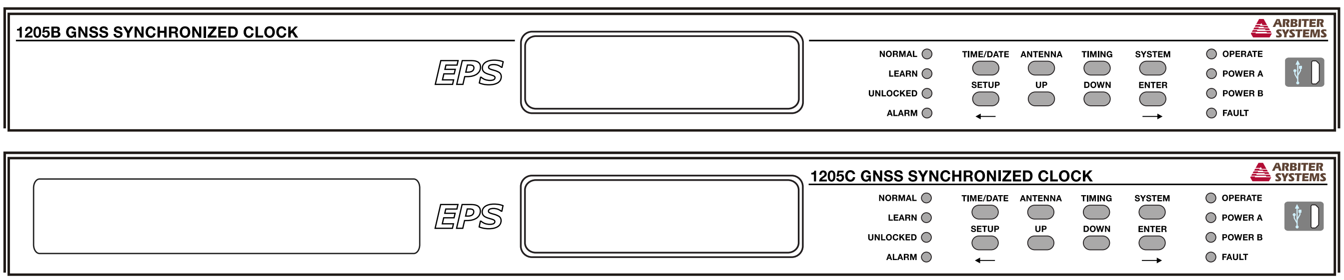
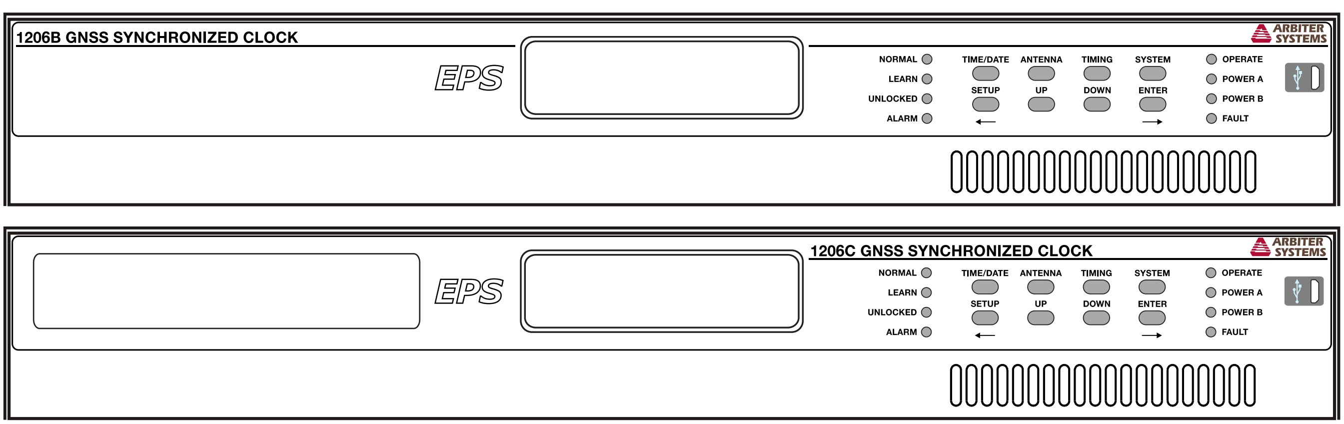
MODEL 1205B/C
MODEL 1206B/C
GNSS SYNCHRONIZED CLOCK
OPERATION MANUAL





ARBITER SYSTEMS, INC.
PASO ROBLES, CA 93446
U.S.A.
WWW.ARBITER.COM

Description

This manual is issued for reference only, at the convenience of Arbiter Systems. Reasonable effort was made to verify that all contents were accurate as of the time of publication. Check with Arbiter Systems at the address below for any revisions made since the original date of publication.

Contact Information

Arbiter Systems, Inc.
1324 Vendels Circle, Suite 121
Paso Robles, CA 93446
USA

(805) 237-3831

www.arbiter.com
sales@arbiter.com
techsupport@arbiter.com

What This Manual Covers

This manual describes the configuration and operation of the Model 1205B/C and the Model 1206B/C series of GNSS Synchronized Clocks. This version of the manual is written for clocks having a firmware date that was available at the time of this publication. Any changes made in subsequent revisions, which affect operation or specifications, will be noted with either a revised version of the manual or a product bulletin. To display the overall clock firmware version, press the SYSTEM key (see Section 4.6.1) or use the web interface as illustrated in Section 5.3.28.

Firmware Versions & Updates

Firmware updates are available by download from the Arbiter Systems website from www.arbiter.com. For service, contact the factory. Electronic versions of this manual are available from the Arbiter website.

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Model 1205B/C
Model 1206B/C
GNSS Synchronized Clock
Operation Manual

Reorder Number: AS0100300
Printed Document: PD0051500 Rev. C

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Chapter 1 Getting Started

1.1 Overview

This manual describes the Model 1205B/C and Model 1206B/C, which are new GNSS[1] synchronized clocks and use EPS™ technology. Consult this document for all necessary information for configuring and operating these two models. The 1205B and 1206B do not have a large LED time/date display, and the 1205C and 1206C have a second large LED time/date display.

1.2 Security and Performance Advantages

Each Model 1205B/C and Model 1206B/C provides the utmost in timing stability, protection from communication attacks and false GNSS signals. A new series of synchronized secure clocks by Arbiter Systems, the Model 1205B/C offers two levels of ultra-stable, crystal holdover oscillator. With either oscillator available to stabilize clock timing, the Model 1205B/C provides a high level of timing stability in the presence of a false GNSS signal, or from losing the GNSS reception. Model 1206B/C with a rubidium oscillator provides the highest level of holdover stability.

Using “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. Additionally, clocks can synchronize to multiple satellite receiver systems.

1.3 Standard Features

With six standard outputs to provide unmodulated IRIG-B, 1 PPS and Programmable Pulse, each clock has substantial drive capability to supply timing to multiple loads. Each clock can use two current Global Network Satellite System (GNSS) receivers, which include US GPS, Russian GLONASS, Chinese Beidou, and European Galileo.

Available options include redundant power supplies, optional outputs supporting several connector types, several standard timing signals and a second, backup GNSS receiver.

Dedicated terminals on the rear-panel, main connector are configured for event capture. Event timing has 100 nanosecond resolution, and the clock sequentially records up to fifty events internally.

Each model includes exceptional accuracy and stability across the board, due to ultra-stable holdover oscillator with guaranteed holdover capability of less than 1 ms/day. The Model 1206B/C has a rubidium oscillator with the ultimate in holdover stability of less than 1 µs/day, but otherwise has the same features as the Model 1205B/C.

[1] GNSS stands for Global Navigation Satellite System, and includes the US GPS, Russian GLONASS, European Galileo and Chinese Beidou systems.

1.4 Standard Accessories

These are the included components and accessories shipped with the clock.

- 1205B/C or 1206B/C GNSS Synchronized Clock
- Choice of internal power supply(s)
- Antenna cable assembly: 50 feet of RG-6 cable with type F connectors
- Universal GNSS antenna
- Two rack-mount ears with hardware, mounted
- Quick start guide

A full instrument manual is available for download from www.arbiter.com. A printed manual is available to order.

1.4.1 Handling Precautions

Mechanical Shock: Use care when handling the GNSS antenna as it may be damaged if dropped. Store the antenna in a safe place until its final installation.

Static Discharge: These clocks use static-sensitive components and should be guarded against static discharges. These components are protected. However, they are exposed when the cover is removed.

CAUTION: Connect only the antenna cable coming from the antenna into the rear-panel antenna input connector. This connector leads to the GNSS receiver, which may be damaged by high voltage or a static discharge. All Model 1200 series clocks have an internal surge arrestor to help protect against nearby lightning strikes. However, the optional, external surge arrestor provides additional protection. For more surge arrestor information, see Section 3.3

1.4.2 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 with accessories stored below it. See Figure 1-1.

2. 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.
3. Some accessories (i.e., antenna, antenna cable and quick setup guide) are in separate compartments. Two rack-mount ears are pre-installed.
4. Handle the GNSS antenna carefully, as it may be damaged if dropped.

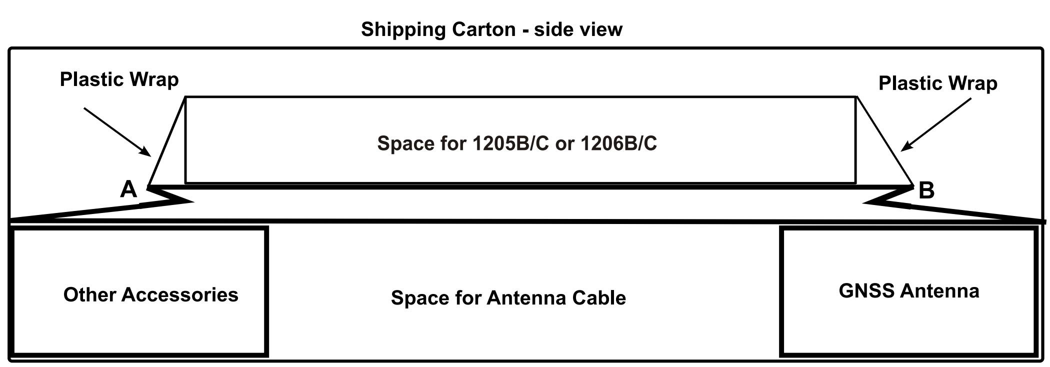


Figure 1-1 Packaging of Accessories

1.4.3 Removing Rackmount Ears

Each clock comes with pre-installed rack-mount ears suitable for mounting in a 19-inch rack. The rack-mount ears may be removed if not needed.

Each rack-mount ear has two (2) M5x10mm flat head screws attaching it to the clock. The clock is shipped with a bag labeled “AS0105000 Cover Screws” that contains four (4) M5x10mm pan-head screws.

1. Use a Torx T25 driver or large slot screwdriver to remove the two screws from each rack-mount ear, freeing the rack-mount ear.
2. Use a Torx T25 driver or slotted screwdriver to replace the removed screws with the included M5x10 mm pan-head screws. NOTE: It is not recommended to reuse the flat-head screws without the rack-mount ears.

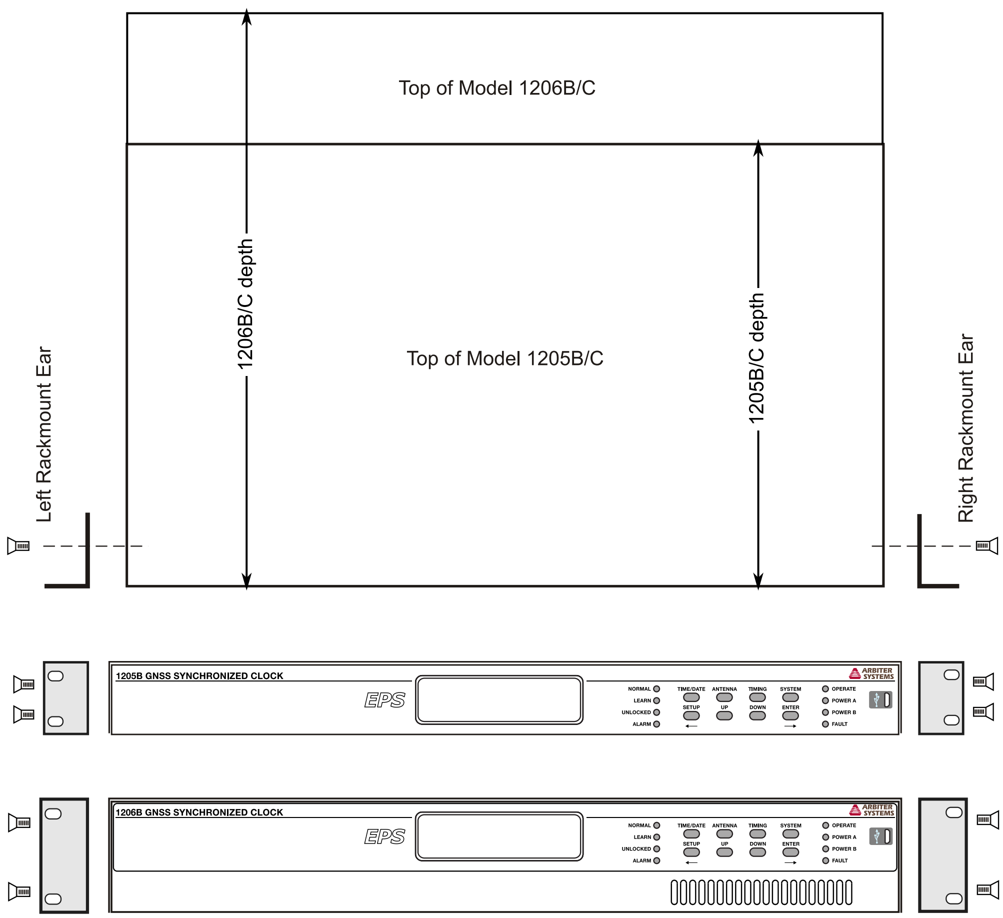


Figure 1-2 Rack-Mount Ear Locations

Chapter 2 Front and Rear Panels

2.1 Overview

This chapter identifies the connectors, controls, and displays found on the front and rear panels. Figures 2.1 and 2.2 illustrate the front panels of the 1205B, 1205C, 1206B and 1206C clocks. “C” clocks have a large LED display on the left side of the front panel. Models 1206B and 1206C have air vents at the lower right of the front panel.

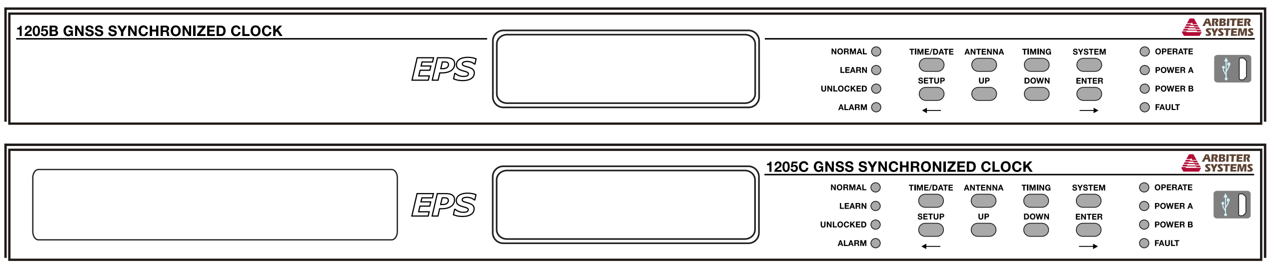


Figure 2-1 Model 1205B/C Front Panel View

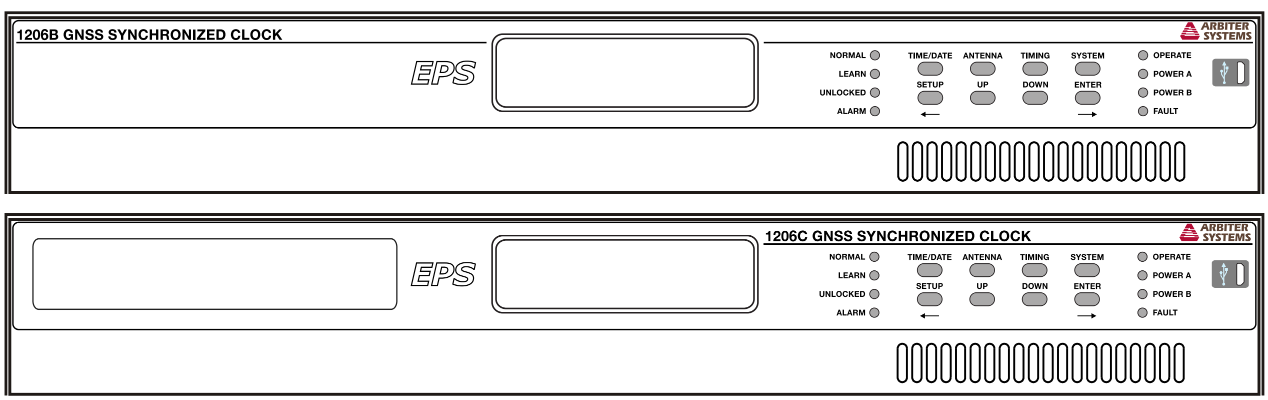


Figure 2-2 Model 1206B/C Front Panel View

2.2 Front Panel Controls and Indicators

All clocks have eight annunciator LED's, a two-line by twenty-character LCD and eight-button keypad; the Model 1205C and 1206C add a six-character, LED time/date display for greater visibility. Most keys are informational only, except for the front-panel backlight control. The SETUP key allows users to view the clock configuration if permitted under security settings.

Definitions for the annunciator LEDs and front panel keys are found below. Each of four upper keys are defined to provide specific clock information, such as time and date, geographical position and instrument status. The lower keys provide increased access within the individual menus.

2.2.1 Command Key Definitions

Figure 2.3 illustrates the keypad and annunciator LEDs, showing the placement and basic functions. The details below provide additional description for each of these keys.

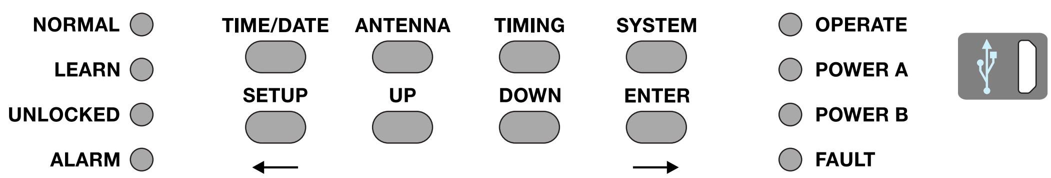


Figure 2-3 Keypad and Annunciator LEDs

TIME/DATE: Press the TIME/DATE key to set the display(s) to the desired display mode. There are four time/date display modes available, which are individually displayed by repeatedly pressing the TIME/DATE key. Changing the front panel time display mode does not affect time and date information broadcast from rear-panel timing outputs.

ANTENNA: Press the ANTENNA key to view the antenna status. Antenna status includes antenna voltage and current, GNSS satellite tracking information, signal-to-noise ratios, longitude, latitude, and elevation of the antenna according to the most recent position fix.

TIMING: Press the TIMING key to view the clock status, time quality (time deviation and sigma), holdover estimated uncertainty, and event/deviation values. Press the UP or DOWN keys in the EVENT/DEVIATION menu to scroll through event records and display up to 50 recorded events. In the 1 PPS deviation mode, the display updates the 1 PPS deviation data each second.

SYSTEM: Press the system key to view the clock serial number and firmware version, power supply voltage(s), EEPROM status, faults, alarms, network status, NTP/PTP, analog input and option board information.

SETUP: Press SETUP to view the clock configuration if security setting allows. Menus include: COM1 settings, COM2 settings, local time offset, out of lock setting, relay configuration, back light mode, (antenna) cable delay, I/O Block output configuration, event mode, option board information.

UP: Used in conjunction with other menus for selection to scroll upward through the available menu choices. Also assists in navigating through main menus in normal order.

DOWN: Used in conjunction with other menus for selection, or to scroll downward through available menu choices. DOWN also assists in navigating through main menus in reverse order.

ENTER: Press ENTER to advance to a submenu of the current menu, if available. For example, in the HD Output Current menu, press ENTER to open the submenu and press the UP/DOWN keys to review the six high drive output current screens.

2.2.2 LED Status Indicators

Figure 2.3 also illustrates the eight LED's 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 off and the NORMAL LED may be off. The following definitions apply to these indicators:

LEARN: Illuminates orange when clock is finding its position and stabilizing: approximately 24 hrs. GNSS anti-spoofing is not active.

NORMAL: Illuminates green when the clock has finished the learn mode. GNSS anti-spoofing is active.

UNLOCKED: Illuminates red when the clock has never synchronized or has lost synchronization with GNSS.

ALARM: Illuminates red when alarms are active.

OPERATE: Illuminates green when the clock is operating.

POWER A: Illuminates green when power supply A is providing power.

POWER B: Illuminates green when power supply B is providing power.

FAULT: Illuminates red when one or more fault conditions are active.

2.2.3 LCD Display

Each model has an LED backlit liquid crystal display (LCD), which provides a 20-character by 2-line readout. The readout displays instrument status, time and date, and instrument configuration.

2.2.4 Large LED Display: Model 1205C & Model 1206C

Models 1205C and 1206C add a six-character, 20-millimeter (0.8 inch) LED time and date display. The LED display can indicate the time, in hours minutes and seconds, in local or UTC time zones. Pressing the TIME/DATE key will also display the date format as MM/DD/YY or DD.MM.YY. Configure date format from front panel or through the web interface.

2.2.5 USB

Each clock has a Micro-USB B male connector on the front panel. This port connects to a PC as a serial port and allows for secure shell communication. The menu structure is the same as the secure web interface connection. Defaults: 115200,8,N,1. See Chapter 6.

2.3 Rear Panel Information

This section contains information to assist you in identifying where to connect inlet power, the GNSS antenna cable, and all input and output connections on these clocks. Figure 2-4 and Figure 2-5 illustrate the rear panels of the Model 1205B/C and Model 1206B/C. Listed below are the connectors grouped according to general clock functions, from left to right.

- Three Ethernet ports – RJ45 connectors or Type LC Fiber Optic
- 32-pin multifunction I/O connector
- Antenna input connector, antenna status LED, ground lug
- Three optional I/O connector slots
- Main power inlet – Power A; optional (redundant) power inlet – Power B

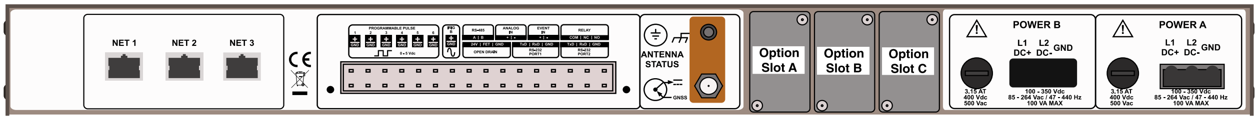


Figure 2-4 Model 1205B/C Rear Panel View

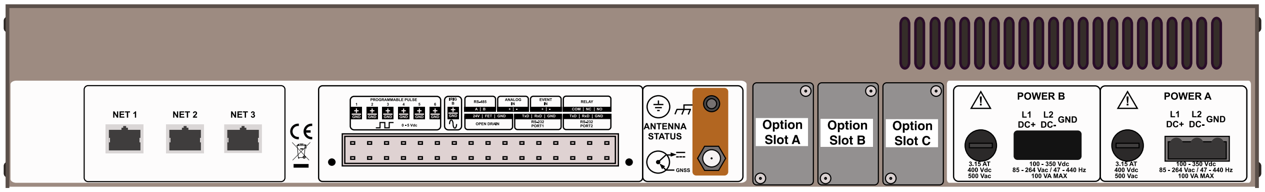


Figure 2-5 Model 1206B/C Rear Panel View

2.3.1 Power Inlet

Two different power supplies are available: Low voltage DC ONLY and Universal High Voltage (AC/DC). Carefully examine the paperwork you received to make sure you have correctly identified the inlet connections and voltages.

2.3.1.1 Universal Power Inlet

The universal power inlet allows high voltage ac and dc inputs. This includes a terminal power strip with Surge Withstand Protect Circuitry (SWC), and inlet supply range of 85 Vac to 264 Vac, 47 Hz to 440 Hz for the Model 1205B/C and 47 Hz to 63 Hz for the Model 1206B/C. The dc range for both products is 110 Vdc to 370 Vdc, < 100 W typical.

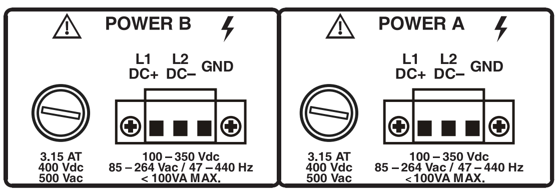


Figure 2-6 Universal Power Supply Inlet Connector

2.3.1.2 Low DC Power Inlet

Terminal Power Strip with Surge Withstand Protect Circuitry (SWC), and inlet supply with a range of 22 Vdc to 67 Vdc, DC ONLY.

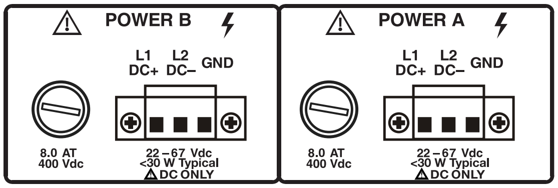


Figure 2-7 Low DC Power Supply Inlet Connector

2.4 Antenna Input

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 3.

Figure 2-8 Rear Panel Antenna Inlet Connector

While the antenna draws about 29 mA, it requires the voltage to be between 3.4 Vdc and 5.5 Vdc. The optional inline preamplifier draws approximately 25 mA at 5 Vdc. A voltage drop at the antenna would normally occur due to the DC resistance of the antenna cable, which is based on the total current drawn by the antenna, and inline amplifier if installed.

2.5 Main I/O Connector Block Functions

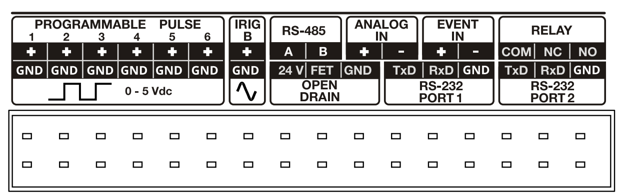


Figure 2-9 Main I/O Connector Block and Label

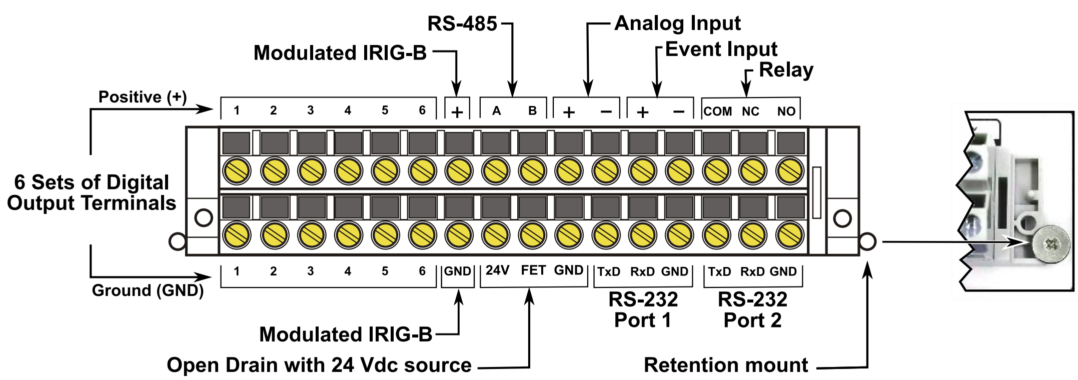


Figure 2-10 Main I/O Connector Block and Label

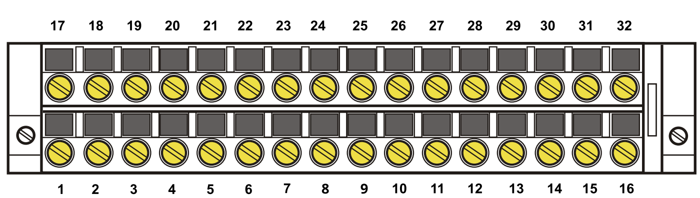


Figure 2-11 Main I/O Connector Plug Numbering

2.5.1 Specifications for Main Connector Functions

- Relay: Normally Closed (NC) is shorted to Common (COM) when the clock is powered off. Normally Open (NO) contact is not connected to COM when the clock is powered off.
- Event In: 5 V logic
- Analog In: Input voltage range: 50 Vrms – 300 Vrms. Measures frequency and voltage.
- Open Drain: High voltage FET with 24 V source – switches to chassis ground.
- Modulated IRIG-B: Output is 4.5 Vpp open circuit; drives 3 Vpp into 50 ohms.
- Digital Output 1 – 6: drives up to 125 mA each, TTL/CMOS levels.
- RS-232: Ports 1 and 2 use three terminals: Tx, Rx and Gnd.
- RS-485: Uses transmit A and transmit B.

Function Name	Terminal 1	Terminal 2	Terminal 3
Relay[2]	COM = 30	NC = 31	NO = 32
Event In	+ Input = 28	Return = 29	N/A
Analog In	Signal A (+) = 26	Signal B (−) = 27	N/A
RS-485	A (+) pin = 24	B (−) pin = 25	N/A
Modulated IRIG-B	+ pin = 23	− pin = 7	N/A
Digital Output 6	+ pin = 22	− pin = 6	N/A
Digital Output 5	+ pin = 21	− pin = 5	N/A
Digital Output 4	+ pin = 20	− pin = 4	N/A
Digital Output 3	+ pin = 19	− pin = 3	N/A
Digital Output 2	+ pin = 18	− pin = 2	N/A
Digital Output 1	+ pin = 17	− pin = 1	N/A
Open Drain	24V = 8	FET = 9	GND = 10
RS-232 Port 1	TxD = 11	RxD = 12	GND = 13
RS-232 Port 2	TxD = 14	RxD = 15	GND = 16

Table 2-1 Main Input/Output Functions and Connections

2.5.1.1 Locking the Main I/O Connector to Chassis

The Main I/O connector has a retaining feature. Figure 2-10 shows the proper installation of the retaining screw hold the connector in place.

2.5.2 Event Input

For timing external events, or 1 PPS deviation, based on the GNSS-synchronized time, connect to the Event In terminals shown in Figure 2-10 and Figure 2-9. To configure the Event Input in the UI, see Section 5.3.22.

2.5.3 RS-232 and RS-485 Communication Ports

Each model has three standard communication ports; RS-232 supported on COM1 and COM2, and RS-485. The RS-232 ports do not use flow control. The RS-485 is transmit only.

[2] NO (Normally Open); NC (Normally Closed); COM (Common). “Normally” is the relay position when the clock is powered off.

2.5.4 SPDT Relay Contacts

One set of SPDT relay contacts provide contact closure for several clock conditions including: out of lock, alarm, fault, stabilized and loss of inlet power (also called failsafe). Conditions can be OR'ed. Additional SPDT relay contacts are available as options – see Sections 2.6 and 0.

Figure 2.9 illustrates three contacts. From left to right they are common (COM), normally closed (NC), and normally open (NO). "Normally" refers to the relay condition when the clock is powered off. The information below gives the contact states for two conditions: (1) faulted (including power off) and (2) not faulted. For a list of faults and alarms, see Section 4.2.3.

1. Faulted, or Power OFF: NC to COM is shorted, NO to COM is open.
2. Not Faulted and Power On: NC to COM is open, NO to COM shorted.

2.5.4.1 Failsafe Mode

Failsafe occurs with the loss of inlet power, and the relay contacts are faulted. For additional information on relay setup, including specifications, see Sections 2.6 and 11.3.5.

2.6 Optional Inputs and Outputs

Space for up to three optional modules allow you to customize the Model 1205B/C or 1206B/C; called Slot A, B and C – refer to Figure 2-4, Figure 2-5, and Figure 2-12.

