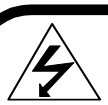
# Modular Master Clock
# User Manual

## P/N: 900000179
## Revision C

## For Brandywine Communications products with the following Part Numbers:
## 033XXXXXX

# Safety Warnings

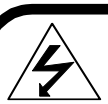


**WARNING:**

This unit contains lethal AC voltages. Disconnect the unit from the AC supply before removing the cover.

**WARNING:**

This unit contains dual power supplies. Isolate BOTH power supplied from AC Power before removing the top cover.



**WARNING:**

**The lightning flash with an arrowhead inside of an equilateral triangle is intended to alert the user to the presence of un-insulated "dangerous voltage" within the product's enclosure. The "dangerous voltage" may be of sufficient magnitude to constitute a risk of electrical shock to people. Do not attempt to repair the unit without first unplugging it.**

**CAUTION:**

**The exclamation point inside of an equilateral triangle is intended to alert the user to the presence of important operation and maintenance instructions in the user guide. Only qualified personnel should repair this unit. Several board assemblies contain static sensitive devices. Appropriate procedures must be used when handling these board assemblies.**

**Revision History**

| Revision | Date | Comments | ECO Number |
|---|---|---|---|
| A | 04/15/2021 | Initial release | ECO11688 |
| B | 12/13/2023 | Added sections for PTPSW OSM and 1PPS-RS422 ISM | ECO12886 |
| C | 03/20/2024 | Added additional info to UniversalOSM for 1PPX output type | ECO13016 |

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# 1 Introduction

Figure 1 - Modular Master Clock

Brandywine's Modular Master Clock represents the next generation of modular timing systems. Built on the highly successful High Performance Timing System, the Modular Master Clock is a leap forward in design.

**Features**:

- Redundant design with multiple signal paths built in for high-availability.
- The modular design is highly adaptable and can be field-upgraded, allowing a future-proof solution
- 12 expansion slots in the 2U version and 6 expansion slots in the 1U variant.
- Ideal for applications that require an unusual mix of interfaces
- Unique optical crosslink architecture for either Master-Secondary hierarchical setups or Master-Master crosschecking and failover
- 2U version is operated by an intuitive touch-screen interface, a first for any master clock system.
- All key components are hot-swappable and are dual redundant.
- The Output Signal modules are hot-swappable from the front, eliminating the need to disconnect cables.
- Secure Management interface through SNMPv3 and encrypted password access from the front panel

At the center of the system are Brandywine's powerful dual-redundant Master Clock Modules (MCM), which are capable of receiving time from a GPS signal, either from a standard CA code receiver, or external reference sources, such as IRIG-B, 1PPS, 10 MHz or HaveQuick. There is now an available Input Signal Module (ISM), which allows the MCM to accept 2 additional input references.

The output signals for the Modular Master Clock are generated by up to 12 hot-swappable Output Signal Modules (OSM), and are ideal for custom solutions or future expansion. Available modules include NTP module, Analog

Low-Phase-Noise frequency module, IEEE-1588 PTP module, time code modules such as IRIG A, B, G, H, and NASA 36, Pulse Rates, PTTI, as well as an optical crosslink module.

## 1.1 Modular Master Clock Basic Concept

The Modular Master Clock is a master clock that can have its capabilities defined by the use of standardized modules, allowing custom solutions to be created from standard hardware.

Through the use of these standardized modules, distributed timing networks for high accuracy applications may be readily created.

## 1.2 Modular Master Clock system overview

This system overview graphic (Figure 2) provides a visual representation of the Modular Master Clock's internal structure.

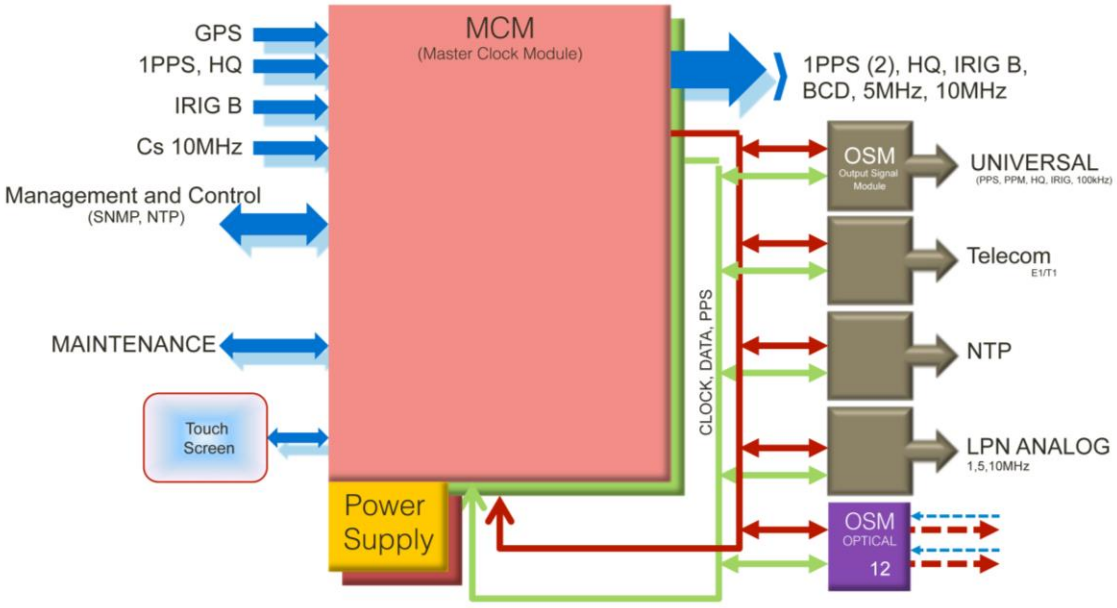



Figure 2 - Modular Master Clock Block Diagram

## 1.3 Specifications (Basic Unit)

### 1.3.1 Reference Inputs

**GPS Receiver (Optional)**

| | Commercial GPS Option |
|---|---|
| Satellite Signal | GPS $L_1$ 1575.42 MHz |
| Satellite Code | C/A 1.023 MHz |
| Receiver Type | Parallel 12 Channel, 12 Satellites tracked continuously and simultaneously |
| Position Accuracy | 2.4 m horizontal, 5 m altitude with respect to WGS-84 after 24 hours of position averaging |
| Warm start | <20 seconds |
| Autonomous Start | <120 seconds |
| Cold Start, Automatic | No input of time or position is required |
| Antenna & 100' cable | Included at no extra cost. |
| Dynamic Operation | Specify Dynamic Mode at time of order[2] |

**GPS Pulse-per-second (1PPS) Input**

| | |
|---|---|
| Signal Format | Per ICD-GPS-060B |
| Rate | 1 pulse per second |
| Impedance | 50 ohm |

**GPS Have Quick Time Code Input**

| | |
|---|---|
| Signal Format | Per ICD-GPS-060A, STANAG 4246 HQ2A STANAG 4430 |
| Rate | 1 frame per second |
| Impedance | 1k ohm |
| Connector Type | 15 Pin D-Sub Male |

**External IRIG B Input**

| | |
|---|---|
| Signal Format | IRIG BCD 124, B125, B126, B127 Per IRIG 200-04 |
| Code Selection | Automatic |
| Control Functions | Per IEEE1344, SPAWAR Std |
| Rate | 1kHz modulated sinewave |
| Modulation ratio | 2.5:1 to 3.3:1 10:3 nominal |
| Amplitude | 1 $V_{p-p}$ to 5$V_{p-p}$ |
| Impedance | >600 ohm |
| Connector Type | 15 Pin D-Sub Male |

**External Sync Input (applicable when internal GPS option is installed)**

| | |
|---|---|
| Signal Format | 2.5- 10$V_{0\text{-}peak}$ |
| Rise Time | <50ns |
| Rate | 1 pulse per second |
| Impedance | 50 ohm |
| Connector Type | 15 Pin D-Sub Male |

**External 10MHz Reference Input**

| | |
|---|---|
| Frequency | 10MHz +/- 1E-11 |
| Amplitude | 8-15dBm |
| Impedance | 50 ohm |
| Connector Type | BNC |

### 1.3.2 Outputs

**Pulse-per-second (1PPS) Output 1**

| | |
|---|---|
| Signal Format | Per ICD-GPS-060B |
| Rate | 1 pulse per second |
| Rising Edge | On Time |
| Rise Time | <50ns |
| Fall time | <100ns |
| Pulse Width | 20 µs ±5% default. |
| Amplitude | 10V ±10% |
| Output condition | when TFOM<7 only |
| Connector Type | BNC |
| Number of Outputs | 2 |

**Have Quick Time of Day Output**

| | |
|---|---|
| Signal Format | Per ICD-GPS-060A, STANAG 4430 |
| Rate | 1 pulse per second |
| Rising Edge | On Time |
| Rise Time | <100ns |
| Fall time | <100ns |
| 1PPS coherence | < 100ns of rising edge of 1PPS |
| Amplitude | 5V ±5% |
| Accuracy to 1PPS | <100ns |
| Output condition | when TFOM<7 only |
| Connector Type | 3 Pin |

**BCD Time Code Output**

| | |
|---|---|
| Signal Format | Per ICD-GPS-060A |
| Rate | 50 bits/sec |
| 1PPS coherence | < 100ns of rising edge of 1PPS |
| Mark (logical 1) | +2.5V ±1V |
| Space | (logical 0) -2.5V ±1V |
| Output condition | when TFOM<7 only |

**IRIG B Time code Output**

| | |
|---|---|
| Signal Format | B122, B124, |
| Control Functions | B124 CF definition per IEEE1344 |
| Rate | 1kHz modulated sinewave |
| Modulation ratio | 10:3 ±10% |
| Amplitude | $3V_{p-p}$ ±20% into 50Ω load |
| Output condition | when TFOM<7 only |

**Alarm Output**

| | |
|---|---|
| No of outputs | 1 ( wire-OR'd from 2 MCMs) |
| Signal Format | Dry contact closure Normally closed |
| Normal Operation | Relay Active |
| Connector Type | 15 Pin D-Sub Male |

**Reference Frequency Outputs**

| | |
|---|---|
| Signal Format | Sinusoid |
| Frequency | 5 MHz, and 10 MHz |
| Amplitude | 13dBm/$1V_{rms}$ |
| Harmonic Distortion-30dBc | |
| Non-Harmonic | -70dBc 1-500MHz |

**NTP Output**

| | |
|---|---|
| Signal Format | Ethernet 100BaseT |
| Protocols supported | NTPv3 (RFC-1305) NTPv4 (RFC-5905) |
| No of Outputs | 2 |
| Authentication | SHA-1, MD5, AutoKey |

**Management**

| | |
|---|---|
| Front Panel | Full color Touch screen |
| Remote | SNMP V3 |
| Management Viewer | MMCView |
| Firmware upgrade | Using MMCModule Update secure tool |

