SAGE 1X10 Operation & Maintenance Manual

S1X10-AAA-00001 V1.1

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SAGE 1X10 Operation & Maintenance Manual

For Reference Only

Manual No. **S1X10-AAA-00001**

Document Approval

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					Chris Kerr, Offer Manager, SAGE

SAGE RTU Product Line
California Proposition 65

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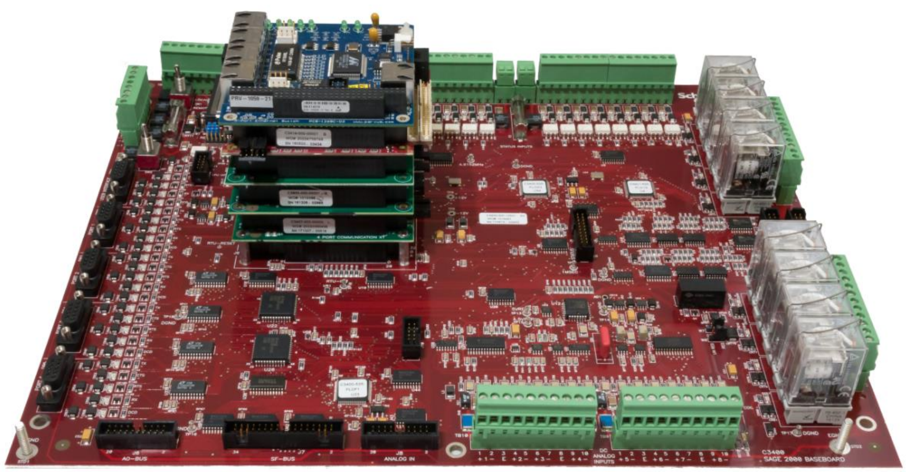
Identification

Product name:	SAGE RTU Product Line
References involved:	C3400 (SAGE 2400), C3800 (3030 M), C3700 (SAGE 1410), C3500 (SAGE 1430), C3600 (SAGE 1450), C3810 (LANDAC II), C3812 (SAGE 4400), C3414, C3132, C3133, C3140, C3230, C3231, C3232, C3233, C3235, C3241, C3243, C3244, C3247, C3248, C3263, C3320, C3321, C3322, C3330, C3360, C3429, C3430, C3432, C3437, C3438, C3476, C3831, C3835, C3861, C3439, C3442, C3443, C3444, C3445, C3446, C3447, C3448, C3449, C3450, C3451, C3452, C3453, C3454, C3455, C3456, C3457, C3459, C3460, C3462, C3464, C3465, C3466, C3467, C3468, C3469, C3470, C3471, C3472, C3473, C3474, C3475, C3477, C3478, C3479, C3480, C3481, C3482, C3484, C3485, C3486, C3487, C3488, C3489, C3490, C3491, C3492, C3493, C3494, C3495, C3530, C3532, C3534, C3550, C3551, C3552
Country - State	USA - California



California Proposition 65 Warning Statement for California Residents

⚠ **WARNING**: This product can expose you to chemicals including Lead, which is known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

Details of the supplier:

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1 Introduction

Throughout this manual, the term SAGE 1X10 refers to the SAGE 1110, the SAGE 1210, the SAGE 1310 and the SAGE 1X10 collectively.

This user manual describes the operation and maintenance of the SAGE 1X10 Remote Terminal Unit (RTU). It provides the detailed technical information necessary for installation, operation, setup, and maintenance of the SAGE 1X10.

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

The SAGE 1X10 Remote Terminal Unit is designed to operate in harsh environmental conditions. The SAGE 1X10 is able to concentrate data gathered from a number of Intelligent Electronic Devices (IEDs) and return that data to one or more SCADA master systems.

1.1 Features

The SAGE 1X10 uses the latest electronic technology for reliability, speed and maintainability. It is intended for use as a communications concentrator and is configured with two RS232 ports, one RS485 port, and one fiber optic port. The RTU can easily be expanded to include up to eight additional RS232 ports.

The SAGE 1X10 has the following new features:

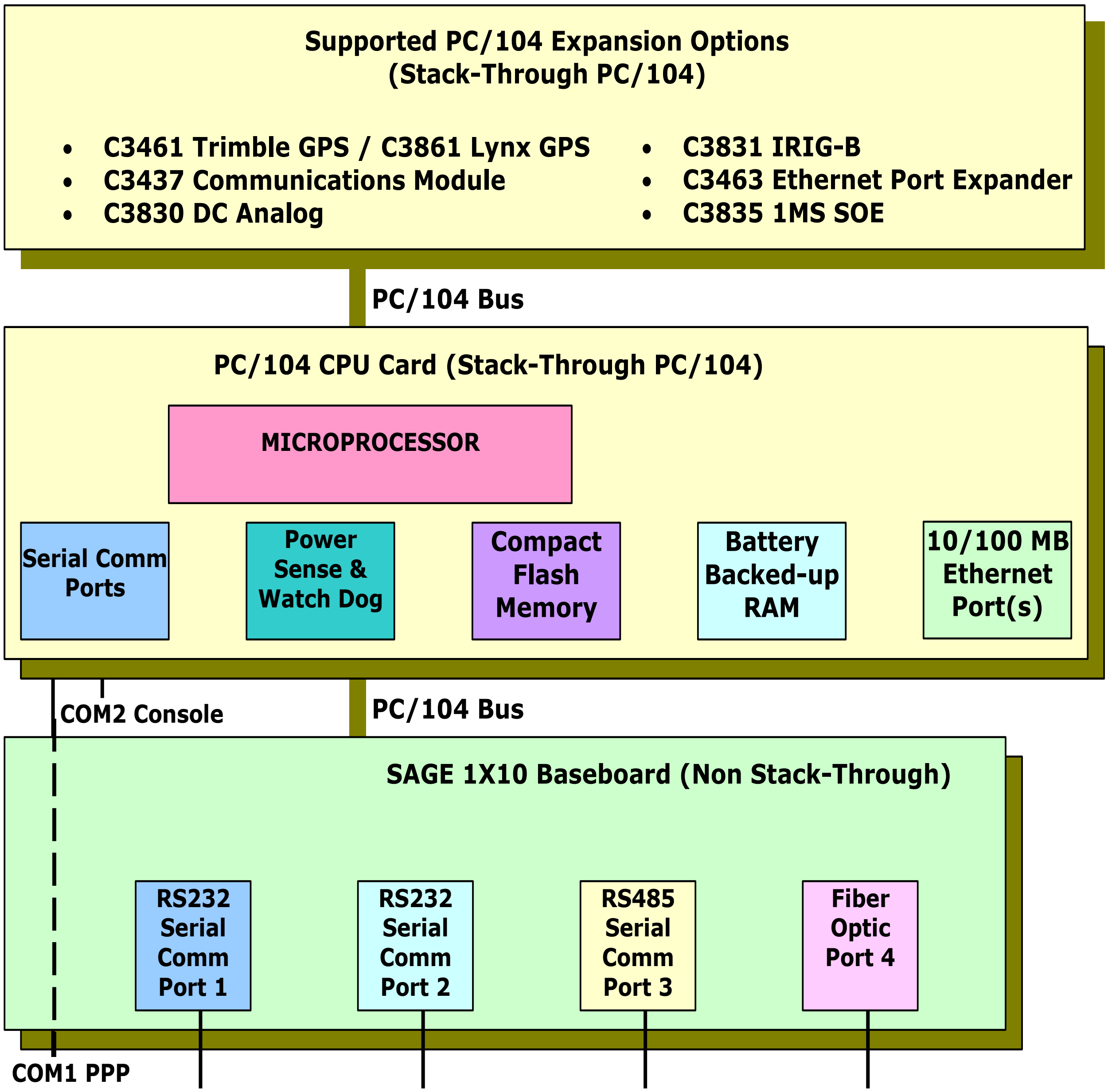
- Easy-to-use Graphical User Interface (GUI) via Microsoft Internet Explorer or Chrome
- Embedded web server with HTTPS
- Built-in Ethernet with TCP/IP
- File Transfer Protocol (FTP) / Secure FTP
- May be configured either locally or remotely
- Point naming (no more counting point numbers to find your 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

1.2 Architecture

Figure 1-1 shows a simplified block diagram of the SAGE 1X10 that illustrates its general architecture and major components. The SAGE 1X10 consists of a Baseboard and a microprocessor daughter board.

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 RS232 Comm ports.

Figure 1-1 SAGE 1X10 Simplified Block Diagram



1.3 Graphical User Interface (GUI)

The SAGE 1X10 is easily configured using the standard web browser, Internet Explorer version 6.0 or later or Chrome in the latest firmware version. 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
- Optional SAGE Offline Configuration Tool
- PPP connection using a null-modem cable to the UIF port
- Console – this method commonly used to read and/or change IP address

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 SFTP on the Secure Firmware 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: The initial setup is for a Username of "Admin" and a Password of "Telvent1!" (SAGE 1410 only). The Password for the other 1X10 RTUs is "Admin".

Note: The initial TCP/IP address is 172.18.150.50 or 192.168.1.1 (depending on firmware)

Note: For the latest firmware, please see the appendix Accessing the Customer Website in the config@WEB Software Users Guide

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 1X10 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 Ports

The SAGE 1X10 is polled by one or more Master Stations that are considered to be the Host. The basic SAGE 1X10 has 4 serial communication ports (Port 1-4) and one additional User Interface (UIF) serial communication port. Two host ports are fully RS232 compliant and can be operated in asynchronous or synchronous modes. A third port supports RS485 communications and a fourth port supports fiber optic serial communications.

The UIF is a dedicated RS-232 port that supports Point to Point Protocol (PPP). This port can be used for initial setup, local maintenance and configuration updates. However, it is commonly used only to configure the IP address of the Ethernet port. Once the Ethernet port is set up the UIF port will run concurrently on the RS-232 port and the Ethernet port.

All SAGE 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 1X10 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 1X10 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 Relay Ladder Logic (RLL)

The SAGE 1X10 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 1X10 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.

1.7 Packaging

The SAGE 1X10 has a footprint of only 8"W x 5"L x 2"H and is designed to be retrofitted into a variety of existing enclosures and apparatus. No special cooling or ventilation is required.

2 Specifications

2.1 User Computer Requirement

OPERATING SYSTEM	Windows XP and above with Internet Explorer Version 6 or above. Chrome can be used in later firmware versions. If using XML to Excel macro, Microsoft Office 2003 or above.

2.2 CPU/Memory

NOTE: Please refer to CPU Manual for CPU specifications.

2.3 Communications Ports

NUMBER OF 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	Baseboard: 2 ea. RS232C 1 ea. RS485 1 ea. Fiber optic
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)

2.4 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)

2.5 Power Requirements

INPUT VOLTAGE	9 to 33VDC required by the Baseboard
OPTIONAL POWER SOURCES	120/240VAC with added supply/battery charger; 12VDC, 48VDC, 129VDC with added DC/DC supply
INPUT POWER	Approximately 6.25W max. for 10V to 33V
INPUT/OUTPUT ISOLATION	500 VDC
BATTERY CHARGER	Optional external unit

2.6 Visual Indicators

LEDs	Input Power LED 5 LEDs per RS232 port (DCD, RX, RTS, TX, CTS) 2 LEDs per RS485 port (RX, TX) 2 LEDs per fiber optic port (RX, TX)
PC/104 CPU LEDs	Please refer to CPU Manual

2.7 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

2.8 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	±4.5V, +5V
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

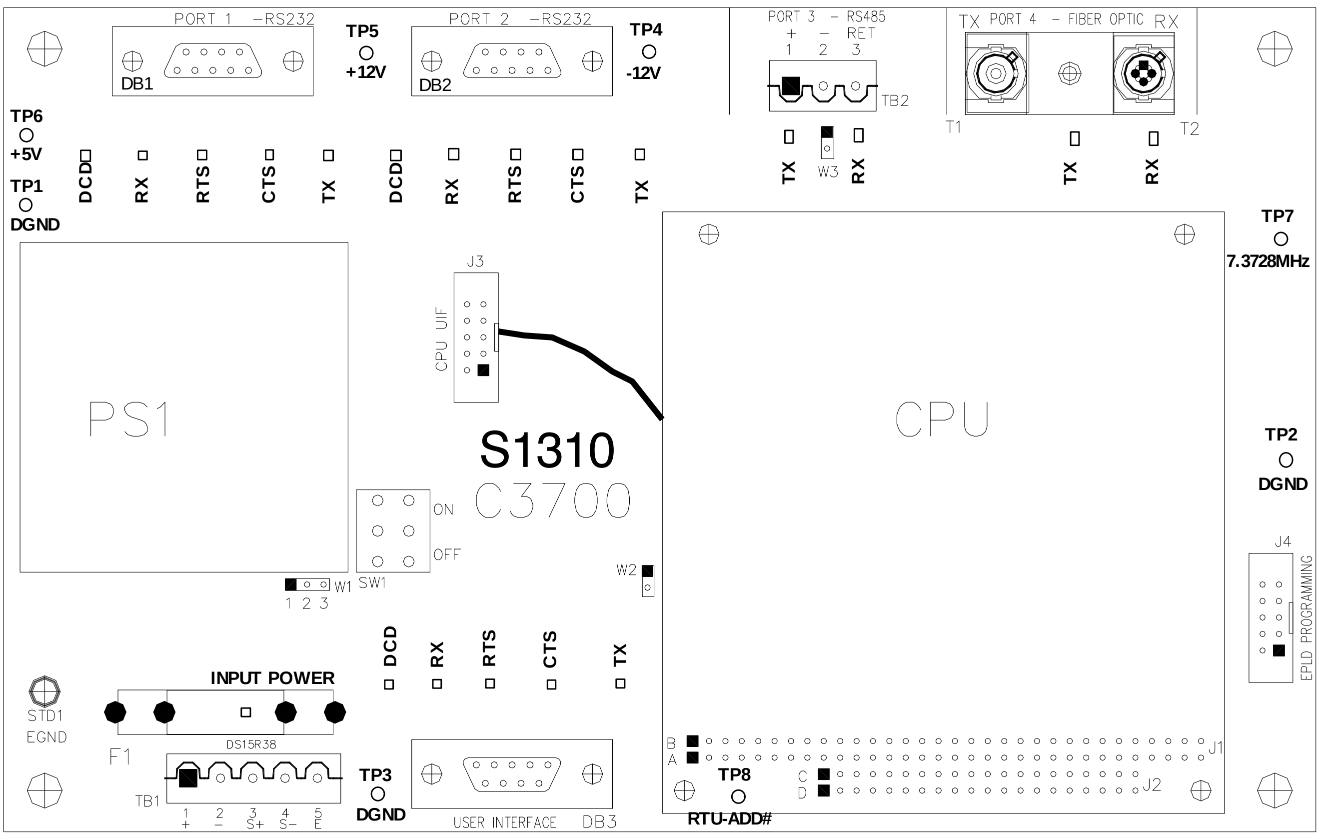
This chapter describes the normal installation and operation procedures for the SAGE 1X10 RTU. Prior to moving the RTU assembly to the installation site, we recommend that you perform a preliminary functional test to verify that the configuration is correct for the intended site and also to check for any undetected shipping damage. Preliminary testing should be performed after the RTU has been setup using the information in Chapter 2 of the config@WEB Software Users Guide.