2.6.1 Option Module Selection

- 2 – 5 volt @ 125 mA logic outputs – BNC or ST fiber optic.
- 4 – 24 volt @ 25 mA logic outputs – terminals.
- 2 – High speed clock outputs: 1 MHz, 5 MHz or 10 MHz; BNC, TNC, ST.
- 2 – SPDT Relay Contacts with separate 24 Vdc service – terminals.
- Second GNSS receiver (redundant) – type F connector.

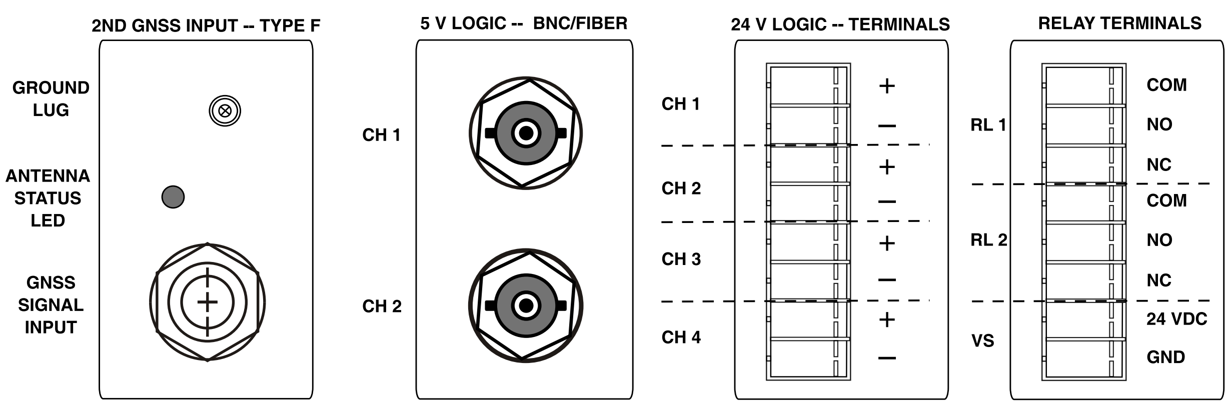


Figure 2-12 Optional Mixed I/O Connectors -- Type F, BNC, Fiber ST & Terminals

2.7 Network Connections

All models have three Ethernet ports available for clock configuration, port management as well as serving time using NTP or PTP. The network section may be ordered with copper RJ-45 connectors, fiber optic connectors, or a mix of copper and fiber. RJ-45 connector versions have two separate link status LEDs tell you if the connection is either 10 Base-T (green) or 100 Base-T (yellow).

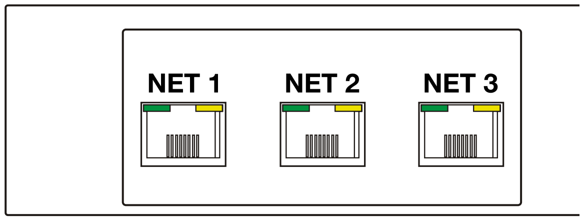


Figure 2-13 Network Connections – RJ-45 Copper Ports

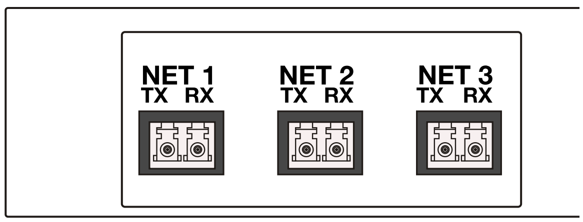


Figure 2-14 Network Connections – Type LC Fiber Ports

Note: A mix of both copper and fiber optic ports may be ordered.

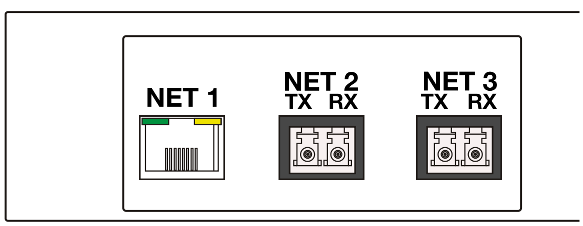


Figure 2-15 Network Connections – Copper RJ-45 and Type LC Fiber Ports

Chapter 3 Antennas and Cables

3.1 Mounting the Antenna and Antenna Cable

All clocks come complete with the necessary hardware to be able to receive GNSS signals: an RG-6 cable assembly and a GNSS antenna. Cable assemblies have male F connectors and connect between the antenna and the rear panel of the clock. This section should help you with installing the GNSS antenna and antenna cable(s) to the clock. It should also be a source of information should you need to trouble shoot the antenna cable system.

Optional accessories are available to help you customize GNSS reception for your clock. These include antenna cables up to 330 feet (100 meters), inline amplifiers, surge arrestors, splitters, and antenna mounting kits.

3.1.1 GNSS Antenna Location

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

3.1.2 Mounting the Antenna

The standard antenna is designed for mounting on a 26-mm diameter pole (1.05-inch OD or 3/4-inch ID pipe), with either a standard 1-inch×14 (approximately M25.4×1.81) marine-mount thread or a 3/4-inch NPT pipe thread. The Type F connector at the bottom of the antenna is protected from direct exposure to the elements when the antenna is mounted in this way and will extend the operational life of the antenna-to-cable interface.

To mount the antenna, you will need a piece of 3/4-inch 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 antenna connector. Arbiter Systems sells an antenna mounting kit that simplifies installation for a variety of locations.

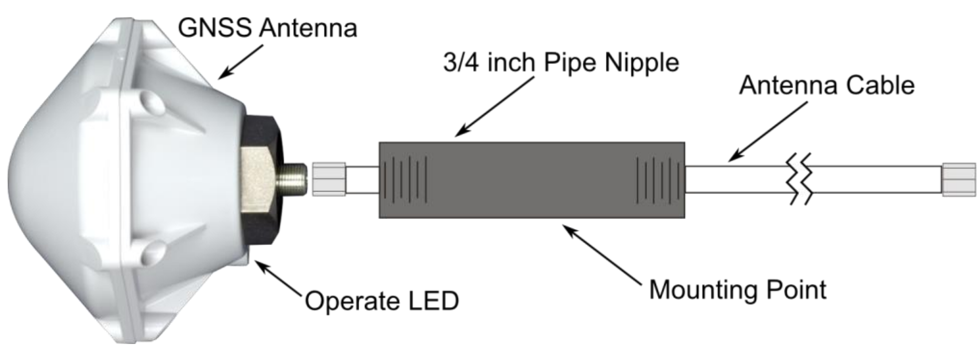


Figure 3-1 Antenna Assembly for Mounting

3.1.2.1 Antenna mounting procedure:

1. Thread the RG-6 antenna cable through the pipe nipple.
2. Tighten the F-type male connector to the antenna. **WARNING! Do not spin the antenna onto cable. Hold the antenna and tighten using cable nut.**
3. Thread the pipe into the antenna.
4. Mount the pipe and antenna/cable assembly to a stationary point.

3.1.3 Optional Antenna Mounting Kit, P/N AS0044600

The Antenna Mounting Kit is designed specifically for use with antennas shipped with Arbiter Systems clocks. The included hardware 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. Also, the bracket may be mounted to a flat surface.

For complete details on this product request installation instructions for Arbiter Systems GNSS Antenna Mounting Kit found in document number PD0024700. All metal hardware is stainless steel.

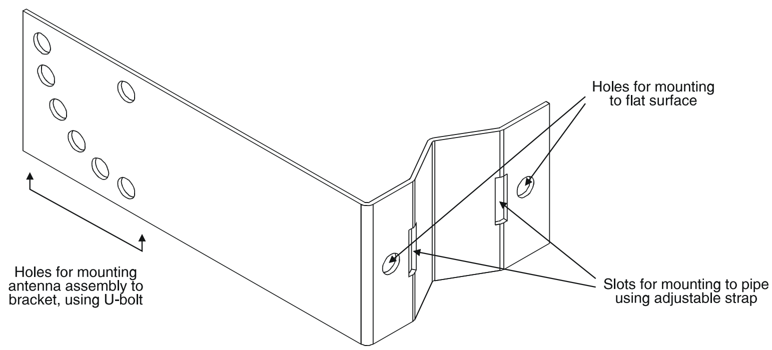


Figure 3-2 Antenna Mounting Bracket

Qty	Description	ASI P/N
1	GNSS antenna mounting bracket	HD0052700
1	U-bolt, 1 1/8”, with backing plate & 2 hex nuts	HP0014700
1	3/4” × 4” threaded pipe, PVC, schedule 80	HP0014804
1	Hose clamp, worm drive	HP0014900
1	Mounting bracket stabilizer	HD0054200

Table 3-1 Antenna Mounting Kit Parts List

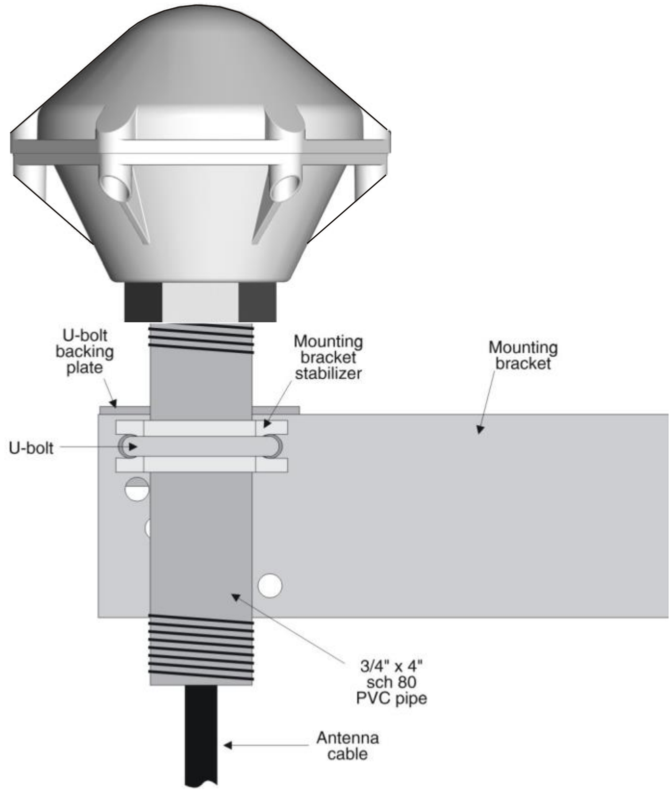


Figure 3-3 Antenna Mounting with AS0044600

3.2 Verifying Antenna and Cable Operation

A multi-color LED, located at the base of the antenna, indicates antenna operation; green indicates proper operation (between 3.3 Vdc and 5.0 Vdc), amber indicates that the voltage is low (below 3.3 Vdc). 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 is defective or damaged.

3.2.1 Checking the Antenna Status

To view the antenna status from the front panel, press the ANTENNA key until the display reads STATUS: (message). 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, OPEN, or SHORT.

Without a 5 Vdc signal applied to the antenna, the GNSS clock will not synchronize with the satellite systems 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.

3.2.1.1 “Good” – Antenna/Cable System Performance

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

3.2.1.2 “Open” – Antenna/Cable Fault

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

3.2.1.3 “Short” – Antenna/Cable Fault

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

3.2.1.4 Other Antenna/Cable Indications

A tricolor LED at the rear panel, next to the antenna connector, also indicates status: green = normal operation, amber = low voltage or open circuit, and red = a short circuit.

3.3 GNSS Surge Arrester, P/N AS0094500

The clocks have an internal surge arrester consisting of a gas discharge tube and high voltage capacitors to protect the GNSS receiver from voltage spikes.

Arbiter also sells an external surge arrester for additional protection. Figure 3-4 illustrates the external GNSS surge arrester kit, which is mounted in line with the antenna cable. The external surge arrestor has two female F connectors, which are bidirectional, and two mounting holes and a ground attachment point. It comes with hardware for connecting to a solid ground. The surge arrester passes power to the GNSS antenna but does not draw power.

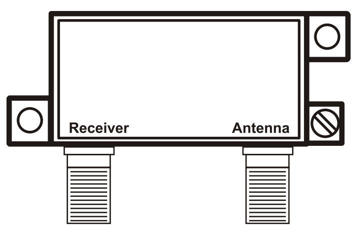


Figure 3-4 GNSS Surge Arrester

3.3.1 Using the GNSS Surge Arrester

Before installation, review the documentation on this device found in Appendix A. The surge arrester is weatherproof except for the F connectors.

3.4 Technical Details of GNSS Antennas and Cables

3.4.1 Length and Loss Considerations

3.4.1.1 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 3-2.

3.4.1.2 Effects of Cable Parameters

The type and length of the antenna cable are important considerations because they affect specific parameters described in the following paragraphs. Damaged cables may also affect performance.

3.4.1.3 Antenna + Cable Delay

Two compensation factors are added together to assure the best accuracy: antenna cable delay and antenna group delay. Cable delay is calculated from the velocity factor and physical length of the cable. 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 3-2. Otherwise, use Equation 3-1 to calculate cable delay. The GNSS antenna contributes a group delay is 40 nanoseconds. These two values add together for a total of 100 nanoseconds (15-meter cable plus the antenna).

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

Equation 3-1

Where:

T = Cable delay, in nanoseconds
λ = Cable length, in meters
C = Speed of light (3 × 108 meters per second)
Kv = Nominal velocity of propagation (0.85 for RG-6)

3.4.1.4 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 (P/N AS0044700).

3.4.1.5 DC Resistance

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

3.4.1.6 Available Antenna Cables and Accessories for Longer Runs

Arbiter Systems offers longer antenna cables for use with all models of clocks when the standard 15 m (50 ft) cable is inadequate. For RG-6 cable runs greater than 100 m (328 ft), up to 175 m (578 ft), Arbiter offers a 21 dB in-line amplifier. A larger RG-11 style cable is available that can be used for runs to 183 m (600 ft) without the in-line pre-amplifier, or 300 m (1000 ft) with the pre-amplifier.

P/N	Description	Delay, ns	Signal Level, dB
CA0021315	15 m (50 ft) cable, RG-6	60 ns	-5 dB
CA0021330	30 m (100 ft) cable, RG-6	119 ns	-9 dB
CA0021345	45 m (150 ft) cable, RG-6	177 ns	-13 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	3.92 ns/m	-17.5 dB/100 m
AS0044700	21 dB in-line amplifier	1 ns	+21 dB
AP0013400	2 Way Splitter, 1 port DC pass	< 10 ns	-4 dB max.

Table 3-2 GNSS Cable Data and Accessory Information

3.4.2 Physical Protection

Consider common causes of physical damage when routing the antenna cable: closing doors, falling objects, foot traffic, heat and vibration. The cable is not intended for hanging in midair. Allow a sufficient bend radius to prevent kinks. Allow extra length to prevent tension on the connectors and a service loop, if a connector needs replacement.

Always leave a drip loop wherever the cable enters a structure to prevent water from entering via the cable jacket.

3.4.3 Adjacent Signals

The standard RG-6 cable is triple-shielded, with good shielding properties. However, the quad-shielded RG-11 cable provided even more isolation and may be a better choice if the cable is routed near high power RF sources or alongside transmitter cables.

3.4.4 Antenna Power

The RF preamplifier within the antenna requires 3.3 Vdc to 5 Vdc at approximately 30 mA nominal for operation. The GNSS receiver supplies this power through the coaxial antenna cable. Avoid shorting the center conductor to the shield of the coaxial cable as it may damage the preamplifier. 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 exist, review the tests described in Section 3.2.

3.4.5 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.

3.4.6 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.

3.4.7 User-Supplied Antenna Cables

Any RF cable meeting the requirements described above for signal loss and DC resistance may be used. Signal loss must be < 21 dB at 1575.42 MHz, and the cable DC resistance should not drop the supply voltage to the antenna below 3.3 Vdc. However, prior to using a non-standard antenna cable, verify proper installation by reviewing Section 3.2

Chapter 4 Startup and Operation

4.1 Initial Startup Sequence

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

1. All eight annunciator LEDs should flash momentarily, then the OPERATE LED, POWER A LED (and POWER B LED, if installed) and UNLOCKED LED should glow 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. The larger LED display on Models 1205C and 1206C will not display time or date until the clock is stabilized.
8. Learn and Normal LEDs – will not illuminate the first time starting the clock as the clock has not been initialized. Should light after initializing the Learn mode.

4.1.1 Display Indication at Startup

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

```
ARBITER SYSTEMS GNSS
 MODEL 1205B CLOCK
```

```
 COPYRIGHT © 2022
ARBITER SYSTEMS, INC
```

```
 TIME NOT AVAILABLE
```

4.1.2 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 at this time will produce the message:

```
 TIME NOT AVAILABLE
```

The clock will not produce time on either display or any digital outputs until it is stabilized. This method was chosen to prevent incorrect data from reaching connected devices.

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 change state if set to the out-of-lock function.

4.2 Operating Modes

Initially, the very the first time the clock starts up it will be uninitialized. 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 uninitialized forever unless initiating the learn mode from the user interface (UI). Power cycling the clock has no effect on this. Once the learn mode is initiated the clock should never again revert to the uninitialized mode. Initiating the learn mode through the UI is explained in Section 5.3.4

4.2.1 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 not enforced. After 24 hours the clock should complete the learn mode and revert to the normal mode in which anti-spoofing protective measures are active.

4.2.2 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 spoofing alarm 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.

4.2.3 Faults and Alarms

If a problem occurs, the clock may indicate this as either a fault or an alarm. A fault LED signifies an internal clock problem that may clear on its own or may need attention. An alarm LED 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. Faults may be declared on the front panel or from the UI. See details in Section 4.6.4 for active fault messages, and Section 4.6.5 for active alarm messages.

Faults	Alarms
TBP communications fault	Position change (spoof)
Holdover/GNSS fault	
Brownout Fault	
Antenna Fault	
8 MHz Fault	
Watch Dog Timer Fault	
Power Supply Fault	
Prog. Pulse Overload Fault	

Table 4-1 List of Faults and Alarms

4.3 Time/Date Key Displays

4.3.1 Time and Date Display, UTC

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

```
UTC          12:34:54
SAT        5 NOV 2022
```

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

4.3.2 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 309 2022
```

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

4.3.3 Time and Date Display, Local Time

This mode displays the time and date after the Daylight Saving Time correction and local offset have been applied, but in the same format as that of the Date and Time, UTC.

```
LOCAL        05:34:58
SAT        5 NOV 2022
```

4.3.4 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        05:34:59
SAT      DAY 309 2022
```

NOTE: Unless the Daylight Saving Time and local offset parameters have been set properly, this and the previous display may not reflect the correct local time.

4.3.5 Daylight Saving Time/Summer Time (DST)

The Daylight Saving Time (DST) configuration feature allows customized settings.

4.4 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.

4.4.1 GNSS Tracking

To view the number of satellites being tracked, use this display. GNSS receivers can track up to 72 satellites of the multiple satellite systems.

```
   GNSS TRACKING
GPS:10 GLN:08 GAL:07
```

4.4.2 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:41 GLN:35 GAL:41
```

4.4.3 GNSS Setting

GNSS Setting indicates which satellite systems are being used in the clock

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

4.4.4 Antenna Status

Antenna Status provides the voltage and current supplied to the GNSS antenna. Values indicated in the display below are representative of 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
  5.06 V,   15 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.

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

4.4.5 Position Display Modes

At startup the clock will attempt to track satellites and compare its startup position with any geographical position information stored in memory. If no previous position information exists, the clock will need to go through the 24-hour learn mode. See Section 4.2 for more detail on operating modes. If the startup position matches a stored position, then the clock will resume operating in the normal mode. If a previously stored position does not match the startup position the clock will alarm. If in this situation the clock was just moved to a new location it will be necessary to restart the Learn mode. See Section 5.3.4 to restart the learn mode.

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.

4.4.6 Longitude Display

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

```
    LONGITUDE
 120° 41’ 34.016” W
```

4.4.7 Latitude Display

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

```
     LATITUDE
  35° 35′ 50.800″ N
```

4.4.8 Elevation Display

Displays the antenna elevation in meters and fractional meters referenced to the WGS-84 datum.[3]

```
      ELEVATION
   229.39 m   WGS-84
```

4.5 Timing Key Displays

4.5.1 Clock Status

Press the TIMING key to view performance characteristics of the clock. It is during the learn mode that the clock gathers information about its geographical location and refines its position data. It is also a 24-hour time period when the clock is most vulnerable to false, or incorrect, GNSS signals.

```
   CLOCK STATUS
   STABILIZED
```

4.5.2 Time Quality

Following the 24-hour period in the learn mode the clock switches to the normal mode. During the learn mode, the clock is tracking its position, signal strength and time, and is the most vulnerable. During the normal mode the clock is not affected by false or lost GNSS signals to upset the time but relies on the recorded history and excellent holdover qualities.

By default, “Time Quality” is a 2 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 ns) of the GNSS clock. Users may select standard deviation for estimates of time quality and holdover uncertainty based on the chosen value for sigma. See Section 5.3.2, to change sigma in the UI.

```
  TIME UNCERTAINTY
 30.34 nSec   2.00 σ
```

[3] WGS-84 is an Earth-centered, Earth-fixed terrestrial reference system and geodetic datum (1984).

4.5.3 Holdover Estimated Uncertainty

After operating for a period of 24 hours from startup, and synchronized to the GNSS, the 1205/1206 can begin providing uncertainty estimates. These values are estimates of clock accuracy when it is no longer synchronized to the GNSS, and 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). It takes about seven times the holdover interval to calculate the estimated uncertainty for that period. Dashes will appear if the measurement time period is shorter than seven times that time period. For example, after initially running synchronized for a period of 24 hours, it would take seven additional hours to calculate uncertainty for the sixty-minute interval.

```
HOLDOVER ESTIMATED
   UNCERTAINTY?
```

```
HOLDOVER UNCERTAINTY
15 min.   35.21 uSec
```

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

4.5.4 Spoofing Status

Press the TIMING key to review the spoofing status of the clock. The Spoofing Status and Threshold values are described in Section 5.3.11

```
SPOOFING STATUS
0  (THRESH  75)
```

4.5.5 Event/Deviation

You can preview two possible displays when pressing the ENTER key in the EVENT/DEVIATION menu: (1) event recording, or (2) 1 PPS deviation. Setup one or the other in the I/O Block menu, Input tab in the UI.

```
EVENT / DEVIATION
```

Review event or 1 PPS deviation results from the front panel LCD or download through one of the serial ports. If configured for event, successive events appear when repeatedly pressing the UP or DOWN keys. Displays “NO DATA” when no records exist. When configured for 1 PPS deviation, it updates the mean and sigma of 16 successive values once per second. For additional detail, please see below and Section 9.6.

4.5.6 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:mm: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 (0 to 59) and fractional seconds of the event

4.5.7 Deviation Display

If PPS Deviation is selected in the UI, press the TIMING key until reaching EVENT DEVIATION, then press ENTER. Dashes show no input.

```
1PPS         --.-- uS
SIGMA:       --.-- uS
```

4.6 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 and firmware version, power supply voltages, EEPROM, faults, alarms, Network status, NTP/PTP status, analog input and HD (High Drive, or prog. pulse) output current.

4.6.1 Serial Number and Firmware Version

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

```
S/N      C000101
VERSION: 1.32
```

4.6.2 Power Supply

The clock may have one or two power supplies installed: main Power Supply A and optional Power Supply B. If the clock has one power supply, it will be in position A. The second, optional, supply will be in position B. If supply B is not installed the voltage will be indicated by dashes.

```
POWER SUPPLY STATUS
PSA:24.3v  PSB:24.2V
```

4.6.3 EEPROM Errors

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

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

4.6.4 Fault Indications

There are several faults that may be indicated on the LCD. If a fault occurs and the FAULT LED illuminates, the clock may be unreliable and the Time Quality value on the IRIG-B message is set to maximum (i.e., poorest quality). View individual faults in the UI under the Clock menu, Faults tab.

4.6.4.1 Time Base Processor Faults

A Time Base Processor Fault is essentially a communication fault. 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: TBP COM ERROR
dd/mm/yyyy hh:mm:ss
```

4.6.4.2 Holdover/GNSS Faults

There are several issues that may instigate the Holdover/GNSS fault, which are listed below. The Time Base Processor (TBP) is no longer receiving a 1 PPS signal from the GNSS receiver.

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
GNSS RECEIVER FAIL
```

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

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

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. SUSPECT
```

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

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

```
FAULT: HO / RECEIVER
HO OSCILLATOR FAIL
```

4.6.4.3 8 MHz Fault

The main processor clock did not initialize properly. The 8 MHz signal (Holdover Oscillator) is not getting to the main processor.

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

4.6.4.4 WatchDog Timer Fault

The watchdog timer generated a reset, which means that the firmware hung up somewhere.

```
FAULT: WATCH DOG
TIMER RESET
```

4.6.4.5 Brownout Fault

The brown out detector generated a reset, which would normally indicate a power supply issue.

```
FAULT: BROWN OUT
DETECTOR RESET
```

4.6.4.6 Power Supply Fault

The clock can be configured for two power supplies: power supply A and power supply B. The fault indicates that the voltage from a configured power supply is low.

```
FAULT: POWER SUPPLY
PSA: ---V PSB: ---V
```

4.6.4.7 Antenna Faults

Messages for faulty antenna/cable conditions are (1) Antenna Short, and (2) Antenna Open. Both messages are illustrated below. The first message indicates an antenna short, and the second display indicates an antenna circuit open with the current of zero milliamperes. These fault messages will disappear once the connection is restored.

```
FAULT: ANT  LO VOLT
0.02 V     127 mA
```

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

4.6.4.8 Programmable Pulse Overload Fault

The signal has dropped below the minimum voltage and the signal(s) may not transmit correctly.

```
FAULT: PP OVERLOAD
dd/mm/yyyy hh:mm:ss
```

4.6.4.9 Boot Loader Missing Fault

A firmware package that allows the installation of new clock firmware is not detected and will need to be restored at the factory.

```
FAULT:
BOOT LOADER MISSING
```

4.6.5 Alarm Indications

4.6.5.1 Position Change

If the clock (or GNSS antenna) is moved to a new location, it is possible that a Position Change Alarm may occur. If it does, the ALARM LED will light and a message will be displayed in the SYSTEM menu. To view message, press ENTER at the submenu indicating “ALARM?”

```
POS. CHANGE 123456 m
dd/mm/yyyy hh:mm:ss
```

4.6.6 Network Status

Provides the IP addresses and hardware (MAC) addresses for all three network ports. Press ENTER to view NET1 and UP or DOWN keys to view all ports. NET2 is an example of a good link (GD). NET1 shows a bad link condition (BD). NET3 is not shown in this example.

```
NETWORK STATUS?
```

```
NET1:10.10.1.102
64:73:E2:00:00:E3 BD
```

```
NET2:10.10.1.154
64:73:E2:00:00:E4 GD
```

4.6.7 NTP/PTP Status

Provides status of both NTP and PTP services. Values include RUNNING, NOT RUNNING, LOCKED, UNLOCKED. Press the ENTER key to view status.

```
 NTP / PTP STATUS?
```

```
NTP: SYNCHRONIZED
PTP: RUNNING
```

4.6.8 Analog Input

The Analog Input provides the values measured at input pins 26 and 27, located at the large block connector. These data are viewable from the front panel under the SYSTEM key. Press the SYSTEM key multiple times to cycle through the different status information of the clock. Stop on the display ANALOG INPUT to view the measured frequency and voltage magnitude

```
    ANALOG INPUT
60.020 HZ  119 Volts
```

Press the SYSTEM key once more to view the frequency deviation and system time offset.

```
ANALOG ΔF -0.003 Hz
    ΔT   +1.2574 Sec
```

4.6.9 HD Output Current

Provides a value for the current delivered from any of the six high drive (HD) outputs. Press the ENTER key and UP or DOWN keys to view individual output currents.

```
 HD OUTPUT CURRENT?
```

```
   OUTPUT CURRENT
HD1  61mA  HD2  61mA
```

```
   OUTPUT CURRENT
HD3   0mA  HD4   0mA
```

```
   OUTPUT CURRENT
HD5   0mA  HD6   0mA
```

Chapter 5 User Interface (UI)

This chapter covers the setup and maintenance of the clock using the User Interface (hereafter called UI).

Setup and maintenance are minimally available through SSH console. See Chapter 6.

- Administrate directly or through LDAP.
- Securely configure the clock.
- Check clock status and verify a clock configuration.
- Copy a configuration file from one clock for uploading to another clock.
- Configure options and special functions.
- Upload new firmware packages to a clock's flash memory.

5.1 Administration

There are two methods of administrating the clock: (1) directly, which is currently available, and (2) through an LDAP server, which is currently not available. Initially, when logging in to the clock you will have the option to connect using LDAP.

5.1.1 Configure Directly

Currently, there is one account: "admin". In the future, there will initially be a choice to connect directly or through LDAP and change the username.

5.1.2 Logging in to the User Interface Directly

1. Open your web browser and type in the IP address of one of the ports in the web browser address bar.
2. Press the ENTER key, which should open the UI login.

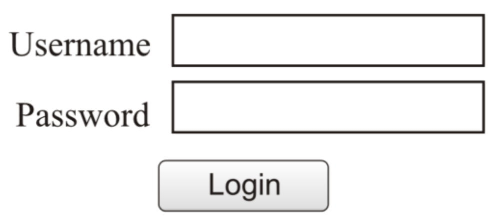


Figure 5-1 Login to the UI

3. Type in your Username and Password. The default username is "admin" and default password is "password" (no quotes).
4. Click the Login button. If you typed in the correct username and password, the UI should appear. Note that there are two general areas on the interface: (1) the menus on the left side, and (2) the various tabs at the top of each menu.

The clock responds when you type in the IP address of one of the clock's Ethernet ports into your web browser. To determine the IP address on the front panel, press the SYSTEM key until reaching Network Status and press the ENTER key. Now use the UP or DOWN keys to scroll through the network settings. *The clock will display the IP address if the port is connected to a network.*

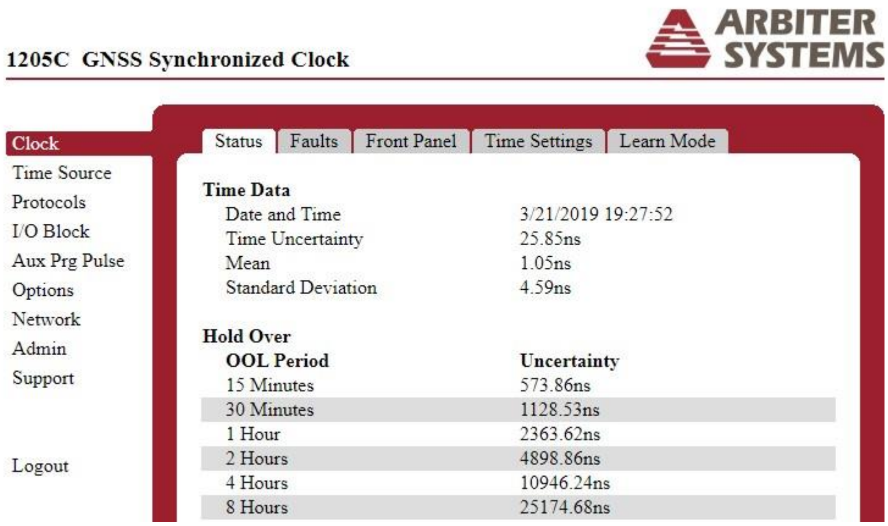


Figure 5-2 Partial View of Initial Log In Page

5.1.3 The IP Address

The default configuration: NET1 is set to static (192.168.0.232). NET2 and NET3 are set to DHCP (Dynamic Host Configuration Protocol).