**Power and Environmental Specifications**

***Power***

| | |
|---|---|
| No of Inputs | 1 standard, 2 redundant optional |
| Voltage | 90-250VAC ±10% 50/60 Hz |
| Connector | IEC 320 standard, optional MS3102A-10SL-3P |

***Physical Dimensions***

| | |
|---|---|
| Length (depth) | 20.00" (Chassis Depth) |
| Width | 17.00" (Chassis) – 19.00" (Front Panel) |
| Height | 3.47" (Chassis Height) |
| Weight | 25 lbs nominal (slides not included) |

***Cooling Requirements***

| | |
|---|---|
| Air Temperature | -15ºC to +53ºC |
| Altitude Conditions | 1500 ft to +11,000 ft. |
| Airflow | 30 cfm Redundant Fans |

***Shock and Vibration Requirements or Sensitivities***

| | |
|---|---|
| Functional (operating) Shock | MIL-STD 810F Method 516.5 Procedure I |
| Bench Handling Shock | MIL-STD 810F Method 516.5 Procedure VI |
| Vibration, Functional (operating) | MIL-STD-167-1 |
| ***EMI*** | EN55022, EN55024, FCC Part 15 |
| ***Safety*** | CE Certified |

## 1.3.3 OSM Specifications

### 1.3.3.1 Optical Crosslink Specifications:

**Physical**

| | |
|---|---|
| Connector Type | LC Duplex optical connector interface conforming to ANSI TIA/EIA604-10 (FOCIS 10A) Simplex fiber in security mode. |
| No of Outputs | 2 bi-directional per OSM |
| Location | Rear Panel |

**Synchronization Accuracy**

| | |
|---|---|
| Phase Measurement Accuracy | <2ns |
| End to End Synchronization Accuracy | <12ns |

**Optical**

| | |
|---|---|
| Wavelength | Single Mode 1300nm |
| Safety | Class 1 CDRH/IEC 825 compliant |
| Range | 2000 m with 9/125um single mode fiber (SMF) Up to 40KM available as option. |

### 1.3.3.2 Universal Output Signal Module Specifications:

#### *1.3.3.2.1 Pulse-per-second (1PPS) Output*

| | |
|---|---|
| Signal Format | Per ICD-GPS-060B |
| Rate | 1 pulse per second |
| Rising Edge | On Time |
| Rise Time | <50ns |
| Fall time | <100ns |
| Pulse Width | 20 µs ±5% default. |
| Amplitude | 10V ±10% |
| Output condition | when TFOM<7 only |
| Connector Type | BNC |

#### *1.3.3.2.2 Pulse-per-minute (1PPM) Output*

| | |
|---|---|
| Signal Format | Per ICD-GPS-060B |
| Rate | 1 pulse per minute |
| Rising Edge | On Time |
| Rise Time | <50ns |
| Fall time | <100ns |
| Pulse Width | 20 µs ±5% default. |
| Amplitude | 10V ±10% |
| Output condition | when TFOM<7 only |
| Connector Type | BNC |

#### *1.3.3.2.3 Pulse-per-X-second (1PPX) Output*

| | |
|---|---|
| Signal Characteristcs | Per ICD-GPS-060B |
| Rate | 1 pulse per X second(s) |
| Rising Edge | On Time |
| Rise Time | <50ns |
| Fall time | <100ns |
| Pulse Width | 20 µs ±5% default. |
| Amplitude | 10V ±10% |
| Output condition | when TFOM<7 only |
| Connector Type | BNC |

#### *1.3.3.2.4 Have Quick Time of Day Output*

| | |
|---|---|
| Signal Format | Per ICD-GPS-060A |
| Rate | 1 pulse per second |
| Rising Edge | On Time |
| Rise Time | <100ns |
| Fall time | <100ns |
| 1PPS coherence | < 100ns of rising edge of 1PPS |
| Amplitude | 5V ±5% |
| Accuracy to 1PPS | <100ns |
| Output condition | when TFOM<7 only |
| Connector Type | 3 Pin |

#### *1.3.3.2.5 BCD Time Code Output*

| | |
|---|---|
| Signal Format | Per ICD-GPS-060A |
| Rate | 50 bits/sec |
| 1PPS coherence | < 100ns of rising edge of 1PPS |
| Mark (logical 1) | +2.5V ±1V |
| Space | (logical 0) -2.5V ±1V |
| Output condition | when TFOM<7 only |
| Connector Type | 3 Pin |

#### *1.3.3.2.6 IRIG B Time code Output*

| | |
|---|---|
| Signal Format | B122, B124, |
| Control Functions | B124 CF definition per IEEE1344 B124 CF definition per SPAWAR standard |
| Rate | 1kHz modulated sinewave |
| Modulation ratio | 10:3 ±10% |
| Amplitude | $5V_{p-p}$ ±20% |
| Output condition | when TFOM<7 only |
| Connector Type | BNC |

#### 1.3.3.2.7 IRIG A Time code Output

| | |
|---|---|
| Signal Format | A132, A137 per 200-16 |
| Rate | 10kHz modulated sinewave |
| Modulation ratio | 10:3 ±10% |
| Amplitude | $5V_{p-p}$ ±20% |
| Output condition | when TFOM<7 only |
| Connector Type | BNC |

#### 1.3.3.2.8 IRIG G Time code Output

| | |
|---|---|
| Signal Format | G142, G146 per 200-16 |
| Rate | 100kHz modulated sinewave |
| Modulation ratio | 10:3 ±10% |
| Output condition | when TFOM<7 only |
| Connector Type | BNC |

#### 1.3.3.2.9 XR3

| | |
|---|---|
| Signal Format | XR3 |
| Rate | 250Hz modulated sinewave |
| Modulation ratio | 10:3 ±10% |
| Amplitude | $5V_{p-p}$ ±20% |
| Output condition | when TFOM<7 only |
| Connector Type | BNC |

#### 1.3.3.2.10 2137

| | |
|---|---|
| Signal Format | 2137 |
| Rate | 1kHz modulated sinewave |
| Modulation ratio | 10:3 ±10% |
| Amplitude | $5V_{p-p}$ ±20% |
| Output condition | when TFOM<7 only |
| Connector Type | BNC |

#### 1.3.3.2.11 Alarm Output

| | |
|---|---|
| No of outputs | 1 (wire-OR'd from 2 MCMs) |
| Signal Format | Dry contact closure Normally closed |
| Normal Operation | Relay Active |
| Connector Type | 15 Pin D-Sub Male |

### 1.3.3.3 Analog Low Phase Noise Specifications:

| | | |
|---|---|---|
| No of outputs | | 4 |
| Signal Format | | Sinusoid |
| Frequency | | 1 MHz, 5 MHz, or 10 MHz |
| Amplitude | | 13dBm/1$V_{rms}$ |
| Harmonic Distortion-30dBc | | |
| Non-Harmonic | | -80dBc 1-500MHz |
| Phase Noise | | |
| | 10 MHz dBc | 5MHz dBc |
| 1Hz | -90 | -95 |
| 10Hz | -120 | -125 |
| 100Hz | -145 | -145 |
| 1kHz | -155 | -155 |
| 10kHz | -155 | -155 |
| **Physical** | | |
| Connector Type | | BNC |

### 1.3.3.4 Analog Distribution Module Specifications

**Output Specifications**

| | |
|---|---|
| Output Amplitude, Sinewave into 50 ohm: | 13dBm±3dBm |
| Harmonices: | -40dBc |
| Spurious: | -80dBc |
| Isolation: | 80dB |

**Phase Noise**

| | |
|---|---|
| 1Hz | -60dBc/Hz |
| 10Hz | -90dBc/Hz |
| 100Hz | -115dBc/Hz |
| 1000Hz | -145dBc/Hz |
| 10kHz | -150dBc/Hz |

### 1.3.3.5 NTP Server Specifications:

| | |
|---|---|
| Signal Format | Ethernet 100BaseT |
| Protocols Supported | NTPv3 (RFC-1305)<br>NTPv4 (RFC-5905) |
| No of Outputs | 2 |
| Authentication | SHA-1, MD5, AutoKey |

### 1.3.3.6 PTP Switch Output Signal Module Specifications:

| | |
|---|---|
| Signal Format | Ethernet 1000/100/10 BaseT<br>Fiber (Depends on configuration) |
| Protocols Supported | PTPv2 (IEEE 1588-2008)<br>NTP (RFC-1305) |
| No of Outputs | 3 |
| Authentication | SHA-1, MD5, AutoKey |

### 1.3.4 ISM Specifications

#### 1.3.4.1 1PPS-RS422 Input Signal Module Specifications:

**Pulse-per-second (1PPS) Input**

| | |
|---|---|
| Signal Format | Per ICD-GPS-060B |
| Rate | 1 pulse per second |
| Impedance | 50 ohm |

**Time Code Input**

| | |
|---|---|
| Signal Format | NMEA: ZDA |
| Rate | 115.2 Kbps |
| Impedance | 100 ohm |
| Electrical Interface | RS422 |
| Connector Type | 15 Pin D-Sub Male |

**Time Code Output**

| | |
|---|---|
| Signal Format | NMEA: ZDA, I-24 |
| Rate | 115.2 Kbps |
| Electrical Interface | RS422 |
| Connector Type | 15 Pin D-Sub Male |

# 2 Setup

Remove the Modular Master Clock from the shipping carton. The following items should be included in the shipment:
1x Modular Master Clock
2x Power supply cables
1x CD-ROM containing User Manual and Utility Software
1x GPS Antenna and 100' cable if the GPS option is included

## 2.1 Installation

### 2.1.1 Mounting

The Modular Master Clock can be installed into a 19" rack mount cabinet using rack slides. Slides are installed using 10-32 UNF-2B hardware.
Optional Rack Mount Slides:

P/N 002000123, SLIDE, RACK, 24", 21" TRAVEL, 85 LB
Part Numbers:
Brandywine: 002000123
General Devices: C-300-S-124
Newark: 93B6957
P/N 002000150, SLIDE, RACK, 28", 27" TRAVEL, 80 LB
Part Numbers:
Brandywine: 002000150
General Devices: C-300-S-128

Original Manufacturer: General Devices Chassis Trak Type C300.

### 2.1.2 Power

Insert the power cord of the Modular Master Clock into an electrical socket to power up the unit.

If dual redundant power is required, connect both power sources to independent power sources

Note that the Modular Master Clock uses a custom power cable designed to lock in place. Be sure to only use power cables made by Brandywine Communications

Power Cable Part Number: 002206312

### 2.1.3 Ethernet (optional)

Connect one end of an Ethernet patch cable to the Modular Master Clock Ethernet located on the Master Clock Module. Connect the other end of the Ethernet cable to the network with an Ethernet hub or switch.