3.1 General Installation Procedure

The SAGE 1X10 is small enough (8"W x 5"L x 2"H) that it usually can be mounted in an existing cabinet. All that is needed is four #8 screws and standoffs. Detailed mounting information may be found on drawing C3700-600-00002 in the Drawings appendix of this manual. The entire board consumes less than 9 watts, so no special ventilation is needed.

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

Figure 3-1 SAGE 1X10 Baseboard



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.

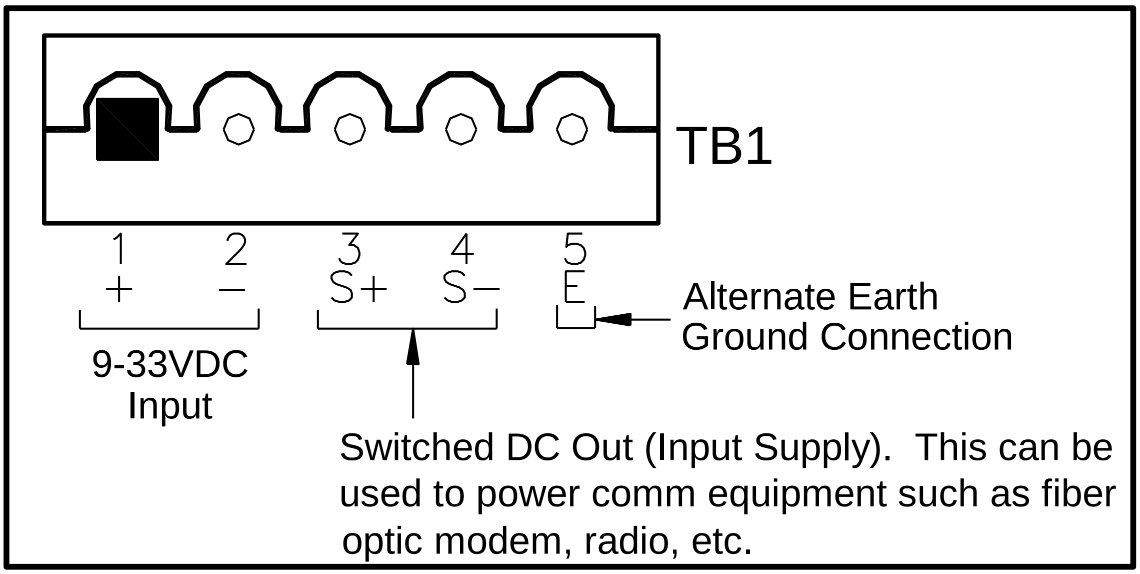
3.2 Power Terminations

Field input power will vary according to project requirements. The assembly includes circuit protection devices for the field power. In a minimum configuration, however, field power is connected directly to the Baseboard.

The Baseboard (Figure 3-1) runs on +9 to +33VDC. If the field input power is the AC line or a DC source other than +9 to +33VDC, the enclosure will include a power supply and separate terminations for field power. In this case, the power supply will be pre-wired to the Baseboard. Refer to your RTU assembly drawing for the input power terminal assignments. It will be clear from the drawing where to hook up the hot and neutral or the field+ and field-, and chassis ground.

If the RTU is being directly powered from a +9 to +33VDC source with no switch or circuit protection device between the source and Baseboard, the input power must be connected to terminal strip TB1 on the Baseboard (see Figure 3-2). Make sure the input power is de-energized and then connect +9 to +33VDC to terminal 1 and DC return to terminal 2.

Figure 3-2 Baseboard Power



3.3 Serial Comm Ports

The SAGE 1X10 baseboard has 5 ports. One port is dedicated to the User Interface (UIF). The four other ports (1 through 4) use a dual Serial Communications Controller 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. 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 Table 3-1.

3.3.1 RS232 Connections

The pinout of the DB-9 RS232 connectors is summarized in Table 3-1. For the simplest connection, 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 RS232 channel are supplied with LEDs as indicated in the last column of the table.

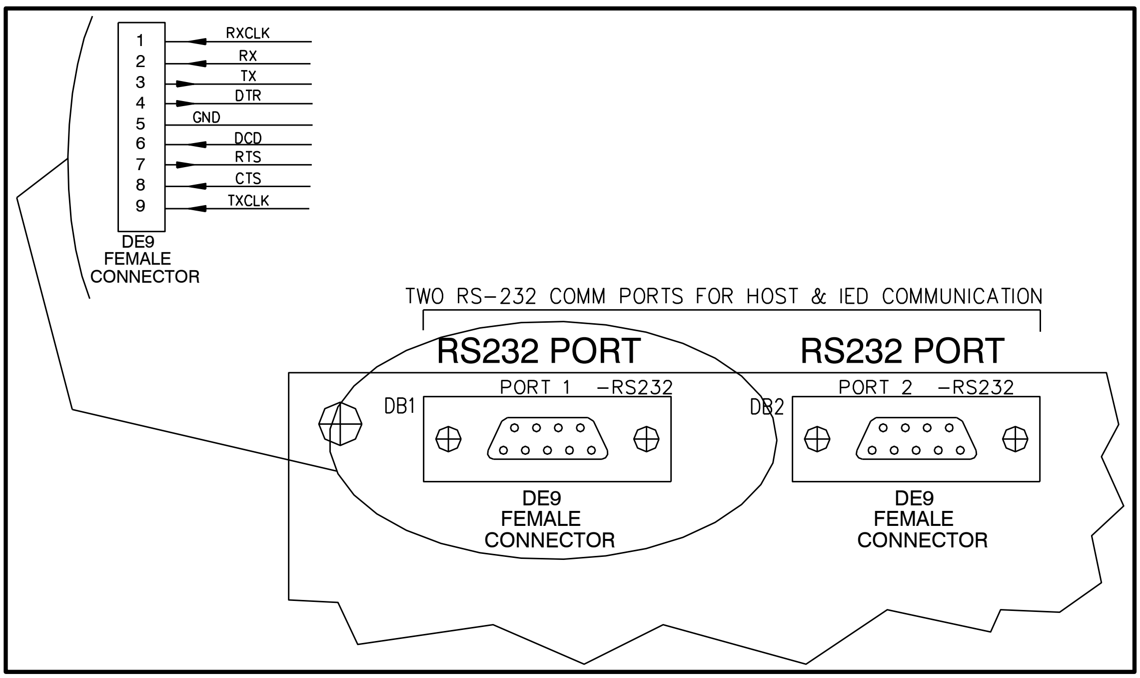
Table 3-1 DB-9 (RS232) Connector Pinouts

Baseboard						C3438	LEDs
SIGNAL	**PIN**	**DESCRIPTION**	**TYPE**	**UIF**	**Port 1-2**	**Port 5-12**	
RXCLK	1	Receive Clock	input		X	X	
RXD	2	Receive data	input	X	X	X	X
TXD	3	Transmit data	output	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 3-3, 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.

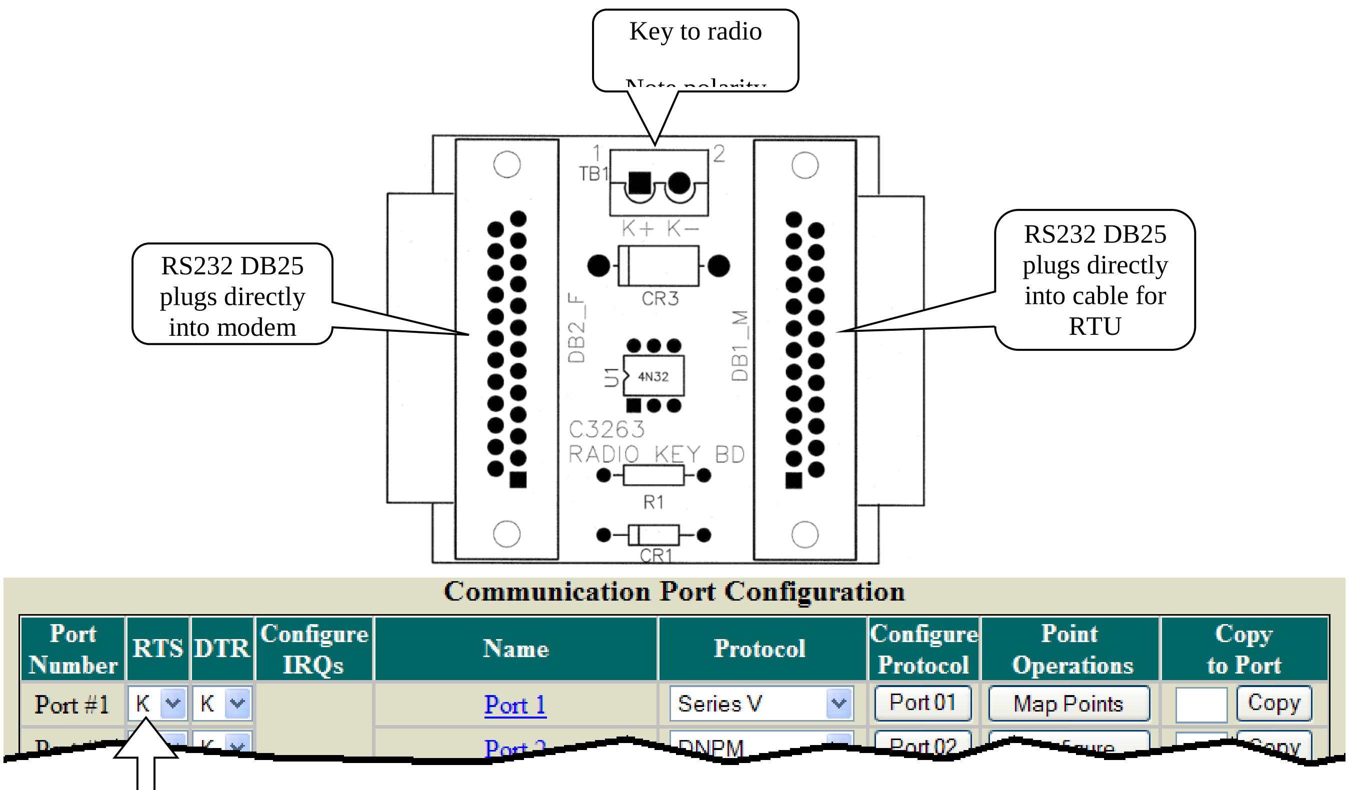
Figure 3-3 Connections for the RS232 Ports



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 3-4 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.

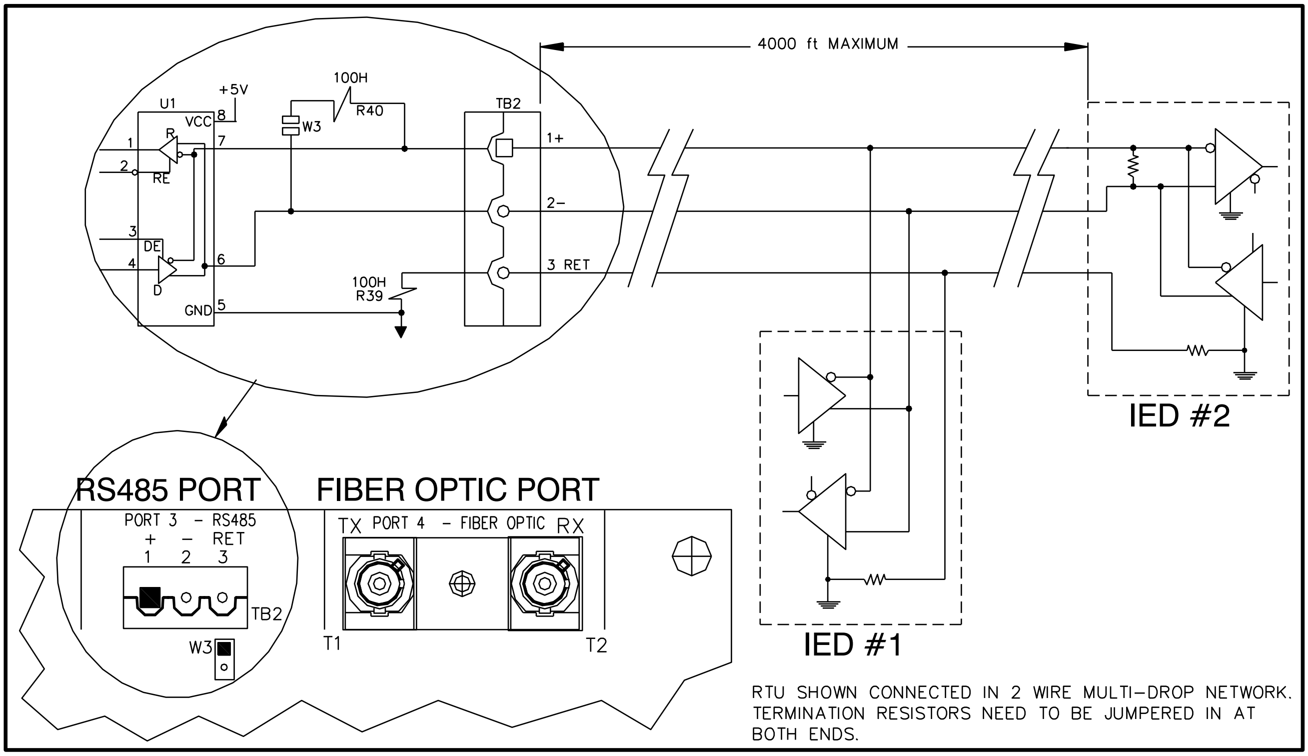
3.3.3 RS485 Connections

Port 3 of the RTU is designed to be connected to a 2-wire RS485 LAN. The RTU can act as either the master or a slave on such an interface.

Figure 3-5 shows an RS485 2-wire connection with the RTU at one end of the RS485 LAN and IED#2 at the other end. Each end of the RS485 LAN must have a termination resistor installed. The termination resistor is usually in the range of 100-120 ohms. This is easily accomplished in the SAGE 1X10 by installing jumper W3. Of course, 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 1X10. If the SAGE 1X10 is somewhere in the middle of an RS485 LAN, jumper W3 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 3-5 Connections for the RS485 Port



The RS485 port has an LED for TX and an LED for RX.

3.3.4 Fiber Optic Connections

Port 4 of the RTU is designed to be connected to a fiber optic point-to-point interface or a looped fiber optic LAN. In both cases, the RTU can act as the master or a slave device. The fiber optic interface is designed using LED transmitters and receivers with ST type connectors and needs nothing more than simple multi-mode cable.

Figure 3-6 shows a point-to-point fiber optic connection. As shown, the maximum distance for a fiber optic connection to an IED is 16000 feet (just over three miles). Please see Chapter 2 of the config@WEB Software Users Guide to properly configure the fiber for ECHO and LONG cable. Figure 3-7 shows a typical fiber loop for IEDs. Please note that the master device in such a loop would have its echo setting set to OFF, but each of the slave devices (IEDs) would have their echo setting set to ON.

