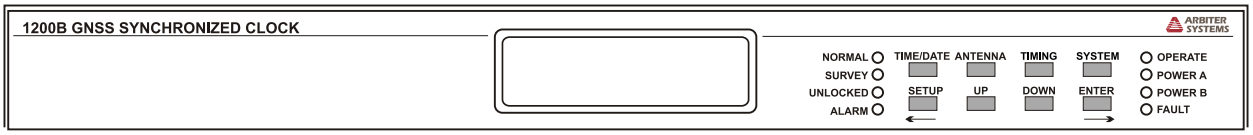
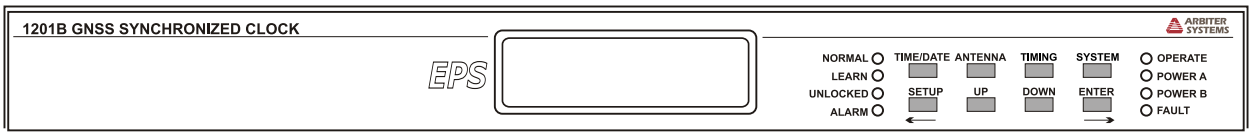
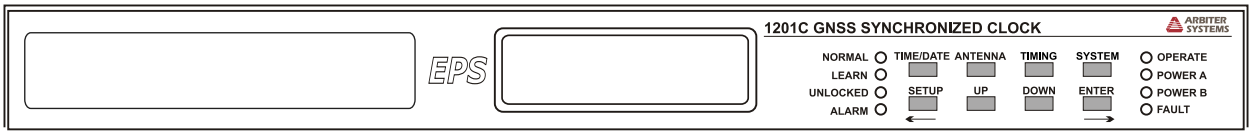
MODEL 1200B
MODEL 1201B/C
GNSS SYNCHRONIZED CLOCK
OPERATION MANUAL







ARBITER SYSTEMS, INC.
PASO ROBLES, CA 93446
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WWW.ARBITER.COM

Description This manual describes the operation and configuration of the Model 1200B and Model 1201B/C GNSS Synchronized Clocks. It is issued for reference only, at the convenience of Arbiter Systems. Reasonable effort was made to verify that all contents were accurate at publication. Check with Arbiter Systems for any revisions made since the original publication date.

Contact Information

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How to Determine Firmware Version Date

To display the firmware date for the clock, press SYSTEM until reaching the Serial Number (S/N) and firmware version screen. To determine the current firmware date for this product, see the Arbiter website.

Firmware Updates – Main Board

The clock main board requires a flash package file and a utility program to update firmware. Both are downloadable from the Arbiter website.

Firmware Updates – Network Options

Network options require an additional flash package and a modern web browser to update firmware. Flash package file updates are downloadable from the Arbiter website.

Firmware Updates – Non-Network Options

Some non-network options require an EEPROM to update firmware. For example, the Power System Time, Frequency, and Phase Monitor requires an EEPROM replacement on the option board to upgrade firmware.

NOTE: Where applicable, firmware updates may include supplemental documentation, or a new version of this manual.

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See Contact Information on page ii.

Model 1200B and Model 1201B/C GNSS Synchronized Clock Operation Manual

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Chapter 1

Getting Started

1.1 Model 1200B and 1201B/C Common Features

The foundation of these clocks is the GNSS receiver. It is capable of tracking the USA GPS, Russian GLONASS, European Galileo, and the Chinese Beidou constellations. In standard configuration, there are three terminal block outputs capable of providing unmodulated IRIG-B, modulated IRIG-B, 1 PPS, and Programmable Pulse. The clocks have substantial drive capability to supply timing to multiple loads in parallel.

Available options include redundant power supplies and auxiliary option boards that provide additional output signals and drive. See Appendix B for option board information.

Any of the standard I/O connectors may be configured for event capture, or the COM1 RS-232 port may be used for timing the arrival of data. The event timing has 100 nanosecond resolution, and the clock sequentially records up to fifty events internally.

1.2 Model 1201B/C Advantages

The Arbiter Systems Model 1201B/C provides the utmost in timing accuracy, stability, and protection from communication attacks and false GNSS signals. First in a new series of synchronized secure clocks by Arbiter Systems offering an ultra-stable, crystal holdover oscillator, the Model 1201B/C can provide the highest level of timing stability in the presence of a false GNSS signal, or from losing the GNSS reception.

The Model 1201B/C is more accurate at 100 ns whereas the Model 1200B accuracy is 200 ns.

The Model 1201B/C also benefits from the addition of ultra-stable oscillators with guaranteed holdover capability. The standard holdover oscillator has a drift rate of less than 1 ms/day.

The addition of the holdover oscillator allows the Model 1201B/C to incorporate "EPS" technology, for Enhanced Performance and Security. Three components used provide for secure clock operation include: (1) encryption protection for secure connections, (2) GNSS anti-spoof shielding, and (3) intelligent holdover capability.

A strategic component providing the highest level of anti-spoofing of the GNSS is a new multiphase detection GNSS antenna. With this antenna the clock will be able to accurately track the active satellites and detect false GNSS (spoofed) signals.

1.3 Standard Accessories

Components and accessories shipped with the clock are listed below. A pdf version of the operation manual may be downloaded from the Arbiter website.

- GNSS Synchronized Clock
- Choice of internal power supply
- Antenna Cable, 15 m (50 ft) with connectors
- GNSS Antenna
- Rack-mount ears with hardware, attached
- Quick Setup Guide
- Utility software – free download from www.arbiter.com

1.4 Handling Precautions

Mechanical Shock The GNSS antenna may be damaged if dropped. Use care when handling.
Static Discharge The clocks are electronic devices and use static-sensitive components in their operation. Use care to minimize static discharges, especially when the cover is removed.

1.5 Unpacking and Locating Accessories

For shipping, the clock and included accessories are packaged in a carton with the clock held down with a piece of plastic wrap and accessories below it. See Figure 1.1.

1. Carefully grip points A and B and pull up. As the clock packaging expands outward, the plastic wrap loosens so you can remove the clock.
2. Some of the accessories (i.e. antenna, antenna cable and rack-mount ears) are located below the clock in separate compartments.
3. Handle the GNSS antenna carefully, as it may be damaged if dropped.

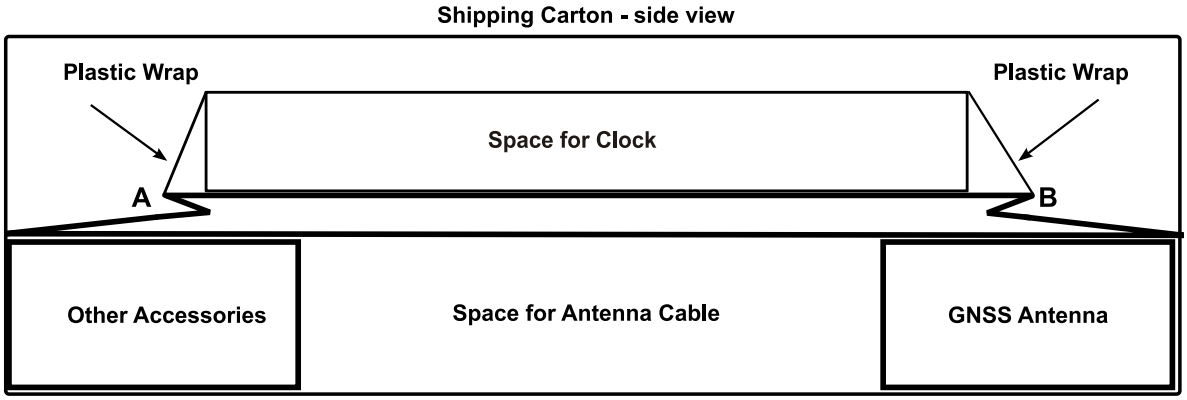


Figure 1.1: Packaging of Accessories

1.6 Removing Rackmount Ears

Each clock comes with two, pre-installed rack-mount ears suitable for mounting in a 19 inch rack system. These ears have four mounting holes, two used to attach the rack-mount ear to one side of the clock, and two that attach the clock to the rack-mount system.

1.6.1 Removal Instructions

1. Using a Torx T25 driver or large slot screwdriver, remove the two M5×10 mm flat head screws attaching one rack-mount ear to the clock cover at the front of the chassis.
2. Remove the rack-mount ear and replace the two M5×10 mm flat head screws with the included M5×10 mm pan head screws.
3. Repeat this procedure with the other side of the chassis and other rack-mount ear.

Rack-mount Ear Locations

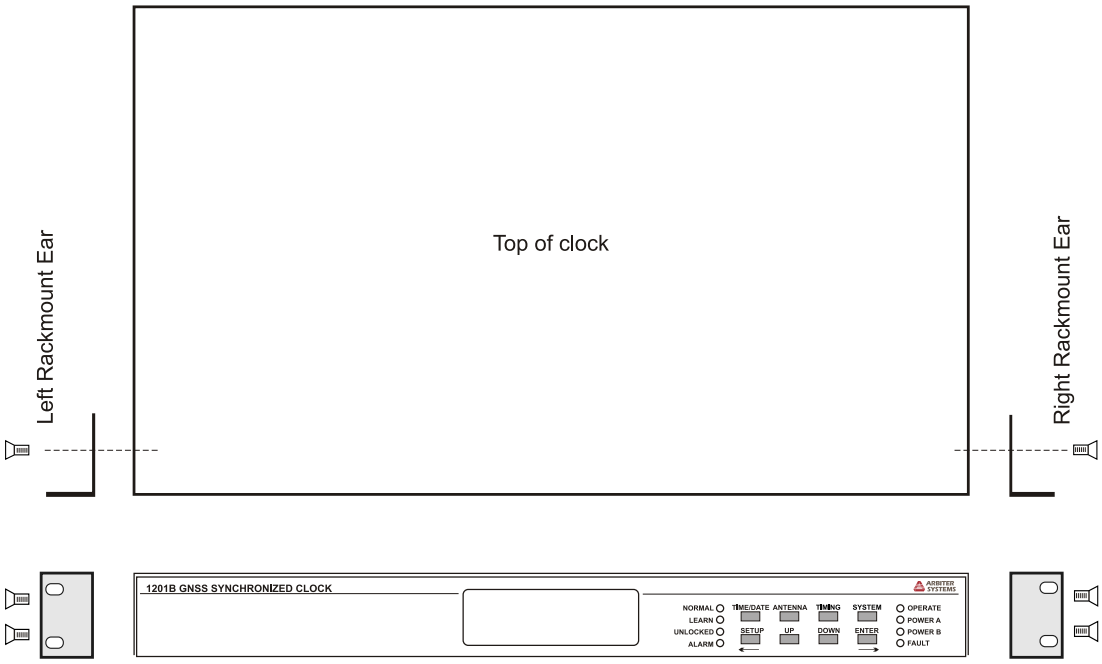


Figure 1.2: Attaching Rackmount Ears

Chapter 2

Front and Rear Panels

2.1 Introduction

This section identifies the connectors, controls, and displays found on the front and rear panels of the 1200B and 1201B/C series clocks. Take care to review all of these items prior to connecting any cables and wires, and configuring the clock.

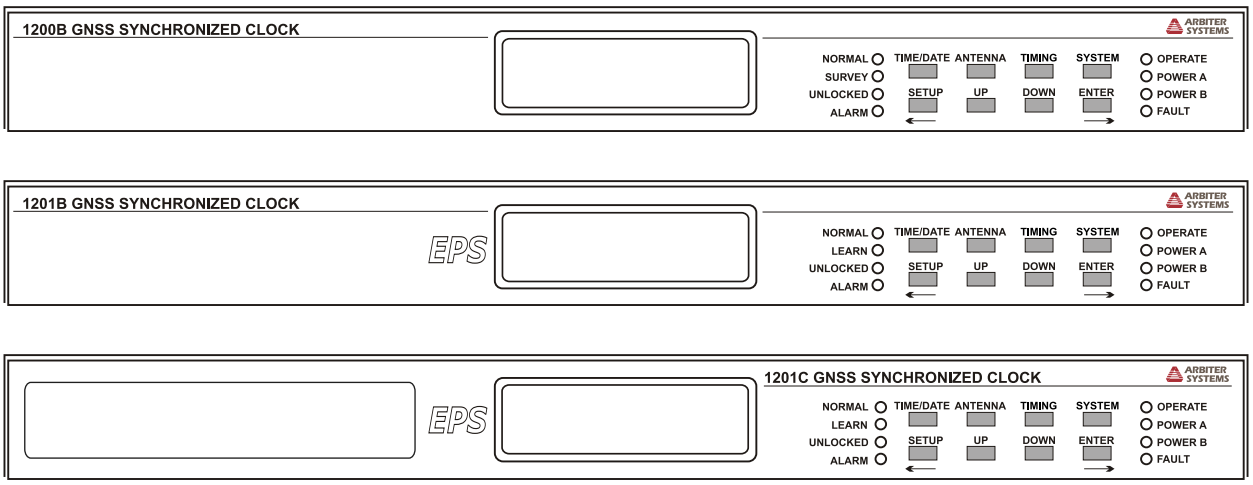


Figure 2.1: Model 1200B and Model 1201B/C Front Panel Description

2.2 Front Panel Controls and Indicators

The Model 1200B, Model 1201B, and Model 1201C all have eight annunciator LEDs and an eight-button keypad. The top row of keys are informational, including time and date, antenna status, geographical position, and instrument status. The bottom row of keys allows you to configure various clock functions, depending on the chosen security level. Figure 2.1 illustrates the front panels of each clock.

2.2.1 Command Key Definitions

Figure 2.2 illustrates the keypad and annunciator LED placement on the clocks. The details below provide additional description for each of these keys.

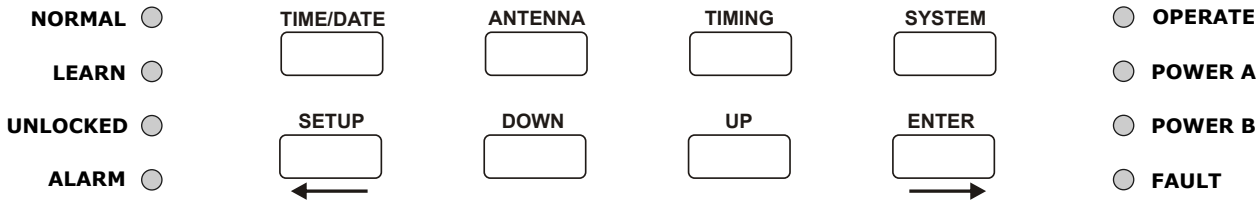


Figure 2.2: Keypad and Annunciator LEDs (LEARN is labeled SURVEY on the 1200B)

- TIME/DATE: Press to change the display(s) to the desired mode. There are four modes available and repeatedly pressing this key will scroll through all modes. Changing the time display does not effect time data of the rear-panel timing outputs.
- ANTENNA: Press to view the antenna status (indicating antenna voltage and current), GNSS satellite tracking information, longitude, latitude, and elevation of the antenna location according to the most recent position fix.
- TIMING: Press the to view the clock status, time quality (in time deviation and sigma), estimated holdover uncertainty and event/deviation values. EVENT/DEVIATION displays up to 50 event records, or continuously updates the 1 PPS deviation data.
- SYSTEM: Press the system key to view the clock serial number and firmware version, power supply voltage(s), EEPROM status, faults, and option board information.
- SETUP: Press SETUP to invoke a series of menus used to adjust configurable parameters within the clock. In numeric data entry mode, moves the cursor to the left. Allows security lockout.
- UP: Used in conjunction with other menus for selection, to adjust values upward, or to scroll upward through the available menu choices. Also assists in navigating through main setup menus in normal order.
- DOWN: Used in conjunction with other menus for selection, to adjust values downward, or to scroll downward through available menu choices. Also assists in navigating through main setup menus in reverse order.
- ENTER: Used for confirming changes made within Setup menus. Generally, pressing ENTER also advances to the next parameter, or returns to a higher menu level. In numeric data entry mode, moves the cursor to the right.

2.2.2 LED Status Indicators

Figure 2.2 also illustrates the eight LEDs that provide information about the operational status of the instrument. For normal operation, with the clock locked and accurate, the OPERATE LED and POWER A and/or POWER B LED should be lit. While the clock is collecting position and timing information the LEARN LED may be lit and the NORMAL LED may be off. The following definitions apply to these indicators:

- LEARN (1201B/C): Illuminates orange when clock is finding its position and stabilizing: approximately 24 hrs. GNSS anti-spoofing is not active.
- SURVEY (1200B): Illuminates orange when clock is finding its position and stabilizing.
- NORMAL (1201B/C): Illuminates green when the clock is operating in normal mode, and follows after the learn mode inactive; the learn LED will be off, and GNSS anti-spoofing is active.
- NORMAL (1200B): Illuminates green when the clock is operating in normal mode, and follows after the learn mode inactive; the survey LED will be off.
- UNLOCKED: Illuminates red when the clock has not yet synchronized, or has lost synchronization, with the GNSS.
- ALARM: Illuminates red when an alarm has been activated.
- OPERATE: Illuminates green when the clock is operating.
- POWER A: Illuminates green when power supply A is providing power to the clock.
- POWER B: Illuminates green when power supply B is providing power to the clock.
- FAULT: Illuminates red when one of the faults[1] has been activated.

2.2.3 LCD Display

The Model 1200B, Model 1201B and Model 1201C all have an LED backlit liquid crystal display (LCD), which provides a 20-character by 2-line readout. The readout displays instrument status, time, date, and event data. If configured to do so, the readout may also display the current configuration of operating parameters.

2.2.4 Large LED Display: Model 1201C

The Model 1201C adds a six-character, 20 millimeter (0.8 inch) LED time and date display. The LED display can indicate the local or UTC time, in hours, minutes, and seconds. Pressing the TIME/DATE key will also display the date format as MM/DD/YY or DD.MM.YY. Configure this date format from front panel or through the serial port.

2.3 Rear Panel Identification and Connectors

This section contains information to assist you in identifying the location of the inlet power, the GNSS antenna cable, and all of the input and output connections on the clock. Connection details are in Chapter 3.

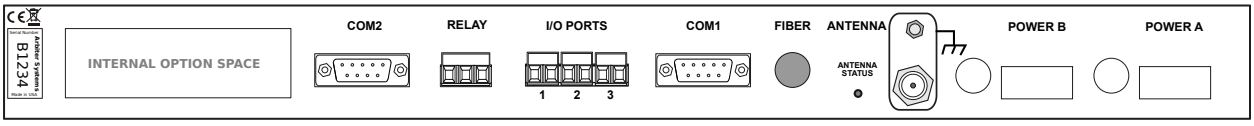


Figure 2.3: Model 1200B and Model 1201B/C Rear Panel Description

[1]see Fault Indications on page 29.

Chapter 3

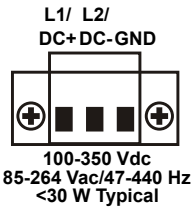
Connecting Inlet Power, Input and Output Signals

Instructions in this chapter include making connections to the rear panel of the clock. Carefully examine the labels to verify the inlet connections and voltages. It is possible to have two different inlet voltage ranges. The clock has no power switch. It becomes energized with the application of power.

3.1 Universal, High Voltage Power Supply Inlet

The universal, high voltage power supply accepts 85 Vac to 264 Vac, 47 Hz to 440 Hz or 100 Vdc to 350 Vdc (< 30 Watts typical) on a pluggable, three-terminal connector. This power supply inlet can be located in a position labeled POWER A or POWER B on the rear panel. See Figure 3.1.

Figure 3.1: Universal Power Supply Inlet Connector



3.1.1 Universal Supply: Connecting Inlet Power

The terminals are labeled as L1/DC+, L2/DC- and GND. L1 is the hot lead, L2 is the neutral, and GND is the ground.

Strip the inlet wire 6 mm (1/4 in) and DO NOT TIN the bare wire with solder. Insert each wire into the appropriate terminal and tighten the set screws clockwise to secure. When connecting power to the clock, connect the ground lead first.

For AC inlet power: L1 is the hot lead, L2 is neutral, and GND is ground.

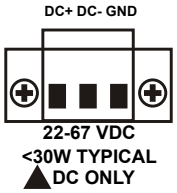
For DC inlet power: DC+ is the positive lead, DC- is the negative lead, and GND is ground.

The clock has no power switch. It becomes energized with the application of power.

3.2 Low DC, Power Supply Inlet

The low DC supply accepts 22 Vdc to 67 Vdc ONLY (< 30 VA typical) and uses the same three-terminal inlet connector as the Universal High Voltage Supply. This power supply inlet can be located in a position labeled POWER A or POWER B on the rear panel. See Figure 3.2.

Figure 3.2: Low DC Power Supply Inlet Connector



3.2.1 Low DC: Connecting Inlet Power

The terminals are labeled as DC+, DC- and GND. DC+ is the positive lead, DC- is the negative lead, and GND is ground.

Strip the inlet wire 6 mm (1/4 in) and DO NOT TIN the bare wire with solder. Insert each wire into the appropriate terminal and tighten the set screws clockwise to secure. When connecting power to the clock, connect the ground lead first.

When wiring station batteries to this power supply, make sure to first connect an earth ground wire to the station ground. Then connect the positive and negative leads to the appropriate battery terminals.

The clock has no power switch. It becomes energized with the application of power.

3.2.2 Surge Withstand Protection

Both the Universal and Low DC power supplies provide input surge withstand protection (SWC) for compliance with ANSI C37.90-1 and IEC 801-4.

3.3 Power Supply Fuses, Types and Ratings

Use the fuse table below for identifying the correct fuse for your power supply.

Power Supply	**Fuse Part No.**	**Fuse Specifications**	**Size, diameter × length**
Universal	FU0003001	3.15 A, 500 V, Time Lag, no leads	5 mm × 20 mm
Low DC Only	FU0003100	8.0 A, 500 V, Time Lag, no leads	5 mm × 20 mm

Table 3.1: Fuse Chart

3.3.1 Replacing Fuses

The fuse compartment is located on the left side of each inlet connector. Fuses for Power A and Power B are located in separate compartments. To check or replace each fuse, first disconnect inlet power from the clock. Use a medium, flat-bladed screwdriver push in and turn counter-clockwise. The cover and fuse should pop out.

CAUTION: Replace fuse only with another of the same type and rating. See Table 3.1 above for the correct fuse configured for your power supply option.

3.4 Antenna Input

Figure 3.3 illustrates the female Type F, GNSS antenna input, connector. This connector also supplies 5 Vdc through the cable to energize the antenna and inline preamplifier if installed. For further information, see Chapter 4, Antenna and Cable Information.

Figure 3.3: GNSS Antenna Connector

3.5 Event Input

For timing external events based on the GNSS-synchronized time, you may use ports 1, 2, and 3, COM1 (RS-232 port), and one of the optional BNC connectors. Figure 5.1 illustrates the locations of these connectors and the internal jumpers.

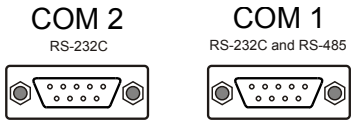
3.6 Single Fiber Optic Output

The clock may be equipped with an optional, multimode fiber optic output with ST connector, located between COM1 serial port and the antenna connector. The output may be any digital signal available in the clock. For additional information on this optional output, see Appendix B.

3.7 RS-232 and RS-485 Communication Ports

The clock has two standard communication ports, COM1 and COM2. RS-232 is supported on COM1 and COM2 and RS-485 transmit only is supported on COM1.

Figure 3.4: Communication Ports, COM1 and COM2



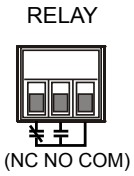
3.8 SPDT Relay Contacts

A set of SPDT relay contacts provide “failsafe” status for a number of clock conditions including: out-of-lock, alarm, fault, and loss of inlet power. Failsafe means that the relay is in fault state if power is lost. For additional information on relay setup, including specifications, see Sections 7.7, 8.4 and Appendix A. Figure 3.5 illustrates the three contacts. For a list of faults, see Section 6.2.2.

Faulted or Power OFF: NC to COM is shorted, NO to COM is open.

Not Faulted and Power On: NC to COM is open, NO to COM shorted.

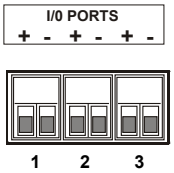
Figure 3.5: Relay Contacts Connector



3.9 Standard Inputs/Outputs

Figure 3.6 illustrates the timing input/output connectors available for multiple purposes including modulated IRIG-B, unmodulated IRIG-B, 1 PPS, programmable pulse, open drain pull down, and event input. For information on driving multiple devices connected in parallel from a single output connector, see Chapter 9, Timing, IRIG-B and Pulses.

Figure 3.6: Standard Input/Output Connectors



3.10 Connecting I/O Signals

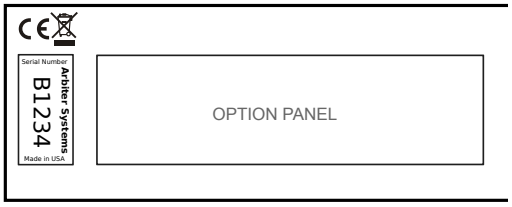
Terminals are Phoenix-type with 5 mm spacing and will accept between 0.25 mm to 2.5 mm (24 AWG to 14 AWG) diameter wire. For option boards that have terminals for output connectors, see the respective section, by option name, in Appendix B for details about those options and connectors. BNC connectors, on installed option boards, are female.

To connect wires to the terminal, strip the insulation back to expose about 6 mm (1/4 in) of bare wire. DO NOT tin with solder. Insert the stripped wire into the terminal and tighten the set screws clockwise to secure.

3.11 Option Board Location

Figure 3.7 illustrates the option location on the left side of the rear panel. When an option is installed, there will be one or more connectors and labels to identify purpose. Details about available options are in Appendix B.

Figure 3.7: Option Board Location



Chapter 4

GNSS Antenna and Cable Information

Chapter 4 covers the installation of the GNSS antenna, antenna cable(s) and accessories. It should also be a source of information should problems arise with the antenna/cable system.

The clock comes complete with the necessary accessories to be able to receive GNSS signals: 50 ft of RG-6 cable and a GNSS antenna. Longer cables are available. The antenna cable is connected between the female F connector on the antenna and the female F connector at the rear panel of the clock.

4.1 GNSS Antenna Installation

To properly receive GNSS signals, the GNSS antenna needs to be mounted clear of buildings and surrounding elements that may block the GNSS signals being transmitted by the satellites. For complete coverage, the antenna needs to have a clear view of the sky from 10 degrees above the horizon to directly overhead for all points of the compass. Minimal installations, where the antenna is mounted in a less favorable location, may work however reception may be limited during certain hours of the day.

4.1.1 Mounting the Antenna

The standard antenna is designed for pole mounting on a 26 mm pole (1.05 in OD or 0.75 in ID pipe), with either a standard 1 in – 14 TPI (approximately M25.4 mm OD $\times$ 1.81) marine-mount thread or a 0.75 in NPT pipe thread. The Type F connector on the inside of the antenna is protected from direct exposure to the elements when the antenna is mounted in this way. This will extend the operational life of the antenna-to-cable interface.

Ordinarily, the antenna can be mounted using a short piece of gray, 0.75 in plastic pipe nipple that can be attached to a solid fixture. The piece of pipe nipple should be threaded up into the antenna receptacle after connecting the antenna cable to the Type F cable adapter. Arbiter Systems sells an antenna mounting kit that simplifies installation for a variety of locations. Figures 4.1, 4.2 and 4.3 illustrate several components for a suggested mounting method.

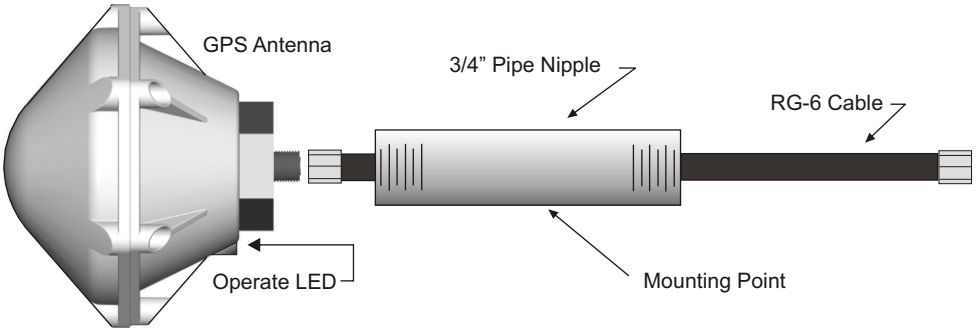


Figure 4.1: Antenna Assembly for Mounting

Antenna mounting procedure:

1. Thread the RG-6 antenna cable through the plastic pipe.
2. Tighten the Type F male connector to the female connector on the antenna.
3. Thread the plastic pipe into the antenna mounting nut.
4. Mount the plastic pipe and antenna/cable assembly to a fixture.

WARNING! Do not spin the antenna onto the antenna cable nut. Thread and tighten the cable nut to the antenna connector by hand, or snug with a 7/16 in open-end wrench.

4.1.2 Optional Antenna Mounting Bracket

The antenna mounting kit is designed specifically for use with antennas shipped with Arbiter Systems GNSS-synchronized clocks. The hardware included with the bracket allows installation of the antenna on a mast or pipe up to about 2 inches in diameter. A different clamp may be substituted for use with a larger diameter pipe. The antenna bracket can be mounted to a wall, a roof, or any other flat surface using the correct hardware.

For complete details on this product, request *Installation Instructions for Arbiter Systems GNSS Antenna Mounting Bracket*. All metallic hardware is stainless steel.

Qty	Description
1	GNSS antenna mounting bracket
1	U-bolt, 1.125 in, with backing plate and 2 hex nuts
1	0.75 in × 4 in threaded pipe, PVC, schedule 80
1	Hose clamp, worm drive
1	Mounting bracket stabilizer

Table 4.1: Antenna Mounting Bracket Parts List

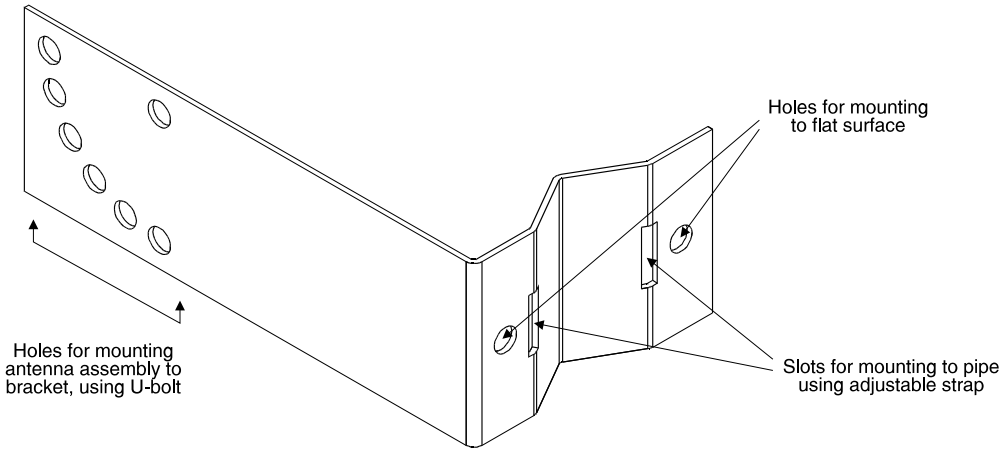


Figure 4.2: Antenna Mounting Bracket

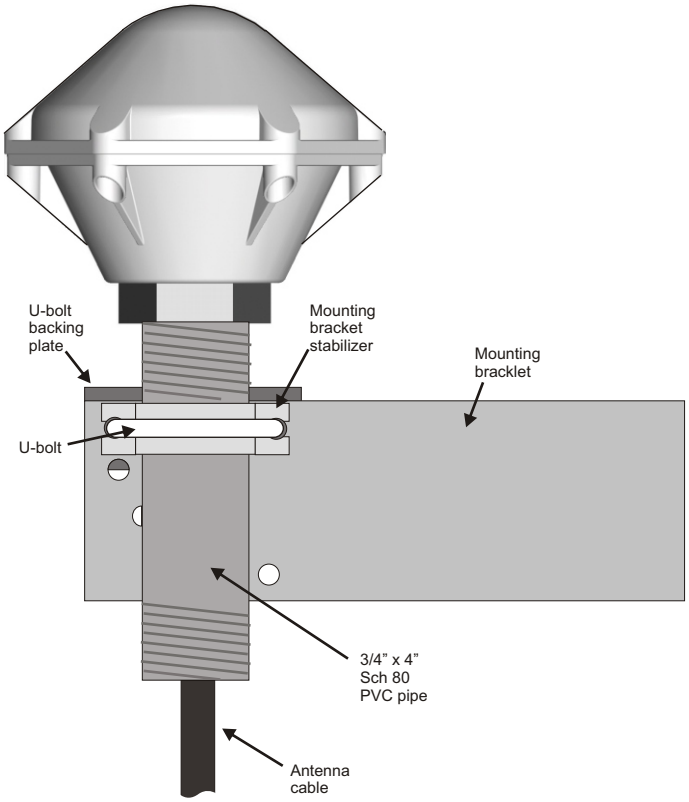


Figure 4.3: Antenna with Mounting Kit

4.2 Verifying Antenna and Cable Operation

A multi-color LED, located at the base of the antenna, indicates antenna operation; green indicates proper operation (i.e. the antenna is getting the correct voltage), amber indicates that the voltage is low. For an open or short circuit condition in the antenna/cable system, the 5 Vdc supplied by the clock will most likely not be present at the antenna and the antenna LED would be unlit. The LED might also remain unlit if the antenna was damaged or defective.

4.2.1 Checking the Antenna Status

To view the antenna status from the front panel of the clock, press the antenna key until the display reads STATUS:. It also displays the antenna voltage and current. The clock provides +5 Vdc to the GNSS antenna, which is carried through the antenna cable. Nominal antenna current is 29 mA. Press the antenna key until you reach the antenna system status message. The message in the display will provide an overall rating of the antenna performance: GOOD, SHORT, or OPEN.

An acceptable antenna voltage is from 4.9 Vdc to 5.1 Vdc. Without a 5 Vdc signal applied to the antenna, the GNSS clock will not synchronize with the satellite system, and may generate an out-of-lock alarm if the Out-of-Lock feature is enabled. Also, the displayed message will change depending on the antenna/cable condition, as seen in the display indications below. With the inline preamplifier connected, the "GOOD" current will increase to approximately 54 mA. Actual current and voltage will vary according to the connected load – i.e. cable, preamplifier and antenna.

"Good" – Antenna/Cable System Performance

```
STATUS: GOOD
4.98 V,    29 mA
```

"Open" – Antenna/Cable Fault

```
STATUS: OPEN
5.03 V,    0 mA
```

"Short" – Antenna/Cable Fault

```
STATUS: SHORT
0.01 V,    125 mA
```

4.2.2 Other Antenna/Cable Indications

A tri-color LED at the rear panel, next to the antenna connector, indicates in a similar manner as the antenna LED explained above: green indicates normal operation, amber indicates a low voltage or open circuit, and red indicates a short circuit condition.

4.3 GNSS Surge Arrester

The clock has an internal gas discharge tube (GDT) surge arrester rated at 20 kA to protect the GNSS receiver from voltage spikes. ***WARNING****: The ground lug near the antenna input connector must have a solid connection to ground for the GDT to work properly.*

Arbiter also sells an external surge arrester which is mounted in-line for additional protection. See Appendix A for more details.

4.4 Technical Details of GNSS Antennas and Cables

4.4.1 Length and Loss Considerations

Standard Antenna Cable

The standard antenna cable assembly included with the clock is constructed using a 15 m (50 ft) length of RG-6 type low-loss coaxial cable, terminated with male Type F connectors. Optional lengths of RG-6 coax are separately available for longer runs; see Table 4.2, Cable Data and Accessory Information.

Effects of Cable Parameters

To receive GNSS signals and properly operate the clock, the type and length of the cable are important. Due to their effect on specific parameters described in the following paragraphs, any changes to the length and/or type of antenna cable should be made carefully. Damaged cables may also affect performance.

Cable and Antenna Delay

Two factors must be compensated for to assure the best accuracy from the clock, cable delay and antenna group delay. Together they are called System Delay. These two values are added together and configured in the clock. Firmware uses these values to counteract the effect that the combined delay has upon GNSS timing accuracy. Cable delay is calculated from the velocity factor and physical length of the cable. Antenna group delay is fixed at 40 nanoseconds, and is contributed by the GNSS antenna itself. During the initial factory calibration of the clock, this combined value called System Delay is entered into the clock memory.

The delay for a standard, 15-meter RG-6 cable is 60 nanoseconds. For other cable assemblies supplied by Arbiter Systems, the delay is tabulated in Table 4.2 below. For cable assemblies not found in Table 4.2, use Equation 4.1 for calculating cable delay. For other lengths and types of cables, remember to add 40 ns to your cable delay and enter that value into the clock.

$$T = \lambda \frac{1}{CKv} \tag{4.1}$$

Where:

T = Cable delay, in nanoseconds;
λ = Cable length, in meters;
C = Speed of light (3×10^8 meters per second);
Kv = Nominal velocity of propagation (0.85 for RG-6).

P/N	Description	Delay, ns	Signal Level, dB
CA0021302	2 m (6 ft) cable, RG-6	8 ns	-2 dB
CA0021306	6 m (20 ft) cable, RG-6	24 ns	-3 dB
CA0021315	15 m (50 ft) cable, RG-6	60 ns	-5 dB
CA0021330	30 m (100 ft) cable, RG-6	118 ns	-9 dB
CA0021345	45 m (150 ft) cable, RG-6	177 ns	-13 dB
CA0021350	50 m (164 ft) cable, RG-6	196 ns	-14 dB
CA0021360	60 m (200 ft) cable, RG-6	236 ns	-17 dB
CA0021375	75 m (250 ft) cable, RG-6	295 ns	-21 dB
WC0004900	305 m (1000 ft) roll RG-11	3.924 ns/m	-17.5 dB/100 m
AS0044700	21 dB in-line amplifier	1 ns	+21 dB

Table 4.2: GNSS Cable Data and Accessory Information

Attenuation

Attenuation depends upon the cable length, and the loss per unit length. The total attenuation must be limited to 21 dB (maximum) at the GNSS L1 frequency of 1575.42 MHz. Loss up to 42 dB can be accommodated with the separately available 21 dB in-line preamplifier.

DC Resistance

The cross-sectional area and length of the conductors in the cable determine the dc resistance. Since power to the RF preamplifier in the antenna, and possible inline amplifier, is supplied via the antenna cable, excessive dc resistance will degrade performance.

Available Antenna Cables and Accessories for Longer Runs

Longer antenna cables are available. Unbroken RG-6 cable lengths up to 100 m (328 ft) are available. Not long enough? A 21 dB in-line preamplifier allows for a adding up to another 75 m (250 ft) for a total combined length up to 175 m (574 ft). Still not long enough? Another option is RG-11 cable which allows for an unbroken length up to 195 m (640 ft) or up to 315 m (1033 ft) with the 21 dB in-line preamplifier.

Physical Protection

When routing the antenna cable, protect it from physical damage, which may result from closing doors, falling objects, foot traffic, etc. Also, when routing around corners, allow for sufficient bend radius to prevent kinks. Extra length should be allowed at both ends of the cable to prevent tension on the connectors, which could cause damage or failure. Extra length is useful as a service loop, in the event that a connector needs replacement.

Do not stretch the cable midair over any appreciable distance without support. Cable degradation or failure could result. Always leave a drip loop wherever the cable enters a structure, to prevent water from entering the structure via the cable jacket. The maximum temperature rating for the type of cable provided with the clock is 75 °C (167 °F). Exercise care when routing the cable near sources of heat to avoid cable damage.

Adjacent Signals

Although the standard RG-6 style cable is triple-shielded and has excellent shielding properties, be cautious when routing near high power RF sources or alongside cables carrying high power RF, such as transmitter cables. In these applications, consider using RG-11 style cable (P/N WC0004900). Its quad-shielded design provides even more isolation.

Antenna Power

The RF preamplifier within the antenna requires 5 Vdc at approximately 30 mA nominal for operation. A power supply within the clock generates this voltage, which is applied to the antenna via the two conductors of the coaxial antenna cable. Avoid shorting the center conductor to the shield of the coaxial cable as it may damage the preamplifier. Conversely, a high-resistance connection or open circuit would deprive the preamplifier of power. Either a short circuit or open circuit condition in the antenna cable will render the clock unable to receive satellite signals.

Prior to initial operation or if problems are suspected, go through the tests described in Section 4.2.

Connection to Antenna

The male Type F connector on one end of the antenna cable mates with the female Type F connector on the antenna. Avoid placing mechanical stress on the cable attachment to the antenna.

Connection to Clock

The male Type F connector on the opposite end of the antenna cable connects to the female Type F connector on the rear panel of the clock.

User-Supplied Antenna Cables

Any RF cable meeting the requirements described above for loss ($< 21\,\mathrm{dB}$ at $1575.42\,\mathrm{MHz}$) and dc resistance ($< 15\,\Omega$ total loop resistance) may be used with the clock. However, prior to using a non-standard antenna cable, verify proper installation by reviewing Section 4.2.

For additional technical details concerning the GNSS, GNSS antennas and antenna cabling see Appendix A, Technical Details and Specifications.

Chapter 5

Setting Internal Jumpers

Jumpers in the clock are shipped in the factory default position[1], or according to the purchase order notes. Should it be necessary to change any jumpers or to enable an alternate function, follow the instructions in this chapter.

5.1 Cover Removal

The instrument cover must be removed to change jumper configuration.

1. Disconnect the power cord.
2. Using a Torx T25 driver, remove the eight screws securing the cover and rack mount ears.
3. Lift the cover off.

5.2 Setting Mainboard Jumpers

Figure 5.1 indicates important jumper and test point locations on the mainboard. Use this illustration to assist you with locating the jumpers you may want to configure. Jumpers are noted on the mainboard with a "JMP" prefix before the numbered location. For example, jumper 3 would have a label of JMP3 on the mainboard. Table 5.1 lists all of the current jumpers, their specific functions and default settings.

[1]Factory default jumper settings are marked with an asterisk and located in Table 5.1.

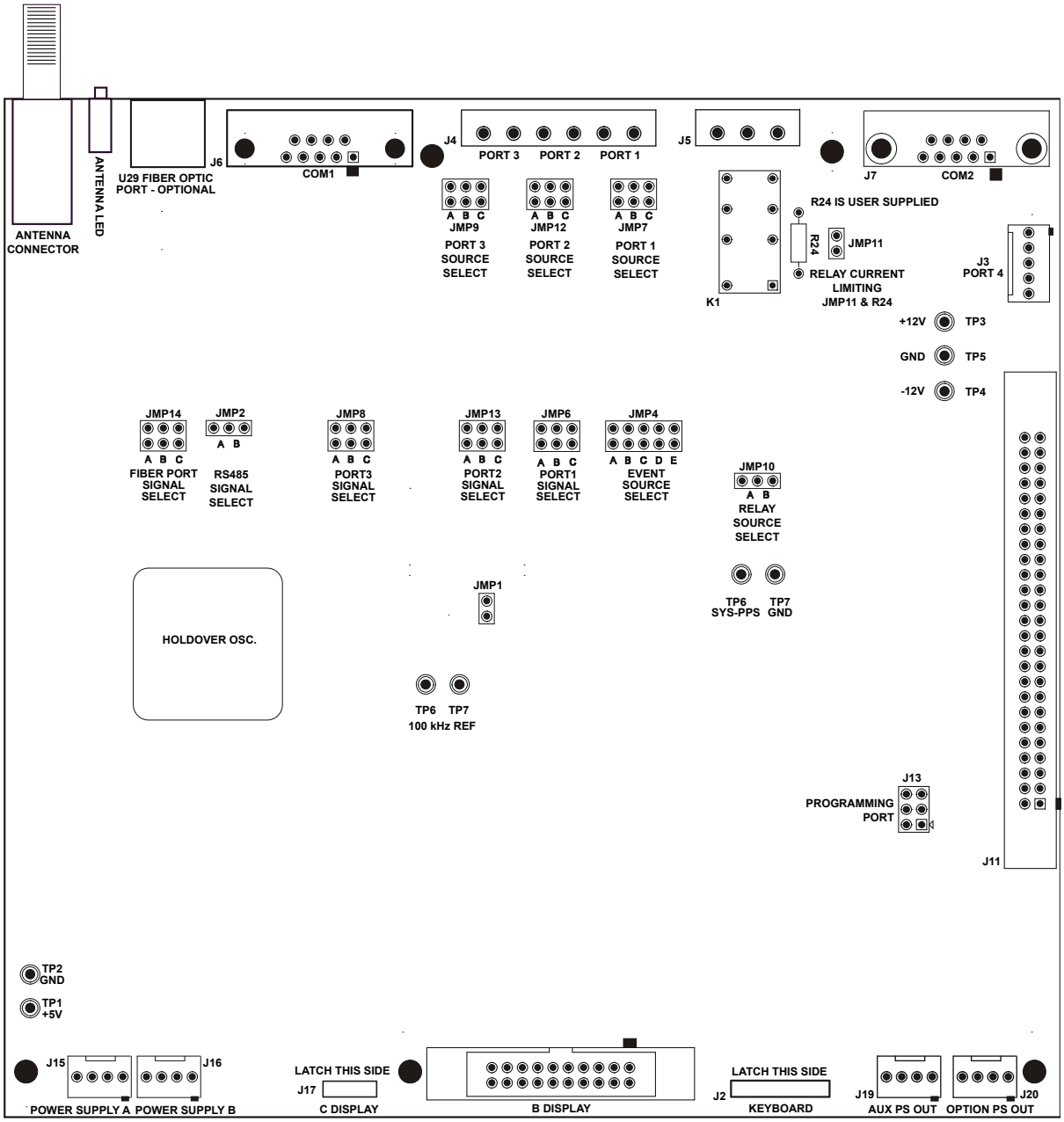


Figure 5.1: Main board and Jumper Locations

	I/O PORT 1		I/O PORT 2		I/O PORT 3		FIBER	RS-485	RELAY
Drive Type		**JMP7**	**JMP12**			**JMP9**			
CMOS		A*	A			A*			
OPEN DRAIN		B				B			
EVENT IN		C	C			C			
Signal Select	**JMP6**		**JMP12**	**JMP13**	**JMP8**		**JMP14**	**JMP2**	**JMP10**
IRIG-B Modulated			B*						
IRIG-B Unmodulated	C*			C	C		C*	B	
1 PPS	A			A	A*		A		
Programmable Pulse	B			B	B		B		B
Data Out								A*	
Status									A*

* Default Setting

Table 5.1: Main Board Output Signal Selection

5.2.1 Digital Outputs: Port 1, Port 2 and Port 3

PORT 1, Port 2, and PORT 3 provide identical digital signal choices. Available digital signals are unmodulated IRIG-B, programmable pulse and pulse per second (1 PPS). These two ports may also be jumpered to a 200 volt FET for pull down applications. Additionally, either port may be used as an event input. Configuration requires two jumpers. One jumper sets the type of signal and ther other sets the signal source. See table 5.1 for a complete list.

5.2.2 IRIG-B Unmodulated, 5 V Outputs

A 5 V_{TTL} unmodulated IRIG-B signal is available with the following jumper configuration.

Port Number	Required Jumper Positions
1	JMP6 = C and JMP7 = A
2	JMP13 = C and JMP12 = A
3	JMP8 = C and JMP9 = A

Table 5.2: Unmodulated IRIG-B Jumper Table

5.2.3 1 PPS, 5 V Output

A 5 V_{TTL} pulse per second signal is available with the following jumper configuration.

Port Number	Required Jumper Positions
1	JMP6 = A and JMP7 = A
2	JMP13 = A and JMP12 = A
3	JMP8 = A and JMP9 = A

Table 5.3: 1 PPS Jumper Table

5.2.4 Programmable Pulse, 5 V Outputs

A 5 V_{TTL} programmable pulse signal is available with the following jumper configuration.

Port Number	Required Jumper Positions
1	JMP6 = B and JMP7 = A
2	JMP13 = B and JMP12 = A
3	JMP8 = B and JMP9 = A

Table 5.4: Programmable Pulse Jumper Table

5.2.5 Analog Output: Port 2

Port 2 is the only port that may be configured for modulated IRIG-B

Port Number	Required Jumper Positions
Modulated IRIG-B	JMP12 = B (JMP13 is not used for this signal)

Table 5.5: Analog Signal Jumper Table

5.2.6 Event Input

Port 1, Port 2, Port 3, COM1 RS232, or the Option E09 *Event In* port may be configured to capture events. Refer to Chapter 10 for Event Input theory and configuration.

Port Number	Required Jumper Positions
COM 1 RS-232	JMP4 = A
1	JMP4 = B and JMP7 = C
2	JMP4 = C and JMP12 = C
3	JMP4 = D and JMP9 = C
Ext. Connector (Option E09)	JMP4 = E

Table 5.6: Event Input Jumper Table

5.2.7 Relay Operation

Two different relay operations can be set with jumpers: (1) out of lock, and (2) programmable pulse. Switching conditions configured with jumper JMP10 in position "A" include, out of lock, alarm, fault, stabilized and clock powered off. Conditions can be "OR'ed" so that all, some, or one condition can be used to trigger the relay. Jumper JMP10 in position "B" selects for a programmable pulse. Jumper JMP11 connects to the common terminal directly, or may include a selectable, internal resistor (R24) in the common line to control relay current. To configure which relay clock conditions are active see Section 8.6.

Relay Function	Required Jumper Positions
Out of Lock, fault, alarm, stabilized	JMP10 = A
Programmable Pulse	JMP10 = B
Direct COM Connection	JMP11 in and no resistor
Resistive COM connection	JMP11 out and resistor mounted

Table 5.7: SPDT Relay Jumper Table

5.2.8 Fiber Optic Output: Optional

Optionally, one 820 nanometer fiber optic output with type ST connector is available for transmitting any available digital signal, such as 1 PPS, Programmable Pulse and unmodulated IRIG-B, over multimode fiber.

Timing Signal	Required Jumper Positions
1 PPS	JMP13 = A
Programmable Pulse	JMP13 = B
IRIG-B unmod.	JMP13 = C

Table 5.8: Unmodulated IRIG-B Jumper Table

5.2.9 Final Setup Instructions

After correctly setting the necessary jumpers make sure to replace the clock cover before powering up the clock. Read over Chapter 6 for a detailed understanding of the clock behavior during startup.

Configure clock operation through the utility software (the Utility), or through the front panel keys. Chapter 7 discusses configuring the clock functions remotely using the Utility and Chapter 8 discusses configuring the clock using the front panel interface.

For additional technical detail concerning timing signals, please see Chapter 9.

Chapter 6

Startup and Operation

6.1 Initial Startup Sequence

Make sure that the chassis cover is installed before powering ON any of these clock models. The clock will begin a start sequence when you connect power to the clock inlet connector, either Power A or Power B (if equipped with two power supplies). As soon as power is applied, the clock will begin the startup sequence and a number of things should occur as listed below:

1. Annunciator LEDs should flash momentarily, then the OPERATE LED, POWER A LED (and POWER B LED, if installed) and UNLOCKED LED should light steadily.
2. The liquid crystal display (LCD) should display several introductory messages (see below).
3. Initially, the SPDT relay should be in the faulted position.
4. Eventually, the UNLOCKED LED should extinguish.
5. The SPDT relay should change to Locked (non-faulted) position after a few minutes.
6. The LCD should indicate that the clock is locked.
7. After the startup messages, the LCD should indicate TIME NOT AVAILABLE until the clock is stabilized, then begin displaying the time of day and date.
8. In the 1201B/C, the LEARN LED should light for 24 hours, after which it will extinguish and the NORMAL LED will illuminate.

6.1.1 Display Indication at Startup

When power is applied, the LCD should indicate as follows:

```
ARBITER SYSTEMS GNSS
 MODEL 1200B CLOCK
```

or

```
ARBITER SYSTEMS GNSS
MODEL 1201B/C CLOCK
```

```
COPYRIGHT (C) 2020
ARBITER SYSTEMS, INC.
```

```
TIME NOT AVAILABLE
```

6.1.2 Clock Time, Startup Mode

When the clock first starts, it will not indicate the correct time until it is locked to the GNSS. Pressing the TIME/DATE key before the UNLOCKED LED is extinguished will produce the message:

```
TIME NOT AVAILABLE
```

IRIG-B time and the LCD display will not produce a time while the clock is starting up. The large C display and any serial port broadcast (if turned on), will not produce or broadcast the time until the clock is locked and stabilized. This method was chosen so that there would be no mistake in interpreting that the clock was in startup mode.