# 3 Configuration

Power on the Modular Master Clock by switching the rear Power Supply Module to the upwards "On" position, The Front Panel LCD display will illuminate, and the display will show a blank grey screen while the system is warming up. Once the system completes powering up, the overview screen will be displayed. (Figure 3)

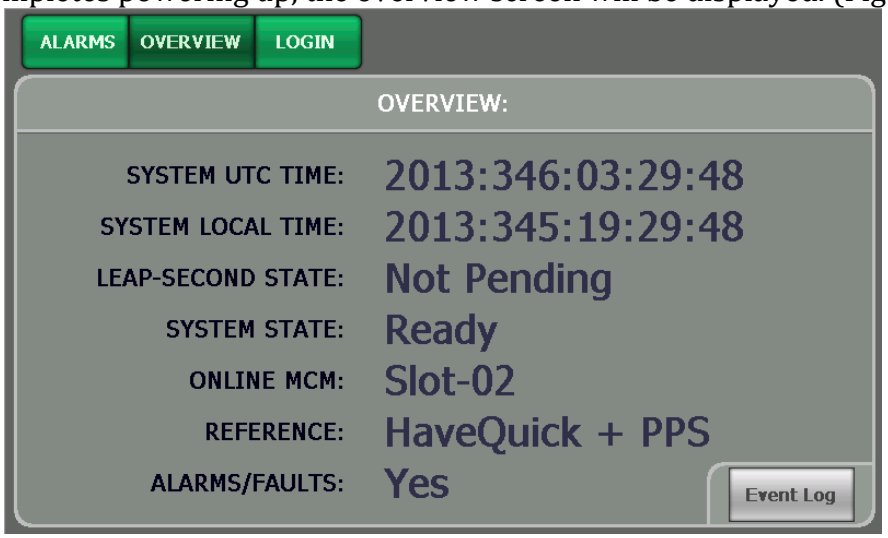



Figure 3 - Modular Master Clock System Overview

Use the top row of tabs to navigate between the List of Current Alarms (ALARMS), Overview (OVERVIEW), and the configuration menu (LOGIN).

## 3.1 Event Log

To access the event log (Figure 4), select the "Event Log" button in the lower right corner of the Overview screen (Figure 3). For a List of all possible events, refer to Appendix A – Event List.

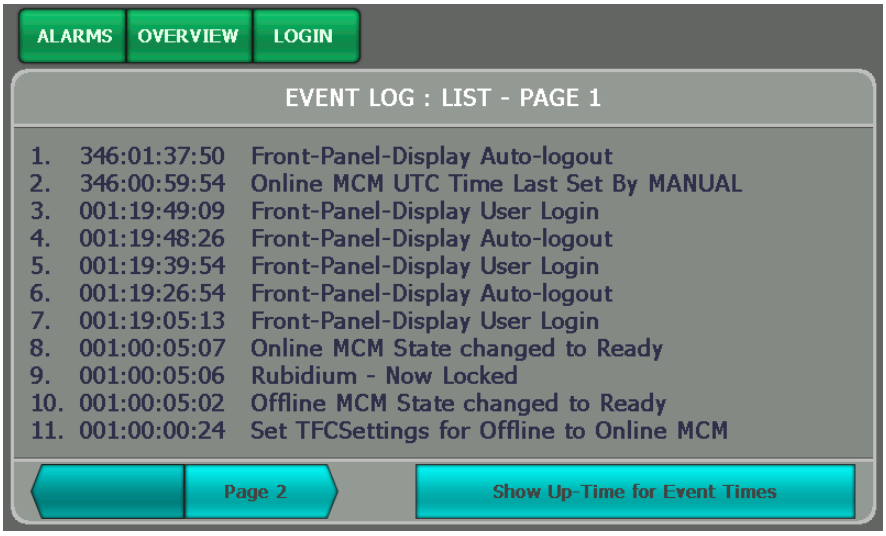



Figure 4 - Event Log

## 3.2 Current Alarms (ALARMS)

The ALARMS tab on the top left hand corner of the screen will open the current alarms list. This list will show all the current alarms that are active. These alarms are not latched, and will be deleted from the list once the cause of the alarm has been cleared. Some higher priority alarms are categorized as "Buzzer Alarms" since they are linked to an audible warning. For a list of all possible alarms, refer to Appendix C - List of Possible Alarms.

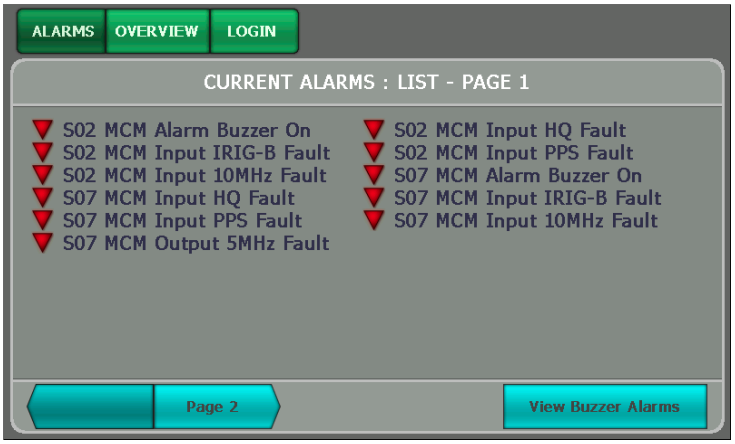



Figure 5 - Current Alarm List

### 3.2.1 Buzzer Alarms

Buzzer alarms are alarm events that cause the system to emit an audible warning tone. These alarms require the immediate attention of the operator. To access a list of the current buzzer alarms, select the "View Buzzer Alarms" button from the lower right hand corner of the screen. To clear a buzzer alarm, select the button labeled "Turn off Alarm Buzzer!" in the lower right hand corner of the "CURRENT ALARMS: LIST" screen. Once selected, the button on the lower right hand corner of the screen will change to "View Current Alarms."

To switch back to the current alarm list, select the button "View Current Alarms" in the lower right hand corner of the screen." For a list of all possible buzzer alarms, refer to Appendix B - List of Possible Buzzer Alarms.

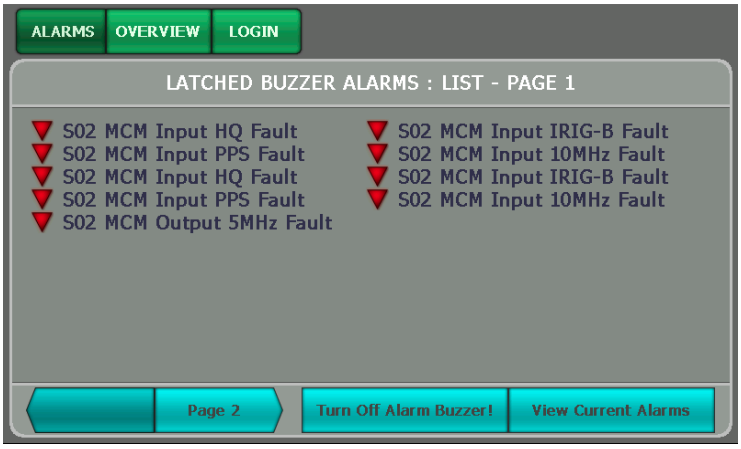



Figure 6 - Buzzer Alarms

## 3.3 Configuration Menu

To access the configuration menu, select the "LOGIN" tab at the top of the screen. The Modular Master Clock's front panel display is password-protected for security purposes. Enter the display password to log in. (The factory default is a blank password)

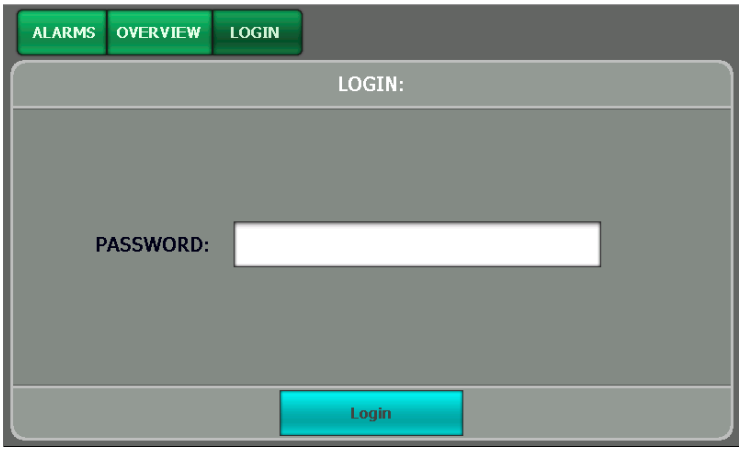



Figure 7 - Login Screen

After logging in, select which unit to control from the Chassis Selection Screen (SELECT TFC). By using the optical crosslink capability of the Modular Master Clock, additional units can be remotely managed in the same manner as directly controlling them.

To access configuration and control for the local chassis, select the button labeled "Top-Level (MGU)."

**If Optical Crosslink modules are installed and configured, selecting a Crosslink icon will access the chassis connected via the crosslink.**

**NOTE**

Only a Secondary Distribution Unit (SDU) with information assurance mode disabled can be controlled and configured from the front panel display of the corresponding Master Generation Unit (MGU). An MGU cannot be controlled from another MGU or from an SDU. For more information on the Information Assurance mode, refer to section 3.4.3.1.

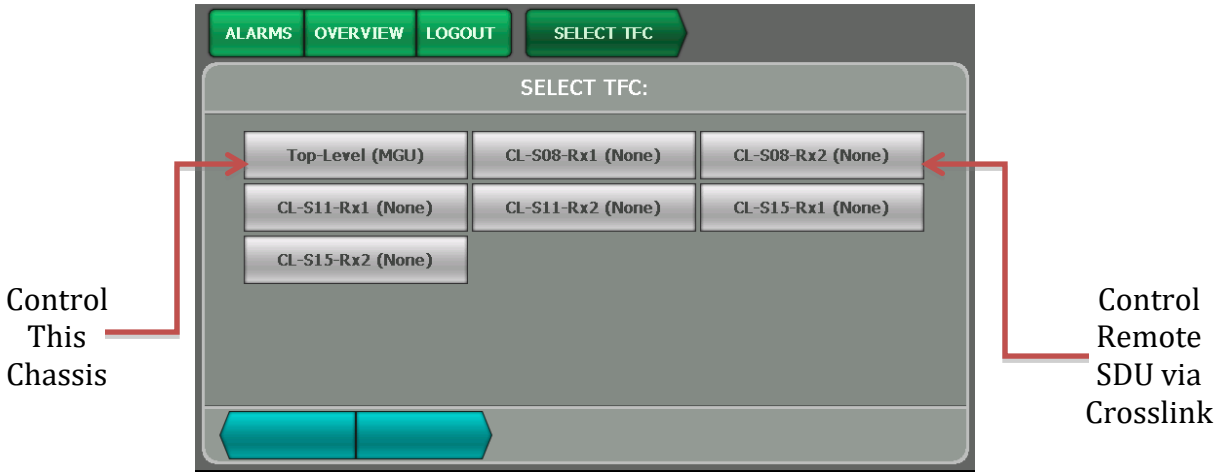



Figure 8 - MMC Unit Selection Screen

From here, select which module to manage via the module selection screen.