Figure 3-6 Fiber Optic Point-to-Point Connections

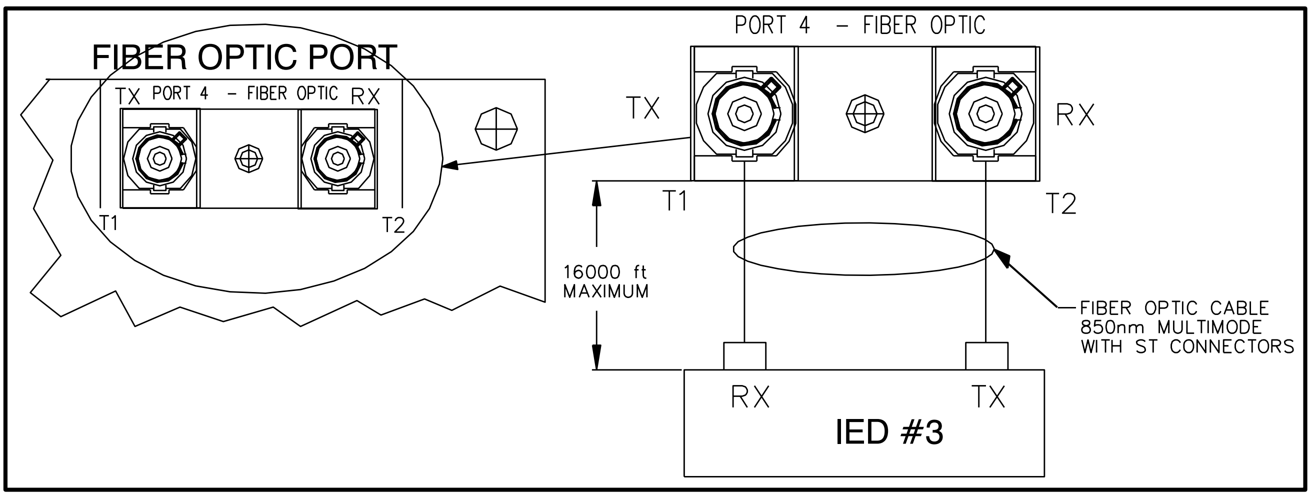
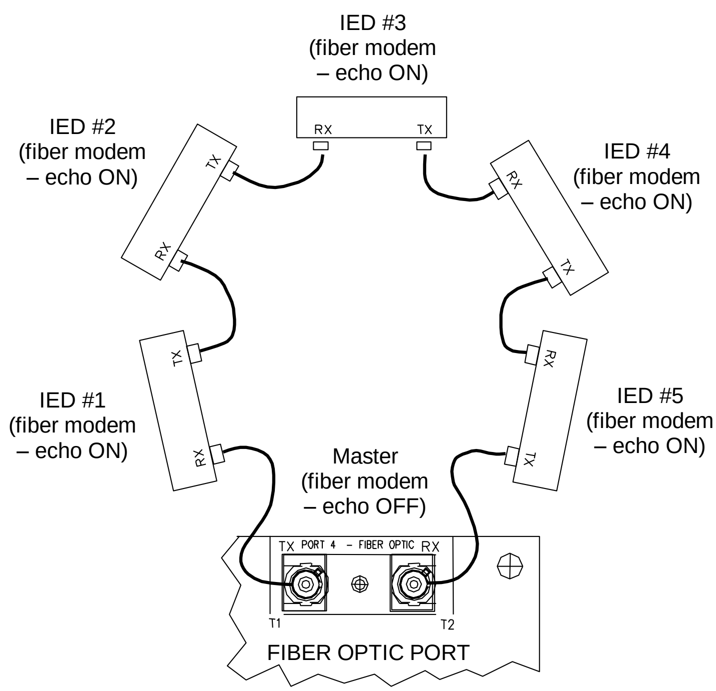


Figure 3-7 Typical Fiber Optic Loop for IEDs



The fiber port has an LED for TX and an LED for RX.

3.3.5 User Interface Connections

There are four physical ways to connect to the SAGE 1X10:

- 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 IE or Chrome. 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.

Please see the appendices in the config@WEB Software Users Guide for further connection information.

3.4 Jumpers

All jumper designations and functions for the Baseboard and PC/104 Cards are found in Chapter 4 Maintenance of this document. 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.

3.5 PC/104 Expansion Installation

The PC/104 interface provides for expanded functionality. PC/104 expansion cards are optional.

3.5.1 C3461 PC/104 Trimble GPS Receiver (Optional)

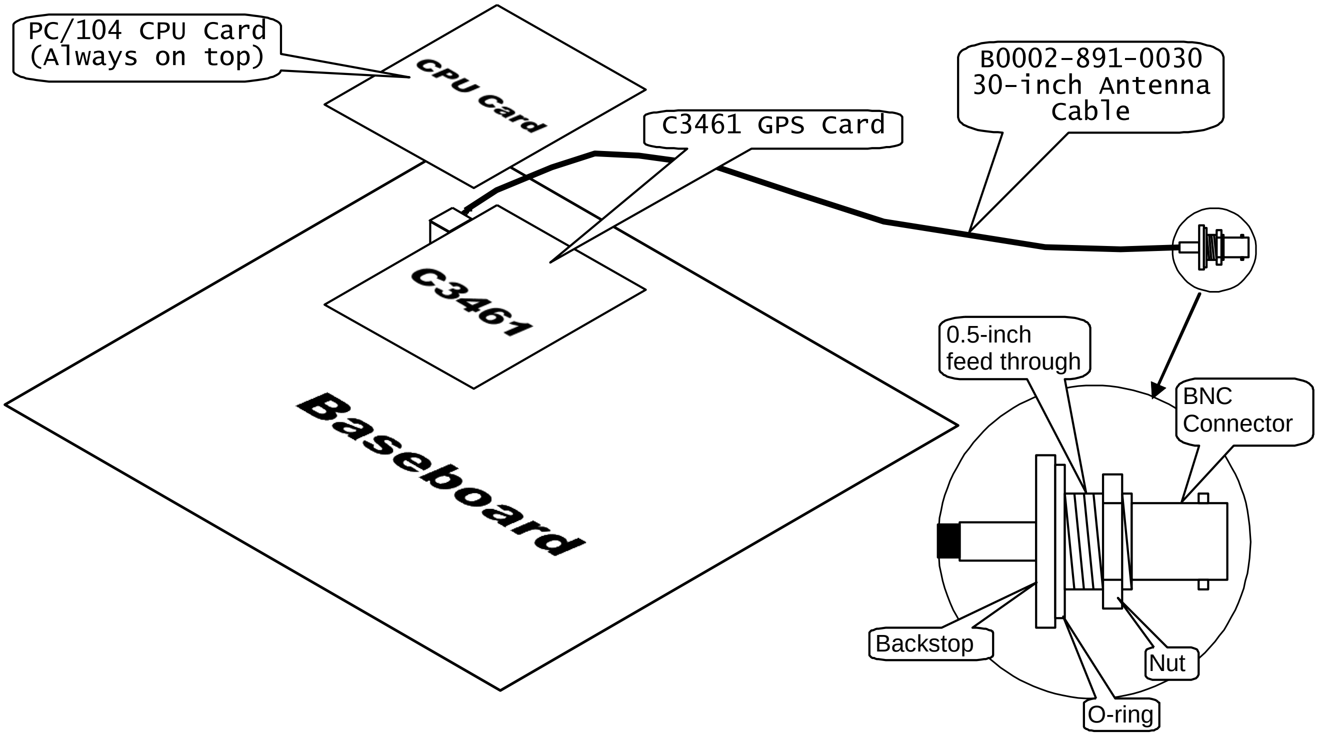
The C3461 PC/104 Trimble GPS Receiver consists of the SATPAK Carrier Board and the Trimble GPS Receiver Board riding piggy-back.

Caution: The SATPAK Carrier Board and the Trimble GPS Receiver Board are permanently joined (See Figure 3-9). 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.

1. As shown in Figure 3-8, the C3461 requires only a few steps for physical installation:
2. Unplug the CPU card.
3. Plug the C3461 into the baseboard.
4. Plug the CPU card into the top of the C3461. The CPU card must always be on top.
5. 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.
6. Mount the GPS antenna in an elevated, clear area outside the building.
7. Connect a suitable length of BNC cable* from the antenna to the cabinet-mounted BNC connector.

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

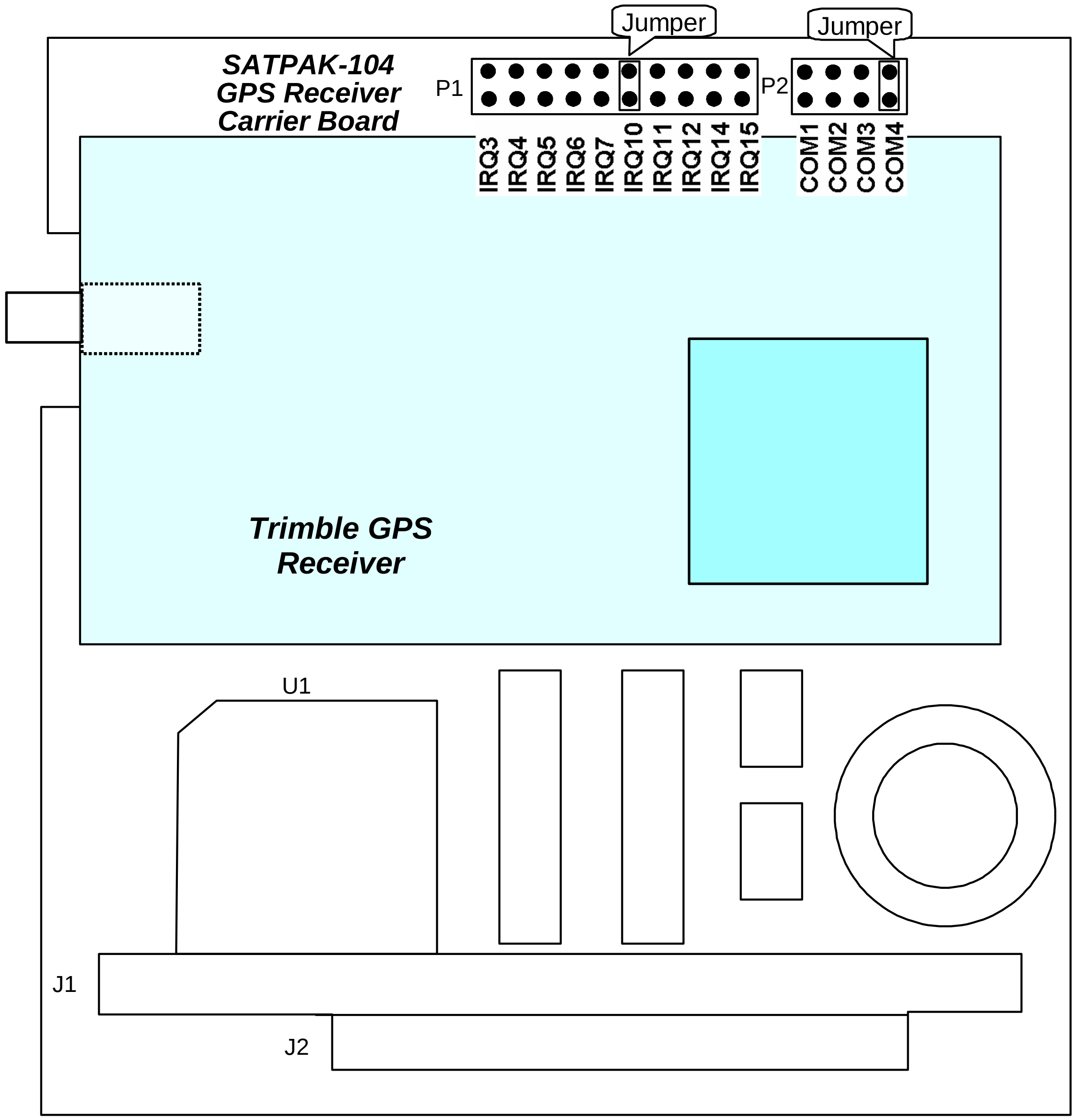
Figure 3-8 C3461 PC/104 Trimble GPS Receiver



3.5.2 C3461 GPS PC/104 Jumper Configuration for P1 & P2

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

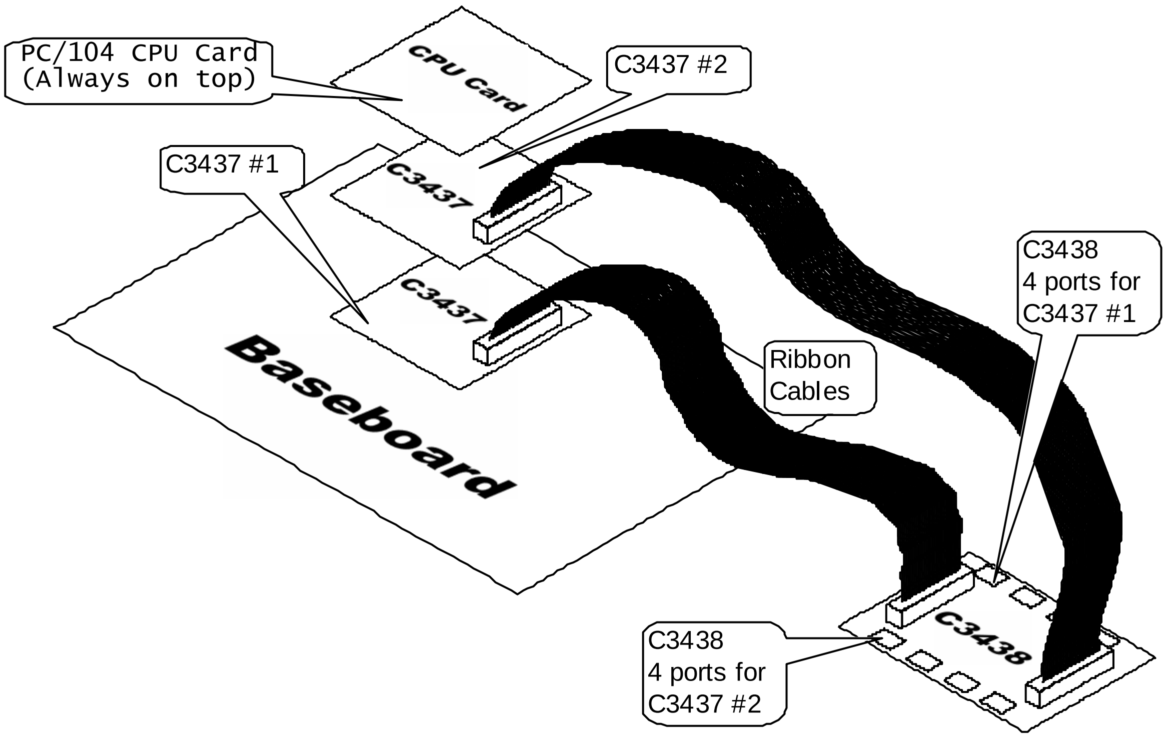
Figure 3-9 C3461 Board Layout



3.5.3 C3437 PC/104 Comm Expansion & C3438 RS232 Port Card (Optional)

The C3437 is a PC/104 card which must be plugged into the top of any existing PC/104 cards. One C3437 will service four ports on a C3438 (see Figure 3-10). Another C3437 is required to service the remaining four ports on the C3438.

