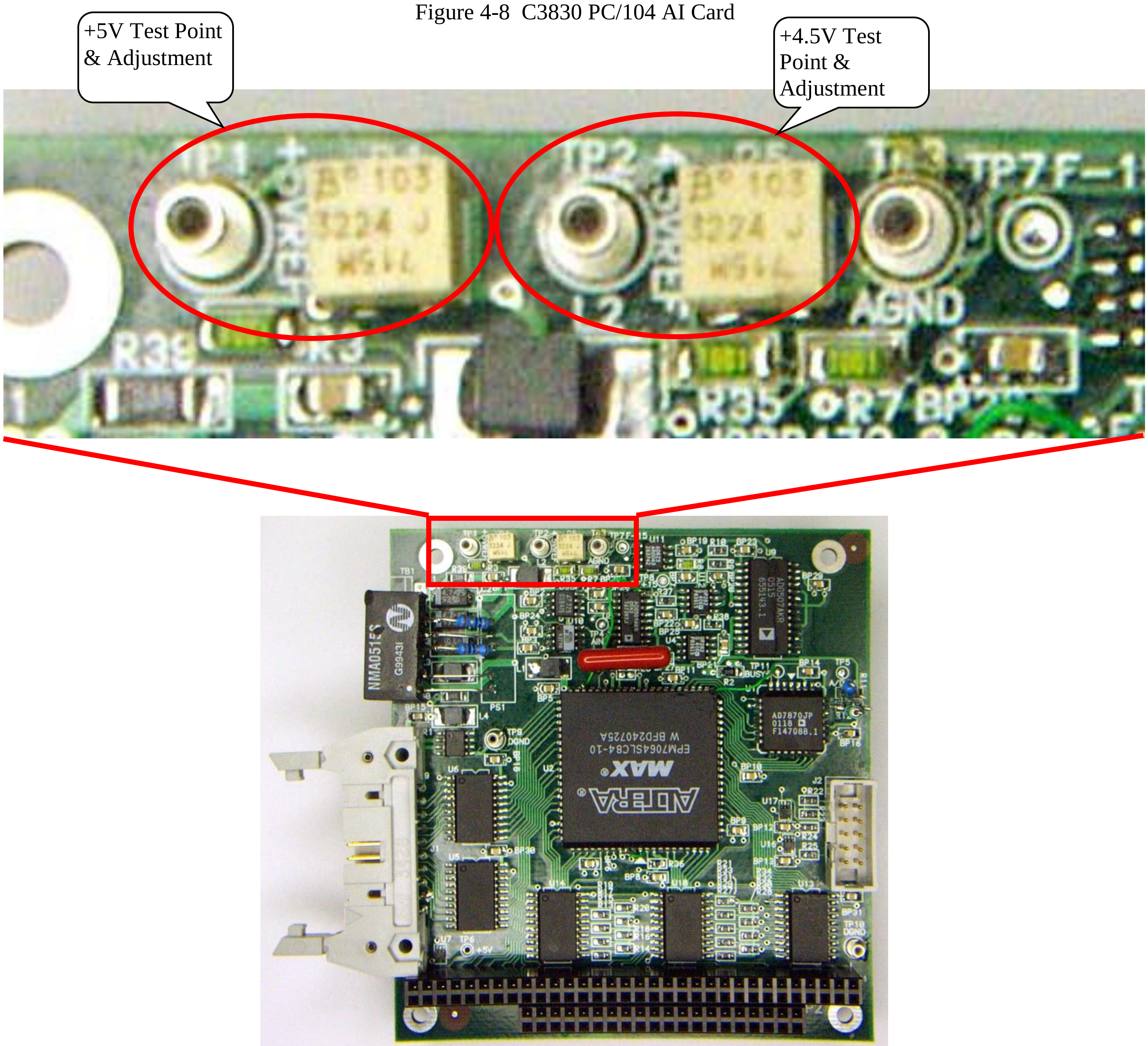
4.3 Analog Input Calibration (Optional C3830 Card)

The analog input card has a simple calibration technique that is intended for use while the RTU is operating on-site. The RTU has two dedicated internal references that provide 5V and 4.5V, which are used to calibrate the A/D. Since the RTU is generating these references, only a precision voltmeter and a small screwdriver are required to perform the calibration. See the figure below to locate adjustments and test points.

1. Connect the voltmeter between TP3 (analog ground) and TP1 (5V reference)
2. Adjust potentiometer R4 until the meter indicates 5.000 Volts ±0.001V.
3. Connect the voltmeter between TP3 (analog ground) and TP2 (4.5V reference).
4. Adjust potentiometer R5 until the meter indicates 4.500 Volts ±0.001V.

This ensures the internal ±100% and ±90% reference points are accurate.

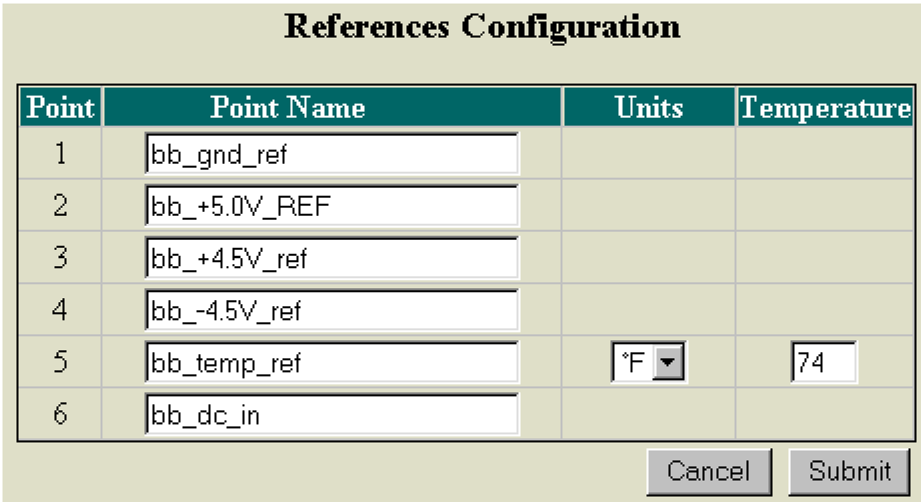
Figure 4-8 C3830 PC/104 AI Card



4.4 Temperature Calibration (Optional AI Card)

The References Configuration screen allows you to set the temperature units (°F or °C) and correct the temperature reading. This step should not be done remotely because you must enter the current correct temperature at the RTU. See below. Click Submit when you are satisfied with the configuration, or Cancel to back out of the function without saving.