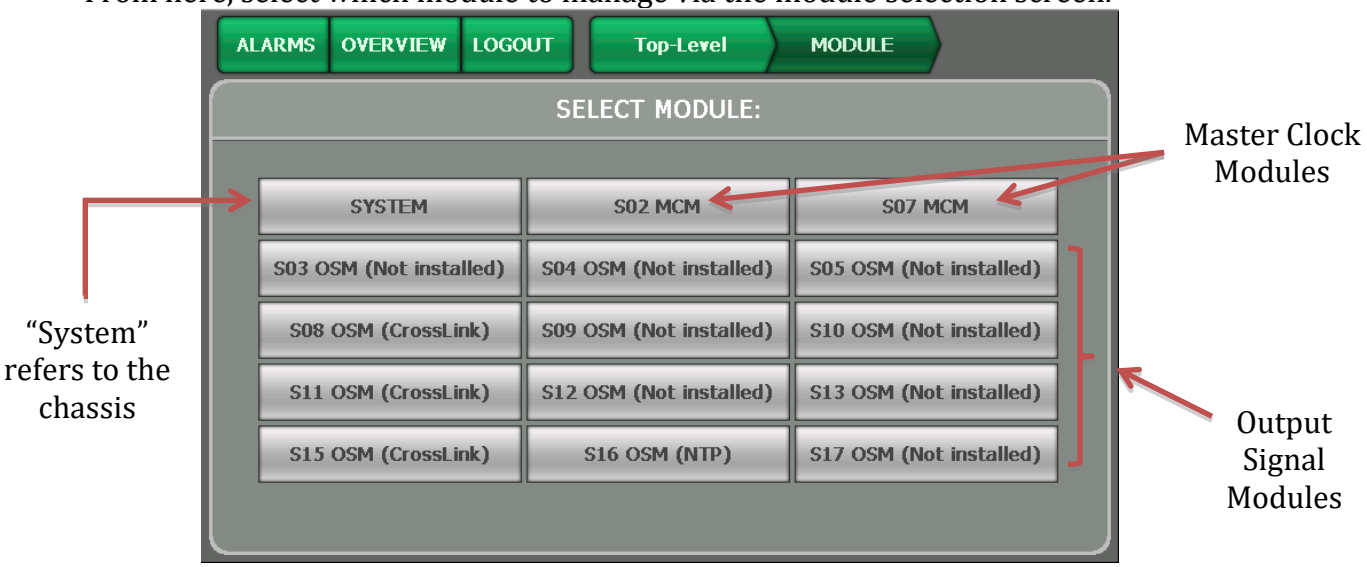



Figure 9 - Module Selection Screen

## 3.4 SYSTEM

Under the Systems page, global settings for that particular Modular Master Clock chassis can be adjusted.


Figure 10 - System Settings

### 3.4.1 System Inventory

Select the "Inventory" button to open the INVENTORY screen within the system settings, it is possible to view the system's serial number, and revision, as well as the chassis serial number and revision.


Figure 11 - System Inventory

### 3.4.2 System Status

Select the "Status" button to open the STATUS screen. This screen shows the current fault status of the system (Figure 12 - System Status Fault Display), the status of each Master Clock Module (Figure 13 and Figure 14), and the input reference status (Figure 15).

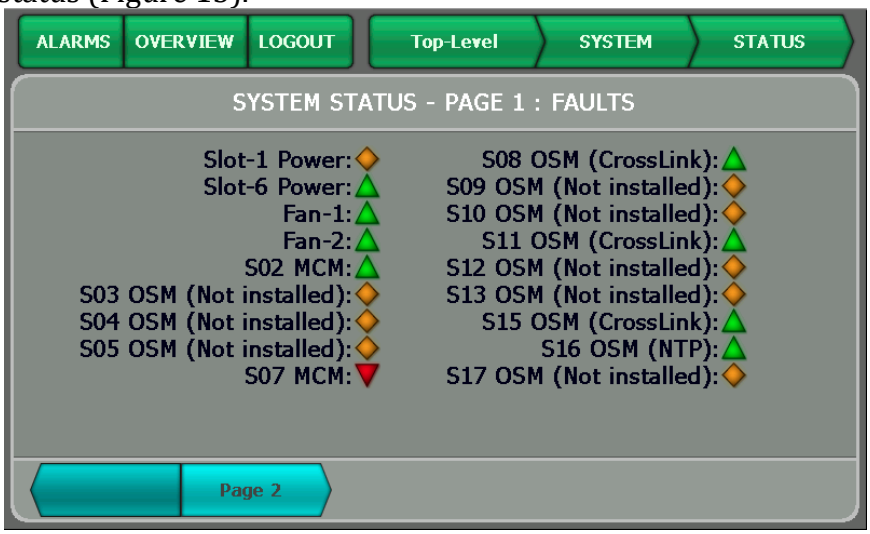



Figure 12 - System Status Fault Display

A green triangle pointing upwards indicates that the board module is installed and is operating nominally.
A red triangle pointing downwards indicates that the board module is installed, but it is returning a fault condition.
An amber diamond indicates that there is no board module installed in that particular slot.

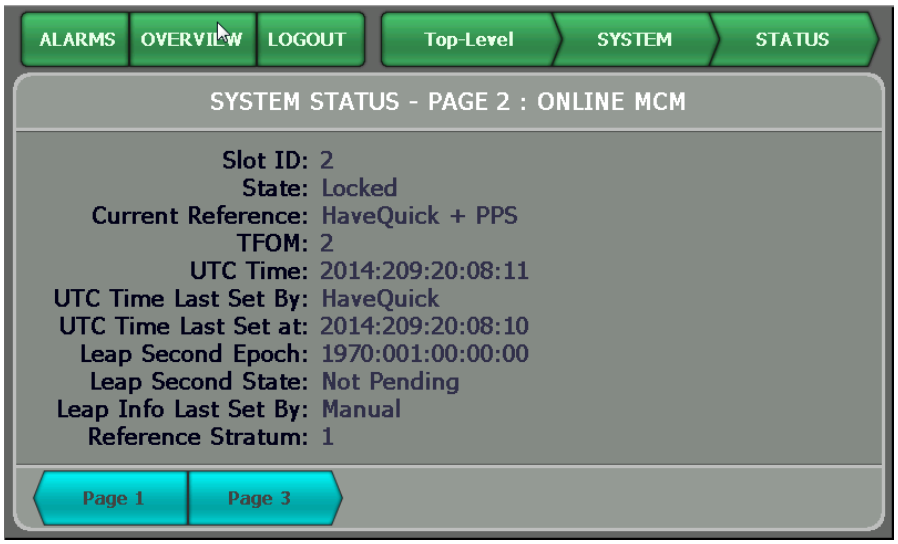



Figure 13 - Online MCM Status

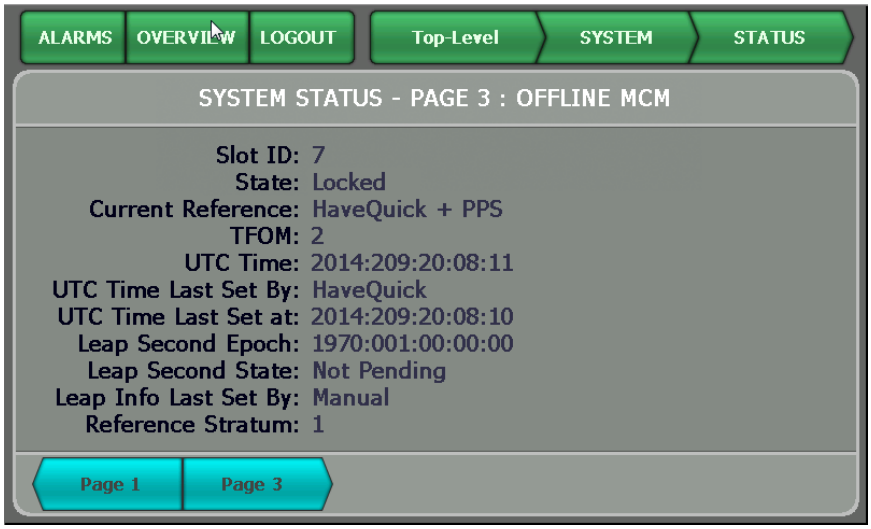



Figure 14 - Offline MCM Status

**Slot ID** – This indicates the slot number the Master Clock Module is plugged into
**State** – The current state of the MCM, possible states are: Ready, Acquiring, Locked and Holdover
**Current Reference** – The current reference source of the Master Clock Module
**TFOM** – Time Figure of Merit
**UTC Time** – The current system time in UTC
**UTC Time Last Set By** – The reference that was last used to set the time of day and phase
**UTC Time Last Set At** – The time that the system last updated it's time of day from the reference source.
**Leap Second Epoch** – The time when a pending leap second will be implemented.
**Leap Second State** – Displays whether or not a leap second is currently pending.
**Reference Stratum** – Indicates the degree of connection to a primary reference. Stratum 1 is direct connection, Stratum 2 is via crosslink

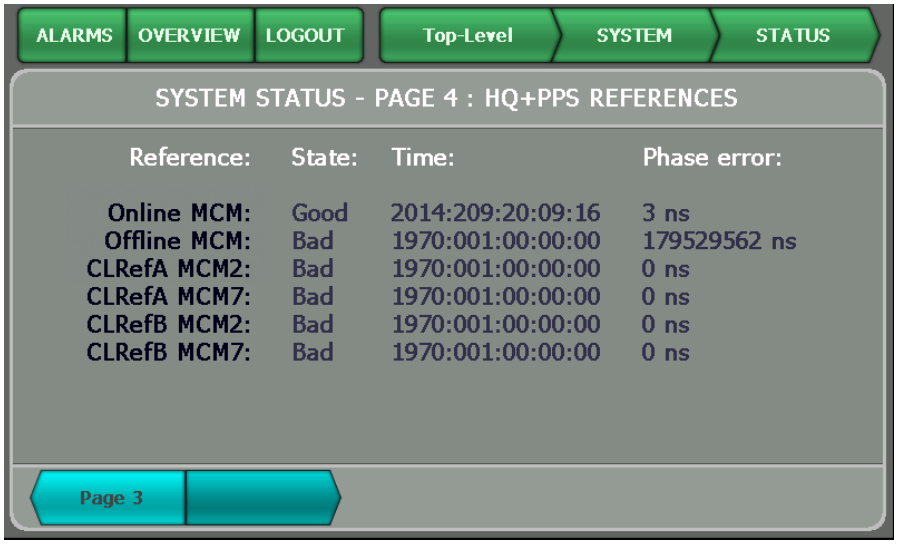



Figure 15 - Reference Status

#### 3.4.2.1 Reference Status

The Reference Status (Figure 15) page lists the status conditions for each of the input references.
The reference column lists each input reference.
The state column lists the current reference state for each input reference. An input reference is listed as "Bad" if the input source is not available, if it returns a fault, or if the input reference deviates too far from the other input references.
The time column lists the current year, day of year and 24 hour UTC time of day.
The phase error column lists the phase error from each input reference source.