Figure 3-10 Installing the C3437/C3438 Communications Expansion Cards



3.5.3.1 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

3.5.3.2 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 RS232 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

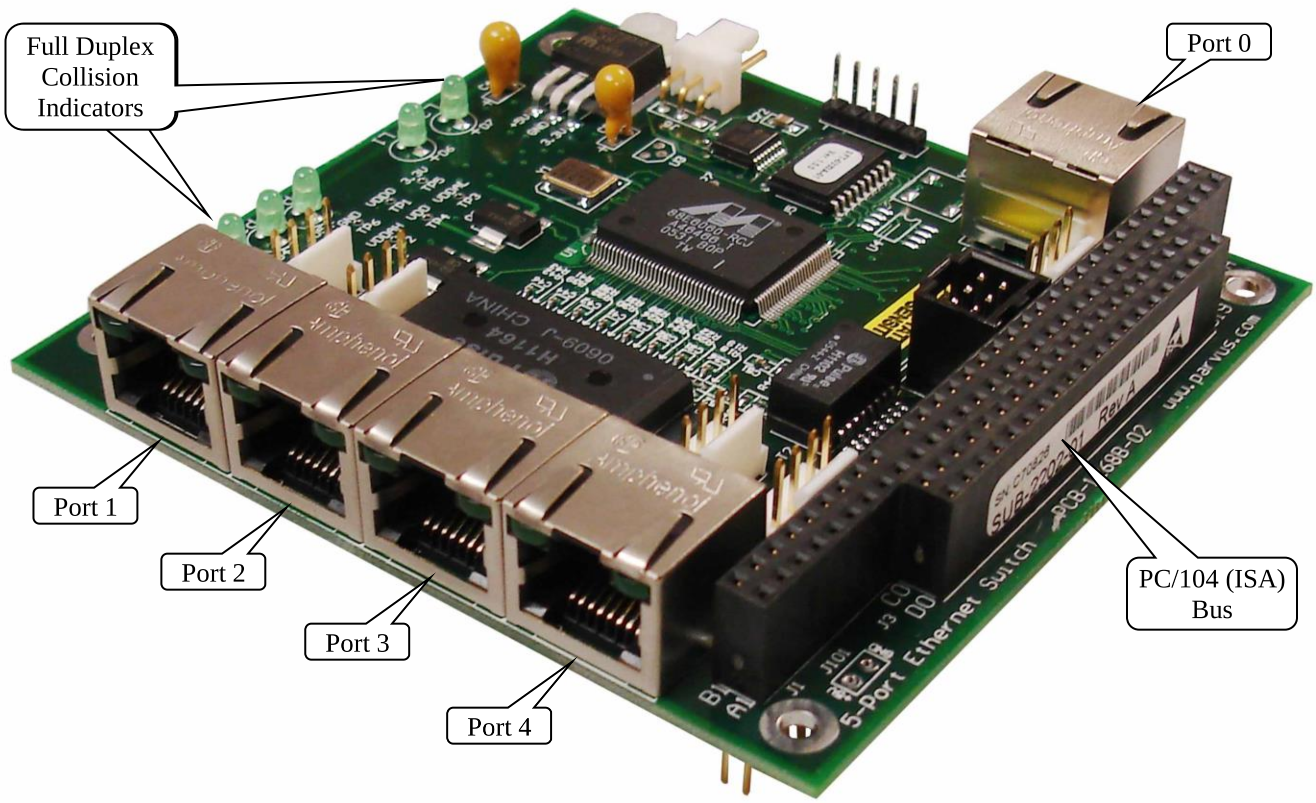
The pins in the DB-9F are used as follows:

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

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

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 3-11 C3463 5-Port Ethernet Switching Hub



3.5.5 C3831 PC/104 IRIG-B Card (Optional)

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

Figure 3-12 C3831 PC/104 IRIG-B Card

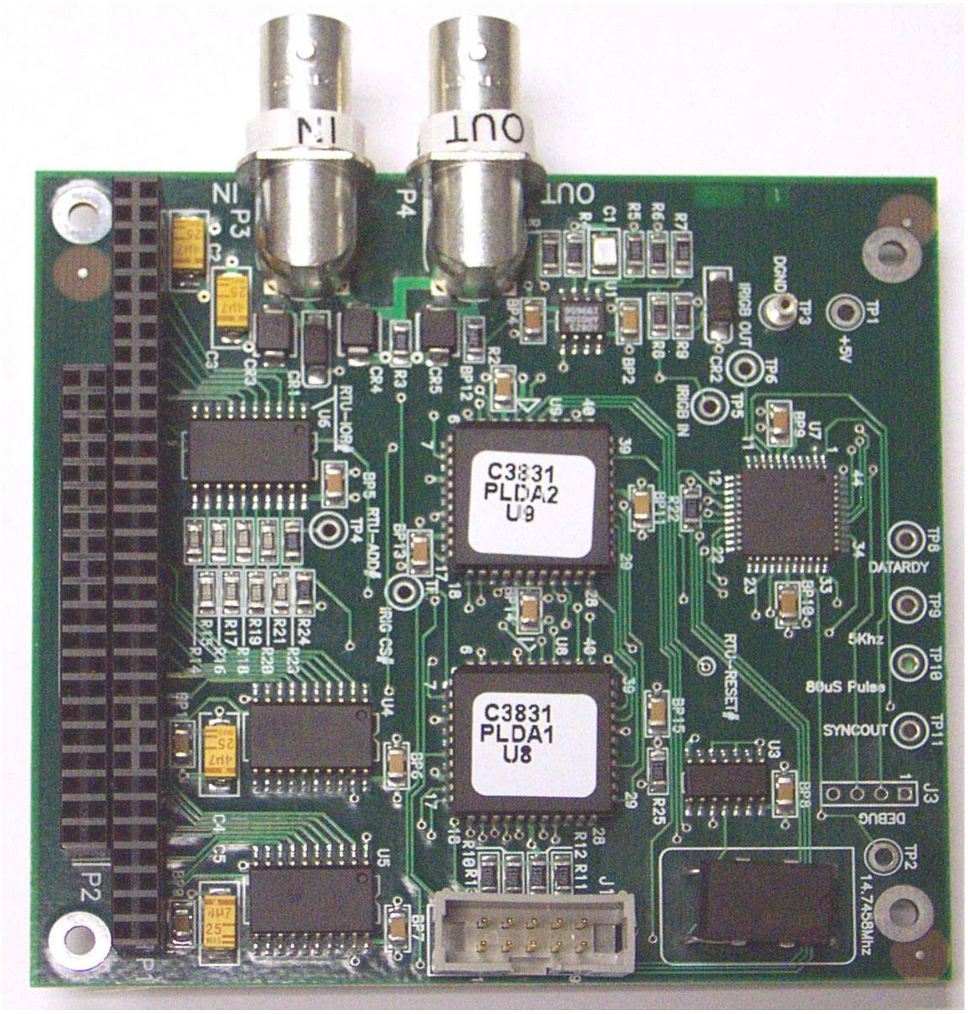
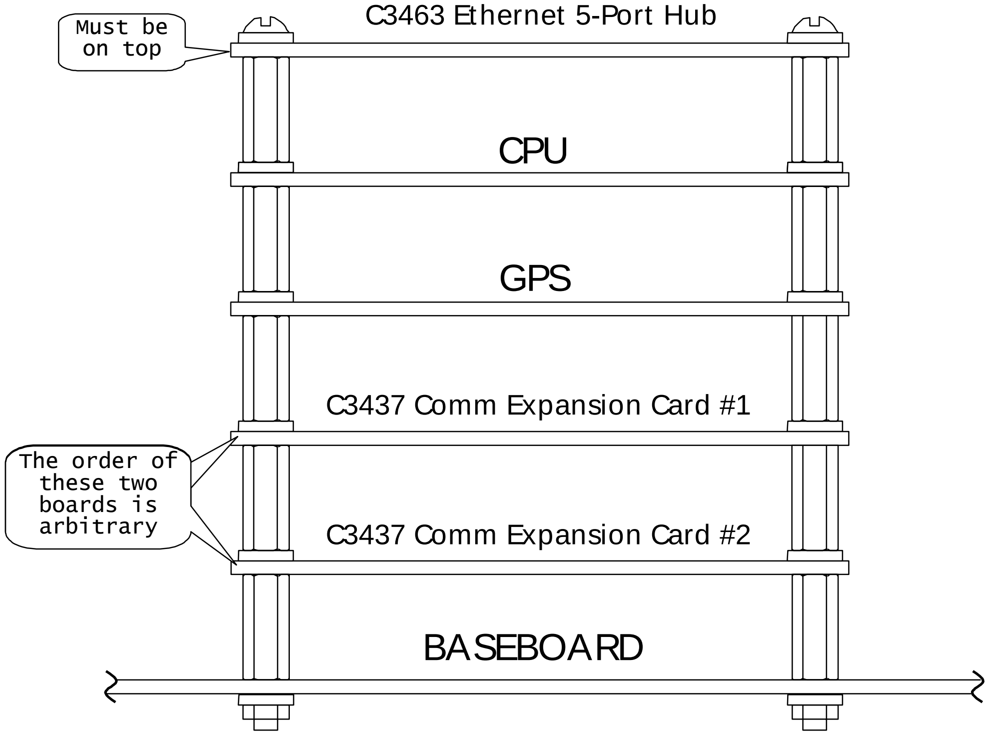


Figure 3-13 PC/104 Card Stacking



3.5.5.1 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.

3.5.5.2 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

3.5.5.3 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

3.5.6 C3830 PC/104 AI Card

The PC/104 Analog Input Module is an option that can be used with the SAGE 1X10, 1330, or 3030 models. It adds 256 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 3-14 C3830 PC/104 AI Card

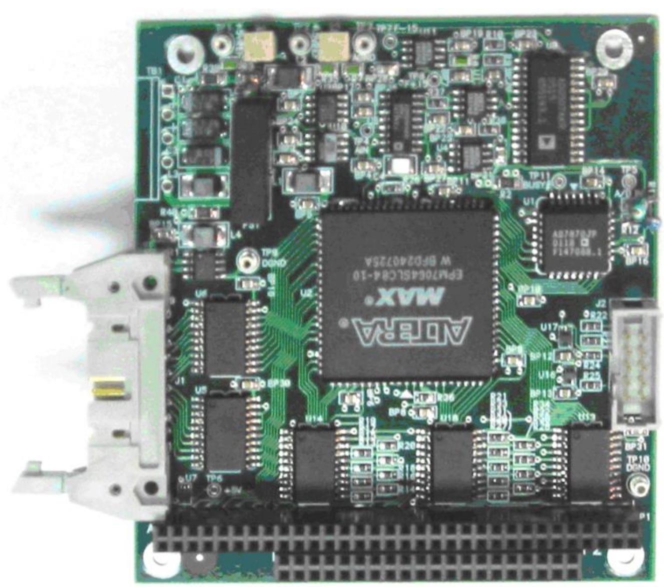
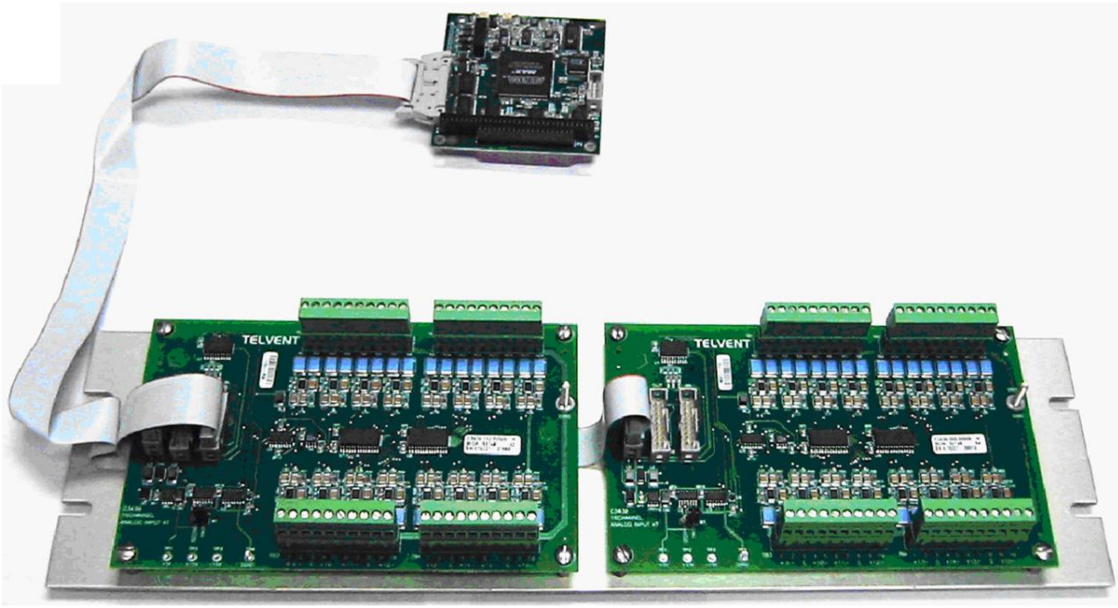


Figure 3-15 C3830 PC/104 AI Card w/XTs



4 Maintenance

This chapter describes the various calibration procedures for maintaining the SAGE 1X10. Those users who desire a more thorough technical understanding of the SAGE 1X10 should refer to Chapter 5 Theory of Operation which contains detailed descriptions of each module, and to the back of this manual, 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 1X10 RTUs:

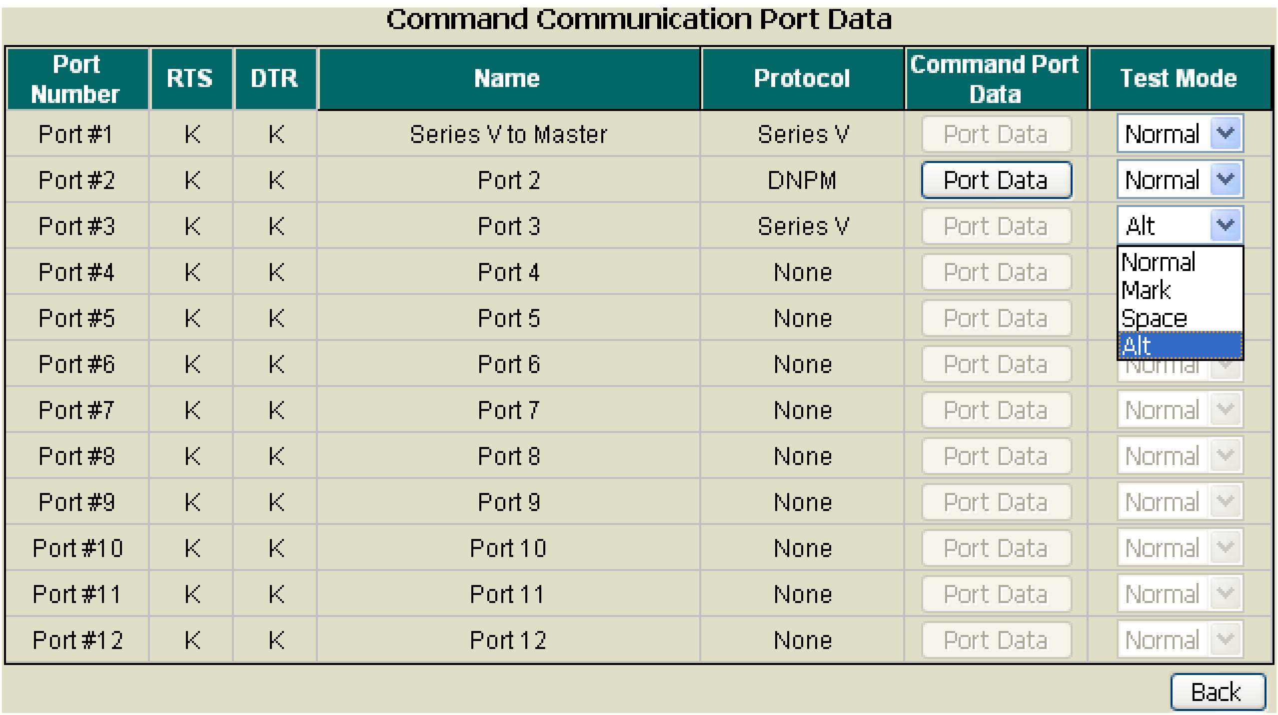
- General-purpose 3-1/2 digit DMM

The SAGE 1X10 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	Alt
Port #4	K	K	Port 4	None	Port Data	
Port #5	K	K	Port 5	None	Port Data	
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