5.1.4 Important Configuration Change Notes

These configuration changes will cause the network connection to drop: (1) changing from HTTP to HTTPS, (2) changing a Network configuration, or (3) changing a System configuration *on the port which you are connected*.

- If changes are made to another port, the connection will not be dropped.
- Make sure to click the Apply button where required.
- If the “Successful” notification appears after changes were made, then a re-logging in is not needed. Otherwise, re-log in with the new configuration to make the changes persistent.
- To lose changes, reboot the clock before re-logging in.
- After making any changes, the NTP service may experience a short delay before becoming accurate. This delay would be longer if the clock is power cycled, since the clock must again lock to at least four satellites and establish its geographical position.

5.2 Security

Set up security features through the UI. Security cannot be setup from the front panel or through RS-232 ports. One of the goals of these security features is to help in complying with NERC CIP[4] requirements. Currently, security is fixed with one level of password protection. Future upgrades include multiple levels of access, so that operation can be tailored to the user’s preferences.

The usual method to query and configure this clock is through the UI, which provides the capabilities allowed with their specific permissions. For the upmost in security, clock features may be set up requiring credentials, i.e., a username and password. As such, the clock comes with a default username and password, in which the password may be changed. Alternatively, the clock may be set up with unrestricted access, and security disabled. Future updates include the ability to change the username.

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

5.3 User Interface

5.3.1 User Interface Startup Page

When logging in to the UI, the opening screen should be on the Clock menu, Status tab. The information on this page cannot be edited.

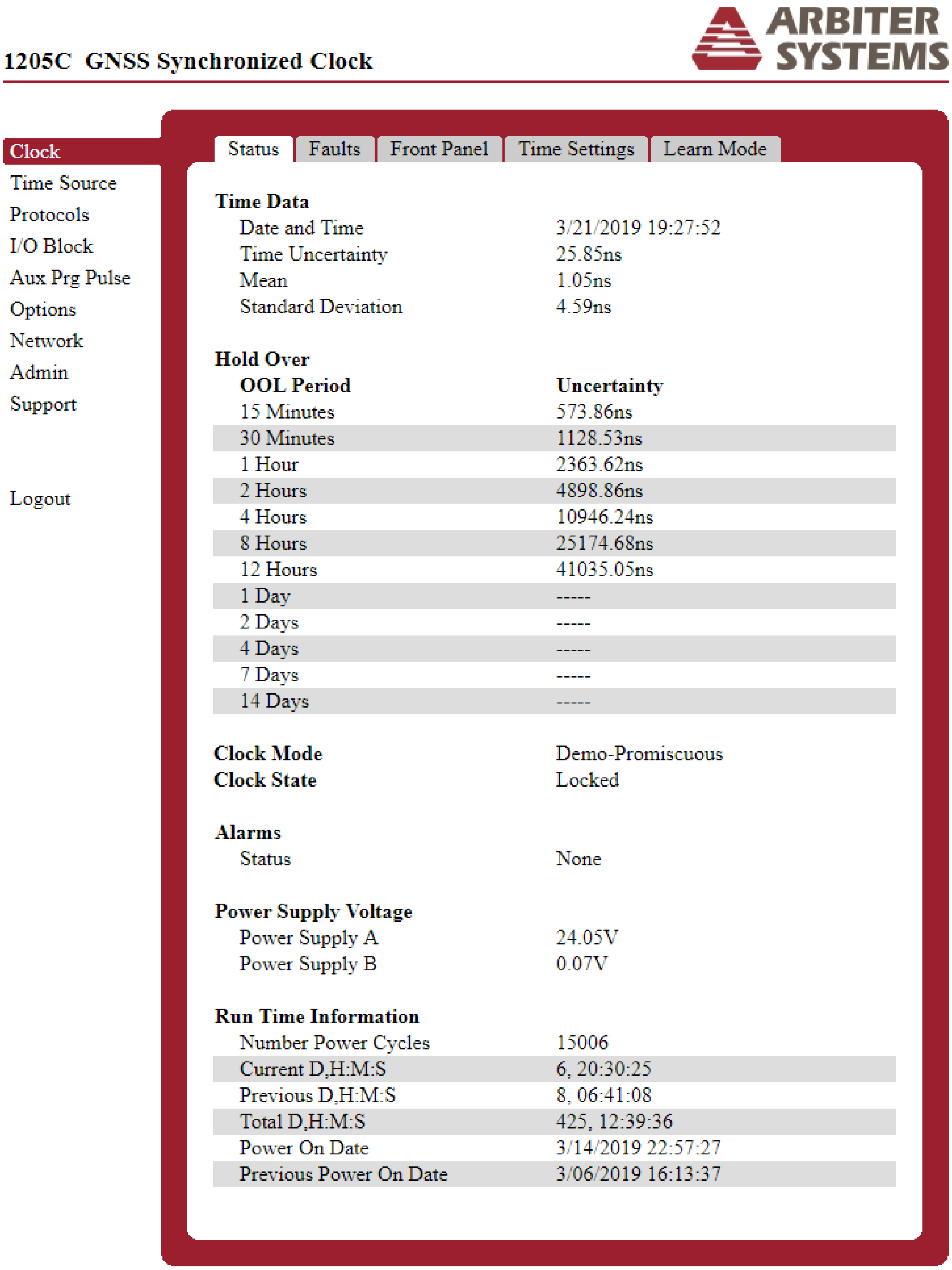


Figure 5-3 User Interface Startup Page

5.3.2 Time/Date Settings

The Time/Date page allows you to set up the Local Time offset from UTC and the automatic Daylight Saving Time (or Summer Time) adjustments.

Slew Control – Limits the speed at which timing of the 1 PPS changes at re-lock. If, for example, the clock is unlocked for a long time (e.g., off by 1 ms) and then re-locks, it will bring the timing error back to zero offset, but it will be limited to the slew control value.

Trajectory Estimate Sigma – The standard deviation (known as sigma) determines the spread around the mean/central tendency. Default value for calculating Time Quality is 2.0 sigma, or 95 % probability that the Time Quality will be the value listed. Sigma values range from 1.0 to 6.0.

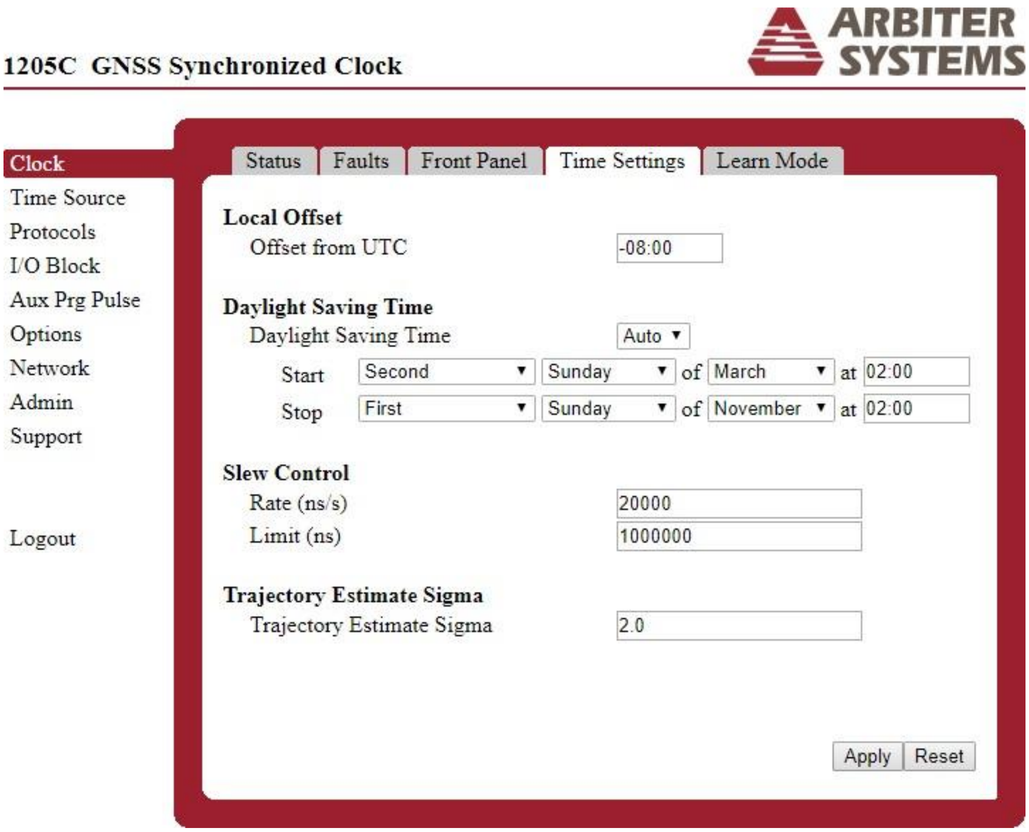


Figure 5-4 Time Settings

5.3.3 User Interface Configuration

From the System menu and Configure tab, you can set up the UI for HTTP or HTTPS, enable session time outs and to respond to ping requests.

WARNING: If using HTTPS, you will need to upload a PEM file. **Do not upload a PEM file that has not be verified.** See Appendix C for information on generating a PEM file.

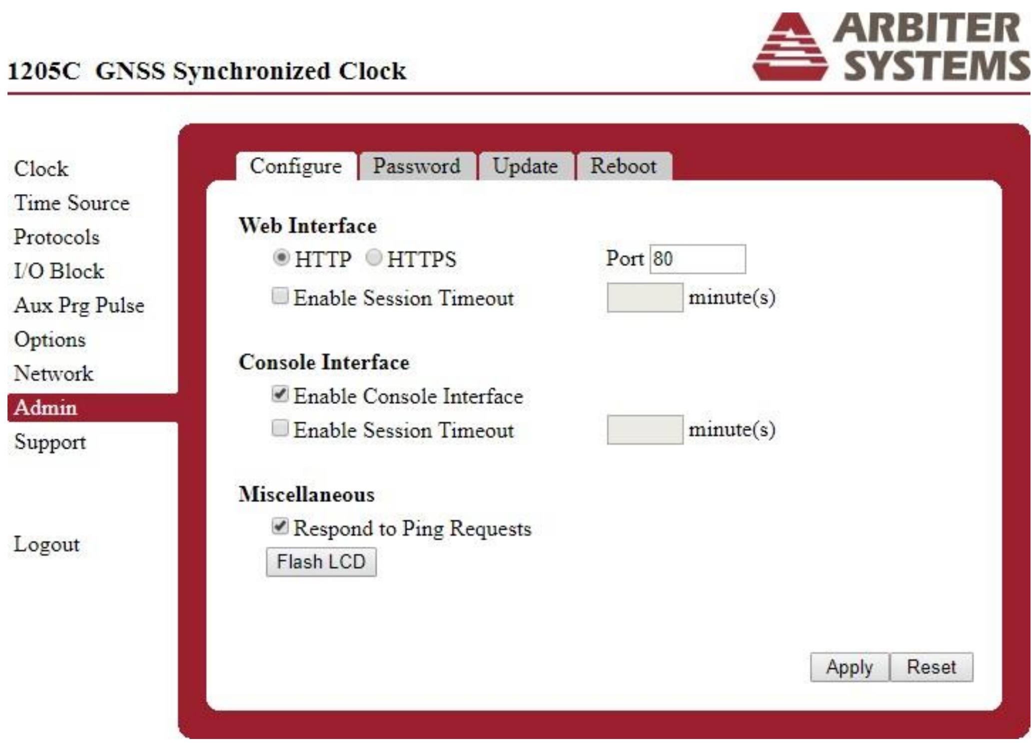


Figure 5-5 Configuring the User Interface

5.3.4 Learn/Normal Modes

Select the Clock menu, click the Learn Mode tab, click the Initiate Learn Mode check box and click Apply to begin to initialize the clock. The clock should enter the Normal mode after completing the 24-hour Learn mode.

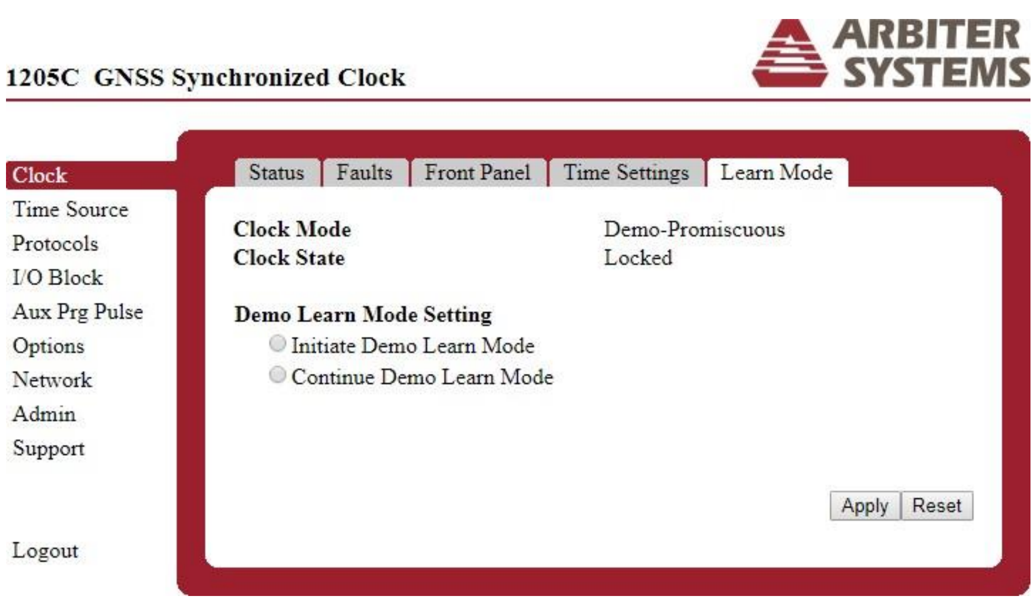


Figure 5-6 Configuring the Learn/Normal Modes

5.3.5 Configure Password

To configure the password, select the Admin menu and click the Password tab. Fill in the current and new passwords. Remember to write down any new password and keep it in a safe place.

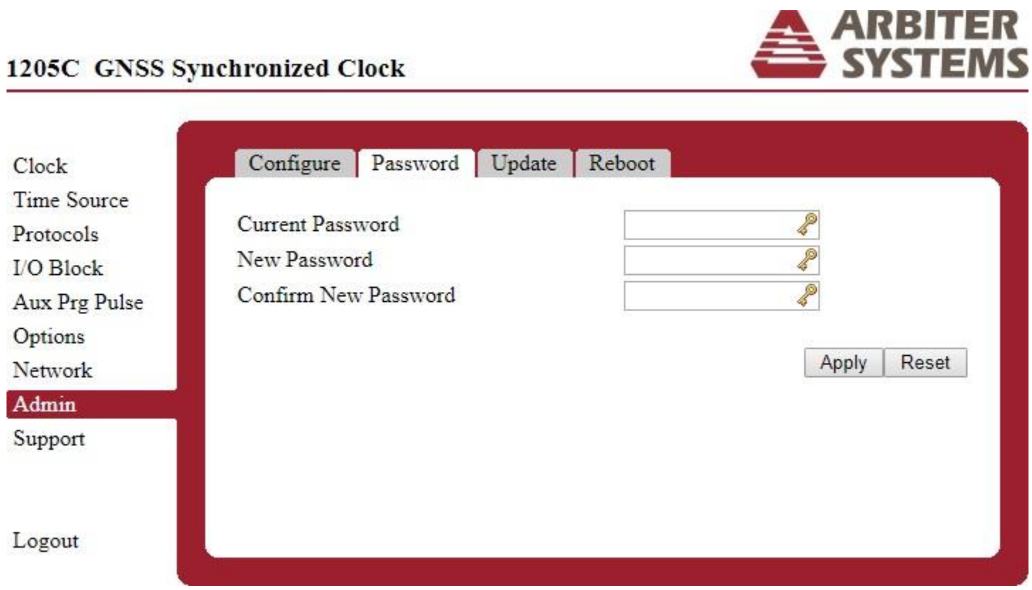


Figure 5-7 Configure System Password

5.3.6 Firmware Updates

Use this page to upload a new firmware file to the Model 1205B/C and the Model 1206B/C. Select the Admin menu and click the Update tab. Make sure to have the new firmware update file available on your computer and click on the Choose File button. Next, select the file and click the Upload button. At the conclusion a message should appear when the update is successful.

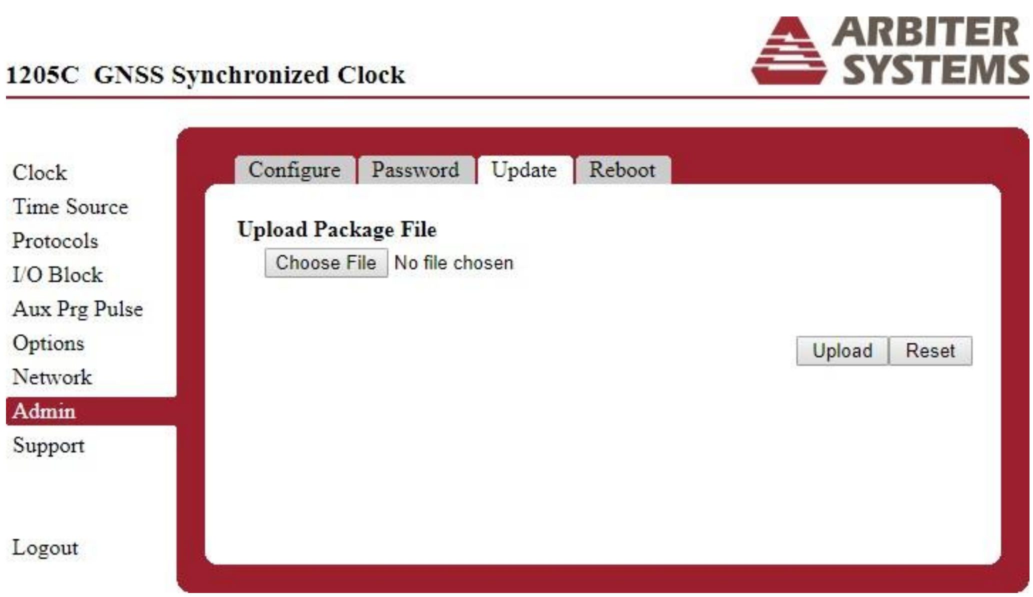


Figure 5-8 Upload a Firmware Update

5.3.7 Reboot System

Select the Admin menu and click the Reboot tab. Next, click the Reboot button to reboot of the network system only. At the conclusion of the reboot, you will be presented with the login screen and will need to re-login to the clock.

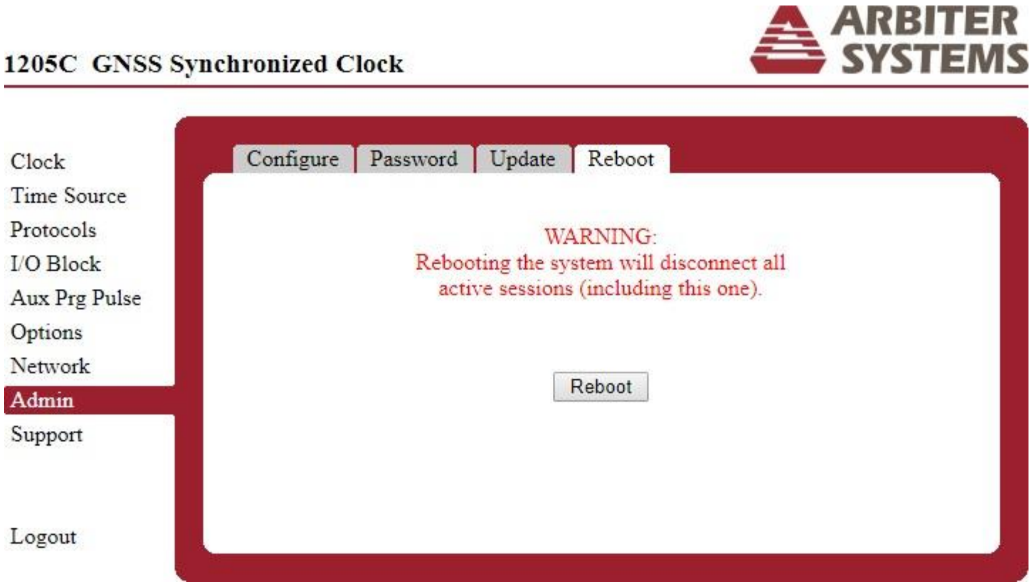


Figure 5-9 Rebooting the System

5.3.8 Configure Front Panel Elements

Select the Clock menu and click on the Front Panel tab. Select the Backlight Mode drop down menu as either Off, Auto or On. If equipped with a large LED display, select as MM.DD.YY, DD.MM.YY, or Disabled. Also, select the (front panel) Keylock and Display mode preference.

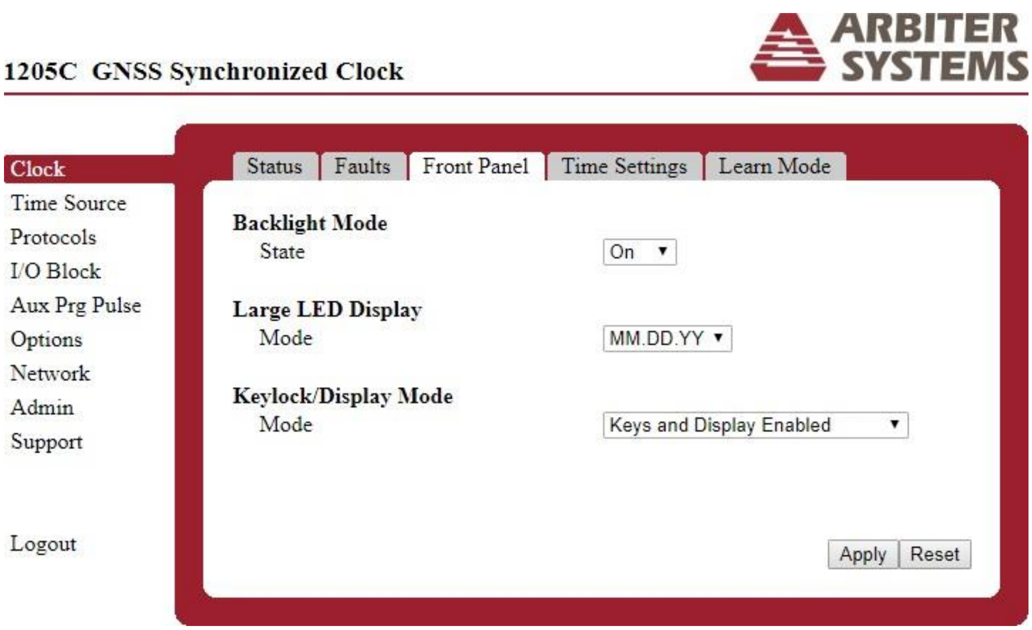


Figure 5-10 Configuring the Front Panel Elements

5.3.9 GNSS Information

Select the Time Source menu and click on the GNSS tab to view all the satellite related information, including GNSS receiver, antenna position, GPS and GLONASS contributions.

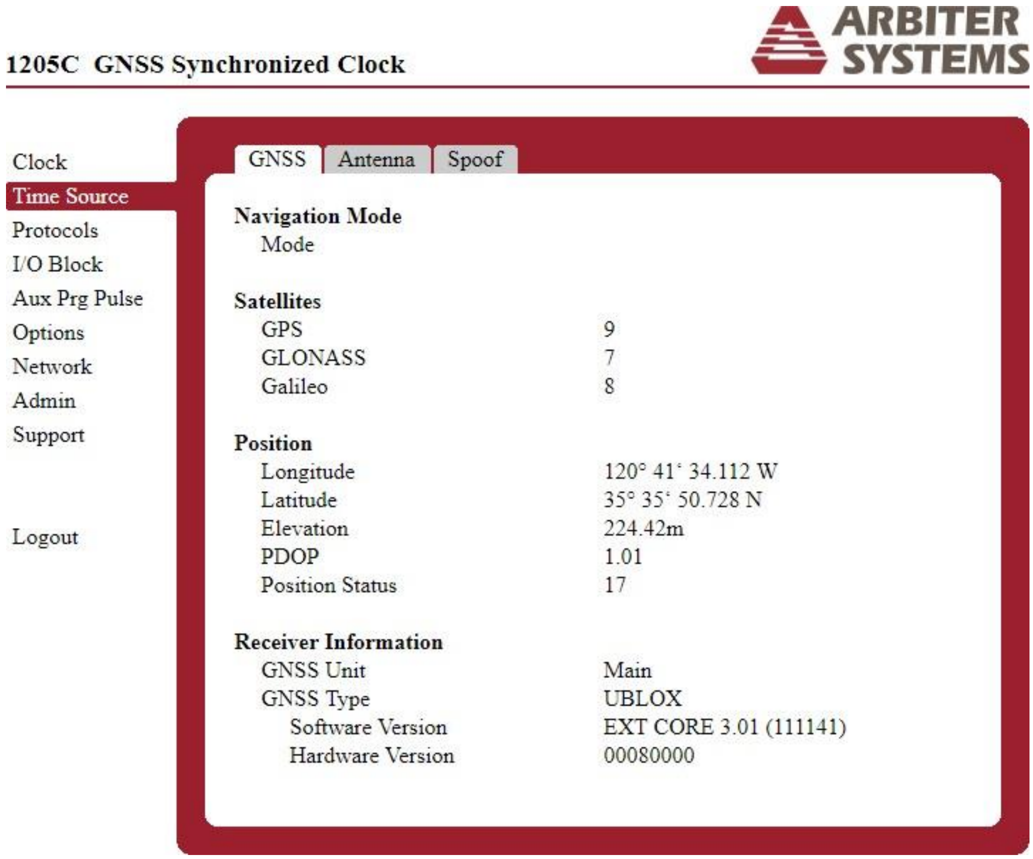


Figure 5-11 GNSS System Information

5.3.10 Antenna Information

Select the Time Source menu and click on the Antenna tab to view all of the antenna related information, including voltage setting, antenna and cable delays and active status.

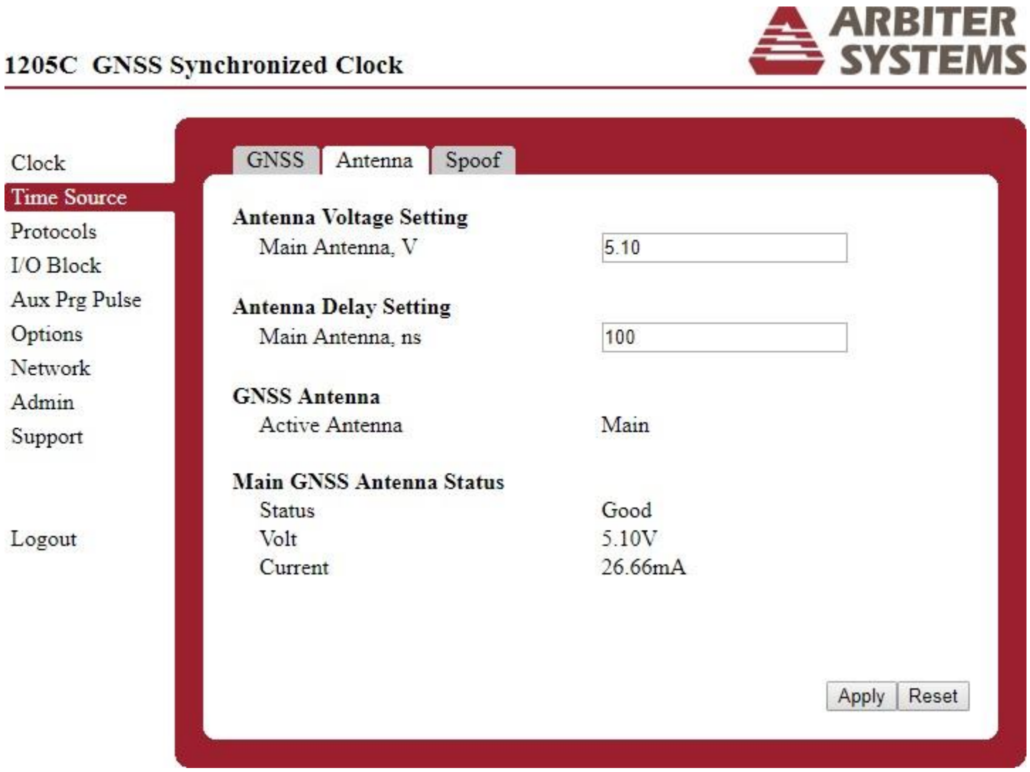


Figure 5-12 Antenna Information

5.3.11 Spoofing Information

Select the Time Source menu and click on the Spoof 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.*

5.3.11.1 Spoof Status

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.

5.3.11.2 Spoof Setting

For anti-spoofing to work in the clock, the Spoof Setting State must be enabled. Otherwise, spoofed GNSS signals will be ignored in the clock. Select “Disabled” if you want to turn off the anti-spoofing feature. Testing has shown that the default Spoof Setting 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.

5.3.11.3 Spoofing Auto Terminate

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

5.3.11.4 Spoofing Auto Re-Lock

If disabled, the clock will never attempt to recover from a spoofing detection. Normally, if the clock sees the spoofing attack terminate it will attempt to re-lock and clear the "alarm."

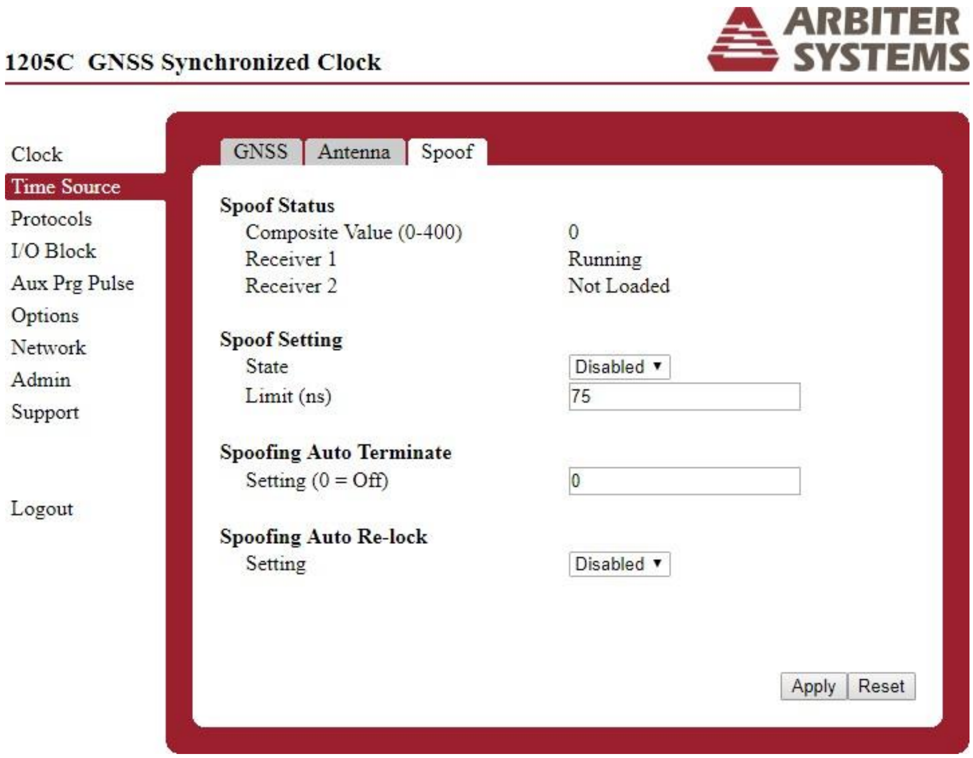


Figure 5-13 Spoofing Information

5.3.12 General Clock Status

Select the Clock menu and click on the Status tab to view all the time related information. This includes time data, hold over uncertainty, time status, leap seconds, alarms, power supply presence and voltage(s) and run time information.