Figure 4-9 References Configuration



4.4.1 Test Points

The following test points are included on the SAGE 1X30 baseboard:

Table 4-3 Test Points

Testpoint	Signal	Schematic Page	Allowable Range
TP1	DGND	5	N/A
TP2	DGND	5	N/A
TP3	DGND	5	N/A
TP4	+12 Volts	5	11.4 to 12.6
TP5	–12 Volts	5	–12.6 to –11.4
TP6	4.9152MHz	5	4.9149 to 4.9155
TP7	* RTU-ID#	1	N/A
TP8	+5 Volts	5	4.95 to 5.05

* This signal is asserted as a low pulse whenever any I/O is accessed on the baseboard.

4.5 Jumper Positions, Baseboard

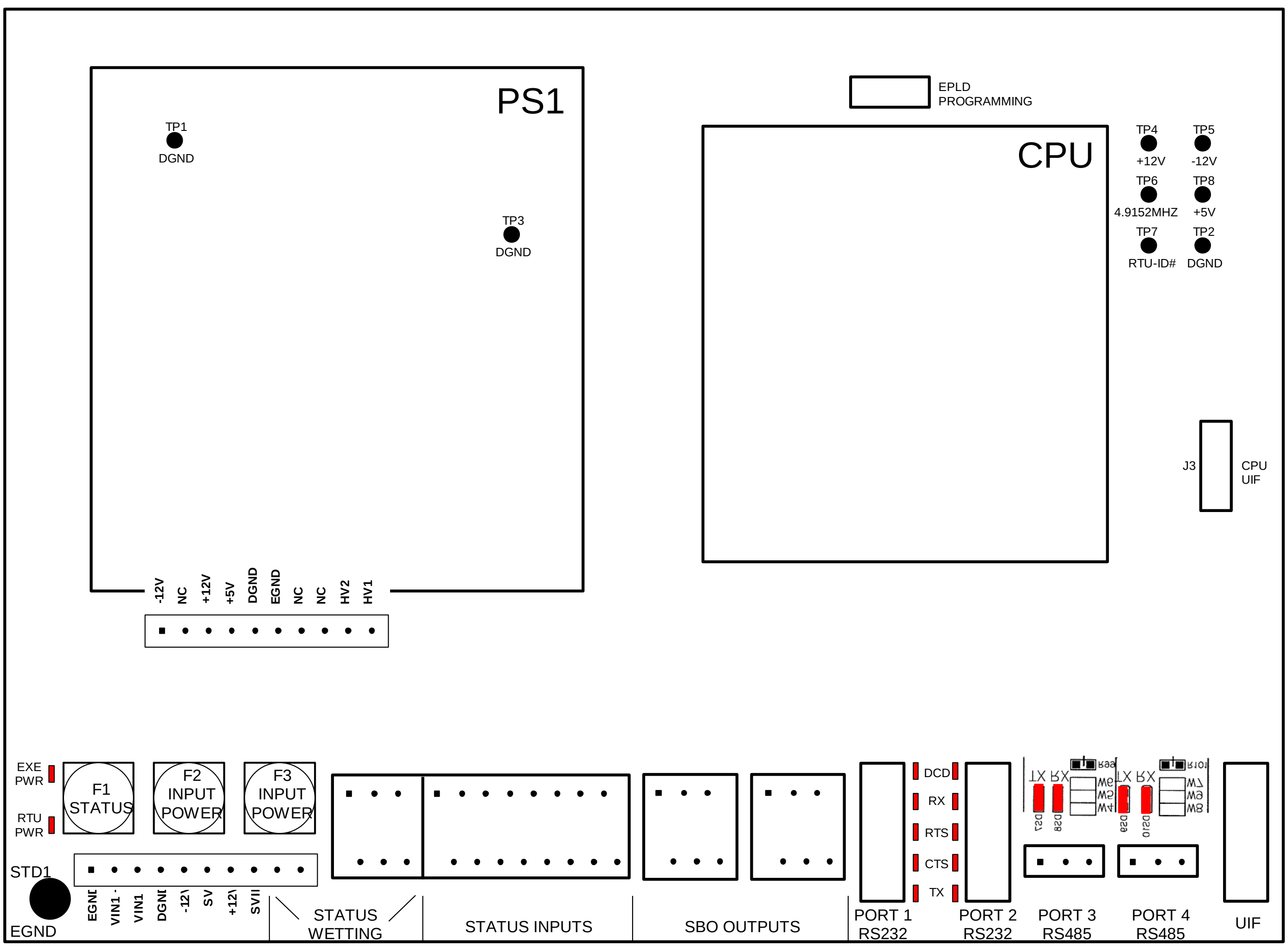
4.5.1 Baseboard C3500-001-REV-A through C3500-001-REV-D

The Baseboard jumpers are positioned by default as noted in Figure 4-10. This may not agree with the configuration required for proper operation of your RTU. Determine the setup for your RTU by checking the function column in Table 4-4.

Table 4-4 Jumper Positions

JUMPER	SECTION	FACTORY DEFAULT	DESCRIPTION
W4	PORT 3	OUT	OUT FOR NO BIAS RESISTORS
W5		OUT	
			IN FOR RS485 TERMINATION
W6		IN	OUT FOR NO TERMINATION
W7	PORT 4	IN	IN FOR RS485 TERMINATION
			OUT FOR NO TERMINATION
W8		OUT	
W9		OUT	OUT FOR NO BIAS RESISTORS

Figure 4-10 SAGE 1X30 LEDs, Test Points, and Jumpers



4.5.2 Baseboard C3500-001-REV-E and Later

The Baseboard jumpers are positioned by default as noted in Figure 4-10 SAGE 1X30 LEDs, Test Points, and Jumpers. This may not agree with the configuration required for proper operation of your RTU. Determine the setup for your RTU by checking the function column in Table 4-5 Jumper Positions, Baseboard.