### 3.4.3 System Settings

The System Settings screen allows the user to configure and adjust various settings that pertain to the entire Modular Master Clock system:

- Enable/Disable Information Assurance Mode
- Switch the unit between acting as a Master Generation Unit (MGU) or a Secondary Distribution Unit (SDU)
- Switch between Manual and Automatic Master Clock Module switching
- Manually selecting the Master Clock Module
- Adjust output delays
- Set local time offset and Daylight Savings offset and start and stop dates
- Change the front panel access password
- Adjust the display brightness

#### 3.4.3.1 TFC Function Setup (Page 1)

This page of the settings menu (Figure 16) allows for the selection of whether a unit is to function as a Master Generation Unit (MGU) or a Secondary Distribution Unit (SDU), as well as to switch the system into Information Assurance (IA) mode.
The different system setups that are possible are:

- Multiple-Redundant Master-Master configuration:

- In this setup, multiple units are set up as Master Generation Units, and they will continuously cross-check each other for high accuracy and availability.

- Master-Secondary configuration:
  - In this setup, one or more Master Generation Units feed time to one or more Secondary Distribution Units, which, in turn, have their own sets of outputs.
- Master-Secondary with Information Assurance:
  - This setups features one or more Secondary Distribution Units being fed from a Master Generation Unit, but with Information Assurance mode enabled. In this mode, the Master Generation Unit will optically transmit time, but without expecting any status and control messages to be returned. In this mode, the Master Generation Unit will NOT be able to alter any settings or access the fault status of the Secondary Distribution Unit.

The different chassis setups that are available from the TFC Type Dropdown Selector are:

- **MGU**: Master Generation Unit. In this mode, the unit is considered a master reference, and is assumed to be receiving its input time from primary source, such as GPS, and is broadcasting that time reference as HaveQuick and 1PPS via the Optical Crosslink.
- **SDU**: Secondary Distribution Unit. In this mode, the unit is receiving its input time from another Modular Master Clock and is passively listening to the input references from the Master Generation Units.

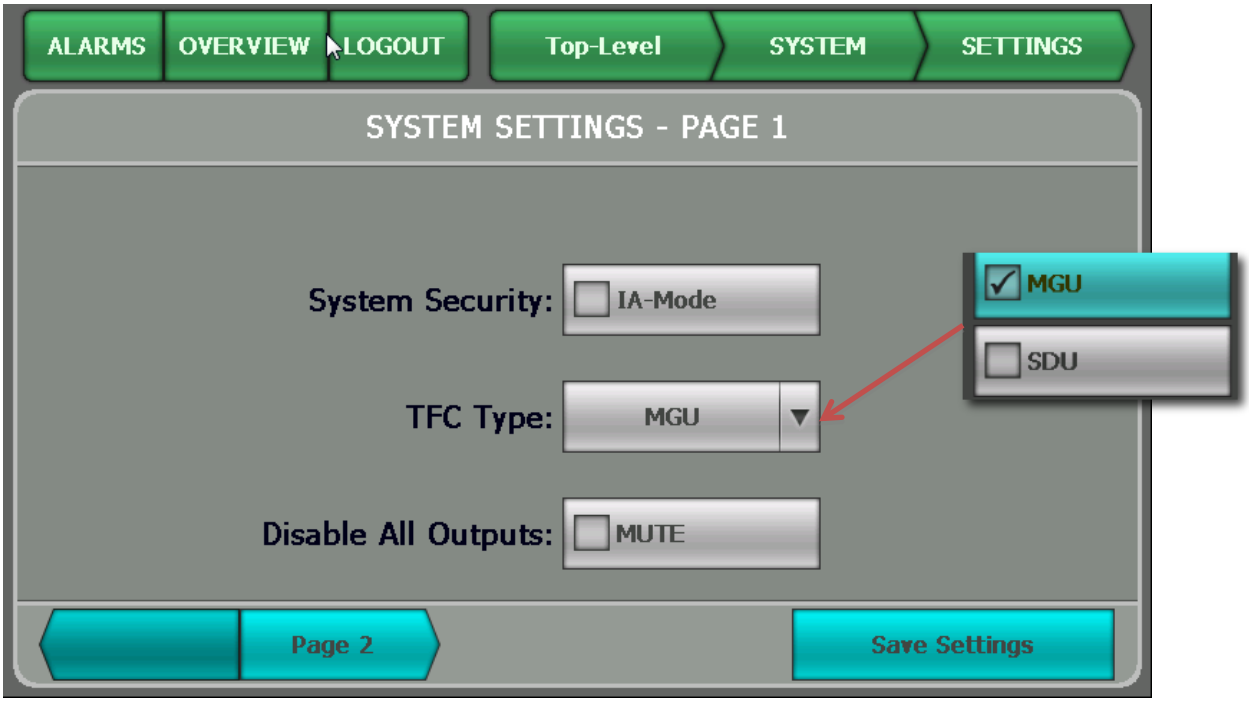



Figure 16 - System Settings Page 1

### 3.4.3.2 Master Selection (Page 2)

This page (Figure 17) allows the user to select the Master Clock Module switching mode, accessible via the "MCM Master Select" dropdown menu. This page also allows the user to manually select which Master Clock Module (MCM) is used if the system is set to manual switching.

- **MCM Master Select:** Manual or Automatic switching between Master Clock Modules.
- **Manual MCM Master:** If the system is set to Manual switching, this setting selects which Master Clock Module to use, Slot 2 or Slot 7.

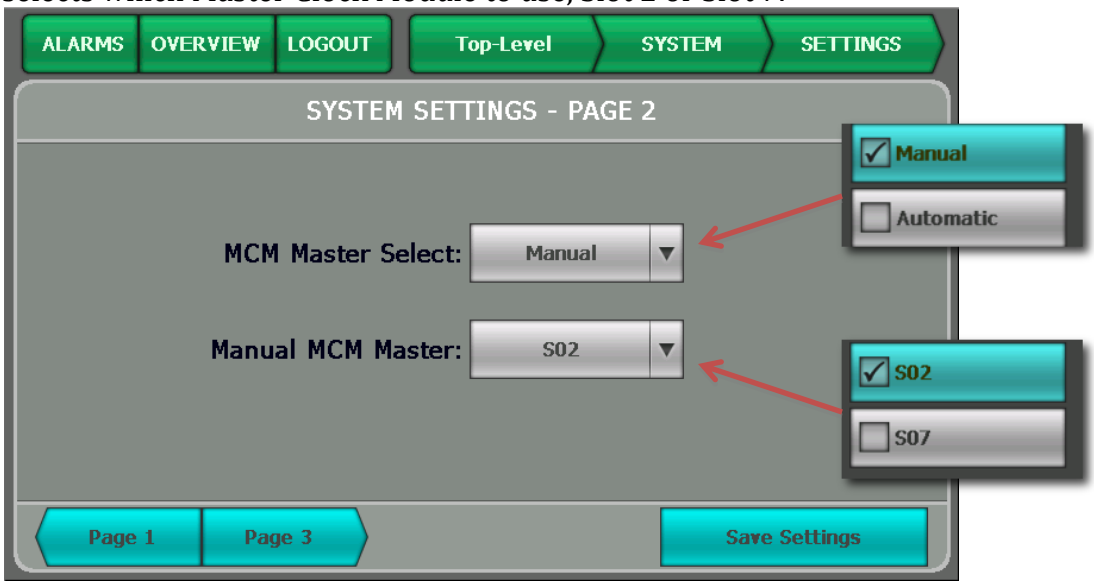



Figure 17 - System Settings Page 2

### 3.4.3.3 Output Delays (Page 3)

This page (Figure 18) allows the user to adjust the output delays from the system to each of the outputs. A positive value will increase the delay, a negative value will decrease the delay.

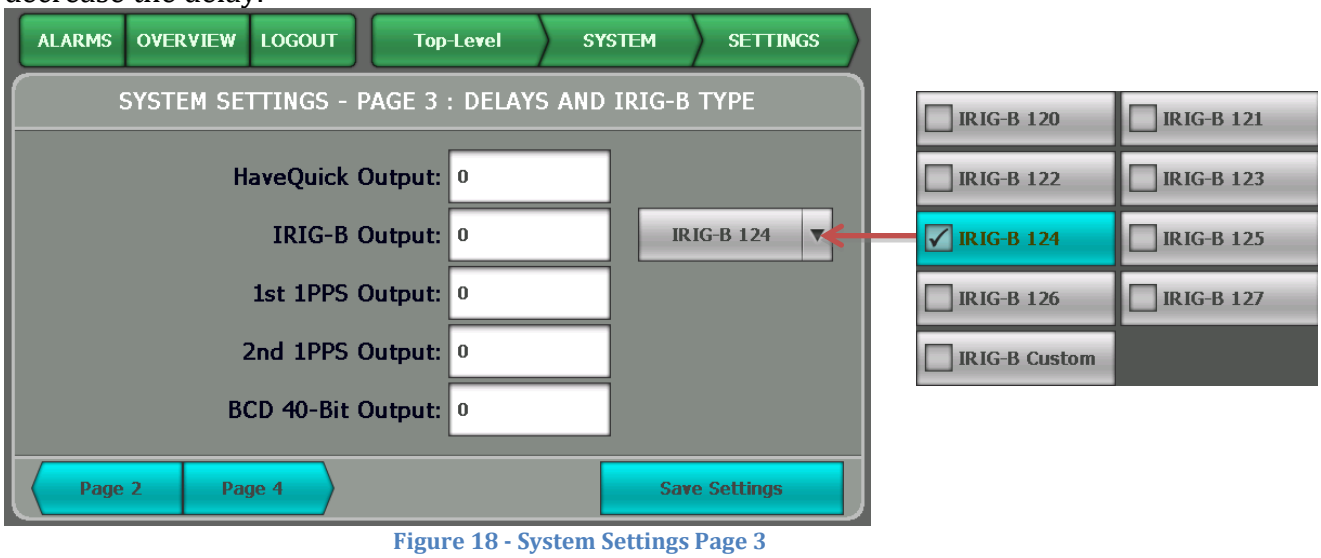



Figure 18 - System Settings Page 3

### 3.4.3.4 Local Time Settings (Page 4)

The Modular Master Clock defaults to UTC Time, however, this settings page (Figure 19) can be used to adjust the Time Zone and Daylight Savings Time offset of the system to match the local time. Both the Time Zone and the Daylight Savings Time offset settings are entered in minutes. For example, Eastern Standard Time is 5 hours behind UTC, thus would be entered as -300 for the Time Zone offset.