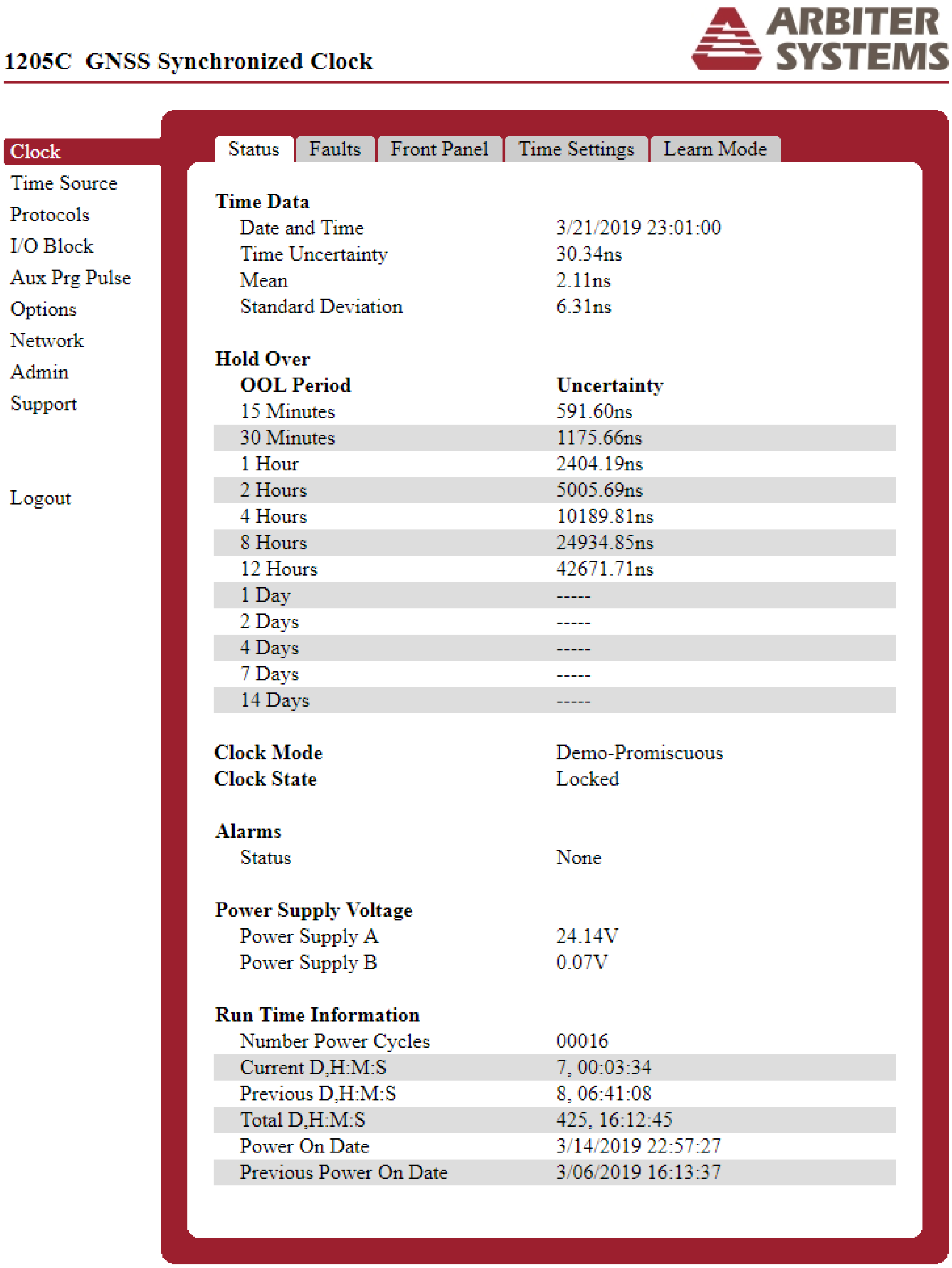


Figure 5-14 General Clock Status

5.3.13 Configure Standard Relay

Use this menu to configure the standard relay located in the large connector block shown in Figure 5-15. Select the condition(s) for activating the relay. Multiple selected relay configurations are OR'ed.

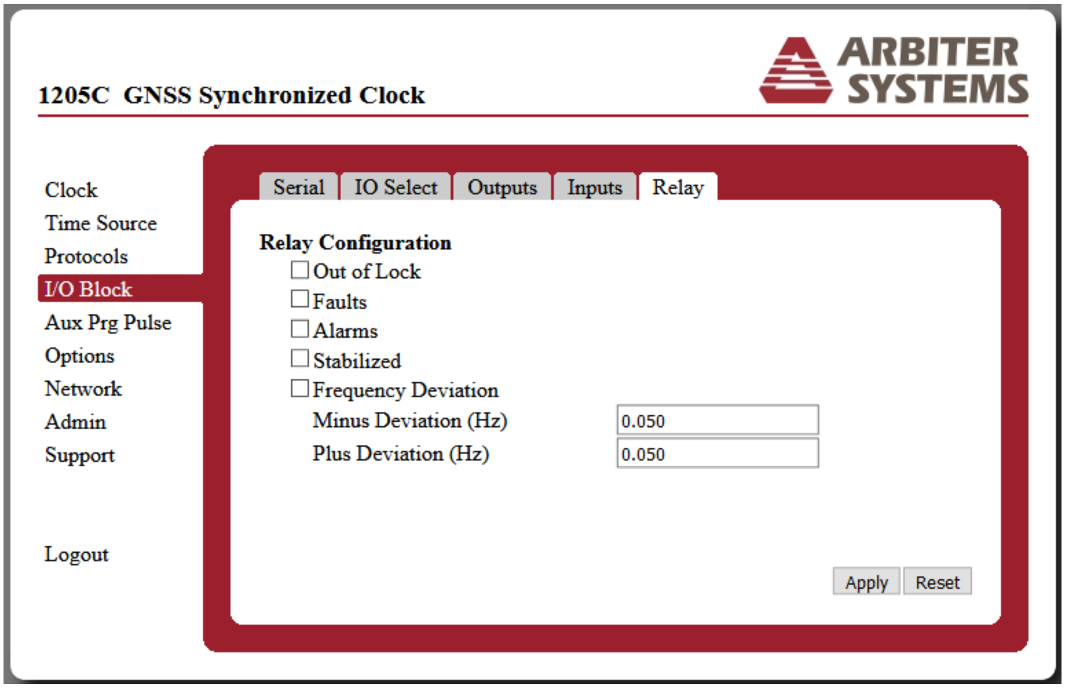


Figure 5-15 Standard Relay Configuration Menu

5.3.14 Network Status

Select the Network menu and click on the Status tab to view all the network related information, including IP addresses, if available, hardware addresses and activity.

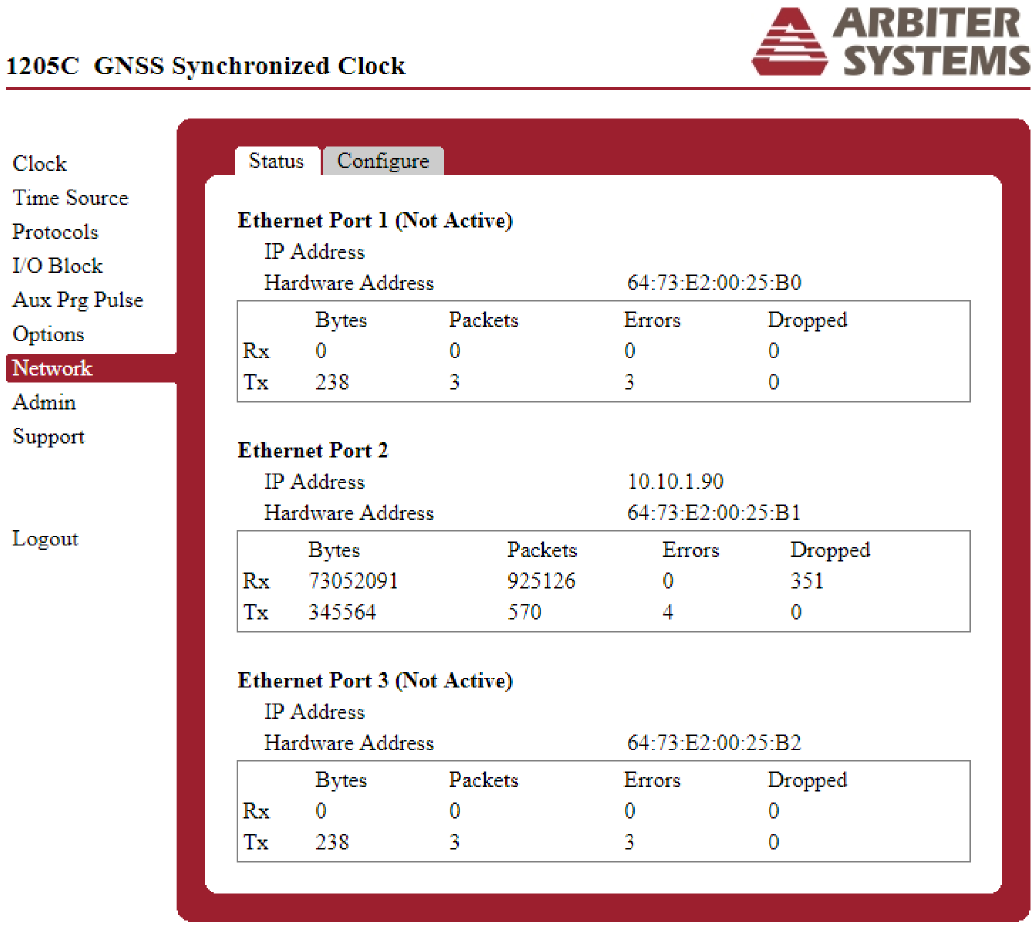


Figure 5-16 Network Status Page

5.3.15 Network Configuration

Select Network menu and click on the Configure tab to view the port configuration page. Use this page to configure the Ethernet ports on the Model 1205B/C and the 1206B/C. Select any port for DHCP (Dynamic Host Control Protocol) or Static. Notice that when selecting Static that there are three additional boxes that appear to allow for setting the IP address, the Net Mask and a Gateway. Also, if checked, VLAN settings appear.

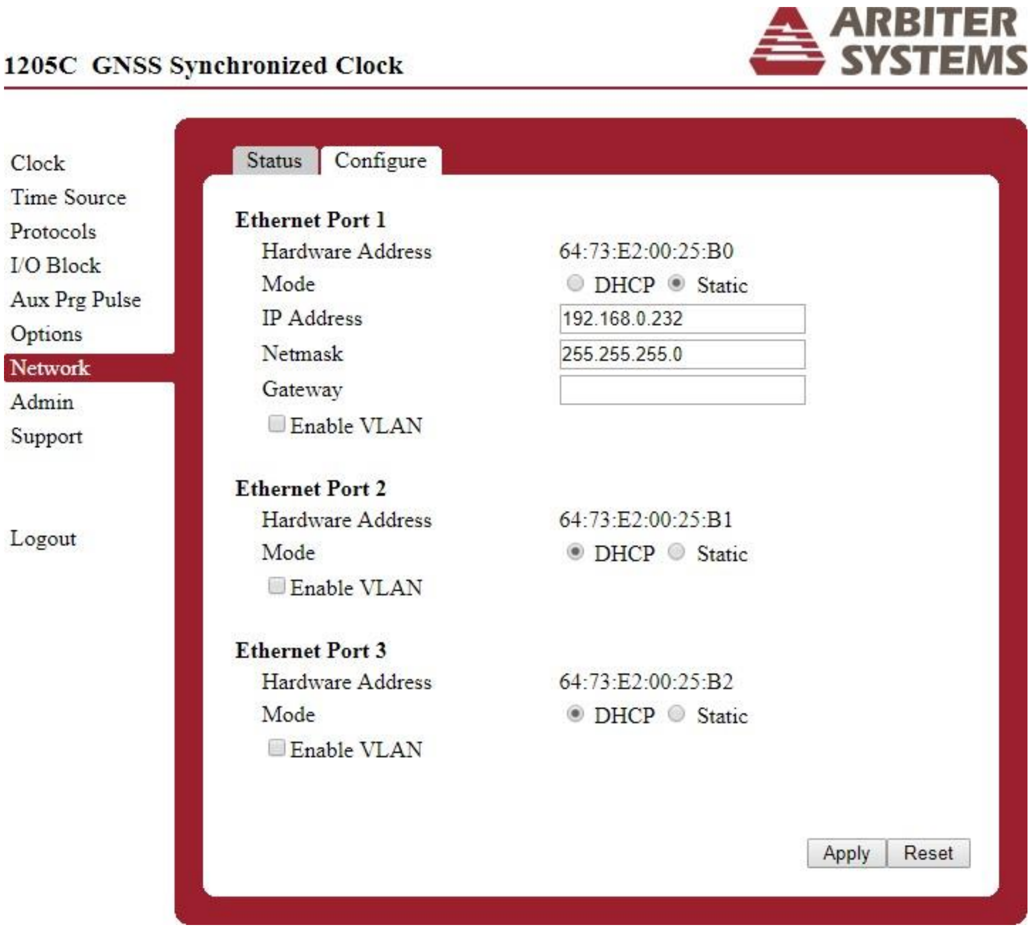


Figure 5-17 Ethernet Port Configuration Page

5.3.16 Analog Input over IP

The Analog Input frequency data is available over the Ethernet ports via a Telnet connection.

To configure:

- Navigate to the Analog Input tab of the Network Menu
- Select the Mode (Off/ASCII/VORNE)
- Select the Time Reference (UTC/Local)
- Select the Port Number (default is 49543)
- Select the Max Connections (default is 1)
- Click Apply

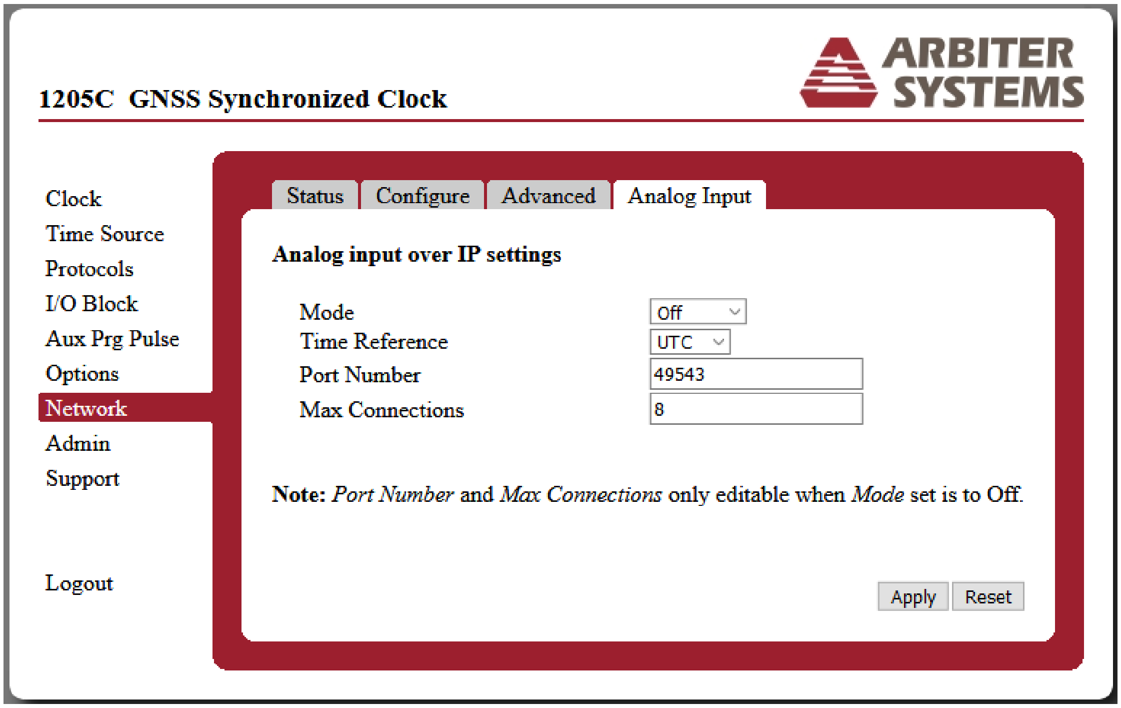


Figure 5-18 Analog Input over IP Settings Page

5.3.17 Serial Port Communication Settings

Configure the RS-232 and RS-485 port settings on this page. Select the I/O Block menu and click on the Serial tab to view and change the settings. Currently, the RS-485 mirrors COM1 settings.

5.3.17.1 Available COM Settings

- Baud Rate: 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200
- Data Bits: 7, 8
- Parity: None, Even, Odd
- Stop Bits: 1, 2

Broadcast settings include nine modes (including Off and a custom string), broadcast rate (in seconds), Time Reference (UTC and Local) and a place to type in the custom broadcast string values. For more information on custom broadcast strings, see 11.7.7Appendix A.

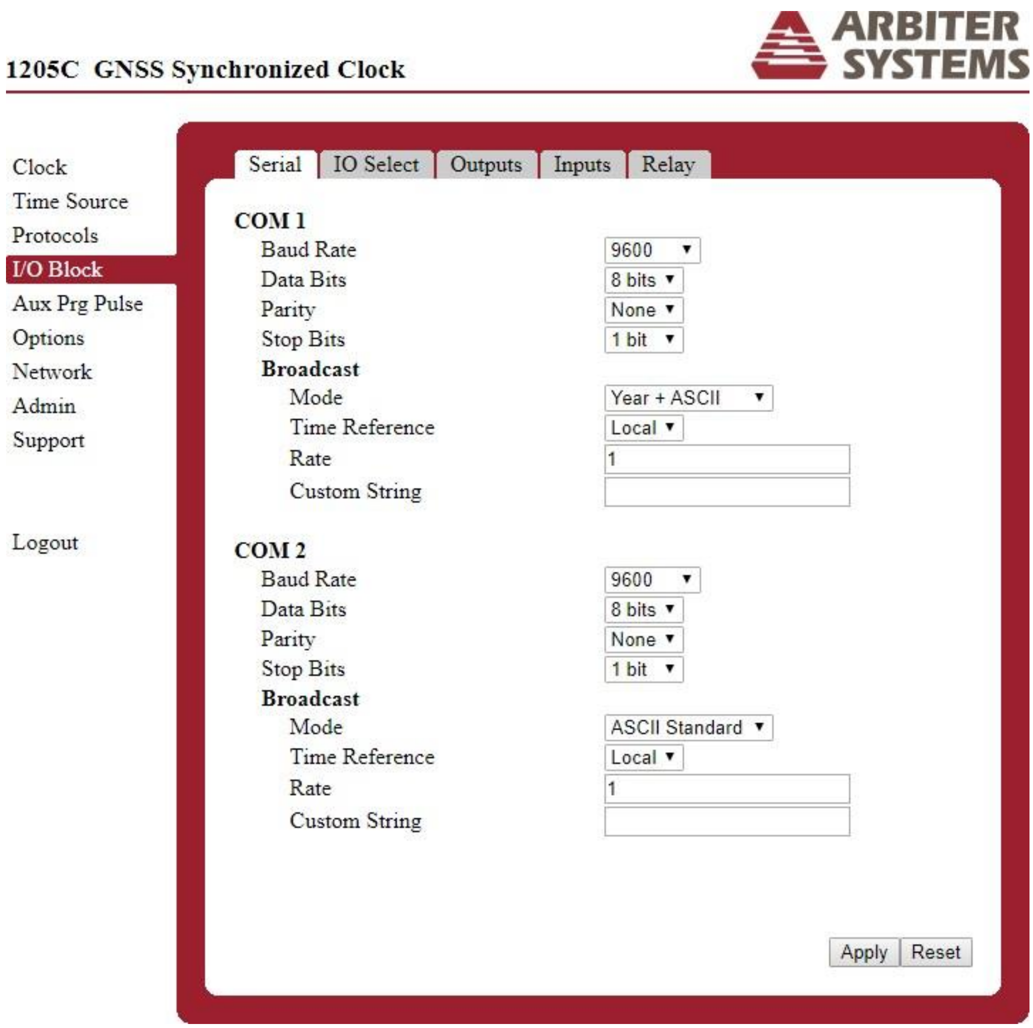


Figure 5-19 Serial Communications Port Settings Page

5.3.18 Programmable Pulse Output Settings

Use this page to configure all six of the programmable pulse outputs, or digital outputs, of the 1205 and 1206. All standard inputs and outputs are located on the large connector block.

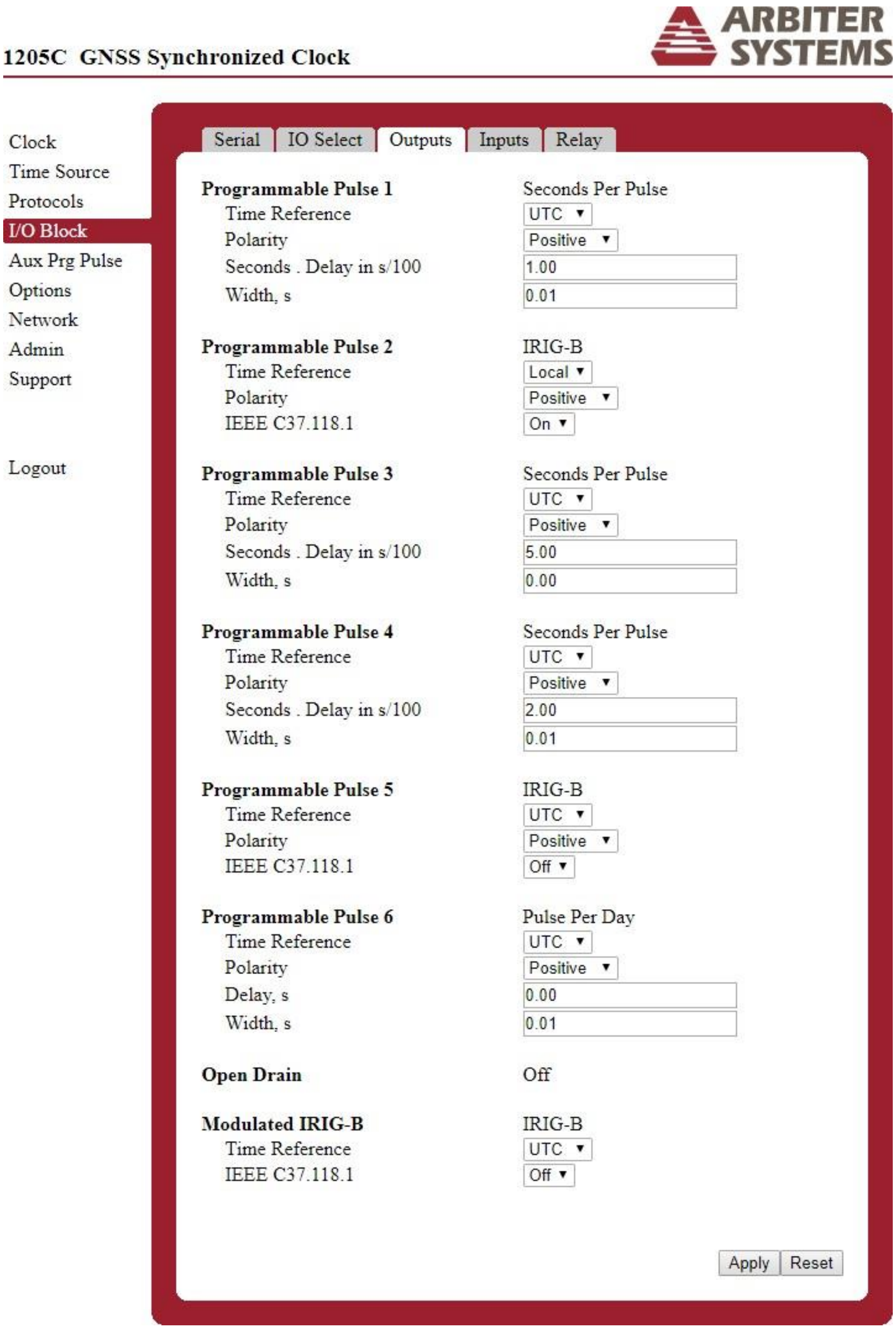


Figure 5-20 Programmable Pulse Settings Page

5.3.19 Open Drain, High Voltage Switching

Use this menu to set up the open drain switching feature in the Model 1205 and 1206. Under the I/O Block menu, I/O Select tab, Open Drain and choose the type of open drain signal and click the Apply button. Next go to the I/O Block, Outputs tab and select the Open Drain values and click the Apply button. For additional technical information on setup and configuration of the open drain feature, see Section 9.8.

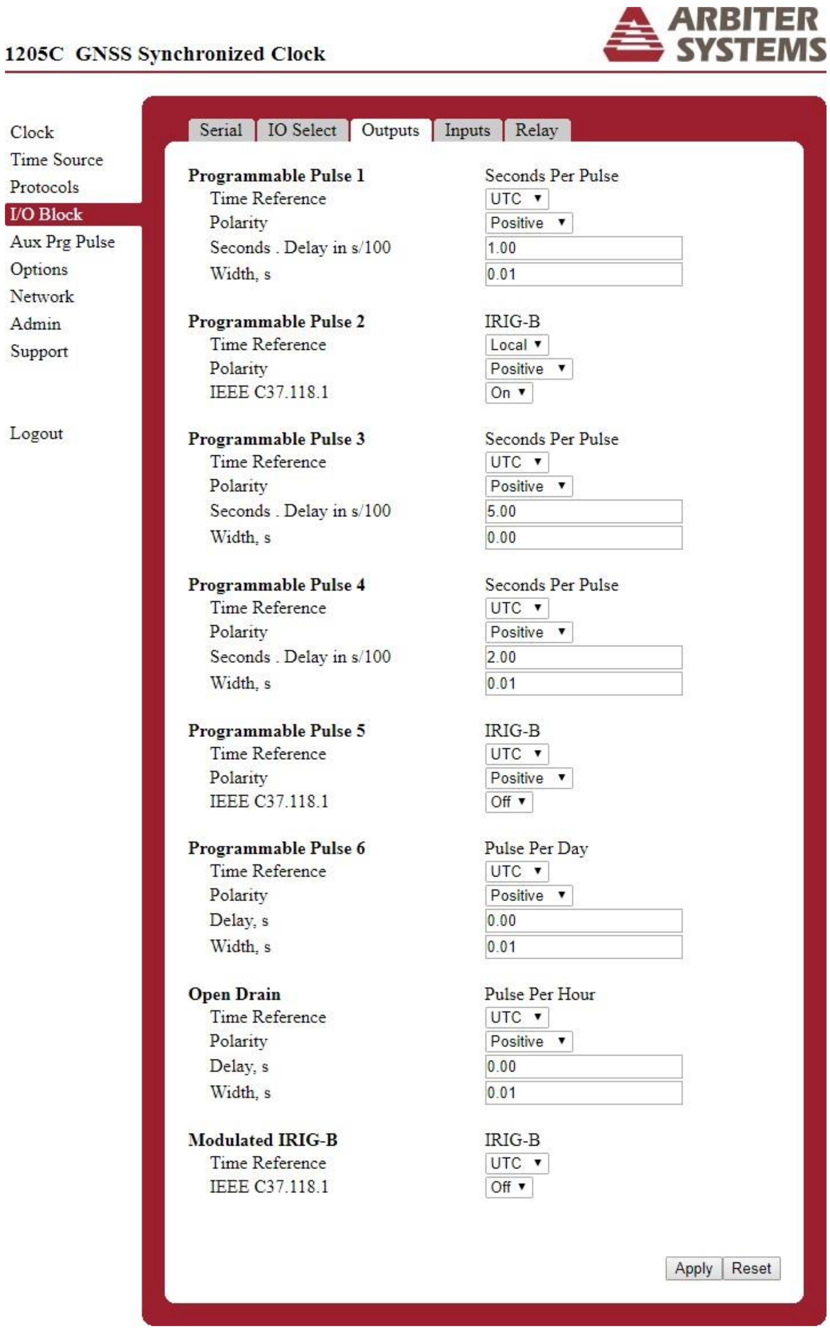


Figure 5-21 Open Drain Setup Menu

5.3.20 Modulated IRIG-B

Enable modulated IRIG-B in the I/O Block menu, I/O Select tab. Configure it in the I/O Block menu, Outputs tab. For additional information on IRIG-B, see Section 9.2.1.