Table 4-5 Jumper Positions, Baseboard

Jumper	Name	Pins	Normal	Function	Sheet
W1	INT	1-2	INT	1-2 IN = internal 1 msec signal	5
	EXT	2-3		2-3 IN = external 1 msec signal	
W2	RS232	1-2	RS232		1
	GPS	2-3		Telvent Internal Debugging	
W3	RS232	1-2	RS232		1
	GPS	2-3		Telvent Internal Debugging	
W6	–	–	IN	Terminates RS485 line with 100 ohms	2
W7	–	–	IN	Terminates RS485 line with 100 ohms	2

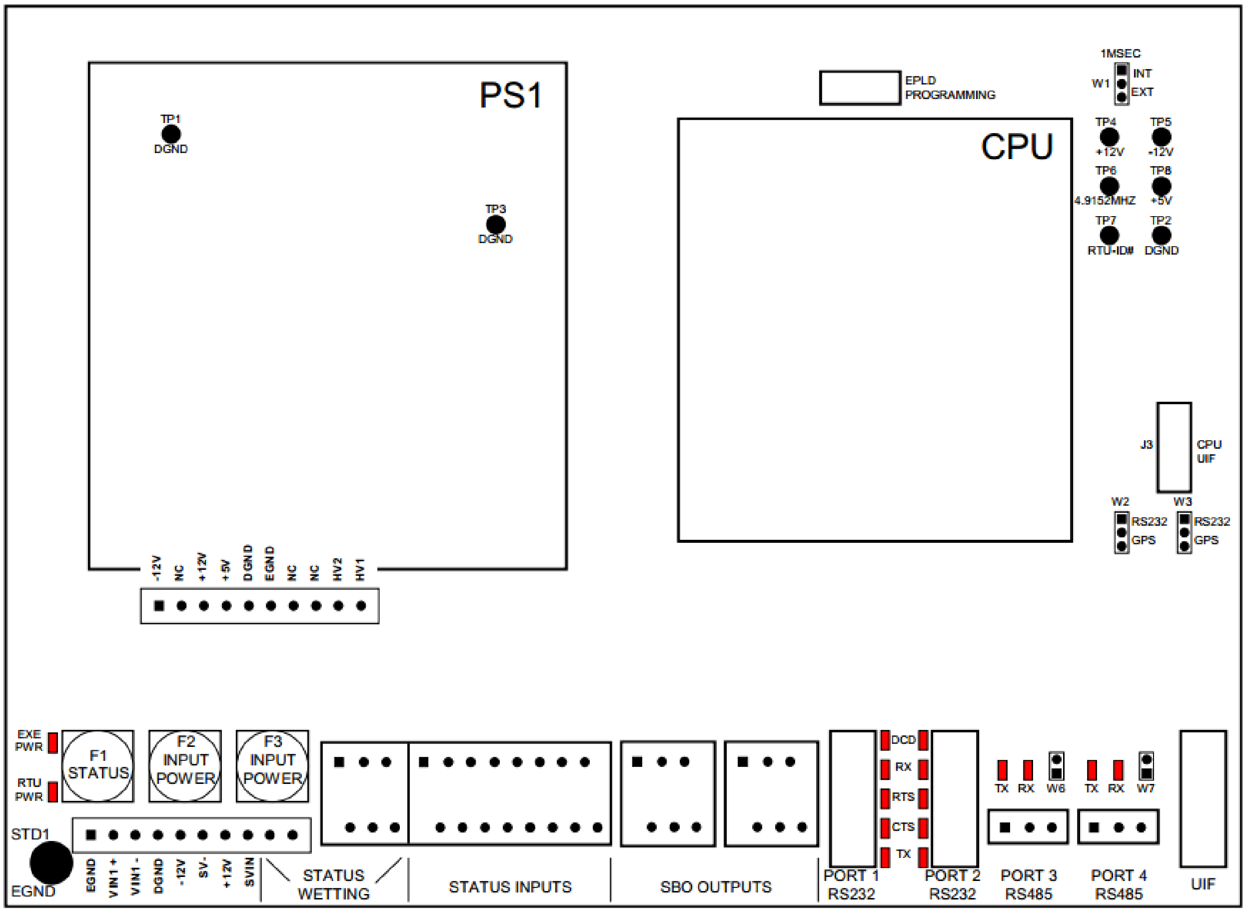


Figure 4-11 SAGE 1X30 LEDs, Test Points and Jumpers

4.6 Jumper Positions & Test Points, C3437 PC/104 Communications Card

Please see the Installation chapter to set jumpers correctly.