Figure 19 - System Settings Page 4

### 3.4.3.5 Password Settings. (Page 5)

This page allows the user to set or change the front panel login password (Figure 20). The login password is the password that is required to be entered to access the Front Panel Display (Figure 7). (Version 4.3.75 or later) Passwords must be between 15 and 64 characters, and must have at least one uppercase letter, one lowercase letter, one number, and one special character.

**NOTE: If the login password to the unit is lost, the unit must be returned to Brandywine, as the user cannot restore factory settings.**

If the Master Clock Modules are running firmware version 4.2.58 or later, the procedure in Appendix D – Factory Reset can be used to reset each Master Clock Module to factory default settings. Otherwise, the system must be returned to Brandywine Communications to restore it to factory settings.

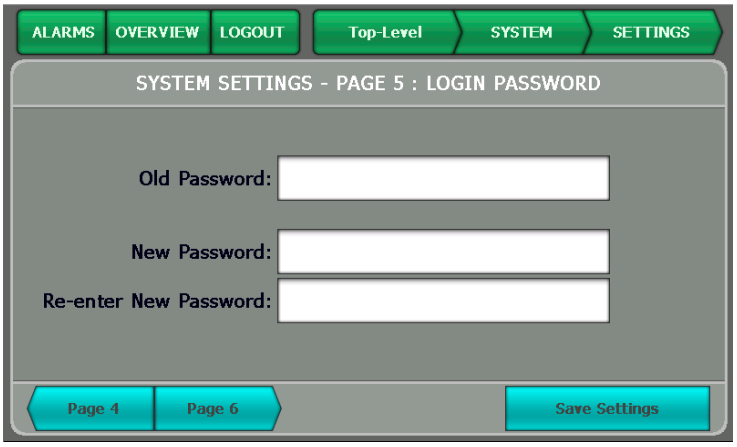



Figure 20 - System Settings Page 5

### 3.4.3.6 Display Brightness

The final settings page (Figure 21) allows the user to adjust the brightness of the Modular Master Clock's LCD display. 1 is the lowest setting and 5 is the highest.

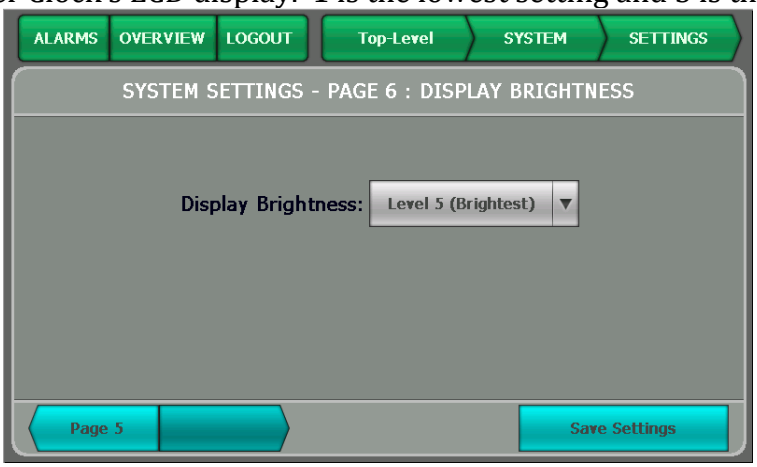



Figure 21 - System Settings Page 6

## 3.5 Master Clock Module Status and Configuration

The Master Clock Module is the oscillator at the heart of the MMC. The MMC may use either one (standard) or two (optional) hot-swappable Master Clock Modules for redundancy and high-availability operation. The MCM may be configured with one of three types of oscillator, depending upon price/performance desired. The MCM is accessed either via the front touch screen display, an external Ethernet port, or a front panel maintenance Ethernet port. All aspects of the MMC operation are available through the front panel display. For MMC configurations where multiple chassis are connected via an optical fiber link, the status and configuration of a remote chassis can be accessed across this link. (See Paragraph 3.4.3.1 for details)

MCM's installed in a 2U chassis provide a number of signal outputs without the need to install any Output Signal Modules.

Each MCM includes provision for Information Assurance. The front panel display is password protected, and the password is stored in encrypted form. Password requirements and updates are implemented by means of warning screens. All Network connections use both authentication and privacy corresponding to the protocol in use. Only required ports and protocols are enabled.

From the Modular Master Clock configuration menu, select the Master Clock Module, listed as "MCM," this will open the MCM status and configuration page. (Figure 23)

The Master Clock Module's port assignments are noted below in Table 1 - Master Clock Module Connector .

| Connector | Type | Function |
|---|---|---|
| **J1** | BNC | 1PPS Output #1 |
| **J2** | BNC | 1PPS Output #2 |
| **J3** | BNC | IRIG-B (AC) Output |
| **J4** | Mating Connector:<br>TYCO/AMP 1-1437719-5 | HaveQuick Output |
| **Pin 1** | | HaveQuick Out |
| **Pin 2** | | NC |
| **Pin 3** | | GND |
| **J5** | BNC | 5 MHz Output<br>S02 GPS Input |
| **J6** | BNC | 10 MHz Output<br>S07 GPS Input |
| **J7** | BNC | 10 MHz Input |
| **J8** | Mating Connector:<br>TYCO/AMP 1-1437719-5 | BCD Time Code Output |
| **Pin 1** | | BCD+ |
| **Pin 2** | | BCD- |
| **Pin 3** | | GND |
| **J9** | BNC | 1PPS Input |
| **J10** | 15 Pin DSub<br>NorComp 171-015-202-001 | |
| **Pin 1** | | NC |
| **Pin 2** | | NC |
| **Pin 3** | | NC |
| **Pin 4** | | RS422 Tx- |
| **Pin 5** | | Alarm COM |
| **Pin 6** | | Alarm NC |
| **Pin 7** | | NC |
| **Pin 8** | | Ground |
| **Pin 9** | | NC |
| **Pin 10** | | Have Quick Input |
| **Pin 11** | | RS422 Tx+ |
| **Pin 12** | | NC |
| **Pin 13** | | IRIG-B AC Input |
| **Pin 14** | | NC |
| **Pin 15** | | NC |
| **J11** | RJ-45 | Ethernet (NTP, SNMP v3, MMCView [opt.]) |
| **J14 (opt.)** | RJ-45 | Ethernet (NTP, SNMP v3, MMCView [opt.]) |