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 is 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

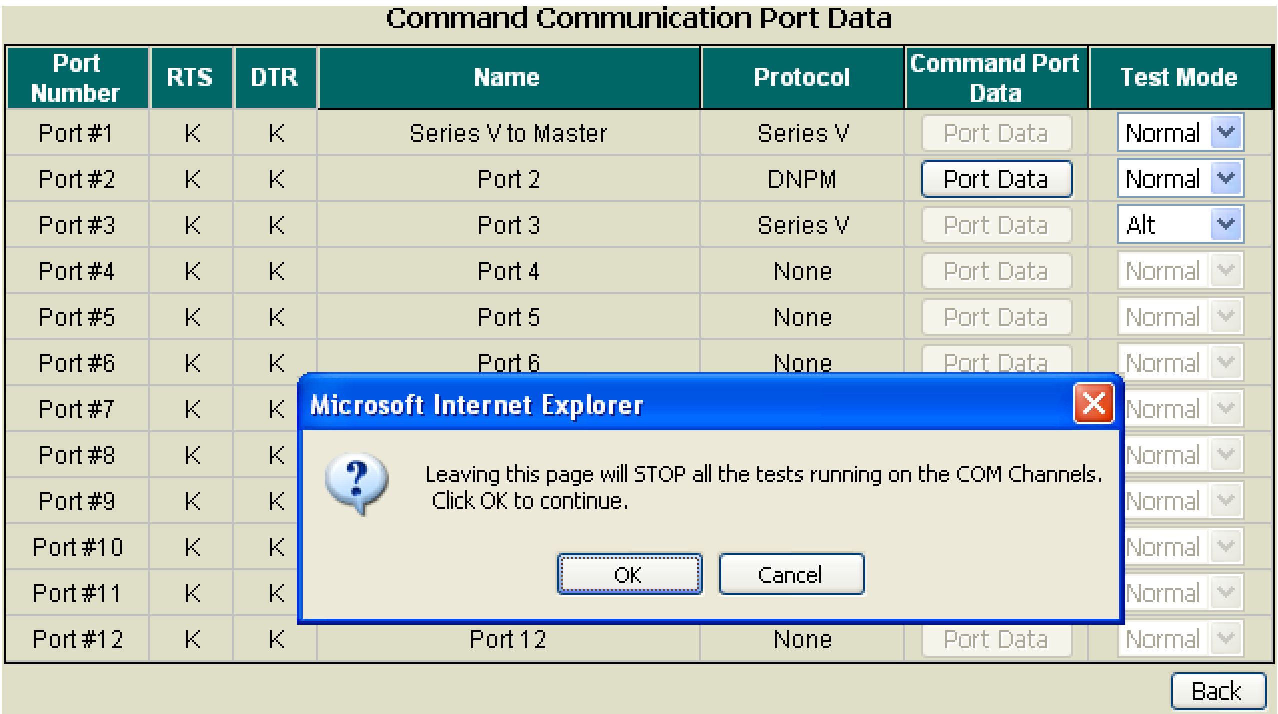
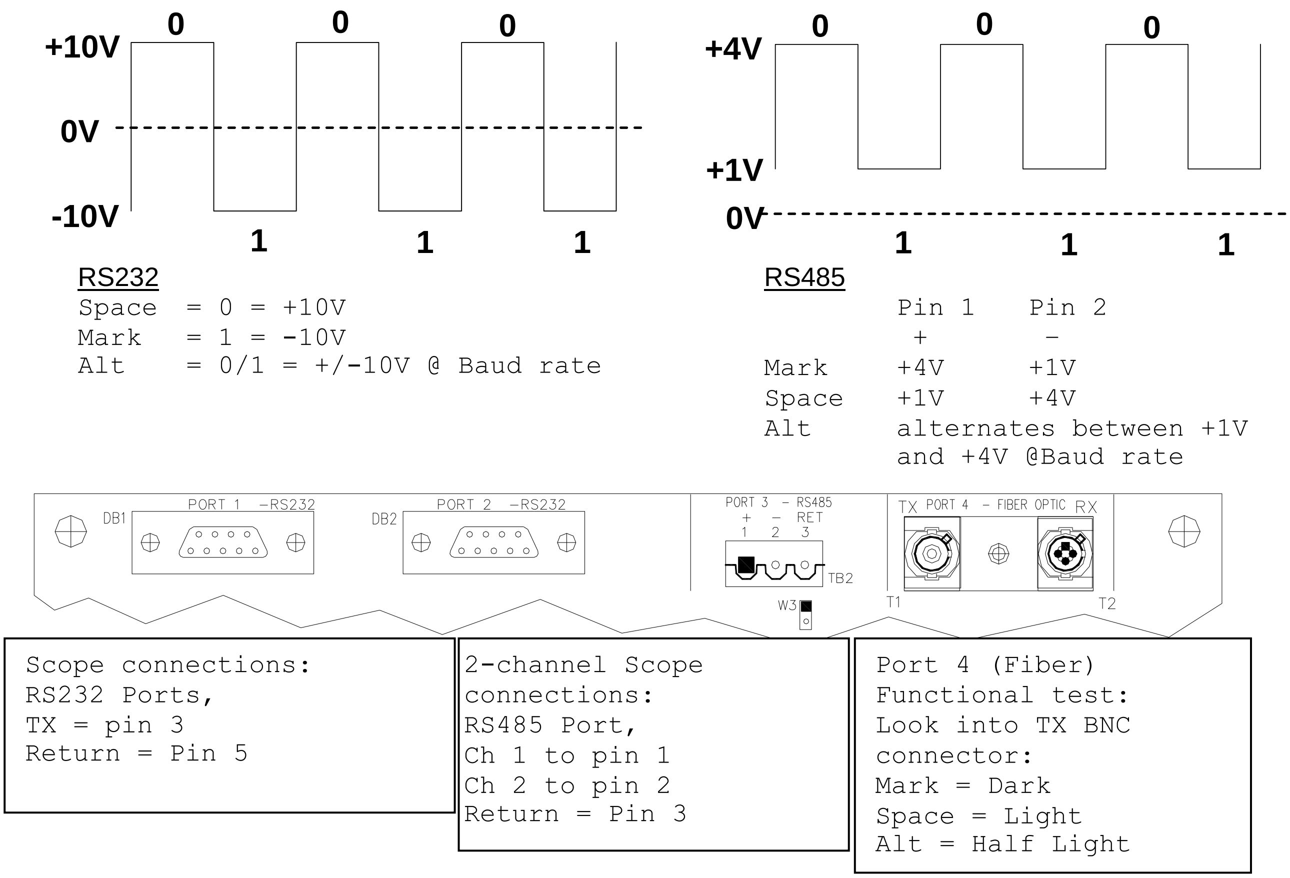


Figure 4-3 Comm Port Test



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 1X10. If you are troubleshooting to the component level, the use of Chapter 5 Theory of Operation and the drawings in the back of this manual will be helpful.

Caution: Do not insert or remove PC cards from the Baseboard unless the power supply has been turned off.

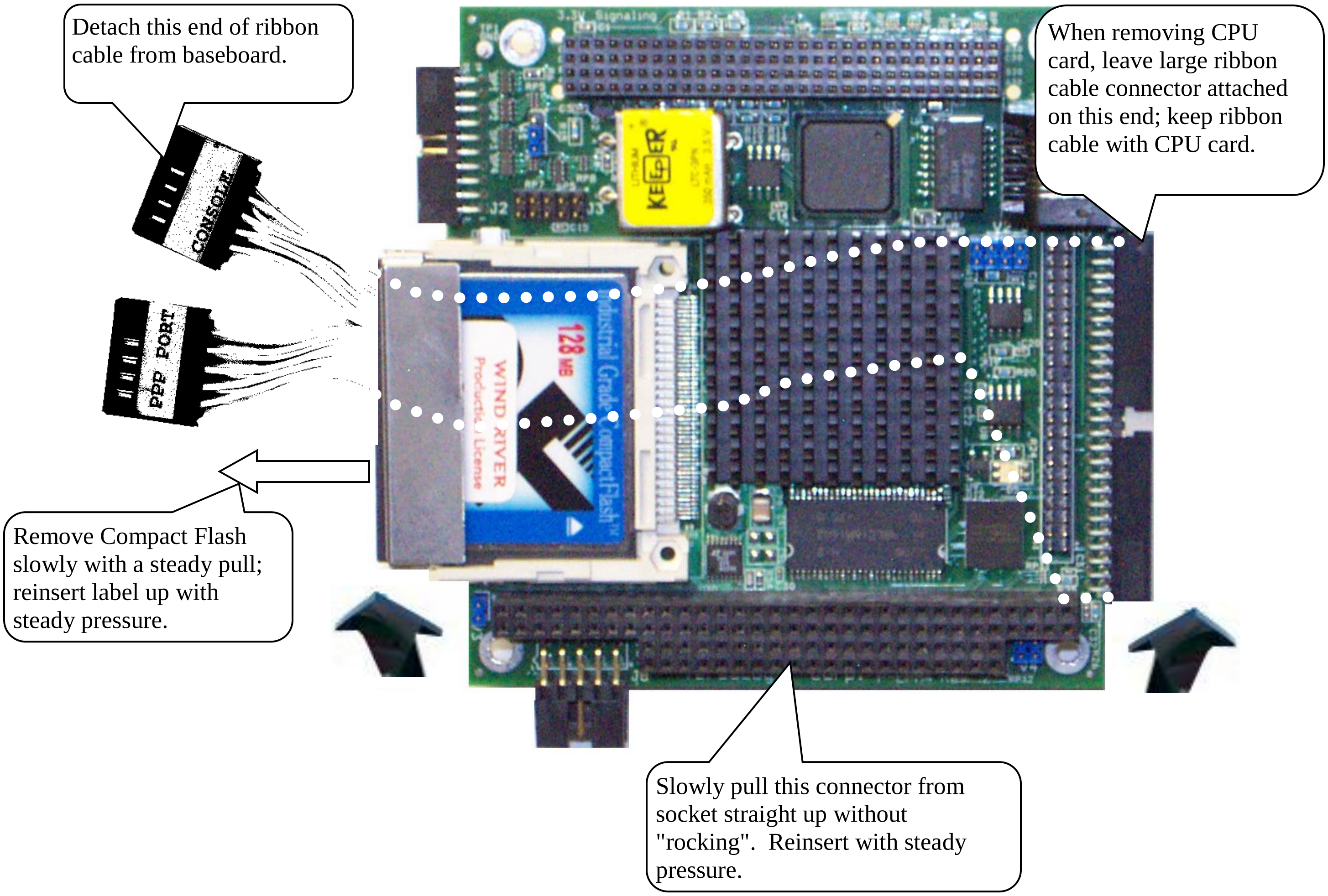
4.2.1 Removing PC/104 CPU Card or Compact Flash

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 PC/104 CPU Card with Ribbon Cable & Compact Flash



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 4-8 for the location of LEDs and Test Points on the Baseboard, and to Figure 4-5 for the location of LEDs on the C3438 Communications Expansion Card. The SAGE 1X10 has been designed with an ample number of LEDs to provide the operator an indication of the activities being performed by the RTU.

Power

The power LED (DS15) is illuminated and Baseboard power is provided when SW1 is on.

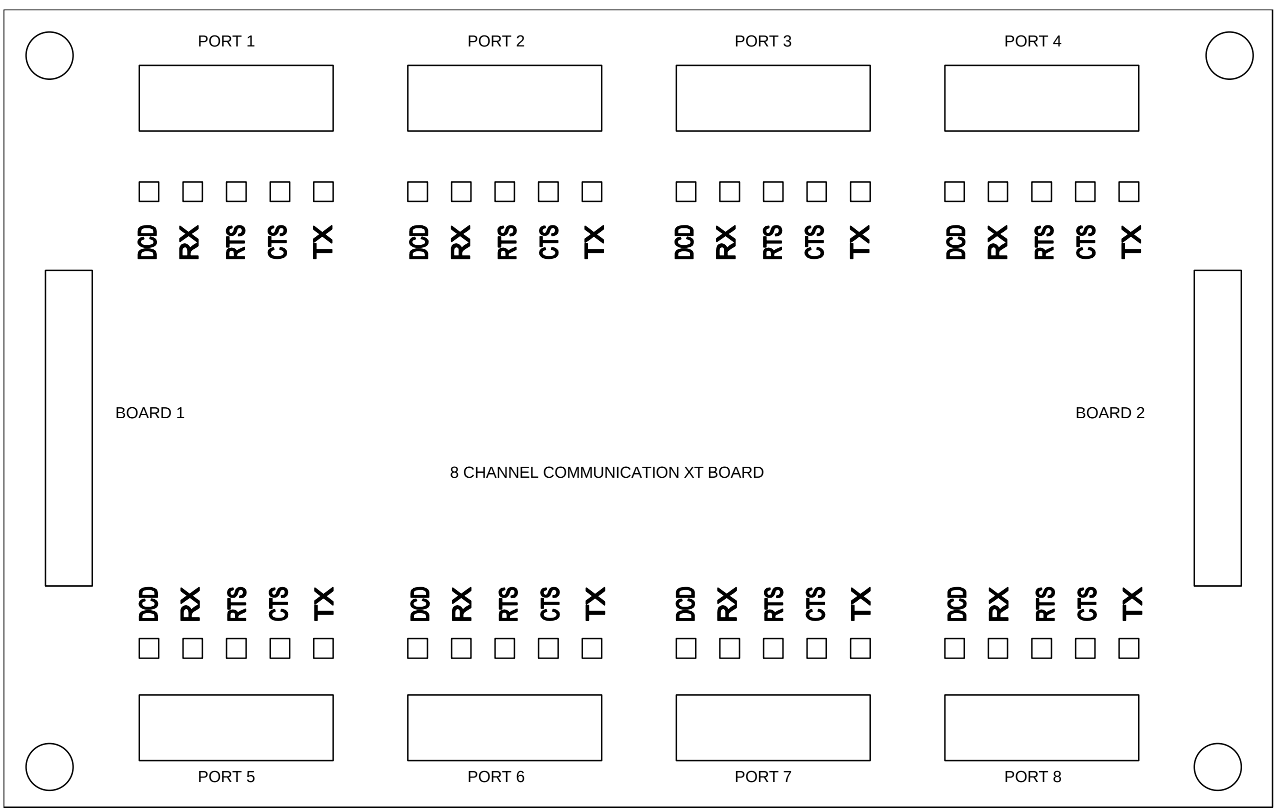
Communication

All the communications ports (RS232, RS485, fiber optic), including the ports on the C3438, are annunciated by LEDs as noted in Table 4-1, Figure 4-5, and Figure 4-8.