When the full set of ephemeris data is received by the GNSS receiver from the GNSS (satellites), the time will be accurate. At this time, the UNLOCKED LED will extinguish and the SPDT relay will close if set to the out-of-lock function.

6.2 Operating Modes: Model 1201B/C Only

Initially, the very the first time the clock starts up it will be in the promiscuous mode. In this mode, the clock performs position fixes each second and does not keep track of antenna position and satellite information. The clock will stay in the promiscuous mode forever unless the learn mode is initiated. Power cycling the clock has no affect on this. Once the learn mode is initiated the clock should never again fall back into the promiscuous mode. To enter the Learn mode, see Section 7.6.

6.2.1 Learn and Normal Modes

During the learn mode, the clock tracks its position over time looking for anomalies, such as a satellite suddenly appearing or disappearing, and satellites that are out of position. It is during the learn mode that the clock establishes its basis of operation with the GNSS, and anti-spoofing protective measures are suspended. After 24 hours the clock should complete the learn mode and revert to the normal mode in which anti-spoofing protection is operative.

Normal Mode Operation and Re-entry

While operating in the normal mode, the clock should run undisturbed from problems such as GNSS spoofing, or a faulty antenna. If a problem occurs, the clock will maintain its time and operate with accuracy based on the internal holdover oscillator. Holdover estimated uncertainty, found under the TIMING menu, will provide you with an estimate of the timing accuracy for defined periods during which the clock is not locked to the GNSS. If while operating in the normal mode the clock is power cycled, it should restart and continue operating in the normal mode.

6.2.2 Faults and Alarms

If a problem occurs, the clock may indicate this as either a fault or an alarm. A fault signifies a hardware problem inside the clock that may clear on its own or may need attention. An alarm signifies some external influence that may interfere with the operation of the clock. During an alarm, the clock will adopt protective measures to guard its integrity until the interference is no

longer detected. Further definition of the faults and alarms are defined in Table 6.1, and may be declared on the front panel and from the web interface. See details in Section 6.6.4 for fault display indications.

Faults	**Alarms**
Time Base Processor (TBP) communication	Position change
8 MHz	1024 week error
Holdover/GNSS	Time jump
Watch dog timer	Bogus SV info
Brownout	–

Table 6.1: List of Faults and Alarms

6.3 Time/Date Key Displays

6.3.1 Time and Date Display, UTC

Displays UTC, in the Time and Date format, as maintained by the United States Naval Observatory (USNO).

```
UTC          12:34:56
SAT        3 MAY 2014
```

NOTE: Daylight saving and local offset have no effect on this display.

6.3.2 Time of Year Display, UTC

Displays UTC, in Time of Year format, which differs from the previous format by replacing the date with the day of year.

```
UTC          12:34:56
SAT      DAY 123 2014
```

NOTE: Daylight saving and local offset have no effect on this display.

6.3.3 Time and Date Display, Local Time

This mode displays the time and date after applying the Daylight Saving Time correction and local offset.

```
LOCAL        05:34:56
SUN        3 MAY 2014
```

6.3.4 Time of Year Display, Local Time

This mode displays the time of year after the daylight saving time correction and local offset have been applied, but in the same format as that of the Time of Year, UTC.

```
LOCAL        05:34:56
SAT      DAY 123 2014
```

NOTE: *Unless the daylight saving and local offset parameters have been set properly, this and the previous display may not reflect the correct local time.*

6.4 Antenna Key Displays

Press the ANTENNA key a few times to move between screens related to antenna performance, GNSS tracking, as well as the antenna's geographical position.

6.4.1 GNSS Tracking

Displays the number of satellites being tracked per constellation.

```
GNSS TRACKING
GPS:08 GLN:06 GAL:08
```

6.4.2 GNSS Signal-to-Noise Ratio

Signal to Noise describes the signal power to noise power as a ratio in decibels (dB). For example, 40 dB means that the signal power is 10,000 times stronger than the noise.

```
GNSS SIGNAL/NOISE
GPS:34 GLN:30 GAL:38
```

6.4.3 GNSS Setting

GNSS Setting indicates which satellite systems are being used in the clock. In this case either US GPS, Russian GLONASS, European Galileo, or any combination of these systems can be used.

```
GNSS SETTING
GPS:ON GLN:ON GAL:ON
```

6.4.4 Antenna Status

Antenna Status provides the voltage and current supplied to the GNSS antenna. Values indicated in the display below are fairly represent the Arbiter GNSS antenna at the time of this writing. The clock can supply a range of voltage values to accommodate different antennas.

```
STATUS: GOOD
 5.02 V,     29 mA
```

If the display indicates that the clock is not tracking satellites (00) make sure that the antenna is mounted outside and in the clear from surrounding elements that may block the GNSS signals. Also see Section 4.2 for information on troubleshooting antenna problems.

Note that the last screen indicates that the status is good and that the voltage and current are correct for a GNSS antenna.

6.4.5 Position Display Modes

The clock has two modes of operation: normal and demo. If the clock starts in the normal mode and is acquiring satellites, the position information is the last position fix stored in the clock's memory while locked to at least four satellites. If the clock starts in the demo mode, then it will determine the position from scratch - no position information is stored.

Synchronization to a minimum of four satellites is necessary for precise determination of longitude, latitude, and elevation. When meeting this minimum satellite lock requirement, its position will accurately correspond to the present antenna location.

Longitude Display

Displays the antenna longitude in degrees, minutes, seconds and fractional seconds, East or West.

```
     LONGITUDE
XXX° XX' XX.XXX" W*
```

Where:
*W = WEST, E = EAST

Latitude Display

Displays the antenna latitude in degrees, minutes, seconds and fractional seconds, North or South.

```
     LATITUDE
XX° XX' XX.XXX" N*
```

Where:
*N = NORTH, S = SOUTH

Elevation Display

Displays the antenna elevation in meters and fractional meters referenced to the WGS-84 datum.

```
     ELEVATION
XXXXX.XX m WGS-84
```

6.5 Timing Key Displays

6.5.1 Clock Status

Press the TIMING key to review the clock with regard to its accuracy and stability. While the clock is starting and learning about its position, it is in the LEARN mode. It is a time when the clock is most vulnerable to false, or incorrect, GNSS signals.

```
CLOCK STATUS
ACQUIRING TIME
```

6.5.2 Time Quality

The Model 1201B/C learn mode will typically last 24 hours before it switches to the normal mode. During the learn mode, the clock is tracking its position and is vulnerable. During the normal mode the clock is not affected by false or lost GNSS signals to upset the time, but relies on its history and excellent holdover qualities.

```
     TIME QUALITY
22.63 nSec     2.00 σ
```

6.5.3 Holdover Estimated Uncertainty Model 1201B/C Only

"Time Quality" is a 2.0 sigma (σ) estimate based on time-base processor measurements. This is basically saying that there is a 95% confidence factor that the clock will be within the estimate given (e.g. 22.63 nSec) of the GNSS clock.

```
HOLDOVER ESTIMATED
   UNCERTAINTY?
```

"Uncertainty" provides estimates of clock accuracy when it is no longer synchronized to the GNSS. Uncertainty is a statistic based on time-base processor measurements of the local oscillator. Select one of the time intervals of interest: in minutes (15, 30, 60), in hours (2, 4, 8, 12, 24), and in days (2, 4, 7, 14, 30). Selecting one of the time periods will provide the uncertainty for that time period with one exception. It takes about seven times the holdover interval to calculate the estimated uncertainty for that period of time. Therefore the TBP may produce dashes if the measurement time period is shorter than seven times that time period. For example, it would take seven hours to calculate uncertainty for sixty minutes.

To view individual uncertainties for each time period, go to the "UNCERTAINTY?" screen, press the ENTER key and then the UP or DOWN key to cycle through each value.

6.5.4 Event/Deviation

There are two possible displays when pressing the ENTER key in the EVENT/DEVIATION menu: one for event recording and one for 1 PPS deviation.

```
EVENT / DEVIATION
```

Events or 1 PPS deviation results may be viewed on the front panel LCD, or downloaded through the serial port. If configured for event, successive events appear when repeatedly pressing the UP or DOWN keys. If there are no records, the second line will indicate "NO DATA". If configured for 1 PPS deviation, it will indicate the mean and sigma of 16 successive values. For additional detail, please see Section 10.2.1.

Event Display

Press the TIMING key until reaching EVENT/DEVIATION, then press ENTER. Use the UP or DOWN keys to scroll through the available event records. Events are displayed as follows:

```
Ch A EVENT nn
ddd:hh:ss.sssssss
```

Where:

`nn` = event number (01 to 50)
`ddd` = day of year of the event (001 to 366)
`hh` = hour of the event (0 to 23)
`mm` = minute of the event (0 to 59)
`ss.sssssss` = second and fractional seconds of the event

Deviation Display

If DEVIATION is selected, press the TIMING key until reaching EVENT/DEVIATION, then press ENTER. Values are continuously updated each second (dashes show no input):

```
1 PPS:     --- µS
SIGMA:     --- µS
```

6.6 System Key Displays

Press the SYSTEM key to review the clock identity and systems that support accurate and stable timing. These include clock serial number, firmware version, power supply voltages, EEPROM, faults, and installed option board status.

6.6.1 Serial Number and Firmware Date

The first display indication indicates the clock serial number and firmware version.

```
S/N:     C00101
VERSION: 00.01
```

6.6.2 Power Supply

The clock may have one or two power supplies: Power Supply A and Power Supply B. A single power supply will be in position A and power supply B (PSB) voltage will show by dashes.

```
POWER SUPPLY STATUS
PSA: 24.3V PSB: ----
```

6.6.3 EEPROM Errors

If the number of corrected (CORR.) errors begins to climb, contact the factory about replacing the EEPROM.

```
EEPROM STATUS
CORR. ERRORS = 0
```

6.6.4 Fault Indications

If a fault occurs and the FAULT LED illuminates, the clock is unreliable and the Time Quality value on the IRIG-B message is set to maximum (i.e. poorest quality).

```
FAULT NONE
```

Indicates no fault - normal operation.

```
FAULT: ANT. OPEN
 4.96 V,    0 mA
```

Indicates an antenna fault with current at zero milliamperes. This fault disappears if antenna connection is restored.

```
FAULT: TBP COM ERROR
dd/mm/yyyy hh:mm:ss
```

An error in communication exists between the TBP and the main processor. The fault disappears if communication is reestablished. Second line is the time the fault occurred.

```
FAULT: VCXO FAIL
dd/mm/yyyy hh:mm:ss
```

The 8 MHz, Holdover Oscillator, signal is not getting to the main processor.

```
FAULT: HO / RECEIVER
GNSS RECEIVER FAIL
```

The Time Base Processor (TBP) is no longer receiving a 1 PPS signal from the GNSS receiver.

```
FAULT: HO / RECEIVER
RECEIVER SUSPECT
```

The Time Base Processor is receiving a 1 PPS signal from the receiver, but its rate is out of bounds (a parametric failure).

```
FAULT: HO / RECEIVER
HO OSC. SUSPECT
```

The Holdover Oscillator frequency and/or drift parameters are out of bounds (parametric failure).

```
FAULT: HO / RECEIVER
HO OSC. LOOP UNLOCKED
```

The Holdover Oscillator (HO) Phase Lock Loop (PLL) is unlocked, which means that the PLL is unable to maintain lock between the HO and the VCXO.

```
FAULT: HO /RECEIVER
HO OSC. FAIL
```

The Time Base Processor (TBP) is no longer receiving a signal from the Holdover Oscillator (HO).

Chapter 7

Utility Software

The Model 1200B and the Model 1201B/C have their own independent Utility Software. This chapter primarily covers the Model 1201B/C Utility Software (Utility) but there are enough similarities that it is relevant to the Model 1200B Utility Software.

The (Utility) was developed to provide the following specific functions.

- To securely configure the clock.
- To verify configuration by comparing the software's configuration with a clock's configuration.
- To copy (Read) a configuration file from one clock for uploading (Write) to another clock.
- To upload new firmware to a clock's flash memory.
- To configure the level of security.

7.1 Clock Security Notes

The Utility is the only way to set up security features in the clock. Security cannot be setup from the front panel or through RS-232 commands found in Chapter 11. Security must also be disabled to configure the clock using RS-232 commands.

7.2 Configuring with the Utility

The following sections illustrate how to use the Utility to configure the clock.

7.2.1 Obtaining the Utility

To obtain the Utility, go to the Arbiter website[1] and select Software Downloads under the Service/Support menu. Scroll down to Timing Software and select Model 1201B/C Software or Model 1200B Software. Download the Utility to your computer. Double click the icon and in a few moments the program should start as illustrated in Figure 7.1.

[1] Download from http://www.arbiter.com

7.2.2 Installing the Utility

The Utility does not need to be installed as most programs require. Instead you can copy the executable file to your computer and run it by double clicking on the program icon. Alternatively, you can make a shortcut to the program.

7.2.3 How the Utility Software Works

The Utility allows you to read, write (configure) and verify operation on the clock. It also allows you to upload new firmware to the clock and save clock configuration files for upload to another clock. While it is idle, it releases the serial port on your computer for use by other programs. For computers without serial ports, you will need to use a USB to serial converter.

The clock does not have to be locked to GNSS during configuration. Date, time and position data, however, will not be accurate. Some level of security is required to communicate with the clock and configure it. The clock has six levels of security so that you can protect it from unwanted intrusion.

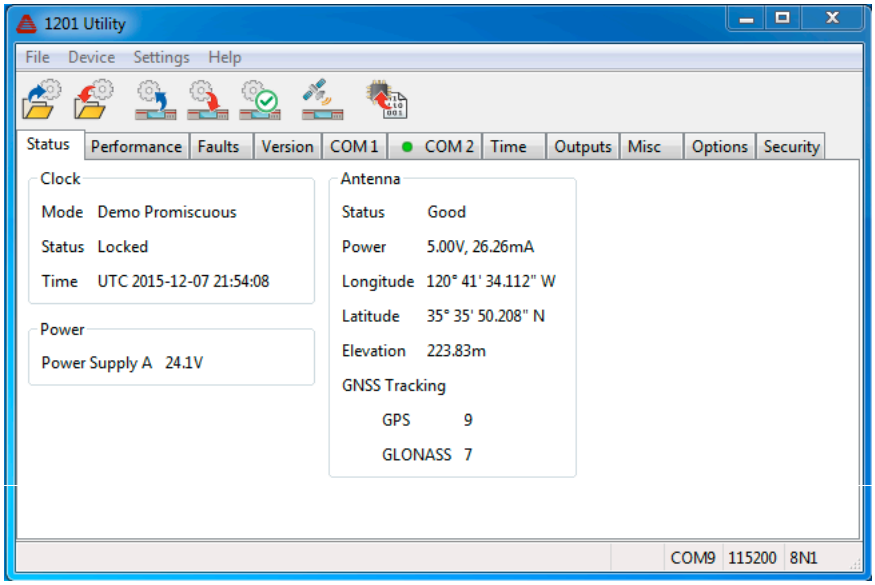


Figure 7.1: Utility Software, Opening Window

Setup Tip

In this chapter, you may want to start with the clock security set to Level 0 or 1. Doing so allows you to review the communication settings for COM1 and COM2 from the front panel. If not, you would be guessing at the settings until you made a connection. Once the communication settings are known, you can connect with the clock and configure everything, including security.

7.3 Security

One of the goals of these security features is to help in complying with NERC CIP[2] requirements. The clock security is flexible, allowing multiple levels of access.

The clock may be queried and configured using the Utility, which uses a proprietary binary protocol allowing access through a custom user interface. For the upmost in security, clock features may be set up requiring usernames and passwords. As such, the clock comes with a default username and password, which may be changed by the user. Alternatively, the clock may be set up with unrestricted access, and security disabled. Note that security features may only be configured through the Utility.

If your clock came with the NTP/PTP option installed, it will have its own security that is separate from the clock itself and accessed through the web interface. See Section B.11 for details on general setup of the NTP/PTP option, including security and authentication.

7.3.1 Security Features

There are six levels of security on the clock, which will assist users in two ways: (1) for a specific use, and (2) protection from unintended use. The clock allows two-letter serial commands as used on earlier clock models, however these commands will be restricted as described below. Operation from the front panel interface will likewise be limited as shown in the table.

Level	**Password**	**Front Panel Interface**	**"Two Letter" Serial Commands**
0	No	- Unrestricted use	- Unrestricted use
1	Yes	- Configuration disabled - Access all clock information	- Configuration disabled, except for changing broadcast mode[1] - Access all clock information
2	Yes	- Access limited to viewing non-configuration information	- Configuration disabled - Access all clock information
3	Yes	- Access limited to viewing non-configuration information	- Access limited to viewing non-configuration information
4	Yes	- Only TIME key is active	- All commands disabled.
5	Yes	- Front panel display and keys disabled	- All commands disabled

Table 7.1: Security Levels and Features

[1] For Level 1, a user connected to a COM port may change that port's configuration (e.g. broadcast ON/OFF).

[2] North American Electric Reliability Corporation – Critical Infrastructure Protection

7.4 Establishing a Serial Connection

NOTE: A null-modem cable is needed to connect with the clock to the computer's serial port. Pin connections and functions are as follows:

PC side	–	**Clock side**
3, TxD	–	2, RxD
2, RxD	–	3, TxD
5, GND	–	5, GND

Table 7.2: Serial Cable Pin Out

For computers without a serial port, you will most likely need to use a USB to serial converter. These devices normally associate a COM port number (on your computer) with the USB device. For the Windows operating systems, you may look this up under Device Manager > Ports.

From the Utility, select Settings > Serial Port , choosing the correct COM port associated with your computer. See Figure 7.2. If your computer has its own serial port, choose that one. If you are using a USB-to-serial converter, choose the one that is associated with your USB-to-Serial converter.

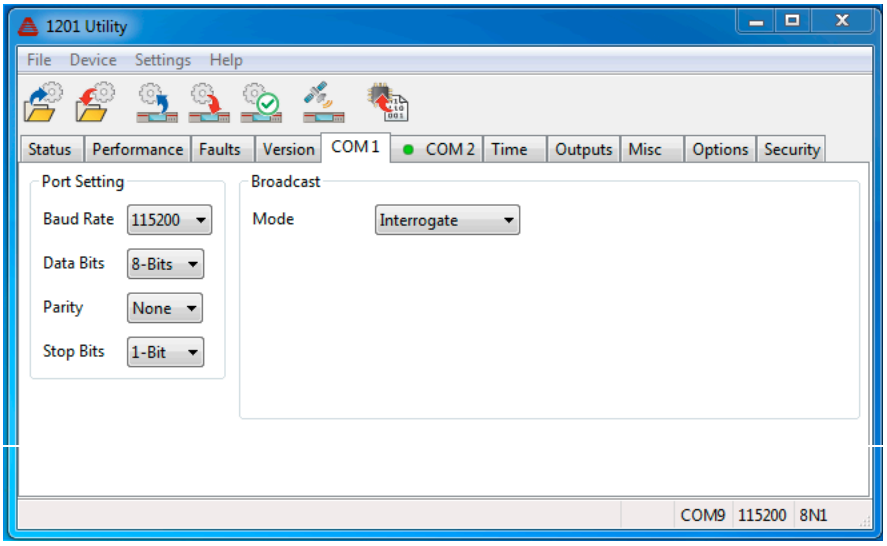


Figure 7.2: Connecting with the Clock

Verify that the baud rate listed under Serial Port Settings is the same as on the clock. To verify the baud rate from the front panel of your clock, security must be set to Level 0 or 1. Press the SETUP key on the clock; the first menu should state, "SET SERIAL COM 1?"; press SETUP again and the second menu should state "SET SERIAL COM 2?" Press ENTER at "SET SERIAL COM 1" or "SET SERIAL COM 2" to verify the port parameters for either COM1 or COM2.

7.5 Reading the Clock Configuration

When first starting the Utility there will be two functions available: Open and Read. Read allows you to poll the connected clock and download all of the configured information. You can find Read by either by selecting Device > Read, or by clicking the Read icon. When selecting the Read function by either method, the Utility will immediately try to read the configured settings in the connected clock. If it is successful, it will show a progress bar for a few seconds and then populate all of the values in the Utility windows. See Figure 7.3.

Open selects a file to upload to a connected clock. Open a file by selecting File > Open or by clicking the Open icon (blue folder). For more information on uploading a configuration file to the clock, go to Section 7.17.

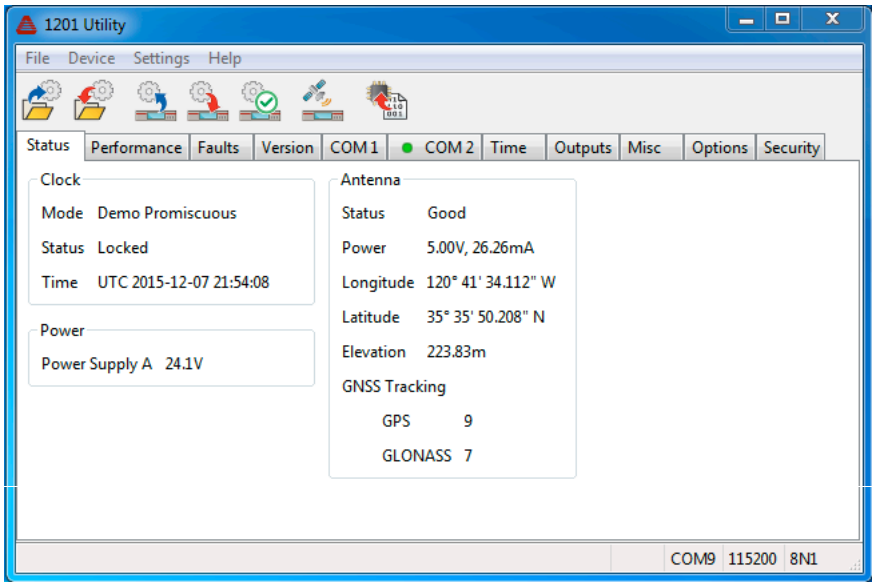


Figure 7.3: Reading the Clock Configuration

If for some reason you get a message that the Utility could not read the clock, make sure to check Settings at the top of the Utility window to verify (1) you are trying to connect using the correct COM port on your computer, (2) that you are using the correct baud rate, or other settings, (3) that you have the correct serial cable (null-modem), and (4) you have the correct Utility version for your firmware. See Table 7.2 in Section 7.4.

7.6 Starting the Learn Mode

Initially, the very first time that the clock starts up, it will be in the Promiscuous Mode. While in this mode, the clock is not protected against GNSS spoofing, clock movement and other things that would disturb its operation. To run securily against these disturbances, the clock must go through a Learn Mode for approximately 24 hours after which it will enter the Normal Mode. If the Learn Mode is never initiated, a clock will continue to run in the Promiscuous Mode. Secure operation is not possible in the Promiscuous Mode or the Learn Mode. Once the clock passes through the Learn Mode, it will never again operate in the Promiscuous Mode.

To initiate the Learn Mode, in the Utility menu, choose Device, then Start the Learn Mode, or click the Start the Learn Mode icon. Another menu should appear to verify your choice, yes or no. Once the Learn Mode is initiated, the orange LEARN LED will illuminate for approximately 24 hours. After 24 hours, and a successful Learn operation, the clock will revert to the Normal Mode and the green NORMAL LED will illuminate and the LEARN LED will extinguish.

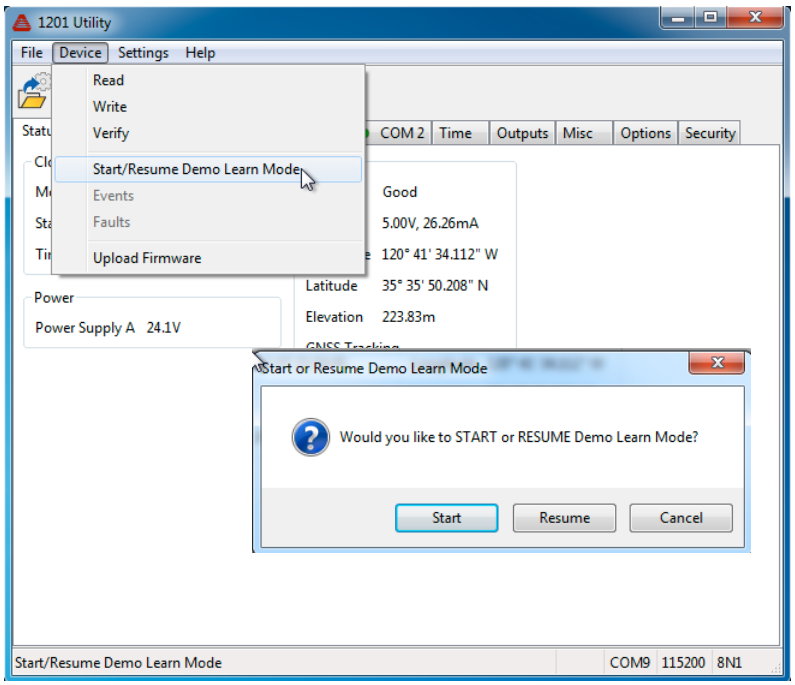


Figure 7.4: Initiating the Learn Mode

7.7 The Status Screen

After selecting Device > Read, or clicking the Read icon, the Utility will display the first tab information labeled Status. Status is organized in three groups: (1) clock status, (2) power supply status, and (3) antenna status. The definitions from Figure 7.5 below define the values in this menu item.

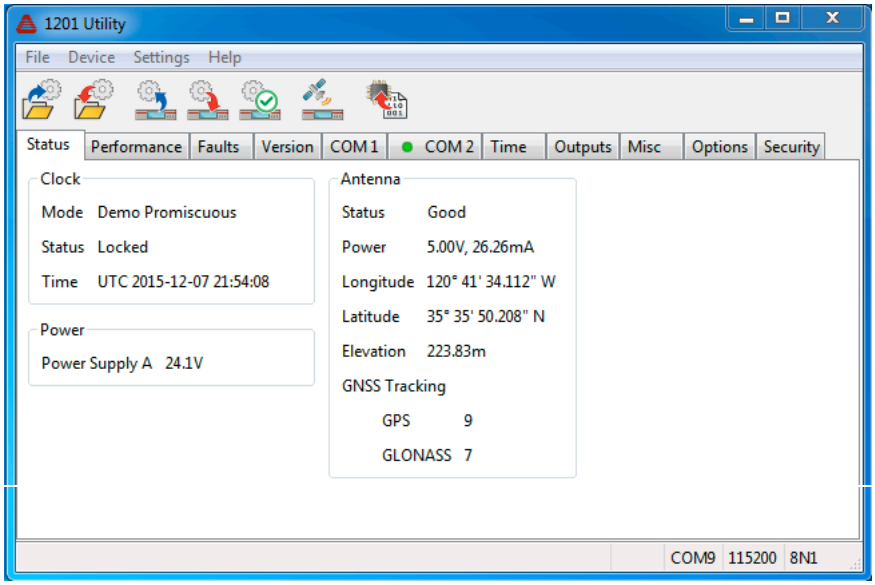


Figure 7.5: Status Screen

7.7.1 Definitions

Clock Status

Four values are provided for clock status. They are: (1) whether the clock is in demo or normal mode, (2) the time format, (3) the date format, and (4) the mean clock time quality and sigma.

Power Supply

Provides the voltages for the internal power supplies: A, or A and B.

Antenna

- basic antenna/cable status, whether good or bad
- voltage and current supplied to the antenna through the cabling
- geographical position – longitude, latitude, elevation
- number of GNSS satellites being tracked – GPS, GLONASS, Galileo, BeiDou
- GNSS signal-to-noise ratio in dB for both the GPS, GLONASS, Galileo, BeiDou

7.8 The Performance Screen

The performance screen gives a glimpse at how the clock is performing with regard to run time, time quality and estimated holdover uncertainty. Run Time includes the number of power cycles, previous run time (before the last power cycle), current run time and total run time. Time quality is a 2σ estimate of accuracy. Estimated holdover uncertainty is an estimate of how the clock will drift (based on the installed oscillator) over various time intervals if the clock were to lose lock with the GNSS. Since these are dynamic values, you must read the clock to view new readings over time. Those displayed are only good for the moment you last read the clock.

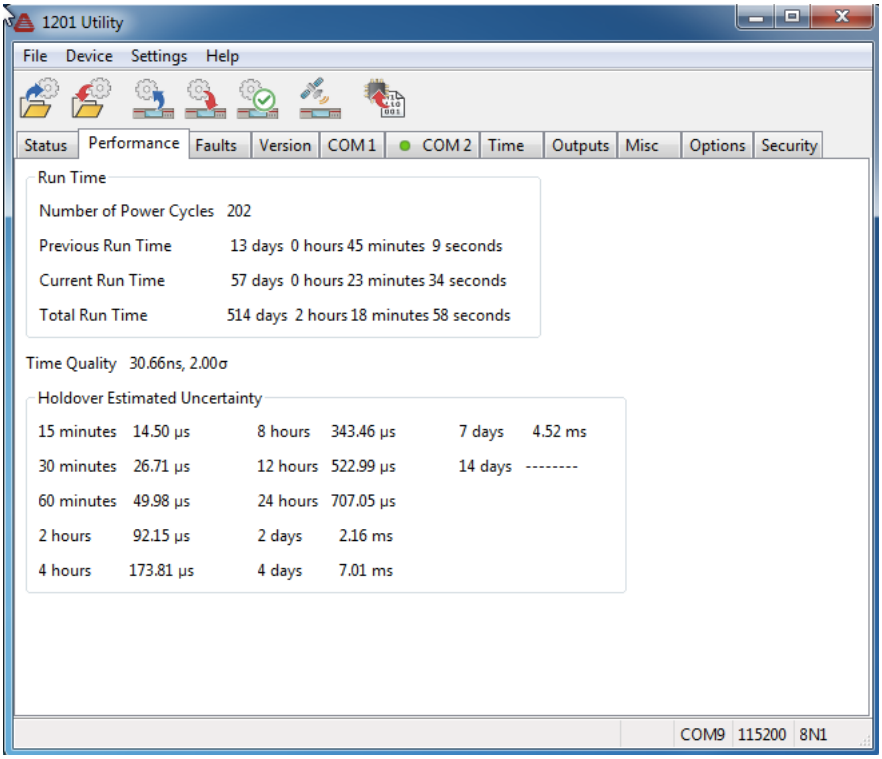


Figure 7.6: Performance Display Screen

7.9 The Fault Screen

The fault screen provides some control over the behavior of the fault reporting and recording system on the clock. The Clear box will remove the specific fault record from memory and the reported fault from the status display. The Mask box deactivates the triggering of the specific fault. For example, if you check the Mask box for Antenna, the status message will not appear and recorded message will not be in memory if the antenna is disconnected or fails. The Latch box assures that when a specific fault occurs that the status message will persist, and not disappear, until it is cleared.

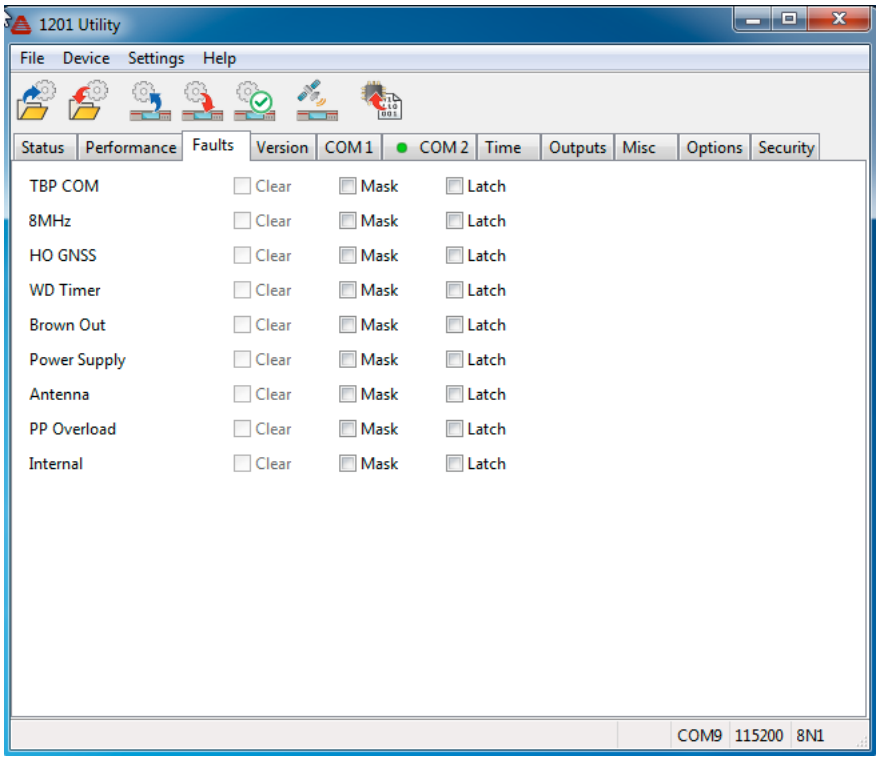


Figure 7.7: Fault Display Screen

7.10 The Version Screen

Choose the Version tab to view the clock serial number and firmware version, which is defined by the release date.

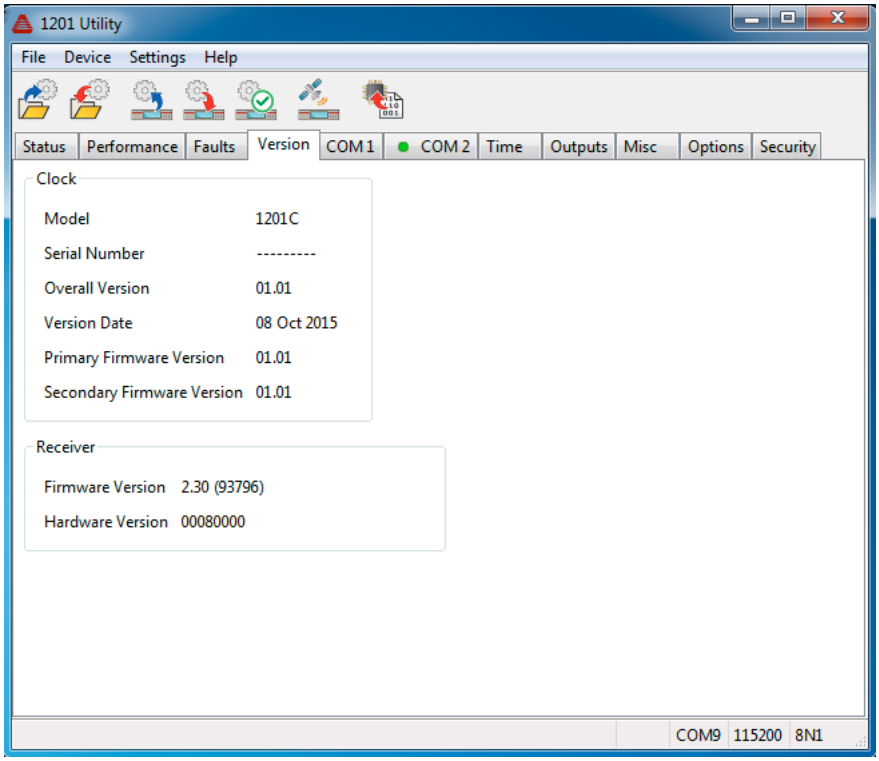


Figure 7.8: Version Display Screen

7.11 COM1 & COM2 – Communication Screens

COM1 and COM2 are two separate communication ports, which are set up independently and accessible from separate tabs. This section will cover the setup of COM1. COM2 is set up similarly and the setup screen looks identical except for the title. Make sure to check your connection on the clock's rear panel.

NOTE: If using a USB-to-Serial converter, connect it to COM2 ONLY.

Select the COM1 tab, as seen in Figure 7.9, to view and configure any communication parameters on that port, including broadcast modes. When you click the read icon, or select Device > Read from the menu, the Utility reads all the clock settings. Check all of the settings listed under COM1 Port Settings.

If intending to broadcast a message from COM1, check the Broadcast section and select under Mode from a number of pre-configured messages. Custom broadcast messages may be created through the scripting as described in Section 11.2.2.

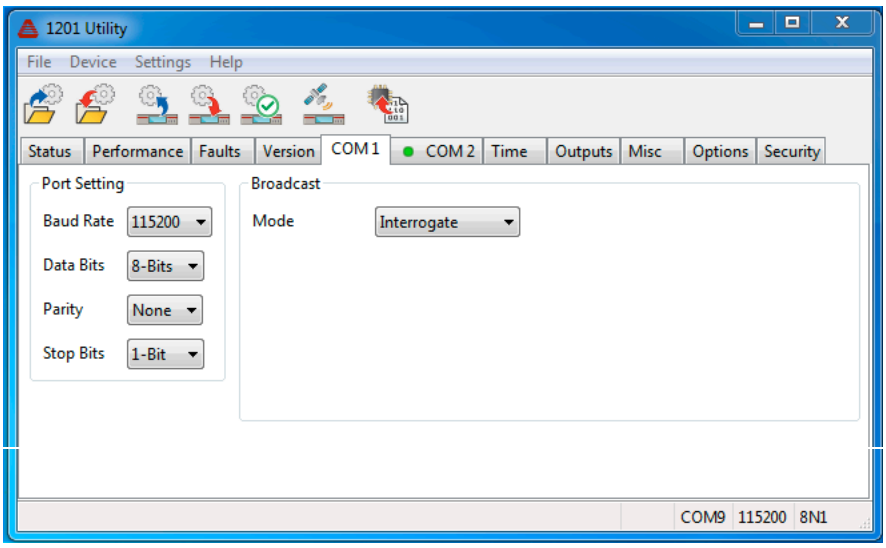


Figure 7.9: Communication Settings Screen

Port Setting: Set the baud rate, word length, parity and stop bits. Flow control is not used.

Broadcast: Set Message Type according to the list of configured broadcast messages. Custom messages may also be configured. Set broadcast rate and broadcast time reference to either UTC or Local.

7.12 The Time Screen

Select the Time tab to set up your local offset, and daylight saving time (DST) preferences. Local offset should not change, and is the difference between UTC and your local standard time. For example, Pacific Standard Time is -8 hours, and Singapore is +8 hours. H1owever, DST advances the time by one hour, and removes the hour advance each year. DST can be turned Off, On, or set to Auto for automatic changeovers in your specific locale. The default AUTO DST occurrence is set for North America.

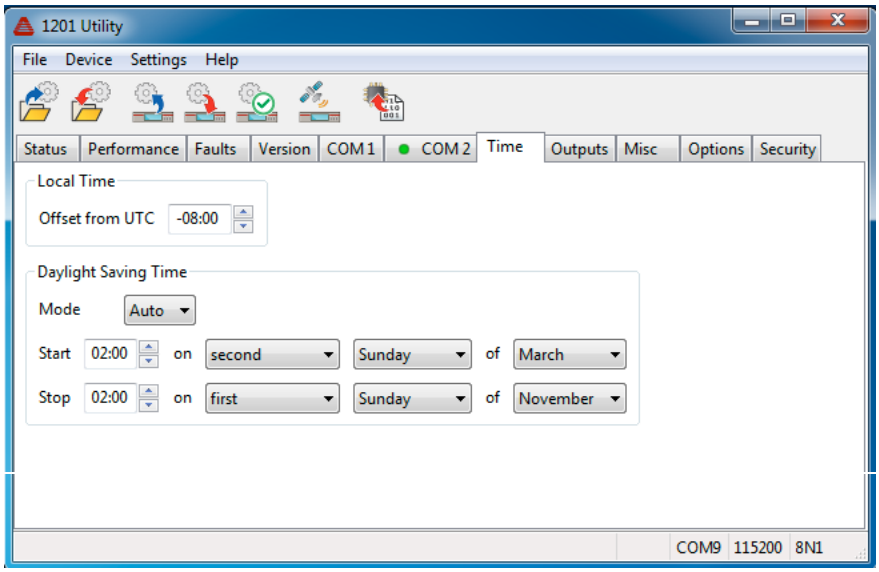


Figure 7.10: Time Adjustment Screen

Daylight Saving Time

The daylight saving time settings change when selecting Auto by adding some new windows to select the start and stop date and time. The start and stop times are given in minutes after midnight. The start and stop dates are chosen by the week and weekday of the start and stop month.

DST Background

In 2007 the U.S. Federal Government changed the start and stop dates to increase the number of days allotted to DST. Prior to the change, DST started at 2:00 a.m. the first Sunday of April and ended at 2:00 a.m. on the last Sunday of October. Currently, DST starts at 2:00 a.m. on the second Sunday of March and ends at 2:00 a.m. on the first Sunday of November. The result is an additional 4 to 5 weeks allotted to DST, depending on the specific year.

Since individual countries and regions have their own names, times and dates for the same effect as DST, the clock was designed to adjust for all these differences around the earth.

7.13 The Outputs Screen

The Outputs screen provides for the setup of three groups of output functions: (1) the IRIG-B time code settings, (2) the programmable pulse settings, and (3) the relay operation.

7.13.1 Standard IRIG-B Section

Two settings in the IRIG section set up: (1) the time zone, and (2) the C37.118.1 setting. IRIG-B settings selected in this window apply to any output connector configured with a jumper set to IRIG, or modulated IRIG-B. One mode of Programmable Pulse allows an alternate instance of unmodulated IRIG-B, with a different time zone and IEEE C37.118.1 setting. See Section 7.13.1 to configure a separate and independent instance of unmodulated IRIG-B using Programmable Pulse.

In the IRIG window, select a time zone (either Local or UTC) and the IEEE C37.118.1 setting (either ON or OFF).

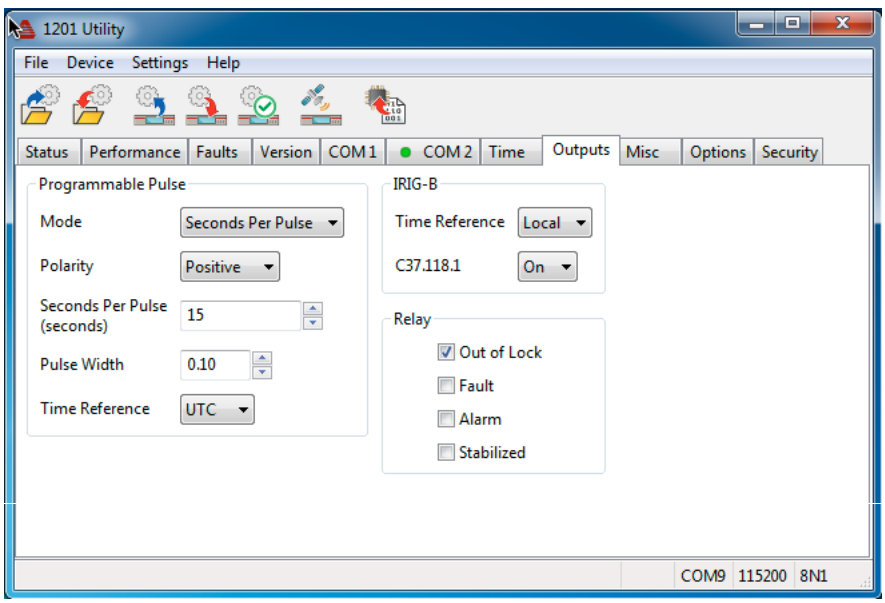


Figure 7.11: IRIG-B Adjustment Screen

IRIG-B Connection & Timing Information

For additional information on time codes, IRIG-B, and connecting, see Chapter 9.

Several application notes and white papers are available and address connection issues in more depth. These may be obtained from the Arbiter website at *http://www.arbiter.com*; under Documentation.

Select the Programmable Pulse section to configure how the clock sends pulses out any port when a jumper is set to Programmable Pulse. There are six different modes available within the programmable pulse feature of the clock.

Pulse Modes: (1) Auxiliary IRIG-B (2) Seconds per Pulse, (3) Pulse per Hour, (4) Pulse per Day, (5) Single Trigger, (6) Slow Code, (7) DCF77, (8) DCF77 Modified.

Auxiliary IRIG-B: This is a completely independent instance of IRIG-B. Select IRIG-B as Mode and go to IRIG-B tab to set up auxiliary time zone and IEEE C37.118.1 setting.

Polarity: Pulses may be set to transition positively or negatively.

Single Trigger: Specify the time and date, UTC or Local, for a pulse event.

Pulse Width: From 10 ms (0.010 s) to 24 hours in 10 ms increments, depending on mode.

Pulse Delay: The number of seconds after the top of the hour to delay the pulse in the Pulse per Hour mode.

7.13.2 Auxiliary IRIG-B Mode

Select IRIG-B under Mode, and some of the other selections will normally change when you select a different mode. Within this auxiliary IRIG-B mode, you will have the same setup variables as with the standard IRIG-B outputs.

With any of these programmable pulses modes, make sure to select the Programmable Pulse jumper assigned to the specific output port (1, 2, or 3). See Table 5.1.

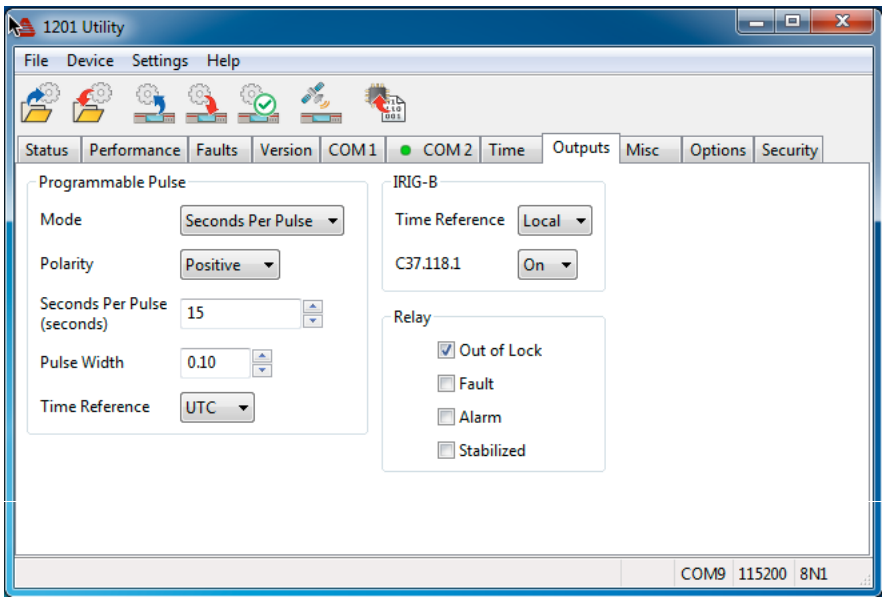


Figure 7.12: Programmable Pulse Setup Screen

7.13.3 Seconds Per Pulse Mode

Choose this programmable pulse mode to provide a pulse every X number of seconds, where X can be from 1 to 60,000 seconds. After configuring the pulse mode, make sure to change the jumper for the chosen port to programmable pulse. See Table 5.1.

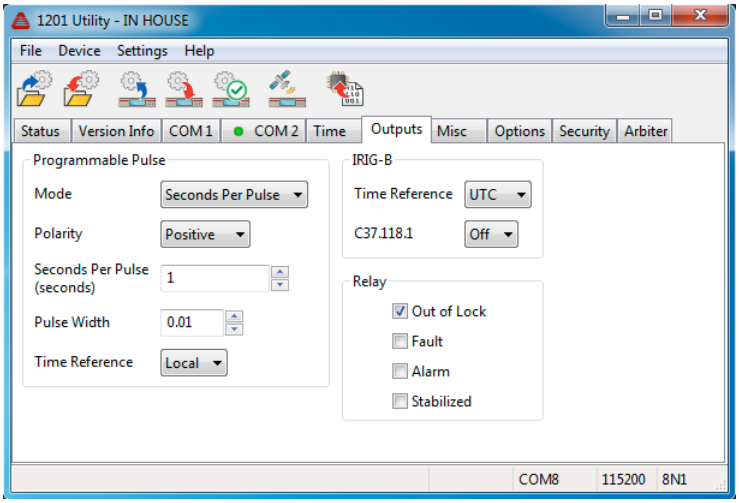


Figure 7.13: Programmable Pulse Seconds Per Pulse Screen

7.13.4 Pulse Per Hour Mode

Choose this programmable pulse mode to provide a pulse every X number of seconds after the hour, where X can be from 0 to 3,599 seconds. Configure the pulse width, from 10 milliseconds to 600 seconds. After configuring the pulse mode, make sure to change the jumper for the chosen port to programmable pulse. See Table 5.1.

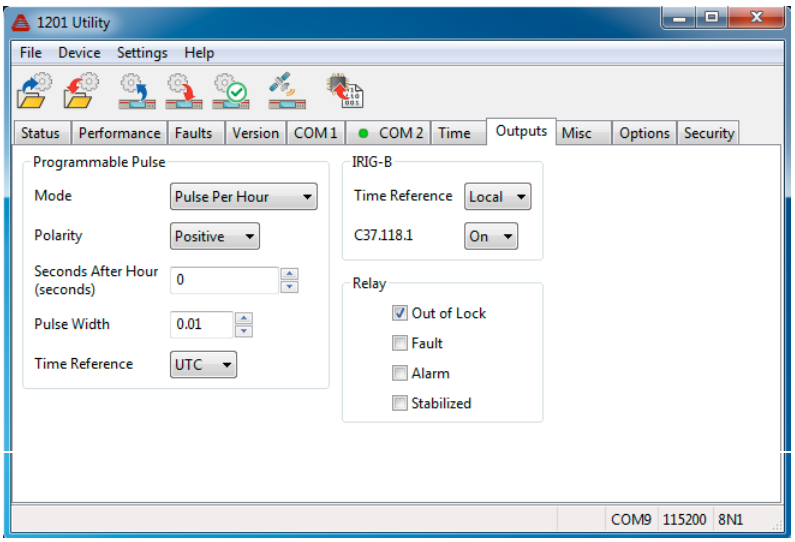


Figure 7.14: Programmable Pulse, Pulse Per Hour Screen

7.13.5 Pulse Per Day Mode

Choose this programmable pulse mode to provide a pulse every day at the chosen hour, minute, second and fractional seconds. Configure the pulse width, from 10 milliseconds to 600 seconds. Check jumpers in Table 5.1.

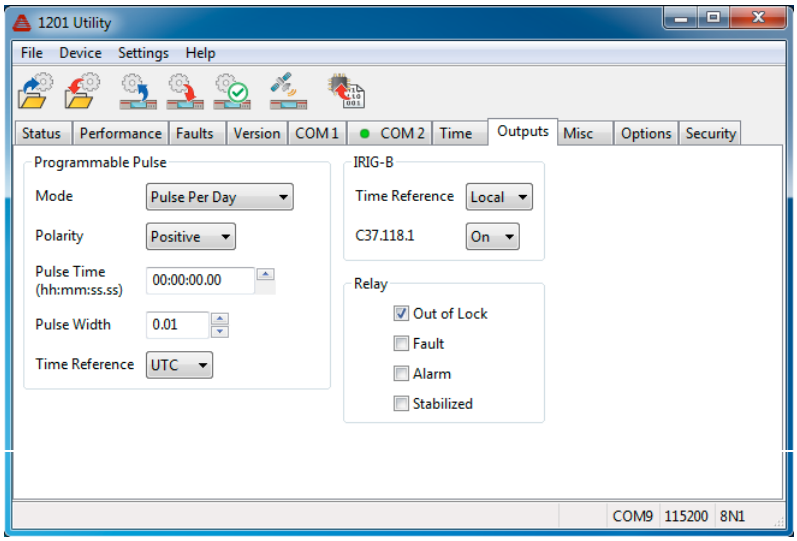


Figure 7.15: Programmable Pulse, Pulse Per Day Screen

7.13.6 Single Trigger Mode

Choose this programmable pulse mode to provide a pulse every year at the chosen Julian Day of year, hour, minute, second and fractional seconds. Single Trigger polarity may start as either high (positive) or low (negative). When the trigger occurs, it transitions to the opposite polarity and remains at that value until Single Trigger is deliberately reset. Check jumpers in Table 5.1.