Figure 4-12 Jumper Positions & Test Points, C3437 PC/104 Communications Card

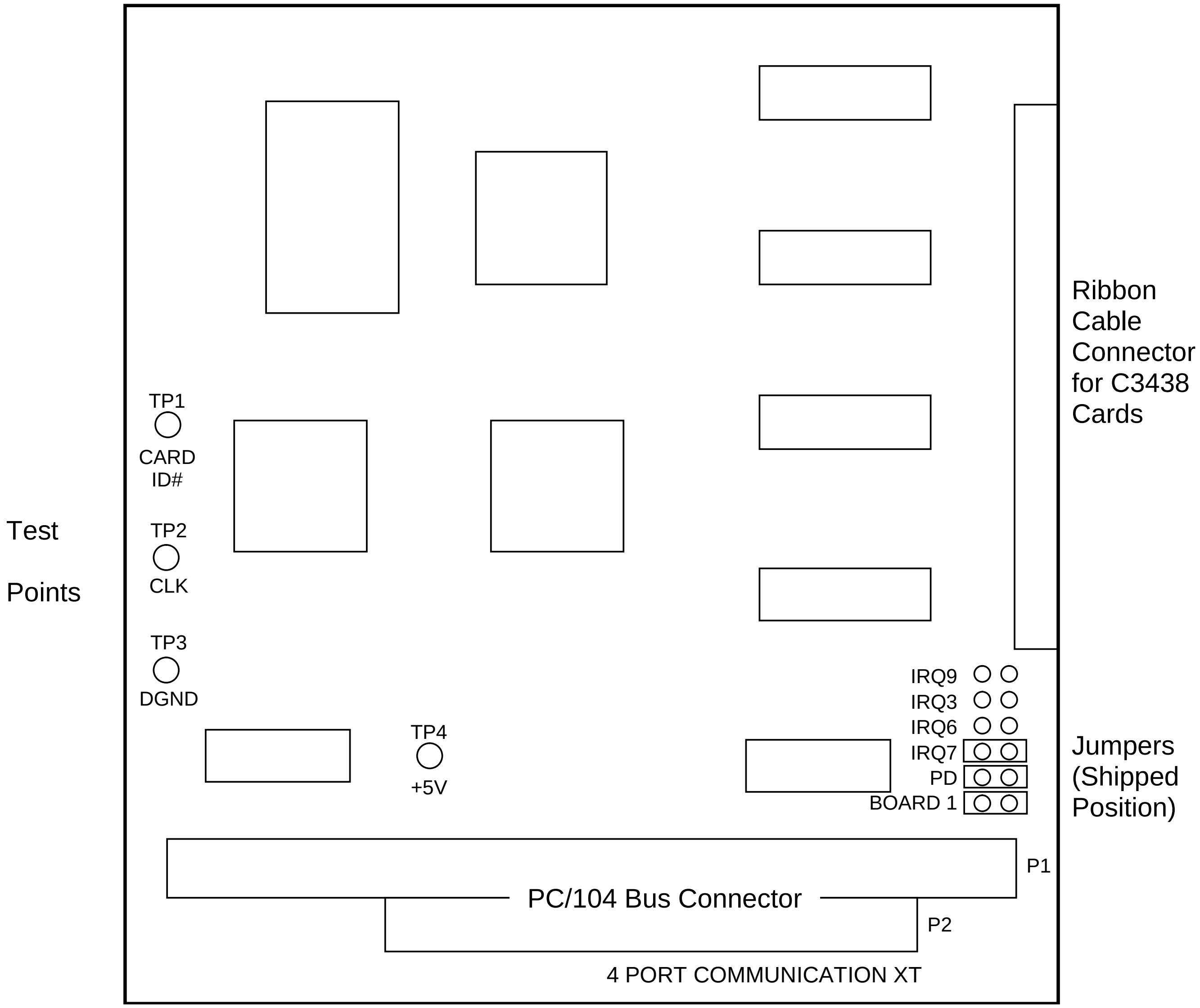
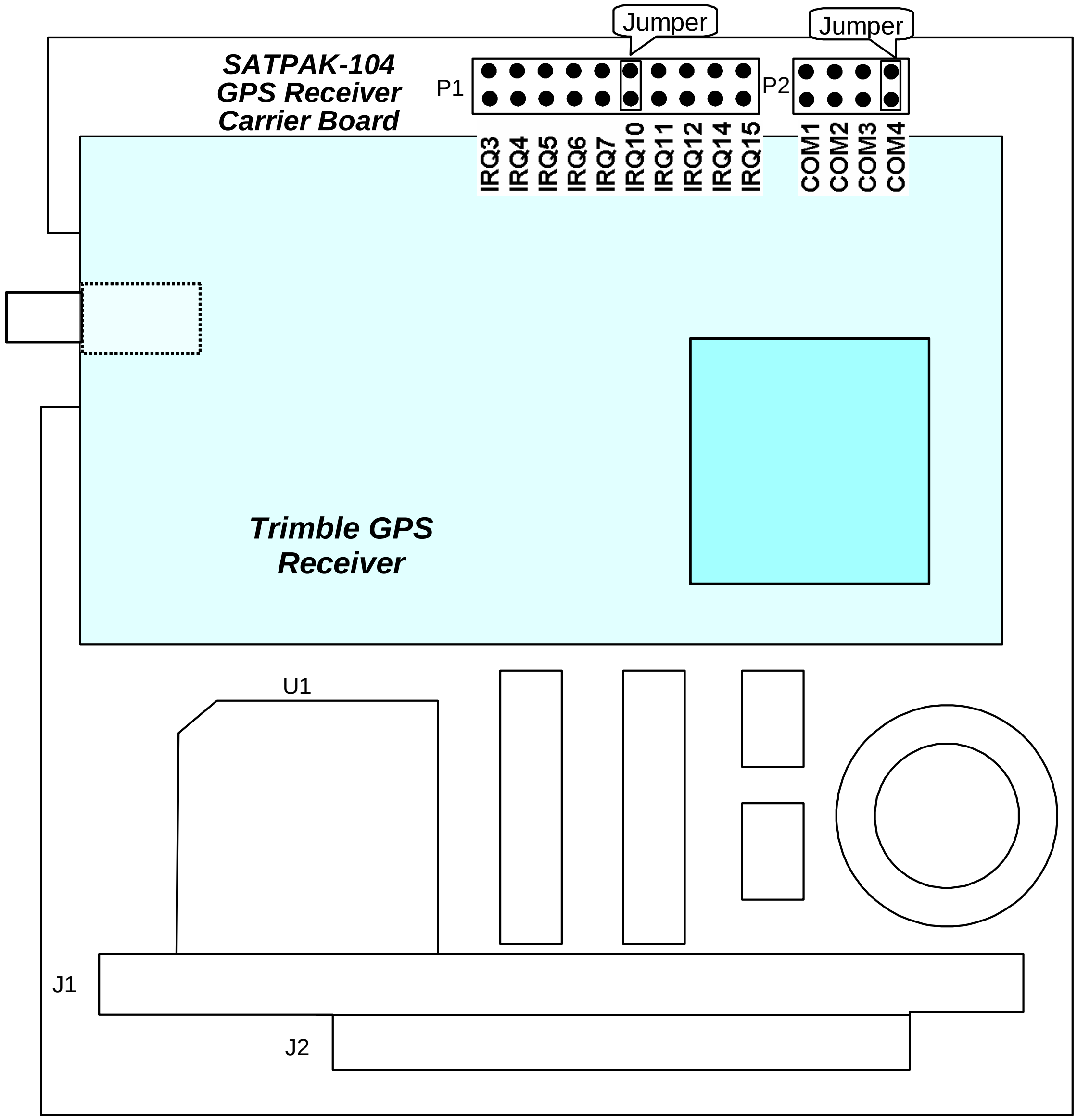


Table 4-6 Jumper Chart

JUMPER	SECTION	PIN	DEFAULT INSTALL	DESCRIPTION
W2	IRQ9	1–2		INTERRUPT 9
	IRQ3	3–4		INTERRUPT 3
	IRQ6	5–6		SHARED INTERRUPT 6
	IRQ7	7–8	IN	INTERRUPT 7
	PD	9–10	IN	PULLDOWN RESISTOR
	BOARD 1	11–12	IN	BOARD 1 SELECT

4.7 **Jumper Positions, C3461 PC/104 GPS Card**

Figure 4-13 Jumper Positions, C3461 PC/104 GPS Card



5 Theory of Operation

This section provides detailed technical design information on the SAGE 1X30 and its various external modules, including design of the firmware and hardware. Use this chapter if you want to troubleshoot and repair to component-level on the modules. This section is based on the simplified block diagrams included with the text.