Table 1 - Master Clock Module Connector Outputs

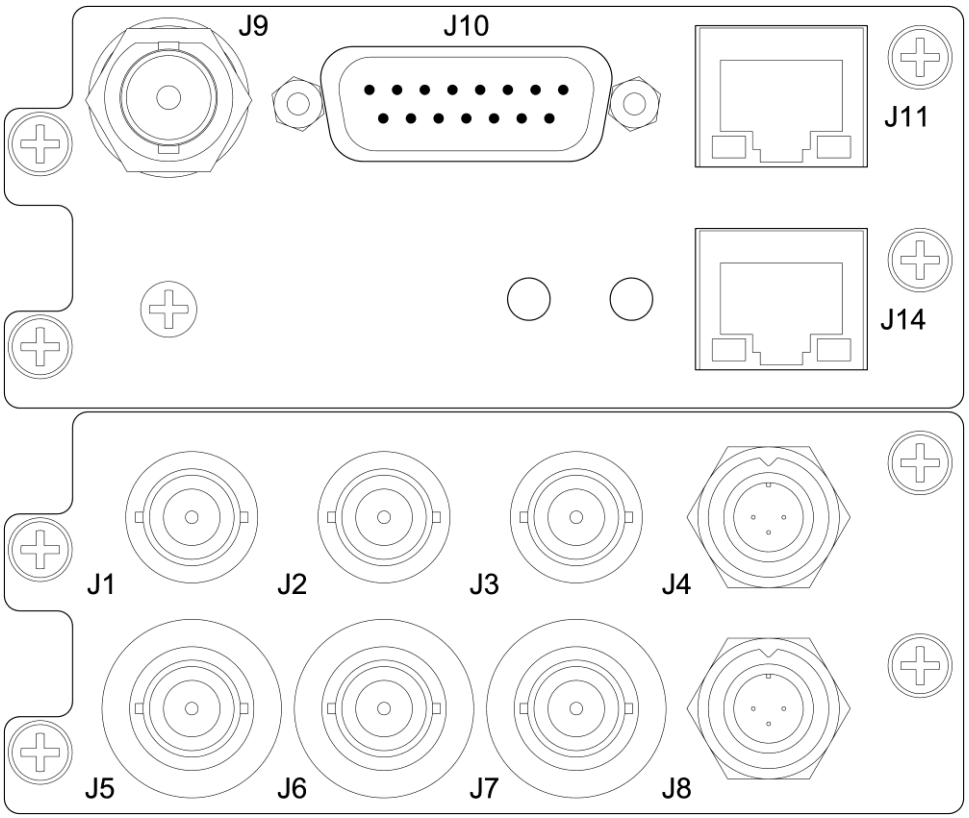



Figure 22 - Master Clock Module Rear Panel View

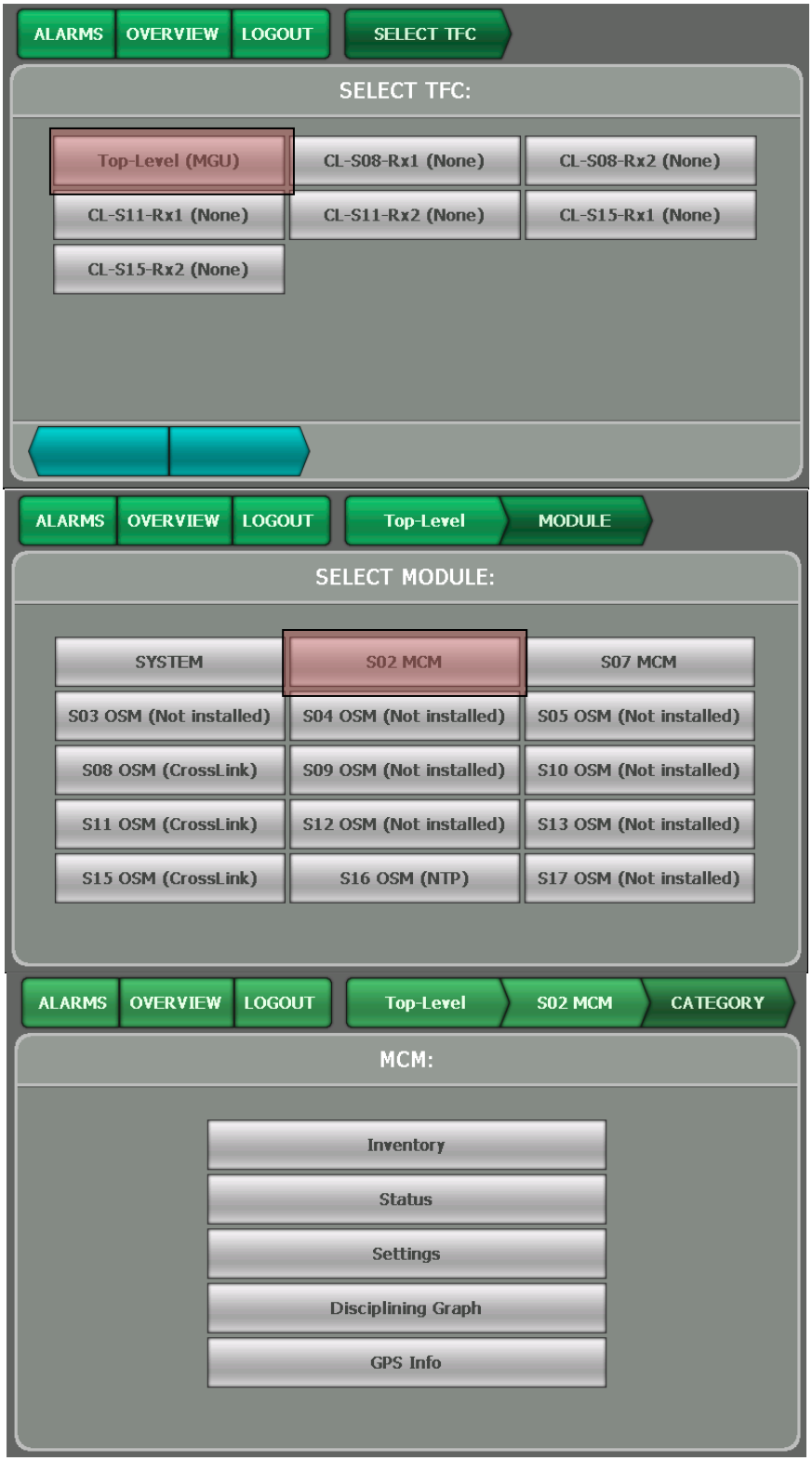



Figure 23 - Master Clock Module Status and Configuration Page

### 3.5.1 Master Clock Module Inventory

The "MCM INVENTORY" screen (Figure 24) displays the Master Clock Module's Serial Number, Firmware Version, FPGA Version, Hardware number, Oscillator Firmware Version, Oscillator Hardware Version, Oscillator Serial Number, the IPv6 addresses of both Ethernet ports, as well as the required MMCView Version.

**Note:** Full functionality cannot be guaranteed if the required MMCView Version is not used.


Figure 24 - MCM Inventory

### 3.5.2 Master Clock Module Status

The Master Clock Module Status Screen is broken down into five pages, which displays the following information:

- MCM Faults (Figure 25 - MCM Fault Listing)
- MCM Faults (cont.) (Figure 26 - MCM Fault Listing (cont.))
- Phase/Freq/Time Faults (Figure 27 - MCM Phase/Freq/Time Faults)
- MCM Status (Figure 28 - MCM Status)
- Input Reference Status (Figure 29 - MCM Input Status)

#### 3.5.2.1 MCM Faults (Page 1)

This page lists the current fault status of the Master Clock Module.

- **A Green Triangle Facing Upwards:** This means that the input or output is connected and is operating nominally.
- **An Amber Diamond:** This means that the specified connection is not responding to communications.
- **A Red Triangle Facing Downwards:** The connection is connected but is returning a fault.


Figure 25 - MCM Fault Listing

### 3.5.2.2 MCM Faults (cont.) (Page 2)

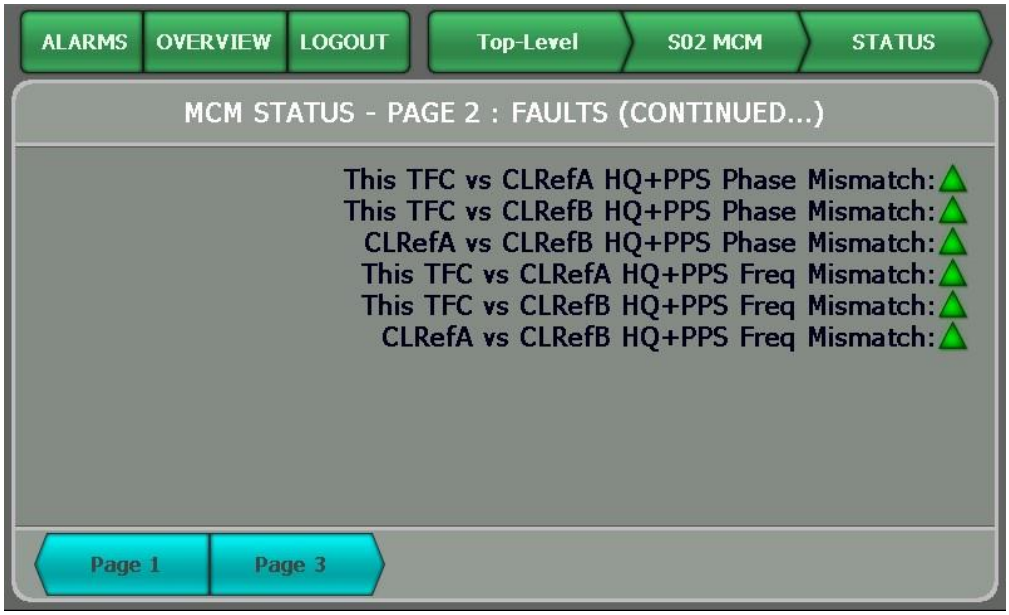



Figure 26 - MCM Fault Listing (cont.)

### 3.5.2.3 Phase, Frequency, and Time Faults (Page 3)

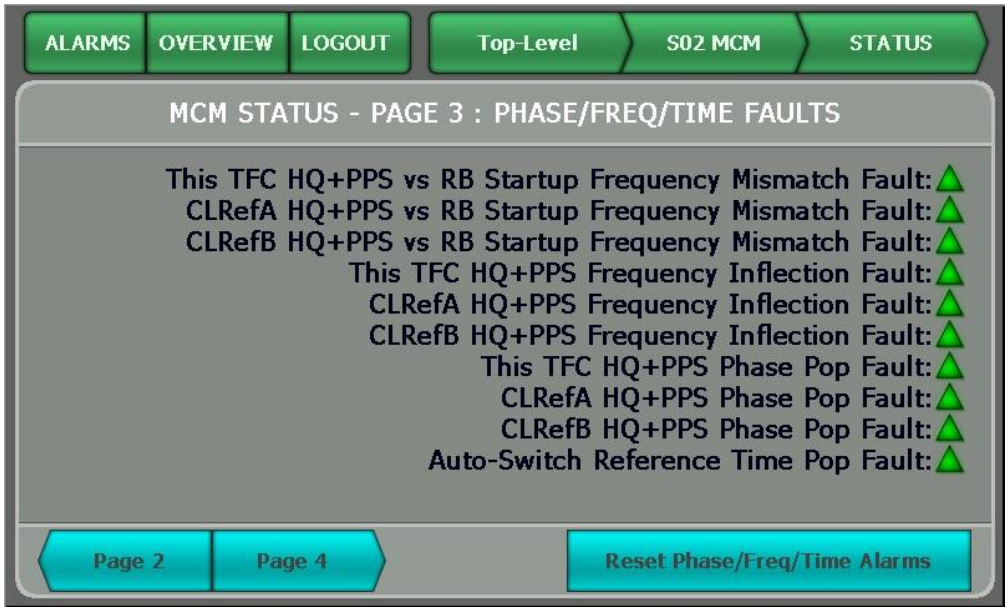



Figure 27 - MCM Phase/Freq/Time Faults

### 3.5.2.4 MCM Status (Page 4)

**Slot ID** – The slot number the Master Clock Module is plugged into, can either be slot number 2 or slot number 7
**State** – The current state of the MCM, possible states are: Warmup, Ready, Acquiring, Locked and Holdover.
**Current Reference** – The current reference source of the Master Clock Module
**TFOM** – Time Figure of Merit
**UTC Time** – The current system time in UTC
**UTC Time Last Set By** – The time that the UTC time was last set, this will be continuously updated if connected to a valid reference
**UTC Time Last Set At** – The time that the system last updated it's time of day from the reference source.
**Leap Second Epoch** – The day and time that a pending leap second will occur.
**Leap Second State** – Displays whether or not a leap second is currently pending.
**Reference Stratum** – Indicates the degree of connection to a primary reference. Stratum 1 is direct connection, Stratum 2 is via crosslink
**Up-Time** – Time elapsed since power on.