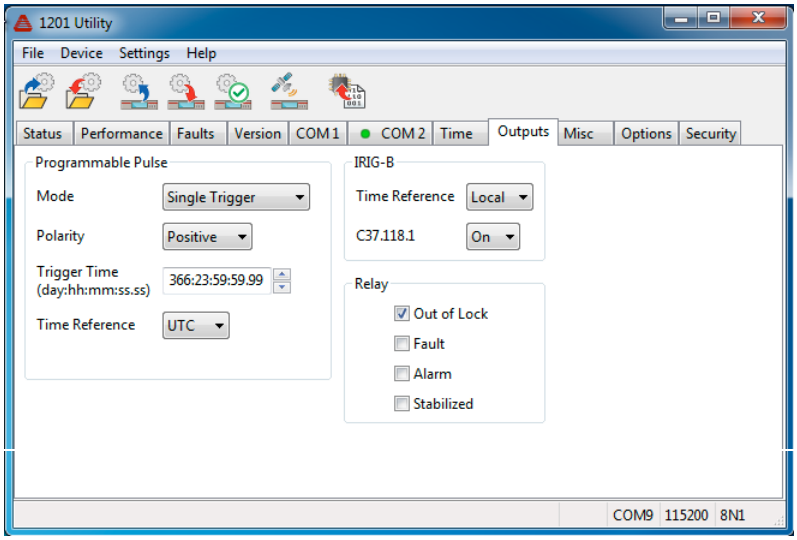


Figure 7.16: Programmable Pulse, Single Trigger Screen

7.13.7 Slow Code

Selecting slow code causes the output to be held high and go LO for two seconds on the minute, four seconds on the hour and six seconds on the day.

7.13.8 DCF77 and DCF77 Modified

The DCF77 is a German longwave time signal and standard-frequency radio station. DCF77 is controlled by the *Physikalisch-Technische Bundesanstalt* (PTB), Germany's national physics laboratory and transmits in continuous operation (24 hours). It is operated by *Media Broadcast GmbH* (previously a subsidiary of *Deutsche Telekom AG*), on behalf of the PTB.

TDCF77 timing signal is a one-minute time signal produced from any of the digital outputs, but synchronized to the GNSS time signals and not the German system. DCF77 Modified is almost identical to DCF77 except that the 59th bit is a 0.5 second pulse instead of zero. See more detail in Section 9.3.8

7.14 Miscellaneous Screen

Figure 7.17 illustrates the Misc screen where there are a few less frequently configured items, including: Antenna Power, System Delay, LCD Backlight (ON, OFF, Auto), C-Display Format, Event Input settings and Out of Lock Detection.

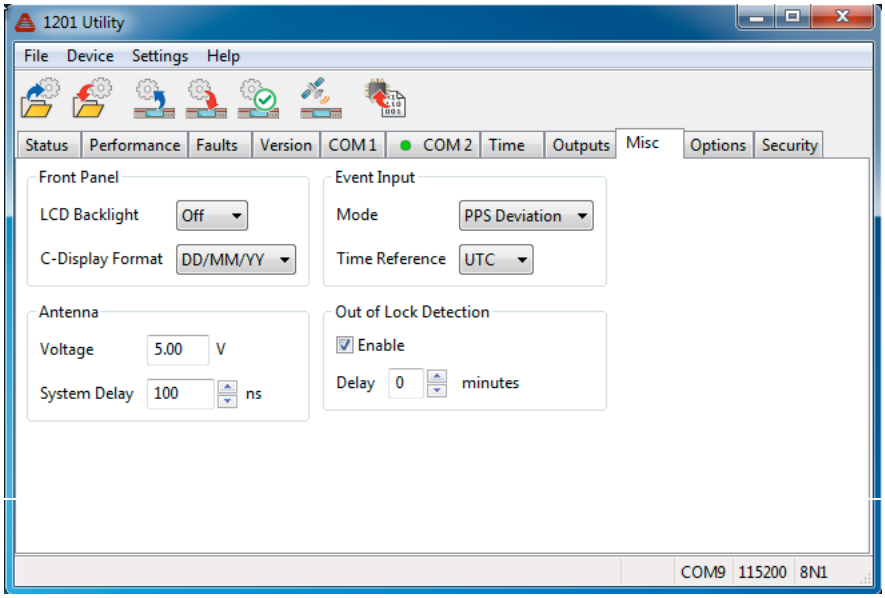


Figure 7.17: Miscellaneous Screen

7.14.1 Miscellaneous Items

Antenna Power: The antenna receives up to 5 Vdc from the clock and draws about 29 mA. These values may be viewed from the front panel by pressing the Antenna key.

System Delay:] Compensates for the time delay of the antenna cable plus the antenna group delay. Time is given in nanoseconds (10^{-9} s).

LCD Backlight: Sets the LCD backlight operation to ON, OFF, or Auto mode. In Auto mode, the LCD backlight will illuminate when a key is pressed and will remain ON for about 30 seconds.

C-Display Format: Sets the Model 1201C to display the date in one of two formats – MM/DD/YY or DD.MM.YY.

Event Input Modes: allows a choice of setting the input mode as event recording or continuous 1 PPS recording with mean and sigma. Also, allows event recording to be timed according to the local or UTC time zone.

7.15 Option Screen

Figure 7.18 illustrates the Option Screen, which allows the configuration of a specific installed option board. By configuring the correct option by name here, the clock will recognize what is installed and provide any needed information to the relevant clock function(s). When some options are selected, like the Time and Frequency Monitor, other settings not shown in Figure 7.18 will appear.

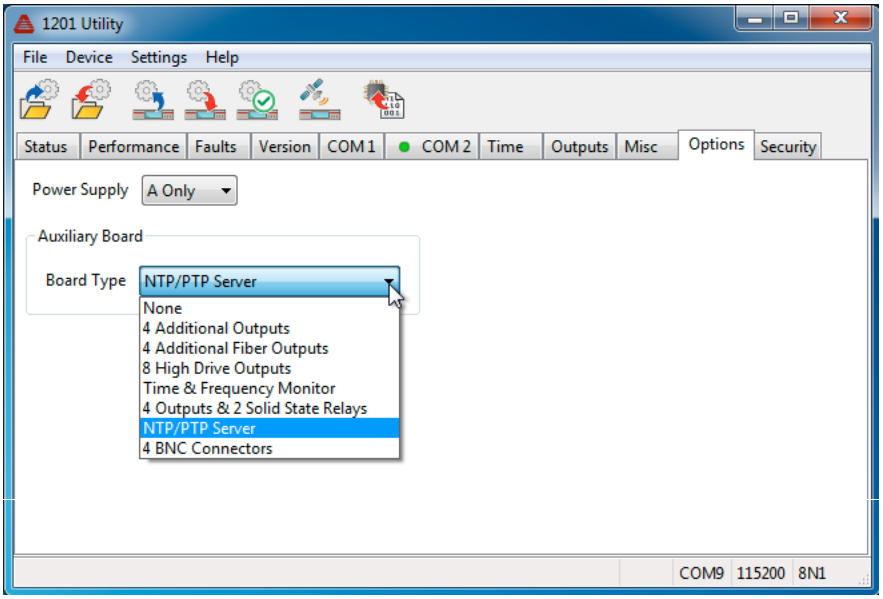


Figure 7.18: Option Board Configuration Screen

Option No.	Option Board Description	Page
E01	Four Additional Configurable Outputs	120
E02	Four Fiber Optic Outputs	123
E03	Eight-Channel, High Drive IRIG-B Outputs	125
E04	Power System Time, Frequency and Phase Monitor	130
E05	Four Additional Outputs with Dry Contacts and +25/50 Vdc	136
E06	NTP/PTP Server – Copper/Copper Ports	141
E07	NTP/PTP Server – Copper/Fiber Ports	141
E08	NTP/PTP Server – Fiber/Fiber Ports	141
E09	Four BNC Connectors (Parallel to Pluggable Terminal Strip)	185

Table 7.3: Option Board Descriptions

7.16 Security Screen

You can access three functions from the Security screen: Security levels, Password control and Spoofing. Figure 7.19 illustrates the security screen. Under Security you can set up to control specific access points. There are six levels of security (0, 1, . . . , 5) that provide various levels of operation from the front panel keyboard and display, and restrict the RS232 ports access. Note that the Front Panel and COM Port values change automatically with changes to Device Security Level. Under Passwords you can assign and manage both user (operator) and administrator passwords. Spoofing allows you to control the level for anti-spoofing function in the clock.

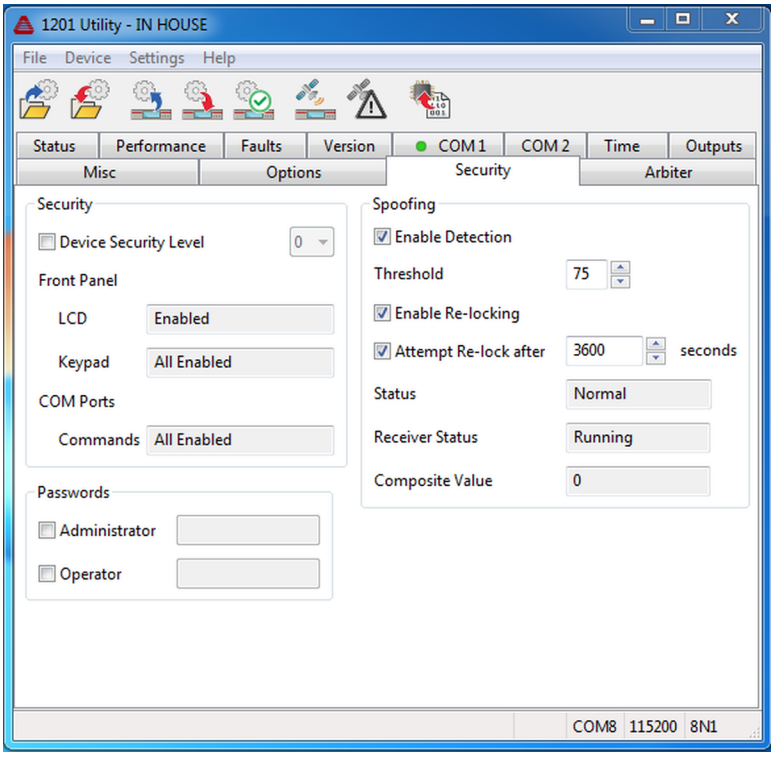


Figure 7.19: Security Configuration Screen

In the application window select the Security tab to view all of the spoofing related information. *Note that for spoofing detection to be active the clock must be in the normal mode.*

Spoofing

Spoofing status currently comprises four measured values: (1) position change, (2) time messaging offset, (3) fine time deviation, and (4) fine time rate deviation. Each value can be measured and presented with a number from 0 to 100 and a combined value of 0 to 400. A value of zero is as good as it gets and a value of 100 for each measured value would indicate virtually positive proof of spoofing. If all four values were 100, then the combined total would equal 400.

Spoof Enable and Threshold

For anti-spoofing to work in the clock, the Enable Detection checkbox must be checked. Otherwise, spoofed GNSS signals will be ignored in the clock. Uncheck the box if you want to turn off the anti-spoofing feature. Testing has shown that the default Spoof Threshold Limit of 75 is an optimum

and should not be changed. This value has been chosen to provide an extremely low likelihood of false detection, while having very high sensitivity to a real attack.

Enable Re-Locking
If disabled (unchecked) the clock will never attempt to recover from a spoofing detection. Normally, if "Enable Re-locking" is checked and the clock sees the spoofing attack terminate, it will attempt to re-lock and clear the "alarm."

Attempt to Re-lock After
As the name suggests this feature terminates the spoofing features after a specific period of time (in seconds) has elapsed, regardless of the detection state. Requires the Enable Re-locking setting be enabled.

For more information on clock's security, see Section 7.3.

7.17 Uploading a Configuration

The Utility allows you to save a configuration file from one clock and upload the saved file to other clocks. To do this,

1. Start the Utility and connect to the originating clock. Make sure you have chosen the correct COM port number and baud rate.
2. Select Device > Read, or click the Read icon, to download the configuration.
3. Select File > Save to save a copy of the downloaded configuration.
4. Connect the serial cable, and possibly USB-to-serial adapter, to the new clock. Make sure that the COM port and baud rate settings are correct on the second clock.
5. Select Device > Write, or click the Write icon, to upload the saved configuration to the new clock.
6. Select Device > Verify, or click the Verify icon, to verify that the upload matches the configuration file.

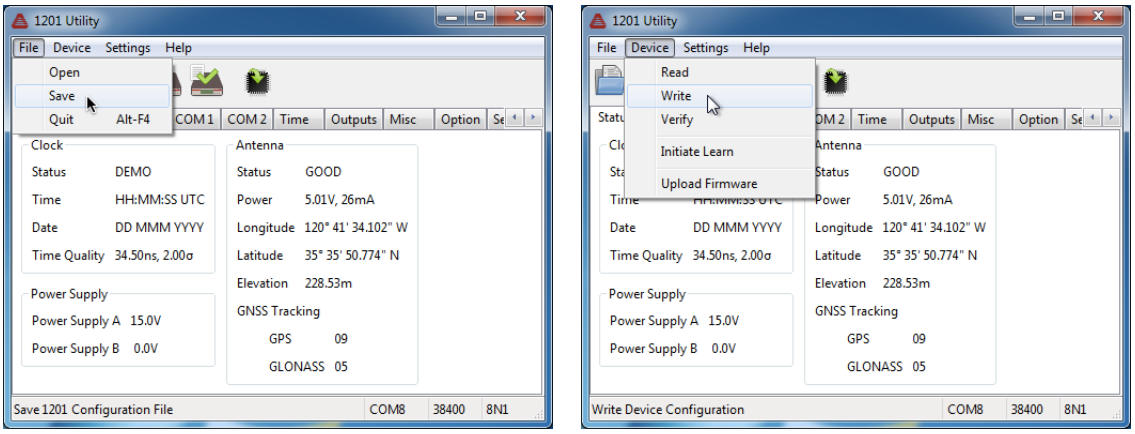


Figure 7.20: Uploading a Configuration File to another clock

Clearing the Event Buffer

To clear all events stored in the event buffer, select Device > Events > Clear Events. See Figure 7.21.

While *broadcasting* event records, the buffer will continually be overwritten with new data. Therefore, you would not need to use the Clear feature while *broadcasting* event data.

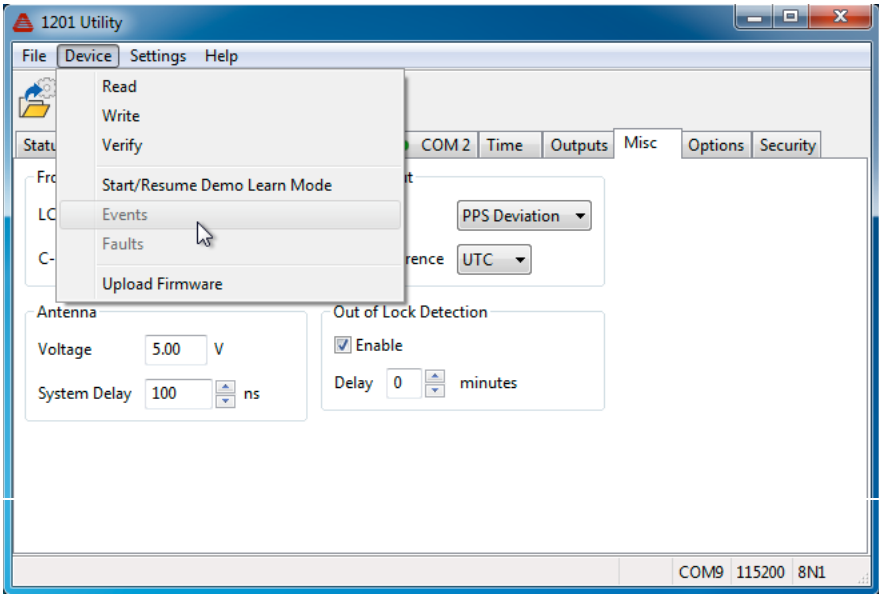


Figure 7.21: Clearing Events in the clock

7.18 Uploading New Firmware

Before starting the upload process, there are a few things to have prepared ahead of time. Obtain the new firmware from Arbiter Systems. Make sure that the clock and the computer are powered by an uninterruptable power source. Lastly, test the serial connection by performing a Device > Read.

NOTE: The default password for uploading firmware is ***admin***.

1. Select Device > Upload Firmware (see Figure 7.22), or click the Upload Firmware button, and you will open a file browser window to select the firmware file.
2. Select the file and click Open and a smaller Upload Firmware window should appear (see Figure 7.23.
3. Click the Upload to Device button and a progress bar should appear indicating the progress of the upload.
4. At the same time, the clock LCD display should indicate FIRMWARE UPLOAD MODE until the process has completed.
5. After a successful upload, the clock should restart in the mode that it was in before the upload, either Learn or Normal.

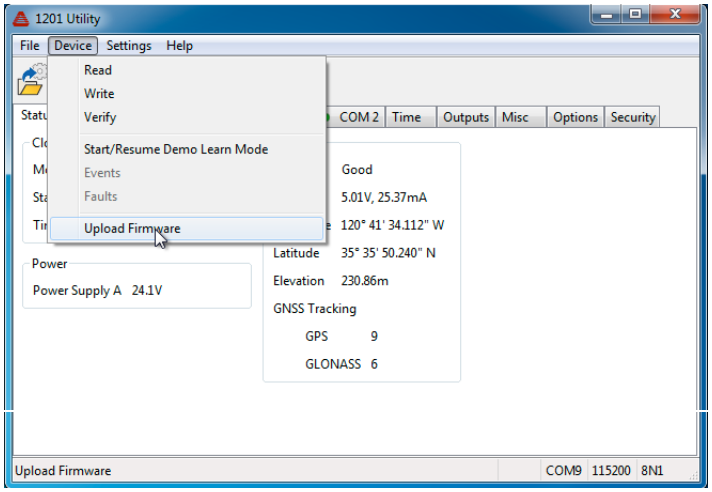


Figure 7.22: Starting the Upload Process

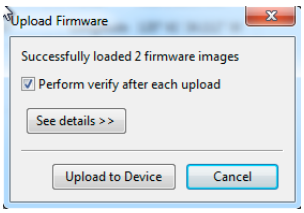


Figure 7.23: Uploading Firmware

7.19 Setting to Factory Defaults

At some time it may be necessary to reset the clock to its original firmware configuration when it left the factory. This is called "resetting to factory defaults" and requires disabling security. Resetting the clock to factory defaults *clears memory* including any information that may cause problems with its operation. To return the clock firmware configuration to factory defaults, follow the instructions listed below. After resetting, you can use the Utility to save the default configuration to file.

1. Disable security (to level 0) on the clock using the utility software.
2. Cycle power on the clock: OFF, then ON.
3. Press the Setup key when you see the first message displayed on the LCD, and display message should change to:

   ```
   MODEL 120XX CLOCK
   VERSION DDMMMYY
   ```

   Then the display should change to read:

   ```
   SET FACTORY DEFAULTS?
   PRESS ENTER
   ```

4. Press the Enter key and the message should change to read:

   ```
   ARE YOU SURE?
   YES = UP NO = DOWN
   ```

5. Press the UP key to confirm. The display should cycle through the following messages.

   ```
   LOADING DEFAULTS
   ```

   ```

   DEFAULTS COMPLETE
   ```

6. The factory default settings are now restored.
7. Reset security on the clock if required.

Chapter 8

Front Panel Menu System

This chapter covers the operation of the clock using the front panel display and keypad.

8.1 Menu System

Since the front panel operation is based on specific security levels, verify the security level as enumerated in Section 7.3. Only the lowest level – Level 0 – allows a user to configure the clock from the front panel.

8.1.1 Upper Keys

The overall menu structure of the upper row of keys is illustrated in Table 8.1, with bold headings representing keys in the top row of the keypad. Configuration from the keypad is described in following sections. Press any one of these four keys to initiate and progress downward through the menu structure.

TIME/DATE	**ANTENNA**	**TIMING**	**SYSTEM**
UTC DATE & TIME	GNSS TRACKING	CLOCK STATUS	SERIAL #/VERSION
UTC DAY OF YEAR	GNSS SIGNAL TO NOISE RATIO	TIME QUALITY	POWER SUPPLY STATUS
LOCAL DATE & TIME	GNSS SETTINGS	HOLDOVER ESTIMATED UNCERTAINTY	EEPROM STATUS
LOCAL DAY OF YEAR	ANTENNA STATUS VOLTAGE & CURRENT	EVENT/DEVIATION	FAULT
	LONGITUDE	EVENT DETAILS	OPTION STATUS
	LATITUDE		
	ELEVATION		

Table 8.1: Menu Structure – Upper Keys

1. Event/Deviation can be selected as either 1 PPS Deviation or Event records, and must be configured as such from the Utility or the front panel keys.

8.1.2 Lower Keys

To start configuring using the keypad, press SETUP as illustrated in Figure 8.1. Accessing the clock configuration menus depends on your clock's security settings. For reference, individual setup menus are listed in Table 8.2, and in greater detail throughout this chapter.

8.1.3 Configure Using the Keypad

Figure 8.1 illustrates the clock keypad and annunciator LEDs, with Table 8.2 listing the various menus used to configure the operation. Press the setup key to enter the clock configuration menus, starting with the main RS-232 port parameters.

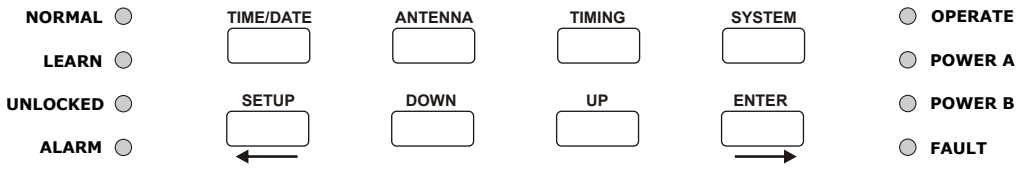


Figure 8.1: Keypad

Configure Key Definitions

SETUP Key: Press SETUP to enter the clock configuration menus. Repeatedly pressing SETUP scrolls through the main menus in one direction. In numeric data entry mode, press SETUP to move the cursor to the left.

Alternate Menu Navigation: Press SETUP once, then press UP or DOWN to scroll the main menus in either direction.

ENTER Key: Press ENTER to confirm changes made within setup menus. Generally, pressing ENTER also advances the next parameter, or returns to the previous menu level. In numeric data entry mode, press ENTER to move the cursor to the right.

UP Key: Press UP, within the setup menus, to adjust numerical values upward, or to scroll upward through the available menu choices. UP also assists in navigating through main Setup Menus in normal order.

DOWN Key: Press DOWN, within the setup menu, to adjust numerical values downward, or to scroll downward through available menu choices. Also assists in navigating through main Setup menus in reverse order.

At the end of each detailed setup menu section are references to the corresponding RS-232 commands for configuring these functions.

8.1.4 The Setup Menus

No.	Setup Menus	Setup Items
1	Set Serial COM 1?	Main RS-232 port parameters and broadcast
2	Set Serial COM 2?	Second RS-232 port parameters and broadcast
3	Set Local Time?	Set local offset, daylight saving mode
4	Set Out-Of-Lock?	Set out-of-lock mode, and time interval before alarm occurs
5	Set GNSS?	Set which constellations to use
6	Set Status Relay	Set out of lock, alarm, fault and stabilized indicators
7	Set Back Light?	Set to ON, OFF or AUTO mode
8	Set System Delays?	Set combined antenna group delay and cable delay in nanoseconds
9	Set Prog. Pulse?	Set mode, pulse width and time zone
10	Set IRIG Time Data?	Set IRIG-B time zone and IEEE C37.118.1 control bits
11	Set Event/Deviation?	Set for event, or 1 PPS deviation
12	Set Learn Mode?	Initiate a 24 hour learn mode
13	Set Option Control?	Configure auxiliary board option (if installed)
14	Set C Disp. Format?	Configure the month and day format of the large display (Model 1201C)

Table 8.2: Front-Panel Setup Menu Definitions

8.1.5 Default Firmware Settings

When shipped from the factory, and unless specified otherwise, all models will be configured with default settings. Most users elect to modify the clock settings to fit their locale and desired operation. Default settings are listed in Table 8.3.

Menu Item	Default	Menu Item	Default
COM 1 Port	9600, 8, N, 1	COM 2 Port	9600, 8, N, 1
Local Time & DST	none, OFF	Out-of-Lock	01 minute
Relay Config.	ON, ON, ON, OFF[a]	Backlight	Auto
System Delays	60 ns	Prog. Pulse	IRIG-B
IRIG Time Data	UTC, C37.118.1 OFF	Event/Deviation	1 PPS Deviation
Option Control	None	C. Display Format	MM/DD/YY

Table 8.3: Default Clock Settings

[a]Default settings for the four triggering conditions: Out of Lock, Fault, Alarm, Stabilized

8.1.6 Configuration Flow Diagrams

This section explains how to use the setup menu flow diagrams in the following sections. The LCD screens display contents of each menu. Use the lower row of keys to configure clock settings.

1. Always start configuring by pressing SETUP.
2. Scroll through the menus using either UP or DOWN.
3. When you see the specific menu to configure, press ENTER to start configuring.
4. Once in the individual menu, use UP or DOWN to make selections.
5. To configure numerical values, see Section 8.1.7 below.
6. Press ENTER to install the new value and move to the next menu.
7. Press any of the upper row of keys to exit the configure menus.

The figure below illustrates two elements of the setup menu flow chart: a larger rounded rectangle and a small oval. The larger rounded rectangles represent messages within the clock LCD display, and the small oval symbol represents the individual keys of the eight-button keypad.

8.1.7 Numeric Data Entry Mode

Numeric data entry mode is activated anytime you enter a menu that requires a change in numerical value. When in this mode, press UP or DOWN to change the numerical value of the digit. Next, press SETUP or ENTER to move the cursor to the left or right. Keep moving along in this manner changing all the required digits to complete the whole number. Press ENTER at the end to move the cursor to the right, and finally to store the number.

8.2 Serial COM Port Settings

Press SETUP to enter the configuration menus.

8.2.1 Serial COM 1

Use the "SET SERIAL COM 1" menu (See Figure 8.2) to configure RS232 settings and to broadcast data. To configure COM 1 port parameters press ENTER, then UP or DOWN to choose the desired value. Once selected press ENTER again to install the chosen value and move ahead configuring other COM1 parameters.

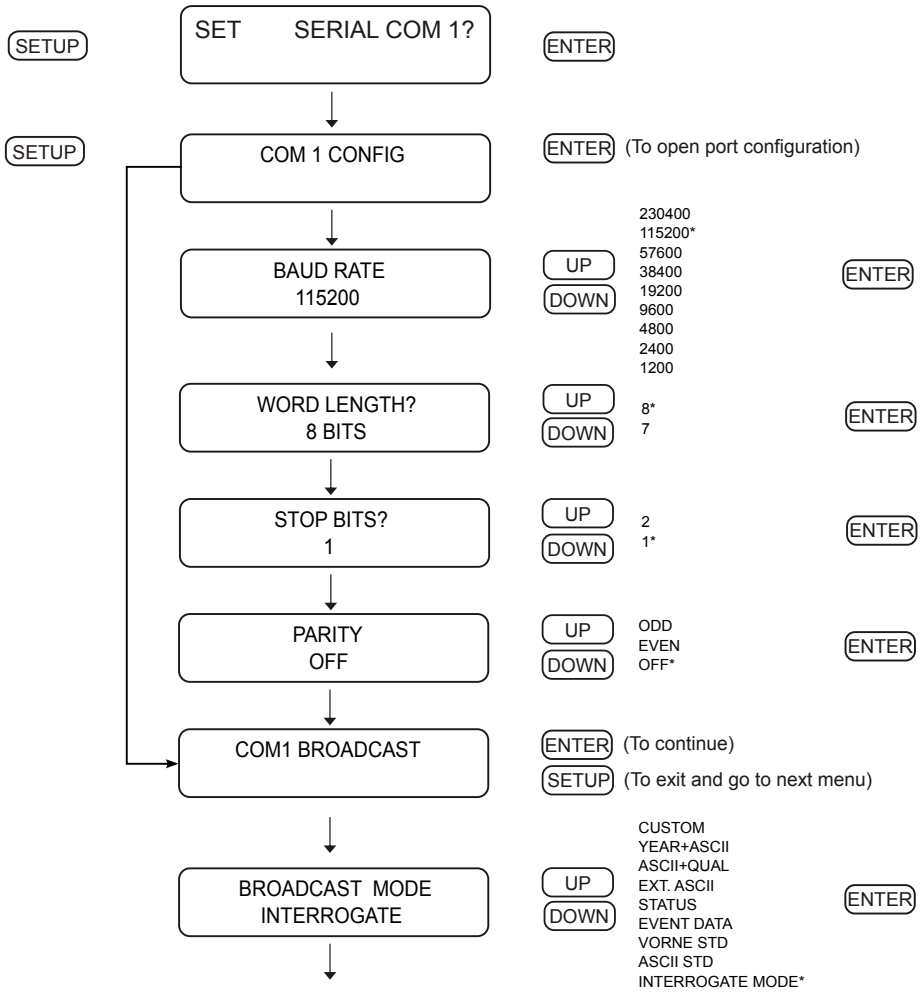


Figure 8.2: Main RS-232 Setup

8.2.2 Serial COM 2

Use the "SERIAL COM 2" menu to set it up in the same manner as Serial COM 1. At the conclusion of setting Serial COM 1 press ENTER and the display will indicate "SET SERIAL COM 2?" Another way to reach this is to press SETUP twice when starting from any of the upper key menus.

8.3 Setting the Local Time

Use the "SET LOCAL TIME?" menu to configure the local offset from UTC to your local standard time, and add any Daylight Saving settings if they apply. Offsets may be adjusted in 15-minute increments, up to plus or minus 12 hours. Daylight Saving is adjusted for start and stop times and based on month, week of month, day, and time of day. Use this menu to set up basic DST adjustment.

For RS-232 command, see Section 11.2.6.

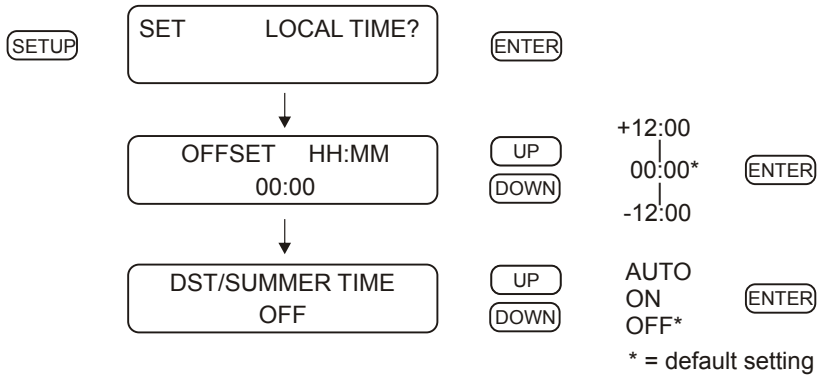


Figure 8.3: Local Hour Setup

8.3.1 Set Daylight Saving Time (DST)

DST/Summertime settings are a continuation of the "SET LOCAL TIME?" menu shown in Figure 8.3. When the menu indicates "SET DST/SUMMER TIME?" make sure to follow the instructions on the clock display. DST menus are illustrated in Figure 8.4 on the next page, and are only available if you choose the AUTO selection. They do not appear if you choose ON or OFF, as seen in Figure 8.3.

DST Details

For automatic changeover, choose the AUTO setting explained above. Make sure to determine the changeover requirements in your locale before trying to adjust the settings. The default setup is for North America, where DST begins on the second Sunday of March at 2 am and ends on the first Sunday of November at 2 am. Settings illustrated in Figure 8.4 are based on North America.

For RS-232 command, see Section 11.2.6.

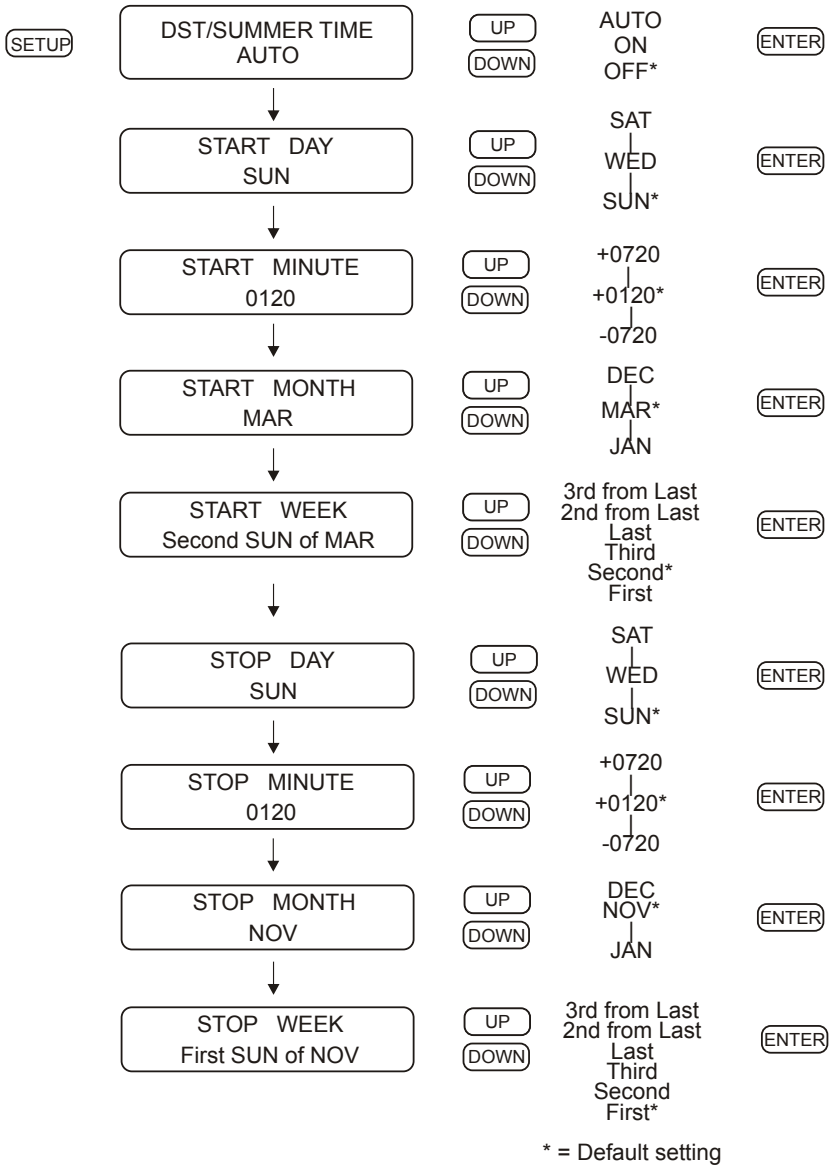


Figure 8.4: Auto Daylight Saving Setup

8.4 Setting Out of Lock Indication

This setting controls how the clock responds to an out-of-lock condition. Out-of-lock means the GNSS receiver is no longer tracking any satellites and that the time may drift according to characteristics of the internal holdover oscillator. The default setting is one minute. Unlocked indications include an illuminated red unlocked LED, and the SPDT relay depending how the relay is configured. The relay may also be configured to respond to several other clock conditions, which are discussed in Section 8.6. *For RS-232 command, see Section 11.2.13.*

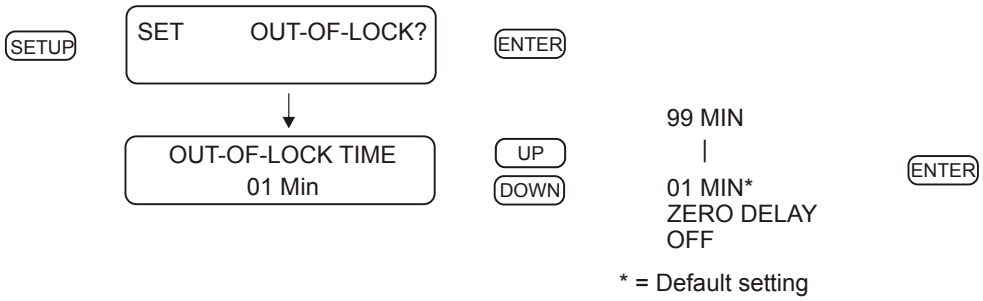


Figure 8.5: Out-of-Lock Setup

Out of Lock Status Indicator

The out of lock function will indicate the number of days, hours and minutes since the time the clock lost lock with the GNSS. The counter stops at 45 days and the clock LCD indicates as follows:

```
UNLOCKED
45d --h --m
```

After the clock regains synchronization with the GNSS, the unlocked counter resets to zero and the UNLOCKED message disappears.

8.5 Set GNSS Constellation

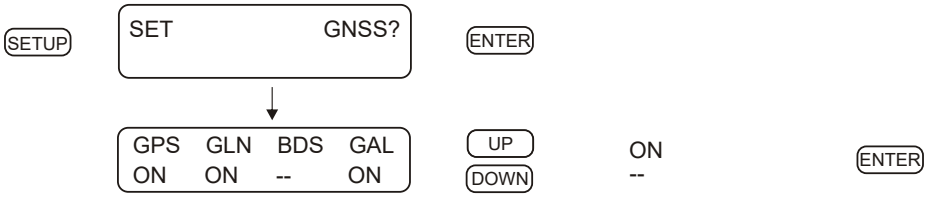


Figure 8.6: GNSS Constellation Setup

Constellation Details

- GLONASS and BeiDou can not be selected at the same time.
- Galileo can not be selected by itself.

8.6 Set Mulitpurpose Relay Configuration

Use the "SET RELAY CONFIG?" menu to configure how the multipurpose relay responds to several clock conditions. Clock conditions include (1) out of lock, (2) faults, (3) alarms, (4) stabilization, and (5) failsafe. These are described in the setup procedure shown in Figure 8.7. Alarms consist of any outside influence, such as a sudden change in GNSS position[1], that may affect the operation of the clock. Faults consist of an internal hardware problem with the clock, such as an oscillator failure, or a GNSS receiver failure. See page 29 for a description of fault conditions. Failsafe refers to the relay faulting when the clock loses power. All of these events may be configured to trigger the relay separately or concurrently. The relay may also be configured to actuate with a programmable pulse, which is discussed below.

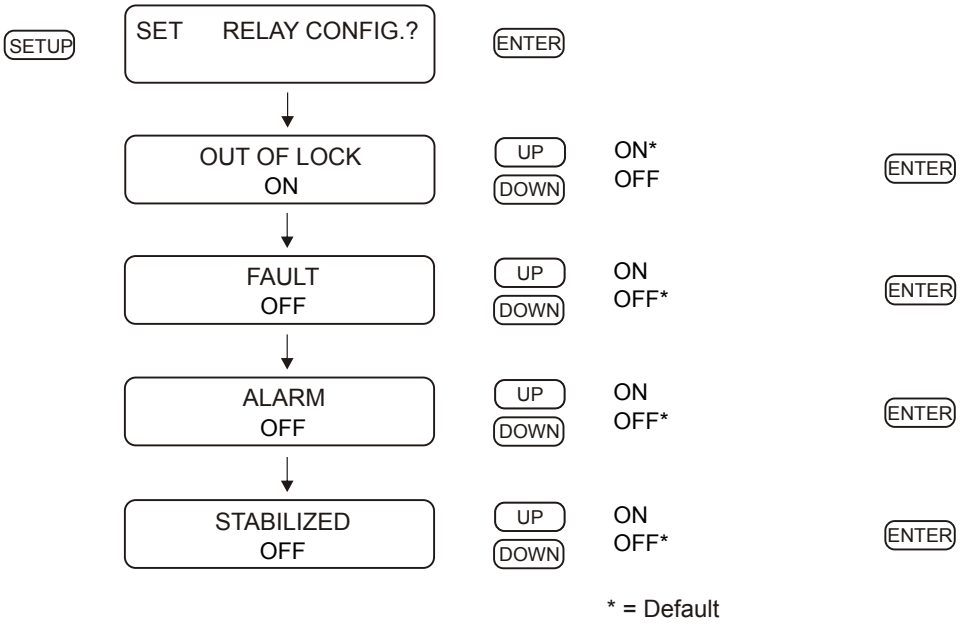


Figure 8.7: Relay Setup

8.6.1 Triggering the Relay with a Programmable Pulse

To work with built-in programmable pulse features, set up the relay jumper (JMP10) as discussed in Section 5.2.4, then set up the programmable pulse mode as discussed in Section 8.9. Configuration settings described in Figure 8.7 do not apply to the relay when the relay jumper (JMP10) is set for Programmable Pulse. However, the front-panel annunciator LEDs and other indications still apply to out-of-lock condition, faults, and alarms when the relay jumper is set for programmable pulse.

WARNING: The relay has a limited lifetime depending on the voltage and current applied to the relay contacts. Be sure to check the relay specifications in Table 12.1 before triggering the relay with a programmable pulse.

[1]One notable condition might occur with someone spoofing GNSS signals.

8.7 Setting the Back Light

Use the "SET BACK LIGHT?" menu to configure how the back light operates. Settings are either BACK LIGHT OFF, BACK LIGHT ON, or BACK LIGHT AUTO. In the Auto setting, the back light will operate for approximately 30 seconds before switching off. Press any key to restart the backlight operation, otherwise you can set the backlight to ON to extend the viewing time.

For RS-232 command, see Section 11.2.7.

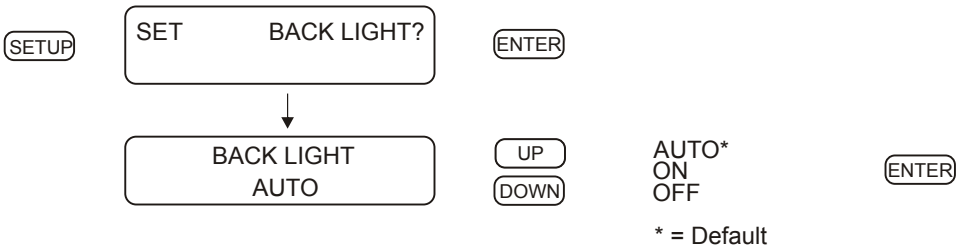


Figure 8.8: Back Light Setup

8.8 Setting System Delays

Use the "SET SYSTEM DELAYS?" menu to compensate for the delay in time of the GNSS signal received at the antenna to reach the receiver. The time delay is entered in nanoseconds (10^{-9} seconds) and includes the antenna group delay and the antenna cable delay. Antenna cable delay is a product of the length of the cable and the its velocity factor. Without compensating for these delays, the time would be slow by this amount. To determine or calculate the cable delay for a specific cable type and length see Section 4.4.1. Cable delay is approximately 60 ns for a standard 50 ft length. Antenna group delay is constant at proximately 40 ns. Consult the antenna data sheet for the individual group delay specification.

For RS-232 command, see Section 11.2.12.

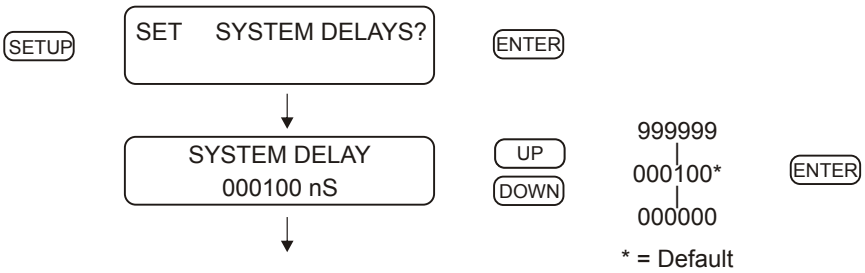


Figure 8.9: System Delay Setup

8.9 Setting Programmable Pulse Mode

Use the "SET PROG. PULSE?" menu to set up one of the many pulse modes, in which you can broadcast over one of the standard outputs (Port1, Port2, or Port3) at a predetermined interval or rate. Also, there is a "PULSE PER DAY" mode and a "SINGLE TRIGGER" (or pulse per year) mode. Programming includes adjusting the pulse width from a minimum of 10 milliseconds to 600 seconds, depending on your application. It also allows you to configure the pulse to occur at either UTC or Local time where applicable.

Programmable pulses may also be configured to trigger the internal relay. Remember to consult with the relay specifications before using this mode as the relay has a limited lifetime. See Section 12.3.4 for relay specifications.

8.9.1 Entering Numerical Values

When installing numerical values first use the UP/DOWN keys to change the digits and then SETUP and ENTER to move the cursor left or right. Use the UP/DOWN keys for each digit and ENTER as required. To complete the installation after you have configured the numerical value, keep pressing the ENTER key to move the cursor to the right and exit the menu.

NOTE: Single Trigger transitions from low to high, or high to low, and remains in that condition until reset. Therefore, in single-trigger mode pulse width does not apply.

For RS-232 command, see Section 11.2.11.

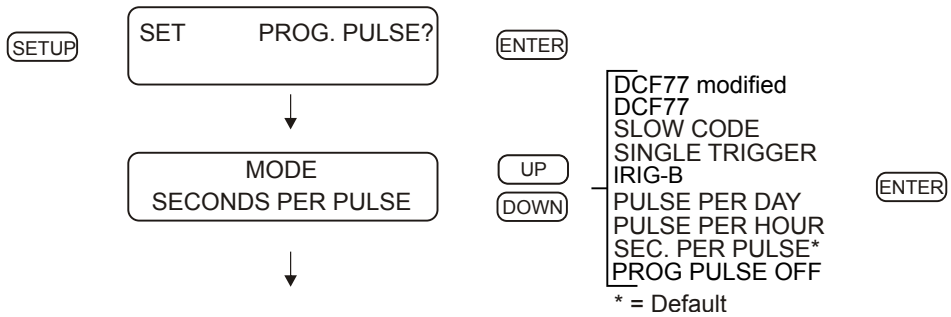


Figure 8.10: Programmable Pulse Setup

Auxiliary IRIG-B

One special mode that can be used in the programmable pulse feature is a separate instance of unmodulated IRIG-B. If IRIG-B mode is selected, programmable pulses are disabled. Therefore, if a separate instance of IRIG-B is required, make sure that the programmable pulse feature is not needed. To use this separate instance of IRIG-B, make sure any of the ports used for this mode have the respective jumper set to Prog Pulse. After setting the jumper(s), complete the setup in the Utility, or as described in Section 8.9.5.

8.9.2 Programmable Pulse: Seconds-Per-Pulse Mode

Use the "SEC. PER PULSE?" mode to generate a pulse every X number of seconds, from 1 to 60,000 seconds (16+ hours), and a Pulse Width of from 10 milliseconds to 600 seconds. Pulse Polarity marked (+) starts at a logic low and transitions high. Pulse Polarity marked (–) starts at a logic high and transitions low. Refer to Section 8.9 above for additional detail on the Programmable Pulse settings.

For RS-232 commands, see Section 11.2.11.

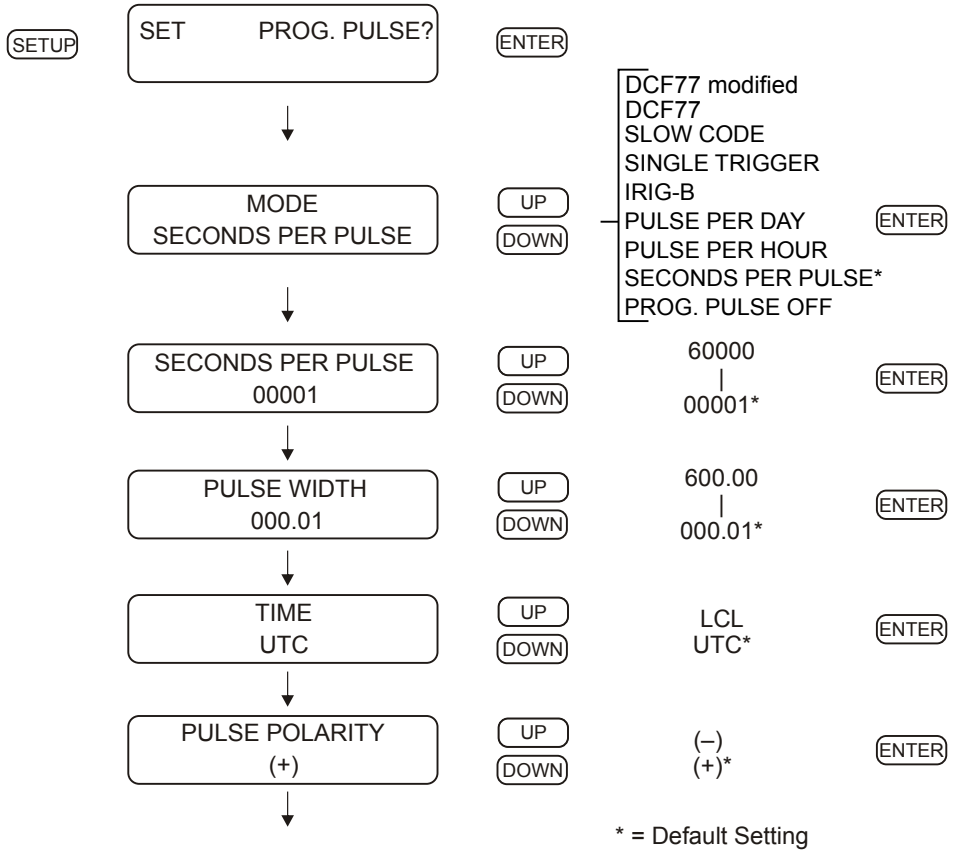


Figure 8.11: Seconds-Per-Pulse Setup

8.9.3 Programmable Pulse: Pulse-Per-Hour Mode

Use the "PULSE PER HOUR?" mode to generate a pulse every hour, at the number of specified seconds (from 0 to 3599 seconds) after the hour. Configure as illustrated in Figure 8.12. Refer to Section 8.9 above for additional detail on the programmable pulse modes, and entering numerical values.

For RS-232 commands, see Section 11.2.11.

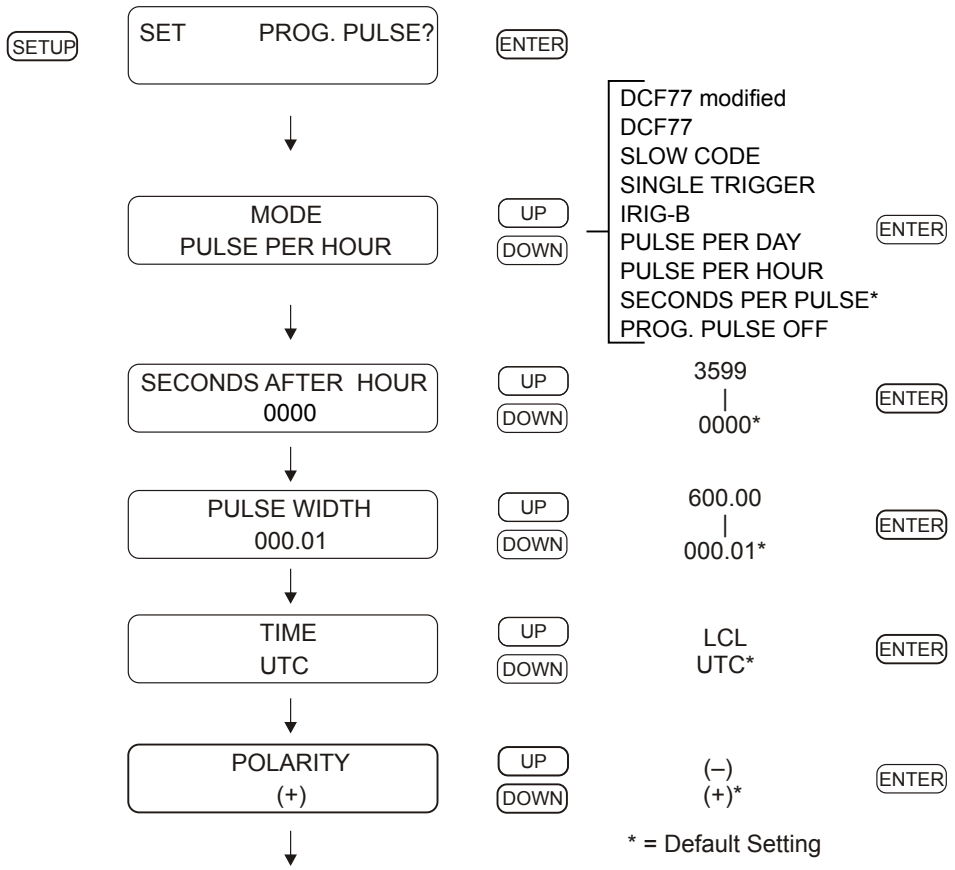


Figure 8.12: Pulse-Per-Hour Setup

8.9.4 Programmable Pulse: Pulse-Per-Day Mode

Use the "PULSE PER DAY?" mode to generate a pulse every day, at the specified hour, minute, second and fractional seconds. Configure as illustrated in Figure 8.13. Refer to Section 8.9 above for additional detail on the Programmable Pulse mode, and entering numerical values.