Use the C3500-002-REV-C schematic drawings and printed circuit assembly drawings in the Drawings chapter of this manual for a more detailed study.

5.1 Basic Architecture

The SAGE 1X30 uses the PC104 interface for its CPU interface. This makes it easy to upgrade your RTU as application needs change. The I/O complement is fixed. However, its 4 communication ports (expandable to 12) coupled with a large suite of IED protocols allow concentration of many types of data from down-stream devices.

5.1.1 PC/104 Architecture

The open architecture of the PC/104 bus interface provides for expanded functions. You may add a PC/104-based GPS receiver and/or C3437/C3438 Communication cards that allow up to eight additional Comm ports.

The PC/104 architecture is a compact version of the IEEE P996 (PC and PC/AT) bus, optimized for the unique requirements of embedded systems applications. The PC/104 bus derives its name from the 104 signal contacts on the two bus connectors (64 pins on P1, plus 40 pins on P2). The main differences from the IEEE P996 are:

1. Reduced form-factor (3.550 x 3.775 inches)
2. Self-stacking, eliminating need for backplanes or card cages
3. Minimized component count and power consumption (typically 1-2 watts per module) and reduced bus drive requirement (typically 4 mA)

5.2 SAGE 1X30 Microprocessor Overview

See CPU Manual for processor overview Hardware Design

5.2.1 PC/104 Bus Interface/Connector

The bus interface connector is compatible with the PC/104 Consortium specification.

Contact the Consortium at:

PC/104 Consortium
849 Independence Ave., Suite B
Mountain View, CA 94043
Phone: 650.903.8304
Fax: 650.967.0995
Email: info@pc104.org

The PC/104 standard is available on the web in downloadable PDF format at:

URL: http://www.pc104.org

5.2.2 Baseboard Communication Ports

The SAGE 1X30 baseboard has 2 RS232 and 2 RS485 serial communication ports plus one RS232 User Interface port. The RS232 ports are accessed through 9-pin female connectors. The RS485 ports are accessed through a 3-pin Phoenix connector. All pins have electrical surge protection. The combined data rate for all four ports is 100k baud. Baud rates are individually selected by port. The UIF is dedicated at 9600 baud.

Communication ports 1&2 (RS232 only) found on DB2 & DB3 each have 5 hardware LED indication of communication activity. These ports are capable of supporting synchronous and asynchronous protocols and in synchronous modes can receive both the TX and RX clocks to support their data.

Communication ports 3&4 (RS485 only) found on TB7 & TB8 each have 2 LEDs to indicate TX and RX functions of that port.

All 4 communication ports share a common interrupt and receive a 4.9152 MHz clock. The internal clock gives them the ability to receive and transmit data at up to 38.4k baud.

5.2.3 Power Input

The basic power requirements of the SAGE 1X30 are ±12V and +5V. These requirements may be satisfied with a choice of on-board supplies with the following input options:

Nominal Power Input	Input Range	Variance
220VAC	90-250VAC/100-350VDC	C3500-A1X-X0000
120VAC	90-130VAC/110-175VDC	C3500-A2X-X0000
48VDC	38-63VDC	C3500-A3X-X0000
24VDC	10-40VDC	C3500-A4X-X0000
24VDC	19-32VDC	C3500-A5X-X0000
24VDC	10-33VDC	C3500-A6X-X0000

The input to the on-board supply (if this option is installed) is at TB1-2 and TB1-3. This input is protected by varistors RV4, RV6, and RV7, plus a fuse on each input line (F2 and F3).

5.2.4 C3437 PC/104 4-Port Communication XT

Each C3437 supports four external ports on a C3438 card. Up to eight ports are supported by using two C3437 PC/104 cards and one C3438 Port XT. The C3437 is connected by ribbon cable to the C3438.

P1 and P2 are the PC/104 interface connectors. The card acts as an 8bit slave ISA card and as such only decodes the first nine addresses from the bus. Addresses SD9 - LA23 are in the connector but not landed on the C3437 printed circuit board.

The communication controller is a Zilog 85230. These devices have 4 byte TX FIFOs and 8 byte RX FIFOs.