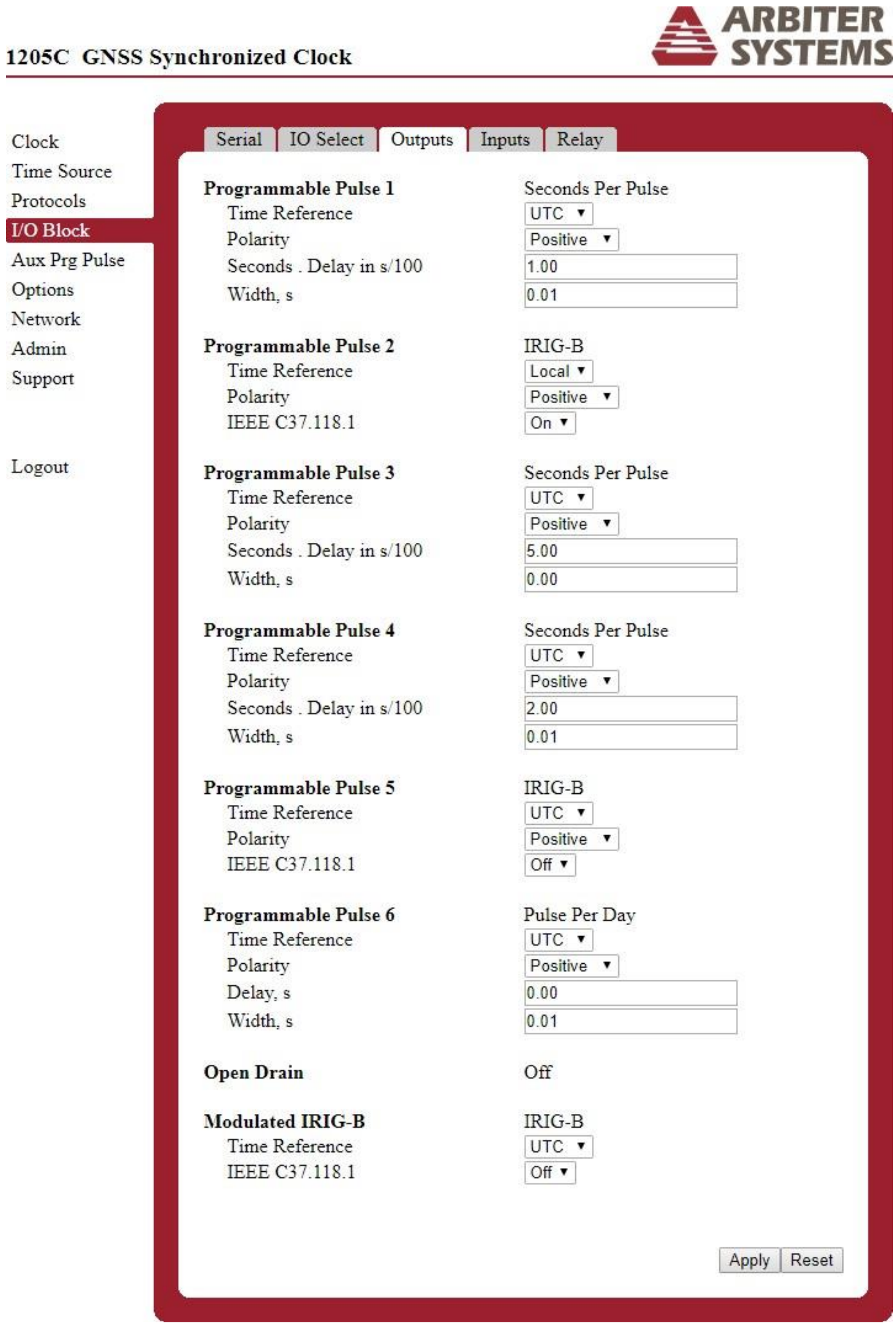


Figure 5-22 Modulated IRIG-B Setup Menu

5.3.21 Optional Outputs – Slots A, B and C

Optional output slots A, B and C individually provide specific inputs and outputs installed at the time of order. Figure 5-23 illustrates the auxiliary programmable pulse modes that can be selected for Slot B. Aux PP Select allows you to select an auxiliary programmable pulse mode (see Figure 5-24) and Aux PP Config allows you to configure the auxiliary mode selected in Aux PP Select rather than the standard programmable pulse modes. In this way, you could set up a separate instance of IRIG-B with a different time zone, or C37.118.1 setting.

Programmable pulse modes are selected and configured under the I/O Block menu, I/O Select and Output tabs.

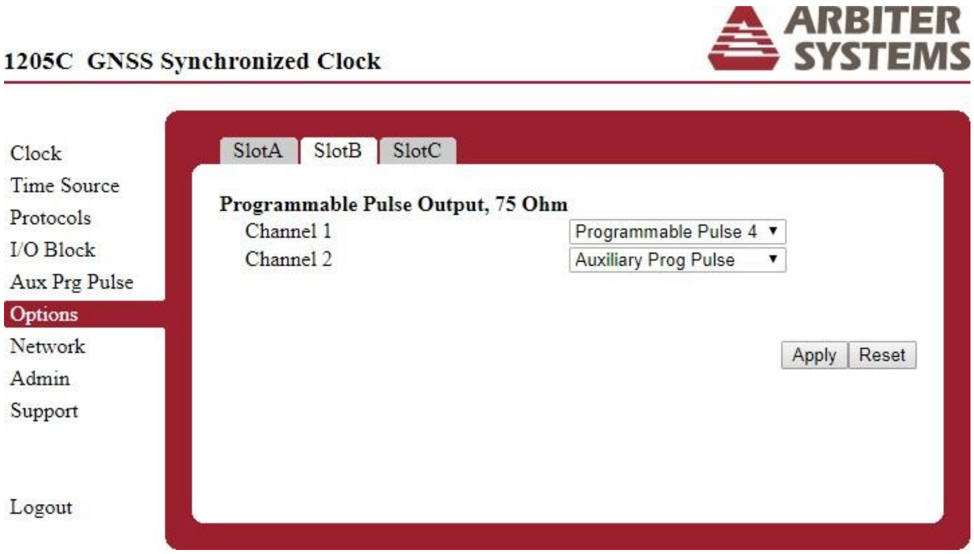


Figure 5-23 Optional Programmable Pulse Output

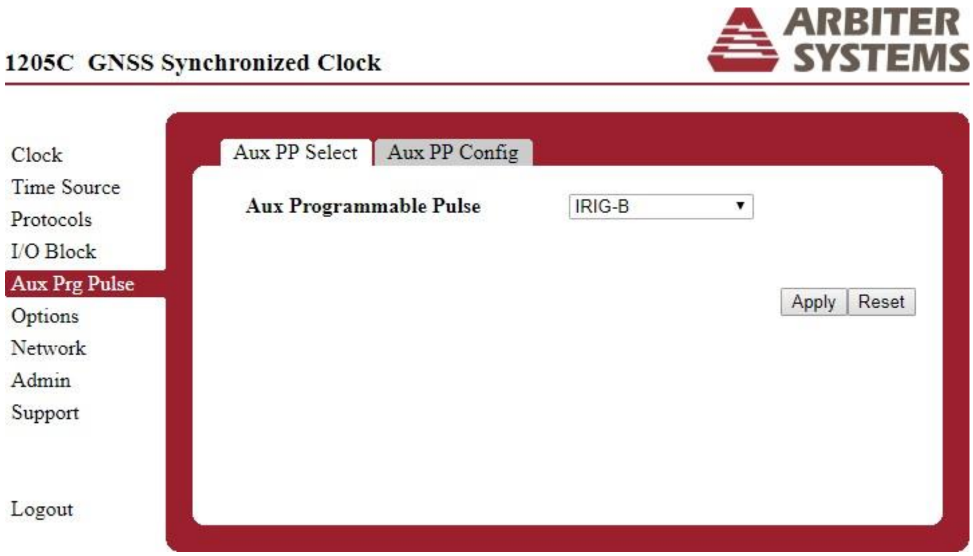


Figure 5-24 Auxiliary Programmable Pulse Select Menu

5.3.22 Event Inputs and System Frequency

Select the I/O Block menu and click on the Inputs tab to configure and view the Inputs page information. The Analog Input provides the clock with the ability to accept either a 50 Hz or 60 Hz (± 10 Hz), 50 Vrms to 300 Vrms input signal and measure the instantaneous frequency and magnitude of the fundamental component while rejecting the effects of harmonics, noise, and DC offsets. Measurement results are available via the Ethernet ports, the RS-232 outputs, and the front panel display.

Event Input Setup selects for either Event timing or 1 PPS deviation for a digital signal connected to the clock. When Event is selected the page will display a list of up to 50 recorded events. When 1 PPS Deviation is selected the page changes to replace the recorded events to indicating the average 1 PPS deviation for the previous 16 seconds and the 1 PPS sigma.

To choose either Event Input, or 1 PPS Deviation, go to the I/O Block menu and I/O Select tab and choose through the Input Mode Setting drop down menu.

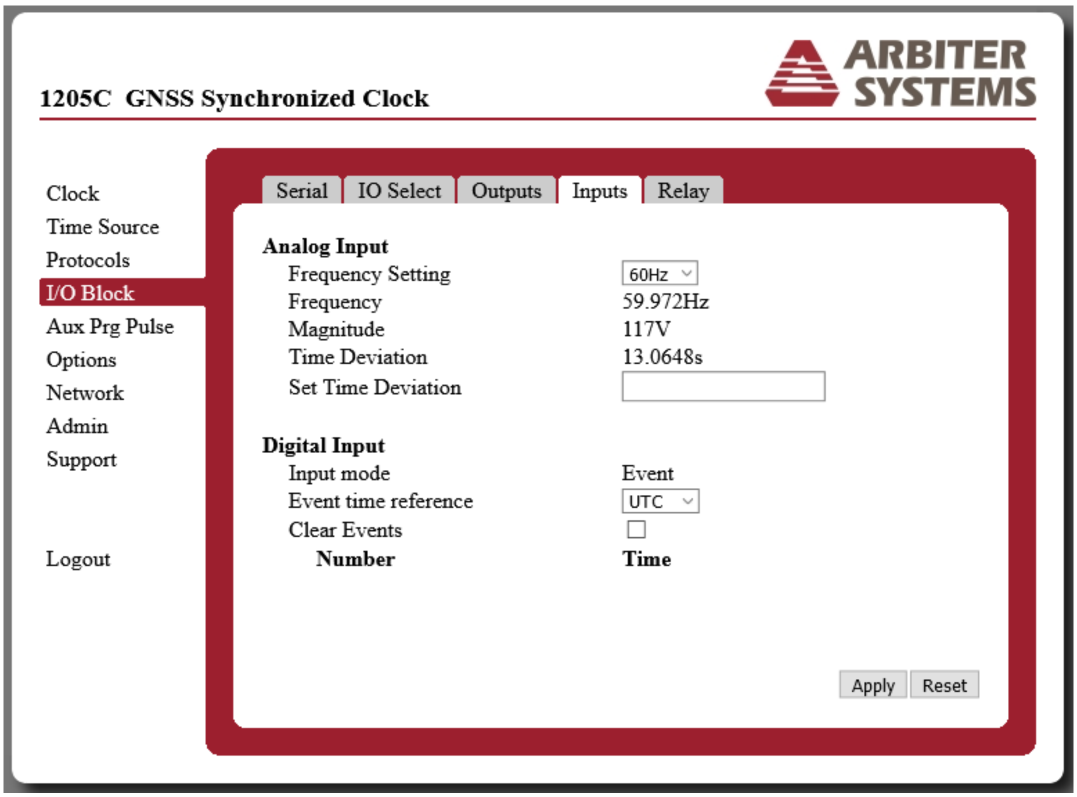


Figure 5-25 Input Page Information

5.3.23 Fault Status and Configuration

Select the Clock menu and click on the Faults tab to view the fault status and configuration.

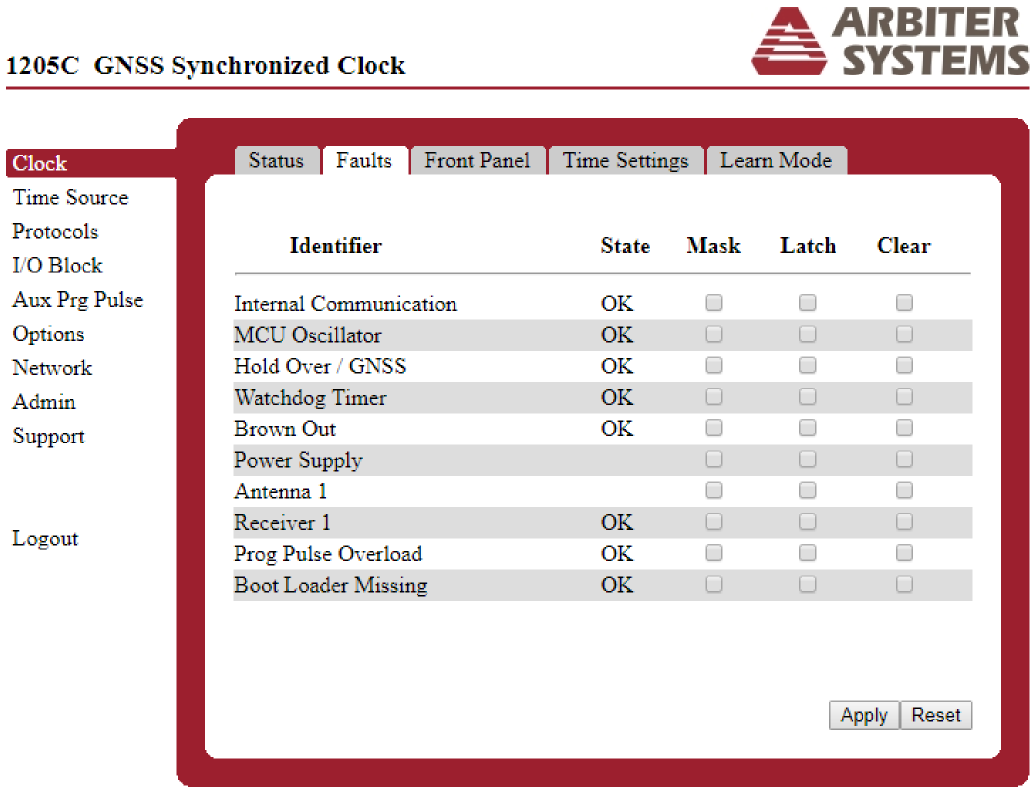


Figure 5-26 Viewing the Fault Status and Configuration

5.3.24 Configure PTP Protocols

Select the Protocols menu and click on the PTP tab to view all available PTP configurations.

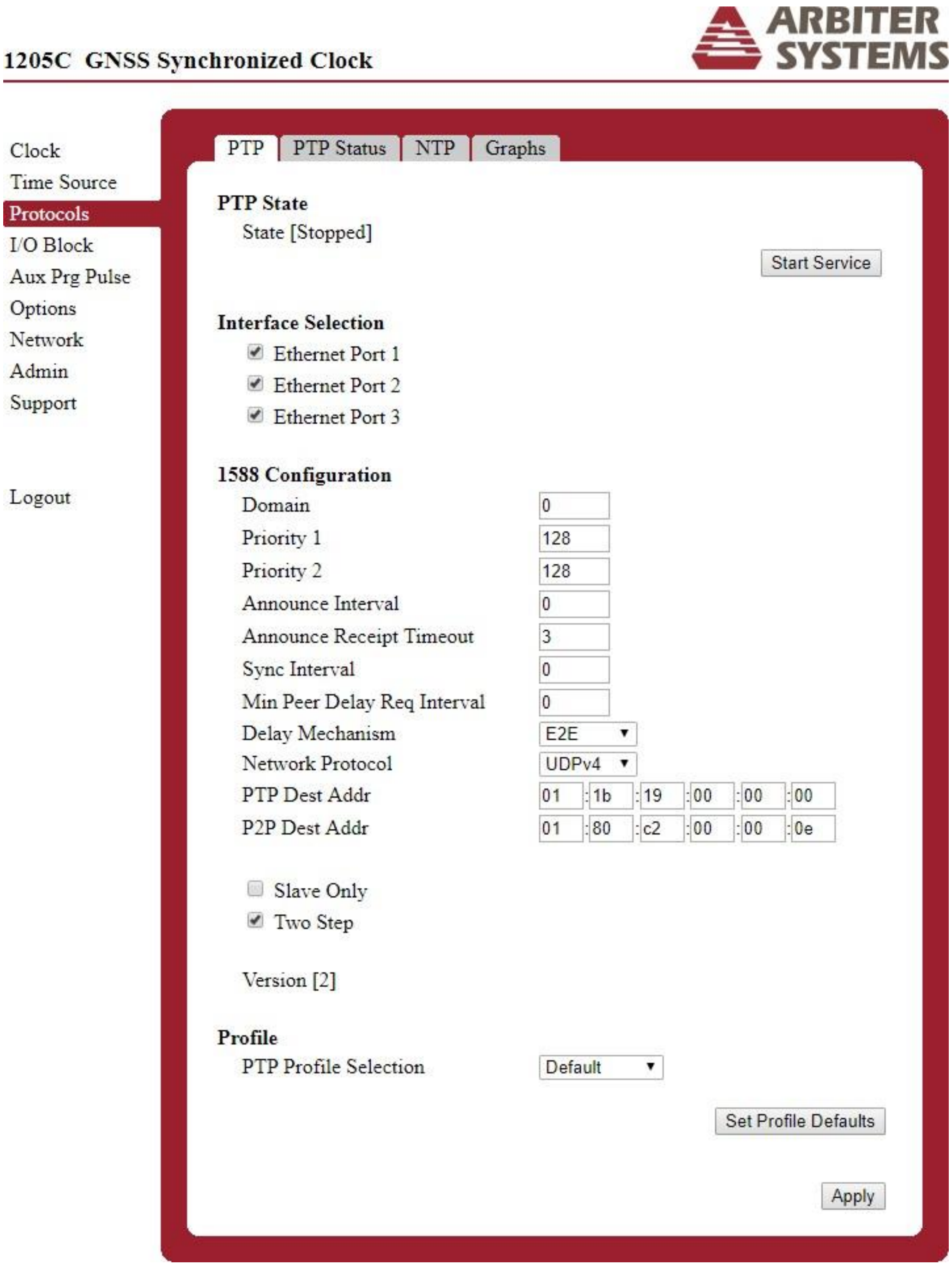


Figure 5-27 Configuring PTP Operation

5.3.25 View PTP Status

Select the Protocols menu and click the PTP Status tab to view all PTP status information. To configure PTP click on the PTP tab.

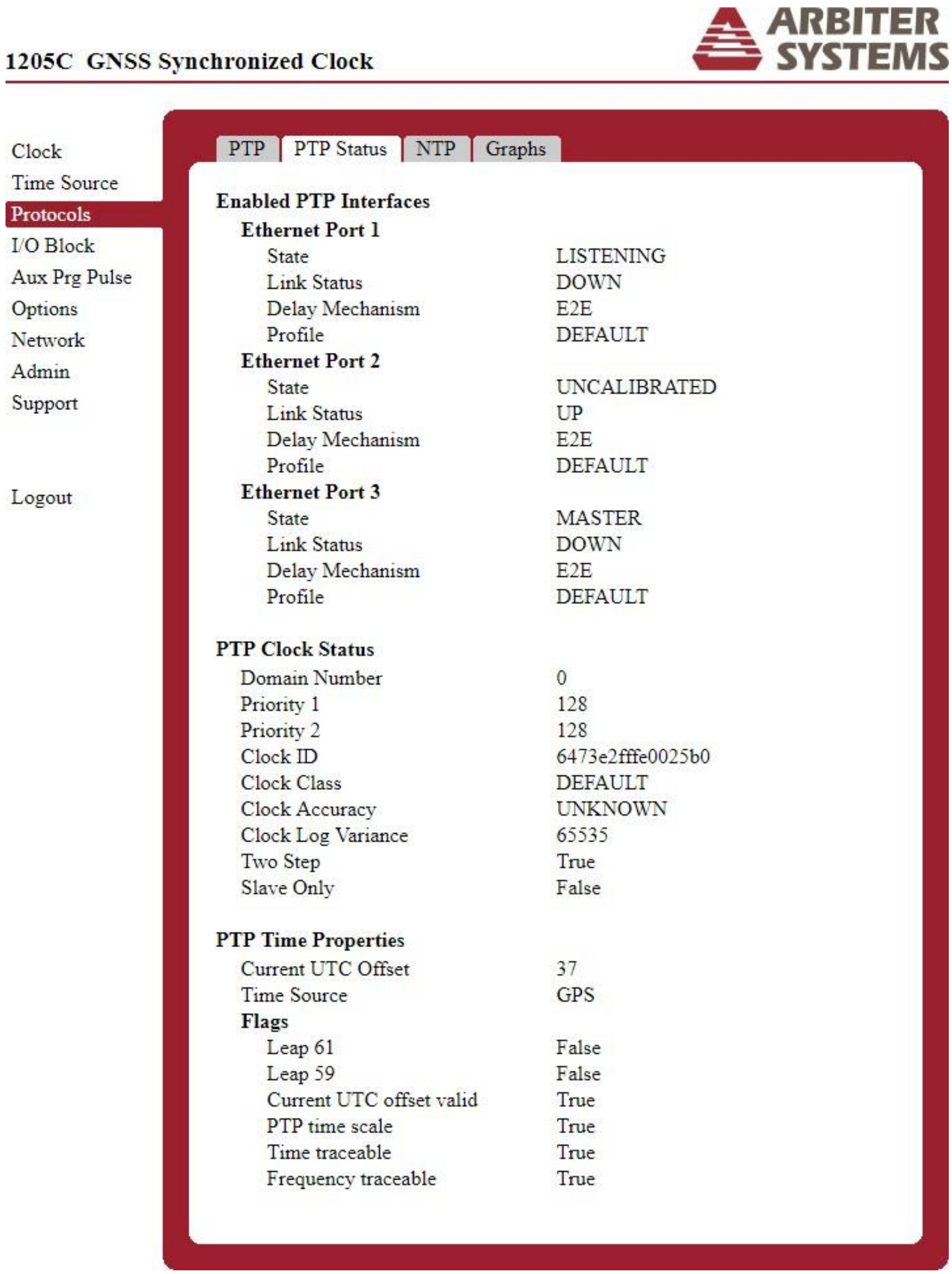


Figure 5-28 PTP Status Page

5.3.26 Configure NTP Protocols

Select the Protocols menu and click on the NTP tab to configure and view all available NTP related information.

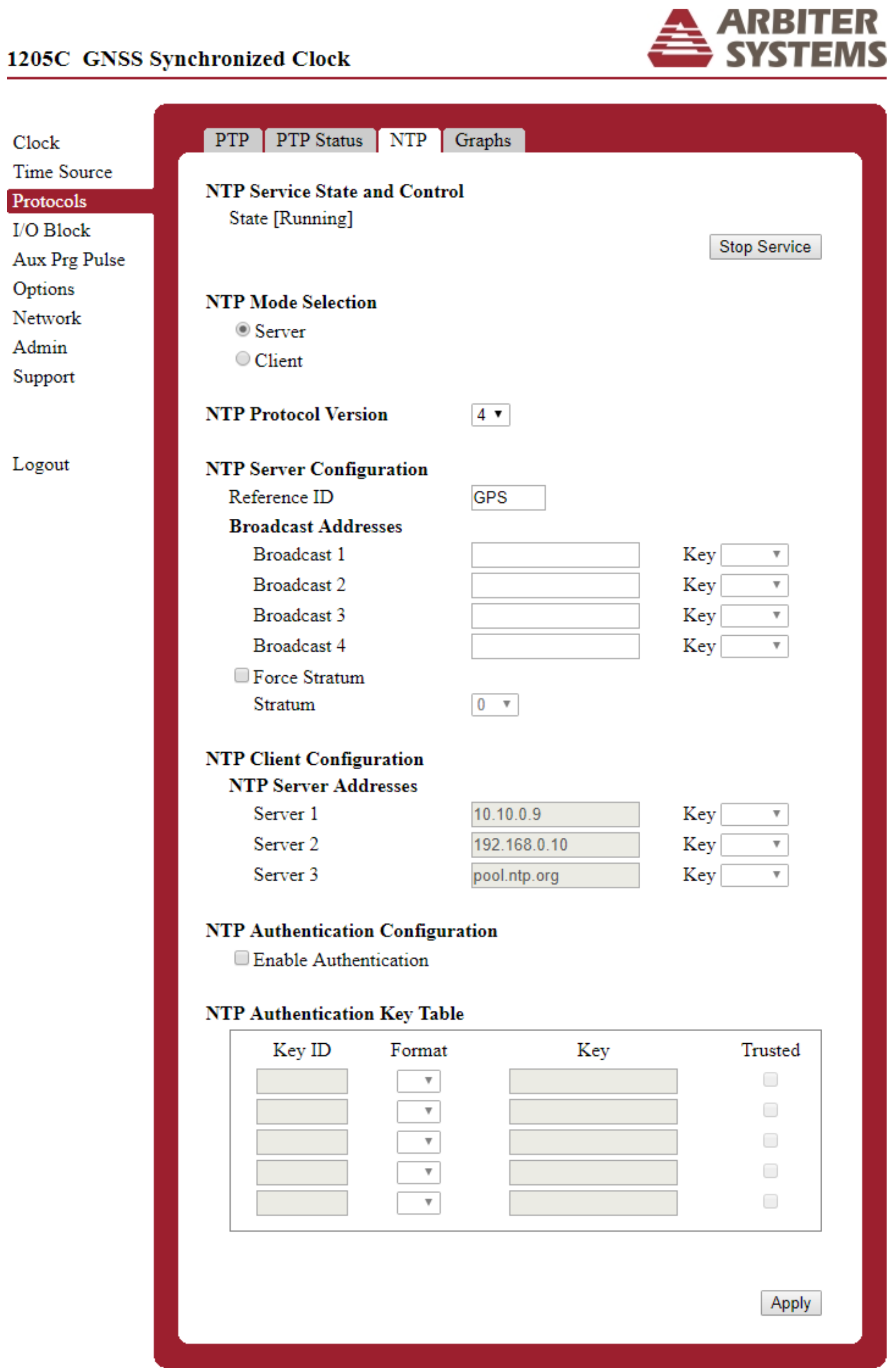


Figure 5-29 View and Configure NTP Operation

5.3.27 NTP/PTP Uncertainty Measurements Plot

Select the Protocols menu and click on the Graphs tab to view the plots of time uncertainty for NTP and PTP. Time uncertainty measurements over an approximate 24-hour time period are displayed in microseconds for NTP and in nanoseconds for PTP.

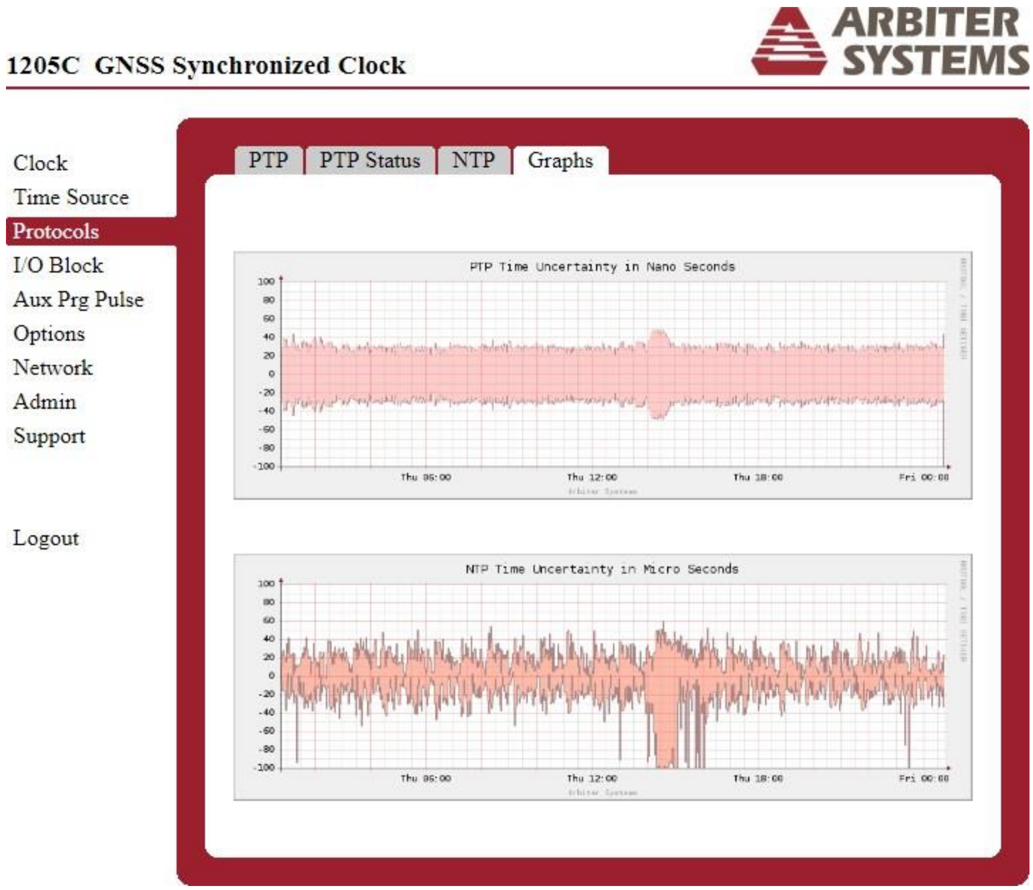


Figure 5-30 NTP/PTP Uncertainty Measurements

5.3.28 Support – Contact Page and Firmware Versions

Use the support information below to contact Arbiter Systems. The Version tab should help you identify the versions of specific firmware elements running on your clock.

Figure 5-31 Contact Support Page

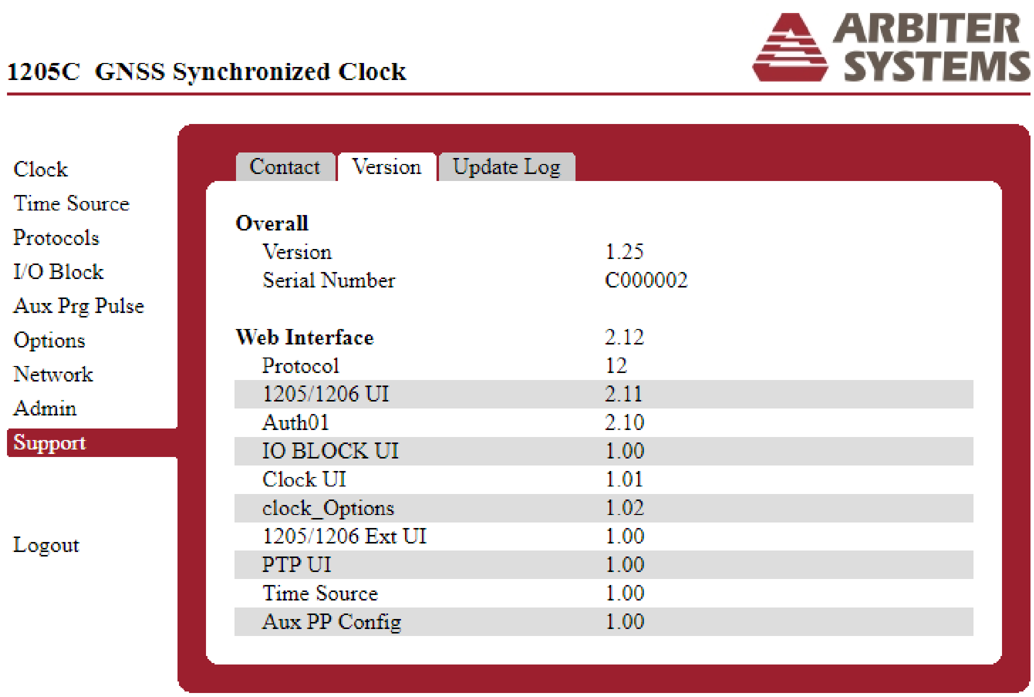


Figure 5-32 Version Support

5.3.29 Support – Update Log

The Model 1205B/C and Model 1206B/C keep a log of all the firmware updates by name and date.