Table 4-1 Communication LEDs

Signal	Baseboard					C3438 Communications Expansion Card							
		RS232		RS485	Fiber	RS232							
	UIF	CH-1	CH-2	CH-3	CH-4	CH-1	CH-2	CH-3	CH-4	CH-5	CH-6	CH-7	CH-8
Tx	DS20	DS5	DS10	DS11	DS13	DS5	DS10	DS15	DS20	DS25	DS30	DS35	DS40
CTS	DS19	DS4	DS9			DS4	DS9	DS14	DS19	DS24	DS29	DS34	DS39
RTS	DS18	DS3	DS8			DS3	DS8	DS13	DS18	DS23	DS28	DS33	DS38
Rx	DS17	DS2	DS7	DS12	DS14	DS2	DS7	DS12	DS17	DS22	DS27	DS32	DS37
DCD	DS16	DS1	DS6			DS1	DS6	DS11	DS16	DS21	DS26	DS31	DS36

Figure 4-5 C3438 Board Layout



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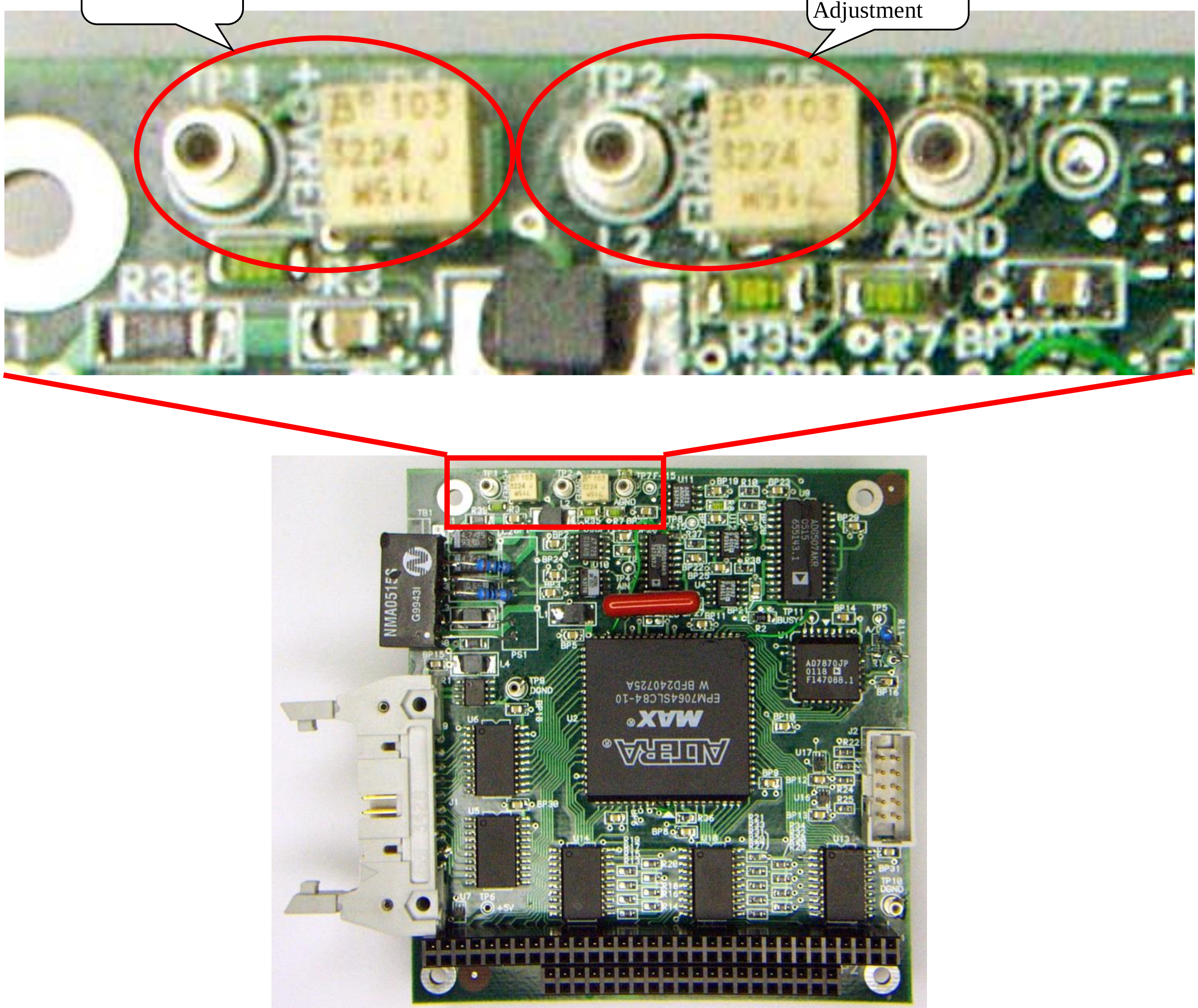
4.3 Analog Input Calibration (Optional C3830 Card)

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.

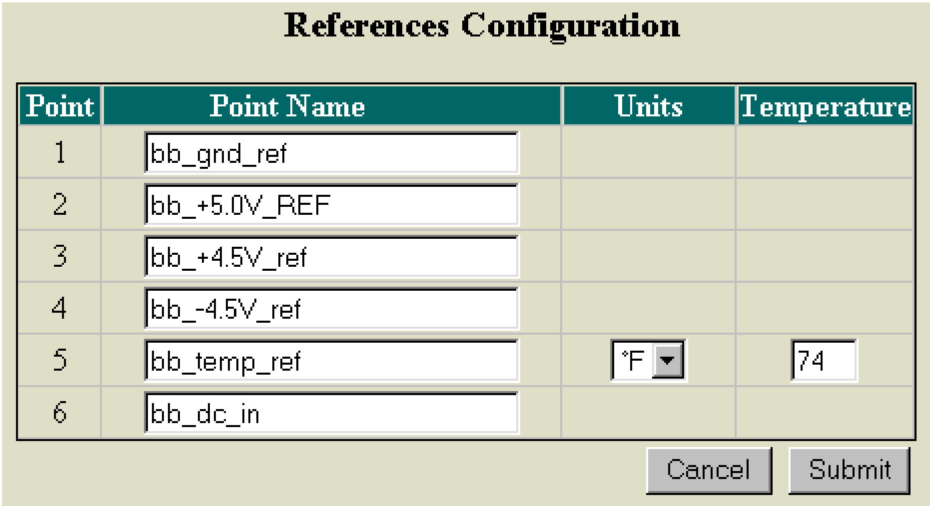
Figure 4-6 C3830 PC/104 AI Card



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 4-7 References Configuration



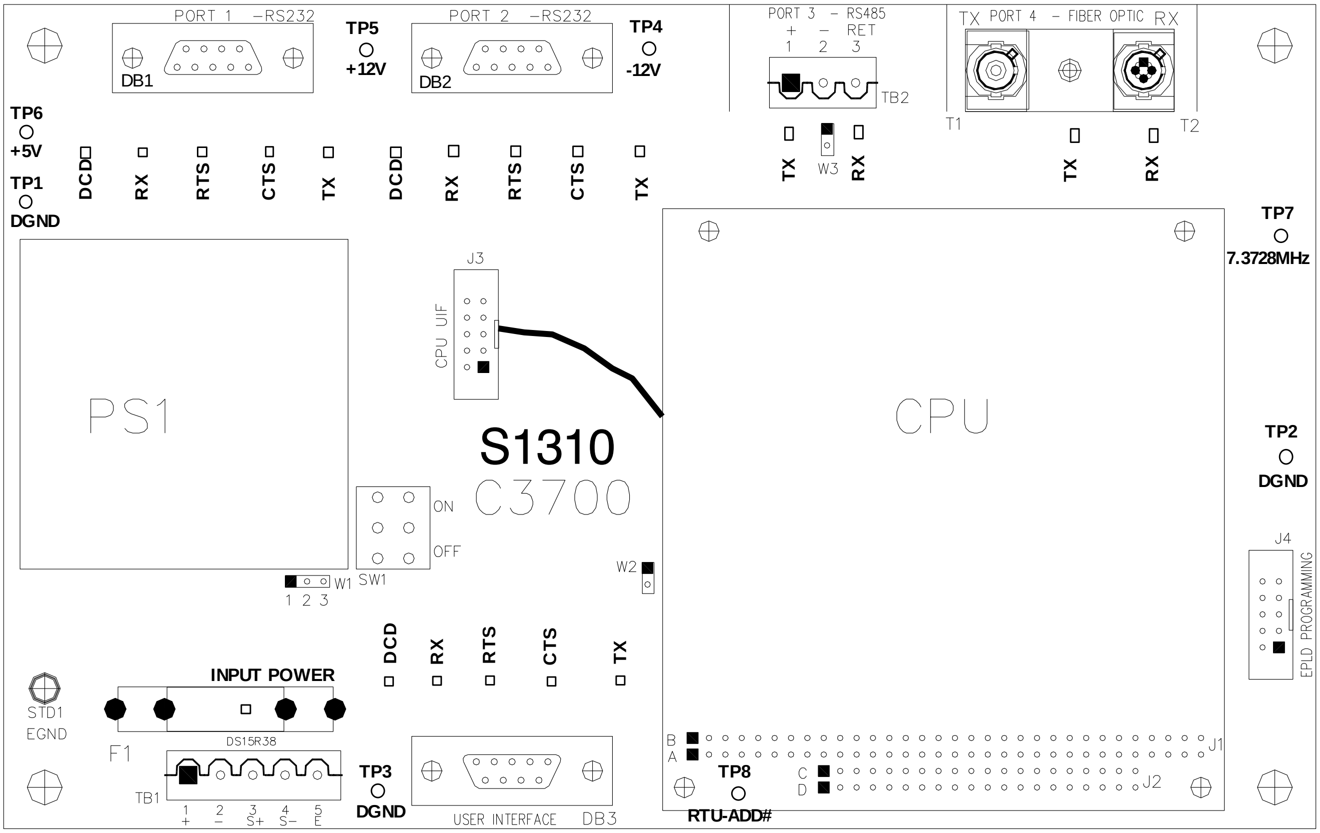
4.4.1 Test Points

The following test points are included on the SAGE 1X10 baseboard: See Figure 4-8.

Table 4-2 Test Points

Testpoint	Signal	Schematic Page	Allowable Range
TP1	DGND	3 of 3	N/A
TP2	DGND	3 of 3	N/A
TP3	DGND	3 of 3	N/A
TP4	-12 Volts	3 of 3	-12.6 to -11.4
TP5	+12 Volts	3 of 3	11.4 to 12.6
TP6	+5 Volts	3 of 3	4.95 to 5.05
TP7	7.3728MHz	3 of 3	7.3724 to 7.3732

Figure 4-8 Baseboard LED, Test Point, & Jumper Map



4.5 Jumper Positions, Baseboard

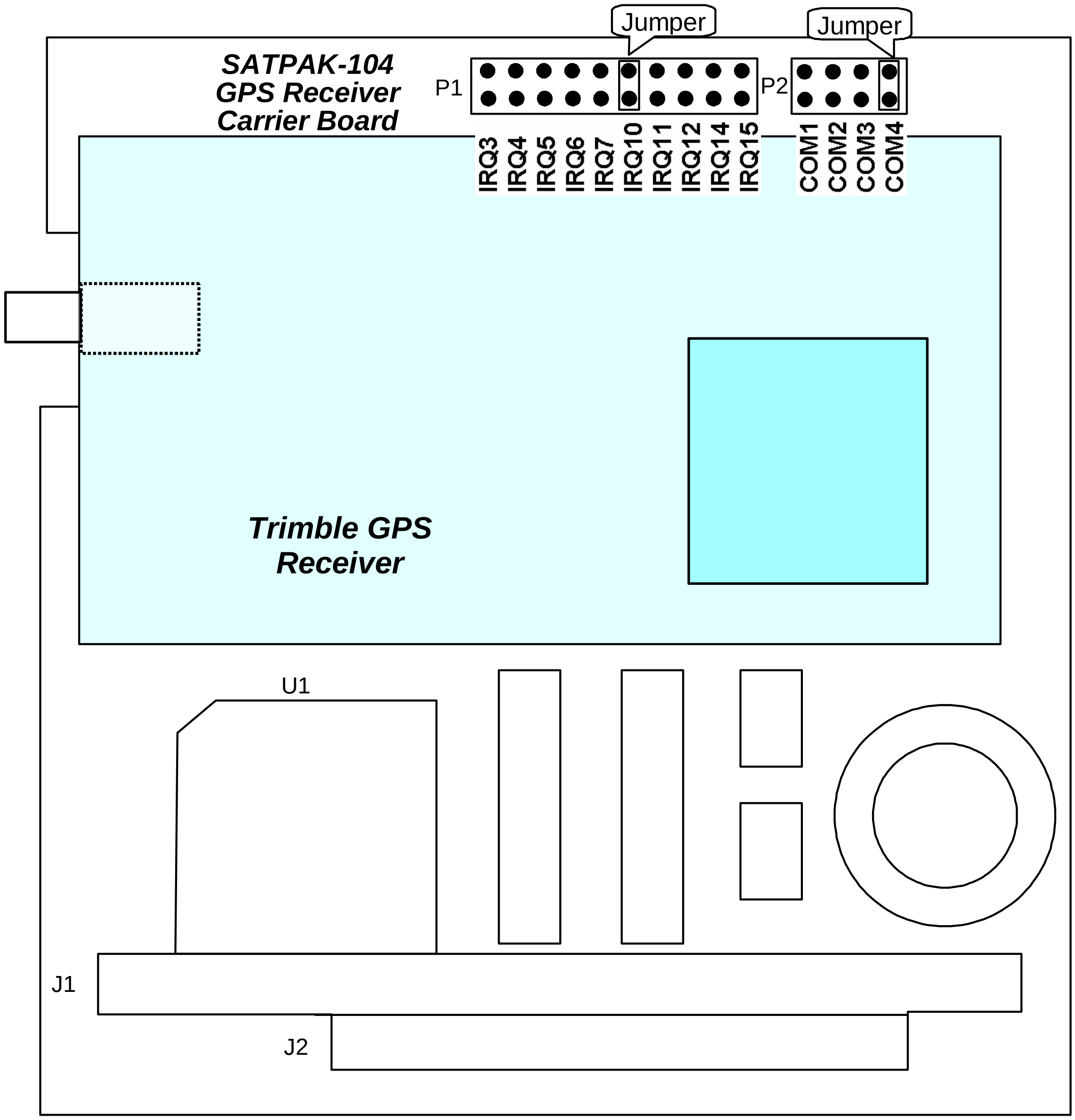
The factory test Baseboard jumpers are positioned as noted in Table 4-3. This may not agree with the configuration required for proper operation of your RTU. Determine the setup for your RTU by checking the function column in the table. For a detailed view of the SAGE 1X10 baseboard, please see the drawings at the back of this manual. See Figure 4-8 for location of jumpers. Please see the following sections below for further jumper information.