Figure 5-1 C3437 Board Layout

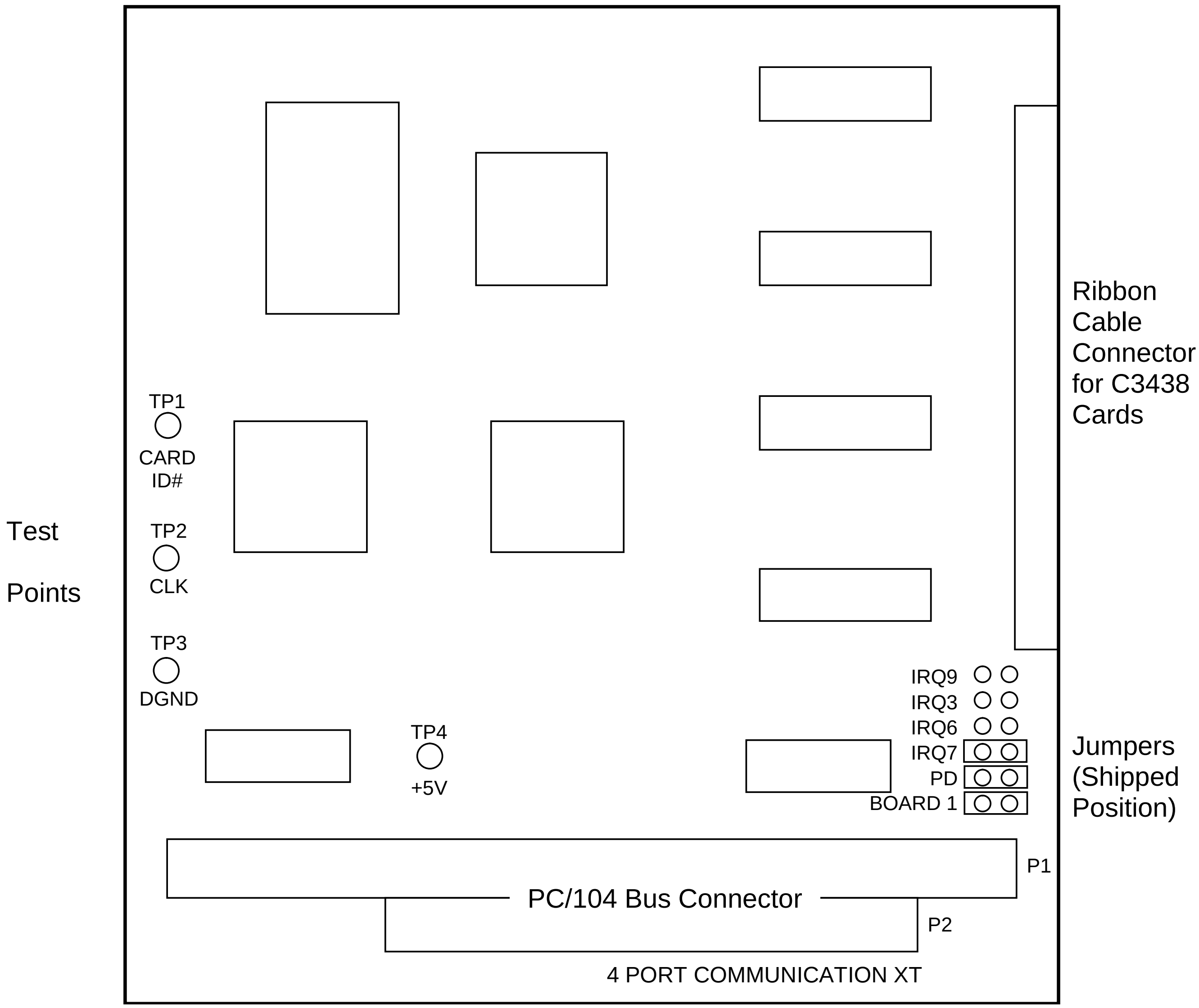


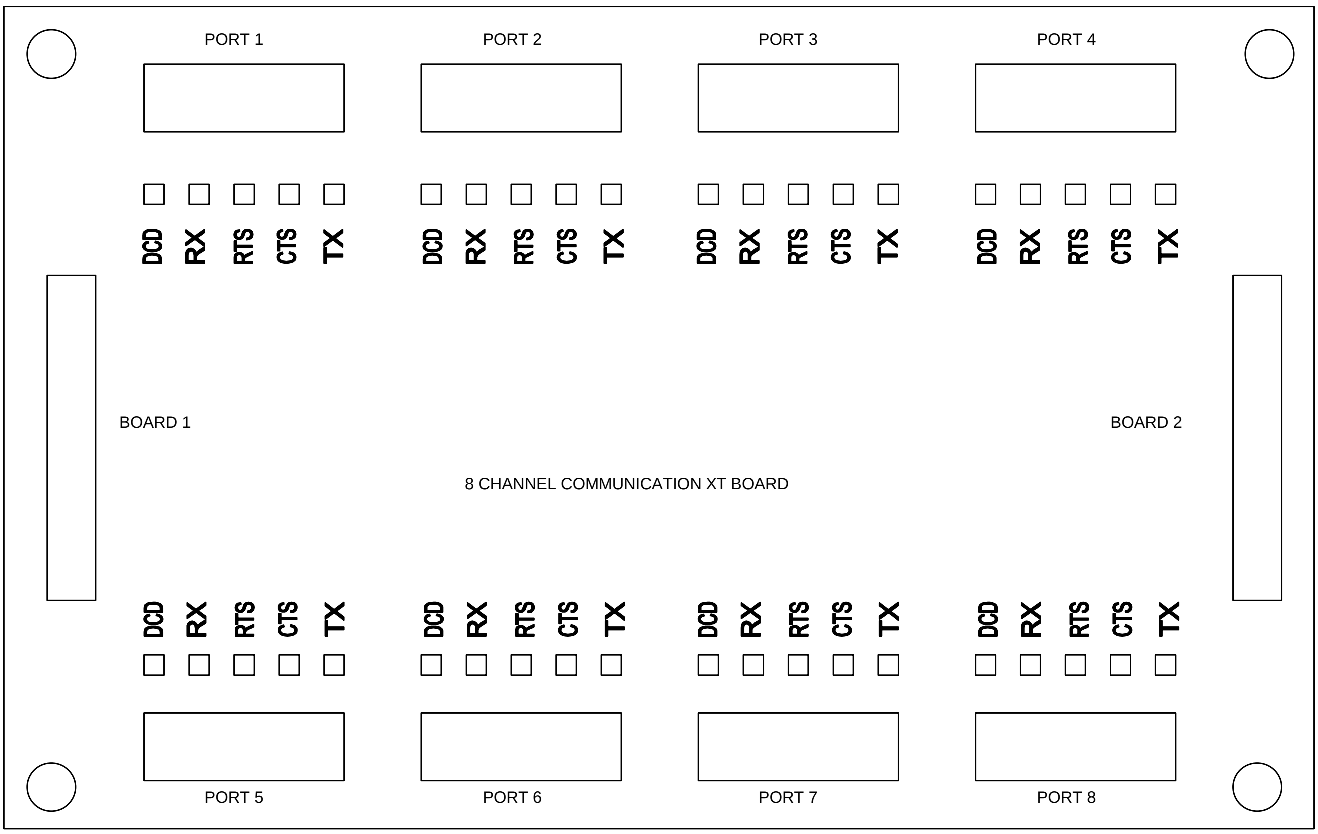
Table 5-1 I/O Port Addresses for the 4-Channel C3437 Communications Card

Port (hex)	ACRONYM	DEFINITON	READ/WRITE
180-183	CS-COM1&2	85230 Ports	READ & WRITE
184-187	CS-COM3&4	85230 Ports	READ & WRITE
188-18B	CS-COM5&6	85230 Ports	READ & WRITE
18C-18F	CS-COM7&8	85230 Ports	READ & WRITE

5.2.5 C3438 8-Channel Communication XT

Each port on the C3438 has its own RS232 driver. Each of the eight ports are identical and each can receive both transmit and receive clocks.