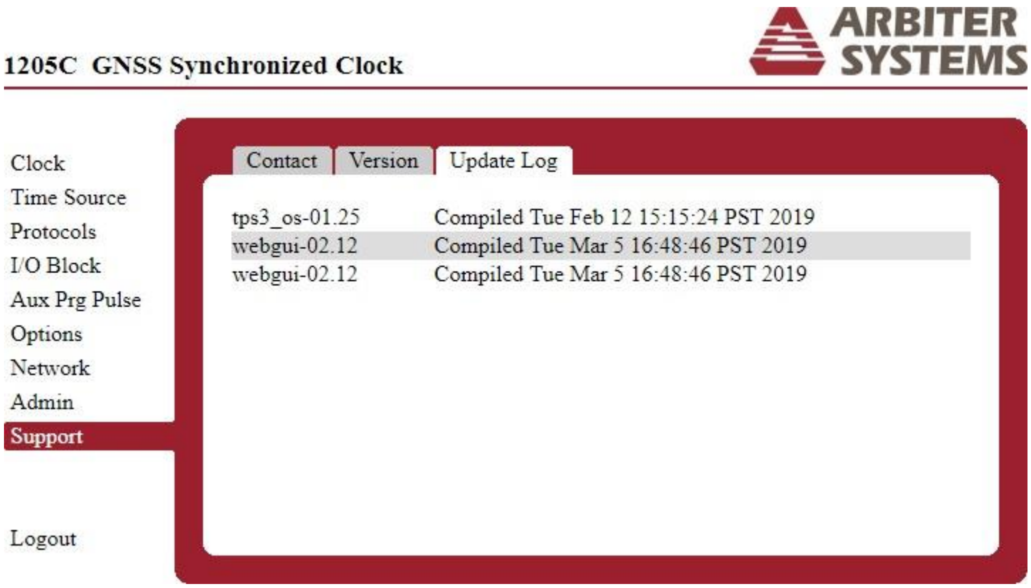


Figure 5-33 Update Log Support

5.3.30 Logout

Terminates your session in the User Interface.

Chapter 6 SSH Console Interface

Chapter 6 covers the setup and maintenance of the clock using the Secure Shell (SSH), console interface.

6.1 Using the SSH Console Interface

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 Linux or Mac users, Terminal works fine. At the command prompt (t> is the command prompt) type:

```
t>ssh admin@ip address
```

Press ENTER after typing the IP address. Shortly, you should be prompted for the password. Type in the password and press ENTER. For security reasons, when typing the password in the terminal window, it will not appear.

To view the IP addresses on the clock display, press the SYSTEM key until reaching the NETWORK STATUS menu. Press the ENTER key, then the UP or DOWN keys. Messages should appear separately for NET1, NET2, and NET3. If the IP addresses do not appear, then check to

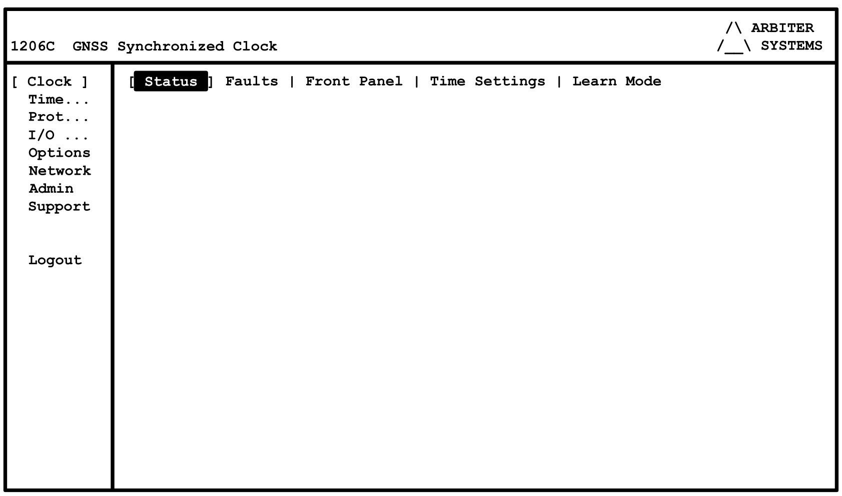


Figure 6-1 SSH Console Interface – Startup Screen

make sure a network cable is connected between the chosen port and an active network or your computer. Normally, the clock will display dashes when a cable is not connected to any port.

If there is no DHCP server on the network, connect to NET 1. Factory default settings include NET 1 set to 192.168.0.232, and NET 2 and NET 3 set for DHCP. Make sure that the Link LED is lit, or an IP address appears in the display.

6.1.1 Useful Keys for SSH 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. Then, press return (enter) to open the menu.

6.2 SSH Console Menus

6.2.1 Network Status Page

```
                                                                    /\ ARBITER
1206C  GNSS Synchronized Clock                                     /__\ SYSTEMS

  Clock     [ Status ] Configure | Advanced | Analog Input
  Time...
  Prot...   Ethernet Port 1
  I/O ...       IP Address                  10.10.1.16
  Options       Hardware Address            64:73:E2:00:01:16
[ Network ]              Bytes     Packets       Errors      Dropped
  Admin         Rx      381501        6298            0            5
  Support       Tx         790          11            3            0

            Ethernet Port 2
  Logout        IP Address                  10.10.1.17
                Hardware Address            64:73:E2:00:01:17
                         Bytes     Packets       Errors      Dropped
                Rx     5794613       76340            0            0
                Tx     2134268       25286            4            0

            Ethernet Port 3 (Not Active)
                IP Address
                Hardware Address            64:73:E2:00:01:18
```

Figure 6-2 Network Status Page Using SSH

6.2.2 Network Configuration Page

Configuration of each port is identical, and all ports include the same features. The hardware address is always listed. The IP address, netmask and gateway are only listed if selecting a Static IP address. VLAN ID and Priority are only visible when VLAN is checked.

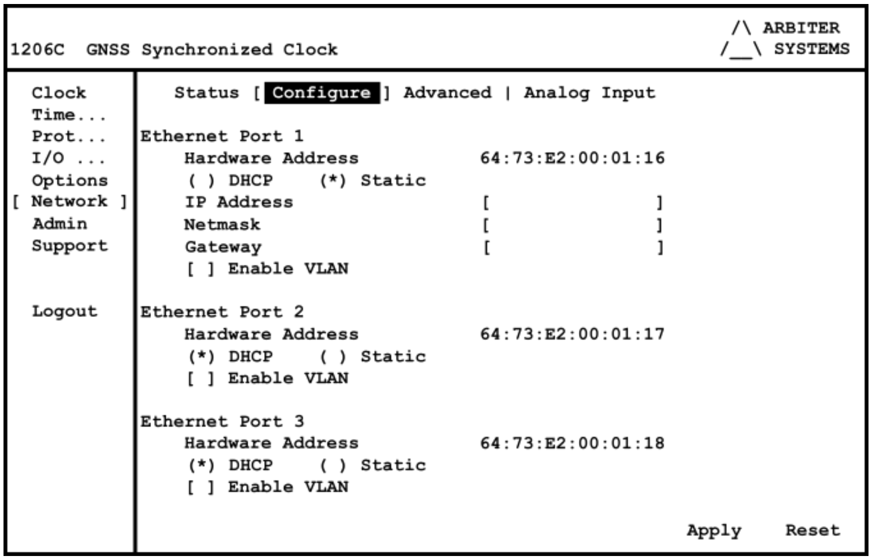


Figure 6-3 Network Configure Page Using SSH

6.2.3 Administration – Configure

To configure the user interface (UI) using SSH select the Admin menu, then select Configure tab and press RETURN (or ENTER) on your keyboard. Selectable changes include choosing HTTP or HTTPS, session time outs, and responding to ping requests.

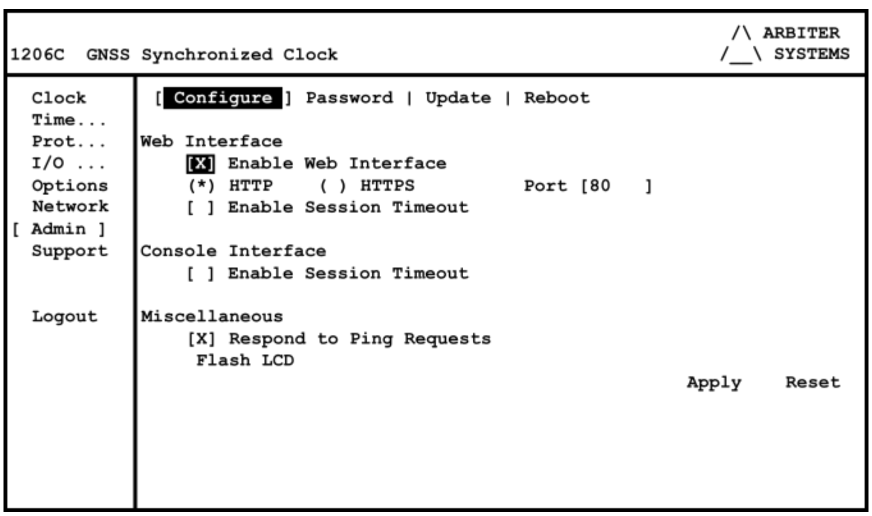


Figure 6-4 Admin Configure Page Using SSH

6.2.4 Administration – Password

To set or change a password select the Admin menu, then the Password tab and press RETURN (or ENTER).

```
                                                                /\ ARBITER
1206C  GNSS Synchronized Clock                                 /__\ SYSTEMS

  Clock        Configure [ Password ] Update | Reboot
  Time...
  Prot...     Current Password             [                ]
  I/O ...     New Password                 [                ]
  Options     Confirm New Password         [                ]
  Network
[ Admin ]                                                Apply    Reset
  Support


  Logout
```

Figure 6-5 Configure Password Using SSH

6.2.5 Administration – Firmware Update

To update clock firmware using SSH select the Admin menu and then the Update tab. Choose the server where the new firmware resides, the username and file path.

```
                                                                /\ ARBITER
1206C  GNSS Synchronized Clock                                 /__\ SYSTEMS

  Clock        Configure | Password [ Update ] Reboot
  Time...
  Prot...     Install update package from Remote Server
  I/O ...
  Options     Server     [                ]
  Network     Port       [22        ]
[ Admin ]     Username   [                ]
  Support     Filepath   [                                ]

                                                      Cancel    Install
  Logout
```

Figure 6-6 Update Firmware Using SSH

6.2.6 Administration – Reboot

To reboot the clock using SSH select the Admin menu and then select the Reboot tab.

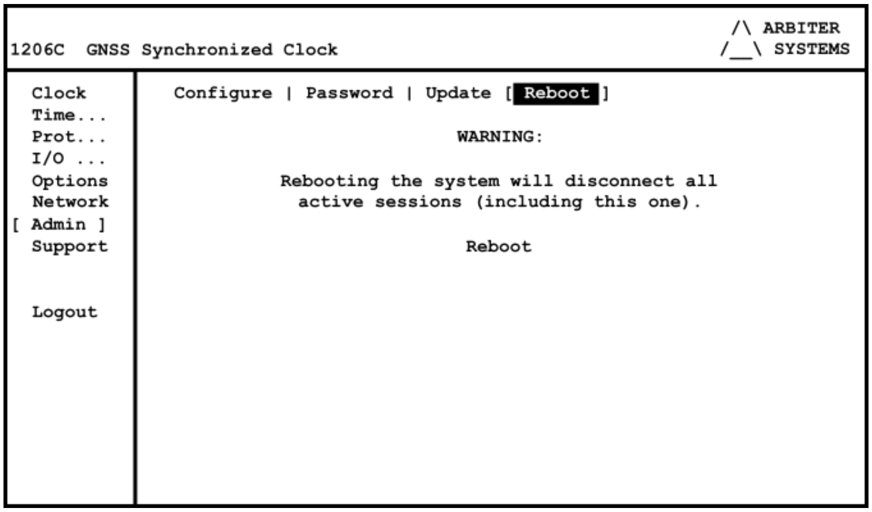


Figure 6-7 Reboot the System Using SSH

6.2.7 Support – Contact

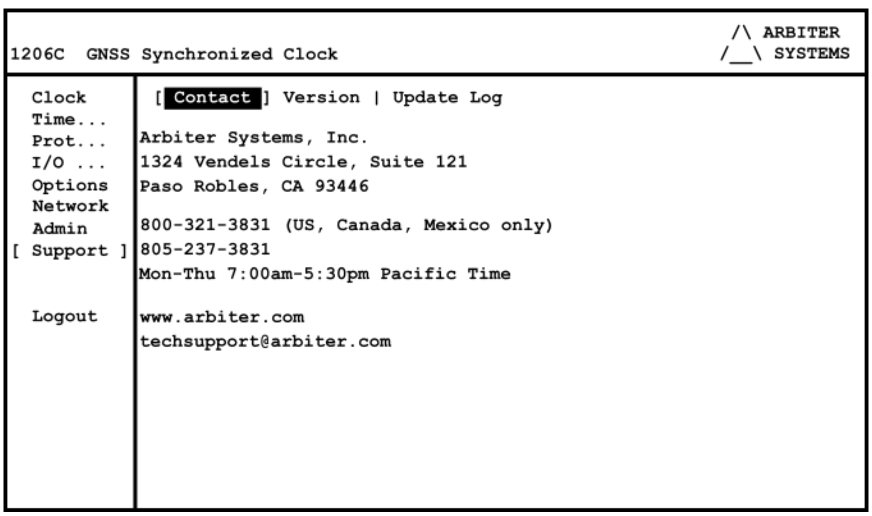


Figure 6-8 Arbiter Contact Information Using SSH

6.2.8 Support – Version

Firmware versions are currently unavailable in the SSH console.

6.2.9 Support – Update Log

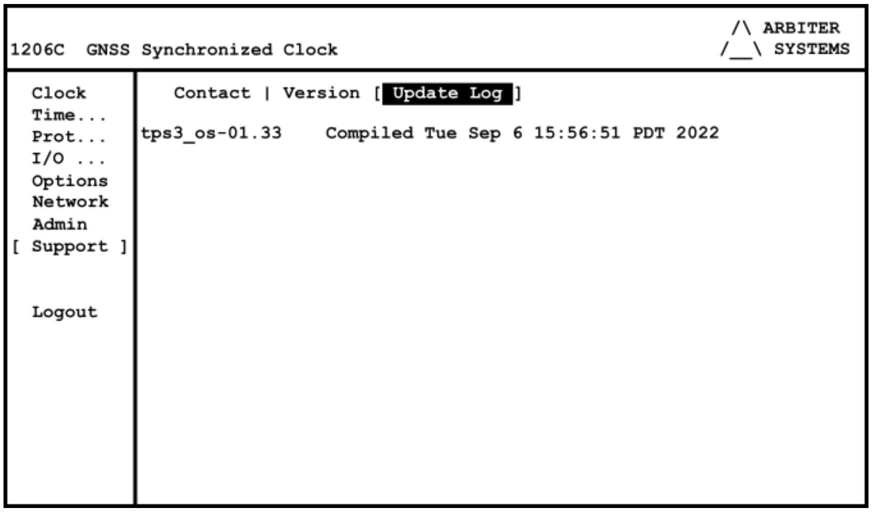


Figure 6-9 Firmware Update Log Page Using SSH

6.2.10 Other SSH Console Features

The previous items are representative of what the SSH Console currently features and how they function. Additional features will become available with future firmware updates.

Chapter 7 SNMP Support

This chapter reviews SNMP for the Model 1205B/C and Model 1206B/C in more detail. Simple Network Management Protocol (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. SNMP operates on this basis in the Model 1205B/C and 1206B/C.

An SNMP managed network consists of three components: A managed device, an agent and a network-management system (NMS). These clocks are considered a managed device running an SNMP agent that responds to queries from the network-management system.

7.1 SNMP Version Information

Currently, SNMP v3 is supported.

7.1.1 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.

7.2 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 clock). The agent will respond to queries from the management program to return values of these objects. The management program may also be able to configure some settings in the clock. A file representative of the MIB table may be downloaded from the Arbiter web site.

7.3 SNMP Service

Descriptions that follow are based on the web interface.

Note that SNMP configuration is available only through the web interface.

7.4 SNMP Traps, or Notifications

SNMP Traps or Notifications 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 clock can send notifications to three target IP addresses.

7.4.1 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.

7.4.2 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 NTP/PTP server.
    4. **Enable Admin Logout** – notifies when someone logs out from 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.

7.5 MIB Table

The text of the MIB table is current as of the publication date of this manual and is produced by Arbiter's technical team. Updates are available by download from the Arbiter web site. Also, the SNMP agent that runs on the NTP/PTP server is also available for download and used in these clock models. The MIB table is normally loaded in a MIB browser, and the agent is normally uploaded into the NTP/PTP server.

Chapter 8 NTP/PTP Server

8.1 General Description

The NTP/PTP server provides Network Time Protocol (NTP) and Precision Time Protocol (PTP)[5] on the three standard copper Ethernet ports or the optional Type LC fiber-optic connectors (62.5/125 µm and 50/125 µm multi-mode fiber). Contact factory for other connector types.

8.1.1 Network Time Protocol (NTP) Server

The server supports NTP versions 1, 2, 3, and 4. Authentication supports authentication via DES and MD5 cryptographic checksums as defined in RFC 5905[6]. The server supports symmetric key authentication. Time is distributed over the network interface to computers, controllers and other equipment needing the correct time. It allows a secure connection to configure, using either the preferred HTTPS User Interface, or the SSH Console.

8.1.2 Precision Time Protocol (PTP) Server

The server supports PTP according to Standard IEEE 1588 2008 (or current). However, for highest accuracy, the entire network required must have PTP-enabled 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 µs. Accuracy without hardware assist should be better than 100 µs.

8.1.3 Configuration Protocols

There are three supported configuration protocols: HTTP, HTTPS, and Secure Shell console (SSH). If a secure channel is required, then choose either HTTPS using the web interface or SSH using the console. A valid signed certificate is needed for secure communication. See Appendix C for PEM file tips. The web interface requires a web browser. Firefox and Chrome are recommended. Internet Explorer and Edge do not work to update the firmware. The console interface requires an SSH client. As a default the server comes configured for an HTTP connection.

8.1.4 NTP/PTP Server Setup

The clock must be locked to GNSS and stable to enable the NTP/PTP server. The following sections guide you through this initial configuring the NTP/PTP server. See Section 5.3.24 and Section 5.3.26 for the web interface.

The server is available with either static IP addresses, DHCP assigned IP addresses, or both static and DHCP. By default, NET 1 is defined with a static IP address, NET 2 and NET 3 are defined with DHCP.

Note: If your 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.

---

[5] IEEE 1588v2 – IEEE 1588-2008

[6] Includes RFC 5906, 5907 and 5908

8.1.4.1 Default Port Addresses

By default, the server comes configured as follows:

NET1	IP address -- STATIC Netmask Gateway	192.168.0.232 255.255.255.0 Not set
NET2	IP address -- DHCP	
NET3	IP address -- DHCP	

8.1.5 NTP Status Display Indications

8.1.5.1 GNSS Clock and Server Stabilizing

During the stabilization process, the clock will display different status messages that indicate whether the 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 server. Press the SYSTEM key until NTP/PTP STATUS? displays and then press the ENTER key to access these status messages.

```
NTP: PLEASE WAIT
PTP: PLEASE WAIT
```

Server Status – Waiting for NTP to stabilize (up to 1 hour).

```
NTP: UNLOCKED
PTP: NOT RUNNING
```

Server Status – Clock Unlocked; PTP not enabled from user interface.

```
NTP: ERROR
PTP: ERROR
```

Server Status – Synchronization problems.

8.1.5.2 GNSS Clock and Server Stabilized

Once the GNSS clock and NTP/PTP server have stabilized, the NTP/PTP STATUS? will change to that shown below. Additional network information is available per port: link status, IP address, and MAC address. Press the SYSTEM key until NETWORK STATUS? displays and then press the ENTER key to access these messages.

```
NTP: SYNCHRONIZED
PTP: RUNING
```

Server Status – Normal operation; from NTP/PTP status menu.

```
NET1:
64:73:E2:00:00:E3 BD
```

NET 1 status – Bad connection (cable disconnected?).

```
NET2:10.10.1.148
64:73:E2:00:00:E4 GD
```

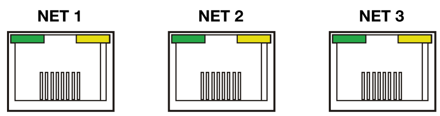
NET 2 status – Good connection. The IP address of any port is visible after a network cable is connected from the network to the clock.

```
NET3:
64:73:E2:00:00:E5 BD
```

NET 3 status – Bad connection (cable disconnected?).

8.1.5.3 LED Indications

To view the status LEDs, see the rear panel. No LEDs are present with fiber connectors. See Section 0 for other available connector types.



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 8-1 NTP/PTP Server LED Indications

8.1.5.4 Configuring with the User Interface

See Section5.3.26 for information on configuring NTP, and Section 5.3.24 for information on configuring PTP. If either port is configured to use a static IP address, you may need to contact your network administrator to help identify the assigned IP address(es), Netmask and Gateway.

8.1.5.5 Using the Ethernet Console Interface

Note that the console is limited in scope and may not support all functions. If either port is configured to use a static IP address, you may need to contact your network administrator to help identify the assigned IP address(es), Netmask and Gateway. For complete details on setting up the clock and network using the Ethernet Console Interface, see Chapter 6.

8.1.5.6 Using the USB Console Interface

The USB Console interface has the same appearance as the Ethernet Console Interface. For complete details on setting up the clock and network using the USB Console Interface, see Chapter 6.

8.1.6 Specifications

8.1.6.1 Performance

NTP	< 100 µs, depending on network load and clock accuracy
PTP	< 100 µs, with software assist < 100 ns, typical with hardware assist

8.1.6.2 Interface

Network	Three Ethernet (Version 2.0/IEEE 802.3) 10/100BT or Multi-mode SSF modules
Protocols	NTP, SNTP, PTP (Power Profile), UDP, ICMP, SNMP, TCP, SSH, SCP, SSL, HTTP, HTTPS DHCP
Ports	Port 22 – SSH Console (SSH may be enabled or disabled) Port 53 – DNS Port 67 & 68 – DHCP Port 80 – HTTP (Port # may be changed)

Chapter 9 Main Input/Output (I/O) Module

9.1 Main I/O Timing Functions

The Main I/O Module provides many of the standard functions common to existing Arbiter clocks, thereby making these I/O Block features available within this new generation network product. These standard clock functions include:

- Six high-drive timing outputs (Section 9.2)
- One modulated IRIG-B (analog) timing output (Section 9.4)
- Two RS-232 serial ports for broadcasting (Section 9.5)
- One RS-485 serial port for broadcasting (Section 9.5)
- One set of SPDT, multi-function relay contacts (Section 0)
- One event input, wide voltage range (Section 9.6)
- Analog input, line frequency measurement (Section 9.7)
- One open drain, 300 V FET for high voltage switching (Section 9.8)

9.2 Six High Drive Outputs

Six high-drive timing outputs each have a separate digital driver capable of delivering up to 125 mA at 4 Vdc. Taken together, this is 750 mA of drive power. Each of these outputs are completely configurable to produce the following signals:

- IRIG-B – unmodulated, IEEE C37.118.1-2011 ON or OFF, UTC or Local time zone
- Programmable pulse – many modes, including 1 PPS
- DCF77 – one minute time code

This means that each of the six outputs could be configured for a separate instance of IRIG-B, or a specific programmable pulse. For example, you could set the time zone to UTC or Local and C37.118.1-2011 continuous time quality reporting ON or OFF.

Each output may be fanned out to a number of devices, the actual number depending on the overall load of the receiving devices. To determine the maximum number of devices that the digital drivers can support, you will need to determine the load current, or input impedance, for each device connected to the individual main I/O output. See Section 0 for more information.

9.2.1 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 Model 1205B/C and 1206B/C transmits (IRIG) Format B with four variations.

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

Table 9-1 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 C37.118.1-2011 OFF, contains only time information including the seconds, minutes, hours and days, recycling yearly. Continuous time quality is added with IEEE C37.118.1- 2011 ON. 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.

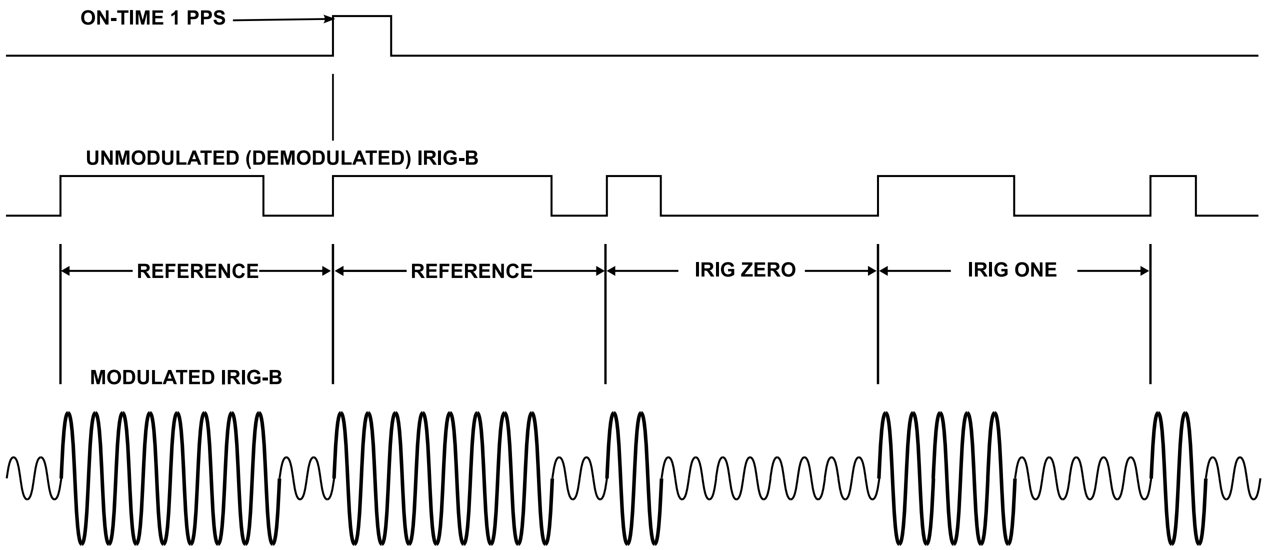


Figure 9-1 IRIG-B Waveforms

9.2.1.1 Modulated and Unmodulated IRIG-B

Figure 9.1 illustrates the primary differences between modulated and unmodulated IRIG-B. Notice that while modulated IRIG-B is distinctive because of the 1 kHz sine wave carrier, it is similar to unmodulated IRIG-B because the peak-to-peak values of the carrier follow the same form as the

digital waveform, where the information is contained. Note that the leftmost reference bit is the last bit of the previous second, and the next reference bit, of both modulated and unmodulated IRIG-B, is the start bit of the new second and in sync with the rising edge of a 1 PPS signal.

9.2.1.2 IRIG-B IEEE 1344 & C37.118.1-2011

As mentioned above, turning IEEE C37.118.1 ON in the clock enables three extra bits of the Control Function (CF) portion of the IRIG-B time code that provides continuous time quality. Within the CF 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.

NOTE: To download a copy of of the IRIG-B 2004 specification, please go to the Arbiter web site (at www.arbiter.com) and check under the Documentation menu.

9.2.2 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.

9.2.3 Programmable Pulse (PROG PULSE)

Since these clocks have six separately configurable outputs, different programmable pulse outputs may be configured. There are five programmable pulse modes available. To configure programmable pulse outputs, use the user interface as described in Chapter 5.

Prog. Pulse Mode	**Configured Feature**
Seconds per pulse	Set X number of seconds between pulses, 0 – 60,000
Pulse per hour	Set number of seconds after each hour, 0 – 3599.99
Pulse per day	Set hour, minute, second, fractional seconds, 0 – 86,399.99
Single trigger	Set day, hour, minute, second, fractional seconds
Slow code	Starts high (5V) and goes low (0V) for 2 seconds on the minute, 4 seconds on the hour, 6 seconds on the day

Table 9-2 Programmable Pulse Modes and Features

9.2.4 DCF77 Time Signal

Models 1205B/C and 1206B/C can provide the DCF77 time signal as an output by choosing it from the user interface within the programmable pulse selections. 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 1205B/C and 1206B/C produces DCF77 output timing at 5VTTL (CMOS) based on the radio signal protocol but synchronized to the GNSS. Figure 9-2 shows the standard format with the 59th bit absent.

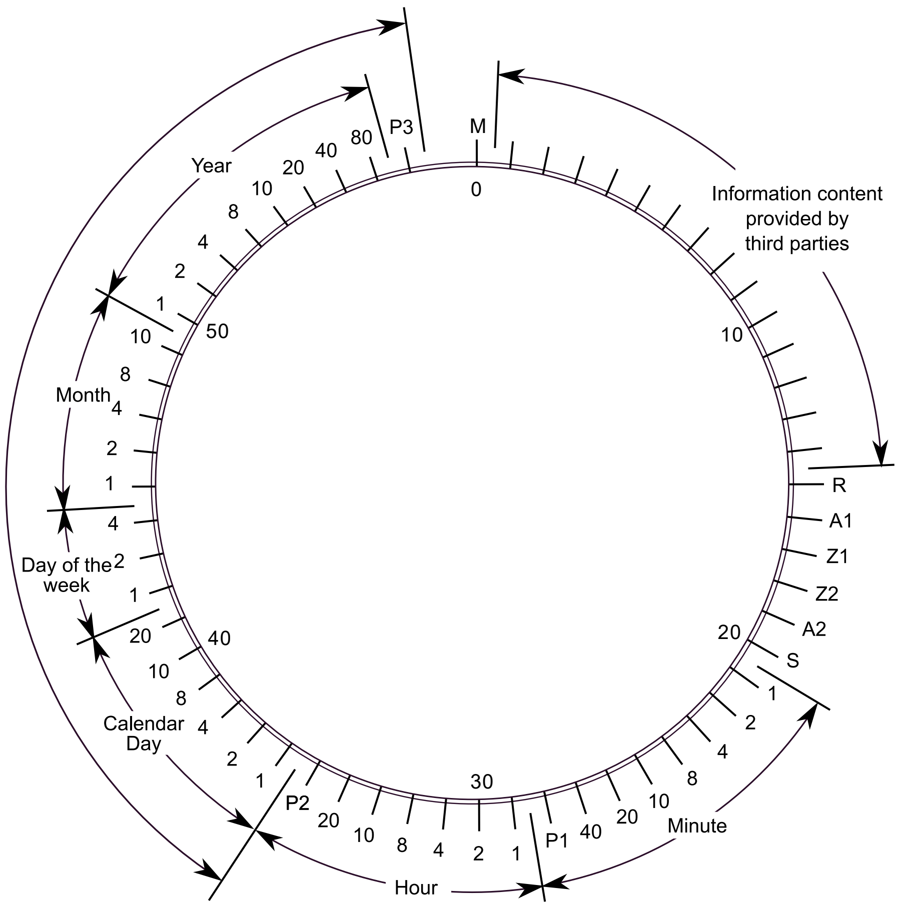


Figure 9-2 DCF77 Timing Diagram – see Marker Details

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[7] 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
P1, P2, P3	Parity check bits

Table 9-3 DCF77 Marker Details

[7] CET is Central European Time (UTC + 1:00). CEST is Central European Summer Time (UTC + 2:00).