Table 4-3 Jumper Positions, Baseboard

Jumper / Position	Function	Factory Setting	Sheet
W1 / 1-2	Ties board’s DC ground to input – (TB1-2)	IN	3 OF 3
W1 / 2-3	Isolates board’s DC ground from input		
W2 / IN	Asserts the non-maskable interrupt (used for software debugging only)		1 OF 3
W2 / OUT		OUT	
W3 / IN	Terminates RS485 line with 100 ohm resistor	IN	2 OF 3
W3 / OUT	Unterminates RS485 line		

4.6 Jumper Positions, C3461 PC/104 GPS Card

Figure 4-9 Jumper Positions, C3461 PC/104 GPS Card



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

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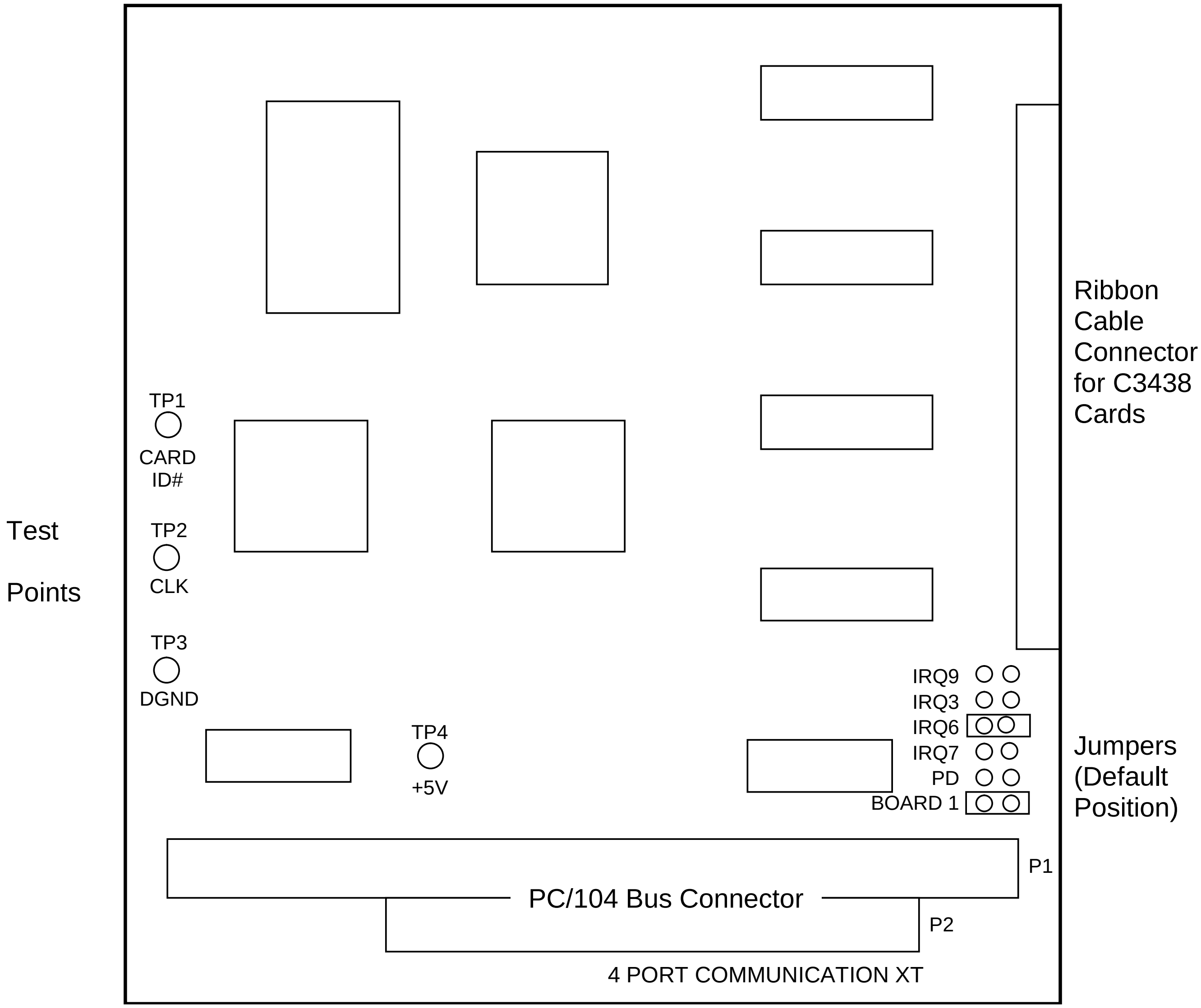
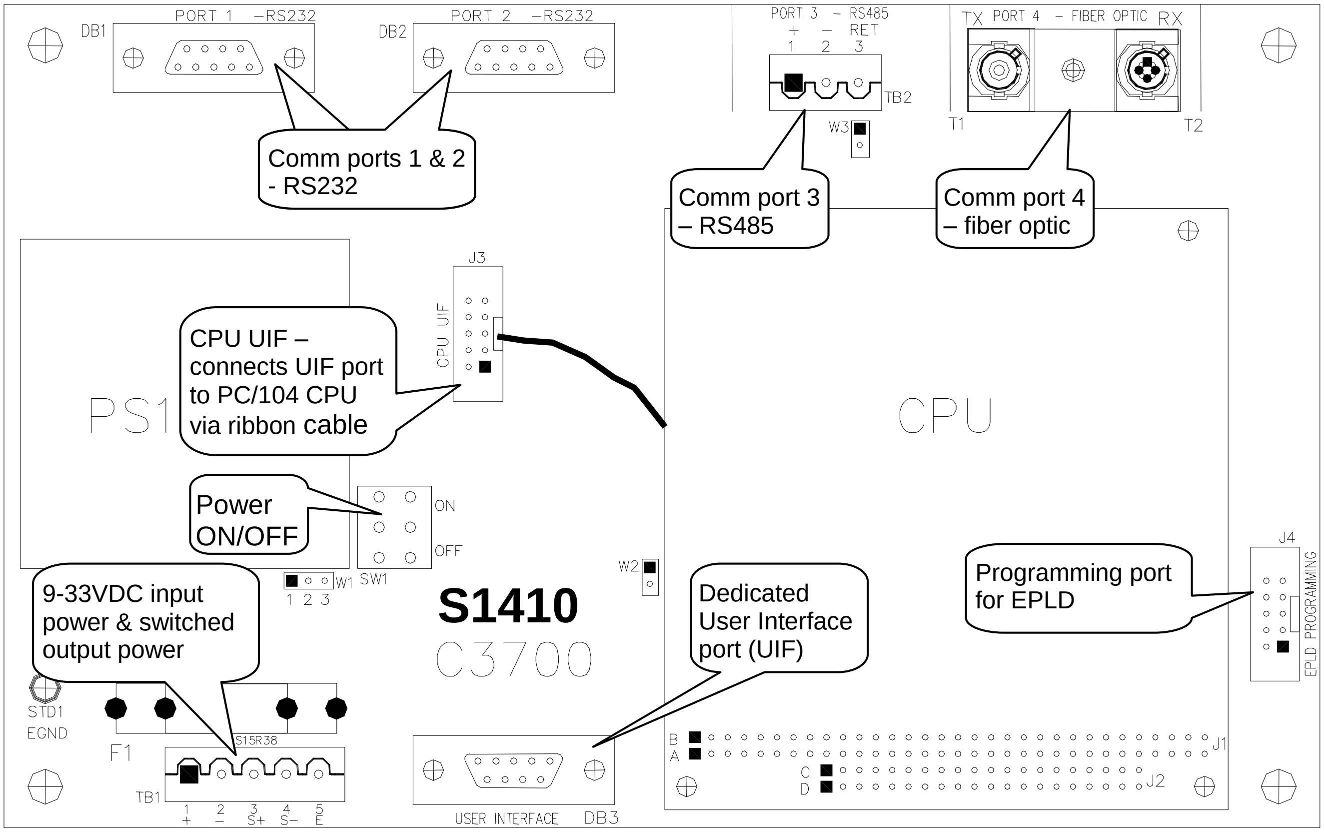
Figure 4-10 Jumper Positions & Test Points, C3437 PC/104 Communications Card



4.8 I/O Locations & Functions

Figure 4-11 I/O Locations & Functions



5 Theory of Operation

This section provides detailed technical design information on the SAGE 1X10, including design of the firmware and hardware. It is intended for use by those who wish to perform component-level troubleshooting and repair on the modules. This section is based on the simplified block diagram shown in Chapter 1. The schematic drawings and printed circuit assembly drawings contained in the back of this manual can be used for a more detailed study.

5.1 Basic Architecture

The SAGE 1X10 microprocessor controlled RTU is composed of a Baseboard and a Daughter board. Each unit performs a specific part of the functions necessary for operation as an intelligent remote terminal unit in a SCADA system. The Baseboard handles all communications with the Master Station(s). It maintains a central database containing all of the input/output data, and issues various types of commands as they are received from the Master Station(s).

5.1.1 PC/104 Architecture

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 which 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 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 1X10 Microprocessor Overview

Please refer to CPU manual for Processor Overview

5.3 Hardware Design

5.3.1 PC/104 Bus Interface/Connector

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

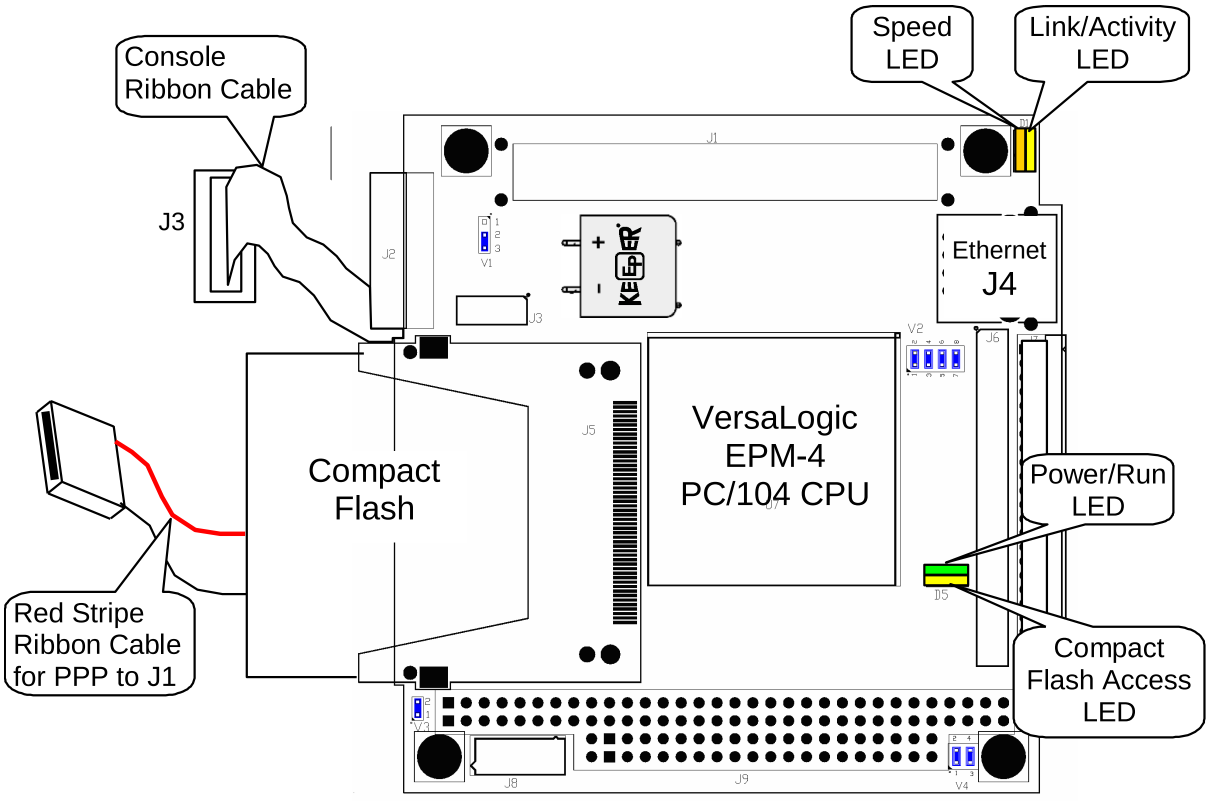
Contact the Consortium at:

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

Figure 5-1 EPM-4 PC/104 CPU Card



5.3.2 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 acts as the PC/104 interface. The RTU acts as an 8bit slave ISA card and as such only decodes the first nine addresses from the bus. Addresses SD15 - LA23 are in the connector but not brought out to the RTU.