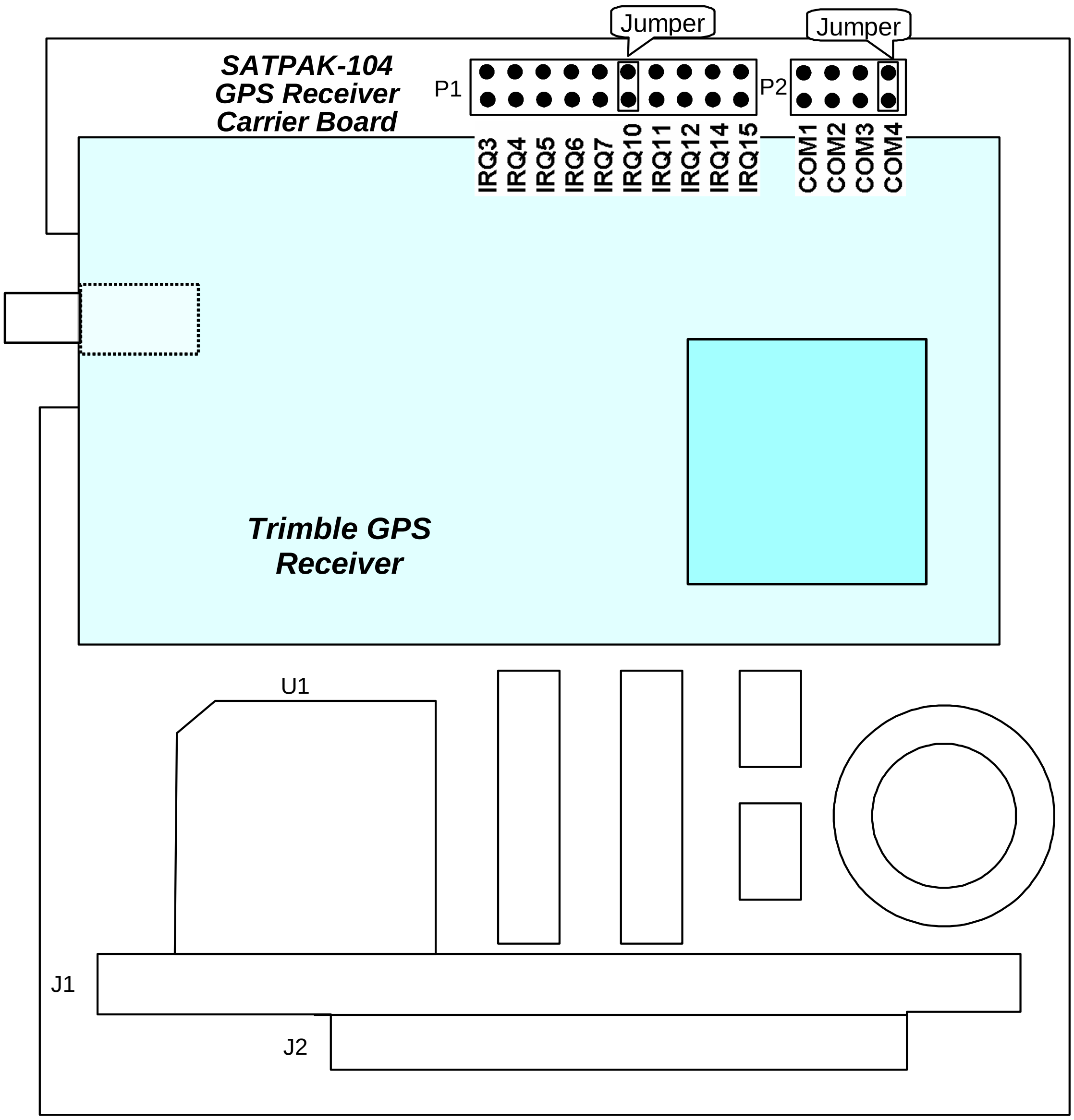
Figure 5-2 C3438 Board Layout



5.2.6 C3461 PC/104 Trimble GPS Receiver

The C3461 PC/104 Trimble GPS receiver consists of two boards; a PC/104 carrier card (SATPAK-104), with a Trimble GPS receiver riding piggy-back. See Figure 5-3.