9.3 Multi-Function Relay Contacts

The main I/O has one set of SPDT mechanical relay contacts that may be configured for the following functions or indications:

- programmable pulse outputs
- fault (internal)
- alarm (external)
- out of lock
- clock stabilized

Note that the relay lifetime is rated for a minimum of 100,000 cycles, which should govern the chosen function, especially if being used for programmable pulse. For example, setting the relay contacts for 1 PPS would run out the life in less than two days.

Three, labeled terminals represent the Common (COM), Normally Open (NO), and Normally Closed (NC) contacts. Conditions are when relay is de-energized (clock power off). The information below gives the contact condition for two states: (1) Fault, or clock powered OFF, and (2) No Fault, or clock powered ON.

1. Fault, or Powered Off – COM to NC shorted, COM to NO open.
2. No-fault and Powered ON – COM to NC open, COM to NO shorted.

9.4 Analog Timing Output – Modulated IRIG-B

One analog output (labeled IRIG-B +/-) provides for a modulated IRIG-B driver for multi-drop applications within the receiving device's specified voltage range. See Figure 9.1 for reference. Some devices have a limited input voltage range (e.g., 3.3 Vpp ±0.5V), and others are specified with a wide input range (e.g., 0.5 to 20 Vpp). Make sure to compute the device current to verify if the input voltage to the device receiving modulated IRIG-B is within its range as described in the device literature and in Section 9.10.5. The Model 1205 and 1206 analog clock drivers should maintain 3 Vpp minimum into 50 Ω.

9.5 RS-232C/485 Ports

The Main I/O connector has two separate RS-232C serial ports and one RS-485 port. RS-232 ports have three terminals: Transmit, Receive and Ground. The RS-485 port has three terminals: Transmit A and Transmit. There is no Receive A and Receive B. Important functions include serial time-code broadcasts to meters and wall displays. Data is in ASCII format, which is a character-encoding scheme originally based on the English alphabet. As such, information appears as readable English characters.

9.5.1 Selecting and Starting a Broadcast

To select and start a broadcast message from any serial port, connect to the clock using the user interface (username and password needed) and select the module shown in the rear panel diagram. The rear panel diagram reflects the current status of module type and location. For a custom broadcast see 11.7.7Appendix D.

9.5.2 Serial Broadcast Messages

Configure the serial port on the Main I/O module to broadcast specific messages to devices via RS-232C and RS-485 protocols. See Figure 2-9, Figure 2-11, and Table 2-1 for pin locations. RS-485 port is transmit only; connections are Transmit A and Transmit B. The following messages may be broadcast from the Main I/O module and can be started from the user interface (Section 5.3.17).

9.5.2.1 ASCII Standard

Configures the clock to broadcast the time-of-day as ASCII standard data from any of the serial ports. Use the user interface Main I/O panel to configure settings.

Output String:	<SOH>ddd:hh:mm:ss<CR><LF>
Where:	<SOH> = start of header (ASCII 1) ddd = day of year hh = hour (0-23) mm = minutes (0-59) ss = seconds (0-59) <CR> = carriage-return <LF> = line-feed

9.5.2.2 Vorne Standard

Output String:	11nn<CR><LF> 44hhmmss<CR><LF> 22±ff.fff<CR><LF> 33±s.ss<CR><LF> 34±sss.sss<CR><LF> 66hhmmss<CR><LF> 77nn.nnn<CR><LF> 88nnn.nn<CR><LF> 89nnn.nn<CR><LF> 55ddd<CR><LF> BEL
Where:	11 = minutes out of lock 44 = UTC/local time; hh = hours (0-23), mm = minutes (0-59), ss = seconds (0-59) 22 = frequency deviation 33 = time deviation* 34 = time deviation* 66 = system time; hh = hours (0-23), mm = minutes (0-59), ss = seconds (0-59) 77 = system frequency 88 = system phase (all dashes because this is not measured in the 1205/1206) 89 = system magnitude 55 = day of year BEL = ASCII BELL (on-time character) <CR> = carriage-return <LF> line-feed

9.5.2.3 Vorne Extended

Output String:

11nn<CR><LF>
44hhmmss<CR><LF>
22±ff.fff<CR><LF>
33±s.ss<CR><LF>
34±sss.sss<CR><LF>
66hhmmss<CR><LF>
77nn.nnn<CR><LF>
88nnn.nn<CR><LF>
89nnn.nn<CR><LF>
55ddd<CR><LF>
35±ssss.sss<CR><LF>
BEL

Where:

11 = minutes out of lock
44 = UTC/local time; hh = hours (0-23), mm = minutes (0-59), ss = seconds (0-59)
22 = frequency deviation
33 = time deviation*
34 = time deviation*
66 = system time; hh = hours (0-23), mm = minutes (0-59), ss = seconds (0-59)
77 = system frequency
88 = system phase (all dashes because this is not measured in the 1205/1206)
89 = system magnitude
55 = day of year
35 = time deviation*
BEL = ASCII BELL (on-time character)
<CR> = carriage-return
<LF> line-feed

The decimal points shown above are not actually transmitted in the data stream, but their position is implied. The displays are configured to show the decimal point in this position.

*Time Deviation is output in three formats in the same data stream: 33±s.ss, 34±sss.sss, and 35±ssss.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.

Output for 35±ssss.sss format will be like 34±sss.sss but with another digit to the left of the decimal. Decimal points are implicit and do not appear in the data stream.

Time Deviation Range	Form (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 9-4 Vorne Out-of-Range Time Deviation Values

9.5.2.4 Event Data

Output String: (Local) mm/dd/yyyy hh:mm:ss.sssssss nnnAL<CR><LF>
(UTC) mm/dd/yyyy hh:mm:ss.sssssss nnnAU<CR><LF>
Where: Nnn = Event Buffer Read Index Number
L = Local Time
U = UTC

9.5.2.5 Status/Fault Data

Configures the clock to broadcast any status and fault data from the main RS-232C port *when it changes*. Fault and Status data may also be accessed through one of the Ethernet ports. Assigned to specific RS-232C port in the user interface. NOTE: When a valid fault is detected, the specific status/fault is broadcast once (with date and time) to the chosen serial port. When the fault clears, another message is sent describing the cleared fault. Examples follow:

Output String: (Local) ddd:hh:mm:ss S=xx:yy F=xxxx:yyyy HO GNSS=xx

Where: ddd = day of year
hh = hours
mm = minutes
ss = seconds
S (Status Indications)
xx = current state
yy = last reported state
F (Fault Indications)
xxxx = current faults
yyyy = last reported state
HO GNSS
xx = Holdover Oscillator and GNSS state values

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 9-5 Status Indications of Time Base Processor

Bit	Wt, N_{16}	Fault		Bit	Wt, N_{16}	Fault
0	1	Communications		6	40	Antenna 1
1	2	8 MHz		7	80	Antenna 2
2	4	Holdover/GNSS		8	100	GNSS Receiver 1
3	8	WD Timer		9	200	GNSS Receiver 2
4	10	Brown Out		10	400	Prog Pulse Overload
5	20	Power Supply		11	800	Boot Loader Missing

Table 9-6 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 9-7 Holdover Oscillator and GNSS Fault/Status

9.5.2.6 Extended ASCII

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

Where:
<CR> = carriage-return
<LF> line-feed
Q = time quality
  space = locked maximum accuracy
  ? = (ASCII 63) unlocked, accuracy not guaranteed
yy = two-digit year
ddd = day of year
hh = hour (0-23)
mm = minute (0-59)
ss = second (0-59)
000 = fractional seconds
_ = space(s)

9.5.2.7 ASCII + Quality

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

Where:
<SOH> = start of header (ASCII 1)
ddd = day of year
hh = hour (0-23)
mm = minute (0-59)
ss = second (0-59)
Q = time quality
  space = locked maximum accuracy
  . = (ASCII 46) < 1 µs
  * = (ASCII 42) < 10 µs
  # = (ASCII 35) < 100 µs
  ? = (ASCII 63) > 100 µs
<CR> = carriage-return
<LF> line-feed

9.5.2.8 Year + ASCII

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

Where:
<SOH> = start of header (ASCII 1)
yyyy = year
ddd = day of year
hh = hour (0-23)
mm = minutes (0-59)
ss = seconds (0-59)
Q = time quality
- space = locked maximum accuracy
- . = (ASCII 46) < 1 µs
- * = (ASCII 42) < 10 µs
- # = (ASCII 35) < 100 µs
- ? = (ASCII 63) > 100 µs

<CR> = carriage-return
<LF> = line-feed

9.5.2.9 ASCII + Analog

Sends time error, frequency error, and voltage magnitude once per second, in ASCII format.

Output String (local): MM/dd/yyyy hh:mm:ssL xx ±f.fff ±t.tttt ppp.ppp vvv.vv<CR><LF>

Output String (UTC) MM/dd/yyyy hh:mm:ssU xx ±f.fff ±t.tttt ppp.ppp vvv.vv<CR><LF>

Where:
MM/dd/yyyy = date (month/day/year)
hh:mm:ss = time of day (hours:minutes:seconds)
xx = status
- First character is reference status:
  - 0 = Locked
  - 1 = Unlocked
- Second character is clock status per IEEE 1344:
  - space = locked maximum accuracy
  - . = (ASCII 46) < 1 µs
  - * = (ASCII 42) < 10 µs
  - # = (ASCII 35) < 100 µs
  - ? = (ASCII 63) > 100 µs

±f.fff = signed frequency error in Hz
±t.tttt = signed time deviation in seconds
ppp.ppp = phase angle (All dashes. It is not measured in this clock.)
vvv.vv = line voltage, rms
<CR> = carriage-return
<LF> = line-feed

9.5.2.10 True Time Analog Format

Sends time error and frequency error once per second in ASCII format.

Output String	ddd:hh:mm:ssQT±tt.tttF±f.fff<CR><LF>
Where:	Ddd = day of year hh:mm:ss = time of day (hours:minutes:seconds) Q = status space = locked maximum accuracy . = (ASCII 46) < 1 µs * = (ASCII 42) < 10 µs # = (ASCII 35) < 100 µs ? = (ASCII 63) > 100 µs T = indication that time follows ±tt.ttt = signed time deviation in seconds ±f.fff = signed frequency error in Hz <CR> = carriage-return <LF> = line-feed

9.5.2.11 NMEA183GLL

Custom String to configure the National Marine Electronics Association Standard (NMEA-183) GLL broadcast format.

Custom String	$GPGLL,/P1/P2./P3,/P6,/p1/p2./p3,/p6,/h/m/s./f0,/[01?A/:V/]*/C012B/r
Output String:	$GPGLL,llll.llll,a,yyyyy.yyyy,b,hhmmss.sss,A*cs<CR><LF>
Where:	GLL = Geographic Position, Latitude/Longitude llll.llll = latitude of position a = (N)orth or (S)outh yyyyy.yyyy = longitude of position b = (E)ast or (W)est hhmmss.sss in UTC A = status (A = active, V = void) *cs = checksum <CR> = carriage-return <LF> = line-feed

9.5.2.12 NMEA183ZDA

Custom string to configure the National Marine Electronics Association Standard (NMEA-183) ZDA broadcast format.

Custom String	$GPZDA,/h/m/s./f,/D,/M,/Y,/O,/o*/C0121/r
Output String:	$GPZDA,hhmmss.ss,dd,mm,yyyy,±xx,xx,*cs <CR><LF>
Where:	ZDA = Time and Date hhmmss.sss in UTC dd = day mm = month yyyy = year ±xx,xx = local zone description (00 to ±13 hours and minutes) *cs = checksum <CR> = carriage-return <LF> = line-feed

9.6 Event Input

Model 1205B/C and 1206B/C can provide event timing or 1 PPS deviation recordings, that you may broadcast over one of the COM ports. The event input feature allows you to record a 5 Vdc logic level signal, applied to the event input connection, with 0.1-microsecond resolution. To configure and review event data, use the user interface (Section 5.3.22) select the I/O Block menu and click on the Inputs tab. Event Input/1-PPS Deviation and Time Reference selections will appear as shown in Figure 5-25.

9.6.1 Event or 1-PPS Deviation Setup

Select either Event Input or 1-PPS Deviation on the user interface and make sure to choose the time zone you want for the event record.

The clock marks event data when viewed or retrieved using one of these two methods. Thus, if no event data points are viewed or retrieved, recording will be suspended when the event buffer is full. As soon as event data is viewed, or retrieved, its address becomes available for recording.

9.6.2 Event Timing – Latency

Event data are recorded using a high-speed capture circuit operating with a 96 MHz time-base. Latency is limited by the interrupt processing speed of the clock’s microprocessor, 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.

9.6.3 Deviation Measurement

The event input can also be configured to display measured event times as 1 pulse-per-second (1 PPS) deviation measurements. This allows comparison of an external 1-PPS signal to the clock’s precision internal 1 PPS signal. The clock determines the mean time difference between the two signals, which can be read via the user interface or broadcast to either COM1 or COM2.

9.6.4 Deviation Measurement Principle

The measurement technique employed for 1-PPS Deviation uses the same time determination and recording scheme used for Event Time measurement but assumes 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 first 50 events; new event data is given priority over existing data and will overwrite it. Since the incoming signal is at 1 Hz and the circular buffer holds 16 1-PPS events, each event time record will be overwritten once every 16 seconds.

Once every second the processor looks at the most recent group of 16 events. To compute deviation, it uses only the portion of the event data describing fractional seconds (e.g., values between 0.0000000 and 0.9999999). The 16 fractional-second values are normalized around 0.0000000, so that the range of results from the deviation computations will be centered on zero (0.5 seconds). It also computes the statistical Mean and Sigma (Standard Deviation) values on the 16 values. View these statistics via the user interface.

9.6.5 Connecting Input Signals

To receive input signals and to record events, you will need to connect your input signal to the two Event terminals shown in the Main I/O connector in Figure 2-9.

9.6.6 Accessing Data

Event data is *only* accessible through the user interface, or by pressing the TIMING key and viewing on the clock display, if the keypad is enabled.

9.6.7 Broadcasting Event Data

For continuous viewing of event data, as they occur, set the clock to broadcast events, using the user interface. By broadcasting events as they occur, the clock *will continue to overwrite previous event data*.

9.6.8 Status of Event or Deviation

Use the user interface to determine the status of these functions.

9.6.9 Clearing Event Records

To clear the event buffer, click the Clear Events check box in the I/O Block menu, Inputs tab in the user interface. “Clearing” means to completely remove all records at one time. New events may be overwritten only if you view them sequentially, counting from Event 01.

Viewing individual event data marks them as available to be overwritten. For example, if you look at records 1 - 10, and events are occurring while viewing these records, they will be overwritten. Assuming the event buffer is full, and you are viewing data from records 15 – 20, events will not be overwritten until you also view records 1 – 14.

9.7 Analog Input

The Analog Input provides the clock with the ability to accept either a 50 Hz or 60 Hz (± 10 Hz), 50 Vrms to 300 Vrms input signal and measure the instantaneous frequency and magnitude of the fundamental component while rejecting the effects of harmonics, noise, and DC offsets. The measurements are used to calculate frequency deviation and total time deviation, which is system time minus GNSS time, with an accuracy and resolution 0f 0.001 Hz (typical performance < 1 ppm (0.0001 %) of reading), with a settable range of +99999.9999 to -99999.9999. Measurement results are available via the Ethernet ports, the RS-232 outputs, and the front panel display

WARNING: Make sure to first connect the input sampling wire to the clock before connecting it to the line voltage.

9.8 Switching High Voltage Signals

This section provides information on switching high voltage signal lines (up to 300 Vdc) from the open drain FET output. Also available is a fixed 24 Vdc supply that may be used in switching the line. Since FET source is connected to the clock chassis (ground), return lines need to be connected to the chassis.

9.8.1 Example 1: Open Drain Pull Down

Figure 9-3 illustrates one method of connecting the 300-Volt FET for a pull-down event logging application. Use this method with applications when it is acceptable to connect the negative side of the FET to the chassis ground. This application could also be used with a periodic programmable pulse (e.g., 1 Pulse Per Minute) for timing instead of event logging.

9.8.1.1 FET Specifications (IRF740S)

- VDSS = 400V, max drain-source voltage
- RDS(on) = 0.55Ω, max drain-source resistance
- Id = 10 A, max continuous drain current (@ 25 °C)
- PD = 3.1 Watts, max power dissipation

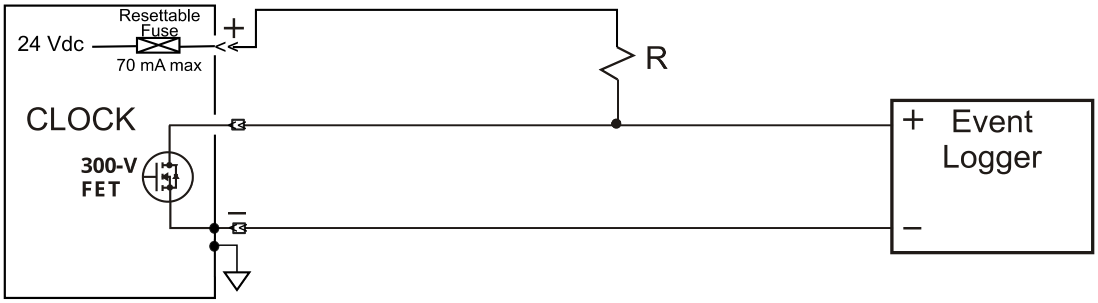


Figure 9-3 300-Volt FET with Pull-Down Resistor

9.8.1.2 Logging Requirements and Circuit Notes

To log an event, the Event Logger must “see” the rising edge of a pulse from 24 to 48 volts. Clocks have an internal 24-volt source to energize the circuit, however an external battery may be used. When the pulse clears, or returns to zero, it will be ready to record another event. The connections in Figure 9.3 are between the 300-Volt FET and the Event Logger. If a 24-volt supply is connected across the lines between the clock and the event logger, a 2.4 k ohm resistor is used in the positive supply line. This limits the FET current to approximately 10 milliamperes. Configure the clock for a negative Pulse Polarity so that the FET is turned on and the voltage Logger + side is held low. When the pulse occurs, the FET will turn off and the + line will rise to the battery voltage and return to zero when the pulse clears.

9.8.2 Example 2: Open Drain with Voltage Source in Series

Figure 9-4 illustrates another method of connecting the 300-Volt FET for a pull-down event logging application, however the voltage source is in series with the FET. Such would be the case if the event logger had an opto-isolator detector and registered an event with application of current through the opto-isolator. This would correspond with the FET in the ‘ON’ state, so pulse configuration would be “Positive.”

9.8.2.1 FET Specifications (IRF740S)

- VDSS = 400 V, max drain-source voltage
- RDS(on) = 0.55 Ω, max drain-source resistance
- Id = 10 A, max continuous drain current (@ 25 °C)
- PD = 3.1 Watts, max power dissipation

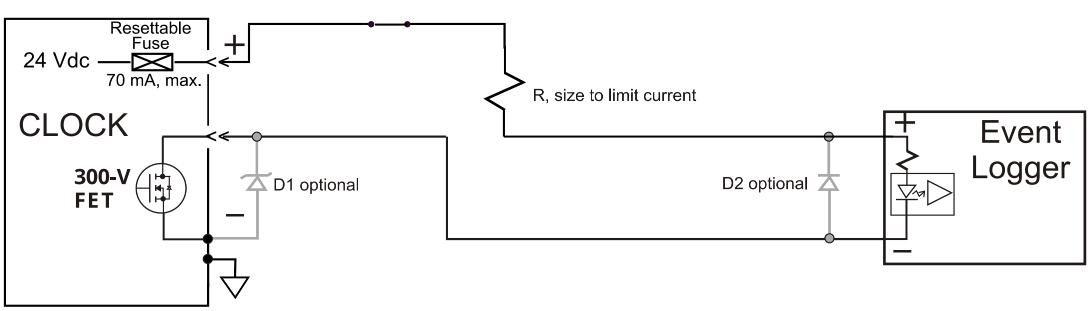


Figure 9-4 300-Volt FET with Voltage Source in Series

9.8.2.2 Logging Requirements and Circuit Notes

To log an event, the FET must be switched “ON,” which causes a current to flow through the large circuit, including the Event Logger. The opto-isolator detects the current and the event is recorded until the FET switches “OFF,” and the current subsides in the opto-isolator. D1 is an optional zener diode to protect against voltage spikes smaller than would be protected by the internal diode in the FET. This diode would be chosen specifically from the given application. D2 is a reverse protection diode (e.g., 1N4001) to protect the opto-isolator. R is a current limiting resistor scaled to limit the current to around 50 mA or less. The resettable fuse breaks at 70 mA and will not reset until the current supplied by the 24-volt supply goes to zero.

9.8.2.3 Configuring for 300-Volt FET Pull Down

The 300 V FET function needs to be configured for the required type of event. For example, Antenna Fault. To configure open a connection to the Network module using the user interface. On the left side of the user interface panel choose the I/O Block menu and Input tab; see Section 5.3.22.

9.9 Main I/O Block Connector Description

The standard main I/O Block connector has thirty-two separate screw terminals with assigned functions

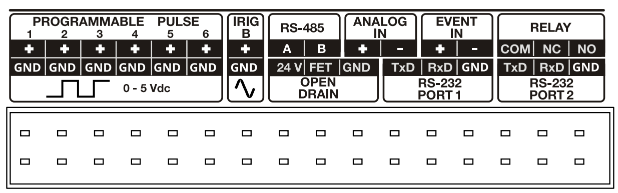


Figure 9-6 Main I/O Connector Function Label

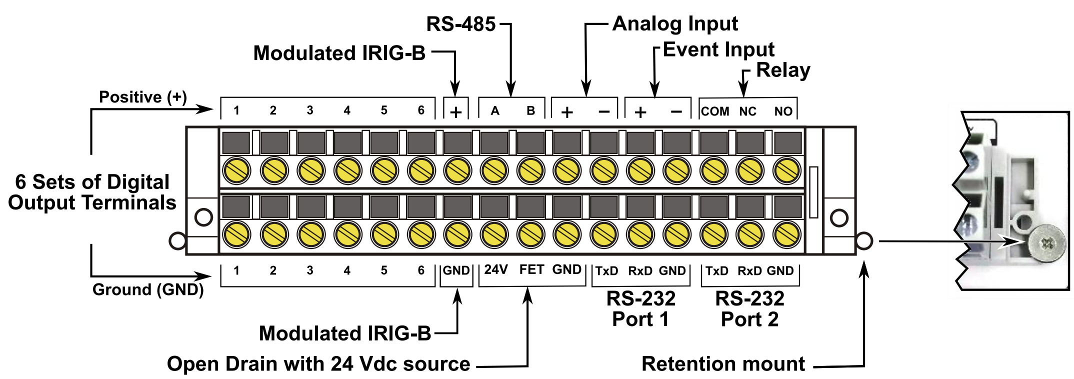


Figure 9-5 Main I/O Block Connector Diagram

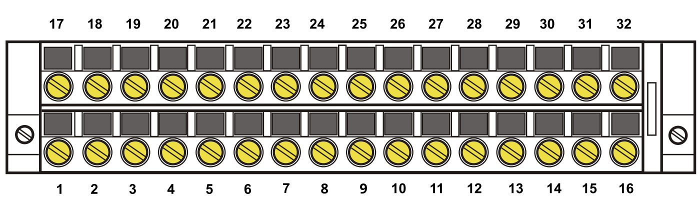


Figure 9-7 Main I/O Block Connect

Function Name	Pin 1	Pin 2	Pin 3
Relay[8]	COM = 30	NC = 31	NO = 32
Event In	+ Input = 28	Return = 29	N/A
Analog In	Signal A (+) = 26	Signal B (−) = 27	N/A
RS-485	A (+) pin = 24	B (−) pin = 25	N/A
Modulated IRIG-B	+ pin = 23	− pin = 7	N/A
Digital Output 6	+ pin = 22	− pin = 6	N/A
Digital Output 5	+ pin = 21	− pin = 5	N/A
Digital Output 4	+ pin = 20	− pin = 4	N/A
Digital Output 3	+ pin = 19	− pin = 3	N/A
Digital Output 2	+ pin = 18	− pin = 2	N/A
Digital Output 1	+ pin = 17	− pin = 1	N/A
Open Drain	24V = 8	FET = 9	GND = 10
RS-232 Port 1	TxD = 11	RxD = 12	GND = 13
RS-232 Port 2	TxD = 14	RxD = 15	GND = 16

Table 9-8 Main I/O Block Functions and Connections

9.10 Connecting Outputs

Make timing signal connections to the 32-pin Main I/O connector using either a shielded, twisted pair, or coax. To adapt from the 32-pin Main connector to a BNC style connector, use a BNC Breakout, or similar adapter

9.10.1 Wiring to Screw Terminals

When wiring to screw terminals prepare the cable by stripping back at least ¼ inch of the insulation and any shielding, and DO NOT tin the bare wire with solder. To attach wires to terminals, first loosen the screw counterclockwise, insert the wire, then turn screw clockwise to tighten. Ground the shield (if present) to the local ground connector at the clock, rather than the receiving end.

9.10.2 How Far Can I Run IRIG-B Cabling?

Before laying cable to transmit IRIG-B over long distances, take time to consider the following factors: (1) resistive losses in cabling, (2) electromagnetic interference, (3) propagation delays and (4) installation and maintenance costs.

When cable is laid from point A to point B, two cable paths are involved: 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 cabling, the resistance for both outgoing and return wires will be the same. As a simple example, you must account for wire losses in 200 feet of wire when connecting an IRIG-B signal to a device 100 feet away from the clock. See Section 9.10.4 for more information on calculating wire losses.

For additional detail on distributing IRIG-B signals over long distances see the following white papers and application notes found on the Arbiter website:

- AN101, Distributing Timing Signals in a High-EMI Environment
- IRIG-B Time Code Accuracy, IED and System Design Issues
- GPS Substation Clock Requirements

[8] NO (Normally Open); NC (Normally Closed); COM (Common). “Normally” refers to the relay position with the clock powered off.

9.10.3 Synchronizing Multiple IED's

In many installations, timing signals are "fanned out" to several devices from a single timing output. This method makes more efficient use of the clock synchronizing capability since the clock drivers are designed to drive multiple loads. The exact number of possible loads must be determined from the input impedance of each connected IED.

9.10.4 Connecting Unmodulated IRIG-B

To drive multiple loads from one unmodulated IRIG-B output, make sure that the loads are wired in parallel. Sometimes called "daisy-chaining," the idea is to drive these loads in parallel from the single output. It is simpler to connect loads to unmodulated IRIG-B than for modulated, because the loads should require the same voltage at the load input.

To determine load current for one Unmodulated IRIG-B output:

1. Using the manufacturers' information, look up the input impedance for each connected device.
2. Calculate the load current for each device (I_{dev} = 5 V ÷ R_{dev}).
3. Sum up all the load currents for each clock output. It should not exceed 125 mA.

9.10.4.1 Unmodulated Example

For example, if the input impedance of the IED is 5 kilohms, determine the device current (I_{dev}) as seen in Calculation 9.1:

$$I_{dev} = \frac{V}{R_{dev}} = \frac{5\ V}{5000\ \Omega} = 0.001\ A\ (1\ mA)$$

Equation 9-1

Connecting ten of the same IED's (as above) to one output would draw a total current of 10 x 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 computed lumped impedance value. This current should not exceed 125 mA.

9.10.5 Connecting Modulated IRIG-B

The total load capacity for the modulated IRIG-B driver depends on the type and number of loads. The main difference in computing the load capacity for modulated IRIG-B and unmodulated IRIG-B is that some of the modulated IRIG-B decoders are sensitive to the peak-to-peak voltage. With greater load capacity, the clock's modulated driver produces more current, which passes through the internal source resister, dropping the available output voltage. The open circuit voltage (i.e., with no loads) is approximately 4.5 Vpp, so any connected loads will cause the available voltage to drop. It is a simple task to compute the available output voltage (Vpp) with a known current.

$$V_{out} = 4.5\ V_{pp} - I_{load} * 19.6\ \Omega_{source}$$

Equation 9-2

Therefore, if you had 10 mA of load current (I_{load}) the available voltage (Vpp) would be 4.304 Vpp. If the load current equals 100 mA, then the available voltage would be 2.54 Vpp. So, you can see how increasing the load current (i.e number of loads) affects the available drive voltage at the clock output.

9.10.6 Wire Losses

Wire losses affect the available timing signal voltage available at the IED. Wire has a certain resistivity associated with it that is determined by its metallic composition, and its resistance determined by the diameter and length. For example, single-strand, 22 AWG (bare, enamel-coated) copper wire has a resistance of approximately 16.1 ohms 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 should essentially have the same resistance per cut length. If we use a twisted pair of 22 AWG (copper as above), then the available voltage (at 100 mA of current) for 500 feet of wire including the source resistor is calculated as:

$$V_{pp} = 4.5 - I * 19.6\ \Omega_{source} - I * 16.1\ \Omega_{wire} = 4.5\ V_{pp} - 01.A * 35.7\ \Omega = 0.93\ V_{pp}$$

Equation 9-3

So, you can see that most of the drive voltage is lost with 100 mA of current and 500 feet of 22 AWG twisted pair transmission line; this includes the voltage losses at the source resistor. 0.93 Vpp may very likely not be detected by the decoder in some IED's. Changing to 18 AWG wire in the above example would change the output voltage from 0.93 Vpp to 1.90 Vpp. Changing the wire to 18 AWG and reducing the current to 50 mA (0.05 A) would give you 3.2 Vpp at the end. *Remember to (1) make your cable runs as short as possible, (2) use a larger diameter cable and (3) carefully distribute the loads.*

9.10.7 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 4.5 Vpp (V_{oc}), the (nominal) acceptable voltage is 3.3 Vpp, and the device current is 10 mA. Determine the dropping resistor value.

First, you must determine the modulated output voltage at 10 mA of drive current. Next, you can calculate the value for the dropping resistor (R_{drop}) as:

$$V_{out} = V_{oc} - R_{source} * I_{dev} = (4.5 - 0.196) = 4.304\ Volts$$

Equation 9-4

$$R_{drop} = \frac{V_{diff}}{I_{dev}} = \frac{4.304 - 3.3}{0.01} = 100.4\ \Omega$$

Equation 9-5

The Power dissipation (P) is found as:

$$P = I^2R = \ 0.01^2 * 100.4 = 0.01\ Watts$$

Equation 9-6

In this example, an eighth-watt resistor should work fine.

For a voltage that is too low, the modulated IRIG-B signal level must be increased by some other means, such as:

1. distributing the loads differently to reduce the current (raising the available voltage),
2. increase the wire size to increase the voltage level,
3. increase the voltage and available drive current by using a distribution amplifier.

Arbiter Systems manufactures two devices to amplify a digital timing signal, the Model 1073A Distribution Amplifier and the Model 10887A Isolated Repeater. Using either of these devices would tend to reduce the transmitted current over a longer haul, providing a higher voltage at the far end for redistribution.