Setting values are Hours, Minutes, Seconds, Fractional Seconds, Programmable Pulse Width and Time Zone (Local or UTC).

For RS-232 commands, see Section 11.2.11.

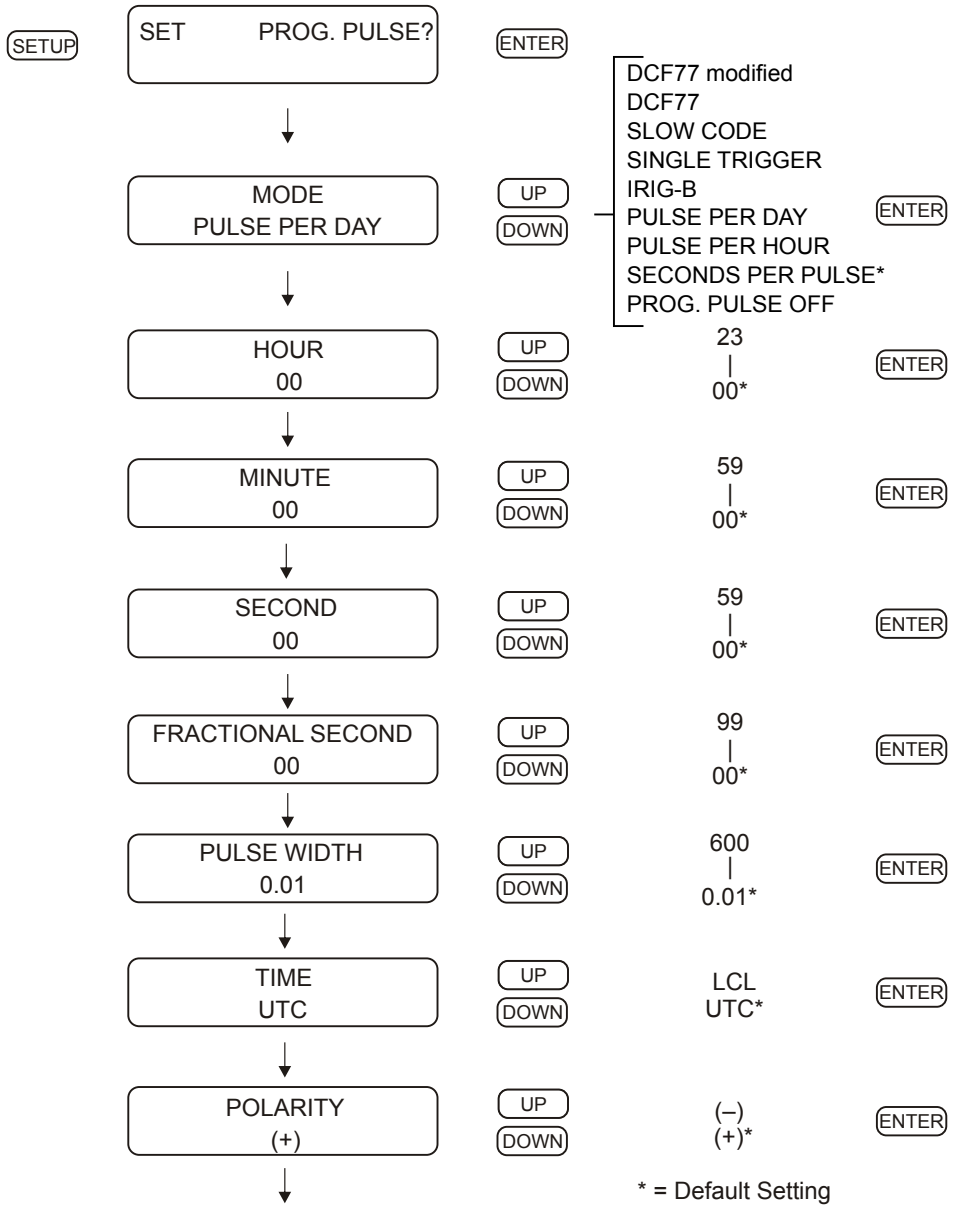


Figure 8.13: Pulse-Per-Day Setup

8.9.5 Auxiliary IRIG-B

Use the "SET PROG. PULSE?" menu to setup a second instance of IRIG-B that may have another time zone and IEEE C37.118.1 setting than the "SET IRIG TIME DATA" menu. When you use this mode, regular programmable pulse features are disabled. Refer to Figure 8.14 when setting up this auxiliary IRIG-B mode.

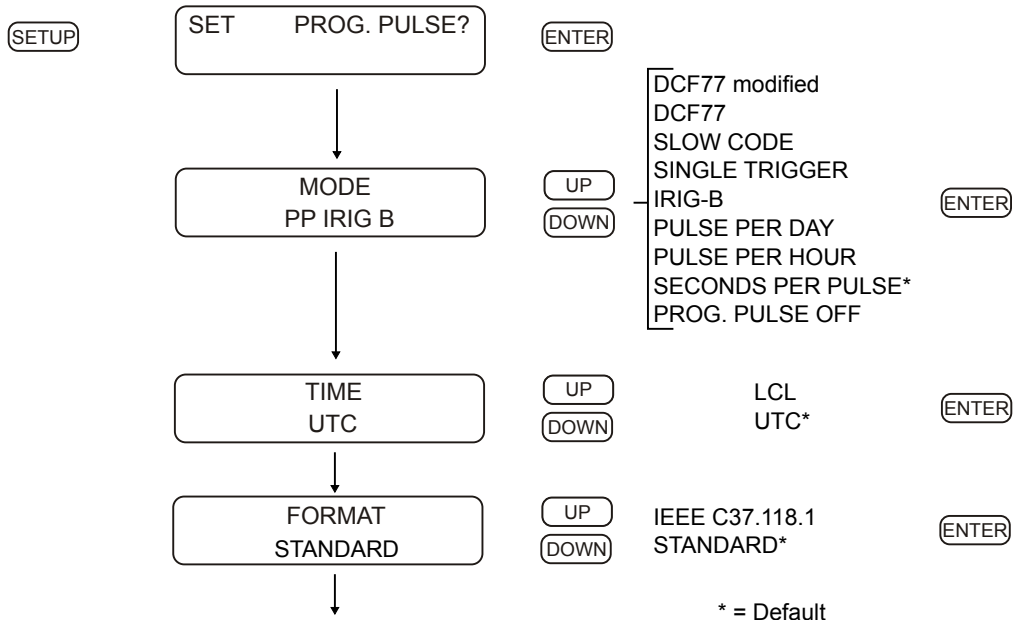


Figure 8.14: Seconds–Per–Pulse Setup

8.9.6 Programmable Pulse: Single Trigger

Use the "SINGLE TRIGGER?" mode to generate a transition once per year at the specified Julian Day, hour, minute, second and fractional seconds. For reference, many calendars indicate the Julian Day. A single trigger will transition from 0 Vdc to 5 Vdc when the Pulse Polarity is set to positive, or from 5 Vdc to 0 Vdc if the Pulse Polarity is set to negative. Output returns only after resetting the single trigger. Refer to Section 8.9 above for additional detail on the Programmable Pulse mode, and entering numerical values.

For RS-232 commands, see Section 11.2.11.

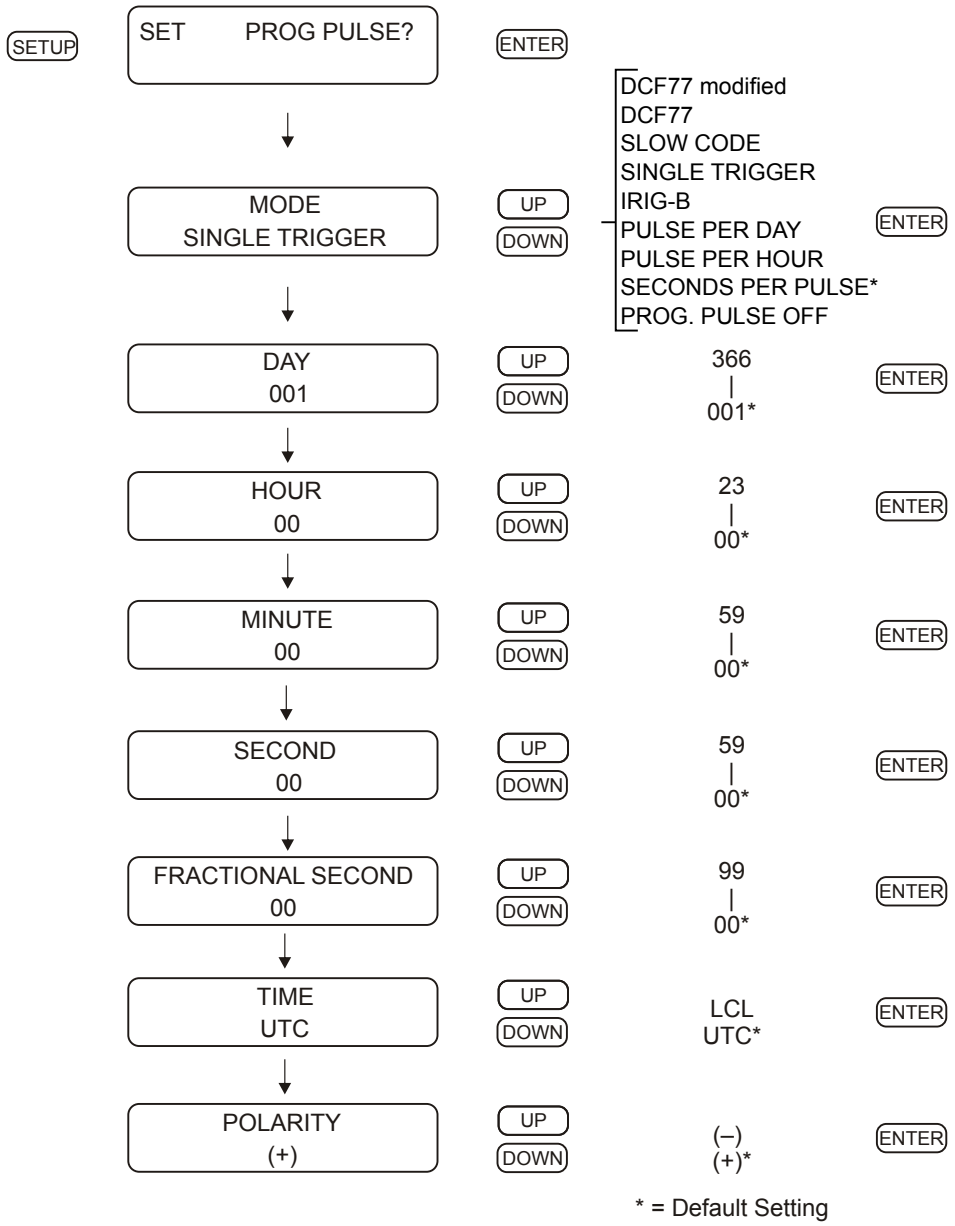


Figure 8.15: Single Trigger Setup

8.9.7 Programmable Pulse: Slow Code

Use the "SLOW CODE UTC?", or "SLOW CODE LCL?" mode to cause the output voltage to be held high and go low for six seconds on the day, four seconds on the hour and two seconds on the minute. Be sure to check for Local or UTC format, otherwise the time could be off by as much as the local offset plus Daylight Saving Time, if used.

For RS-232 commands, see Section 11.2.11.

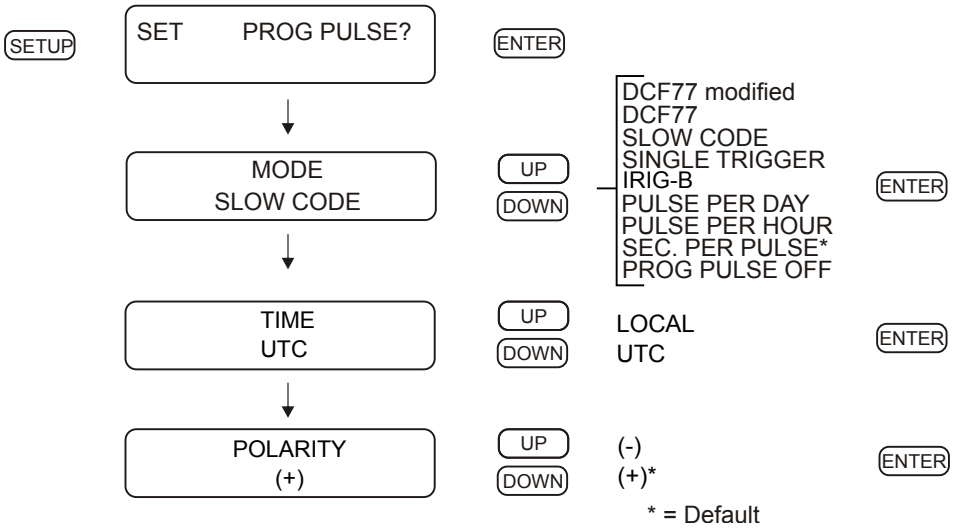


Figure 8.16: Slow Code Setup

8.9.8 Programmable Pulse: DCF77

The clock can provide the DCF77 time signal as an output by choosing it from the front panel within the PROG PULSE selections, or through the utility software. The DCF77 time signal occurs once per minute and provides the year, month, day of week, calendar day, hour and minute, and various markers. See Section 9.3.8 for additional details.

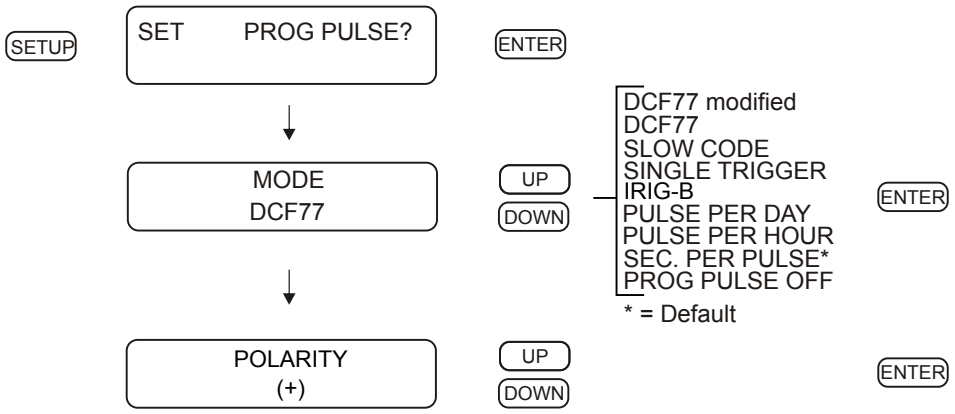


Figure 8.17: DCF77 Setup

8.10 Setting IRIG Time Data

Use the "SET IRIG TIME DATA?" menu to adjust the time zone from UTC to Local, and to turn the IEEE C37.118.1 extension ON or OFF for outgoing IRIG-B time code. Turning the IEEE C37.118.1 control bits ON includes some additional information (see Section 9.3.3) contained in the IRIG-B time code.

For RS-232 commands, see Section 11.2.8.

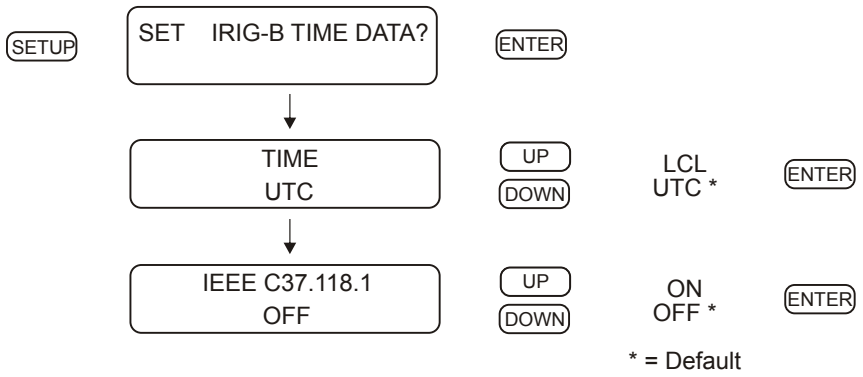


Figure 8.18: IRIG-B Time Data Setup

8.11 Setting the Event or Deviation Modes

Use the "SET EVENT/DEVIATION?" menu to set up either the event capture or the 1 PPS deviation mode. See Section 5.2.6 for information on setting a jumper for event/deviation port selection. Use this menu to configure for either event timing (up to 50 stored events) or one pulse-per-second (1 PPS) deviation, including sigma (see Section 10.2.3 for details on the principle of deviation measurement).

For RS-232 commands, see Section 11.2.3.

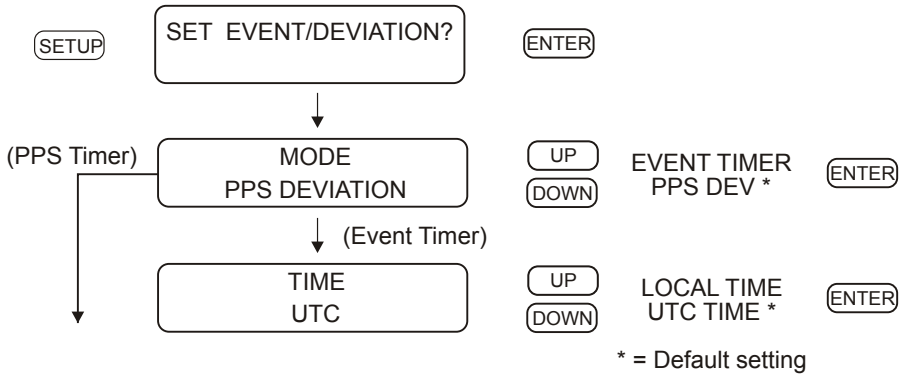


Figure 8.19: Event/Deviation Mode Setup

8.12 Setting Option Control

Use the "SET OPTION CONTROL?" menu to configure any auxiliary board option if mounted in the clock. Some of these options require you to configure additional settings. For information on configuring specific options see the Option List located in Appendix B.

For RS-232 command, see Section 11.2.14.

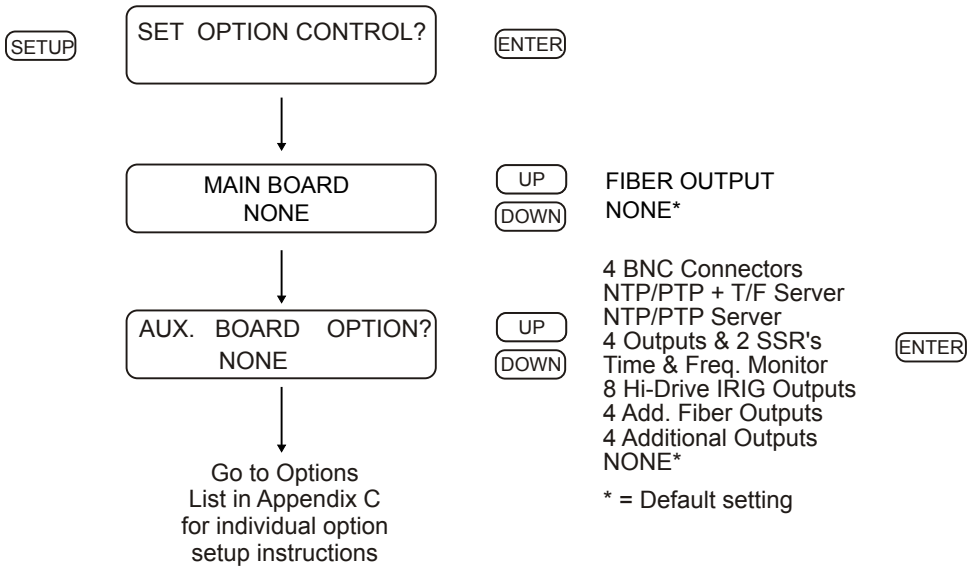


Figure 8.20: Option Control Setup

8.13 Model 1201C LED Display Date Format

Use the "SET C DISP. FORMAT?" menu if you have a Model 1201C to configure how the large LED display presents the date. It can be set to either MM/DD/YY or DD.MM.YY.

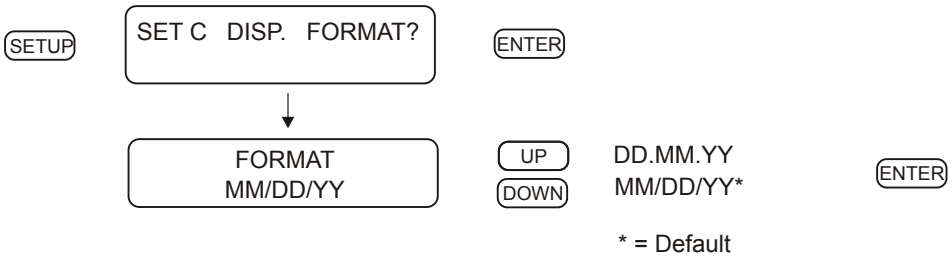


Figure 8.21: Option Control Setup

Chapter 9

Timing, IRIG-B and Pulses

9.1 Introduction

This section covers some basic information about timing signals and how to connect them to your IEDs. Common questions concerning connecting timing signals include:

- What are the types of IRIG-B used in the clock?
- How should multiple devices be connected to one timing output?
- How far can timing signals be transmitted?
- What kind of cabling and connectors should be used?

The steps involved in synchronizing devices to the GNSS are fairly simple and should not take long to complete. To expedite the process, make sure to:

1. Determine the type of timing signal for each device receiving it.
2. Enable the equipment to receive the timing signal, if required.

Various methods are used to configure equipment to receive IRIG-B time codes including setting a physical jumper, or using a setup application in the instrument. Some equipment can auto detect the timing signal, so that nothing else is required, other than connecting the cable.

9.2 Timing Output Description

The rear panels of the Model 1200B, Model 1201B, and Model 1201C are identical, and you will see a number of different types of connectors as illustrated in Figure 9.1. There are three standard timing output connectors, labeled I/O PORTS (1, 2, and 3), where you can connect cables for timing. Additionally, there is an option space that may be occupied by one of several accessory boards that could increase the functionality or number of available timing outputs.

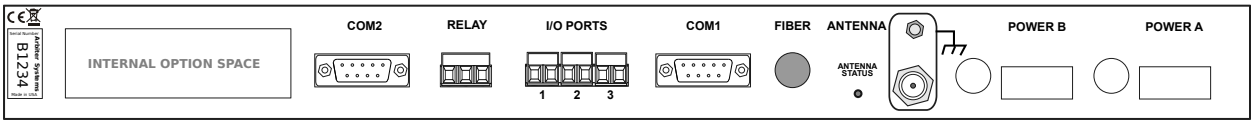


Figure 9.1: Rear Panel Descriptions, optional outputs may be shown

9.2.1 Inputs and Outputs: Port 1, Port 2, Port 3

Three, Phoenix-style, terminal connectors supply timing signals to external equipment and may also be configured for an event input. All three standard ports can source unmodulated IRIG-B, 1 PPS (pulse per second), and Programmable Pulse. Port 2 may also source modulated IRIG-B.

9.2.2 Digital Drivers

Each of the digital outputs is driven by a CMOS 74HCxxx quad driver capable of supplying 75 mA at 5 Vdc. Each I/O port may distribute timing signals to a number of devices depending on the total load current drawn by all of the connected devices. To determine the number of devices you can supply from each output, calculate the load current required by each connected device. For example, if the IED timing signal input (e.g. IRIG-B003) requires 10 mA, one digital output should be able to support up to eight identical devices.

9.2.3 Analog Driver

Modulated IRIG-B is available at Port 2 and uses an analog driver exclusively for this purpose. Using an AD8531 amplifier, the analog driver supplies 4.5 volts peak-to-peak (Vpp) to a 20 Ω source resistor, then to the output connector. The modulated IRIG-B output should provide a minimum of 3 Vpp with a connected load of 50 Ω.

As the load current increases (by adding external loads), more voltage is dropped across the clock source resistor causing the drive voltage to decrease. To assure detection by your equipment, make sure to match the modulated output to within the required voltage range of the receiving equipment. Table 9.1 shows how the actual drive voltage varies with increasing load current. Matching the analog output to your devices should be easy, however in some cases it may be necessary to match the available drive voltage to the IED through use of a dropping resistor.

Drive Current, mA	Actual Drive Voltage, Vpp
0	4.5
1	4.48
10	4.3
100	2.5

Table 9.1: Drive Current vs. Voltage

9.3 Output Signal Description

Both clock models can provide three different digital signals and one analog signal. Digital signals consist of unmodulated IRIG-B, 1 PPS and Programmable Pulse. Analog consists of modulated IRIG-B. 1 PPS is often used to synchronize another (unsynchronized) timing signal. Programmable pulse modes are similar to 1 PPS only they have an adjustable period and pulse width with an on-time rising edge. Programmable pulse modes include, seconds per pulse, pulse per hour, pulse per day, single trigger (once per year), slow code with configurable pulse polarity.

9.3.1 IRIG-B Description

IRIG-B is a complete serial time code that occurs once per second and, depending on the configuration, contains the day of year, hours, minutes, seconds, year and other important information. The clock transmits (IRIG) Format B with four variations as seen in Table 9.2.

Designation	**Signal Type**	**Code Components**
B000	Pulse width code, No carrier	BCD_{TOY}, CF, SBS
B003	Pulse width code, No carrier	BCD_{TOY}, SBS
B004	Sine wave, amplitude modulated, 1 kHz	BCD_{TOY}, BCD_{YEAR}, CF, SBS
B120	Sine wave, amplitude modulated, 1 kHz	BCD_{TOY}, CF, SBS
B123	Sine wave, amplitude modulated, 1 kHz	BCD_{TOY}, SBS
B124	Sine wave, amplitude modulated, 1 kHz	BCD_{TOY}, BCD_{YEAR}, CF, SBS

Table 9.2: IRIG-B Time Code Types Available

The IRIG-B time code consists of 100 bits produced every second, 74 bits of which contain various time, date, time changes and time quality information of the time signal. Consisting of logic ones, zeros and reference bits, the time code provides a reliable method of transmitting time to synchronize a variety equipment.

Three functional groups of bits in the IRIG-B time code are arranged in the following order: Binary Coded Decimal (BCD), Control Function (CF) and Straight Binary Seconds (SBS). The BCD group, with IEEE C37.118.1 OFF, contains only time information including the seconds, minutes, hours and days, recycling yearly. With IEEE C37.118.1 ON, BCD adds year information. The CF group contains other information including time quality, leap year, pending leap seconds and parity. Reference bits separate the various components of the IRIG-B time code.

9.3.2 Modulated and Unmodulated IRIG-B

Figure 9.2 illustrates the primary differences between modulated and unmodulated IRIG-B. You will notice that the while modulated IRIG-B is distinctive because of the 1 kHz sine wave carrier, it is similar to unmodulated IRIG-B since the peak-to-peak values of the carrier follow the same form as the peaks of the digital waveform, which contain the information. Note that the first reference bit of both modulated and unmodulated IRIG-B is in sync with the rising edge of a 1 PPS signal.

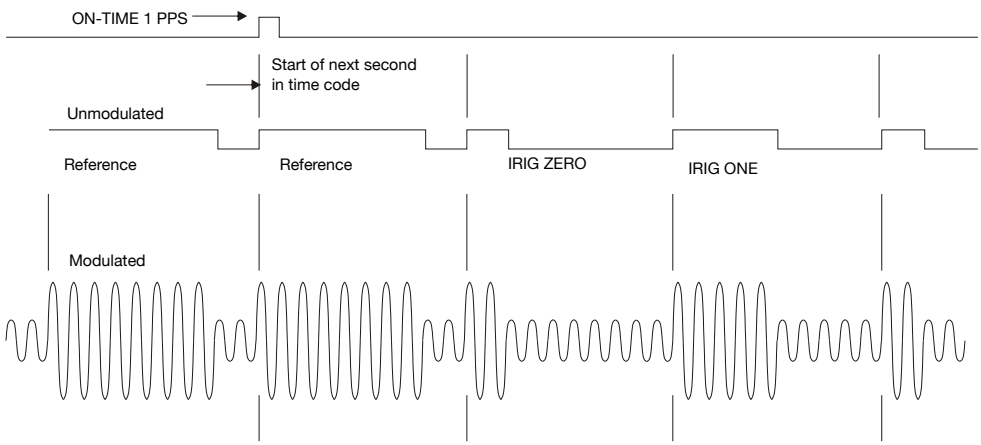


Figure 9.2: IRIG-B Waveforms

9.3.3 IRIG-B IEEE C37.118.1

As mentioned above, turning IEEE C37.118.1 ON in the clock enables extra bits of the Control Function (CF) portion of the IRIG-B time code. Within this portion of the time code, bits are designated for additional features, including:

- Calendar Year (old method, now called BCD_{YEAR})
- Leap seconds, and leap seconds pending
- Daylight Saving Time (DST), and DST pending
- Local time offset
- Continuous Time quality (new with C37.118.1)
- Parity
- Position identifiers

To be able to use these extra bits of information, protective relays, RTU's and other equipment receiving the time code must be able to decode them. Consult your equipment manual to determine if the IEEE C37.118.1 feature should be turned ON in the clock. To view details of the IEEE Std C37.118.1, please check with the IEEE.

9.3.4 1 Pulse-Per-Second (1 PPS)

A one pulse-per-second timing signal is very simple in concept. It is a digital bit transmitted every second with a 10 millisecond pulse width. A critical part of this signal is that it is "on time" at the rising edge when compared with the signal from the Global Navigation Satellite System (GNSS). When configured from any of the TTL/CMOS (5 V) drivers, it has the same drive power as the IRIG-B and the programmable pulse. See Figure 9.2 for a comparison between unmodulated IRIG-B and 1 PPS.

9.3.5 Programmable Pulse (PROG PULSE)

The clock has a programmable pulse feature that may require some jumper and firmware configuration. There are a number of available programmable pulse modes from which to choose – see list below – that include setting the pulse width and time zone. For jumper configuration, please see Section 5.2.4. For available modes and firmware configuration, see Section 8.9.

- Seconds per pulse – set X number of seconds between pulses, 0 – 60,000
- Pulse per hour – set number of seconds after each hour, 0 – 3599
- Pulse per day – set hour, minute, second, fractional seconds
- IRIG-B – set independent instance of unmodulated IRIG-B
- Single trigger – set day, hour, minute, second, fractional seconds
- Slow code – sets 2 seconds on the minute, 4 seconds on the hour, 6 seconds on the day
- Pulse polarity – set positive or negative-going pulse

9.3.6 Programmable Pulse with Open Drain, Setup

For high-level switching on the main board, choose Open Drain from jumper settings described in Section 5.2. Clocks can provide high-level switching at either Port 1 or or Port 3. Connect a voltage of up to 200 volts and pull down a signal with the open drain 200 V FET. Make sure to connect the FET with suitable protection against overvoltage transients and over current conditions. To set timing output jumpers for programmable pulse with 200 V FET, see Table 5.1, or 5.4. Next, you will need to configure the type of programmable pulse mode and timing through the utility software 7.13, setup menus 8.9, or serial port 11.2.11.

9.3.7 Protecting the 200 V FET Connection

Open-drain outputs are not internally protected against over-current or overvoltage. Maximum peak ratings are 100 mA and 200 V. External protections (current-limiting resistors, surge suppression diodes, snubbers, etc.) must be provided by the user, if required, to ensure that maximum ratings are not exceeded even momentarily. Also, consult the data sheet of the TN0104 vertical DMOS FET used in these models.

9.3.8 DCF77 Time Signal

The clock can provide the DCF77 time signal as an output by choosing it from the front panel within the PROG PULSE selections, or through the PROG PULSE selections in the utility software. The DCF77 time signal occurs once per minute and provides the year, month, day of week, calendar day, hour and minute, and various markers. DCF77 is a German long wave time signal and standard-frequency radio station. The clock can produce a DCF77 output timing at 5 V_{TTL} (CMOS) based on the radio signal protocol but synchronized to the GNSS. *Figure 9.3 shows the standard format with the missing 59th bit, whereas DCF77 Modified has the 59th bit set to 0.5 s.* See Section 8.9.8 for setting up the DCF77 timecode as an output.

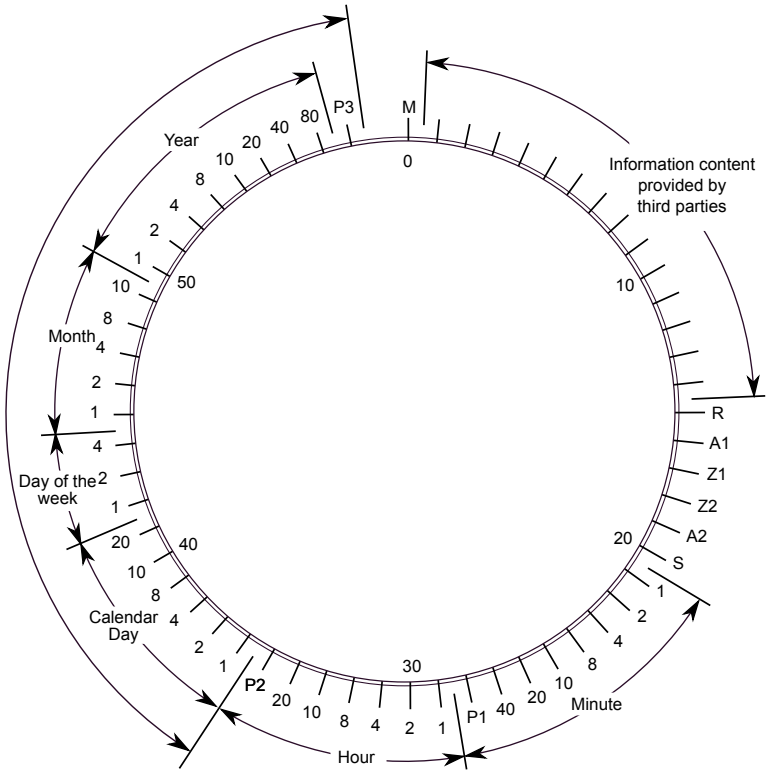


Figure 9.3: DCF77 Timing Diagram – see Marker Details

DCF77 Marker Details

M	minute marker (second marker No. 0): 0.1 s
R	second marker No. 15 indicates service request to the DCF77 signal generation system
A1	announcement of a forthcoming change from CET to CEST or vice versa
Z1, Z2	time zone indication: CET: Z1, 0.1 s, Z2 0.2 s; CEST: Z1 0.2 s, Z2 0.1 s
A2	announcement of a leap second, 0.2 s
P12, P2, P3	parity check bits

CET is Central European Time and CEST is Central European Summer Time. CET is UTC + 1:00, and CEST is UTC + 2:00.

9.4 Connecting the Outputs

The clock comes equipped with Phoenix-style, screw terminal connectors, which are compatible with twisted pair cabling. To attach, strip the wires bare, DO NOT tin with solder, insert into the correct screw terminal positions and tighten clockwise. Use a BNC breakout to adapt coaxial cabling to the clock terminal connectors.

NOTE: If using a shielded, twisted-pair cable (like Belden 8760), connect the cable shield at only one point and if possible at the clock. It has become best industry practice to ground time-code outputs from clocks, and use galvanic isolation of time code inputs to IEDs.[1]

[1] William Dickerson, "Time in the Power Industry: How and Why We Use It," www.arbiter.com, Resources, Documentation

9.4.1 Attaching Cables to Screw Terminals

Strip the insulation back to expose about 6 mm (1/4 in) of bare wire. DO NOT tin with solder. Insert the stripped wire into the terminal and tighten the set screws clockwise to secure.

9.4.2 How Far Can I Run IRIG-B Cabling?

Factors to consider for long digital-signal cable runs: (1) resistive losses, (2) electromagnetic interference, (3) propagation delays, and (4) installation and maintenance costs.

When a length of cable is laid from point A to point B there are two parts: one outgoing and one return. For coaxial cable, the resistance is different for the center conductor than for the outer conductor, or shield. For twisted pair wires, both outgoing and return wires will essentially be the same. As a simple example, to connect an IRIG-B signal to a device 100 feet away from the clock, you must account for resistive losses in 200 feet of wire.

Two useful documents for details on distributing IRIG-B signals over long distances and maintaining accuracy: (1) Application Note 101, Distributing Timing Signals in a High EMI Environment. (2) IRIG-B Time Code Accuracy, IED and System Design Issues. Both are available on this web page: *http://www.arbiter.com/resources/documentation.php*

9.4.3 Synchronizing Multiple IED's From One Clock Output

In many installations, master clock signals are distributed from one output to multiple devices. This method makes more efficient use of the clock synchronizing capability since the clock drivers are designed to handle multiple loads. The exact number of possible loads must be determined from the input impedance of each connected IED.

9.4.4 Connecting Unmodulated IRIG-B

To drive multiple loads from one unmodulated IRIG-B output, make sure that the loads are wired in parallel. A common term for this is "Daisy Chaining", however the idea is to drive all of these loads in parallel from a single output. It is simple to connect loads using unmodulated IRIG-B because all of the loads are driven at the same voltage. Connect loads to one output until reaching the driver limit (dependent on specific output).

To determine load current imposed on one Unmodulated IRIG-B output:

1. Determine the impedance or resistance (R_{dev}) of each IED load (check device manuals).
2. Calculate the load current for each device ($I_{dev} = 5V \div R_{dev}$).
3. To get the total current, sum up all the load currents for all devices connected to the output in question. $I_{devT} = I_{dev1} + I_{dev2} + \ldots + I_{devN}$, where T = Total for N devices.

Unmodulated Example

If the input impedance of an IED is 5 kΩ, determine the device current (I) as seen in Calculation 9.1:

$$I = V \div R_{dev} = 5\ Volts \div 5000\ \Omega = 0.001\ A\ (1\ mA) \tag{9.1}$$

Connecting ten of the same IED's to the same output makes the total current draw: 10 × 0.001 A = 0.01 A (10 mA).

Another method is to determine the lumped impedance of all of the connected IED's in parallel. Then, determine the overall current by dividing the drive voltage (5 V) by the combined parallel impedance of all devices. This current should not exceed 75 mA.

9.4.5 Connecting Modulated IRIG-B

While the modulated driver supplies approximately 4.5 volts peak-to-peak (Vpp) open circuit, it can supply 3 Vpp into 50 Ω. This amounts to about 0.06 A (60 mA) drive current.

Make sure to check the acceptable voltage range for the equipment. Some modulated IRIG-B decoders are fairly sensitive to peak-to-peak voltage levels (3.3 Vpp ± 0.5 Vpp), others are more tolerant (0.1 Vpp to 10 Vpp). With added loads, the clock's modulated driver produces more current, which reduces the voltage at the clock output terminals. Calculation 9.2 shows how to calculate the available output voltage with different drive currents.

$$Vpp = 4.5\ \ Vpp - I \times 20\ \ \Omega \tag{9.2}$$

Therefore, if you had 10 mA of load current (I load) the available voltage (Vpp) would be 4.3 Vpp. If the load current equals 100 mA, then the available voltage would be 2.5 Vpp. Therefore, with an increasing load current (i.e with increased number of loads) there is a reduction in available drive voltage at the clock output. See also Table 9.1.

9.4.6 Wire Losses

Another factor affecting the available voltage is the resistive losses through the cabling. Wire has a certain resistivity associated with it that is determined by its metallic composition, and resistance determined by the diameter and length. For example, single-strand, 22 AWG – bare, enamel-coated – copper wire has a resistance of approximately 19.6 Ω per 1000 feet. To compute the loss we must include both wires in the connection, signal and return. For coaxial cabling, the resistance of the center conductor is rated differently than the shield. For a twisted pair, both of them should essentially have the same resistance per cut length. Using 500 feet of 22 AWG shielded twisted pair wire, and including the source resistor, the available voltage would be as calculated in 9.3:

$$Vpp\ \ available = 4.5 - I \times 20\ \ (R_{source}) - I \times 19.6\ \ (R_{wire}) = 0.54\ \ Vpp \tag{9.3}$$

In this case, 88 % of the drive voltage is lost to the device with 100 mA of current and 500 feet of 22 AWG twisted pair transmission line; this includes the voltage losses at the source resistor. With some decoders, 0.54 Vpp may not be detected. *To assure reliable detection, make your cable runs as short as possible, use a larger diameter wire and carefully distribute the loads.*

9.4.7 Voltage Matching for Modulated IRIG-B

With modulated IRIG-B, it was mentioned that certain decoders are very intolerant of drive voltage variation. If the IED specification says that the acceptable voltage range is 3.3 Vpp ± 0.5 volt, and the available voltage is high, then you must reduce the voltage using a dropping resistor (R_{drop}). The value of the dropping resistor is determined by dividing the difference voltage (V_{diff}) by the device current (I_{dev}). For example, suppose that the available voltage is 4.3 Vpp, the (nominal) acceptable voltage is 3.3 Vpp, and the device current is 10 mA. Determine the dropping resistor value.

$$R_{drop} = V_{diff} \div I_{dev} = (4.3 - 3.3) \div 0.01 = 100.4\ \ \Omega \tag{9.4}$$

The Power dissipation (P) is:

$$P = I^2 R = 0.01^2 \times 100.4 = 0.01\ \ W \tag{9.5}$$

In this example, an 1/8 W resistor should work fine.

For a voltage that is too low, then the modulated IRIG-B signal level must be increased by some other means, such as (1) distributing the load differently to reduce the current (raising the available voltage), (2) by reducing the loss through the wiring, or (3) by using an amplifier.

9.4.8 Cable Delays

Electromagnetic waves travel at the speed of light (C) in free space or vacuum and a fraction of that speed through cabling. The speed of an electromagnetic wave in free space is given by Constant 9.6.

$$C \approx 9.84 \times 10^8 \;\; ft/s \tag{9.6}$$

Since electromagnetic waves travel slower through any cable, cable manufacturers normally specify cable with a velocity factor (VF), which is a percentage of the speed of light in free space, and characteristic of the specific cable. The Velocity Factor for the RG-6 cabling used by Arbiter Systems for GNSS antenna connections, is about 83 % of C. Most transmission lines have velocity factors in the range of 65 % to 97%. Using these values you can determine the actual time delay in your cable distribution system and compare it to your required accuracy. As an example, 840 feet of RG-6 cable (with a velocity factor of 83 %) would delay the timing signal by one microsecond. For IRIG-B timing applications, these delays may not be important, compared to other criteria. Otherwise, you would be forced to compensate for the time delay using another method, such as advancing the timing output or placing another master clock at the remote site.

9.4.9 Solutions

There are many solutions to providing an accurate timing signal to equipment in distant locations. However, the most satisfying solution may not be to string cabling for hundreds of meters. The costs associated with installing and maintaining cabling over a wide area may be unsatisfactory. Since the GNSS is so pervasive, it may prove to be less costly to install another clock at a distant location, which would also improve accuracy and provide redundancy. Before installing cabling over a wide area, be sure to first examine all the possibilities.

Chapter 10

Relay Contacts and Event Inputs

10.1 Relay Contacts

10.1.1 Introduction

One single set of mechanical SPDT relay contacts are available. There are two possible relay choices: Standard Voltage and High DC-Voltage.

10.1.2 Relay Operation

The relay may be configured for programmable pulse[1] or one of these clock conditions: (1) out-of-lock, (2) fault, (3) alarm[2], (4) stabilized, and (5) failsafe, indicating loss of inlet power. Figure 3.5 illustrates the rear panel connection. A fault condition connects the normally closed contact (NC) to the common contact (COM). The normally open contact (NO) operates in a manner opposite to the NC contact.

10.1.3 Standard Voltage Relay Ratings

Specification	Value
Arrangement	1 set of Form C (SPDT) contacts
Contact resistance	100 mΩ
Operate, release time	Approx. 6 ms, 3 ms
Rated voltage	250 Vac (30 Vdc)
Rated switching current (resistive)	8 A at 250 Vac, 5 A at 30 Vdc
Max switching capacity	2,000 VA, 150 W
Expected life	50,000 electrical cycles (100,000 typical)
Min. permissible load	10 mA, 5 Vdc

Table 10.1: Specifications

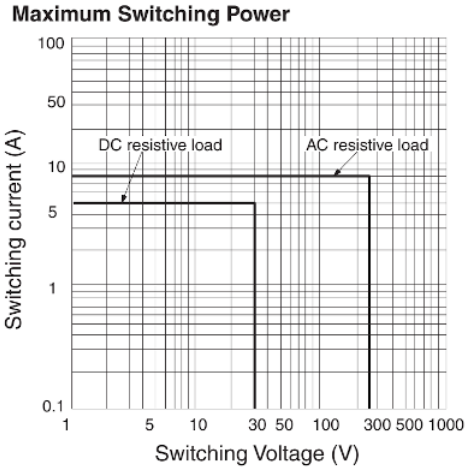


Figure 10.1: Switching Power

[1] Consider the pulse frequency and the relay's life expectancy.
[2] See page 24 for definitions on faults and alarms.

10.1.4 High DC-Voltage Relay Ratings

Specification	Value
Arrangement	1 set of Form C (SPDT) contacts
Operate, release time	Approx. 10 ms, 5 ms
Rated voltage	250 Vac (300 Vdc)
Max switching voltage	400 Vac (300 Vdc)
Rated switching current (resistive)	8 A at 250 Vac, 8 A at 30 Vdc
Max switching capacity	2,000 VA
Expected life	50,000 electrical cycles (100,000 typical)
Min. permissible load	10 mA, 5 Vdc

Table 10.2: Specifications

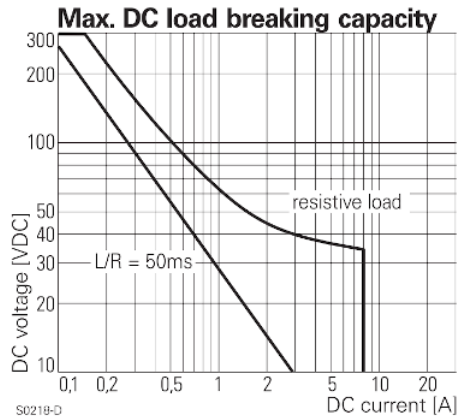


Figure 10.2: Switching Power

10.2 Event and 1 PPS Deviation Recording

10.2.1 Event Timing and Recording

When configured for event timing, the clock can provide one input channel with one hundred nanosecond resolution. This channel is primarily used for synchronization via the RS-232 port with an external computer or other type of device. It may also be used to time an external 5 V CMOS signal applied to one of the I/O connectors; see Section 5.2.7 and 8.11.

Data for individual recorded events can be recalled by pressing the TIMING key, then ENTER at the Event/Deviation menu, or through the Utility software. Data for each event will be retained until it is retrieved using one of these two methods. Thus, if no event data points are retrieved, recording will be suspended when the total number of of events in the buffer is full. As soon as data is retrieved for a recorded event, its address (1 to 25) is made available for data corresponding to a new event.

Because of the method used in the event recording circuit, a minimum of 11 milliseconds must elapse between one event (rising edge) and the next, in order to guarantee that the second event will be recorded. If the second event occurs sooner than 11 milliseconds after the first, the second event may be ignored, but the the time data for the first will still be recorded.

10.2.2 Event Timing Latency

Event data are recorded using a high-speed capture circuit operating with a 32 MHz time base. Latency is limited by the interrupt processing speed of the clock's microcontroller, which in turn depends on its workload at the time the event is received. Since the workload varies from time to time, latency likewise varies. However, response time will, in general, never be less than a few hundred microseconds nor greater than 10 milliseconds.

10.2.3 1 PPS Deviation Measurement

The Channel A input can also be configured to display measured event times as 1 pulse-per-second (1 PPS) deviation measurements. The intended purpose of the deviation measurement function is to allow comparison of an external 1 PPS signal to the clock's internal 1 PPS signal. The clock determines the mean time difference between the two signals, which can be displayed on the front panel or read via the RS-232 Interface.

10.2.4 1 PPS Deviation Measurement Principle

The measurement technique employed for 1 PPS Deviation uses the same time determination and recording scheme used for event time measurement (refer to paragraph above), but makes the assumption that the input signal is periodic and continuous. Also, the operation of the circular memory buffer is modified somewhat, in that recording does not stop after the buffer is full; new Event Data is given priority over existing data, and will overwrite it. Since the incoming signal occurs once per second and the circular buffer holds a number of events, each event time record will be overwritten on a regular basis.

Once every second, the processor looks at the most recent group of 16 events. When computing deviation, it uses only the portion of the event data describing fractional seconds (e.g. values between 0.0000000 and 0.9999999 seconds). By normalizing the 16 fractional second values around 0.0000000, the range of results from the deviation computations will be centered on zero (-0.4999999 to +0.5000000 seconds). Statistical computations are then performed on the 16 values to determine their Mean and Sigma (Standard Deviation) values, which are then displayed on the front panel or output via the Utility software.

10.2.5 Event Timer Input Channel Configuration

In order for the clock to receive an event at one of the input connectors, adjustments to both the hardware and software configuration may be required. The hardware configuration is described in Section 5.2.7 and Section 5.2.6.

10.2.6 Firmware Setup

To display of Event Time Data or 1 PPS Deviation, use . See Figure 8.19 for detail on configuring the Event/Deviation parameters from the front panel. See Section 11.2.3 for details on using the RS-232 interface.

10.2.7 Displaying Data

Event and deviation data can be accessed from either the front panel or via the clock utility software or RS-232 commands. The following paragraphs describe the steps required to access data using the front panel.

1. Press the TIMING key until reaching EVENT/DEVIATION menu, then press ENTER.
2. Press the UP or DOWN keys to scroll through the recorded events.

```
CH A EVENT #nn TZ
ddd:hh:mm:ss.sssssss
```

Where:
nn = event number (01 to 25)
ddd = day of year of the event (1 to 366)
hh = hour of the event (00 to 23)
mm = minute of the event (00 to 59)
ss.sssssss = second and fractional second of the event (e.g. 59.9999999)
TZ = time zone: either UTC or LOCAL

To scroll through any recorded events presently stored in the event-time buffer, press the UP or DOWN key. If the event display mode is exited and then re-entered, the first event data displayed for a given channel will correspond to the same event number as was last displayed for that channel. However, the data itself may be changed if it has been overwritten.

10.2.8 1 PPS Deviation

If the event capture channel is configured for 1 PPS Deviation (via Event/Deviation Setup Menu), the readout will display the deviation of the 1 PPS input signal. In this case, the readout display will have the format:

```
A 1 PPS XXXXX.XX µS
SIGMA: XXXXX.XX µS
```

Where: The top number is the mean (average) value of the most recent 16 records in the event buffer, and represents the mean deviation (in microseconds) of the measured 1 PPS input signal compared to the GNSS 1 PPS signal. A negative number means the applied 1 PPS signal is early, and a positive number means it is late.

The bottom number is the standard deviation (sigma) of the 16 sample values.

If there is no input, the the numerical value is displayed with dashes.

```
A 1 PPS   00.00 µS
SIGMA:    00.00 µS
```

```
A 1 PPS   --.-- µS
SIGMA:    --.-- µS
```

10.2.9 Clearing Records

There are three methods to clear event records: (1) using the utility software, (2) using the front panel keys, and (3) using RS-232 commands. To clear the buffer from the front panel, press the TIMING key four times and ENTER key twice. This will cause the display to issue the following prompt:

```
CLEAR EVENT?
YES = UP     NO = DOWN
```

To clear the event buffer from the utility software, click the Clear button, or go to Device menu and select Clear. To clear events using RS-232 commands, type the CA command and the buffer will immediately be cleared.

Clearing the 1 PPS Deviation Values

Using the Clear feature while in the 1 PPS deviation mode will effectively clear the buffer and start the averaging process over again. Statistical mean and sigma will temporarily go to zero, begin to change more rapidly, then settle down when the 16-value buffer fills after 16 seconds.

Chapter 11

RS-232C Command Set

11.1 Introduction

This chapter provides information on using simple serial commands through either COM1 or COM2 instead of the Utility software. Set security to Level 0 to be able to use all of these commands. Set security to Level 1 if you only want to start or stop broadcasting. Review the security settings using the Utility (Section 7.3) before using the commands in this chapter.