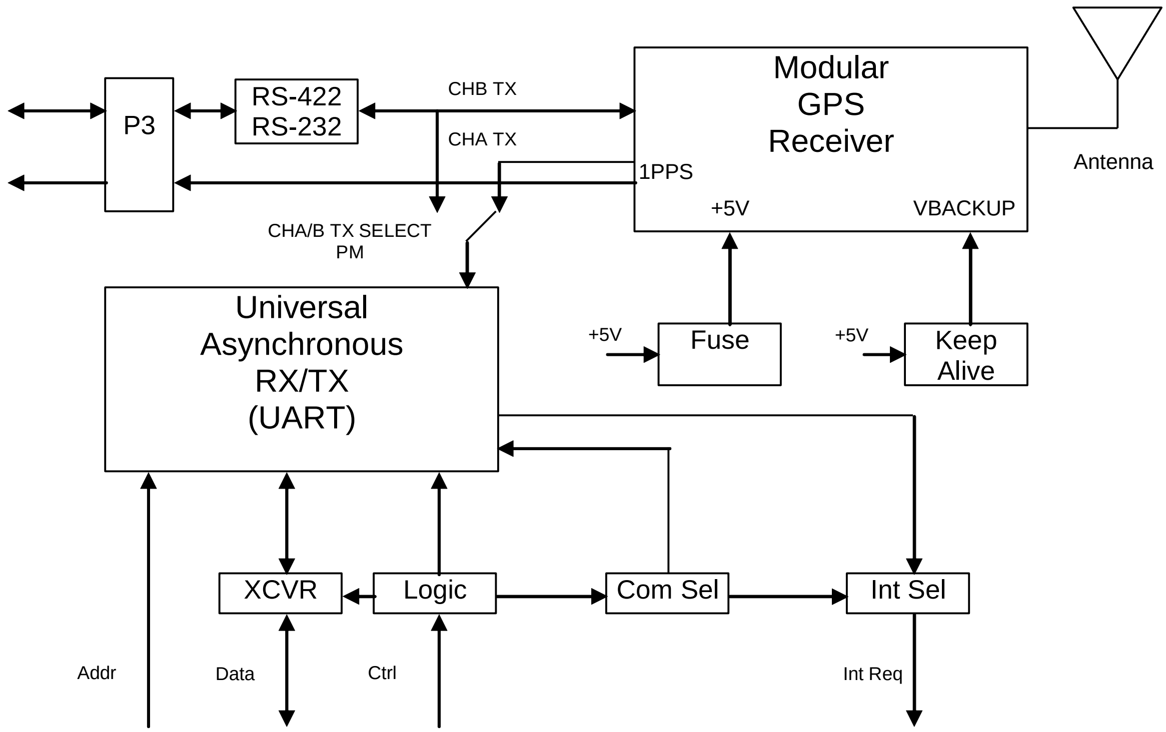
Figure 5-3 C3461 Board Layout



The SATPAK-104 communicates with the GPS receiver through a 16550 universal asynchronous receiver/transmitter (UART). The UART converts the serial TTL data required by the GPS receiver to parallel data required by the PC/l04 protocol. Simple push-on jumpers are used to configure the SATPAK-104 for standard input/output base addresses (COMI, COM2, COM3, COM4) and any of the available bus interrupt lines (IRQ3-IRQ7, IRQl0-1RQl2, IRQ14, or IRQ15). The J2 pass-through connector option must be installed to access interrupt request signals IRQ10-IRQ12, IRQl4, and IRQl5. Custom programmable logic is available if the user must decode base addresses other than those supported by the standard serial communication addresses. The SATPAK-104 also provides signal level conditioning for RTCM-104 serial differential correction signals (RS232 or RS422), and a large value l Farad capacitor to maintain the almanac, ephemeris, and real-time clock of the GPS receiver after power is removed. The GPS receiver is protected with a thermally resettable fuse in line with the +5V power to the GPS receiver. The IPPS signal from the GPS receiver is available on connector P3 located on the SATPAK-104.

The overall block diagram for the PC/104-Trimble receiver combination is shown in Figure 5-4.

Figure 5-4 GPS Receiver Block Diagram



5.3 Select Before Operate

The SBO subsystem uses a relay driver matrix to handle 8 relays. Q1 drives EXE-PWR and is connected to each relay. CSEL8 through CSEL15 connect to relays K1 through K8 respectively.

All drivers have feedback resistor networks which allow the RTU to monitor correct relay driver selection before execution is enabled.

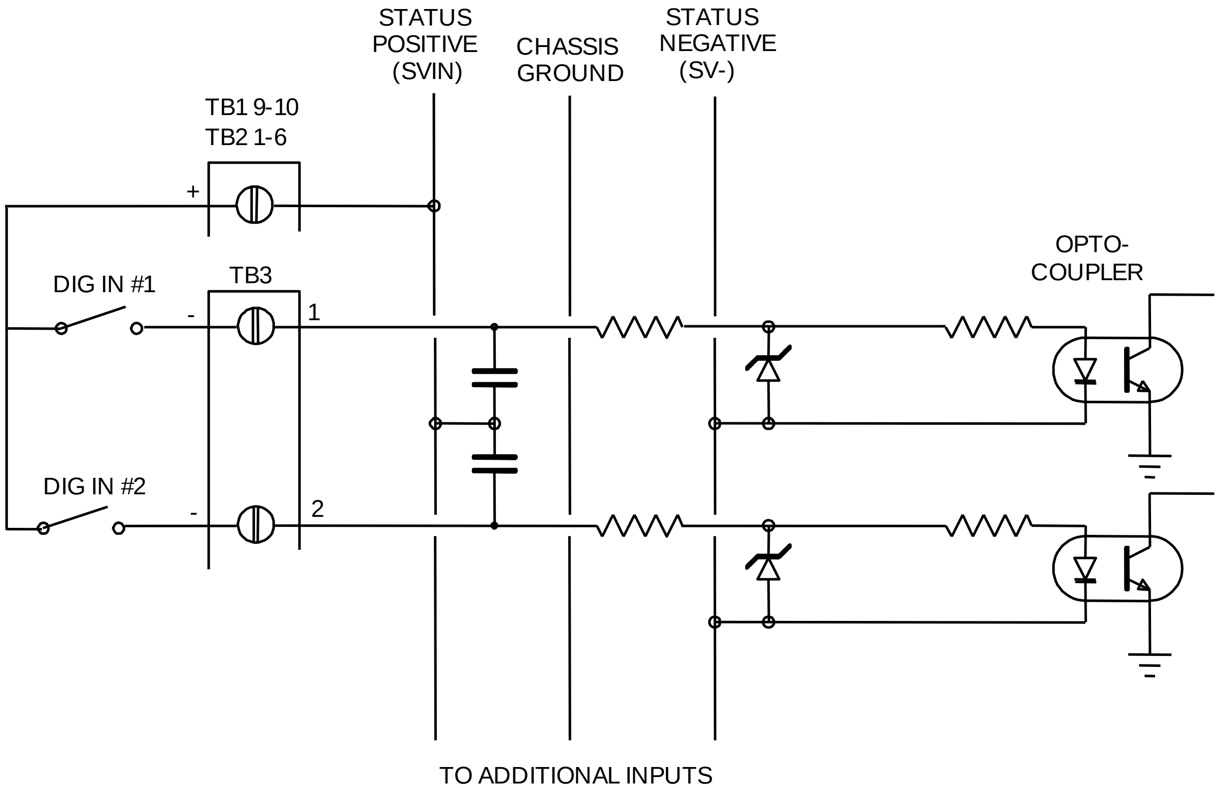
Each contact has a varistor pair to act as protection for the contacts. However, in the event that the baseboard relays are used to drive inductive loads such as a relay the relay should have a kick back diode installed to handle the back EMF from the relay coil.

5.4 Digital Input

The digital input subsystem accepts contact closure inputs as field status or low speed accumulator inputs. All inputs are optically isolated, and debounced by the firmware. Input processing is determined by the input assignment as status, accumulator, etc. and is also firmware controlled. This allows the same hardware to be used for both types of inputs. Figure 5-5 is a simplified schematic of a typical digital input.

The baseboard digital inputs are organized in 2 banks of 8 bits. The baseboard digital inputs are interfaced to the data bus D7-D0 to DI-7 by U2 and U3. Data is allowed to settle before data onto the bus is read. A new status bank is selected by reading the I/O address of the requested status bank, ignoring the data, reading the same I/O address again, then processing the data.

Figure 5-5 Typical Digital Input



5.4.1 Firmware Debounce Algorithm

The Digital Inputs are processed through a digital filter to prevent erroneous Changes Of State (COS) being reported because of contact bounce. The inputs are sampled each 5 msec. Any input that does not match the state of the previous scan is time stamped and stored as a possible COS. A 20 msec counter is started for the suspect input. When the 20 msec expires, the point is again sampled. If it has remained steady it is considered to be a valid COS. The COS flag is set and the status buffer is set to the new point condition. A hardware RC network on each digital input provides additional filtering.