9.10.8 Cable Delays

Compensate for antenna cable delays using the user interface. However, there is no method of advancing the timing to offset the cable delay for timing outputs.

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

$$C \approx 9.84 \times 10^{8} \, feet/second$$

Equation 9-7

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 approximately 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 clock at the remote site.

Chapter 10 Optional Inputs and Outputs

Any Model 1205B/C and 1206B/C Clock can accommodate up to three separate sets of inputs or outputs to customize the unit configuration. Located between the main GNSS antenna inlet and the power supply B inlet, from one to three separate option boards may be mounted inside the clock to provide a variety of functions, including BNC, ST fiber optic and 3.5 mm terminal connectors.

1. × 5 V logic outputs at 125 mA each: BNC and ST fiber connectors
2. × 24 V logic signals at 25 mA each: 3.5 mm terminal connectors
3. × Relays: SPDT (COM, NC, NO), 3.5 mm terminals
4. 1 × Second GNSS receiver input: Type F connector

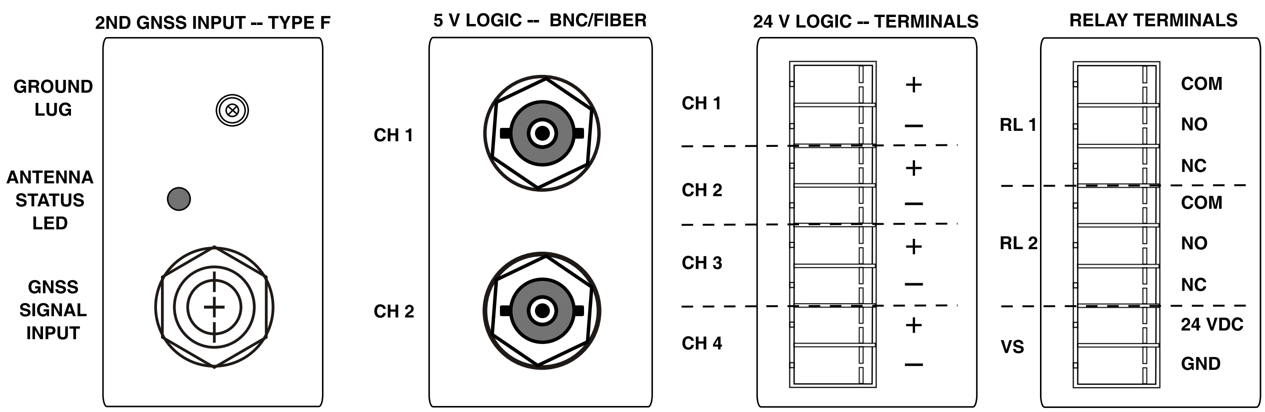


Figure 10-1 Optional Mixed I/O Connectors

10.1 Programmable Pulse Outputs

10.1.1 5 V Logic

With two connectors per section, each of these outputs may drive up to 125 mA at TTL/CMOS logic levels. Connectors may be BNC or ST fiber optic. With BNC connectors, the characteristic impedance can be either 50 Ω or 75 Ω, and coupling may be either AC or DC.

10.1.2 24 V Logic

With four outputs, these terminal strip outputs will drive European relay equipment (e.g., ABB and Siemens) at 24 Vdc and up to 25 mA per output. The terminal strip has 8 pins in sets of two with 3.5 mm spacing.

10.2 High Speed Clock Outputs

These outputs are typically used in telecommunications, for satellite timing reference signals, or for distribution. With up to two connectors per section, the clock could have up to six connectors with independent drivers. Connectors may be BNC or fiber optic ST connectors depending on function. Outputs are square wave with either 50 Ω or 75 Ω impedance and coupling as either AC or DC.

10.3 Dual SPDT Relays

Two separate SPDT mechanical relays, individually programmed, including a 24-volt source at 900 mA; uses 3.5 mm terminal connectors.

10.4 Second GNSS Receiver

Additionally, you may order a second GNSS receiver that will perform all the tasks of the main GNSS receiver with the exception that it will not support the advanced anti-spoofing option, which includes the anti-spoofing antenna.

Chapter 11 Functional Description & Technical Specifications

This section begins with a brief functional description of the clock and follows with a list of the technical specifications and operational characteristics.

NOTE: Specifications are subject to change without notice.

11.1 Functional Description

11.1.1 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.

11.1.2 Power Supply

Each clock may come by option with either one or two power supplies that provide 24 Vdc to the clock. Supply inlet may be either Universal (85 Vac to 264 Vac, 47 Hz to 63 Hz, 110 Vdc to 370 Vdc), or Low DC Only (22 Vdc to 67 Vdc). Supply outputs are over-voltage and over-current protected: Supplies are greater than 80 % efficient. Each clock comes with a surge withstand protect circuit at the supply inlet to guard the supply against sudden overvoltage conditions. The surge protector will normally flatten the overvoltage until it disappears or blows the supply fuse. Supply outputs are connected in parallel to the main board and isolated by diodes.

11.1.3 GNSS Receiver, Antenna and Cabling

All clocks come with an internal multimode GNSS receiver, 15 m (approx. 50 ft) of RG-6 antenna cable and a GNSS antenna. Antennas are active with approximately 35 dB of gain, cover the operating band of US GPS, Russian GLONASS, European Galileo and Chinese Beidou, and receive power through the cable from the clock. A multicolor LED on the underside of the antenna indicates operation: green for proper operation, amber for a low voltage, and off to show it inoperative. To the right of the antenna connector on the clock rear panel is another multicolor LED that indicates operation according to its color: green indicates proper operation, amber indicates an open condition and red indicates a shorted condition. Press the ANTENNA key on the front panel to view GNSS reception information: GNSS tracking, antenna current and voltage, as well as the antenna geographical position

11.1.4 Processing

Models 1205B/C and 1206B/C both operate under the same principles and use the same basic components, only they are arranged differently due to the size of the Stanford Research Systems PRS10 rubidium oscillator in the Model 1206B/C. 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 performance. This chosen architectural separation also allows easy porting of TBP functionality into different timing products.

11.1.5 Clock Management

Clock management is direct through the secure user interface. See Chapter 5 for more detail on security and logging in.

11.1.6 Network

The network section is the communication path with the clock and is secured through authenticating with user credentials. It provides NTP and PTP (IEEE 1588v2) outputs and may be managed using SNMP. While the network section runs on its own processor, it connects to the clock system exchanging system information as well as receiving the important timing data from the clock to produce accurate NTP and PTP signals.

11.1.7 Main I/O Block

The I/O Block section supplies all the standard inputs and outputs, such as IRIG-B, pulses, event capturing, serial broadcasts and relay contacts, through a large 32-pin terminal connector. An analog input port accepts nominal 50/60 Hz system frequencies (50 Vrms – 300 Vrms) to monitor system frequency and voltage.

The usual backbone of I/O Block timing is IRIG-B, which the I/O Block section supplies on six separate and independent outputs on the large connector block. Each output driving up to 125 mA at TTL/CMOS levels, there is ample drive power for numerous relays and other IEDs. Note that each of the six TTL/CMOS outputs are independent, meaning that each may be configured separately for either local or UTC time zone, and applying the C37.118.1 continuous time quality monitoring. One modulated IRIG-B output is provided at 4.5 Vpp and can drive a minimum of 3 Vpp into 50 Ω.

Three serial outputs, with two RS-232 and one RS-485, allow broadcasting time codes or status, however, no serial input is allowed. Configure and start broadcasts through the user interface or SSH console.

One set of multipurpose, single-pole, double-throw mechanical contacts are available for signaling an event, or providing a timed contact based on the programmable pulse feature. Relay selections consist of the following: (1) out of lock (with the GNSS), (2) alarm (external interference, spoofing, etc.), (3) fault (hardware problem), (4) clock stabilization and (5) failsafe. Contacts are labeled as common (COM), normally closed (NC) and normally open (NO). The term “normally” refers to the relay condition when the clock is powered off, which serves as a failsafe indication. Relay conditions may be OR’ed.

11.1.7.1 Main I/O Block Screw Termination Connector Retention / Lock To Chassis

The I/O Block Screw Termination Connector is locked into place with an oversized shoulder screw. See Figure 2-10 or Figure 9-5 for a picture reference.

11.1.8 Optional I/O

The Optional I/O consists of up to three groups of individual functions as listed below, which are separate from the main I/O Block output connector. Choose either one, two or three separate connector blocks. See Rear Panel Configuration below for possible combinations of these connector functions. At this time each block of the optional I/O connectors may provide for the following functions.

- × 5 V logic outputs at 125 mA each: BNC, ST fiber connectors
- × 24 V logic signals at 25 mA each: 3.5 mm terminal connectors
- × High speed clock outputs: 1 MHz, 5 MHz or 10 MHz; BNC, TNC, ST
- × Relays: SPDT (NO, NC, COM), 3.5 mm terminals
- 1 × Second GNSS receiver input: Type F connector

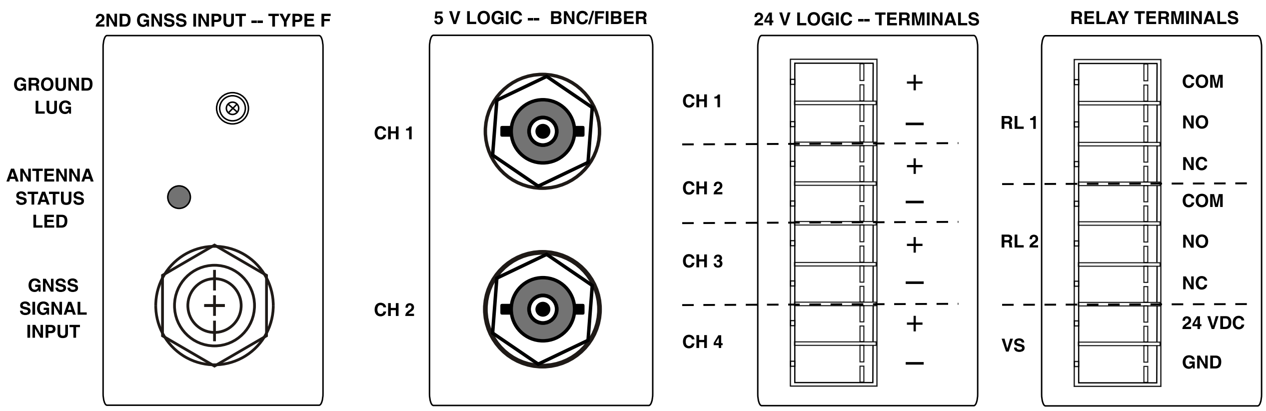


Figure 11-1 Optional Mixed I/O Connectors (BNC & Fiber Optic, ST)

11.1.8.1 5 V TTL/CMOS

Using mainly BNC, coaxial connectors, this section would add to the standard high drive programmable pulse outputs found on the main connector block. Even though it is called programmable pulse, these outputs may be configured as unmodulated IRIG-B, 125 mA high drive.

11.1.8.2 High Speed Clock Outputs

With one high speed clock output per section, these outputs will be targeted towards the telecommunications industry and the satellite industry, which requires a stable 1 MHz, 5 MHz or 10 MHz signal. Outputs are digital (use 74AC04 drivers) and can be AC or DC coupled with either 50 Ohm or 75 Ohm output impedance.

11.1.8.3 24 V Pulse Outputs

Some devices require a higher voltage than 5 V; for these the clock uses the internal 24V main supply of the clock with a level-shifting driver to provide the programmable pulse output signals at a 24V level, rather than the normal 5V. This board has four channels, independently selectable as above, each with two separate terminal pins per channel, for a total of four outputs. These signals use an 8-position 3.5mm pluggable (green) connector. Outputs will be short circuit protected by internal PTC current limiters, rated at 25 mA per output nominal current. Limiting is independent, per output – a short on one output would not affect the others. Output impedance will be approximately 40 ohms.

11.1.8.4 Optional Rear Panel Configuration

This section of the rear panel will have three cover plates (as seen in Figure 2-4 and Figure 2-5), available in several configurations with custom configurations possible. The planned configurations are:

- Blank
- 2, 4, or 6 BNC
- 2, 4, or 6 Fiber (ST)
- BNC + 2 Fiber
- BNC + 4 Fiber
- BNC + 2 Fiber
- Fiber + 24V Quad PP Output
- 1 Type F (for second GNSS input) + two other sections

11.2 Receiver Characteristics

11.2.1 Input Signal Type & Frequency

- GPS L1 C/A code, 1575.42 MHz
- GLONASS L1 band, 1602.0 MHz
- Galileo E1B/C, 1575.42 MHz
- BeiDou B1I, 1561.098 MHz

11.2.2 Timing Accuracy

Specifications apply at the 1 PPS output as of date of publication.

- UTC/USNO ± 100 ns peak – 1205B/C
- UTC/USNO ± 40 ns peak – 1206B/C

11.2.3 Holdover Oscillator

- 1 ms / 24hrs OCXO – standard – 1205B/C
- 1 µs / 24hrs rubidium – 1206B/C

11.2.4 Position Accuracy

- 2 meters, rms

11.2.5 Satellite Tracking

- 72 channel, C/A code
- Receiver simultaneously tracks up to 72 satellites, US GPS, Russian GLONASS, European Galileo, Chinese Beidou.

11.2.6 Acquisition

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

11.3 I/O Configuration

11.3.1 I/O Connectors

One large terminal block for the main functions. Up to six optional BNC or ST connectors for inputs and outputs; up to 12, 24-volt terminals; up to 6 SPDT relays. Network section has three RJ-45 Ethernet (copper) and/or Type LC fiber optic ports.

11.3.2 Standard Output Signals

Modulated and unmodulated IRIG-B are settable to IEEE C37.118.1, and Local or UTC time zone.

- IRIG-B 003 and 000, unmodulated
- IRIG-B 123 and 120, modulated
- 1 PPS; Programmable Pulse
- 300 V FET switching

11.3.3 Input Functions

Input functions included one event input connector and one analog input. Analog input allows system frequency measurement (50 Hz or 60 Hz) on dedicated terminals.

- 50 Hz or 60 Hz, to 1 mHz resolution
- 50 Vrms to 300 Vrms input voltage

11.3.4 Event Input Timing and 1 PPS Deviation

For a received data message, the leading edge of the input signal to trigger the event input, providing synchronization with 0.1µs resolution. One pulse per second (1 PPS) deviation timing may be selected.

11.3.5 SPDT Relay Specifications

- Includes the standard relay and optional relays (if ordered)
- Type, SPDT, plastic encapsulated, sealed plastic construction
- Make/Model, OMRON/G6RN-1-DC5
- Rated switching current: 8 A @ 250 Vac and 5 A @ 30 Vdc
- Max. switching capacity: 2,000 VA, 150 W
- Life expectancy: approx. 100,000 cycles/electrical, 10,000,000 cycles/mechanical
- Max. Frequency: approx. 360 operations/hour

11.4 Network Timing

11.4.1 Accuracy

- NTP: Better than one hundred microseconds, depending on network load and clock accuracy.
- PTP: Better than one hundred microseconds (software); Better than 100 nanoseconds with hardware assist.

11.4.2 Interface – Operator

11.4.2.1 8 Front Panel Status LEDs

- Normal mode (green)
- Learn mode (amber)
- Unlocked (red)
- Alarm (red)
- Operate (green)
- Power A (green)
- Power B (green)
- Fault (red)

11.4.2.2 Front Panel Menus

- Time – 4 Time/Date modes
- Position – GNSS Tracking, SNR, GNSS Setting, Antenna Status, Latitude, Longitude, Elevation
- Clock Status – Mode, Time Quality, Holdover Estimated Uncertainty, Spoofing Status, Event
- System Status – S/N & Version, Power Supply, EEPROM, Fault, Alarm, Network, NTP/PTP

11.4.2.3 Management

- Web (HTTP or HTTPS), SSH and SNMP

11.4.2.4 Setup

- IP Number (DHCP or Static)
- Net Mask
- Gateway
- Reference Identifier
- UDP Broadcast parameters
- Authentication

11.4.3 Interface

11.4.3.1 Network

- Three Ethernet (Ver2.0/IEEE 802.3)
- 10/100BT Standard, RJ-45
- Multi-mode SSF modules (optional)

11.4.3.2 Protocols

- NTP, SNTP, PTP (IEEE 1588™-2008)
- ICMP, SNMP, TCP, SSH, SCP, SSL
- HTTP, HTTPS, DHCP, UDP

11.4.3.3 Default Ports

Port	Protocol
22	SSH Console *May be disabled
53	DNS
67	DHCP
68	DHCP
80 *May be changed	HTTP
123	NTP *If enabled
161	SNMP *If enabled
162	SNMP Traps *If enabled
319	PTP Event *If enabled
320	PTP General Message *If enabled
443 *May be changed	HTTPS *If enabled
49543 *May be changed	Analog Data Input over Internet Protocol (AIDoIP) *If enabled

11.4.4 Options

11.4.4.1 Ethernet Modules

The clock comes with three Ethernet ports; with a default configuration of three RJ-45 copper ports. Optional configurations are 1 copper port and 2 fiber ports, 2 copper ports and 1 fiber port, or three fiber ports.

- Copper (standard): RJ-45 10/100 BT
- Fiber (optional): 62.5/125 µm and 10/125 µm, multi-mode fiber (LC connectors). More small form factor (SFF) fiber modules available (contact factory).

11.5 Clock Interface

11.5.1 Operator Interface

LCD display (B clocks), LCD and LED display (C clocks), 8 front-panel keys, 3 Ethernet ports, 2 RS-232C ports transmit only, 1 RS-485 port transmit only.

11.5.2 Setup Functions

- Web Interface: see Chapter 5 for complete details on configuring.
- SSH Console interface: see Chapter 6 for details on using SSH. Some setup not allowed.

11.5.3 Displays

- 2-line by 20-character, LED backlit supertwist LCD (B and C clocks)
- Large 6-character LED display indicates date or time (C clocks)

11.5.4 LCD Display Functions

- Time & Date: UTC or Local, Day of Year, Date and Time
- Antenna: GNSS Tracking, SNR, Antenna Status, Latitude, Longitude and Elevation
- Timing: Clock Status, Time Quality, Holdover Estimated Uncertainty, Event/Deviation
- System: Clock Serial Number, Firmware Version, Power Supply Status, EEPROM Status, Faults, Alarms, System Frequency Measurement, High Drive Current, Option Status

11.5.5 Annunciators – LEDs

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

11.5.6 Serial Port

- Broadcast ONLY
- RS-232 two ports, RS-485 one port.
- Connector: 32-pin connector block: see Figure 2-9 and Table 2-1 for identification of connections. Selectable baud rate of 1200, 2400, 9600, 19200, 38400, 57600, 115200, or 230400; 7 or 8 data bits; 1 or 2 stop bits; odd/even/no parity.
- Broadcast data formats: Continuous output data in various formats. See Section 9.5.

11.6 Antenna System

The included antenna is weatherproof and directly mounted on a 26 mm pole (1.05 in OD or 3/4 in ID pipe), with either a standard 1 in – 14 (approximately M25.4 x 1.81) marine-mount thread or a 3/4 in NPT pipe thread. Other mounting configurations are available (contact Arbiter Systems). Operates using 5 Vdc conducted through included antenna cable.

11.6.1 Antenna Cable

15-meter (50-foot) cable included with antenna. See Table 3-2 for other cables available.

11.7 Physical Specifications

11.7.1 Dimensions

- Chassis, 1205B/C: 436 mm × 44 mm × 280 mm (17.2 in × 1.75 in × 11.0 in) L x H x W
- Chassis, 1206B/C: 436 mm × 85 mm × 280 mm (17.2 in × 3.34 in × 11.0 in) L x H x W
- Antenna: 80 mm × 84 mm (3.2 in × 3.3 in) (diameter x height)

11.7.2 Weight

- Clock: 1.9 kg (4.3 lb) net. (instrument) Antenna and Cable: 2.0 kg (4.4 lb) net.
- Shipping: 6.0 kg (13 lb) net. (includes antenna, cables and accessories)

11.7.3 Power Requirements

11.7.3.1 Universal AC/DC Supply

Voltage: 85 Vac to 264 Vac, 47 Hz to 63 Hz, 45 VA max. or 110 Vdc to 350 Vdc, 100 W max.

11.7.3.2 LO DC Only Supply

Voltage: 22 Vdc to 67 Vdc ONLY, 30 W typical

11.7.4 Power Connector

Three-pole, terminal strip, 5 mm spacing

11.7.5 Ground Block (lug)

Antenna protective ground: Copper, with M5 (10-32) stud and nut
Internal surge suppressor 20 kA Gas Discharge Tube (GDT)

11.7.6 Electromagnetic Interference

Conducted Emissions: power supply complies with FCC 20780, Class A and VDE 0871/6/78, Class A Surge Withstand Capability (SWC): power inlet designed to meet ANSI/IEEE C37.90-1 and IEC 801-4.

11.7.7 Temperature and Humidity

Component	Operating	Nonoperating
Model 1205B/C	-40 °C to +65 °C	-40 °C to +75 °C
Model 1206B/C	-40 °C to +65 °C	-40 °C to +75 °C
Antenna	-55 °C to +65 °C	-55 °C to +85 °C
Antenna Cable	-40 °C to +75 °C	-40 °C to +80 °C
Humidity	Noncondensing	

Appendix A Using a Surge Arrester

These instructions cover the installation of the Arbiter Systems Model AS0094500, Surge Arrester, as illustrated in Figure A.1. The AS0094500 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.

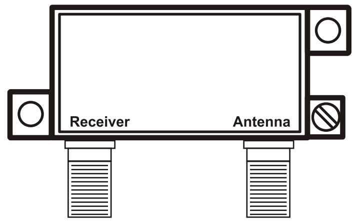


Figure A-1 GNSS Surge Arrester

A.1. Description

The AS0094500 is a three-terminal device with two type F connectors and one ground terminal. One of the F connectors connects to the GNSS antenna and the other F connector to the GNSS receiver in the clock. A screw terminal provides a point to connect an earth ground wire. Being weatherproof, the AS0094500 can be mounted outdoors provided that the cabling and Type F connectors are sealed from the weather. The surge arrester will also pass the voltage and current necessary to energize the GNSS antenna.

A.2. Installation

A.2.1 Mounting Location

Location is a key consideration when installing the Model AS0094500. Mount 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 and reliably it will bypass the induced voltages.

A.2.2 Ground Connection

The Model AS0094500 can 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, with the shortest possible ground path. Hole diameter allows up to 8 AWG wire (0.129 in or 3.26 mm). Alternately, the AS0094500 could be mounted directly to a well-grounded plate within the facility.

A.2.3 Antenna and Clock Connections

The AS0094500 is labeled to indicate which terminals should be connected to the GNSS receiver and to the GNSS antenna. Use only a low-loss, tri-shield or quad-shield 75 Ω 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 frequencies.

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 rubber sealing boot and 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

Install drip loops in the cables to reduce the likelihood of moisture penetrating the device.

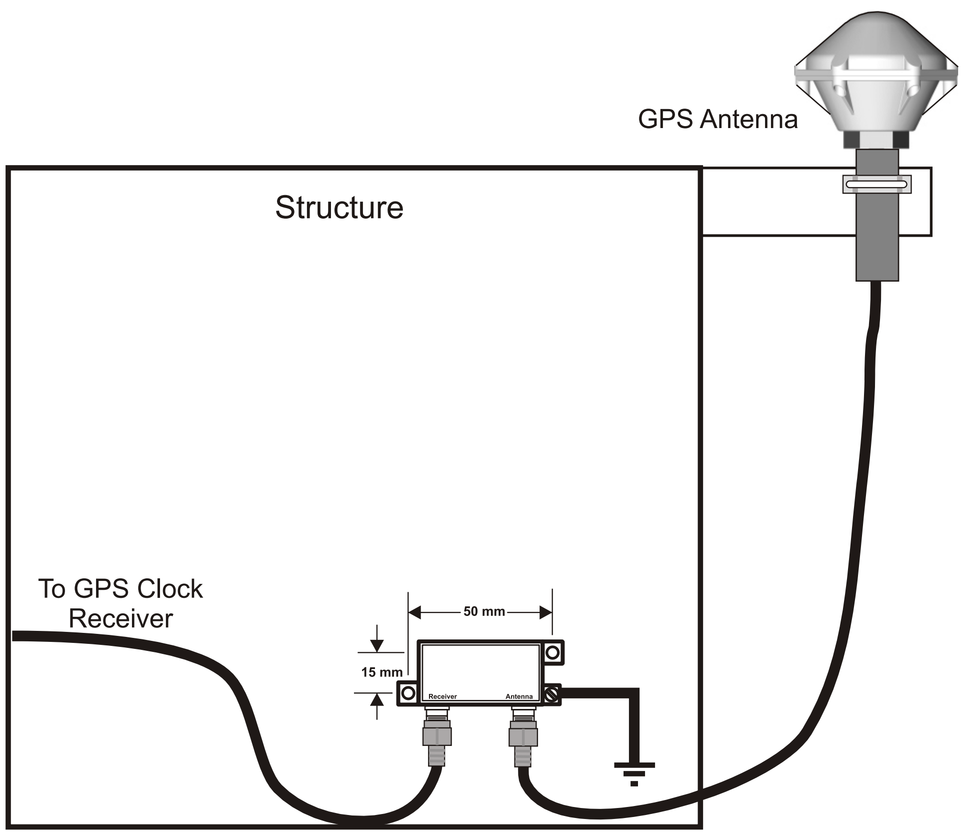


Figure A-2 Suggested Mounting of the Surge Arrester

A.3. Specifications

A.3.1 Physical Dimensions

Overall	59 mm × 38 mm × 18 mm (2.32 in × 1.49 in × 0.71 in) L×W×H
Mounting Hole Dimensions	50 mm × 15 mm (1.969 in × 0.594 in)
Mounting Hole Diameter	4 mm (0.157 in)
F-Connection Dimensions	24 mm, center to center
Weight	48.2 g (1.7 oz)

A.3.2 Electrical Characteristics

Designed for GNSS Protection

Frequency range	DC – 2.150 GHz
Passage of antenna energizing voltage	5 Vdc
Multi-stage circuitry	Heavy duty gas tube
Response time	5 ns
Current suppression	750 A (2 x 10 µs)
Insertion loss	1 dB maximum
Return loss (1 GHz / 1.5 GHz)	16 dB minimum
Firing voltage	90 V
RFI shielding	120 dB

Appendix B CE Mark Certification

B.1.1 Introduction

On the following pages contain the individual CE Mark Certifications for models covered in this manual. This includes Model 1206B/C.

Declaration of Conformity with European Union Directives

Date of Issue:	July 1, 2015
Directives:	89/336/EEC Electromagnetic Compatibility 73/23/ EEC Low Voltage Safety
Model Number(s):	1205B/C GNSS Synchronized Clock 1206B/C 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 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 Option 34 must be configured with an SSL Certificate. The Option 34 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 ‘t>’ 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.

```
t>openssl genrsa -out private.key 1024
```

The generated file (private.key) might look like the following:

```
-----BEGIN RSA PRIVATE KEY-----
MIICXgIBAAKBgQDPoNigXmq2JAlw9DrD0P5Og5c5xsEnt9bPjfuE7MGkDEGN09sC

...more data...

8Xxzzgu4xizBdLmONkHu7b/h7GL6u5smkWVOCesCCR0mKw==
-----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.

```
t>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 clock.

t>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.

t>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 clock in order to enable HTTPS.

Appendix D Creating A Custom Broadcast

D.1. Introduction

The Model 1205B/C and 1206B/C allow the user to construct and install two custom strings to be broadcast from COM1 and COM2: Custom string A from COM 1 and Custom String B from COM 2. If the standard strings are not exactly what you require, you may want to construct one that better matches your requirements. Read this section for information on constructing, installing, and using a custom broadcast string. This appendix includes a small tutorial on constructing strings using the common strings already available in Section 9.5.

D.2. Installing a Custom String

Install, start, and stop a custom broadcast from the user interface, I/O Block menu, Serial tab. See Section 5.3.17.

D.3. 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 the standard broadcast strings as examples.

D.3.1 Custom Broadcast Character Set

Note: Conditionals can use any of the characters in Table D-1 except for Cssnn and Txx, in addition to any string characters. CONDITIONALS CANNOT BE NESTED!

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 f	GNSS elevation: ± dddddd.dd length = 10 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 o	Local hour offset: ± hh where hh=00, . . . , 12 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; 03 = Frequency data ASCII; 04 = True Time Frequency data
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	Frequency data 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 D-1 Characters Used with Custom Strings

D.4. True/False Condition

Command: /[ii? < t > / :< f > /]

Where: 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)
< t > = True condition
< f > = False condition

D.5. Ordinal Condition

Command: /{ii? < 0 > / :, . . . , < n > /; < e >}

Where: ii: 01 = Time Quality (13 possible ordinals)
02 = Time Quality for True Time format (5 possible)
03 = Time Zone Indicator
(3 possible, 0 = DST active, 1 = DST not active, 2 = UTC)
< 0 >, < 1 >, . . . , < n > = ordinal position
< e > = Else condition

D.5.1 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.

D.5.1.1 Ordinal 01

This ordinal consists of 13 different accuracy values as listed in Table D-2 Possible Time Quality Levels, Ordinal 01. 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 specific clock accuracy, not signaling a change until reaching 1 microsecond.

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

/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.

D.5.1.2 Ordinal 02

This ordinal consists of 5 different accuracy values as listed in Table D-3.

/T01/d:/h:/m:/s/{02? /:./:∗/:#/:?/}/r

D.5.1.3 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.

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

D.5.1.4 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.

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

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 D-2 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 D-3 True Time Quality Levels, Ordinal 02

D.6. String Setup Examples and Tutorial

In this section, you will find several 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 D-1.This includes the use of ordinals and conditionals.

D.6.1 ASCII Standard

Desired Output: <SOH>ddd:hh:mm:ss<CR><LF>
Input String Code: /T01/d:/h:/m:/s/r

The input values preceded by “/” are variables from Table D-1 and have defined values. The “:” is a plain ASCII character that is not part of the variable list.

D.6.2 Vorne Simplified

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

D.6.3 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/:/]

This string begins with a true/false conditional 02, which is a change of status. Since it is a part of the Table D-1 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.

D.6.4 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/H20/H20/H20

“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.

D.6.5 ASCII + Quality

Desired Output: <SOH>ddd:hh:mm:ssQ<CR><LF>
Input String Code: /T01/d:/h:/m:/s/{01? /:./:∗/:#/;?/}/r

This string is the Standard ASCII appended with a quality indicator, “Q”. The ordinal will produce all necessary time quality values passed on by the clock. 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.

D.6.6 ASCII + Year

Desired Output: <SOH>yyyy ddd:hh:mm:ssQ<CR><LF>
Input String Code: /T01/Y:/d:/h:/m:/s/{01? /:./:∗/:#/;?/}/r

The ASCII + Year is identical to the ASCII + Qual but includes the four-digit year.

D.7. Common ASCII Characters

Listed below are a few common ASCII control characters used with the clocks. 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 D-4 Common ASCII Characters

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