The clock has two RS-232 ports, COM1 and COM2. COM1 also provides RS-422/485, transmit only. When viewing the rear panel, COM1 is nearest the antenna connector and COM2 is located to the left of the Standard I/O connectors. It is important to note that the COM2 does not support RS-485, and both RS-232 ports DO NOT use flow control.

Use the two serial ports interchangeably for separate functions. You may wish to interrogate the clock on one port for basic information (i.e to configure something) and at the same time be able to broadcast a specific time code to a wall display or meter from the second serial port. While most substation IEDs appear to have standardized on the IRIG-B time code, NTP or PTP, some devices are designed to receive ASCII data through the serial port. Another common RS-485 function is to connect a digital wall display to indicate the system time or system frequency.

11.2 Standard Command Set

This section provides information for controlling and communicating with these clocks via the RS-232C serial interface. All of the RS-232 commands are functionally grouped into similar categories. For example, Section 11.2.2 lists all of the commands used to broadcast the date and time in one of the standard formats.

Each command name and syntax is highlighted in bold at the beginning of each definition. Detailed information used to interpret the commands and responses follows each command heading. Sometimes the command is very short, such as the command to return the Local Time: **TL**. Other commands require a prefix or suffix with the letter command to specify them, such as to broadcast: **Bn**, where n = an integer specifying the broadcast. For example, the command to start the ASCII Standard broadcast string at a rate of once per second, on Local time, from the main RS-232 port is **B1**.

When a command requests information from a clock, it returns the most current data available. Numeric data is returned as an ASCII string of numeric characters, with leading sign and embedded decimal point as required. Strings are normally terminated with carriage return and line feed characters, however not always. Characters are automatically received when typed. You do not need to press ENTER (or RETURN) to send a command. Likewise, if including any of these commands in a programming sequence, do not include any carriage-return or line-feed characters.

In each case, the actual command to do something in the clock follows the word "Command:" and is in bold font. Please read the comments below each command as some commands include one or more commas and in other cases a comma will separate multiple commands.

11.2.1 Installing Custom Broadcast Strings

The clock allows the user to construct and install two custom strings: Custom string A from COM 1 and Custom String B from COM 2. For information on constructing, installing and using a custom broadcast string, please see Section 11.3.

11.2.2 Broadcast Mode Commands

Broadcast Mode: INTERROGATE (Broadcast OFF)

Stops the serial broadcast. B0 = COM1. O0 = COM2.

Command: **B0, O0**
Response: <CR><LF>
Where: <CR>= Carriage Return = Hex 0D
<LF> = Line Feed = Hex 0A

Broadcast Mode: ASCII STD

Starts 1/s time-of-day serial broadcast. B1 = COM1. O1 = COM2.

Command: **B1, O1**
Response: <SOH>ddd:hh:mm:ss<CR><LF>
Where: <SOH> = Start Of Header = Hex 01
ddd = Julian day-of-year
hh = hour
mm = minute
ss = second
<CR> = Carriage Return = Hex 0D
<LF> = Line Feed = Hex 0A

Broadcast Mode: VORNE STD

Starts 1/s broadcast of Vorne large format time display data. B2 = COM1, O2 = COM2.

Command: **B2, O2**
Response: 44hhmmss<CR><LF>
55ddd<CR><LF>
11nn<CR><LF>
<BEL>
Where: 44hhmmss = Address 44 UTC/Local Time
55ddd = Address 55 Day of Year
11nn = Address 11 Out-Of-Lock Time
<CR> = Carriage Return = Hex 0D
<LF> = Line Feed = Hex 0A

Data is transmitted ahead of time and the <BEL> character is transmitted on time. The Vorne displays update simultaneously upon receipt of the <BEL> character. Refer to Arbiter Systems Application Note 103 for more information.

The Vorne output changes depending upon installed options. One example: Power System Time, Frequency and Phase Monitor (Appendix B.9)

Broadcast Mode: EVENT DATA

Starts the event data broadcast. Outputs when an event is recorded. B3 = COM1. O3 = COM2.

Command: **B3, O3**

Response: mm/dd/yyyy hh:mm:ss.sssssss nnnAt<CR><LF>

Where:

mm	= month
dd	= day
yyyy	= year
hh	= hour
mm	= minute
ss.sssssss	= second
nnn	= event buffer read index number
A	= event channel letter
t	= U = UTC time, L = Local time
<CR>	= Carriage Return = Hex 0D
<LF>	= Line Feed = Hex 0A

Broadcast Mode: STATUS/FAULT

Starts the status/fault data broadcast. B4 = COM1. O4 = COM2.

Command: **B4, O4**

Response: Data includes: date, time, and system information.

Examples:
0 06/11/2015 22:45:33 Previous Faults:0x0000 Present Faults:0x0100
1 06/11/2015 22:45:33 LOCKED GPS Tracked:07 GLONASS Tracked:05
2 06/11/2015 23:16:59 Previous Faults:0x0100 Present Faults:0x0140
3 06/11/2015 23:17:04 Previous Faults:0x0140 Present Faults:0x0100

Bit	**Wt,** N_{16}	**Status**	**Bit**	**Wt,** N_{16}	**Status**
0	1	Acquiring Time	4	10	Alarm
1	2	Learn Mode	5	20	Stabilized
2	4	Normal Mode	6	40	Demo Mode Active
3	8	Unlocked	7	80	Reserved

Table 11.1: Status Indications and Definitions

Bit	**Wt,** N_{16}	**Fault**	**Bit**	**Wt,** N_{16}	**Fault**
0	1	Communications fault	5	20	Power supply fault
1	2	8 MHz fault	6	40	Antenna fault
2	4	Holdover/GNSS fault	7	80	Overload fault
3	8	WD timer fault	8	100	Boot loader missing
4	10	Brown out fault	9	200	Reserved

Table 11.2: Fault Indications and Definitions

Bit	**Wt,** N_{16}	**Fault**	**Bit**	**Wt,** N_{16}	**Fault**
0	1	HO Failure	4	10	Outer ctl loop unsettled
1	2	HO Suspect	5	20	Outer ctl loop unlocked
2	4	GNSS fail	6	40	HO ctl loop unlocked
3	8	GNSS Suspect	7	80	Reserved

Table 11.3: Holdover Oscillator (HO) Faults and Definitions Model 1201B/C Only

Broadcast Mode: EXT. ASCII

Starts the time-of-day broadcast prefaced with a time quality indicator. B5 = COM1. O5 = COM2.

Command: **B5, O5**

Response: <CR><LF>Q_yy_ddd_hh:mm:ss.000___

Where:
- <CR> = Carriage Return = Hex 0D (Start of bit transmitted on time.)
- <LF> = Line Feed = Hex 0A
- Q = quality indicator (with indicators shown below)
  - space = Hex 20, locked, maximum accuracy
  - ? = Hex 3F, unlocked, accuracy not guaranteed
- yy = year
- ddd = Julian day-of-year
- hh = hour
- mm = minute
- ss.000 = second
- _ = represents the location of an ASCII space (20h), used for clarity only

Broadcast Mode: ASCII + QUAL

Starts the time-of-day broadcast appended with a time quality indicator. B6 = COM1. O6 = COM2.

Command: **B6, O6**

Response: <SOH>ddd:hh:mm:ssQ<CR><LF>

Where:
- <SOH> = Hex 01 (Start of bit transmitted on time.)
- ddd = Julian day-of-year
- hh = hour
- mm = minute
- ss = second
- Q = quality indicator (with indicators shown below)
  - space = Hex 20, locked, maximum accuracy
  - . = Hex 2E, Error < 1 µs
  - * = Hex 2A, Error < 10 µs
  - # = Hex 23, Error < 100 µs
  - ? = Hex 3F, Error > 100 µs
- <CR> = Carriage Return = Hex 0D
- <LF> = Line Feed = Hex 0A

Broadcast Mode: YEAR + ASCII

Starts the time-of-day broadcast prefaced by year and appended with a time quality indicator. B8 = COM1. O8 = COM2.

Command: **B8, O8**

Response: <SOH>yyyy_ddd:hh:mm:ssQ<CR><LF>

Where:
- <SOH> = Hex 01 (Start of bit transmitted on time.)
- yyyy = year
- ddd = Julian day-of-year
- hh = hour
- mm = minute
- ss = second
- Q = quality indicator (with indicators shown below)
  - space = Hex 20, locked, maximum accuracy
  - . = Hex 2E, Error < 1 µs
  - * = Hex 2A, Error < 10 µs
  - # = Hex 23, Error < 100 µs
  - ? = Hex 3F, Error > 100 µs
- <CR> = Carriage Return = Hex 0D
- <LF> = Line Feed = Hex 0A

Broadcast Mode: NMEA183GLL

Starts the National Marine Electronics Association Standard (NMEA-0183) Geographic Position, Latitude / Longitude, and time (GLL) broadcast from the COM port that received the request.

Command: **0,nB**
Format: n = update rate in seconds, 1 to 9999
Response: $–GLL,llll.llll,a,yyyyy.yyyy,a,hhmmss.sss,A*cs<CR><LF>
Where:

GLL	= Geographic Position, Latitude / Longitude, and time
llll.llll	= Latitude of position
a	= N or S
yyyyy.yyyy	= Longitude of position
a	= E or W
hhmmss.sss	= time of position fix in UTC
A	= data state: “A” is Active, “V” is Void
*cs	= checksum
<CR>	= Carriage Return = Hex 0D
<LF>	= Line Feed = Hex 0A

Broadcast Mode: NMEA183ZDA

Starts the National Marine Electronics Association Standard (NMEA-0183) UTC day, month, year, and local time zone offset (ZDA) broadcast from the COM port that received the request.

Command: **1,nB**
Format: n = update rate in seconds, 1 to 9999
Response: $–ZDA,hhmmss.ss,dd,mm,yyyy,±xx,xx,*cs<CR><LF>
Where:

ZDA	= time and date
hhmmss.ss	= time in UTC
dd	= day, 01 to 31
mm	= month, 01 to 12
yyyy	= year
±xx,xx	= local time zone offset, 00 to ± 13 hours and minutes
*cs	= checksum
<CR>	= Carriage Return = Hex 0D
<LF>	= Line Feed = Hex 0A

Broadcast Data: ABB_SPA_MSG

Starts the ABB SPA broadcast from the COM port that received the request.

Command: **0,nTB**
Format: n = time format: 0 = UTC, 1 = local
Response: >900WD:yy-mm-dd_hh:mm:ss.fff:cc<CR>
Where:

>900WD:	= beginning of string
yy	= year of century, (00. . . 99)
mm	= month, (1. . . 12)
dd	= day of month, (01. . . 31)
_	= space = Hex 20
hh	= hours, (00. . . 23)
mm	= minutes, (00. . . 59)
ss	= seconds, (00. . . 59, or 60 while leap second)
fff	= milliseconds, (000. . . 999)
cc	= checksum (EXCLUSIVE-OR result of previous characters, displayed as HEX byte (2 ASCII characters 0. . . 9 or A. . . F)
<CR>	= Carriage Return = Hex 0D

Broadcast PATEK_PHILIPPE_MSG

Starts the Patek Philippe broadcast. BA = COM1. OA = COM2.

Command: **BA, OA**

Response: T:yy:mm:dd:dw:hh:mm:ss<CR><LF>

Where:
- T = on time mark, Hex 54
- yy = year
- mm = month
- dd = day of month
- dw = day of week
- hh = hour
- mm = minute
- ss = second
- <CR> = Carriage Return = Hex 0D
- <LF> = Line Feed = Hex 0A

Broadcast Mode: KISSIMMEE_MSG

Starts the Kissimmee (Telegyr 5700) broadcast from the COM port that received the request.

Command: **1,nTB**

Format: n = time format: 0 = UTC, 1 = local

Response: ddd:hh:mm:ssQ<CR><LF>

Where:
- ddd = day of year
- hh = hour
- mm = minute
- ss = second
- Q = quality indicator (with indicators shown below)
  - space = Hex 20, locked, maximum accuracy
  - . = Hex 2E, Error < 1 µs
  - * = Hex 2A, Error < 10 µs
  - # = Hex 23, Error < 100 µs
  - ? = Hex 3F, Error > 100 µs
- <CR> = Carriage Return = Hex 0D
- <LF> = Line Feed = Hex 0A

11.2.3 Event Mode Commands

Return Specific Event

Sets the event buffer read index to a specific event number (01 to 50), and returns that event information in either Local or UTC time format depending on how the command, nTA is configured.

Command: **nnA**

Response: mm/dd/yyyy_hh:mm:ss.sssssss_nnAz<CR><LF>

Where:
- mm = month
- dd = day of month
- yyyy = year
- hh = hour
- mm = minute
- ss.sssssss = second
- nn = Event–Buffer Read Index Number
- A = channel A
- z = time reference U = UTC, L = Local
- _ = space, Hex 20
- <CR> = Carriage Return = Hex 0D
- <LF> = Line Feed = Hex 0A

Set Event Channel Time

Sets the time reference to either UTC or local.
Command: **nTA**
Format: n = time format: 0 = UTC, 1 = local
Response: <CR><LF>

Set Channel: Deviation

Sets channel A to the 1 PPS deviation mode.
Command: **AD**
Response: <CR><LF>

Set Channel: Event

Sets Channel A to the event recording mode.
Command: **AE**
Response: <CR><LF>

Clear Event Buffer

Clears the channel A event buffer and then resets the read and write indices to 0.
Command: **CA**
Response: <CR><LF>

Return Deviation for Event Channel

Returns 1 PPS deviation and sigma for the event input.
Command: **DA**
Response: ±dddd.dd ssss.ss<CR><LF>
Where: dddd.dd = the deviation from 1 PPS (GNSS), averaged over 16 samples
ssss.ss = the standard deviation (sigma) of samples
<CR> = Carriage Return = Hex 0D
<LF> = Line Feed = Hex 0A

Return Single Event

Returns a single event record from the channel A event buffer. The record number (nn) increments once for every issuance of this command.
Command: **EA**
Response: mm/dd/yyyy_hh:mm:ss.sssssss_nnAz<CR><LF>
Where: mm = month
dd = day of month
yyyy = year
hh = hour
mm = minute
ss.sssssss = second
nn = Event–Buffer Read Index Number
A = channel A
z = time reference U = UTC, L = Local
_ = space, Hex 20
<CR> = Carriage Return = Hex 0D
<LF> = Line Feed = Hex 0A

11.2.4 Status Mode Commands

Return Status of Event/Deviation

Returns the event/deviation channel setup information, read index number and write index number.
NOTE: When nn = mm, the event buffer is empty, i.e., all recorded event data has been read.

Command: **SA**
Response: d, R = nn, S = mm<CR><LF>
Where: d = input channel mode: D = PPS deviation, E = event
nn = channel read index (01 to 50)
mm = channel write index (01 to 50)
<CR> = Carriage Return = Hex 0D
<LF> = Line Feed = Hex 0A

Return Clock Status

Command: **SC**
Response: g, U=xx, S=nn<CR><LF>
Where: g = locked to GNSS: L = locked, U = unlocked
xx = out-of-lock time, up to 99 minutes.
nn = out-of-lock delay: 00 to 99 minutes, OFF = deactivated, ZDL = zero delay
<CR> = Carriage Return = Hex 0D
<LF> = Line Feed = Hex 0A

Return DCXO Status

Returns the residual, corrected DCXO (Digitally Compensated Crystal Oscillator) status in parts per million. When compared to the 1 PPS.

Command: **SD**
Response: ±pp.pp PPM<CR><LF>
Where: pp.pp = DCXO error
<CR> = Carriage Return = Hex 0D
<LF> = Line Feed = Hex 0A

EEPROM Status

Command: **SE**
Response: T=t CE=ee<CR><LF>
Where: t = 0, No Timeout Error; t = 1, Timeout Error
ee = Number of corrected errors in reading EEPROM data
<CR> = Carriage Return = Hex 0D
<LF> = Line Feed = Hex 0A

Receiver Status

Command: **SR**
Response: V=vv S=ss T=tt P=Off<CR><LF>
Where: vv = number of satellites, visible to the antenna, per almanac
ss = relative signal strength (range: 0 to 100, nominal value = 45)
t = number of satellites being actively tracked
P = Off, no time dilution of precision (TDOP) calculation. 1.0 – 99.0, when there is a TDOP calculation. Must have 3 visible satellites for calculation.
<CR> = Carriage Return = Hex 0D
<LF> = Line Feed = Hex 0A

System Status

Returns the instrument operation status in three parts: System Status (S), Current Fault (F), Holdover/GNSS (HO_GNSS) Fault. See Tables 11.1, 11.2, and 11.3 for bit assignments.
Command: **SS**
Response: S=aa.bb F=cccc.dddd HO_GNSS=ee.ff<CR><LF>
Where: aa = current system status
bb = previous system status
cccc = current system status
dddd = previous system status
ee = current system status
ff = previous system status
<CR> = Carriage Return = Hex 0D
<LF> = Line Feed = Hex 0A

Time Quality

Returns character corresponding to estimated worst-case time quality per IEEE Standard C37.118.1. See Table 11.4 for values.
Command: **TQ**
Response: h<CR><LF>

h	Time Error	h	Time Error
0	Locked, max. Accuracy	7	Unlocked, accuracy < 1 ms
1	Unlocked, accuracy < 1 ns	8	Unlocked, accuracy < 10 ms
2	Unlocked, accuracy < 10 ns	9	Unlocked, accuracy < 100 ms
3	Unlocked, accuracy < 100 ns	A	Unlocked, accuracy < 1 s
4	Unlocked, accuracy < 1 µs	B	Unlocked, accuracy < 10 s
5	Unlocked, accuracy < 10 µs	F	Clock failure
6	Unlocked, accuracy < 100 µs	–	–

Table 11.4: Unlocked Time Quality

11.2.5 System Log Messages

Power Cycles

Returns the number of power cycles.
Command: **PC**

Return a System Log Record

Returns the date, time and system information of a specific record to memory, where n equals the record number. Records are sequential.
Command: **nDE**
Response: 14 05/04/2015 16:49:16 LOCKED GPS Tracked: 10 GLONASS Tracked: 06 (SAMPLE)

Return Version Change

Returns the date, time and overall version when last changed.
Command: **nDV**
Response: 1 05/04/2015 16:49:20 OverAll Version: 1.3 (SAMPLE)

Return System Log Summary

Returns the number of power cycles, run hours, data logs and version logs.
Command: **DS**
Response: Power Cycles: 6, Run Hours: 22, Data Logs: 17, Version Logs: 2 (SAMPLE)

Clear System Log Messages

Clears all of the system messages stored in the memory.
Command: **kDX**
Format: k = key: 1200 = Model 1200B, 1201 = Model 1201B/C

11.2.6 Local/Daylight Saving Time Setup Commands

Return Daylight Saving/Summer Time Settings

Command: **0DT**
Response: Mode :AUTO <CR><LF>
START :02:00 Second SUN of MAR<CR><LF>
STOP :02:00 First SUN of NOV<CR><LF>

Set Daylight Saving/Summer Time Mode

Command: **1,mDT**
Format: m = mode: 0 = OFF, 1 = ON, 2 = AUTO
Where: OFF = no adjustment
ON = adjustment always active
AUTO = adjustment is automatic at the specified dates and times
Response: <CR><LF>

Set Daylight Saving/Summer Auto Start Time

Command: **2,w,x,y,zDT**
Format: w = month (0 through 11), with 0 = Jan, 1 = Feb, ... 11 = Dec
x = week of month (0 through 5), with 0 = First, 1 = Second, 2 = Third, 3 = Last, 4 = Second from Last, and 5 = Third from Last.
y = day of week (0 through 6), with 0 = Sun, 1 = Mon, . . . , 6 = Sat
z = minutes after midnight z (0 through 1440)
Response: <CR><LF>

Set Daylight Saving/Summer Auto Stop Time

Command: **3,w,x,y,zDT**
Format: w = month (0 through 11), with 0 = Jan, 1 = Feb, ... 11 = Dec
x = week of month (0 through 5), with 0 = First, 1 = Second, 2 = Third, 3 = Last, 4 = Second from Last, and 5 = Third from Last.
y = day of week (0 through 6), with 0 = Sun, 1 = Mon, . . . , 6 = Sat
z = minutes after midnight z (0 through 1440)
Response: <CR><LF>

Set Local Offset From UTC

Command: **±hh:[mm]L**
Format: + = positive
- = negative
hh = hour (0 – 12)
mm = minute, increments of 15
Response: <CR><LF>

11.2.7 Front Panel Control Commands

Disable Control Panel

Disables all control-panel keys and blanks the front panel display.
Command: **FB**
Response: <CR><LF>

Enable Control Panel

Enables all control-panel keys and activates the front panel display.
Command: **FE**
Response: <CR><LF>

Lock Setup Keys

Disables setup control keys and activates the front panel display.
Command: **FL**
Response: <CR><LF>

Set Backlight: (OFF, ON, AUTO)

Command: **Ln**
Format: n = mode: 0 = OFF, 1 = ON, 2 = AUTO
Where: OFF = disabled
ON = continuously on
AUTO = active for 30 seconds after last key press
Response: <CR><LF>

11.2.8 IRIG-B Data Output Commands

IRIG Data IEEE C37.118.1

Activates the IEEE C37.118.1 IRIG-B control bits, providing two-digit year, local offset, time quality, and notification of pending leap second and Daylight Saving Time changeovers.
Command: **In**
Format: n = mode: 0 = OFF, 1 = ON
Response: <CR><LF>

IRIG Data: Local, UTC

Configures all IRIG-B output tim to local or UTC.
Command: **IL, IU**
Format: IL = local time
IU = UTC
Response: <CR><LF>

11.2.9 Position Commands

Return Antenna Elevation

Returns the current antenna elevation referenced to the WGS-84 datum.
Command: **LH**
Response: nnnnn.nn<CR><LF>
Where: nnnnn.nn = -1000.00 to +18000.00 meters.
<CR> = Carriage Return = Hex 0D
<LF> = Line Feed = Hex 0A

Return Antenna Latitude

Command: **LA**
Response: xdd:mm:ss.sss<CR><LF>
Where: x = hemisphere: N = North, S = South
dd = degrees
mm = minutes
ss.sss = seconds
<CR> = Carriage Return = Hex 0D
<LF> = Line Feed = Hex 0A

Return Antenna Longitude

Command: **LO**
Response: xdd:mm:ss.sss<CR><LF>
Where: x = hemisphere: W = West, E = East
dd = degrees
mm = minutes
ss.sss = seconds
<CR> = Carriage Return = Hex 0D
<LF> = Line Feed = Hex 0A

11.2.10 Date and Time Commands

Set Receiver Time

Sets the receiver to UTC time *only available on initial power up and not locked to the GNSS.*
Command: **yyyy:MM:dd:hh:mmTS**
Format: yyyy = year
MM = month
dd = day
hh = hour
mm = minute
Response: <CR><LF>

Return Date: Local/UTC

Command: **DL, DU**
Format: DL = local time
DU = UTC
Response: ddmmmyyyy<CR><LF>
Where: dd = day of month
mmm = month, three character abbreviation (JAN to DEC)
yyyy = year

Return Time: Local/UTC

Command: **TL, TU**
Format: TL = local time
TU = UTC
Response: ddd:hh:mm:ss<CR><LF>
Where: ddd = Julian day of year
hh = hour
mm = minute
ss = second

11.2.11 Programmable Pulse Output Commands

Pulse Width, Seconds-Per-Pulse Mode

Configures the pulse width for the Programmable Pulse output.
Command: **nnn.nnPW**
Format: nnn.nn = 0.01 to 600 seconds in 10-millisecond increments
Response: <CR><LF>
For values greater than 1, use a decimal point and enter trailing zeros as applicable.
Examples: 1 = 0.01 second, 10 = 0.10 second, 1.00 = 1 second, 100 = 1 second

Seconds Per Pulse / Pulse Per Hour

Configures the programmable pulse as "Seconds per Pulse" or "Pulse Per Hour" mode.
The first pulse will be on time at the top of the minute. If n is divisible by 60, the first pulse will be on time at the top of the hour. If Pulse-Per-Hour mode, the pulse will be on time at the second after the hour described by n. For example: 1,1200PS will generate a pulse at exactly 20 minutes after the hour.
Command: **m,nPS**
Format: m = 0 seconds-per-pulse mode
m = 1 pulse-per-hour mode
n = 1 - 60000 seconds if seconds-per-pulse mode
n = 0 - 3599 seconds offset from hour if pulse-per-hour mode
Response: <CR><LF>

Set Alarm Time Mark

Sets the time at which the clock issues the programmable pulse. If ddd is set to 0, the pulse will repeat daily at the specified time. If ddd is set from 001 to 366, the output pulse will be generated at the next occurrence of the specified time and date.
Command: **ddd:hh:mm:ss(.ss)OU(OL)**
Format: ddd day of year (1 through 366)
hh = hour (0 through 23)
mm = minute (0 through 59)
ss = second (0 through 59)
(.ss) = fractional seconds in 0.01 increments (00 through 99)
OU = UTC (OL for Local time)
Response: <CR><LF>

Set Pulse Output to Slow Code

Configures the slow code pulse output. Held high and goes low for two seconds on the minute and four seconds on the hour.
Command: **nCM**
Format: n = 0 Slow Code off
n = 1 UTC Slow Code
n = 2 Local Slow Code
Response: <CR><LF>

Set Pulse Polarity

Sets the programmable pulse output polarity. Positive means that the output voltage is held low until the beginning of the pulse period, at which time it goes high. Negative means that the output voltage is held high until the beginning of the pulse period, at which time it goes low.
Command: **nPP**
Format: n = polarity: 0 = positive 1 = negative
Response: <CR><LF>

11.2.12 Antenna System Delay Commands

Set System Delay

Sets the system delay compensation value. See Section 4.4.1 for information on calculating cable delay.
Command: **nnnnnnDA**
Format: nnnnnn = delay: 0 0 ns to 999 999 ns
Response: <CR><LF>

11.2.13 Out-of-Lock Commands

Set Out-of-Lock Time

Configures the amount of delay time (in minutes) following loss of satellite synchronization before an out-of-lock signal
Command: **(-)nnK**
Format: nn = 0, zero delay
nn = 1–99, 1 minute to 99 minutes
nn = -1, any negative number disables out-of-lock
Response: <CR><LF>

11.2.14 Miscellaneous Commands

Return Firmware Version

Returns the firmware version date of the installed ROM.
Command: **V**
Response: dd mmm yyyy<CR><LF>

Set Clock to Model 1200B, 1201B, or 1201C

Sets the clock model. Also activates the large LED display , if equipped.
Command: **n,kXZ**
Format: k = key: 1200 = Model 1200B, 1201 = Model 1201B/C
n = model: 0 = B, 1 = C

Return Display Buffer

Returns the contents of Display Buffer.
Command: **Z**
Response: Echoes current display (40 characters); no line wrap.

Set Option Control

Configures the specified option board in the clock.
Command: **m,n,kXI**
Format: m = option selection number (see Table 11.5)
n = security key: 1200 = Model 1200B, 1201 = Model 1201B/C
k = *only use with Time and Frequency Monitor.* k = 0 for 60 Hz and k = 1 for 50 Hz.
Response: <CR><LF>

Return IP/MAC Address

Returns the IP and MAC addresses of both ports of the NTP/PTP Option. Dashes are used to show either an unassigned or unconnected port IP address.
Command: **IP**
Sample response: `NET1: 192.168.000.232 64:73:E2:00:00:23`<CR><LF>
`NET2: ---.---.---.--- 64:73:E2:00:00:24`<CR><LF>

Option Selection Number, n	Option Description
0	None
1	Four Additional Outputs
2	Four Additional Fiber Outputs
3	Eight High Drive Outputs
4	Time and Frequency Monitor
5	Four Outputs and 2 Solid State Relays
6	NTP/PTP Server
7	Four BNC Connectors

Table 11.5: Option Control Settings

11.3 Custom Broadcast String Reference

11.3.1 Installing a Custom String

The clock is able to store two custom strings for broadcasting: Custom A and Custom B. Custom A may be broadcast from COM1 and Custom B from COM2. Use the @@A ... command to create a Custom A string, and the @@B ... command to create a Custom B string. Available characters and controls that may define these strings are listed in Table 11.6, followed by custom string examples.
Command: **@@A ..., @@B ...**

11.3.2 Start Custom Broadcast

B9 activates the Custom A string broadcast from the COM1 serial port; O9 activates the Custom B string broadcast from the COM2 serial port. Use the B0 and O0 commands to stop the broadcast (see Section 11.2.2).
Command: **B9, O9**

11.3.3 Return Custom String

Use the UB command to return the Custom A string definition, and use the UO command to return the Custom B string definition.
Command: **UB, UO**

11.3.4 Constructing a Custom String

This section provides the character set and rules for constructing a custom string. At the end of this section is a tutorial on how to construct strings using some of the standard broadcast strings as examples.

Custom Broadcast Character Set

Character	Meaning
//	/ character
Cssnn	Xor checksum of specified range, where ss = start location (hex value from 00 to FF) and nn = number of bytes (hex value from 00 to FF)
D	Day of month: 01, . . . , 31
d	Day of year: 001, . . . , 366
e	GNSS elevation: ±dddddd.dd length = 10
f	Fractional Seconds: 00, . . . , 99
Hxx	Hexadecimal value where xx is a hex value from 00, . . . , FF
h	Hour: 00, . . . , 23
Ln	LCD front panel display buffer, 2 lines, 20 characters: L1 = top line; L2 = bottom line
m	Minute: 00, . . . , 59
M	Month: 01, . . . , 12
O	Local hour offset: ±hh where hh=00, . . . , 12
o	Local minute offset: 0, . . . , 59 minutes
Pi	Latitude: where i = 1, degrees (dd); = 2, Minutes (mm); = 3, Fractional minutes (mmmm); = 4, Seconds (ss); = 5, Fractional seconds (fff); = 6, N (North) or S (South)
pi	Longitude: where i = 1, degrees (ddd); = 2, minutes (mm); = 3, fractional minutes; = 4, seconds (ss); = 5, fractional seconds (fff); = 6, E (East) or W (West)
r	Carriage return and line feed
Sii	String Type where ii: 01 = Status change; 02 = Vorne OptE04; 03 = OptE04 ASCII; 04 = True Time OptE04
s	Seconds: 00, . . . , 59
Txx	On time character where xx is a hex value from 01 to FF (Note: Must be at the start or end of the string!)
U	Unlock time: 00, . . . ,99 minutes
vnn	Option E04 values: 01 = Time Deviation; 02 = Frequency; 03 = Frequency Deviation; 04 = Amplitude; 05 = Phase Angle
W	Day of week: 1, . . . , 7 where 1 = Sunday
w	Day of week: 1, . . . , 7 where 1 = Monday
y	Year: 00, . . . , 99
Y	Year: 2000, . . . , 2xxx
z	Display number

Table 11.6: Characters used with Custom Strings

Table 11.6 Notes. Conditionals can use any of the above, with the exception of Cssnn and Txx, in addition to any string characters. CONDITIONALS CANNOT BE NESTED!

True/False Condition

Command: $/[ii? < t > / :< f > /]$
where:
$< t >$ = True condition
$< f >$ = False condition
ii: 01 = Locked; 02 = Status change; 03 = Locked with max accuracy; 04 = Fault; 05 = Daylight Saving Time change pending; ; 06 = Unlocked LED status (whether Unlocked LED On/Off)

Ordinal Condition

Command: $/\{ii? < 0 > / :, \ldots, < n > /; < e >\}$
where:
$< 0 >, < 1 >, \ldots, < n >$ = ordinal position
$< e >$ = Else condition
ii: 01 = Time Quality (13 possible ordinals); 02 = Time Quality; 03 = Time Zone Indicator (3 possible, 0=DST active, 1=Not active, 2=UTC)

Binary	Hex	Value (worse case accuracy)
1111	F	Fault-clock failure, time not reliable
1011	B	10 seconds
1010	A	1 second
1001	9	100 milliseconds (time within 0.1s)
1000	8	10 milliseconds (time within 0.01s)
0111	7	1 millisecond (time within 0.001s)
0110	6	100 microseconds (time within 10^{-4}s)
0101	5	10 microseconds (time within 10^{-5}s)
0100	4	1 microsecond (time within 10^{-6}s)
0011	3	100 nanoseconds (time within 10^{-7}s)
0010	2	10 nanoseconds (time within 10^{-8}s)
0001	1	1 nanosecond (time within 10^{-9}s)
0000	0	Normal operation, clock locked

Table 11.7: List of Possible Time Quality Levels, Ordinal 01

Symbol	**ASCII Character**	**Accuracy**
(space)	32	locked, maximum accuracy
.	46	Error < 1 microsecond
*	42	Error < 10 microseconds
#	35	Error < 100 microseconds
?	63	Error > 100 microseconds

Table 11.8: List of True Time Quality Levels, Ordinal 02

Using Ordinals and Conditionals

An ordinal returns an ASCII character or characters (e.g. 1, 2, 3,...., good, bad, etc.) for a requested value (e.g. clock accuracy). A conditional returns an ASCII character or characters (e.g. 0, 1, locked, unlocked, etc.) based on a true/false request (e.g. Is there a Fault?). Illustrated below are several examples of using ordinals and conditionals when constructing a custom string. You can even construct standard strings to check your work. All the ordinal/conditional examples below use the ASCII Standard broadcast string.

Ordinal 01. This ordinal consists of 13 different accuracy values as listed in Table 11.7. Notice the ordinals (0, 1, 2,...,B,F) are all represented in this example. All need not be used as shown in the second example. This example more closely follows the clock accuracy, not signaling a change until reaching 1 microsecond.

@@A/T01/d:/h:/m:/s/{01?0/:1/:2/:3/:4/:5/:6/:7/:8/:9/:A/:B/:F/}/r

@@A/T01/d:/h:/m:/s/{01?0/:0/:0/:0/:4/:5/:6/:7/:8/:9/;out of lock/}/r

Note that the accuracy values (e.g. 0, 1, 2,...,F) can be replaced with textual values. For example, note that the value "out of lock" in the second example replaced everything after "9" in the first example.

Ordinal 02. This ordinal consists of 5 different accuracy values as listed in Table 11.8.

@@A/T01/d:/h:/m:/s/{02? /:./:*/:#/:?/}/r

Ordinal 03. This ordinal consists of three different time zone values: DST active (i.e. Daylight Saving Time), DST inactive (i.e. Standard Time) and UTC time.

@@A/T01/d:/h:/m:/s/{03? DST Active/: DST Inactive/: UTC/}/r

Conditional 03. In this condition the clock is queried for a locked condition. It answers true with a space if locked and false with a question mark if unlocked.

@@A/T01/d:/h:/m:/s/[03? /:?/]/r

11.3.5 String Setup Examples and Tutorial

In this section, you will find a number of examples of constructing a custom broadcast string that produces one of the standard broadcasts. By building up a custom string that produces a standard broadcast, you to compare the output your custom string produces with that of the standard broadcast. If the outputs agree, then your custom string must be correct. This should give you some confidence in constructing your own broadcast string.

In each broadcast example that follows, the first line will give the broadcast name, the second line will give the desired broadcast output and the third line shows the custom input string code. At the end of each example, you will find some string constructions notes to help you understand how to use the custom string commands in Table 11.6. This includes the use of ordinals and conditionals.

ASCII Standard

Desired Output: <SOH>ddd:hh:mm:ss<CR><LF>

Input String Code: @@A/T01/d:/h:/m:/s/r

Input String Construction Notes: The ordinary method of starting the ASCII Standard broadcast is using the B1 or O1 command as described on page 88. Custom string entry always begins with the @@A for strings output from the COM1 serial port, or @@B for strings output from the COM2 serial port. Next, the T01 specifies the on-time character as a Hex 01, which is the Start of Header. Notice that these characters are preceded by the "/", which precedes each of the other (Table 11.6) characters. "d" is for Julian Day, "h" if for hours, "m" is for minutes, "s" is for seconds, and "r" is for carriage return, line feed. The ":" subdivides the Julian day, hour, minute and second, and no space between characters. After typing in the Input String Code (as shown above), press the Enter key. The code's acceptance is indicated by a carriage return line feed.

Vorne Standard

Desired Output: 44hhmmss<CR><LF>
55ddd<CR><LF>
11nn<CR><LF>
<BEL>

Input String Code: 44/h/m/s/r55/d/r11/U/r/T07

Input String Construction Notes: Note that the ordinary method of starting the Vorne Standard broadcast is using the B2 or O2 command as described on page 88. This input string code begins with the characters "44"; note that these are printed as that and are not preceded by a "/". "h", "m" and "s" follow and include a "r" for carriage-return, line-feed. "55" immediately follows the "r", then a "d" for Julian day, followed by another "r". "11" immediately follows the "r", followed by a "U" for unlock time and "r" for another carriage-return, line-feed. Lastly, the "T07" specifies the on time character as the Hex 07, which sounds the BEL in the machine. Note that the "44", "55" and the "11" are not preceded by a "/" since they are printed as characters.

Status

Desired Output: ddd:hh:mm:ss I=nn:nn X=nn:nn<CR><LF>

Input String Code: /[02?/d:/h:/m:/s /S01/r/:/]

Input String Construction Notes: Note that the ordinary method of starting the Status broadcast is using the B4 or O4 command as described on page 89. This string begins with a true/false conditional 02, which is a change of status. Since it is a part of the Table 11.6 character set, it must be preceded by the "/". After the "?", appears the Julian day, hours, minutes and seconds that indicate the day and time that the status changed. After the "s" (seconds) is an intentional space as shown in the input string code. After the space is the intended "/" and "S01", which indicates a status change string type of "01". The "/:" separates the "or" of the "true or false" conditions, only in this case there is no specified false condition.

Extended ASCII (DTSS MSG)

Desired Output: <CR><LF>
Q_yy_ddd_hh:mm:ss.000___

Input String Code: /T0D/H0A/[03? /:?/] /y /d:/h:/m:/s.000

Input String Construction Notes: Note that the ordinary method of starting the Ext. ASCII broadcast is using the B5 or O5 command as described on page 90. "T0D" sets the on time mark as a carriage return, and "H0A" is line feed. Immediately following is a "03", which is a "locked with maximum accuracy" conditional. This is followed by a space, which indicates that the clock is locked with maximum accuracy. If the condition is false, then it prints a "?". The "/:" separates the true/false outputs. Outside the conditional statement are the normal values that are broadcast at the chosen rate. "y", "d", "h", "m" and "s" are the two-digit year, Julian day, hours, minutes, seconds, followed by three fractional second digits and three spaces.

ASCII + Quality

Desired Output: <SOH>ddd:hh:mm:ssQ<CR><LF>

Input String Code: /T01/d:/h:/m:/s/{01? /:./:*/:#/;?/}/r

Input String Constructions Notes: Note that the ordinary method of starting the ASCII + Quality broadcast is using the B6 or O6 command as described on page 90. This string is very similar to the Standard ASCII described earlier appended with a quality indicator, "Q". All of the notes under ASCII Standard apply, except that "Q" is an ordinal. The ordinal will produce all of the necessary time quality values passed on by the clock. The ordinal begins with a "{" and ends with a "}". "01" is the selected (time quality) value governing the output character. Ordinals are a sequence conditional, meaning that you have values

separated by a "/:" (OR), and (in this case) at last is a "/;" (ELSE). For ASCII + Qual, there are four OR conditions (specific time quality ranges) followed by one ELSE (worst quality range). The initial ordinal is a space, meaning maximum time quality followed by a ".", a "*", a "#" and finally by the ELSE condition of a "?". A carriage return line feed "r" ends the string.

ASCII + Year

Desired Output: <SOH>yyyy ddd:hh:mm:ssQ<CR><LF>

Input String Code: /T01/Y d:/h:/m:/s/{01? /:./:*/:#/;?/}/r

Input String Constructions Notes: Note that the ordinary method of starting the ASCII + Year broadcast is using the B8 or O8 command as described on page 90. The ASCII + Year is identical to the ASCII + Qual described above but includes the four-digit year followed by a space that precedes the Julian day. Notice that there are two characters for year: y (0 to 99) and Y (2000 to 2xxx).

Common ASCII Characters

Listed below are a few common ASCII control characters used with the clock. For a more complete listing of ASCII characters, you will need to consult a additional sources[1]. Other printable characters may be typed in as seen on a keyboard.

Decimal	Hex	Abbreviation	Description
0	00	NUL	Null Character
1	01	SOH	Start of Header
7	07	BEL	Bell (sound)
10	0A	LF	Line Feed
13	0D	CR	Carriage Return

Table 11.9: Short Table of ASCII Characters

[1]See Wikipedia, at http://en.wikipedia.org/wiki/ASCII

Chapter 12

Technical Specifications and Operating Parameters

NOTE: Specifications are subject to change without notice.

12.1 Functional Description

12.1.1 Front Panel Interface

Each "B" clock has eight buttons, eight annunciator LEDs and one LED backlit display. Each "C" clock adds a large six character LED time and date display, which may be adjusted for mm/dd/yy or dd.mm.yy. The only front panel control is the display backlight for convenience.

12.1.2 Processing

The Model 1200B, Model 1201B, and Model 1201C both operate under the same principles and use the same basic components. Differences are: the Model 1200B does not have a holdover oscillator and only the 1201C has a large LED display in addition to the backlit LCD display. Supervision of these clock systems is under the control of several microprocessors dedicated to separate tasks. The main clock processor governs the overall operation of the clock, including the user interface, and input and output control. Two other processors manage the network card (NTP/PTP) and a final processor, called the Time Base Processor (TBP), manages the composite oscillator.

The specific processor used in the TBP is designed for hard, real-time requirements, as well as extremely fast execution of critical code. Additionally, since the TBP does not have to support the system-level clock operation (user interface and I/O control), the TBP does not have changes in the system level impacting the TBP operation. This chosen architectural separation also allows easy porting of TBP functionality into different time products. Some of the key features implemented by the TBP are:

- Inner-loop PLL: This is an N.f hardware loop that locks the VCXO to the high-stability hold-over oscillator (HO) in a unique, proprietary configuration that provides superior stability and reliability.
- Outer control loop: This is a pure software DLL that locks the composite oscillator (VCXO / HO) to the reference signal: the 1 PPS from the GNSS receiver for current products.
- Hold-over operation: The TBP implements a multi-parameter estimator that allows accurate prediction of hold-over oscillator drift, thus allowing the oscillator to be accurately compensated, minimizing drift effects during hold-over.
- Agile antenna support (future): The TBP will implement the real-time algorithms required to support the operation of the agile antenna, when it becomes available.

12.1.3 Power Supply

All clock models may be fit with either one or two power supplies that provide 24 Vdc to the clock. Power supply options include either Universal (86 V_{ac} to 265 V_{ac}, 40 Hz to 440 Hz, 110 V_{dc} to 370 V_{dc}), or Low DC Only (22 V_{dc} to 67 V_{dc}). Each supply comes with a surge withstand protect circuit at the supply inlet to guard the supply against sudden overvoltage conditions. A surge protector will normally flatten the voltage but may take out the supply fuse. Inlet supplies are connected in parallel to the main board and separated by diodes.

12.1.4 Network Section

With Option 34 installed, the network section provides a communication path to the clock that can be secured first by authenticating with user credentials. It provides NTP and PTP (IEEE 1588v2) outputs and may be managed using SNMP. While the network section runs on it's own, it connects to the clock system providing system information as well as receiving the important PPS timing from the clock to produce accurate NTP and PTP signals.

12.1.5 Legacy Section

The legacy section supplies all the standard inputs and outputs, like IRIG-B, pulses, event capturing, serial communications and relay contacts. The usual backbone of legacy timing is IRIG-B, which the legacy section supplies on six separate and independent outputs on the large connector block. Each output driving up to 75 mA at TTL/CMOS levels, there is ample drive power for numerous relays and other IEDs. Note that each of the three TTL/CMOS outputs are individually configurable, with two independent instances of IRIG-B.

There are two serial outputs, with two RS-232 serial ports, and one RS-485 embedded in COM1.

One set of multipurpose, single-pole, double-throw mechanical contacts are available for signaling an alarm, or providing a timed contact based on the programmable pulse feature. Alarms consist of out of lock (with the GNSS), alarm (external interference, spoofing, etc.), fault (hardware problem), and a clock stabilized indication. Contacts are labeled as normally open (NO), normally closed (NC) and common (COM). The term "normally" refers to the relay condition when the clock is powered off, which serves as a failsafe indication.

Other standard functions available include modulated IRIG-B and one fiber optic output for digital timing purposes.

12.1.6 Option Connectors

Option boards provide different input/output functions with appropriate connectors for the signals. For more detail, see the option list in Section 3.11 and in Appendix B.

12.2 GNSS Receiver Characteristics

12.2.1 Input Signal

L1 GPS C/A, L1 GLONASS CT, Galileo, BeiDou

12.2.2 Timing Accuracy

Specifications apply at the unmodulated IRIG-B, 1 PPS and Programmable Pulse outputs when receiving 4 or more satellites

Model 1200B ±200 ns peak
Model 1201B/C ±100 ns peak

12.2.3 Position Accuracy (rms)

2 meters, rms with SA (USA Department of Defense Selective Availability) OFF.

12.2.4 Satellite Tracking

Seventy-two (72) channel receiver: GPS L1C/A, GLONASS L1OF, Galileo E1B/C, BeiDou B1
The receiver simultaneously tracks up to 72 satellites.

12.2.5 GNSS Acquisition Time

- 55 seconds typical, cold start
- 25 seconds, typical, warm start
- 3 seconds, typical, hot start

12.3 I/O Configuration

Input and output signals may be selected on specified connector by means of internal push-on jumpers (see Chapter 5 for jumper selection tables). Each output channel is independently buffered.

12.3.1 I/O Connectors: Main Board

I/O connectors may be configured to any one of the output signals or a specific input function as listed below:

- Port 1: IRIG-B unmodulated, 1 PPS, Programmable Pulse or Event Input; jumper selectable
- Port 2: IRIG-B modulated, 1 PPS, Programmable Pulse, IRIG-B unmodulated or Event Input; jumper selectable
- Port 3: IRIG-B unmodulated, 1 PPS, Programmable Pulse or Event Input; jumper selectable

12.3.2 Standard Output Signals

- IRIG-B: 1 kHz modulated, 4.5 Vpp, 3 Vpp with 50 Ω load, 20 Ω source impedance
- IRIG-B: 5 V CMOS level-shift (unmodulated), 10 Ω source impedance; ±75 mA drive
- 1 PPS: 5 V CMOS, 10 Ω source impedance; ±75 mA drive
- Programmable Pulse: 5 V CMOS, 10 Ω source impedance; ±75 mA drive

12.3.3 Event Input/1 PPS Deviation

- Available on ports 1 to 3, COM1, or Four (optional) BNC Connectors
- This input has a 100 ns timing resolution, and may be configured to record up to 50 sequential events, provided that the events are separated by at least 11 ms. The event log may be read later from the front panel or RS-232 interface. A command is also provided to clear the event log. Event data is stored in battery-backed RAM.
- The Event input may also be configured to accept an external 1 PPS signal, and measure the deviation from a 1 PPS GNSS signal with 100 ns resolution.

12.3.4 Multifunction Relay

Relay may operate under several clock conditions, including: (1) out of lock, (2) alarms, (3) faults, (4) clock not stabilized, and (5) failsafe.

Relay Specification	Type or Rating
Arrangement	1 set of Form C (SPDT) contacts
Contact resistance	100 mΩ
Operate, release time	Approx. 6 ms, 3 ms
Rated switching current (resistive)	8 A at 250 Vac, 5 A at 30 Vdc
Max. switching capacity	2,000 VA, 150 W
Expected life	50,000 electrical cycles (100,000 typical)
Min. permissible load	10 mA, 5 Vdc

Table 12.1: Relay Specifications

12.4 System Interface

For a list of COM1 serial port pins and assigned functions, see Table 12.2. For a list of COM2 serial port pins and assigned functions, see Table 12.3.

Pin Number	Function	Pin Number	Function
1	Not Connected	6	RS-232 Input
2	RS-232, Rx Data	7	Not Connected
3	RS-232, Tx Data	8	RS-422/485, Tx-A
4	Progammable Pulse	9	RS-422/485, Tx-B
5	Ground	–	–

Table 12.2: COM1, RS-232 Port Pin Definitions

Pin Number	Function	Pin Number	Function
1	Not Connected	6	Not Connected
2	RS-232, Rx Data	7	Not Connected
3	RS-232, Tx Data	8	Not Connected
4	Not Connected	9	Not Connected
5	Ground	–	–

Table 12.3: COM2, RS-232 Port Pin Definitions

- Connector: 9-pin D-type subminiature:
- RS-422/485: Transmit only on COM1, the main RS-232 port.
- Communication Parameters: Selectable 1,200 baud to 115,200 baud; 7 or 8 data bits; 1 or 2 stop bits; odd/even/no parity.
- Supports all keyboard functions.

12.4.1 Broadcast Data Formats

For detailed information on all broadcast formats, please see Section 11.2.2.

12.4.2 Synchronization

For a received data message, the leading edge of the start bit may be selected to trigger the Event input, providing synchronization with 100 ns resolution.

12.5 Antenna System

The included antenna is directly mounted on a 26 mm pole (1.05 in OD or 0.75 in ID pipe), with either a standard 1 in – 14 (approximately M25.4 × 1.81) marine-mount thread or a 0.75 in NPT pipe thread. Other mounting configurations are available (contact Arbiter Systems).

- GNSS Antenna Assembly: 0.75 in pipe thread mount, 35 dB gain; 3.3 Vdc to 5 Vdc.
- Optional antenna mounting bracket available to mount on 60 mm (2 in, nominal) pipe (See section 4.1.2).

12.5.1 Antenna Cable

- 15 m (50 ft) cable included with antenna.
- Other cable styles and lengths available, see Table 4.2 under Available Antenna Cables and Accessories for Longer Runs.

12.6 Operator Interface

12.6.1 Setup Methods

- Clock setup: Via RS-232C Interface, use supplied utility software
- 8 Front-panel keys
- NTP/PTP Server, use Ethernet port web interface

12.6.2 Setup Functions

- **Serial COM1** configures port parameters; returns setup and broadcast ASCII string; transmits RS-422/485.
- **Serial COM2**: configure port parameters, return setup and broadcast ASCII string.
- **Local Time & DST**: set local time zone offset from UTC, and daylight saving time offsets.
- **Out of Lock**: Sets the time before an out-of-lock condition alarms. Can be turned off. Counts up to 45 days and clears when clock regains GNSS synchronization. See Section 8.4.
- **Relay Config.**: The internal relay may be set to make/break for the following conditions: (1) out of lock, (2) fault, (3) alarm, (4) clock stabilized, and (5) failsafe.
- **Back Light**: Sets the back light in the LCD display to be ON, OFF, or in Auto mode.
- **System Delays**: Offsets the time delay in nanoseconds for the GNSS signal to pass from the antenna to the GNSS receiver.
- **Programmable Pulse**: Sets the mode, interval and pulse width for programmable pulses. Also has an auxiliary IRIG-B mode, independent from the main IRIG-B setting.
- **IRIG Time Data**: Sets the time zone and IEEE C37.118.1 mode.
- **Event/Deviation**: Set to either Event or 1 PPS Deviation.
- **Option Control**: Configures the option board function in the clock, if installed.
- **C Display Format**: Configures the date format for the large display on Model 1201C clocks to MM/DD/YY or DD.MM.YY.

12.6.3 Display

- Model 1200B and Model 1201B/C include a 2-line by 20-character LED backlit LCD
- Model 1201C also includes a six-character, 20mm LED time display

12.6.4 Display Functions

- Time and Date: UTC or Local, Year-date, Day-of-year
- Option control and monitoring
- Position: latitude, longitude and elevation
- Event time and 1 PPS deviation
- Timing: learn and normal mode; time quality; event/deviation
- Status: clock serial number; power supply; EEPROM; fault; option details
- Configuration: enable/disable
- Clock accuracy, estimated uncertainty
- Setup date format of large display on Model 1201C.