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

Figure 5-2 C3437 Board Layout

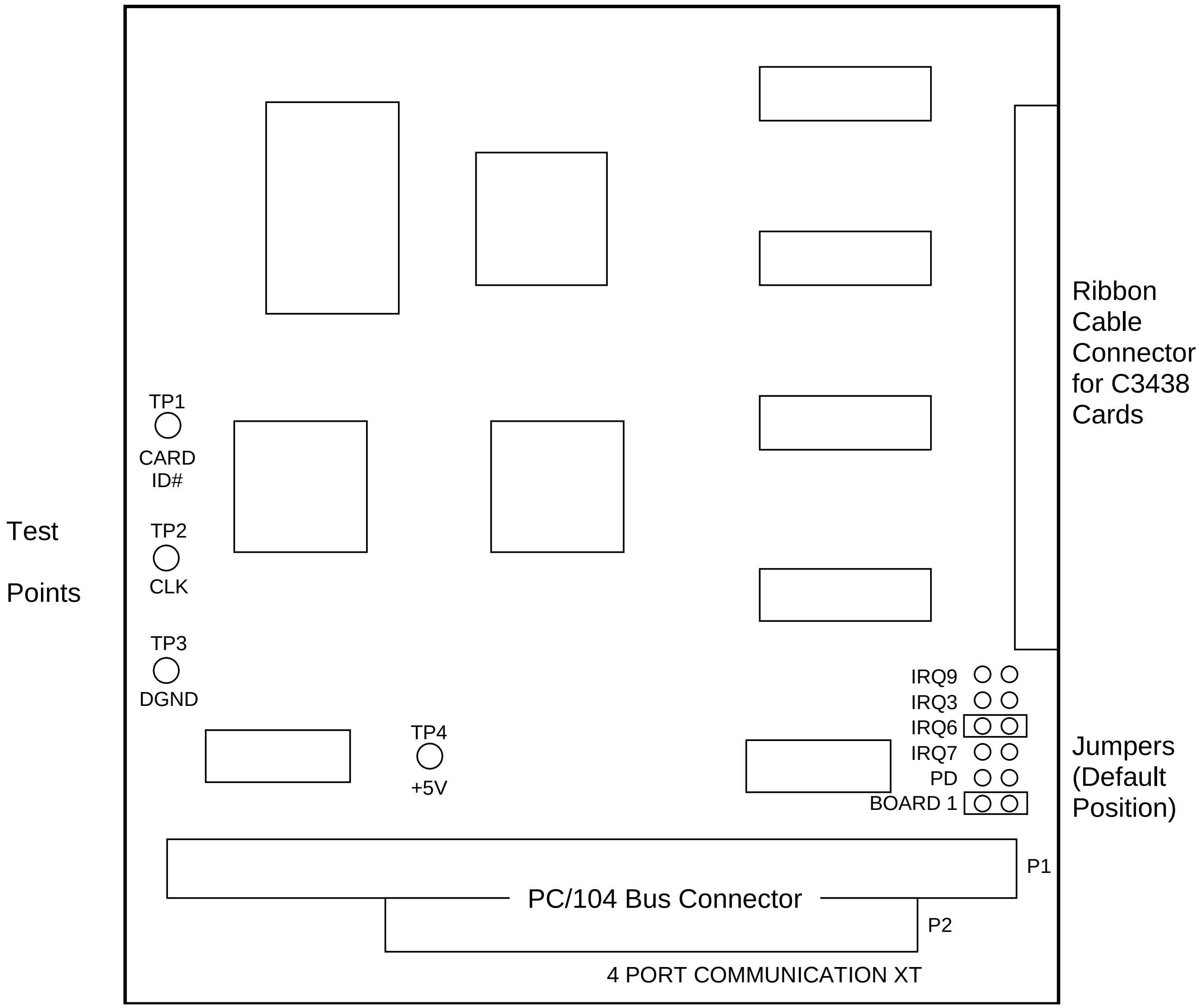


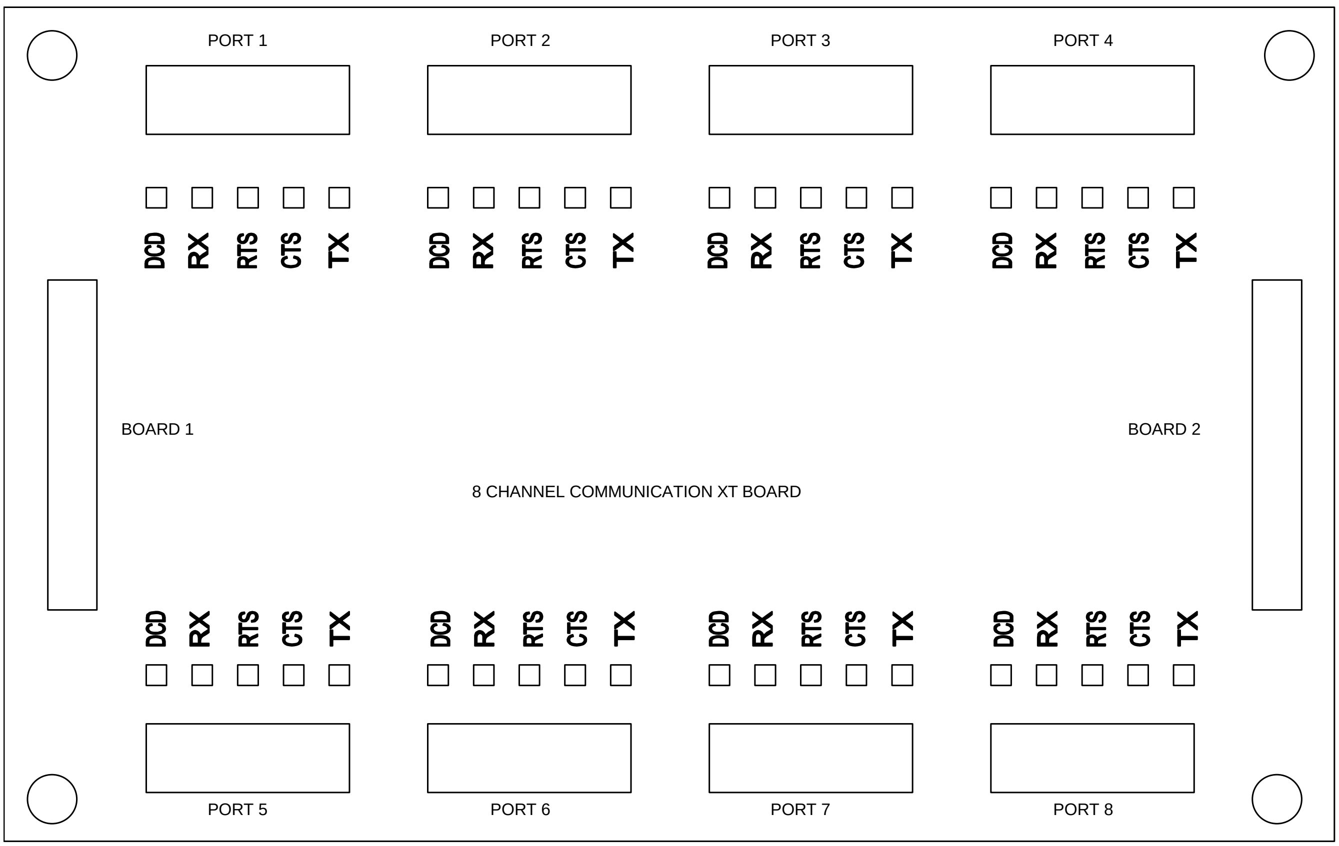
Table 5-1 I/O Port Addresses for the 4-Channel C3437 Communications Card

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

5.3.3 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.

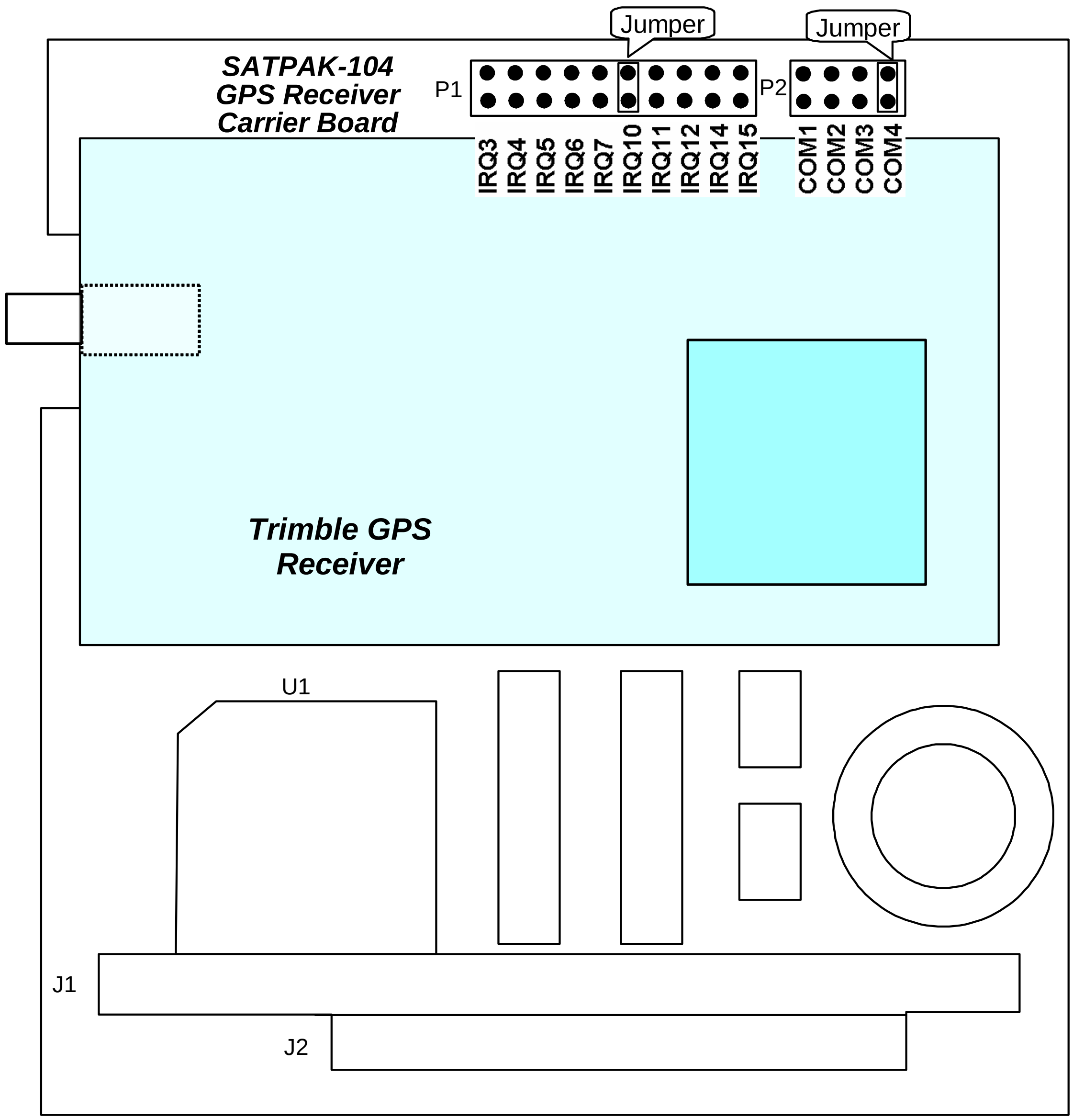
Figure 5-3 C3438 Board Layout



5.3.4 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 5-4.

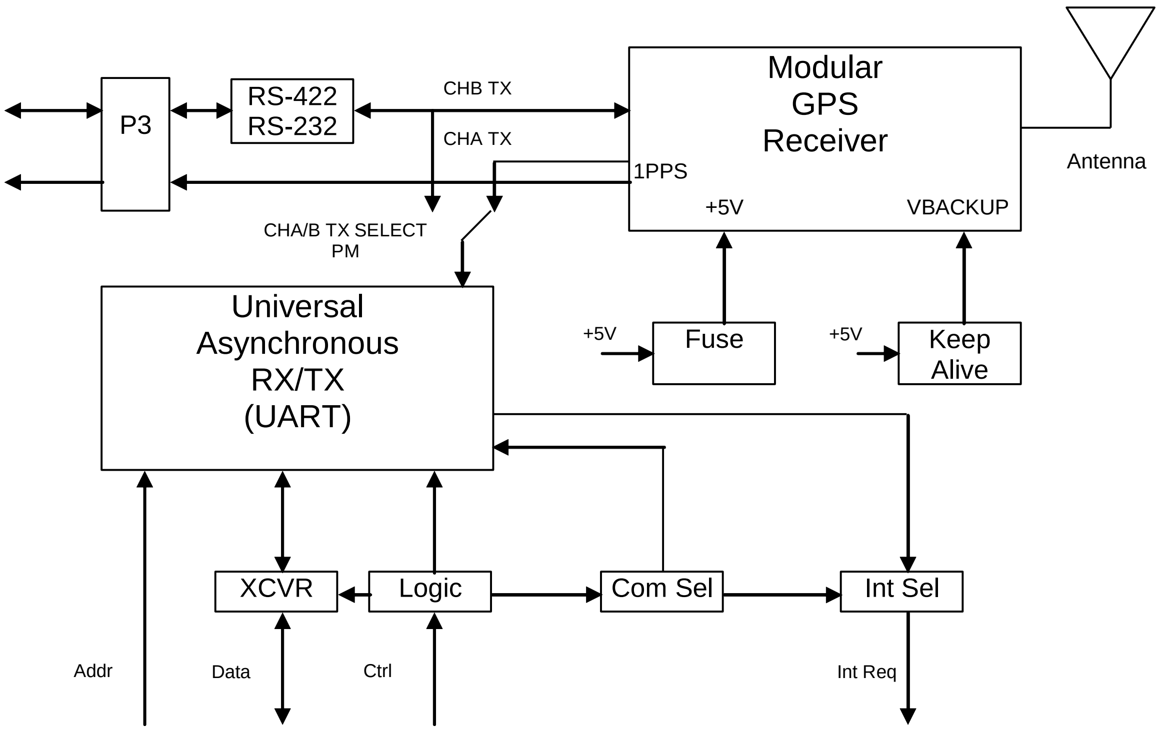
Figure 5-4 C3461 Board Layout



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 (COM1, 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 5-5.

Figure 5-5 GPS Receiver Block Diagram



5.3.5 Power Input

The SAGE 1X10 Baseboard accepts +9 to +33VDC as a power input. Additional inputs of 48VDC and 129VDC may be used with a DC/DC converter. 120VAC or 240VAC may be used with the appropriate supply/charger.

Terminal block input TB1-1 is used for the +9 to +33VDC input. The return is connected to TB1-2. The input is surge protected by varistors RV2 and RV3 and reverse voltage protected by diode CR51 and fuse F1. Over-voltage protection is provided by zener CR51. SW1 controls the power on-off while an LED (DS15) indicates the presence of power to the Baseboard.

In minimum configurations, the entire RTU may be operated from this single power source. The logic voltages needed for the operation of the rest of the system are derived from +9 to +33VDC by regulators which generate the ±12 volts. Zener diodes (CR20, 21, 22) protect the output lines from over-voltage.

5.4 Communications Ports

The SAGE 1X10 baseboard has 4 communications ports. The first two ports are general purpose RS232 ports and are accessed through a standard DB9 female connector. Each pin has electrical surge protection and port status can be determined via hardware LED indication for TX, RX, RTS, CTS and DCD signals.

The third port is configured for RS485. It is has surge protection and supports hardware LED indication for TX and RX data. This port is accessed through a 3 position terminal block that can accept up to 12 Gage wire.

The fourth port is configured for fiber optic communications. Hardware LED indications for TX and RX data are supported. This port is accessed through industry standard ST fiber connectors. The transmitter and receiver are designed to operate with 850nm multi-mode fiber cable.

6 Drawings

The following schematic and assembly drawings are included in this manual as a convenience to allow for troubleshooting. See the 1X10 Drawings.pdf file for the full drawings.

C3700-A00-00000	Assembly Drawing, SAGE 1010 Baseboard	Rev E	2 pages
C3700-200-00XXX	Top Level Board Assembly, SAGE 1210 RTU	Rev 0	1 page
C3700-300-00XXX	Sage 1310 with 586 CPU	Rev 0	1 page
C3700-301-XXXXX	Sage 1310 with 586 CPU & 4 Port Ethernet SW	Rev 0	1 page
C3700-400-00XXX	Sage 1410 with LX-800 CPU	Rev 0	1 page
C3700-401-XXXXX	Sage 1410 with LX-800 CPU & 4 Port Ethernet SW	Rev 0	1 page
C3700-002-REV-B	Schematic, SAGE 1010 Baseboard	Rev B	3 pages
C3700-002-PLDA1	PLD PGRM EP7032S	Rev A	1 page
S1110-600-00001	Application Dwg. for S1110 Wiring	Rev 0	1 page
S1410-600-00001	Application Dwg. for S1410 Wiring	Rev 0	1 page
S1110-600-00002	Application Dwg. for S1X10 Outline & Mounting	Rev 0	1 page
S1310-XXX-XXXXX	S1310 RTU Assy with various Power Input	Rev 0	6 pages