12.6.5 Annunciators

Normal (green)	Learn (yellow)	Unlocked (red)	Alarm (red)
Operate (green)	Power A (green)	Power B (green)	Fault (red)

Table 12.4: Annunciator LEDs

12.7 Physical Specifications

12.7.1 Dimensions

Model 1200B:	436 mm × 44 mm × 280 mm (17.2 in × 1.7 in × 11.0 in)
Model 1201B/C:	436 mm × 44 mm × 280 mm (17.2 in × 1.7 in × 11.0 in)
Antenna:	80 mm × 84 mm (3.2 in × 3.3 in)

Table 12.5: Clock and Antenna Dimensions

12.7.2 Weight

Model 1200B & Model 1201B	**Model 1201C**
1.4 kg (3.0 lb) net. (Instrument)	1.9 kg (4.3 lbs) net. (Instrument)
2.0 kg (4.4 lb) net. (Antenna and Cable)	2.0 kg (4.4 lbs) net. (Antenna and Cable)
4.5 kg (10 lb) includes antenna, cables and accessories (shipping)	5.5 kg (12 lb) includes antenna, cables, and accessories. (shipping)

Table 12.6: Clock and Shipping Weights

12.8 Temperature and Humidity

Component	Operate	Storage
Model 1200B:	−40 °C to +65 °C	−40 °C to +75 °C
Model 1201B/C:	−40 °C to +65 °C	−40 °C to +75 °C
Antenna:	−55 °C to +65 °C	−55 °C to +80 °C
Antenna Cable:	−40 °C to +75 °C	−40 °C to +80 °C
Humidity:	Non-condensing	

12.9 Power Inlet Specifications

The clock may have either one or two user-specified internal power supplies. Additionally, the antenna receives power through the antenna cable connected to the Type F connector on the rear panel.

Universal: 85 Vac to 264 Vac, 47 Hz to 440 Hz, < 20 VA, or 110 Vdc to 350 Vdc, < 30 W typical, with three-position Terminal Power Strip and Surge-Withstand Capability.

Low DC: 22 Vdc to 67 Vdc (dc only), < 30 W typical. Uses a three-position terminal strip and Surge-Withstand Capability.

12.9.1 Power Inlet Connector

Uses a 3-pole terminal strip power inlet with Surge-Withstand Capability (see Figure 3.2 and 3.1).

12.9.2 Electro-Magnetic Interference (EMI)

Conducted Emissions: power supplies (Options A01/B01 and A02/B02) comply with FCC 20780, Class A and VDE 0871/6.78, Class A

Surge Withstand Capability (SWC), power inlet (Options A01/B01 and A02/B02) designed to meet ANSI/IEEE C37.90-1 and IEC 801-4.

Appendix A

Using a Surge Arrester

The surge arrester performs two basic functions:

1. Provides a solid and reliable grounding point for the antenna system connected to a GNSS receiver;
2. Protects connected equipment from the damaging effects of atmospheric static electricity and induced voltage spikes from nearby lightning strikes or other electrical events.

Figure A.1: GNSS Surge Arrester

A.1 Description

The Model AS0094500 is a weatherproof, three-terminal device with two type F connectors and one ground terminal. The type F connectors are interchangeable. It may be mounted outdoors provided that the cabling and type F connectors are sealed from the weather. The arrester also passes dc power to energize the antenna.

Electrical Characteristics

- Frequency Range: DC - 2.150 GHz
- Allows the passage of antenna energizing voltage: 5 Vdc
- Multi-stage circuitry using heavy duty gas tube
- Response time: 5 ns
- Current Suppression: 750 A (2x10 µs)
- Insertion Loss: 1 dB maximum
- Return Loss (1 GHz / 1.5 GHz): 16 dB minimum
- Firing Voltage: 90 Volts
- RFI Shielding: 120 dB

A.2 Installation

A.2.1 Mounting Location

Location is a key consideration when installing the Model AS0094500. It should be mounted as close as possible to a good earth ground, such as a grounding rod or station ground grid. The shorter the path between the arrester and the earth ground, the more effectively it will bypass the induced voltages.

A.2.2 Ground Connection

The Model AS0094500 may be grounded in two ways: (1) via the ground-wire screw connection, or (2) by hard-mounting directly to a grounded metal surface.

If grounding via the ground-wire screw connection, use the largest possible gauge wire. Hole diameter allows up to 8 AWG wire (0.129 in or 3.26 mm). This wire should be as short as possible, and connected to a good earth ground.

Alternately, the arrester may be mounted directly to a well-grounded plate within the facility.

A.2.3 Antenna and Clock Connections

The type F connectors are interchangeable. One connects to the antenna and the other connects to the receiver. Use only a low-loss, tri-shield or quad-shield 75-ohm coaxial cable – RG-6 or RG-11 are the preferred cable types. RG-59, or other similar types of coaxial cable, should be avoided due to greater signal loss and poorer shielding at the GNSS frequency (1.575 GHz).

A.2.4 Weather Sealing the Connections

To protect from weather, use only type F connectors with appropriate sealing features. Typically this includes an o-ring in the male connector that seats against the face of the female connector on the surge arrester. Also, crimped connectors frequently include a silicone gel flooding compound, which enhances the ability of the connection to withstand the rain and humid conditions. To better seal the entire connection, cover the joint with GE Silicone II compound.

Use the proper crimping tool if using crimp-on connectors. Improper tools may not guarantee a strong and sufficiently grounded connector resulting in poor cable performance and GNSS reception. Consider purchasing RF cables of various standard and custom lengths manufactured by Arbiter Systems.

A.2.5 Suggested Mounting

Figure A.2 illustrates the recommended mounting of the AS0094500 with the F-connectors facing downward. Install drip loops in the cables to reduce the likelihood of moisture penetrating the device and the structure.

A.3 Physical Dimensions

Overall:	59 mm × 38 mm × 18 mm (2.32 in × 1.49 in × 0.71 in) L×W×H
Mounting Hole Dim:	50 mm × 15 mm (1.969 in × 0.594 in)
Mounting Hole Dia:	4 mm (0.157 in)
F Connector Dim:	24 mm (0.945 in), center to center
Weight:	48.2 g (1.7 oz)

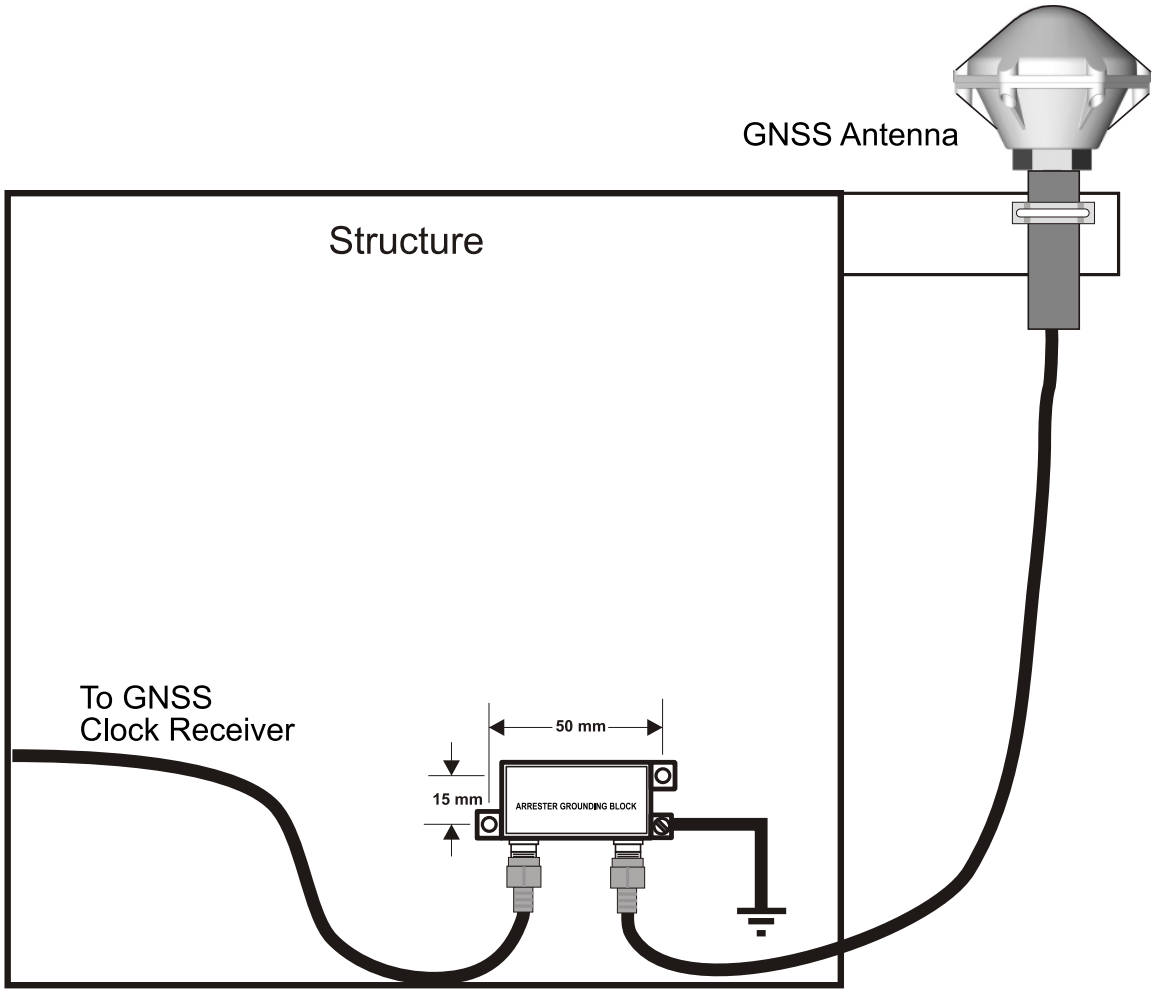


Figure A.2: Suggested Mounting of the GNSS Surge Arrester

Appendix B

Options List

B.1 Introduction

A number of options are available that may be installed in the clock for special purposes. This section describes these options, and provides supplemental and detailed information for operation and configuration of these options. While these options may apply to other clock models than the Model 1200B and the Model 1201B/C, the option reference numbers may be different for the other clock models.

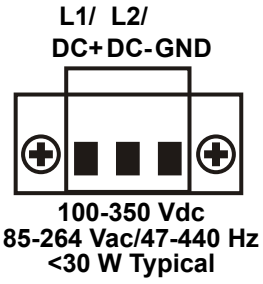
Additionally, there will be references to certain capabilities and specifications that apply only to specific clock models when using these options. For example, with Four Additional Outputs, there will be a large list of possible signals that can be selected with the option board jumpers. Many of these signals do not apply to the Model 1200B and the Model 1201B/C series clocks because the signals do not originate on the main clock board. The key to usage is to check the basic specification of the clock to determine the option capability.

B.2 Universal Inlet Power Supply

B.2.1 High Range Universal Supply with Terminal Power Strip, SWC

This standard power inlet module uses a three-position, screw-type terminal block, and includes surge withstand capability (SWC). The terminal block is intended for use in installations where it is necessary or desirable to have the instrument power hard-wired. See Figure B.1.

Figure B.1: Universal Power Supply Inlet



B.2.2 Specifications

Input Power:

AC Voltage Range:	85 Vac to 264 Vac
Frequency Range:	47 Hz to 440 Hz
DC Voltage Range:	100 Vdc to 350 Vdc
Input Power:	<30 W

Terminal Block:

Terminal Assignment:*	(+), (−), Ground, left to right, viewed from rear
Block Size:	25 mm × 15 mm × 18 mm (0.98 in × 0.59 in × 0.71 in) (W x H x D)
Approvals:	U. L. recognized; C.S.A. approved

*For AC operation, input line may be connected between (+) and (−), without regard to polarity; however proper grounding should always be employed

Fuse:

Arbiter P/N:	FU0003001
Current Rating:	3.15 A, Time Lag
Voltage Rating:	500 Vac, 400 Vdc
Size:	5 mm × 20 mm

Surge Withstand Protection (SWC)
Provides input Surge Withstand Capability (SWC) in compliance with both ANSI C37.90 and IEC 801-4.

Connections
All input power line connections to the rear-panel terminal strip should be made using appropriate power cables which have the insulation removed about 6 mm (1/4 in) from the end or as required for tinning. If a DC source is used, connect the positive lead to the positive (+) terminal, connect the negative lead to the negative (−) terminal and a safety ground lead to the "G" terminal when viewing the instrument from the rear (see Figure B.1).

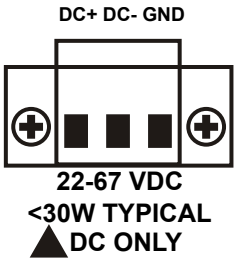
B.3 Low DC Inlet Power Supply

B.3.1 22 Vdc to 67 Vdc ONLY, Terminal Power Strip, SWC

The Low DC power supply replaces the Universal power supply with a three-position, screw-type terminal block, including Surge Withstand Capability (SWC). With DC ONLY inlet voltages from 22 Vdc to 67 Vdc, this feature is intended for use in installations where it is necessary or desirable to have the instrument power hard-wired.

WARNING: Do not apply AC voltages to the inlet terminals.

Figure B.2: Low DC: Power Supply Inlet



B.3.2 Specifications

Input Power

DC Voltage:	22 Vdc to 67 Vdc
Input Power:	< 20 Watts, typical

Terminal Strip

Terminal Assignment:	(+), (−), Ground Left to right, viewed from rear
Block Size:	25 mm × 15 mm × 18 mm (0.98 in × 0.59 in × 0.71 in) (W x H x D)
Block Material:	Glass-filled thermoplastic
Screw Size:	6–32 × 1/4 in
Screw Material:	Cadmium-plated steel
Terminal Spacing:	5 mm (0.196 in)
Approvals:	U.L. recognized; C.S.A. approved

Fuse

Arbiter P/N:	FU0003100
Current Rating:	8 A, time lag
Voltage Rating:	400 Volts
Size:	5 mm × 20 mm

Surge Withstand Protection (SWC)

Provides input Surge Withstand Capability (SWC) in compliance with both ANSI C37.90 and IEC 801-4.

B.4 Holdover Oscillator (1201B/C Only)

C01: Holdover OCXO, 1 millisecond per day

B.5 One Fiber Optic Output

One, optional, fiber optic output is available with Type ST connector and 820 nm transmitter, compatible with multimode fiber. This output is configurable to any of the standard *digital* (CMOS) signal outputs available from the clock and provides an optical output power of -15 dBm minimum (-12 dBm typical) into 62.5/125 µm fiber. Signals include unmodulated IRIG-B, 1 PPS and Programmable Pulse.

B.6 Four Configurable Outputs

B.6.1 General Description

This option adds four rear-panel outputs, which may be configured to any of the available signals in the clock. Note that there are many more jumper settings on the option board than the the clock is capable of providing. The configuration of the four outputs can be changed at any time via internal jumper settings.

B.6.2 Specifications

General	
Output Connectors:	BNC-type RF connectors (4)
Analog Outputs	
Output Type:	LF353, with 560 Ω source resistance
Available Outputs:	modulated IRIG-B (B120 and B123)
IRIG-B, Modulated:	IRIG format B time code, modulated onto 1 kHz 3.8 Vpp sine wave carrier; 2.8 Vpp into 50 Ω
Digital Outputs	
Output Type:	High-speed CMOS (74HC126), 0 V to 5 V, with 47 Ω series resistor
Available Outputs:	unmodulated IRIG-B, 1 PPS, Programmable Pulse, Out-of-Lock
IRIG-B:	IRIG format B time code (unmodulated)

Cover Removal

To change the configuration of this option, the top cover of the instrument must be removed. Turn off the instrument, and disconnect the power cord. Using a T25 Torx driver, remove the eight screws holding the cover (and rack-mount ears, if used) in place, and lift the cover off.

B.6.3 General Information

Output selection incorporates is extremely flexible using jumpers on the option board. Each of the four rear-panel BNC-type I/O connectors found on the rear panel can be configured to perform any of the output signals available from the specific clock model. Figure B.3 shows the locations of board jumpers, and Table B.1 indicates the available signals and their jumper positions.

Signal Selection

To choose a specific signal to be applied to a specific output connector requires setting three jumpers: (1) output function, or the type of signal, like IRIG-B, (2) output mode, whether it's an analog or digital signal, and (3) the clock model in which the option is installed.

Jumper, Output Connector Correspondence

Use jumper JMP1 and JMP9 for output J2, JMP2 and JMP10 for output J3, JMP3 and JMP11 for output J4 and JMP4 and JMP12 for output J5.

Output Function, Output Mode & Clock Model

To choose a specific signal for a specific output use jumpers described in Table B.1.

The clock model is determined by jumpers JMP13 and JMP14. JMP13 = Model 1088B. JMP14 = Models 1084, 1093, 1200, or 1201.

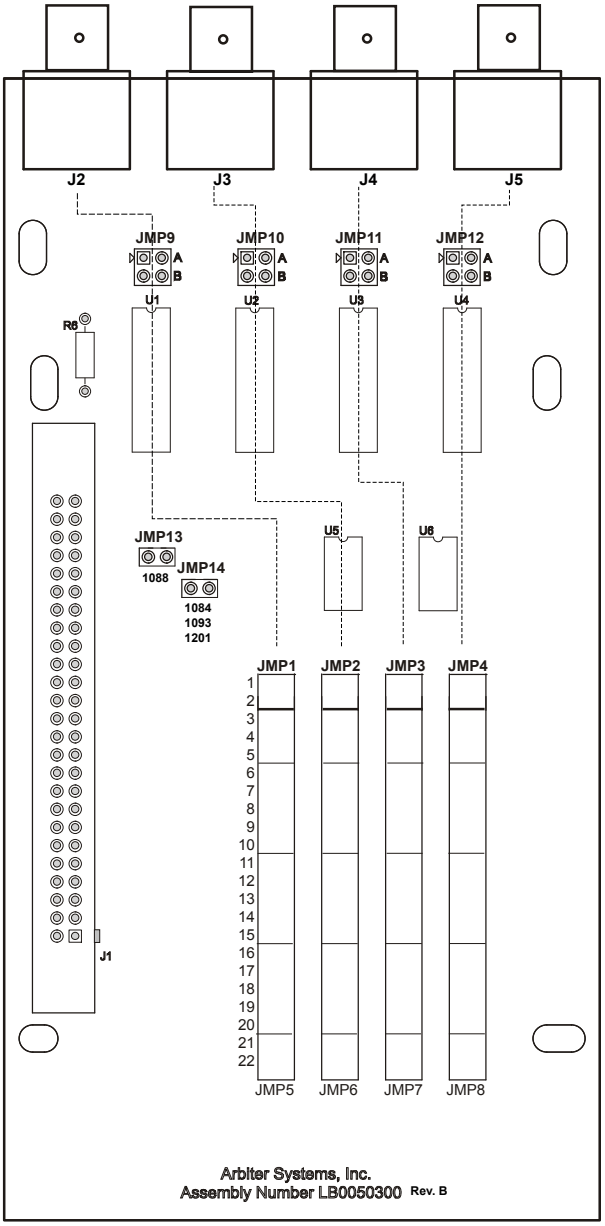


Figure B.3: Jumper Configuration

Driver Jumper Position: JMP9 – JMP12

For JMP1 – JMP4 positions 1 and 2 (shown below in Table B.1), jumpers JMP9 – JMP12 should be in position B. These are used for analog signals. In all other JMP1 – JMP4 positions (i.e. 3 – 20), JMP9 – JMP12 must be in position A for digital signals. Available signal choices in the Model 1200B and the Model 1201B/C are marked in Table B.1 with an asterisk (*).

Position	**Analog Signals**	**Signal Description**
1*	IRIG-B	Modulated IRIG-B
2	Deviation	Frequency input – Model 1088B only
Position	**Digital Signals**	**Signal Description**
3*	IRIG-B:	IRIG format B time code, unmodulated, one second frame rate.
4	IRIG-E:	IRIG format E time code, modulated or unmodulated, 10 second second frame rate.
5	IRIG-H:	IRIG format H time code, one minute frame rate.
6	10 MPPS:	10,000,000 pulse-per-second (PPS) square wave, synchronous to the 1 PPS output.
7	5 MPPS:	5,000,000 PPS square wave, synchronous to the 1 PPS output.
8	1 MPPS:	1,000,000 PPS square wave, synchronous to the 1 PPS output.
9	100 kPPS:	100,000 PPS square wave, synchronous to the 1 PPS output.
10	10 kPPS:	10,000 PPS square wave, synchronous to the 1 PPS output.
11	1 kPPS:	1,000 PPS square wave, synchronous to the 1 PPS output.
12	100 PPS:	100 PPS square wave, synchronous to the 1 PPS output.
13	60 PPS:	60 PPS square wave, synchronous to the 1 PPS output.
14	50 PPS:	50 PPS square wave, synchronous to the 1 PPS output.
15	10 PPS:	10 PPS square wave, synchronous to the 1 PPS output.
16	IRIG-D/1 PPM:	IRIG format D time code (1 pulse per minute), rising edge on time, one hour frame rate.
17	1 PPH:	1 pulse per hour, rising edge on time.
18*	1 PPS:	(10 ms HI), synchronous to 1 PPS/GNSS
19*	Programmable Pulse:	Outputs a single pulse at a preprogrammed time, or a continuous pulse train having a period of one day or less.
20*	Out-of-Lock:	Normally HI after acquisition of satellite signals. Toggles LO nn minutes after loss of satellite signal lock. Range for nn is 00 to 99 minutes, and is set using the Utility software, SETUP menu or RS-232C (refer to clock Operation Manual). Setting of 00 disables this function (output remains HI). This output follows the standard Out-of-Lock function on the clock.
21	Spare 1	To be determined.
22	N/A	Not used

Table B.1: Four Configurable Outputs – Signal Choices

B.7 Four Fiber Optic Outputs

This option provides four individually selectable fiber optic outputs with Type ST connectors and 820 nm transmitters compatible with multimode fiber.

B.7.1 Specifications

Each fiber optic output is jumper-configurable to each of the standard digital (CMOS) signal outputs available in the clock. These include unmodulated IRIG-B, 1 Pulse Per Second and Programmable Pulse.

Analog signals, IRIG-B Modulated, and ±5 V Recorder are not selectable.

Option provides an optical power output of -15 dBm minimum (-12 dBm typical) into 62.5/125 μm fiber.

The optical signal is ON whenever the selected logic signal is HI. Transmitter bandwidth is compatible with all available logic signals.

Cover Removal

The clock cover must be removed to change jumper configuration. Turn off the instrument, and disconnect the power cord. Using a T25 Torx driver, remove the eight screws holding the cover (and rack-mount ears, if used) in place, and lift the cover off.

B.7.2 Output Jumper Enable (JMP2 – JMP5)

Select the output signal by setting jumpers JMP2, JMP3, JMP4, and JMP5 as described in Table B.2 and illustrated in Figure B.4.

JMP1 enables (position A) or disables (position B) all of the outputs.

Output Transmitter	Jumper	Pin	Signal per Output	Notes
CR1	JMP2	1	IRIG-B	1, 2, 3
CR2	JMP3	2	IRIG-E	2, 3
CR3	JMP4	3	IRIG-H	2, 3
CR4	JMP5	4	10 MPPS	2, 3
–	–	5	5 MPPS	2, 3
–	–	6	1 MPPS	2, 3
–	–	7	100 kPPS	2, 3
–	–	8	10 kPPS	2, 3
–	–	9	1 kPPS	2, 3
–	–	10	100 PPS	2, 3
–	–	11	60 PPS	2
–	–	12	50 PPS	2
–	–	13	10 PPS	2, 3
–	–	14	1 PPM	2, 3
–	–	15	1 PPH	2, 3
–	–	16	1 PPS	1, 2, 3
–	–	17	Prog. Pulse	1, 2, 3
–	–	18	IRIG-B Mod. Manch.	2, 3

Table B.2: Four Fiber Optic Output Configuration

1. Signals available on the Model 1093A/B/C, Model 1200B, and Model 1201B/C
2. Signals available on the Model 1088A/B
3. Signals available on the Model 1084A/B/C

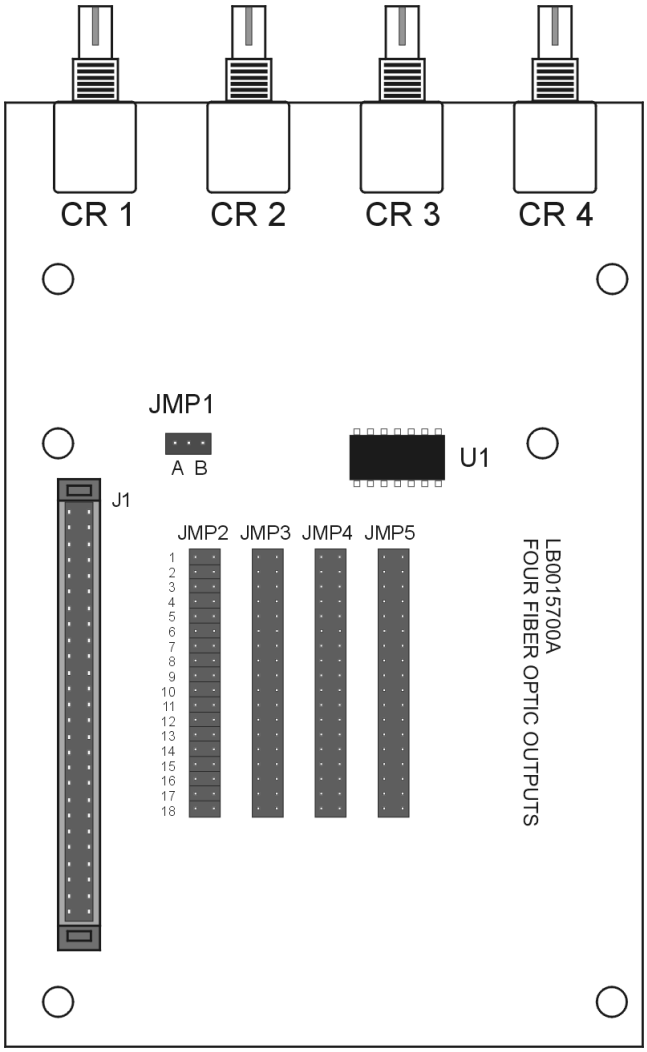


Figure B.4: Jumper Locations

B.8 8-Channel High Drive IRIG-B Amplifier

B.8.1 General Description

This option provides eight independent, IRIG-B buffered outputs, each capable of driving multiple loads. Outputs are short circuit and surge protected. Each output is individually configurable for either modulated or unmodulated IRIG-B signals via jumper settings as illustrated in Figure B.5.

B.8.2 Specifications

Output Selection

Number of Channels:	Eight (8).

Signal Levels:

Modulated:	4.5 Vpp with 20 Ω source impedance; each channel will drive a 50 Ω load to 3 Vpp minimum.
Unmodulated:	+5 V open-circuit; +4 V minimum at 250 mA load current each channel will drive 25 Schweitzer SEL-3xx (in parallel) or 50 SEL-2xx (in series/parallel) relays at 10 mA per relay.

Maximum Load (per driver):

Modulated:	No Limit: will drive a short circuit.
Unmodulated:	250 mA peak current; pulse-by-pulse shutdown if load current exceeds internal limit (self-resetting).

Output Connector

16-position pluggable 5 mm (Phoenix-type) terminal strip with eight 2-position mating connectors.

B.8.3 Option Setup

Using the“ X Utility Software

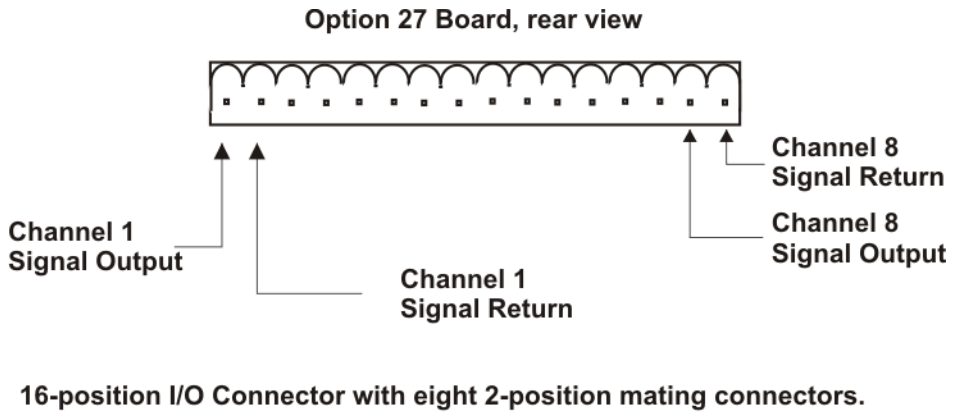
To set up 8 High Drive Outputs using the utility software, please go to Section 7.15.

Using Front Panel Keys

To set up 8 High Drive Outputs from the front-panel keys, please follow the guidelines in Section 8.12.

Using RS-232C Port

To set up 8 High Drive Outputs using the RS-232C port, please follow the guidelines in Section 11.2.14.



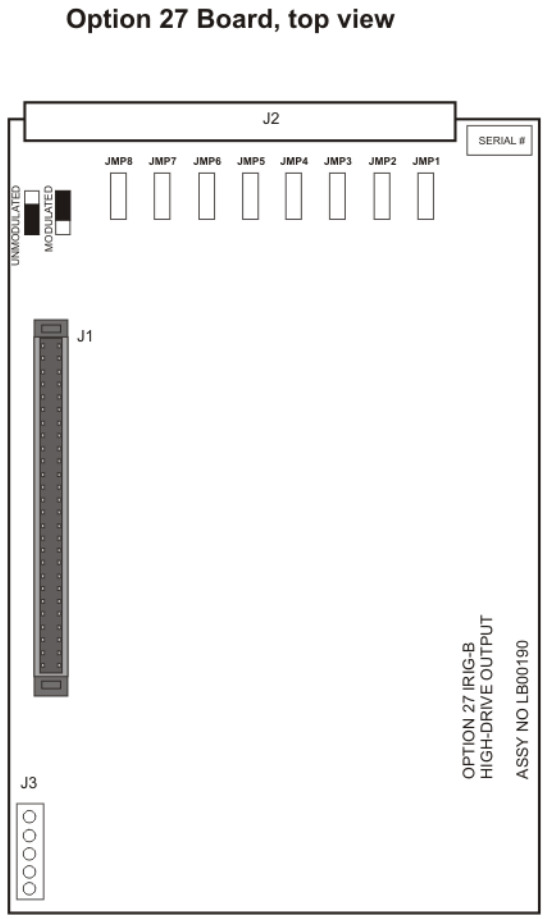


Figure B.5: 8 High Drive Outputs Jumper Locations

B.8.4 Output Load and Loop Example: Unmodulated IRIG-B

When designing circuits for connection to the output bus, several factors must be considered.

1. Loop Resistance
2. Type and quantity of loads connected
3. Maximum loop distance desired

Table B.3 provides a matrix of these factors using the Schweitzer relay(s) as the output load(s). The loop distance figures were obtained using the following types of Belden Wire (cross-referenced to corresponding part number):

	AWG20	AWG18	AWG16	AWG14	AWG12
Shielded	8762	8760	8719	8720	8718
Non-Shielded	8205	8461	8471	8473	8477

Total Loop Resistance	Output Load and Voltage Drop – SEL Relays(1)				Loop Length (ft.)				
	at 0.25 V drop		at 0.5 V drop						
	I(mA)	#SEL-2xx(2)	I(mA)	#SEL-3xx	AWG20	AWG18	AWG16	AWG14	AWG12
10 Ω	25	2	50	5	500	800	1200	2000	3000
5 Ω	50	5	100	10	250	400	600	1000	1500
2.5 Ω	100	10	200	20	125	200	300	500	750
1 Ω	250	25	500(3)	50	50	80	120	200	300

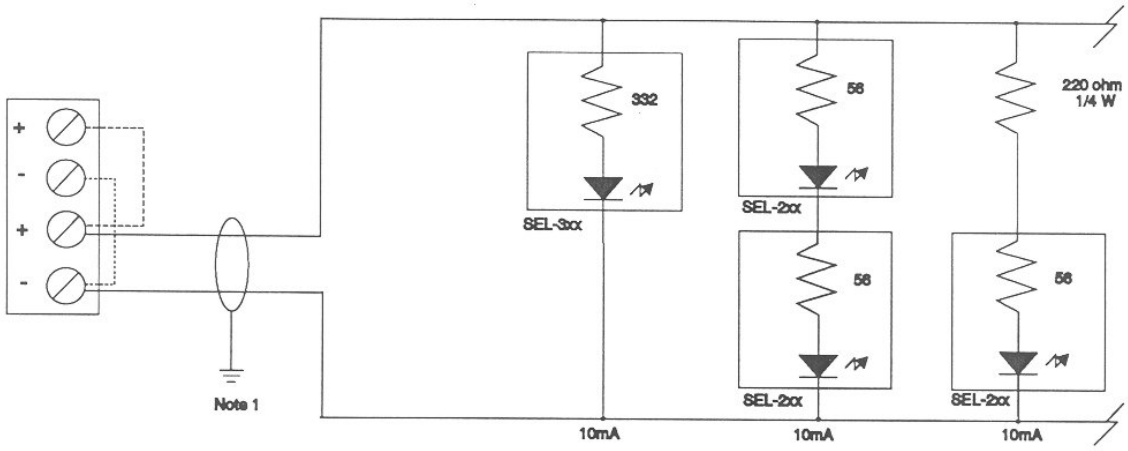
Table B.3: Example, Output Load and Loop Distance Matrix

1. Output Load and Voltage Drop, # SEL-3xx is the number of relays connected as output load.
2. For SEL-2xx, using pairs of relays with inputs of each pair in series, the maximum number of relays is two times that for SEL-3xx.
3. Using 2 drivers in parallel. Parallel connection may be made using AWG22 wire.

B.8.5 Connecting Load(s) to Output Bus

The following example illustrates use of different types of SEL relays connected to the output bus.

Total Load Current: 250 mA (peak) per driver or less.



Note 1:

Shielding is optional. However, if shielding is used, connect drain wire at source end of cable to a local surge ground. Maintain shielding throughout bus by connecting drain wires together at each junction or drop point. Do not connect drain wires at ends of cables. Do not connect drain wires to signal wires. Do not connect shield to ground at more than one location, as this may result in circulating currents.

B.8.6 Output Loading (Modulated IRIG-B)

Driving modulated IRIG-B loads is simpler than for unmodulated IRIG-B loads because input impedances are substantially greater (several kilohms typically); and most modulated IRIG-B loads include some sort of leveling or AGC amplifier, providing tolerance for signal level variations. Consequently, modulated IRIG-B loads may be connected with greater ease; Arbiter Systems recommends that you simply calculate the effective parallel load impedance of the parallel-connected loads. As long as the load impedance is 50 Ω or more per driver, and the loads will accept a 3 Vpp minimum signal level, and the connecting lines are short (5 Ω or less loop resistance), then no further analysis is required.

As with unmodulated signals, two or more drivers may be paralleled if desired. Unlike the current-limited unmodulated IRIG-B drivers, the modulated IRIG-B drivers are impedance-limited and will operate properly into any load impedance, including a short circuit.

If the loop resistance is greater than 5 Ω, then it may be treated as additional source resistance in series with the 20 Ω driver impedance. This source resistance then forms a voltage divider with the load. See calculation for "Output Level at Load" below by using Equation B.1.

For Example (see figure below)

Using Equation B.1 to calculate the Output Level at Load;

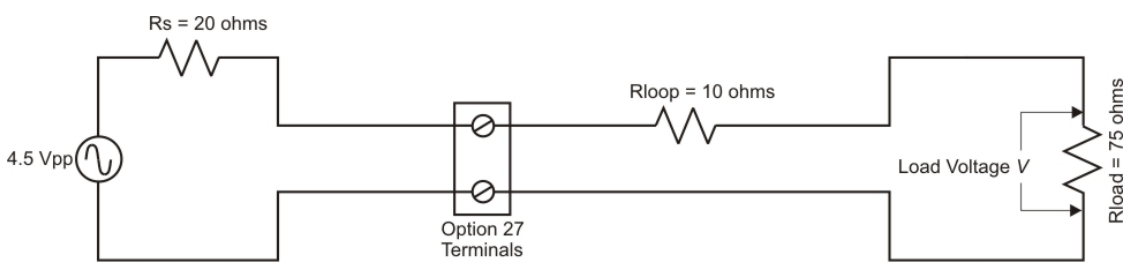
$$V = \frac{R_{load}}{R_S + R_{loop} + R_{load}} \times 4.5 \tag{B.1}$$

Source impedance of driver: 20 Ω

Loop Resistance: 10 Ω

Parallel Load Resistance: 75 Ω

Output Level at Load V = (75 ÷ 105) × 4.5 = 3.2 Vpp



B.9 Power System Time, Frequency and Phase Monitor

B.9.1 General Description

This section describes the optional Power System Time, Frequency, and Phase Monitor.

B.9.2 Discussion

Provides the clock with the ability to accept either a 50 Hz or 60 Hz, 30 Vrms to 300 Vrms signal input and measure the instantaneous phase, magnitude and frequency of the fundamental component while rejecting the effects of harmonics, noise and DC offsets. This option also integrates total time deviation, which is system time minus GNSS time. Measurement results may be output via the rear-panel RS-232 connector or displayed on the front panel. To determine phase shift across a transmission line, the measured phase angles from two units placed at the ends of the line are subtracted and normalized into the range of 0 to 360 (or ±180) degrees. By subtracting the two measurements of absolute phase, which are measured using the same (GNSS time) reference, the reference cancels leaving the phase angle between the two units: A-B = (A-R) - (B-R).

B.9.3 System Reference Connection

To connect the option board to the system reference input perform the following steps:

1. Using the 6 m (20 ft) length of twin axial cable provided, connect the twin-ax connector to the option connector on the rear panel. Hold the cable connector by its body (not by the rotating locking ring) and rotate it inside the twin-BNC connector until you feel it begin to mate with the twin-BNC input of the option assembly. Once the connectors begin to mate, then use the locking ring to secure the connectors together.
2. Strip the unterminated end of this cable and prepare it as required for termination to your System Reference signal. Do not connect the shield of the cable at the reference input end.

CAUTION: The twin-BNC connector, unlike a standard BNC connector, will only mate properly in one orientation, and any attempt to force the connector into position with the locking ring when it is improperly oriented (as may be done with standard BNC connectors) will not work and may damage the connector.

NOTE: The supplied cable is terminated at one end with a twin-BNC connector which mates with the system reference input of the option board.

B.9.4 Firmware Configuration

Apply power and observe front panel display, when CLOCK STATUS STARTUP is displayed, press the SETUP key.

Navigate through the series of menu selections, using either the DOWN, UP or SETUP key, until SET OPTION CONTROL? appears. Press ENTER and navigate to AUX. BOARD OPTION.

Press ENTER, and then press the UP key until option is displayed. Press ENTER. You will be given additional setup choices for the option; Set System Time Dev?, Set UTC/Local Time, Set 50/60 Hz Input, and Return to Main Menu. Select the desired choices. When complete (if this is the first time these options have been activated), turn the clock OFF and back ON again to initialize the Option Boards.

```
AUX. BOARD OPTION
NONE
```

```
AUX. BOARD OPTION
Time & Freq.  Monitor
```

```
SET SYSTEM TIME DEV?
+/-XXXXX.XXX Sec
```

```
TIME
UTC
```

```
FREQUENCY
60 Hz
```

Viewing the Measurements

View the measurements on the front panel display as follows:

1. Press the SYSTEM key repeatedly until it states OPTION STATUS and press ENTER. Observe the following display on the front panel (values are representative):

```
SYSTEM Δ F -0.0010 Hz
       Δ T +0.0000 Sec
```

2. Press the UP or DOWN key again and the following is displayed:

```
SYSTEM FRQ 59.993 Hz
   Time 19:39:25.4327
```

3. Press the UP or DOWN key again and the following is displayed:

```
SYSTEM INPUT 114.91 V
         Phase 359.60°
```

B.9.5 Calibration

The clock is now configured for operation. Calibration for phase and amplitude may be further performed. Specifically, these calibrations have no effect on system time and frequency measurements, and are unnecessary if only time and frequency are required.

Uncalibrated phase accuracy is usually less than 0.3°, and can be reduced to 0.1° typical and 0.2° guaranteed with calibration. Uncalibrated amplitude accuracy is usually less than 1 %, which is the typical performance of this measurement. Amplitude accuracy is not guaranteed, and amplitude measurements are provided primarily to verify that the unit is properly connected and receiving the expected signal level.

B.9.6 Phase Calibration

Phase calibration has been performed at the factory, and the calibration factor (which must be entered into the clock non-volatile memory for it to be effective) is supplied with the assembly. Entering this factor into the clock requires connecting the clock to a computer or terminal via the RS-232 interface. For the computer, use a terminal-emulation program such as Procomm, Windows HyperTerminal or Tera Term Pro[1]. Send the character V to the clock to check that connections and port settings are correct. The clock should respond with the firmware dates in the format 02 Apr 2014 Opt. 26 Jul 2013.

To send the phase calibration factor to the clock, key in the message:

dd.dd,1201PC

Where dd.dd is the calibration factor in degrees, for example -0.16; and 1201 is the key (clock model number – a security key to prevent unintentional modification):

-0.16,1201PC

[1]To download Tera Term Pro, see the Arbiter Website and select "Service/Support > Downloads."

B.9.7 Amplitude Calibration

For amplitude calibration, the format is similar, replacing PC with RV. The calibration factor is approximately 1.0, and is multiplied by the measured result to generate the displayed value. If an accurate ac source at 50 Hz or 60 Hz is available (for example, the Arbiter Systems, Inc. Model 1040C Panel Meter Calibrator), the error can be measured and the correction factor entered as described. For example, if 120 Vrms is applied to the option assembly, and the display indicates 119.1 Vrms, the calibration factor is (120.0 / 119.1) or 1.0076. You would enter 1.0076,1201RV to calibrate the unit (Model 1201B/C). The display should then read close to 120.0 Vrms. To clear the calibration factor, you may set the unit to factory defaults or send the command 1,1201RV.

B.9.8 Option: Specific RS-232 Commands

The following conventions apply to all RS-232 communications:

- Phase angle, in all messages, is defined as zero (or 360) for the positive-going zero crossing coincident with 1 PPS-GNSS, and is scaled between zero and 360 degrees. Phase angle increases with frequency below nominal (50 Hz or 60 Hz) and decreases with frequency above nominal; in other words, if the zero crossing occurs just after 1 PPS-GNSS, the phase angle will be just above zero, and if the zero crossing occurs just prior to 1 PPS-GNSS, phase angle will be just under 360°.
- Time deviation decreases (becomes more negative) with frequency below nominal, and increases (becomes more positive) with frequency above nominal.
- <CR> = carriage-return (0Dh)
- <LF> = line-feed (0Ah)

B.9.9 Option Commands

Return System Frequency

Command: **FS**
Response: SS ff.fff<CR><LF>
Where: SS = UTC seconds
ff.fff = frequency, Hz

Return System Frequency Deviation

Command: **FD**
Response: SS±f.fff<CR><LF>
Where: SS = UTC seconds
f.fff = frequency, Hz

Return System Phase

Command: **PS**
Response: SS±ppp.pp<CR><LF>
Where: SS = UTC seconds
ppp.pp = phase, 0 degrees to 360 degrees

Return System Time Deviation

Returns the accumulated system time deviation.
Command: **TD**
Response: SS±tt.tttt<CR><LF>
Where: SS = UTC seconds
tt.tttt = time deviation, seconds

Return System Time

Returns the monitored system time. Includes deviation from GNSS time.

Command: **TS**
Response: MM DD YYYY hh:mm:ss.ssss SS<CR><LF>
Where: MM = Month
DD = Day of Year
YYYY = Year
hh = hour
mm = minute
SS = UTC seconds
ss.ssss = seconds

Set System Time, UTC

Sets the option to reflect system time in UTC format.

Command: **SU**
Response: <CR><LF>

Set Option System Time, Local

Set the option to reflect system time in local format.

Command: **SL**
Response: <CR><LF>

Return System Status

Command: **SM**
Response: h<CR><LF>
Where: h is the status value
0 = System OK
1 = No System Reference
2 = System okay now but reference lost since last request

Return Time, Frequency, Phase Deviation

Command: **nPD**
Format: n = Time reference requested: 0 = UTC, 1 = Local
k = Security Key (1200 or 1201)
Response: mm/dd/yyyy hh:mm:ssT ss +f.fff +t.tttt ppp.ppp vvv.vv<CR><LF>
Where: mm/dd/yyyy = Date
hh:mm:ss = Time of Day
T = Time reference reeived: U = UTC, L = Local
ss = Status
first character is Reference Status: 0 = Locked, 1 = Unlocked
second character is clock status per IEEE C37.118.1
+f.fff = signed Frequency Error in Hz.
+t.tttt = signed Time Deviation in seconds.
ppp.pp = Phase Angle, 0 degrees to 360 degrees.
vvv.vv = Line voltage, rms Volts.

Start Broadcast Mode: Vorne

Starts 1/s broadcast of Vorne large format time display data. B2 = COM1, O2 = COM2.

Command: **B2, O2**

Response:

11nn<CR><LF>	Out-Of-Lock Time
44hhmmss<CR><LF>	UTC/Local Time
22±ff.fff<CR><LF>	Frequency Deviation
33±s.ss<CR><LF>	Time Deviation*
34±sss.sss<CR><LF>	Time Deviation*
66hhmmss<CR><LF>	System Time
77nn.nnn<CR><LF>	System Frequency
88nnn.nn<CR><LF>	System Phase
89nnn.nn<CR><LF>	System Magnitude
55ddd<CR><LF>	Day of Year
<BEL>	Hex 07

Data is transmitted ahead of time, and the <BEL> character is transmitted on time. The Vorne displays update simultaneously upon receipt of the <BEL> character. Refer to Arbiter Systems Application Note 103 for more information.

The decimal points shown above are not actually transmitted in the data stream. The Vorne displays are configured to show the decimal point in this position.

*Time Deviation is output in two formats in the same data stream: 33±s.ss and 34±sss.sss.

Output for the 33±s.ss format will be +9.bb when the measured value exceeds +9.99 (b = blank). It will be -9.bb when the measured value is less than -9.99.

Output for the 34±sss.sss format will observe the following conventions for out-of-range values and leading blanks. Decimal points are implicit and do not appear in the data stream.

Time Deviation Range	Format (b=blank)
Below -999.99	-bbb.bbb
-999.99 to -100.00	-sss.sss
-99.99 to -10.00	-bss.sss
-9.99 to -0.01	-bbs.sss
+0.00 to +9.99	+bbs.sss
+10.00 to +99.99	+bss.sss
+100.00 to +999.99	+sss.sss
Above +999.99	+bbb.bbb

Table B.4: B2 Broadcast, Time Deviation Values

Start Broadcast Mode: ASCII

Starts 1/s broadcast of Time, Frequency, and Phase Deviation. B7 = COM1, O7 = COM2.

Command: **B7, O7**

Response: mm/dd/yyyy hh:mm:ssT ss +f.fff +t.tttt ppp.ppp vvv.vv<CR><LF>

Where:

mm/dd/yyyy	= Date
hh:mm:ss	= Time of Day
T	= Time reference: U = UTC, L = Local
ss	= Status first character is Reference Status: 0 = Locked, 1 = Unlocked second character is clock status per IEEE C37.118.1
+f.fff	= signed Frequency Error in Hz.
+t.tttt	= signed Time Deviation in seconds.
ppp.pp	= Phase Angle, 0 degrees to 360 degrees.
vvv.vv	= Line voltage, rms Volts.

Start Broadcast Mode: True Time

Starts 1/s broadcast of Time, Time Quality, and Frequency (True Time). BT = COM1, OT = COM2.

Command: **BT, OT**

Response: <SOH>DDD:HH:MM:SSQTsDS.thmFsU.thm<CR><LF>

Where:

<SOH>	= ASCII start of header character (01h)
DDD	= Day
:	= ASCII colon (3Ah)
HH	= Two digits of the hour of day
MM	= Two digits of the minute of day
SS	= Two digits of the second of day
Q	= Quality Sentry character (“ ” , “.”, “*”, “#”, “?”)
	“ ” = space (20h) error $\leqq$ 1 μs
	“.” = period (2Eh) 1 $\leqq$ error < 10 μs
	“*” = asterisk (2Ah) 10 $\leqq$ error < 100 μs
	“#” = pound sign (23h) 100 $\leqq$ error < 1000 μs
	“?” = question mark (3Fh) error $\geqq$ 1000 μs
T	= ASCII T, indicates start of Time Deviation Field
s	= Sign character + (2Bh) or - (2Dh)
D	= Tens of seconds (Time Deviation
.	= Period, decimal point
thm	= Tenths, hundredths and thousandths of seconds
F	= ASCII F, indicates the start of Frequency Deviation Field
s	= Sign character
	+ (2Bh) frequency above nominal
	– (2Dh) frequency below nominal
U	= Units of Hertz (Frequency Deviation)
.	= Period, decimal point
thm	= Tenths, hundredths and thousandths of Hertz

Set Measured System Deviation

Command: **(-)s.fsRD**

Format: s = 0 to ± 2000 seconds
fs = fractional seconds

Response: <CR><LF>

Set Phase Calibration

Command: **p:kPC**

Format: p = Phase Offset in degrees
k = Security Key (1200 or 1201)

Response: <CR><LF>

Set Voltage Amplitude Correction

Command: **v:kRV**

Format: v = Voltage correction per unit with 1.000 equal to no correction.
k = Security Key (1200 or 1201)

Response: <CR><LF>

B.10 Four Additional Outputs and Dry Contacts; +25/50 Vdc

B.10.1 General Description

This section describes an optional board with the following features: Four Additional Outputs With Dry Contact and +25/50 Vdc. With six configurable outputs, this option includes four standard, 5 V CMOS outputs, two Aromat AQV210E solid-state relays (SSRs). A +25 Vdc or +50 Vdc supply is available on-board and may be switched by the SSR outputs.

B.10.2 Specifications

General

Output Connector	16-position, 5 mm Pluggable Terminal Strip. Four 2-position and two 4-position mating connectors provided. The connectors accept wire sizes of 0.25 to 2.5 mm^2 (AWG 12 to 22). See Table B.5 and Figure B.7 for Connector Configuration.

Digital Outputs

Output Quantity	4
Output Type:	5 V CMOS, individually configurable
Output Rating:	+5 V open-circuit, nominal
	75 mA peak current, per channel
	+3.5 V typical at 75 mA peak current
Available Output Signals:	Jumper selectable to any of the digital signals available from the clock mainframe plus on board generation of 1 PPS and Programmable Pulse for the 1200 and 1201 clock models. See Figure B.6 for Jumper location and selections.

Solid State Relay Output

Output Quantity:	2
Output Type:	Aromat AQV210E solid-state relays, 130 mA AC or DC at 350 V peak.
Output Rating:	Limited to 100 mA DC, 140 Vrms / 180 V peak by the fuse and surge suppression devices.
Output timing:	Propagation Delay, 90 μs Nominal, to 50 %.
	Rise Time, 50 μs Nominal, 20 % to 80 %.

Solid State Relay Output, continued

Output Power Supply:	Individually configurable for 0 Vdc, +25 Vdc, or +50 Vdc.
Available Output Signals:	1 PPS, Programmable Pulse, Locked and Out of Lock.
Pulse Width:	Individually configurable for a fixed, 50 ms pulse, or the default width of pulse provided by the clock mainframe.
Available Output Configurations:	1. Dry contact closure. 2. Contact closure to ground. 3. +25/50 Vdc switched for grounded load 4. +25/50 Vdc with contact closure to ground for non-grounded load. See Table B.10.2: Operating Modes of SSR Outputs.

Operating Modes of SSR Outputs

Mode = Dry Contact Closure

1. SSR Output 1 − Connect load to pins 10 and 11 (polarity not important)
2. SSR Output 2 − Connect load to pins 14 and 15 (polarity not important)

Mode = Contact Closure to Ground

1. Short pins 9 and 10, connect load to pin 11
2. Short pins 13 and 14, connect load to pin 15

Mode = +25/50 Vdc Switched to Grounded Load

1. Short pins 11 and 12, connect load to pins 9 (−) and 10 (+)
2. Short pins 15 and 16, connect load to pins 13 (−) and 14 (+)

Mode = +25/50 Vdc Switched to Floating Load

1. Short pins 9 and 10, connect load to pins 11 (−) and 12 (+)
2. Short pins 13 and 14, connect load to pins 15 (−) and 16 (+)

Pin	Function	Setup Jumpers: Default Settings
1 (Rightmost)	CMOS Output 1	JMP4: Signal Select Default = 1 PPH
2	Ground	–
3	CMOS Output 2	JMP3: Signal Select Default = 1 PPM
4	Ground	–
5	CMOS Output 3	JMP2: Signal Select Default = Prog. Pulse
6	Ground	–
7	CMOS Output 4	JMP1: Signal Select Default = IRIG-B
8	Ground	–
9	Ground	–
10	SSR Output 1	JMP5: Signal Select Default = 1 PPM
11	SSR Output 1	JMP7: Standard/50ms Default = 50 ms
12	+25/50 Vdc 1	JMP10: +25/50 Vdc Default = 50 Vdc
13	Ground	–
14	SSR Output 2	JMP6: Signal Select Default = 1 PPM
15	SSR Output 2	JMP8: Standard/50 ms Default = 50ms
16 (Leftmost)	+25/50 Vdc 2	JMP11: +25/50 Vdc Default = 50 Vdc

Table B.5: Output Connectors and Setup Jumpers

B.10.3 Firmware Configuration

1. It is necessary to verify the configuration in the Option Setup Menu so the option is recognized.
2. Apply power and observe the front panel display, when TIME NOT AVAILABLE? is displayed, press the SETUP key.
3. Navigate through the series of menu selections, using either the SETUP or UP key, until SET OPTION CONTROL? appears.
4. Press ENTER, and then press the UP key until 4 Outputs & 2 SSRs is displayed. Press ENTER.
5. Press any of the upper row of keys to exit from the SET OPTION CONTROL? configuration menus.

B.10.4 Output Jumper Setting Changes

1. Set the line power switch to OFF position (if equipped). Disconnect the power cord from rear panel.
2. Remove rack-ears (if equipped) and remove top cover using a T25 Torx driver (4 screws).
3. Locate the appropriate jumper using Figure B.6 and move the jumper to the desired setting.
4. Replace the top cover and rack-ears (if equipped).
5. Connect the power cord to the rear-panel and set the line power switch to ON position (if equipped).

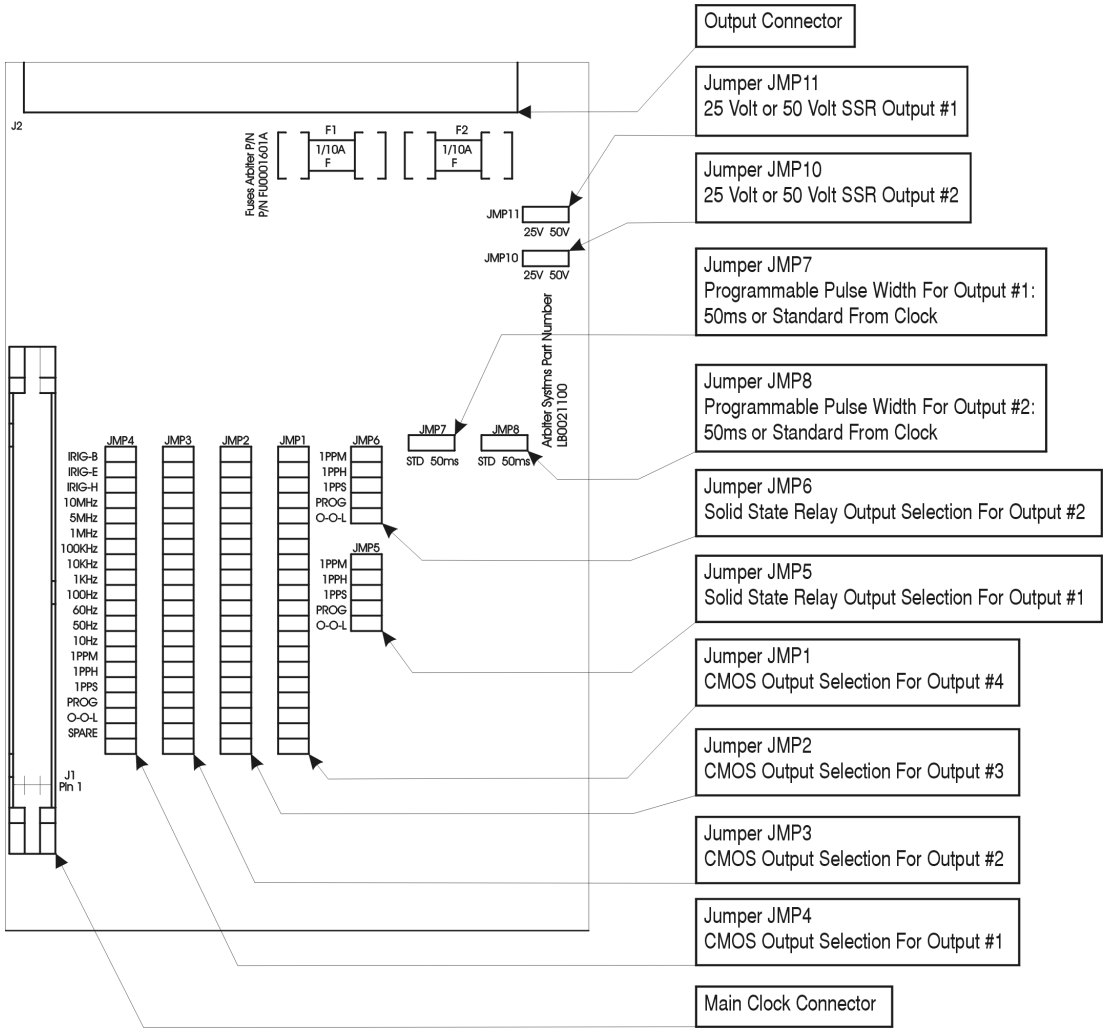


Figure B.6: Option Jumper Locations

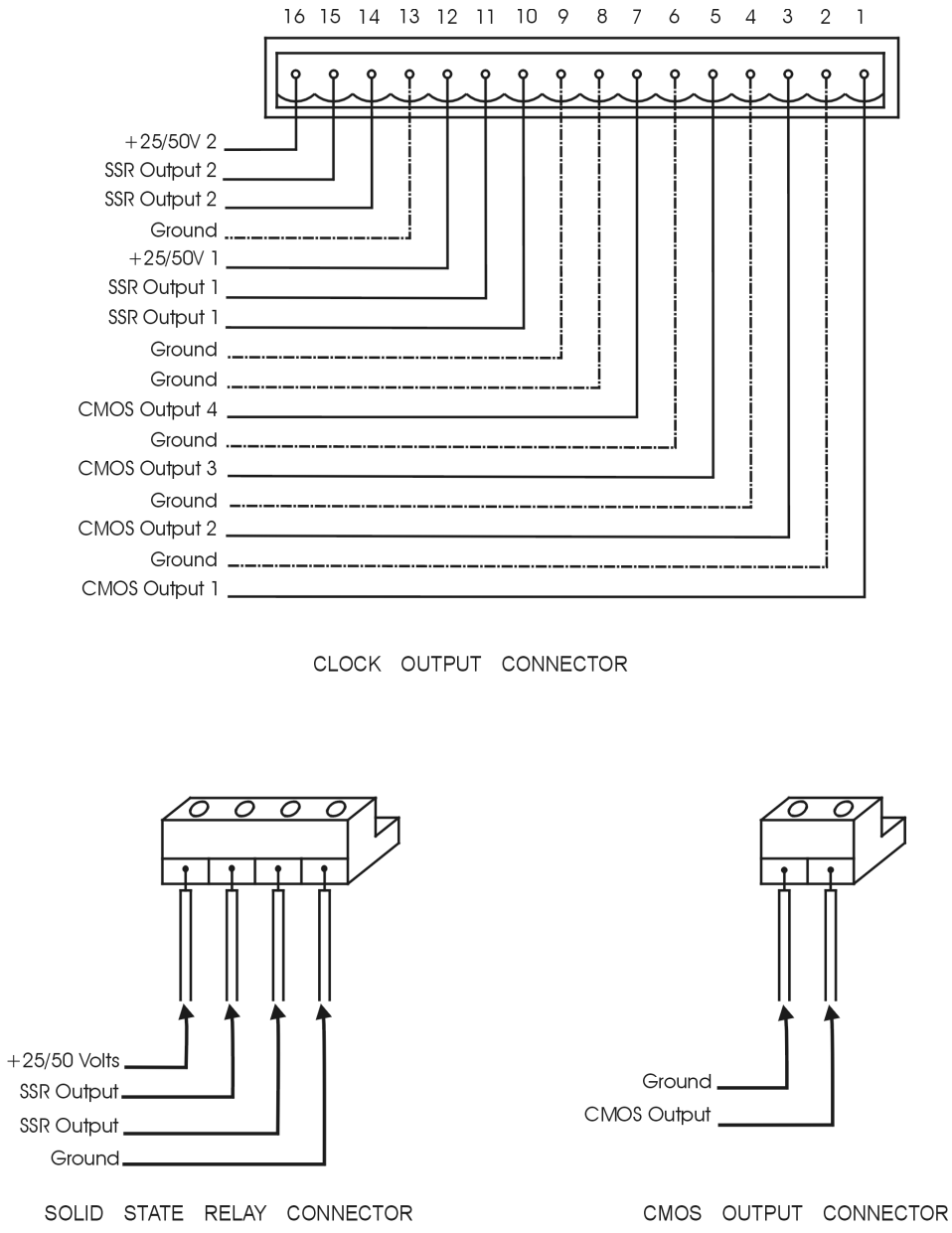


Figure B.7: Option Connector − Signal Locations

B.11 NTP/PTP Server

B.11.1 General Description

This option provides Network Time Protocol (NTP) and Precision Time Protocol (PTP)[2] servers. These instructions will assist you in the setup and configuration of the NTP/PTP server. Configure this option using the Web Interface or the SSH Console.

Standard configuration includes two copper Ethernet ports – Option E06. Optionally, order fiber optic connectors. Standard fiber connector is type LC, 62.5/125 μm 50/125 μm multimode fiber. Option E07 has one copper port and one fiber. Option E08 has two fiber ports. Contact the factory for other connector types.

The NTP/PTP Server has two independent server ports that can access either the NTP (versions 1, 2, 3 or 4 frames) or the PTP servers. This option has been designed in accordance with the latest NTP and PTP standards and may be updated whenever new firmware is available.

PTP with hardware assist offers much better accuracy than with NTP, however to achieve these accuracies requires PTP-enabled network components that provide for latency and jitter to be determined between the clock and each component. When designing for the ultimate in PTP accuracy, evaluate every component in the complete network.

Network Time Protocol (NTP) Server

The NTP/PTP Server allows the clock to act as network (NTP) time server over an Ethernet network and understands NTP version 1 – 4 frames, while optionally supporting authentication via DES and MD5 cryptographic checksums as defined in RFC 5905[3]. The NTP/PTP Server supports symmetric key authentication. Time is distributed over the network interface to computers, controllers and other equipment needing the correct time. The NTP/PTP Server allows a secure connection to configure, using either the preferred HTTPS Web Interface, or using the SSH Console.

Precision Time Protocol (PTP) Server

The NTP/PTP Server allows the clock to act as a Precision Time Server (PTP) according to Standard IEEE 1588 2008. However for highest accuracy, the entire network where PTP is required must have PTP-enabled network components. Without hardware assist through the physical interface, PTP will provide time with the same accuracy as with NTP. Accuracy with hardware assist using PTP should be better than 1 microsecond. Accuracy without hardware assist should be better than 100 microseconds.

Configuration Protocols

Three types of configuration protocols are allowed on the NTP/PTP Server: HTTP, HTTPS and Secure Shell (SSH). Of the three, HTTPS and SSH permit secure channels on the network between the user and the NTP/PTP Server. If a secure channel is required, choose either HTTPS using the Web Interface, or SSH using the Console. HTTPS requires that a valid signed certificate (PEM file) be uploaded into the NTP/PTP Server. Use of Console does not require a signed certificate. Both of these methods are discussed in the following pages, and both require a Username and Password to open a connection. To access the option configuration use the Web Interface you will need Web browser. To access the NTP/PTP Server using the Console, you will need an SSH client. These instructions use an SSH client called PuTTY when describing the Console Interface. NTP/PTP Server comes by default configured for an HTTP connection, and may be configured to use HTTPS.

[2] IEEE 1588v2 – IEEE 1588-2008

[3] Includes RFC 5906, 5907 and 5908

B.11.2 NTP/PTP Server Setup

This section covers initial setup of the NTP/PTP Server. Before the NTP/PTP Server can serve time accurately, the clock must be locked to the GNSS and stable. Once meeting these conditions, the NTP/PTP Server can provide reliable time to a network. The three subsections below will guide you through this initial phase of starting up the clock and configuring the NTP/PTP Server.

The NTP/PTP Server can be ordered with either static IP addresses, DHCP assigned IP addresses, or both static and DHCP. This information should help you decide how to configure the NTP/PTP Server. By default, the NTP/PTP Server is configured with NET 1 assigned a static IP and NET 2 assigned by DHCP.

Note: If your NTP/PTP Server has fiber optic connectors installed, do not disconnect cable while clock is operating or the NTP/PTP service may not recover. If fiber optic cables are disconnected while clock is operating and service stops, power cycle the clock.

Default Port Addresses

By default, the NTP/PTP Server comes configured as follows:

```
NET 1 IP address -- STATIC:  192.168.0.232
       Netmask               255.255.255.0
       Gateway               xxx.xxx.xxx.xxx

NET 2 IP address -- DHCP:    xxx.xxx.xxx.xxx
```

Selecting the NTP/PTP Server in Clock

Before you can use the NTP/PTP Server in your clock, make sure that it is selected as an option. Check the configured option using the Utility software, under the Option tab. Select NTP/PTP Server in the drop down window. Selection may be also checked at the front panel (with security disabled) by pressing the SETUP key and checking under the SET OPTION CONTROL submenu.

1. Press the SETUP key until you reach “SET OPTION CONTROL” and press “ENTER”.
2. Under “AUX BOARD OPTION” the second line will give the option name.
3. Use the UP or DOWN key to select “NTP/PTP Server” and press “ENTER.”
4. “NTP/PTP Server” should now be selected in the clock.

Option Setup Using RS-232 Commands

To select NTP/PTP Server, use a terminal program (HyperTerminal or Tera Term[4]) and null-modem cable. Important pins for a null-modem cable are indicated in Table B.6 below.

PC Port Pins	Clock Port Pins	Port Function
2	3	Transmit
3	2	Receive
5	5	Ground

Table B.6: Null-Modem Cable Connections

1. Open a terminal program at the same baud rate as the clock. The default port settings are 115,200 baud, 8 data bits, no parity and 1 stop bit.
2. Type the letter “v” to verify communication. It should return the firmware date code.
3. For Model 1201B/C type “6,1201XI” (without quotes) and the cursor should jump down to the next line without displaying a question mark.

[4]To download a free copy of Tera Term, see Arbiter website at http://www.arbiter.com/software/index.php.

4. NTP/PTP Server should now be selected in your clock.
5. To test it, type "IP" and it should return the IP addresses of the two Ethernet ports. With no Ethernet cable connected to a port, the IP command will return dashes for the IP address of that port. The MAC address will still be returned as illustrated below.

```
NET1:192.168.000.232 64:73:E2:XX:XX:XX        (Static IP)
NET2:---.---.---.--- 64:73:E2:XX:XX:XX        (DHCP)
```

Logging in with the Web Interface
See Section B.11.3 for details on using the web interface.

NTP Status Display Indications

During the stabilization process, the clock will display different status messages that indicate whether the NTP server is ready to serve time. Clock stabilization requires the clock to be locked to the GNSS for a period of time after which it will provide its time to the NTP/PTP Server. To view NTP/PTP status messages, press the SYSTEM key several times until reaching OPTION STATUS, then press ENTER and the UP or DOWN key.

Server Status: Waiting for clock to lock to satellites.

```
NTP: PLEASE WAIT
PTP: PLEASE WAIT
```

Server Status: Waiting for NTP to stabilize (up to 1 hour).

```
NTP: UNLOCKED
PTP: RUNNING
```

Server Status: Normal Operation.

```
NTP: LOCKED
PTP: RUNNING
```

Server Status: Synchronization problem on the NTP/PTP Server.

```
NTP: ERROR
PTP: RUNNING
```

After the Clock and Server Have Stabilized

After the GNSS clock and the NTP/PTP Server have stabilized, press the SYSTEM button to view server status, link status and port addresses (IP and MAC address).

Server Status

```
NTP: SYNCHRONIZED
PTP: RUNNING
```

Link Status: indicates whether the network connection is good or bad.

```
NET1:  GOOD LINK
NET2:  BAD LINK
```

Port Address:

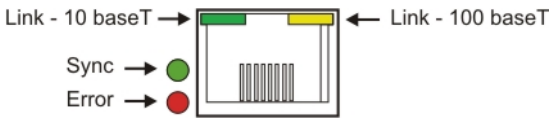
```
NET1:192.168.000.232
64:73:E2:XX:XX:XX
```

To Determine IP Address using RS-232 Commands

Type "IP" in the terminal window and the clock should return the IP and MAC addresses for both ports in separate lines. The IP command will return dashes for an IP address when no cable is connected to that port.

NTP/PTP Server LED Indications

To view the NTP/PTP Server Status LEDs, see the NTP/PTP Server rear panel. The figure and Table B.7 below describe the indications.



LED Name	Color	Meaning
LINK	Steady Green Steady Yellow OFF	Good Link, 10 Mb/s Good Link, 100 Mb/s Bad Link
SYNC	Steady Green OFF	NTP Server Synchronized NTP Server not Synchronized
ERROR	Red OFF	Startup/Error No Errors

Table B.7: NTP/PTP Server LED Indications

B.11.3 Web Interface

Instructions in this section cover the setup and maintenance of the NTP/PTP Server using the Web Interface. Configure the NTP/PTP Server insecurely through the Web Interface using HTTP, or securely using HTTPS. Both methods are discussed in this section. Instructions on using the Secure Shell (SSH) Console Interface for the same purpose are found in Section B.11.4. The NTP/PTP Server may only be configured through one of the Ethernet ports. However, to configure the clock use the front panel interface, or the Utility software.

Making Network Changes Permanent

After making the necessary network connection setting changes, the changes will be permanently committed only after a successful login is detected. These network changes include:

- Changing an IP address between DHCP and Static, or vice versa.
- Changing a port number.
- Changing the web interface between HTTP and HTTPS or vice versa.

It is IMPORTANT to login after making such changes to be sure that the changes are committed to the system. *Alternately, by power cycling the clock before logging back in, the clock will revert to the old settings.*

Logging in to the Web Interface

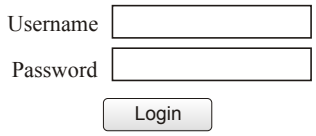
The Web Interface responds when you open a web browser and type in the IP address of one of the NTP/PTP Server ports. Each IP address may also be viewed on the front panel display if the port is connected to a network.

Default Port Addresses

NET 1 = 192.168.000.232

NET 2 = DHCP

1. Connect an Ethernet cable between one of the Ethernet ports on the NTP/PTP Server and your network.
2. Open your web browser and type in the IP address of the connected port in the web browser address bar.
3. Press the ENTER key, which should open the web interface login as seen below.



4. Type in the Username and Password. The Username is “clockoption”, and the default Password is “password”. The password may be changed from within the web interface.
5. Click the Login button. If you typed in the correct Username and Password, the web interface should appear as shown in Figure B.8.

Viewing the IP/MAC Address on the Front Panel

The front panel will indicate the IP address of each port provided a network cable is connected. Press the SYSTEM key until reaching OPTION STATUS NTP/PTP SERVER and press the ENTER key. Use the UP/DOWN keys to scroll to any network-related information, such as the connection (Link) status, the IP address or hardware address. Press any upper key to exit.

Return IP/MAC Address Serial Command

Returns the IP and MAC addresses of both ports of the NTP/PTP Option. Dashes are used to show either an unassigned or unconnected port IP address.

Command: **IP**

Sample response: `NET1: 192.168.000.232 64:73:E2:00:00:23<CR><LF>`
`NET2: ---.---.---.--- 64:73:E2:00:00:24<CR><LF>`

Important Configuration Change Notes

Certain configuration changes will cause you to lose the web interface connection. These configuration changes include:

1. changing from HTTP to HTTPS
2. changing a Network configuration
3. changing a System configuration on the port which you are connected.

If you are making changes to another port, the web interface connection will not be dropped. To make the changes persist, you will need to re-log in to the web interface using the new setting(s). To lose changes, reboot the clock. After making any changes to the NTP service, you may experience a delay of up to five minutes for the NTP service to start.

Startup Page: System

When logging in to the NTP/PTP Server using the web interface, the opening screen should be the System Status information page. This provides an overview of the operation of the NTP/PTP Server. Figure B.8 illustrates the opening System Status page.

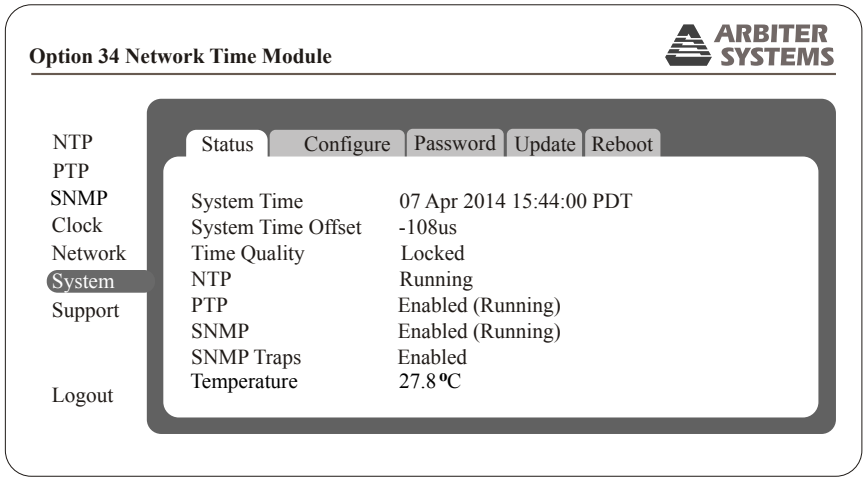


Figure B.8: Startup Page

System Configure Page

Figure B.9 illustrates the System configuration page for the NTP/PTP Server. It includes configuring for HTTP or HTTPS (see next section), enabling session time outs for the web interface and SSH Console, responding to ping requests and setting your time zone. Time zone setting only changes the time as it is read on the web interface under the Clock selection. Just as the receiving device must convert the NTP/PTP time as it arrives at the device to local time zone, so the clock time in the web interface can display local time. A number of time zone settings are found in Section B.11.7.

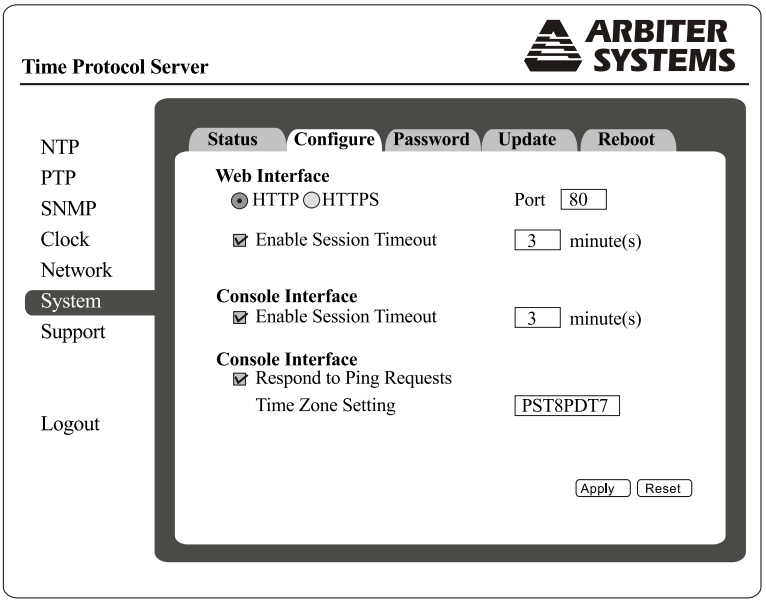


Figure B.9: System Configure Page

System Configure HTTPS Page

WARNING: If you plan to install your own PEM file, generated from a private key and a self-signed certificate, make sure to verify the PEM file before installation, or you could experience a denial of service, and may need to return your clock for repair.

To configure the HTTPS page, follow these instructions. Figure B.10 shows how configuring for HTTPS protocol opens up a dialog to upload a PEM file to the NTP/PTP Server system. After opening the System Configuration page (shown in Section B.11.3 click the HTTPS button and it will open the PEM file dialog shown in Figure B.10. A PEM file includes a private key and signed certificate. You can either purchase one or generate one yourself. A discussion on generating a PEM file using a self-signed certificate in Linux is located in Appendix C. OpenSSL is required to generate a PEM file in Windows 32-bit or 64-bit systems. This same method also seems to work fine in the Mac OS X environment.

Notice that the port numbers have changed from 80 with HTTP to 443 with HTTPS.

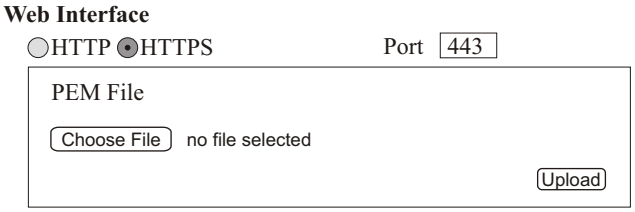


Figure B.10: Configure HTTPS

Enable Timeout (for Web Interface)

See Figure B.9. Check the box adjacent to "Enable Session Timeout" if you want the NTP/PTP Server to automatically log off of the web interface after a predetermined number of minutes. Minutes are declared in the adjacent box, from minimum of 3 to a maximum of 1440.

Console Interface

See Figure B.9. Check the box adjacent to "Enable Session Timeout" if you want the NTP/PTP Server to automatically log off of the SSH Console interface after a predetermined number of minutes. Minutes are declared in the adjacent box, from a minimum of 3 to a maximum of 1440.

Respond to Ping Requests

See Figure B.9. Check the box next to "Respond to Ping Requests" if you want the NTP/PTP Server to respond to ping requests. Leave it unchecked if you do not want the NTP/PTP Server to respond to ping requests.

Time Zone Setting

See Figure B.9. Values placed in this box are based on the POSIX format specification, and determine the time zone offset from UTC, including any Daylight Saving Time offsets. In this example, PST8 means Pacific Standard Time, which is 8 hours earlier than UTC. PDT7 means that Pacific Daylight Time is 7 hours earlier than UTC. For additional information on regional time offsets from UTC, see Section B.11.7. Note that the clock time indicated when selecting the Clock tab is the local time of the NTP/PTP Server.

System Configure Password

To configure the system password follow these instructions. From Figure B.9, select the Password tab. Figure B.11 shows where to configure the System password. In the System page, click the Password tab and fill in the current and new password. Click the Apply button. Password characters must be from ASCII 33 to ASCII 126, and passwords may be from 1 to 16 characters in length. Remember to write down any new password and keep it in a safe place.

Figure B.11: Configure System Password

System Update

Update packages may include uploading more than one file to the NTP/PTP Server. Make sure to follow the instructions included with the update packages. To update any NTP/PTP Server firmware package follow these instructions. From Figure B.9, select the Update tab and click the Choose File button shown in Figure B.12. This should open your file browser in which you should be able to locate the file package obtained from Arbiter Systems. Click the Update button and the file should load to the NTP/PTP Server. After uploading the package the NTP/PTP Server must be rebooted for the changes to take effect.

Figure B.12: Update System Firmware Package

System Reboot

To reboot the NTP/PTP Server follow these instructions. From Figure B.9 select the Reboot tab. Figure B.13 shows only one button to click to reboot the system. Be aware that rebooting the system will disconnect all active sessions with the NTP/PTP Server.

Figure B.13: Rebooting the System

Network Settings and Information

To view the network status of your NTP/PTP Server follow these instructions. Select the Network item on the left side of the web interface. Figure B.14 displays network status for both Ethernet NET 1 and NET 2. This includes the IP addresses, MAC addresses and some standard data traffic statistics.

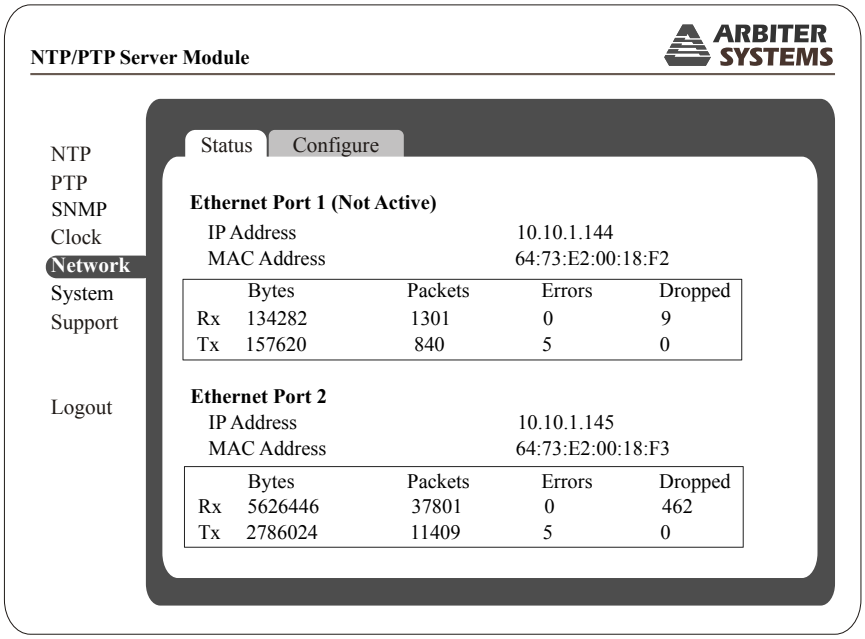


Figure B.14: Checking Network Status

Configure Network Settings

To configure the network settings of your NTP/PTP Server follow these instructions. Figure B.15 illustrates the configurable network functions on NTP/PTP Server. Notice that the Ethernet NET 1 Mode is selected as DHCP and Ethernet NET 2 Mode is selected as Static. When selecting Static, the additional settings (i.e. Address, Netmask and Gateway) will appear.

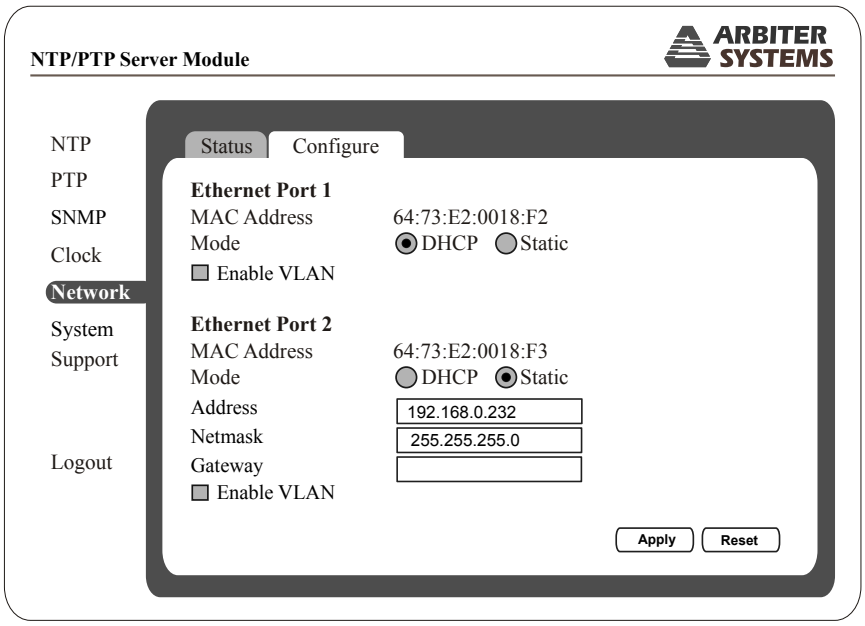


Figure B.15: Configure Network Settings

Configure VLAN

To configure VLAN network settings, follow these instructions. Check the box to the left of Enable VLAN to open these settings as seen in Figure B.16. Settings include an integer ID number, and priority value from 0 to 7 seen in the drop down box. VLAN ID (VID) values range from 0 to 4095.

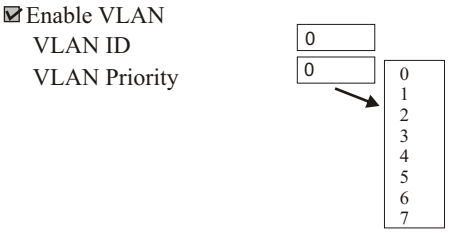


Figure B.16: Configure VLAN Network Settings

GNSS Status and Time Quality

This web interface page displays basic GNSS satellite information and time quality. Select this page to view Time Quality, Satellite information and Leap Seconds accumulated and pending, as shown in Figure B.17.

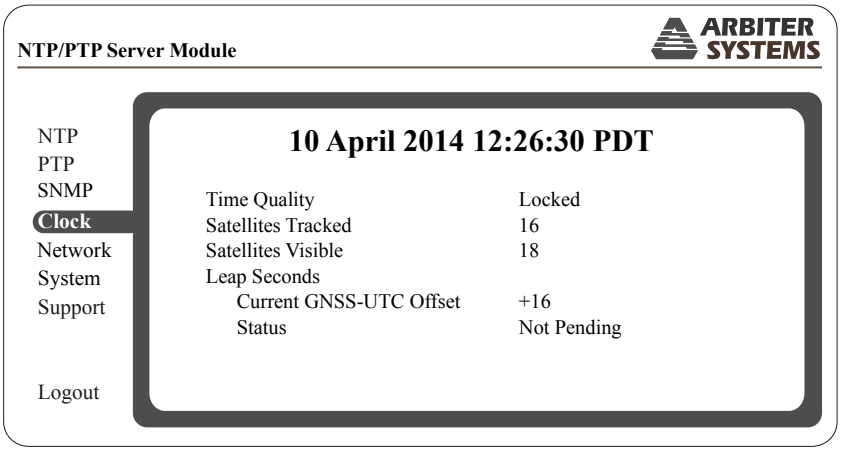


Figure B.17: View Operation

SNMP Status

View this web interface page to check the SNMP status as illustrated in Figure B.18. For additional detail on SNMP, see SNMP Support in Section B.11.5.

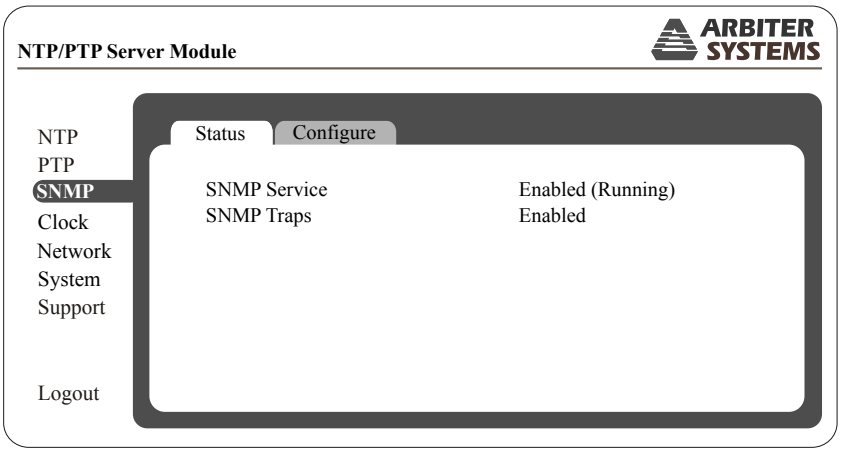


Figure B.18: View SNMP Operation

Configure SNMP

Follow these instructions to configure SNMP operation in the NTP/PTP Server. Figure B.19 illustrates the different selections for enabling the service and selecting traps (notifications). For definitions of SNMP "Configure" selections, see Section B.11.5.

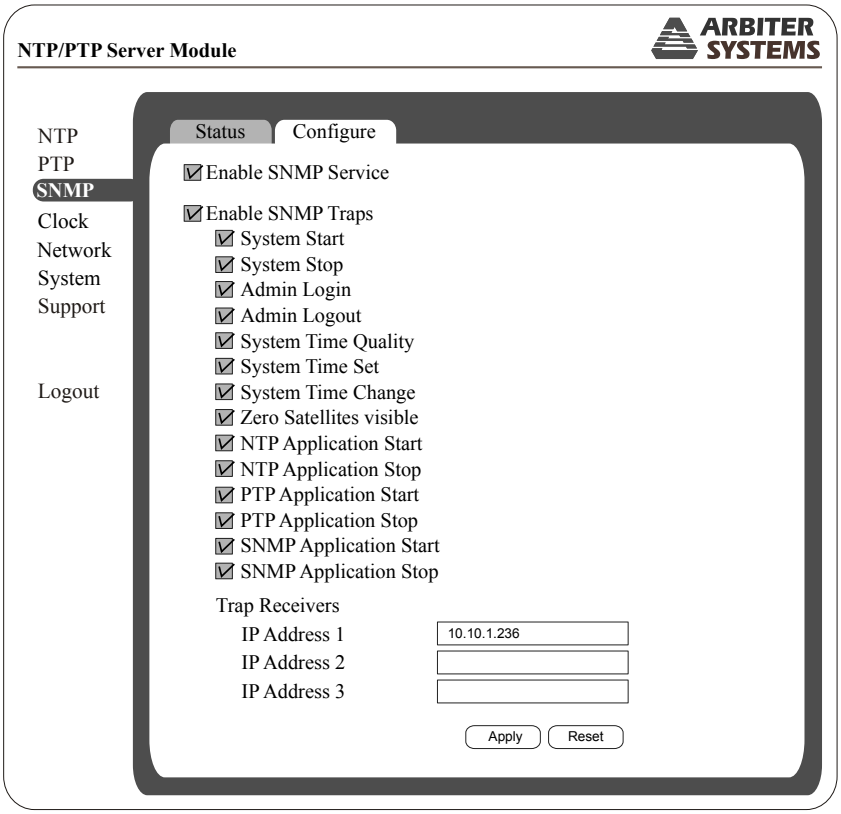


Figure B.19: SNMP Configuration Page

Checking the box enables the specific item; unchecking disables the specific item in the SNMP Configure page. For example, checking the "Enable SNMP Service" turns ON the service. Enabling SNMP Traps and checking specific SNMP traps (or notifications) will not send any notification unless a Trap Receiver is specified by an IP address. Make sure to click the Apply button or the changes will be lost.

PTP Status Page

To view the PTP service, select PTP tab on the left and the Status tab above. "+35" is the Current UTC/PTP Offset in seconds. Note that PTP time is referenced to International Atomic Time (TAI, from the French name *Temps atomique international*). The time offset may change from time to time when leap seconds are added. Figure B.20 illustrates the status of PTP.

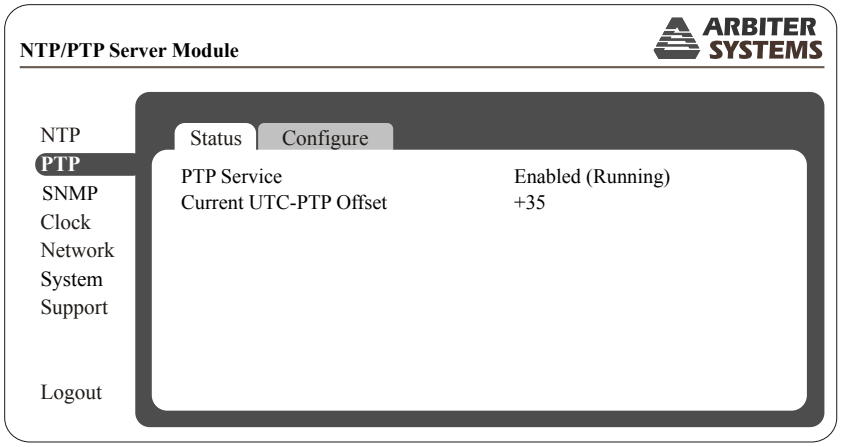


Figure B.20: PTP Status Page

PTP Configuration

To configure PTP follow these instructions. Figure B.21 illustrates the PTP configuration page. Choices for the Delay Mechanism include either P2P (Peer to Peer) or E2E (End to End). Protocol choices include UDP IPv4, UDP IPv6 or Layer 2. Figure B.21 shows the Advanced settings, which can be hidden using the Hide Advanced button.

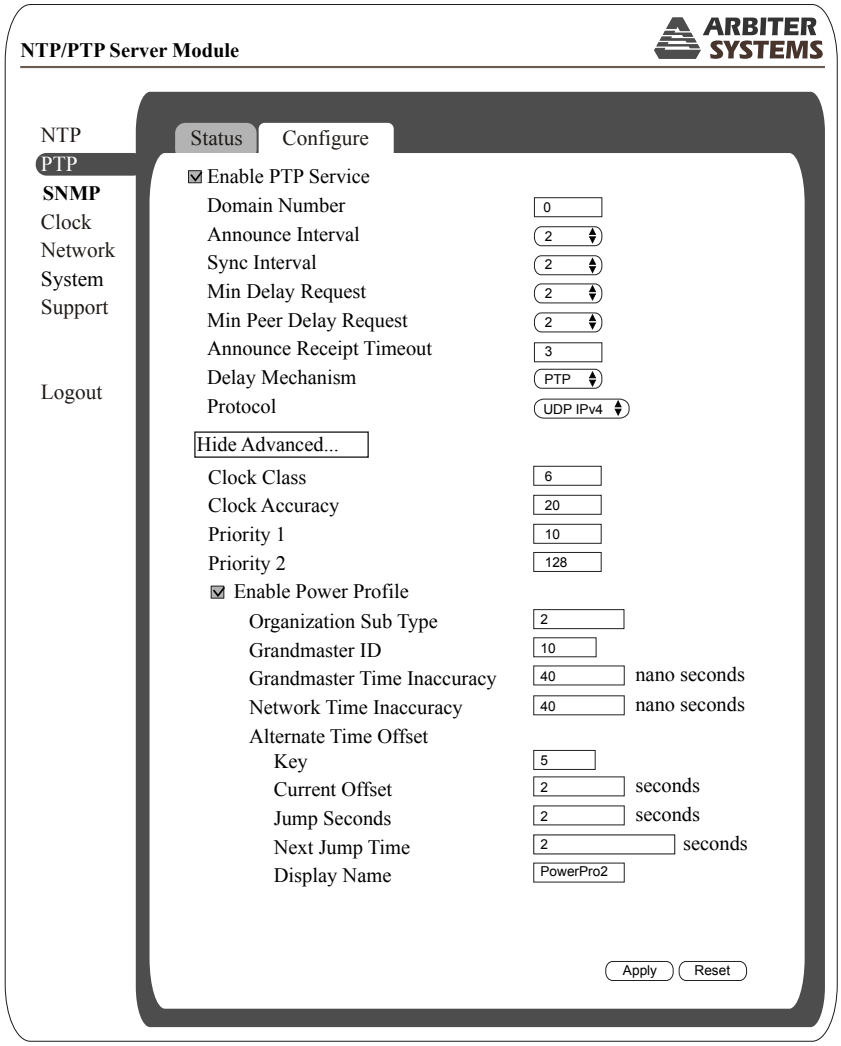


Figure B.21: PTP Configuration Page

PTP Terms

- Domain: a collection of one or more PTP subdomains. A subdomain is a logical grouping of 1588 clocks that synchronize to each other using the PTP protocol, but that are not necessarily synchronized to PTP clocks in another PTP subdomain. Subdomains provide a way of implementing disjoint sets of clocks, sharing a common network, but maintaining independent synchronization within each set.
- Announce interval: specifies the interval between the announce messages. The Announce message is used to establish the synchronization hierarchy. PTP message intervals are always stated and communicated as logarithm to the base of 2 So a setting of 0 means that there is an Announce message being sent every second.

Message interval [ld]	Message interval [sec]
-2	0.25
-1	0.5
0	1
1	2
2	4
3	8

Table B.8: PTP Message Intervals

- Sync interval: the time for sending synchronization messages. The default is 1 second.
- Delay request interval: specifies the time recommended to the member devices to send delay request messages when the port is in the master state. The range is -1 second to 6 seconds. The default is 5 (32 seconds).
- Peer Delay Request: the initial value used before receiving an update in a delay response message from a master clock. It is only used when peer-to-peer (P2P) Delay mechanism is used. Should be $\geq$ the Sync Interval but $\leq$ 32 times the Sync Interval.
- Announce receipt timeout: the number of Announce Intervals that have to pass without receipt of an Announce message before another grandmaster capable clock starts sending its own announce messages. The number is a multiple of the Announce Interval. The minimum number is 3.
- Delay mechanism: communication delay, end to end or peer to peer.
- Protocol: UDP IPv4, UDP IPv6 or Layer2.
- Clock class value: advertises the quality level of the clock. A GNSS clock is given the value of 6.
- Clock accuracy: 22 is used for clock accuracy to within 250 ns.
- Priority 1: the user configurable designation that a clock belongs to an ordered set of clocks. It can bypass the best master clock algorithm. The default is 128 which indicates that the clock is a master.
- Priority 2: the user configurable designation that sets a clocks selection order among equivalent clocks. It determines whether the clock is a Boundary Clock or not. A Boundary Clock is a PTP clock with multiple connections and can act as a master or slave, synchronizing itself to the best master clock. The NTP/PTP Server is not yet available as a Boundary clock so this should be set to 128.
- Two Step: the clock step determines whether the timing information is sent along with the sync message only (one-step) or a subsequent follow-up message (two-step) is sent corresponding to the previous sync message.

NTP Status Page

To view the NTP service, select NTP tab on the left and the Status tab above. Figure B.22 illustrates the status of NTP.

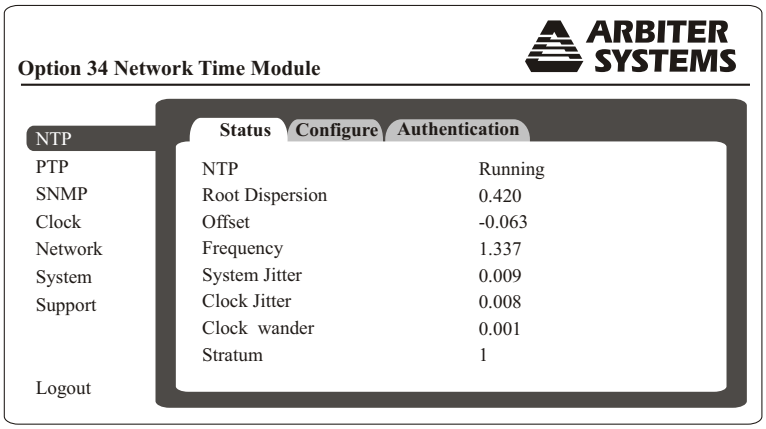


Figure B.22: NTP Status Page

NTP Terms

- NTP: either running or stopped.
- Root Dispersion: (or dispersion) represents the maximum error of the local clock relative to the reference clock.
- Offset: (or clock offset) represents the amount to adjust the local clock to bring it into correspondence with the reference clock.
- Frequency: frequency offset (PPM) relative to hardware clock.
- System Jitter (psi): is defined as the root-mean-square (RMS) average of the most recent offset differences, and it represents the nominal error in estimating the offset (of the system).
- Clock Jitter: is defined as the root-mean-square (RMS) average of the most recent offset differences, and it represents the nominal error in estimating the offset (of the clock).
- Clock wander: is the RMS of exponentially weighted frequency differences. This is not used directly, but can, along with the jitter, be a highly useful monitoring and debugging tool.
- Stratum: the level of each server in the hierarchy is defined by a stratum number. Primary servers are assigned stratum one.

NTP Configure

To configure NTP follow these instructions. Figure B.23 illustrates the NTP configuration page. Choices for the NTP Version include Versions 1, 2, 3 and 4. Multicast and Broadcast addresses may be typed in the assigned boxes.

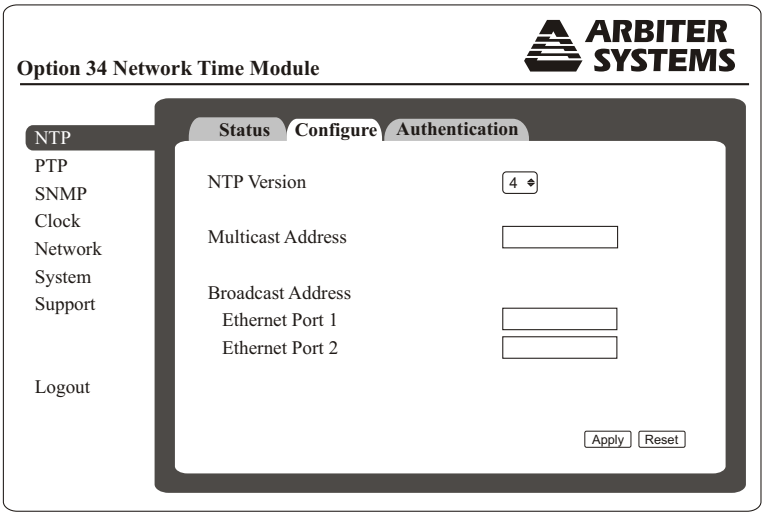


Figure B.23: NTP Configure Page

NTP Authentication

Authentication involves advanced configuration for NTP, and used to prevent tampering with the timestamps on the logs generated by devices. You can configure a device to authenticate the time sources to which the local clock is synchronized. When you enable NTP authentication, the device synchronizes to a time source only if the source carries one of the authentication keys specified by the ntp trusted-key command. The device drops any packets that fail the authentication check and prevents them from updating the local clock. NTP authentication is disabled by default.

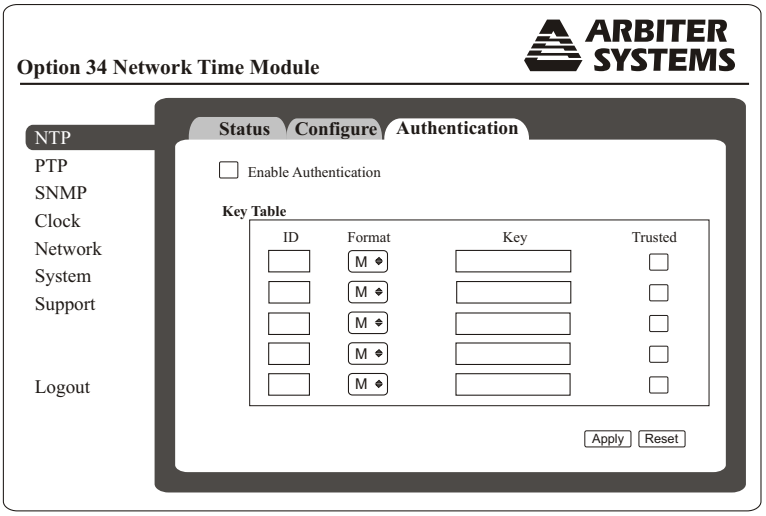


Figure B.24: NTP Authentication Page

There are four authentication formats (S, N, A, M) with different rules for each of the keys. For example, a type M format (MD5) allows the key to have up to 31 ASCII characters like a password. The key ID is an integer and identifies the NTP server key. If authentication is enabled, the client will only synchronize with the server if it is trusted. Therefore, you must select the “Trusted” check box on the authentication page.

NTP/PTP Server Support Pages

Use this page, with Figure B.25, to contact Arbiter Systems and for version support.

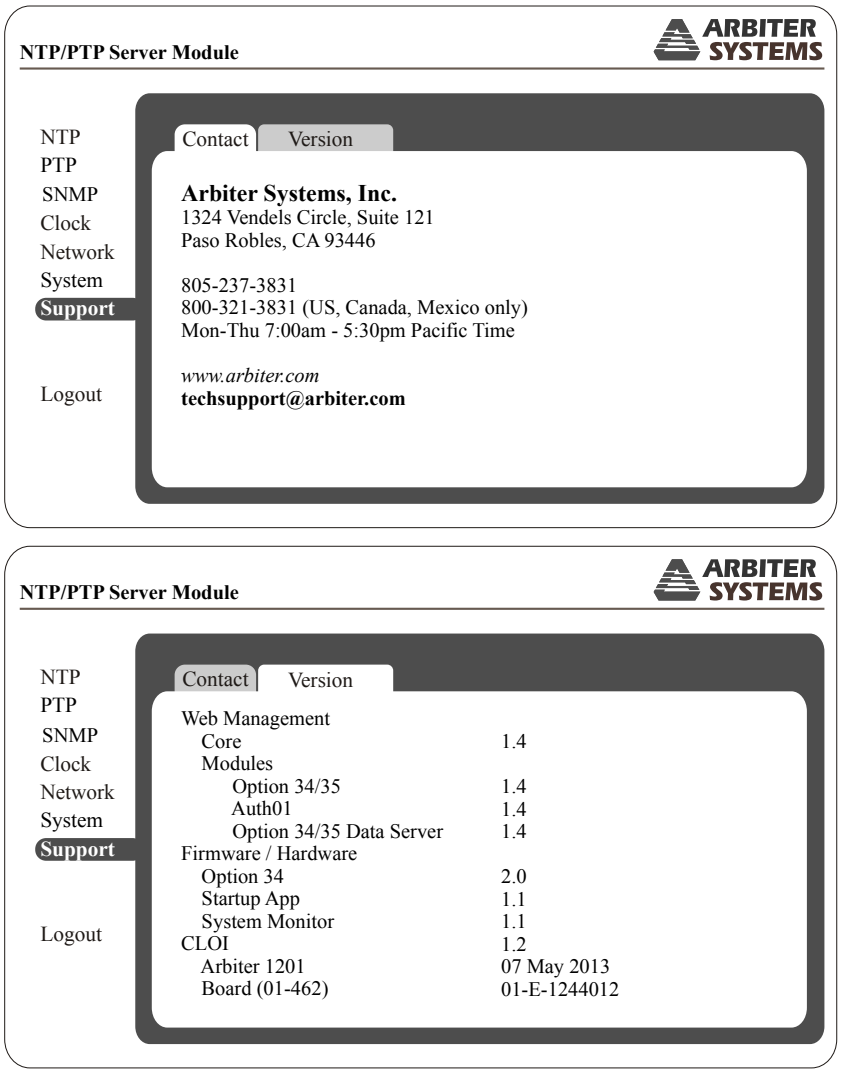


Figure B.25: Contact and Version Information Pages

B.11.4 SSH Console Interface

These instructions cover the setup and maintenance of using the Secure Shell (SSH) Console Interface. Secure Shell is an alternative to using the Telnet protocol, and used for securely gaining access to a remote system like the optional NTP/PTP Server. Configure all settings through one of the Ethernet ports. Instructions on using the Web Interface for the same purpose are found in Section B.11.3.

Any Secure Shell (SSH) client, like OpenSSH or PuTTY™, is suggested. Make sure to select SSH and type in the device's IP address and connect. For Mac users, Terminal works fine. At the command prompt (▷ is the command prompt) type: ▷`ssh clockoption@`*`host`* where *`host`* is either the hostname (if served by your DNS server) or the IP address.

Press ENTER after typing the IP address. Shortly, you should be prompted for the password. Type in the password and press ENTER. The console interface should open and appear similar to Figure B.26.

Startup Page: System Status

When logging in to the NTP/PTP Server using SSH console the opening screen should be the System Status information page. This provides an overview of the operation of the NTP/PTP Servers. Figure B.26 illustrates the opening page.

```
User -- ssh clockoption@(IP address) -- 80x24

Time Protocol Server                                   ARBITER
                                                       SYSTEMS

  PTP      [ Status ] Configure | Password | Update | Reboot
  NTP
  SNMP       System Time            : 14:28:33  05/19/2014
  Clock      System Time Offset     : -114us
  Network    Time Quality           : Locked
[ System ]   NTP                    : Running
  Support    PTP                    : Enabled (Running)
             SNMP                   : Enabled (Running)
             SNMP Traps             : Enabled
  Logout     Temperature            33.3C
```

Figure B.26: SSH Console Interface: Startup Screen

If you do not know the IP address of the port you are connected to, press the SYSTEM key on the front panel several times until you reach OPTION STATUS and press the ENTER. Press the UP or DOWN keys to scroll through the NTP/PTP server pages. Messages should appear separately for NET 1 and for NET 2. If the IP addresses do not appear, then check to make sure a network cable is connected between the chosen port and an active network. If there is no DHCP server on the network, a port set for DHCP will not display. Factory default settings include one port set with a static IP address. Make sure that the Link LED is lit.

IP addresses for all Ethernet ports of the installed NTP/PTP Server are either set automatically by the Dynamic Host Configuration Protocol (DHCP) server on your network, or set to a static address. The front panel will indicate the IP address of each port. The default static IP address is 192.168.0.232.

Useful Keys for Console Navigation

Arrow Keys	–	navigate up, down, left, and right
Enter	–	accept the current selection
SPACE	–	accept the current selection except in edit fields (same as Enter)
Tab	–	cancel an edit/change
Q or q	–	select the Logout menu item

Use the cursor keys to navigate the console elements.

System Configure Page

Figure B.27 illustrates the System configuration page for the NTP/PTP Server. It includes configuring for HTTP or HTTPS (see next section), enabling session time outs for the web interface and console, responding to ping requests and setting your time zone. Time zone setting only changes the time as it is read on the clock display. Just as the receiving device must convert the NTP/PTP time as it arrives at the device to local time zone, so the clock can display local time.

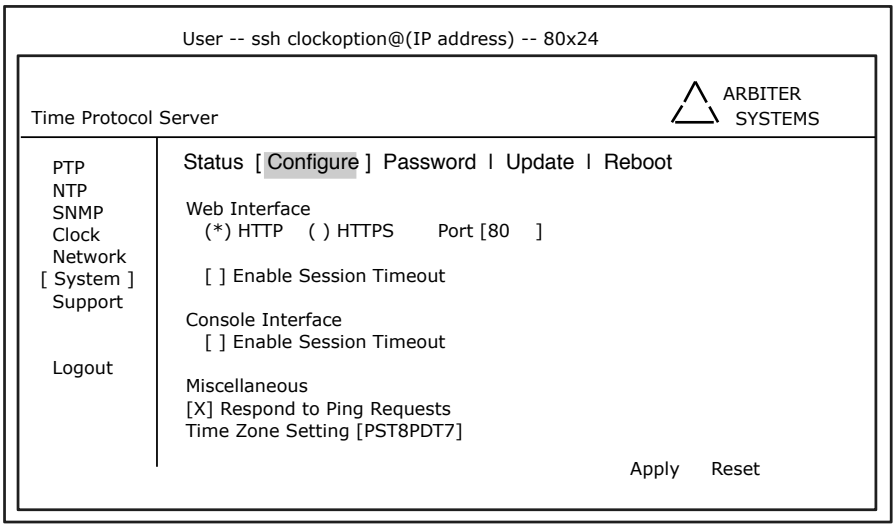


Figure B.27: System Configure Page Using SSH

Configure HTTPS Page

To configure the HTTPS page you must use the Web Interface. For more information see Section B.11.3.

Time Zone Setting

Values placed in this box determine the time zone offset from UTC. In this example, PST8 means Pacific Standard Time, which is 8 hours earlier than UTC. PDT7 means that Pacific Daylight Time is 7 hours earlier than UTC. For additional information on regional offsets, see Section B.11.7.

Configure Session Timeouts

From the System Configure page, use the cursor keys to navigate to the specific timeout feature (either Web Interface or Console Interface) and press ENTER to select. Press ENTER again to deselect.

Configure Password

Using the cursor keys navigate to the System Password page (Figure B.28). In the System/Password page, fill in the old and new password. Remember to write down any new password and keep it in a safe place.

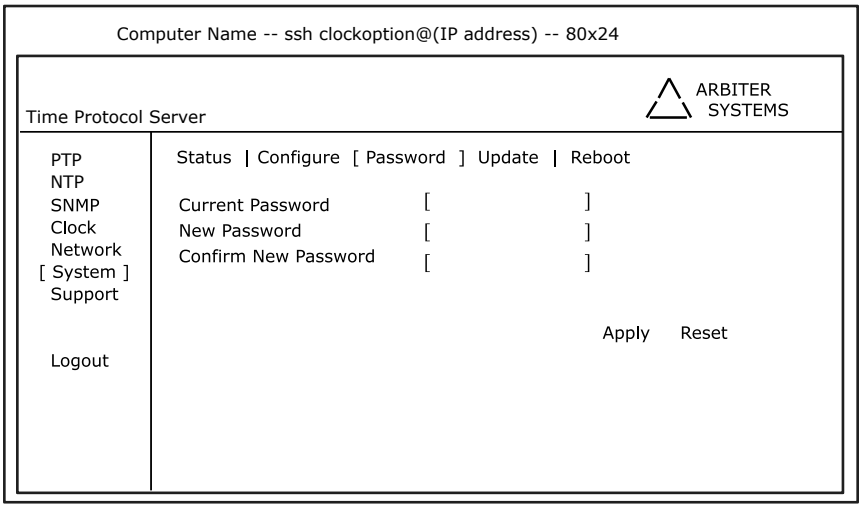


Figure B.28: Configure System Password Using SSH

System Update

The SSH console now allows you to update system files, however it requires that you have an ssh daemon running on the remote server that supports secure copy (scp). It also requires a valid username and password to access the remote server. Finally, you will need to supply a filepath to the update file(s), including only alpha-numeric characters, dash, underscore and path separator (- _ /).

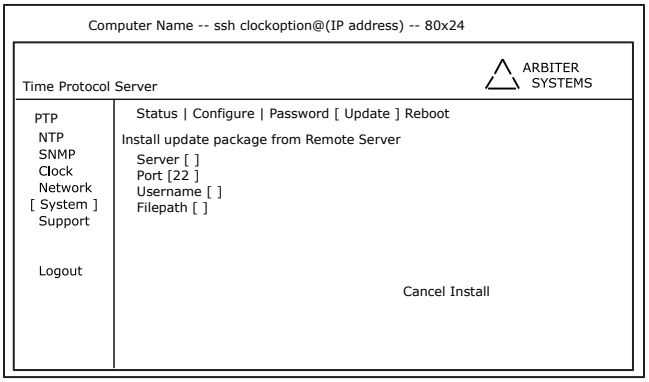


Figure B.29: Update Operating System Using SSH

Firmware Update Example

In this example the was updated from a computer on the same subnet. Supplied information is shown below in brackets.

- Server: [10.10.1.149]
- Port: [22]
- Username: [user]
- Filepath: [/User/user/Desktop/opt34_tps_02.08_update-00.07.apf]

Type the values as indicated in the Update window. The server is considered remote since the Option 34 is pulling a file from the server. In this example the server was a local computer on the same subnet as the clock. Depending on your network and DNS configuration, you may enter a hostname or (always) an IP address. After typing in all the required values, highlight "Install" and press ENTER on the keyboard. A message should appear as follows:

Beginning the file transfer using scp
Password:

Type in the user password (of the remote server or pc) and press ENTER. The ssh console should supply a message that the file was successfully transferred.

System Reboot

Use the cursor keys to navigate to System Reboot, highlight Reboot and press ENTER. Select Yes or No to confirm your choice and press ENTER again. After the system has rebooted, you will need to log back on to the NTP/PTP Server.

Network Settings and Information

To view the network status of your NTP/PTP Server using the SSH Console follow these instructions. Use the cursor keys to navigate to Network Status (Figure B.30), which should display the network status for both Ethernet ports, 1 and 2. This includes the IP addresses, MAC addresses and some standard data traffic statistics.

```
Computer Name -- ssh clockoption@(IP address) -- 80x24

Time Protocol Server                                   ARBITER
                                                       SYSTEMS

  PTP        [ Status ]  Configure
  NTP
  SNMP       Ethernet Port 1
  Clock          IP Address                      10.10.1.145
[ Network ]      Hardware Address                64:73:E2:00:17:38
  System                 Bytes       Packets      Errors     Dropped
  Support    Rx        2649123       39782           0         110
             Tx        1554398       11894           5           0

  Logout     Ethernet Port 2  (Not Active)
                 IP Address
                 Hardware address                64:73:E2:00:17:39
                         Bytes       Packets      Errors     Dropped
             Rx              0           0           0           0
             Tx              0           0           0           0
```

Figure B.30: Checking Network Status Using SSH

Configure Network Settings

To configure the network settings of your NTP/PTP Server follow these instructions. Figure B.31 illustrates the configurable network functions on the NTP/PTP Server. Notice that the NET 1 Mode is selected as DHCP and NET 2 Mode is selected as Static. When selecting Static, the additional settings (i.e. Address, Netmask and Gateway) will appear as seen on NET 2.

```
Computer Name -- ssh clockoption@(IP address) -- 80x24

Time Protocol Server                                   ARBITER
                                                       SYSTEMS
  PTP        Status  [ Configure ]
  NTP
  SNMP       Ethernet Port 1
  Clock          Hardware Address                 64:73:E2:00:18:F2
[ Network ]      ( ) DHCP    (*) Static
  System         IP Address                       [192.168.000.232]
  Support        Netmask                          [   255.255.255.0]
                 Gateway                          [                 ]
  Logout         [ ] Enable VLAN

                 Ethernet Port 2
                     Hardware Address             64:73.E2.00.18.F3
                     (*) DHCP    ( ) Static
                     [X] Enable VLAN
                         VLAN ID        [0    ]
                         VLAN Priority  [0]                    Apply    Reset
```

Figure B.31: Configure Network Settings Using SSH

Enable VLAN

From Figure B.31 notice on NET 2 that Enable VLAN is selected. When selected, the two lines below Enable VLAN appear. These two lines disappear when Enable VLAN is deselected. For VLAN ID, type in up to any four-digit integer. For VLAN Priority, type in any value between 0 and 7.

GNSS Status and Time Quality

This web interface page displays basic GNSS satellite information and time quality. Select this page to view Time Quality, Satellite information and Leap Seconds accumulated and pending, as shown in Figure B.32.

```
Computer Name -- ssh clockoption@(IP address) -- 80x24

Time Protocol Server                                   ARBITER
                                                        SYSTEMS
  PTP
  NTP                      19 May 2014 12:49:17 PDT
  SNMP
[ Clock ]
  Network      Time Quality                    :  Locked
  System       Satellites Tracked              :  26
  Support      Satellites Visible              :  23
               Leap Seconds
                   Current GPS-UTC Offset      :  16
                   Status                      :  Not Pending
  Logout
```

Figure B.32: View Operation Using SSH

SNMP Status

Use the cursor keys to select SNMP, then Status and press ENTER to view the SNMP status as illustrated in Figure B.33.

```
Computer Name -- ssh clockoption@(IP address) -- 80x24

Time Protocol Server                                   ARBITER
                                                        SYSTEMS
  PTP        [ Status ]  Configure
  NTP
[ SNMP ]      SNMP Service                  : Enabled (Running)
  Clock       SNMP Traps                    : Enabled
  Network
  System
  Support
  Logout
```

Figure B.33: View SNMP Operation Using SSH

Configure SNMP

Please use the Web Interface to configure SNMP. See Section B.11.3 for information.

PTP Status Page

To view the PTP service, select PTP tab on the left and the Status tab above. Figure B.34 illustrates the status of PTP.

```
Computer Name -- ssh clockoption@(IP address) -- 80x24

Time Protocol Server                                   ARBITER
                                                        SYSTEMS

[ PTP ]      [ Status ]  Configure
  NTP
  SNMP        PTP Service                      : Running
  Clock           Ethernet Port                1: Disabled
  Network         Ethernet Port                2: Disabled
  System      Current PTP--UTC Offset:         : +36
  Support

  Logout
```

Figure B.34: PTP Status Page Using SSH

Configure PTP Service

Please use the Web Interface to configure PTP. See Section B.11.3 for more information.

NTP Status Page

Use the cursor keys to select NTP, then Status and press ENTER. Figure B.35 illustrates the status page for NTP.

```
Computer Name -- ssh clockoption@(IP address) -- 80x24

Time Protocol Server                                   ARBITER
                                                        SYSTEMS

  PTP        [ Status  ] Configure  |  Authentication
[ NTP ]
  SNMP        NTP                      :  Running
  Clock       Root Dispersion          :  0.451
  Network     Offset                   :  0.095
  System      Frequency                :  8.623
  Support     System Jitter            :  0.008
              Clock Jitter             :  0.010
              Clock Wander             :  0.001
  Logout      Stratum                  :  1
```

Figure B.35: NTP Status Page Using SSH

NTP Terms

- **NTP**: reveals that it is either running or stopped.
- **Root Dispersion**: (or dispersion) represents the maximum error of the local clock relative to the reference clock.
- **Offset**: (or clock offset) represents the amount to adjust the local clock to bring it into correspondence with the reference clock.
- **Frequency**: frequency offset (PPM) relative to hardware clock.
- **System Jitter**: is defined as the root-mean-square (RMS) average of the most recent offset differences, and it represents the nominal error in estimating the offset (of the system).
- **Clock Jitter**: is defined as the root-mean-square (RMS) average of the most recent offset differences, and it represents the nominal error in estimating the offset (of the clock).
- **Clock wander**: is the RMS of exponentially weighted frequency differences. This is not used directly, but can, along with the jitter, be a highly useful monitoring and debugging tool.
- **Stratum**: the level of each server in the hierarchy is defined by a stratum number. Primary servers are assigned stratum one.

NTP Configure

To configure NTP follow these instructions. Use the cursor keys to select NTP, then Configure and press ENTER. Figure B.36 illustrates the NTP configuration page. Choices for the NTP Version include Versions 1, 2, 3 and 4. Multicast and Broadcast addresses may be typed in the assigned boxes.

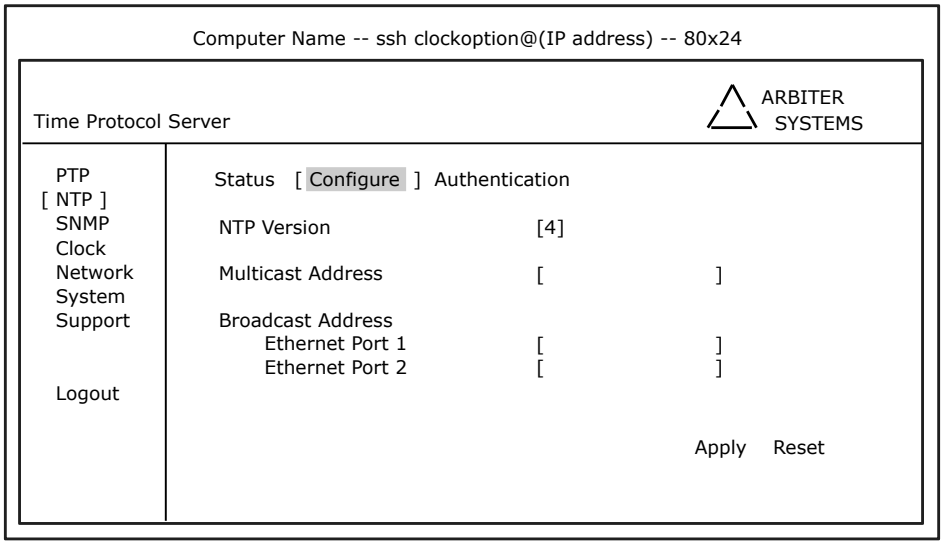


Figure B.36: NTP Configure Page Using SSH

NTP Authentication

Authentication involves advanced configuration for NTP, and used to prevent tampering with the timestamps on the logs generated by devices. You can configure a device to authenticate the time sources to which the local clock is synchronized. When you enable NTP authentication, the device synchronizes to a time source only if the source carries one of the authentication keys specified by the ntp trusted-key command. The device drops any packets that fail the authentication check and prevents them from updating the local clock. NTP authentication is disabled by default.

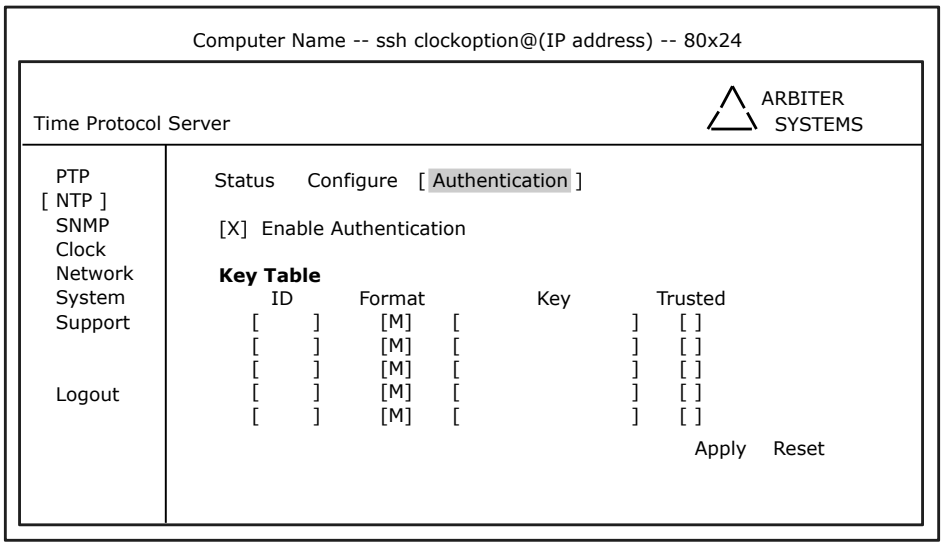


Figure B.37: NTP Authentication Page Using SSH

There are four authentication formats (S, N, A, M) with different rules for each of the keys. For example, a type M format (MD5) allows the key to have up to 31 ASCII characters like a password. The key ID is an integer and identifies the NTP server key. If authentication is enabled, the client will only synchronize with the server if it is trusted. Therefore, you must select the "Trusted" check box on the authentication page.

NTP/PTP Server Support Pages

Use this page, with Figure B.38, to contact Arbiter Systems and for version support.

```
Computer Name -- ssh clockoption@(IP address) -- 80x24

Time Protocol Server                                   ARBITER
                                                       SYSTEMS
  PTP        [ Contact ]  Version     Update Log
  NTP
  SNMP        Arbiter Systems, Inc.
  Clock       1324 Vendels Circle, Suite 121
  Network     Paso Robles, CA 93446
  System
[ Support ]   800-321-3831 (US, Cananda, Mexico only)
              805-237-3831
              Mon-Thu 7:00am-5:30pm  Pacific Time
  Logout
              www.arbiter.com
              techsupport@arbiter.com
```

```
Computer Name -- ssh clockoption@(IP address) -- 80x24

Time Protocol Server                                   ARBITER
                                                       SYSTEMS
  PTP        Contact  [ Version ]  Update Log
  NTP
  SNMP        Console Management
  Clock          Core                          2.5
  Network        Modules:
  System            Auth01                     2.2
[ Support ]         TPS UI Content             2.2

              Firmware / Hardware
  Logout
              Startup App                      1.3
              System Monitor                   1.4
              CLOI                             1.10
              Arbiter 1201                     24 Mar 2016
              Board (01-462)                   01-E-1244233
```

Figure B.38: Contact and Version Information Pages Using SSH

Firmware Update Log

Select the Update Log to view the firmware updates that have been loaded and are running.

B.11.5 SNMP Support

This section provides more detail about Simple Network Management Protocol (SNMP). SNMP was created to provide a standard for managing different networks and the devices on the networks. As such, SNMP is designed to operate on the application layer using different transport protocols (e.g. TCP/IP and UDP), making it independent of network hardware.

An SNMP managed network consists of three components: A managed device, an agent and a network-management system (NMS). The clock is a managed device running an SNMP agent that responds to queries from the network-management system.

SNMP Version Information

Currently, there are three versions of SNMP defined: SNMP v1, v2 and v3. The clock supports these three versions. Here are some differences between versions.

SNMP v1. Basic Operations and Features

- GetUsed by the NMS to retrieve the value of one or more object instances from and agent.
- GetNextUsed by the NMS to retrieve the value of the next object instance in a table or a list within an agent.
- SetUsed by the NMS to set the values of the object instances within an agent.
- TrapUsed by agents to asynchronously inform the NMS of a significant event.

SNMP v2. Additional Operations and Features

- GetBulkUsed by the NMS to efficiently retrieve large blocks of data.
- InformAllows one NMS to send trap information to another NMS and to then receive a response.

SNMP v3. Security Enhancement

- User-based Security Model (USM) for SNMP message security.
- View-based Access Control Model (VACM) for access control.
- Dynamically configure the SNMP agents using SNMP SET commands.

Management Information Base (MIB) Table

Object names are stored in a (MIB) table that reside on a computer, and correspond to values in a managed device. The agent in the NTP/PTP Server will respond to queries from the management program to return values of these objects. Currently, management programs may only read the status of the clock and not configure settings. See Section B.11.5 for a print out of the current MIB table. A soft copy of the MIB table is available to download from the Arbiter Systems website at the following address: www.arbiter.com.

SNMP Service

Descriptions that follow are based on the web interface. The SNMP service (agent) runs on the NTP/PTP Server when enabled in the configuration. Figure B.18 illustrates the SNMP Status screen, which shows that both the SNMP service and traps are enabled. To view the SNMP Status screen, log in to the NTP/PTP Server with the web interface and select the SNMP tab on the left.

Note that SNMP configuration is available only through the web interface.

SNMP Traps

SNMP Traps (v1) or Notifications (v2) may be used to:

- send notification of a change

- signify a problem with the system
- notify that some needed system maintenance was performed
- notify that someone has logged on to the system

Traps, or notifications, are generally sent to an IP address of a computer running SNMP management software. The NTP/PTP Server can store up to three separate target IP addresses.

Enabling SNMP Service and Configuring SNMP Traps

To configure snmp, open your web browser and log in to the NTP/PTP Server. *Note: SNMP cannot be configured using the SSH Console.* Select "SNMP" on the left and "Configure" tab at the top. Figure B.19 illustrates a list of selection boxes to configure your snmp service and traps. At the bottom are three boxes for IP addresses designated as trap receivers, where trap messages may be sent.

SNMP Configuration Reference

Listed below are the configurable options available for snmp traps. Trap events will only be sent out if the Trap Receivers are selected and identified by a valid IP address.

- **Enable SNMP Service**: Select this item to make the snmp service active.
- **Enable SNMP Traps**: Select this item to make any snmp trap active.
    1. **Enable System Start**: notifies when the "System" (i.e. NTP/PTP Server) starts up.
    2. **Enable System Stop**: notifies when the "System" (i.e. NTP/PTP Server) stops.
    3. **Enable Admin Login**: notifies when someone logs in to the NTP/PTP Server.
    4. **Enable Admin Logout**: notifies when someone logs out from the NTP/PTP Server.
    5. **System Time Quality**: notifies when the time quality changes.
    6. **System Time Set**: notifies when the system locks to the GNSS after being turned on.
    7. **System Time Change**: notifies when the clock gets adjusted at some time after being initially set.
    8. **Zero Satellites Visible**: notifies when the clock loses lock.
    9. **NTP Application Start**: notifies when NTP service starts.
    10. **NTP Application Stop**: notifies when NTP service stops.
    11. **PTP Application Start**: notifies when PTP service starts.
    12. **PTP Application Stops**: notifies when PTP service stops.
    13. **SNMP Application Start**: notifies when SNMP service starts.
    14. **SNMP Application Stop**: notifies when SNMP service stops.
- **Trap Receivers**: Select this item to enable SNMP to send messages to snmp receivers.
    1. **IP Address 1**: Type in the IP address of snmp receiver number 1.
    2. **IP Address 2**: Type in the IP address of snmp receiver number 2.
    3. **IP Address 3**: Type in the IP address of snmp receiver number 3.

MIB Table

The text of the MIB table, listed below, is current as of the publication date of this manual and is produced by Arbiter's technical team.

```
–
– ARBITER ALL MIB, Revision 0.0003, 3 DEC 2012
–
ARBITER-ALL-MIB DEFINITIONS ::= BEGIN
IMPORTS
MODULE-IDENTITY, OBJECT-TYPE, enterprises, Integer32, Unsigned32 FROM SNMPv2-SMI
TEXTUAL-CONVENTION, TruthValue FROM SNMPv2-TC
;
–
– The position within the OID hierarchy of this MIB:
–
arbiter OBJECT IDENTIFIER ::= { enterprises 39849 }

sys MODULE-IDENTITY
    LAST-UPDATED "201205250000Z"
    ORGANIZATION "Arbiter Systems"
    CONTACT-INFO
    "
    Arbiter Systems, Inc.
    Paso Robles, CA
    Tel: +1 805 237 3831"
    DESCRIPTION
    "This MIB module defines a MIB which provides general information
    about an Arbiter Systems' product."
    ::= { arbiter 1 }

device OBJECT IDENTIFIER ::= { sys 1 }
diag OBJECT IDENTIFIER ::= { sys 2 }
config OBJECT IDENTIFIER ::= { sys 3 }
gnss OBJECT IDENTIFIER ::= { sys 4 }
systrap OBJECT IDENTIFIER ::= { sys 5 }

ntp MODULE-IDENTITY
    LAST-UPDATED "201205230000Z"
    ORGANIZATION "Arbiter Systems"
    CONTACT-INFO
    "
    Arbiter Systems, Inc.
    Paso Robles, CA
    Tel: +1 805 237 3831"
    DESCRIPTION
    "This MIB module defines a MIB which provides mechanisms to
    monitor and control an NTP server."
    ::= { arbiter 3 }

ntpsys OBJECT IDENTIFIER ::= { ntp 1 }
ntptrap OBJECT IDENTIFIER ::= { ntp 2 }
```

–
– Textual Conventions:
–

MilliUnits ::= TEXTUAL-CONVENTION
DISPLAY-HINT "d-3"
STATUS current
DESCRIPTION ""
SYNTAX INTEGER

MicroUnits ::= TEXTUAL-CONVENTION
DISPLAY-HINT "d-6"
STATUS current
DESCRIPTION ""
SYNTAX INTEGER

–
– General Device Information
–
sysDevLabel OBJECT-TYPE
SYNTAX OCTET STRING
MAX-ACCESS read-only
STATUS current
DESCRIPTION "String identifier for the General Information group."
::= { device 1 }

sysDevProduct OBJECT-TYPE
SYNTAX OCTET STRING
MAX-ACCESS read-only
STATUS current
DESCRIPTION "The product family on which this agent is running."
::= { device 2 }

sysDevModel OBJECT-TYPE
SYNTAX OCTET STRING
MAX-ACCESS read-only
STATUS current
DESCRIPTION "The device model."
::= { device 3 }

sysDevSerialNumber OBJECT-TYPE
SYNTAX OCTET STRING
MAX-ACCESS read-only
STATUS current
DESCRIPTION "The device model."
::= { device 4 }

version OBJECT IDENTIFIER ::= { device 5 }

sysDevVerLabel OBJECT-TYPE
SYNTAX OCTET STRING
MAX-ACCESS read-only
STATUS current

DESCRIPTION “The device model.”
::= { version 1 }

sysDevVerCore OBJECT-TYPE
SYNTAX OCTET STRING
MAX-ACCESS read-only
STATUS current
DESCRIPTION “The device model.”
::= { version 2 }

sysDevVerMonitor OBJECT-TYPE
SYNTAX OCTET STRING
MAX-ACCESS read-only
STATUS current
DESCRIPTION “The device model.”
::= { version 3 }

sysDevVerCLOI OBJECT-TYPE
SYNTAX OCTET STRING
MAX-ACCESS read-only
STATUS current
DESCRIPTION “The device model.”
::= { version 4 }

sysDevVerClock OBJECT-TYPE
SYNTAX OCTET STRING
MAX-ACCESS read-only
STATUS current
DESCRIPTION “The device model.”
::= { version 5 }

sysDevVerNTP OBJECT-TYPE
SYNTAX OCTET STRING
MAX-ACCESS read-only
STATUS current
DESCRIPTION “The device model.”
::= { version 6 }

sysDevVerPTP OBJECT-TYPE
SYNTAX OCTET STRING
MAX-ACCESS read-only
STATUS current
DESCRIPTION “The device model.”
::= { version 7 }

sysDevVerSNMP OBJECT-TYPE
SYNTAX OCTET STRING
MAX-ACCESS read-only
STATUS current
DESCRIPTION “The device model.”
::= { version 8 }

sysDevClockModel OBJECT-TYPE

SYNTAX OCTET STRING
MAX-ACCESS read-only
STATUS current
DESCRIPTION “The device model.”
::= { device 6 }

sysDiagLabel OBJECT-TYPE
SYNTAX OCTET STRING
MAX-ACCESS read-only
STATUS current
DESCRIPTION “Diagnostic information.”
::= { diag 1 }

sysDiagTemp OBJECT-TYPE
SYNTAX MilliUnits
MAX-ACCESS read-only
STATUS current
DESCRIPTION “The current temperature of the device.”
::= { diag 2 }

sysDiagTimeQuality OBJECT-TYPE
SYNTAX OCTET STRING
MAX-ACCESS read-only
STATUS current
DESCRIPTION “Clock time quality status.”
::= { diag 3 }

sysDiagNtpStatus OBJECT-TYPE
SYNTAX OCTET STRING
MAX-ACCESS read-only
STATUS current
DESCRIPTION “The operational status of NTP”
::= { diag 4 }

rec1 OBJECT IDENTIFIER ::= { gnss 1 }

gnssRec1Label OBJECT-TYPE
SYNTAX OCTET STRING
MAX-ACCESS read-only
STATUS current
DESCRIPTION “String identifier for receiver 1.”
::= { rec1 1 }

gnssRec1Type OBJECT-TYPE
SYNTAX OCTET STRING
MAX-ACCESS read-only
STATUS current
DESCRIPTION “Receiver 1 GNSS system type.”
::= { rec1 2 }

gnssRec1SatsVisible OBJECT-TYPE
SYNTAX Integer32
MAX-ACCESS read-only

```
STATUS current
DESCRIPTION "Number of GNSS Satellites visible to receiver 1"
::= { rec1 3 }

gnssRec1SatsTracked OBJECT-TYPE
SYNTAX Integer32
MAX-ACCESS read-only
STATUS current
DESCRIPTION "Number of GNSS Satellites tracked by receiver 1"
::= { rec1 4 }

systrapPowerUp OBJECT-TYPE
SYNTAX OCTET STRING
MAX-ACCESS accessible-for-notify
STATUS current
DESCRIPTION "System powering up"
::= { systrap 1 }

systrapShutDown OBJECT-TYPE
SYNTAX OCTET STRING
MAX-ACCESS accessible-for-notify
STATUS current
DESCRIPTION "System shutting down"
::= { systrap 2 }

systrapAdminLogin OBJECT-TYPE
SYNTAX OCTET STRING
MAX-ACCESS accessible-for-notify
STATUS current
DESCRIPTION "System administrative login"
::= { systrap 3 }

systrapAdminLogout OBJECT-TYPE
SYNTAX OCTET STRING
MAX-ACCESS accessible-for-notify
STATUS current
DESCRIPTION "System administrative logout"
::= { systrap 4 }

systrapTimeQuality OBJECT-TYPE
SYNTAX INTEGER32
MAX-ACCESS accessible-for-notify
STATUS current
DESCRIPTION "System time quality change"
::= { systrap 5 }

--
-- NTP System Group
--
ntpSysString OBJECT-TYPE
SYNTAX OCTET STRING
MAX-ACCESS read-only
```

STATUS current
DESCRIPTION " String identifier for the NTP System Group."
::= { ntpsys 1 }

ntpSysClock OBJECT-TYPE
SYNTAX OCTET STRING
MAX-ACCESS read-only
STATUS current
DESCRIPTION "the current local time. Local time is derived
from the hardware clock of the particular machine and
increments at intervals depending on the design used."
::= { ntpsys 2 }

ntpSysClockDateTime OBJECT-TYPE
SYNTAX OCTET STRING
MAX-ACCESS read-only
STATUS current
DESCRIPTION "the current local time. Local time is derived
from the hardware clock of the particular machine and
increments at intervals depending on the design used."
::= { ntpsys 3 }

ntpSysOffset OBJECT-TYPE
SYNTAX Integer32
MAX-ACCESS read-only
STATUS current
DESCRIPTION ""
::= { ntpsys 4 }

ntpSysFreq OBJECT-TYPE
SYNTAX MilliUnits
MAX-ACCESS read-only
STATUS current
DESCRIPTION ""
::= { ntpsys 5 }

ntpSysSysJitter OBJECT-TYPE
SYNTAX MilliUnits
MAX-ACCESS read-only
STATUS current
DESCRIPTION ""
::= { ntpsys 6 }

ntpSysClkJitter OBJECT-TYPE
SYNTAX MilliUnits
MAX-ACCESS read-only
STATUS current
DESCRIPTION ""
::= { ntpsys 7 }

ntpSysClkWander OBJECT-TYPE
SYNTAX MilliUnits

MAX-ACCESS read-only
STATUS current
DESCRIPTION “”
::= { ntpsys 8 }

ntpSysRootDelay OBJECT-TYPE
SYNTAX MilliUnits
MAX-ACCESS read-only
STATUS current
DESCRIPTION “the total roundtrip delay to the primary
reference source at the root of the synchronization
subnet, in seconds”
::= { ntpsys 9 }

ntpSysRootDispersion OBJECT-TYPE
SYNTAX MilliUnits
MAX-ACCESS read-only
STATUS current
DESCRIPTION “ the maximum error relative to the primary
reference source at the root of the synchronization
subnet, in seconds. Only positive values greater
than zero are possible”
::= { ntpsys 10 }

ntpSysLeap OBJECT-TYPE
SYNTAX Integer32
MAX-ACCESS read-only
STATUS current
DESCRIPTION “ two-bit code warning of an impending leap
second to be inserted in the NTP timescale.”
::= { ntpsys 11 }

ntpSysStratum OBJECT-TYPE
SYNTAX Integer32 (0..255)
MAX-ACCESS read-only
STATUS current
DESCRIPTION “ indicating the stratum of the local clock.
0, unspecified
1, primary reference (e.g.,, calibrated atomic clock,
radio clock)
2-255, secondary reference (via NTP)”
::= { ntpsys 12 }

ntpSysPrecision OBJECT-TYPE
SYNTAX Integer32
MAX-ACCESS read-only
STATUS current
DESCRIPTION “signed integer indicating the precision
of the various clocks, in seconds to the nearest power
of two.”
::= { ntpsys 13 }

ntpSysRefTime OBJECT-TYPE

```
SYNTAX OCTET STRING
MAX-ACCESS read-only
STATUS current
DESCRIPTION " the local time when the local clock was last
updated. If the local clock has never been synchronized,
the value is zero."
::= { ntpsys 14 }

ntptrapPowerUp OBJECT-TYPE
SYNTAX OCTET STRING
MAX-ACCESS accessible-for-notify
STATUS current
DESCRIPTION "NTP server powering up"
::= { ntptrap 1 }

ntptrapShutDown OBJECT-TYPE
SYNTAX OCTET STRING
MAX-ACCESS accessible-for-notify
STATUS current
DESCRIPTION "NTP server shutting down"
::= { ntptrap 2 }

ntptrapSynchronized OBJECT-TYPE
SYNTAX OCTET STRING
MAX-ACCESS accessible-for-notify
STATUS current
DESCRIPTION "NTP server synchronized to GNSS"
::= { ntptrap 3 }

ntptrapSynchronizationLost OBJECT-TYPE
SYNTAX OCTET STRING
MAX-ACCESS accessible-for-notify
STATUS current
DESCRIPTION "NTP server GNSS synchronized lost"
::= { ntptrap 4 }

END
```

NTP MIB Object Definitions

- **ntpSysLeap**: two-bit code warning of an impending leap second to be inserted in the NTP timescale.
- **ntpSysStratum**: indicating the stratum of the local clock. 0, unspecified; 1, primary reference (e.g., calibrated atomic clock, radio clock); 2 to 255, secondary reference (via NTP).
- **ntpSysPrecision**: signed integer indicating the precision of the various clocks, in seconds to the nearest power of two.
- **ntpSysRootDelay**: the total roundtrip delay to the primary reference source at the root of the synchronization subnet, in seconds.
- **tpSysRootDispersion**: the maximum error relative to the primary reference source at the root of the synchronization subnet, in seconds. Only positive values greater than zero are possible.
- **ntpSysRefId**: the particular reference clock. In the case of stratum 0 (unspecified) or stratum 1 (primary reference source), this is a pour-octet, left-justified, zero-padded ASCII string. In the case of stratum 2 and greater (secondary reference) this is the four-octet Internet address of the peer selected for synchronization.
- **ntpSysRefTime**: the local time when the local clock was last updated. If the local clock as never been synchronized, the value is zero.
- **ntpSysPoll**: the minimum interval between transmitted messages, in seconds as a power of two. For instance, a value of six indicates a minimum interval of 64 seconds.
- **ntpSysPeer**: the current synchronization source. Usually this will be a pointer to a structure containing the peer variables. The special value NULL indicates there is no currently valid synchronization source.
- **ntpSysPhase**: The system clock offset per selected source. (needs verification)
- **ntpSysFreq**: The system clock frequency correction per ntpd. (needs verification)
- **ntpSysError**: The current system error per ntpd? (needs verification)
- **ntpSysClock**: the current local time. Local time is derived from the hardware clock of the particular machine and increments at intervals depending on the design used.
- **ntpSysSystem**: the type of local Operating System.
- **ntpSysProcessor**: the type of the local Processor.

B.11.6 NTP/PTP Server Specifications

Performance

NTP:	< 100 microseconds, depending on network load and clock accuracy
PTP:	< 100 microseconds (software) < 1 microsecond with hardware assist

Interface

Network	Two Ethernet (Version 2.0/IEEE 802.3) 10/100BT or multimode SSF modules
Protocols	NTP, SNTP, PTP (IEEE 1588™-2008), UDP, ICMP, SNMP, TCP, SSH, SCP, SSL, HTTP, HTTPS.

Operator Interface

Management	Web and SSH Console
Status LEDs	Sync (green) Fault (red) Link (green – 10baseT, yellow – 100baseT)
Setup	IP number (DHCP or Static) Net Mask Reference Identifier UDP Broadcast parameters MD5 and DES authentication keys are optional

B.11.7 Time Zone Format Strings

Table B.9 lists some common time zone strings as discussed on page 148. These strings are meant to be installed in the NTP/PTP Server to configure the local time indicated as in the Web Interface, Clock screen. Values in this table are constructed and formatted according to the POSIX system. For further information regarding this time zone formatting system, please go to the following link:

http://www.gnu.org/s/hello/manual/libc/TZ-Variable.html.

Some Useful Time Zone Values

"Greenwich Mean Time"	GMT0	"Turkmenistan Standard Time"	TMT-5
"Universal Coordinated Time"	UTC0	"Guam Standard Time"	GST-10
"Fernando De Noronha Std"	FST2FDT	"Eastern Australian Standard"	EAS-10EAD
"Brazil Standard Time"	BST3	"Central Australian Standard"	CAS-9:30CAD
"Eastern Standard (Brazil)"	EST3EDT	"Japan Standard Time"	JST-9
"Greenland Standard Time"	GST3	"Korean Standard Time"	KST-9KDT
"Newfoundland Standard Time"	NST3:30NDT	"China Coast Time"	CCT-8
"Atlantic Standard Time"	AST4ADT	"Hong Kong Time"	HKT-8
"Western Standard (Brazil)"	WST4WDT	"Singapore Standard Time"	SST-8
"Eastern Standard Time"	EST5EDT	"Western Australian Standard"	WAS-8WAD
"Chile Standard Time"	CST5CDT	"Java Standard Time"	JST-7:30
"Acre Standard Time"	AST5ADT	"North Sumatra Time"	NST-7
"Cuba Standard Time"	CST5CDT	"Indian Standard Time"	IST-5:30
"Central Standard Time"	CST6CDT	"Iran Standard Time"	IST-3:30IDT
"Easter Island Standard"	EST6EDT	"Moscow Standard Time"	MSK-4
"Mountain Standard Time"	MST7MDT	"Eastern Europe Time"	EET-2
"Pacific Standard Time"	PST8PDT	"Israel Standard Time"	IST-2IDT
"Alaska Standard Time"	AKS9AKD	"Middle European Time"	MEZ-1MES
"Yukon Standard Time"	YST9YST	"Swedish Winter Time"	SWT-1SST
"Hawaii Standard Time"	HST10HDT	"French Winter Time"	FWT-1FST
"Samoa Standard Time"	SST11	"Central European Time"	CET-1CES
"New Zealand Standard Time"	NZS-12NZD	"West African Time"	WAT-1

Table B.9: Partial List of POSIX Time Zone Strings

B.12 Four BNC Connectors

B.12.1 General Description

This section describes the BNC output connectors option; which is used in the Arbiter Systems Model 1200B and Model 1201B/C GNSS Synchronized Clocks. This option is installed in the AUX. Board option slot.

BNC Output Connectors Option

The BNC output connectors option provides the clock with three BNC output connectors and one BNC input connector. The three BNC outputs are connected in parallel with the existing pluggable terminal strip outputs, while the fourth connector provides a BNC event/deviation input, and cannot be configured as an output. The standard pluggable terminal strip outputs are still usable, but both connectors now share the drive capability.

Physical Configuration

The connectors are mounted on an option plate connected to the rear panel with four M3 Kepnuts and connected to the main board with a five-pin connector (J3). The signals on the output are (when viewing the rear of the clock):

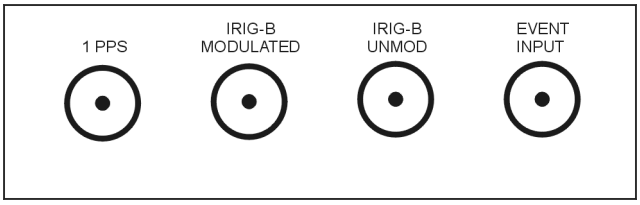


Figure B.39: Four BNC Connectors, Rear-Panel Layout

Appendix C

Creating a Self-Signed Certificate

C.1 HTTPS/SSL Certificate

This appendix discusses a method of generating a PEM file for use with HTTPS. As is the case with any web server, in order to provide a secure connection via HTTPS, the NTP/PTP option must be configured with an SSL Certificate. The NTP/PTP option uses a single PEM File which includes the private key and the certificate. This guide illustrates a method of creating a PEM File using the free and publicly available OpenSSL package. OpenSSL is merely one of many possible solutions – please see your toolkit documentation for exact instructions. This guide assumes you have already downloaded and installed the OpenSSL tools on a Linux system. It also works on Mac OS X systems.

Note: In the following examples, the symbol '▷' denotes the command prompt.

C.1.1 Step 1 - Generate a Private Key

The following command will generate a 1024 bit RSA private key. Please keep this file safe, secure, and not accessible to the public.

```
▷openssl genrsa -out private.key 1024
```

The generated file (private.key) might look like the following:

```
-----BEGIN RSA PRIVATE KEY-----
MIICXgIBAAKBgQDPoNigXmq2JAlw9DrD0P5Og5c5xsEnt9bPjfuE7MGkDEGN09sC

...more data...

8XxzzgU4xizBdLmONkHu7b/h7GL6u5smkWVOCesCCROmKw==
-----END RSA PRIVATE KEY-----
```

C.1.2 Step 2 - Generate a Certificate Signing Request (CSR)

The following command will generate a CSR (certificate signing request) file using the private key generated in Step 1. OpenSSL will prompt for several pieces of information, our example responses are in BOLD text. If you are purchasing a certificate from a commercial vendor, the information provided during this step must match exactly the information you will be providing to the vendor.

```
▷openssl req -new -key private.key -out my.csr
```

```
You are about to be asked to enter information that will be incorporated
into your certificate request.
What you are about to enter is what is called a Distinguished Name or a DN.
There are quite a few fields but you can leave some blank
For some fields there will be a default value,
If you enter '.', the field will be left blank.
-----
Country Name (2 letter code) [AU]:US
State or Province Name (full name) [Some-State]:California
Locality Name (eg, city) [ ]:Paso Robles
Organization Name (eg, company) [Widgits Pty Ltd]:Arbiter Systems, Inc.
Organizational Unit Name (eg, section) [ ]:Lab
Common Name (eg, YOUR name) [ ]:
Email Address [ ]:  techsupport@arbiter.com

Please enter the following 'extra' attributes
to be sent with your certificate request
A challenge password [ ]:
An optional company name [ ]:
```

The generated file (my.csr) might look like the following:

```
-----BEGIN CERTIFICATE REQUEST-----
MIIBsDCCARkCAQAwcDELMAkGA1UEBhMCVVMxEzARBgNVBAgTCkNhbGlmb3JuaWEx

...more data...

YA/JCw==
-----END CERTIFICATE REQUEST-----
```

C.1.3 Step 3A - Purchase a Certificate

To prevent web browsers from warning users about untrusted certificates, an SSL Certificate must be purchased from a trusted authority. If you do not require this level of protection, you may go to Step 3B (Generate a Self Signed Certificate).

Most certificate vendors will ask for the generated CSR file (from Step 2) to be pasted into a field in a web page during the purchase procedure. Be sure to copy the entire contents of the file (including the BEGIN and END tags with the dashes) into the vendor's web form.

Once the purchase has been completed, and other verification steps completed (this will vary from vendor to vendor), they will provide you with a certificate file. You may skip to Step 4.

C.1.4 Step 3B - Generate a Self Signed Certificate

If you do not need a commercially purchased certificate, the following command will generate a Self Signed Certificate using the files created from steps 1 and 2. Most web browsers will warn users that the certificate is not trusted or signed by a trusted authority. Also note that the certificate generated will be valid for 365 days. After this period, users will be additionally warned about an expired certificate until a new certificate is generated and uploaded to the NTP/PTP option.

```
▷openssl x509 -req -days 365 -in my.csr -signkey private.key -out my.crt
```

The generated file (my.crt) might look like the following:

```
-----BEGIN CERTIFICATE-----
```

```
MIICVzCCAcACCQC7uu43uMF1+jANBgkqhkiG9w0BAQUFADBwMQswCQYDVQQGEwJV

...more data...

Jo+H1MXknNISZtcu/xb9gghHG42veveZSg72
-----END CERTIFICATE-----
```

C.1.5 Step 4 - Create the PEM File

Once you have a purchased a certificate, or have a self signed certificate file, the following command will create a single PEM file including the key and the certificate from the previous steps.

```
▷cat private.key my.crt > mycert.pem
```

Please note the "greater than" symbol '>' between 'my.crt' and 'mycert.pem'.

The file mycert.pem can now be uploaded to the NTP/PTP option in order to enable HTTPS.

Appendix D

CE Mark Certification

The following pages contain the individual CE Mark Certifications for models covered in this manual. This includes Model 1200B, Model 1201B, and Model 1201C.

Declaration of Conformity with European Union Directives

Date of Issue:	June 30, 2014
Directives:	89/336/EEC Electromagnetic Compatibility 73/23/ EEC Low Voltage Safety
Model Number(s):	1200B GNSS Synchronized Clock 1201B GNSS Synchronized Clock 1201C GNSS Synchronized Clock
Manufacturer:	Arbiter Systems, Inc. 1324 Vendels Circle, Suite 121 Paso Robles, CA 93446 – USA
Harmonized Standard Referenced:	EN55011 Class A, Radiated and Conducted Emissions EN50082-1 Generic Immunity, Part 1 Residential, Commercial and Light Industrial Environments EN61010-1 Safety requirements of Electrical Equipment for Measurement, Control and Laboratory Use.
Signed:	
Signatory:	Bruce H. Roeder

This certificate declares that the described equipment conforms to the applicable requirements of the directives on Electromagnetic Compatibility 89/339/EEC, Safety 73/23/EEC, and amendments by 93/68/EEC adopted by the European Union.

Appendix E

Statement of Compliance

The following page is a statement of compliance that includes Model 1201B and 1201C.

GNSS Synchronized Clock Statement of Compliance

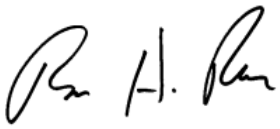
February 5, 2008

TO WHOM IT MAY CONCERN:

All Arbiter Systems, Incorporated GNSS Synchronized Clocks are Primary Standards. They provide time traceable to U.T.C. and U.S.N.O. within published accuracy specifications anywhere in the world. The warranty period for this product is found on page iii of this manual. These products are available with all known time synchronization signals presently in use world wide by the electric power industry.

Arbiter Systems does not supply a type test certificate as requested for GNSS systems as the accuracy is a function of the GNSS system and not of the receiver. However we (Arbiter) hereby certify that this equipment conforms to all Arbiter Systems Incorporated specifications for material and process. All Arbiter Systems calibration products are supplied with a type test certificate guaranteeing traceability to National Standards, but are inappropriate for GNSS clocks, which are Primary Standards by definition.

Regards,



Bruce H. Roeder
International Marketing Manager
Arbiter Systems, Inc.
BHR/sc

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