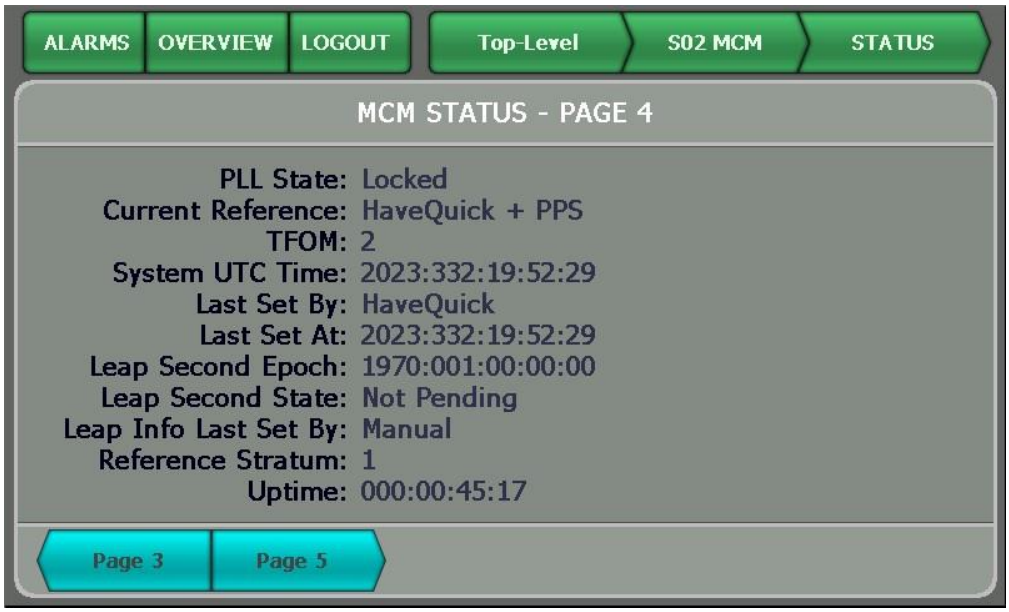



Figure 28 - MCM Status

### 3.5.2.5 MCM Input Reference Status (Page 5)

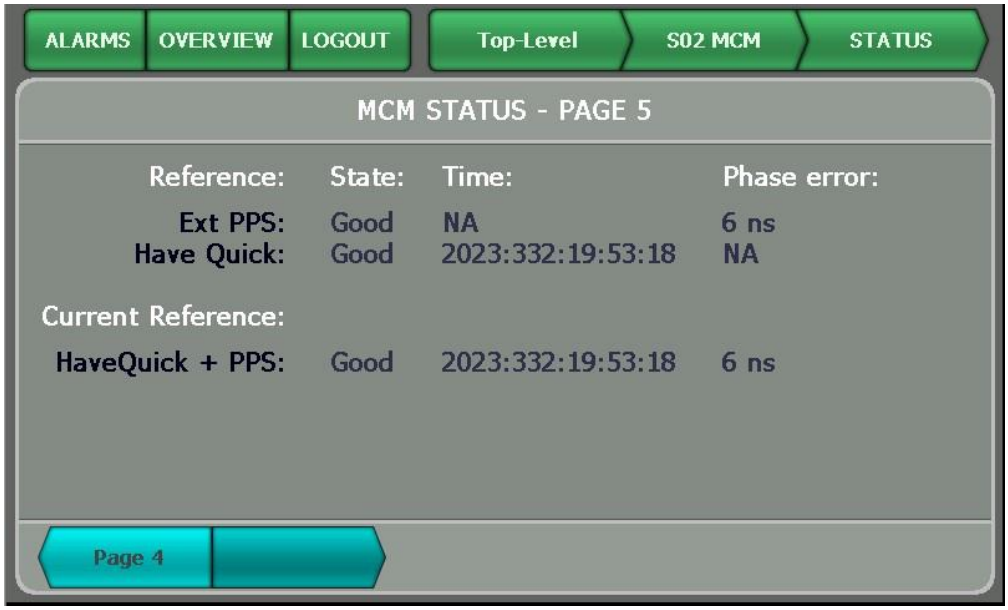



Figure 29 - MCM Input Status

### 3.5.3 Master Clock Module Settings

The Master Clock Module settings pages are the control points to adjust various options for each Master Clock Module; each Master Clock Module can be configured independently:

- Input reference selection
- Switch between automatic and manual reference selection
- Input reference priority
- Automatic reference switching priority
- Input delays
- MCM IP address
- NTP settings
- SNMP settings
- Manual UTC time selection
- Manual leap second adjustment

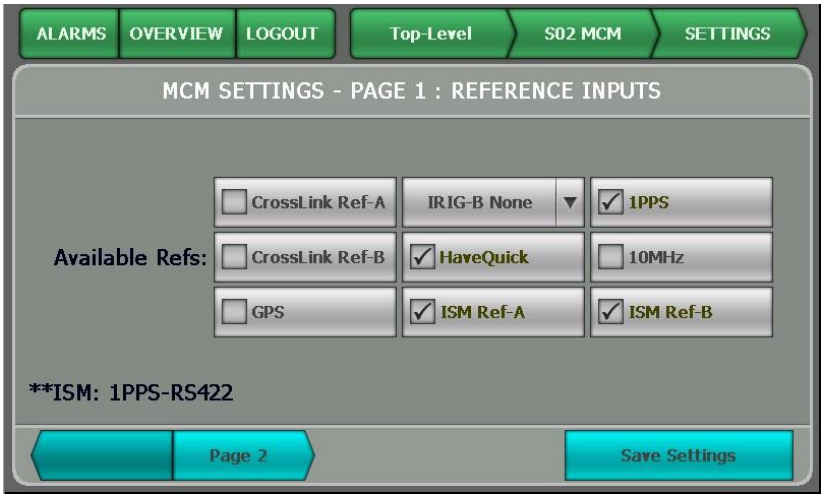



Figure 30 - Master Clock Module Settings Page 1

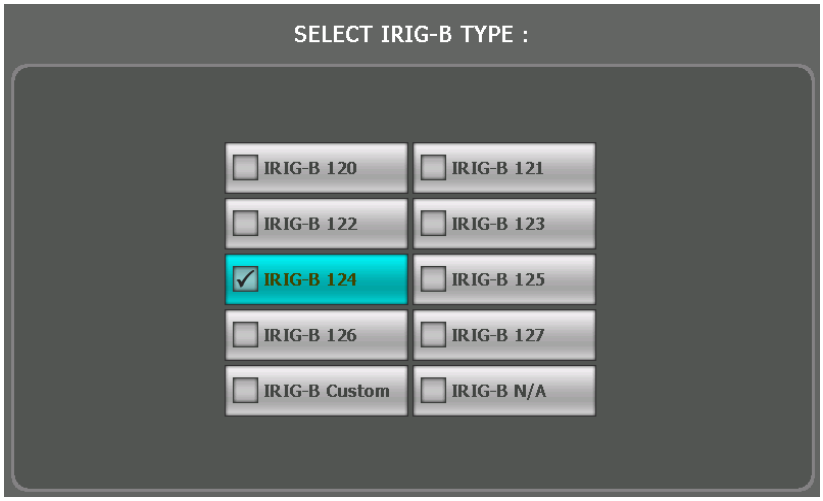



Figure 31 - Master Clock Module IRIG B Reference Types

#### 3.5.3.1 Master Clock Module Reference Selection (Page 1)

This page (Figure 30) is the control point for adjusting the reference inputs for the Master Clock Module

- Available Refs: This section allows the user to select or ignore individual reference inputs, only references that are present should be selected.
  - Optical Crosslink Reference A and B
  - IRIG-B
    - IRIG-B 120 (Requires Manual Entry of Year)
    - IRIG-B 121 (Requires Manual Entry of Year)
    - IRIG-B 122 (Requires Manual Entry of Year)
    - IRIG-B 123 (Requires Manual Entry of Year)
    - IRIG-B 124
    - IRIG-B 125
    - IRIG-B 126
    - IRIG-B 127
  - 1PPS
  - HaveQuick
    - HQ N/A: HaveQuick with no PPS
    - HQ STD: ICD-GPS-060A
    - HQ EXT: STANAG 4372 and STANAG 4430
  - 10MHz
  - GPS
  - Input Signal Module (ISM) Reference A and B

### 3.5.3.2 Master Clock Module Reference Inputs (cont.) (Page 2)

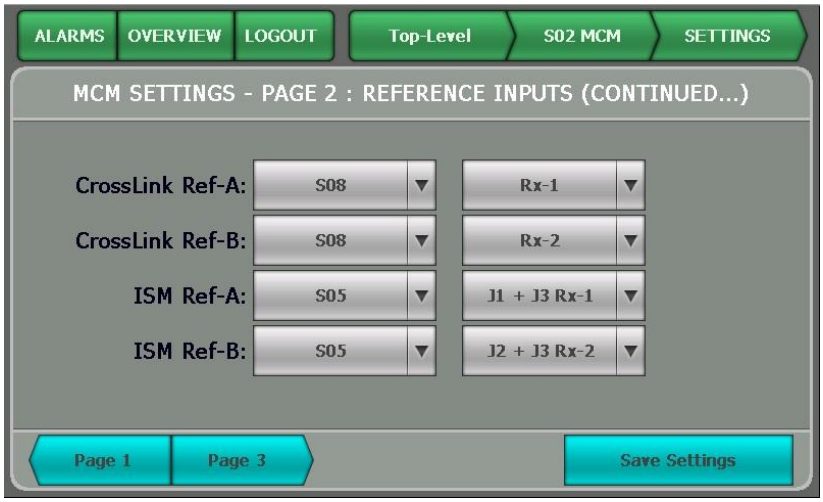



Figure 32 - Master Clock Module Settings Page 2

This page (Figure 32) is the control point for adjusting the Optical Crosslink settings and the Input Signal Module (ISM) settings for the Master Clock Module

- Crosslink Ref-A: Select which Optical Crosslink Module and which receiver port is used for the primary optical crosslink reference
- Crosslink Ref-B: Select which Optical Crosslink Module and which receiver port is used for the secondary optical crosslink reference
- ISM Ref-A: Select which ISM and which receiver port is used for the first additional input reference
- ISM Ref-B: Select which ISM and which receiver port is used for the second additional input reference

### 3.5.3.3 Master Clock Module Reference Switch Settings (Page 3)

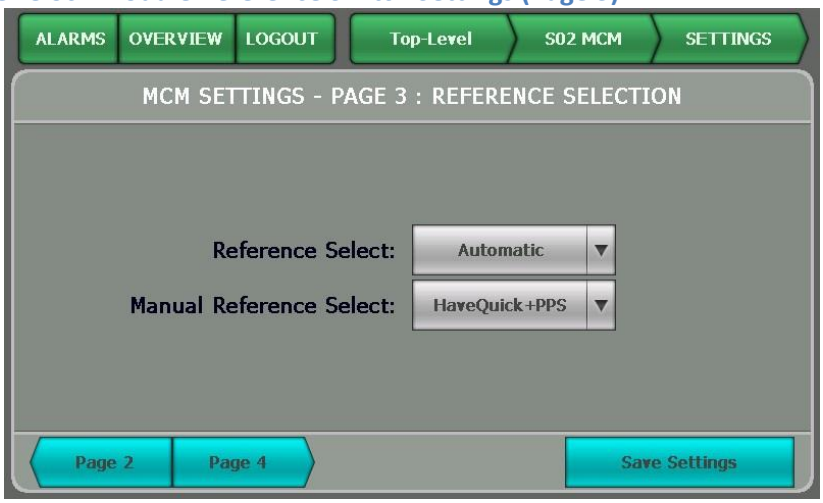



Figure 33 - Master Clock Module Reference Selection

The “REFERENCE SELECTION” page (Figure 33) controls if a single reference is used (Manual) or the highest available reference is used, with automatic selection of lower priority references in the event of failure.

- Reference Select: Automatic or Manual
- Manual Reference Select:
  - Crosslink Reference A or B
  - HaveQuick + 1PPS
  - IRIG-B
  - IRIG-B + 1PPS
  - 10MHz
  - GPS
  - Manual UTC + 1PPS
  - ISM Reference A or B

#### 3.5.3.4 Master Clock Module AutoSwitch Priority Settings (Page 4)

From the “REFERENCE AUTOSWITCH PRIORITIES” page (Figure 34), each input source is given a numerical priority from 1 to 9 with 1 being the highest priority. This determines the order of automatic switching in the event of a reference source failing or if the Modular Master Clock System determines if a reference source is unreliable.


Figure 34 - Master Clock Module Reference AutoSwitch Priorities

#### 3.5.3.5 Master Clock Module AutoSwitch Prevention Settings (Page 5)

This page (Figure 35) controls the autoswitch back prevention for each input reference source. When set to "**Prevented**" the Master Clock Module will not switch back to that source after recovering from a fault indication. This is illustrated in

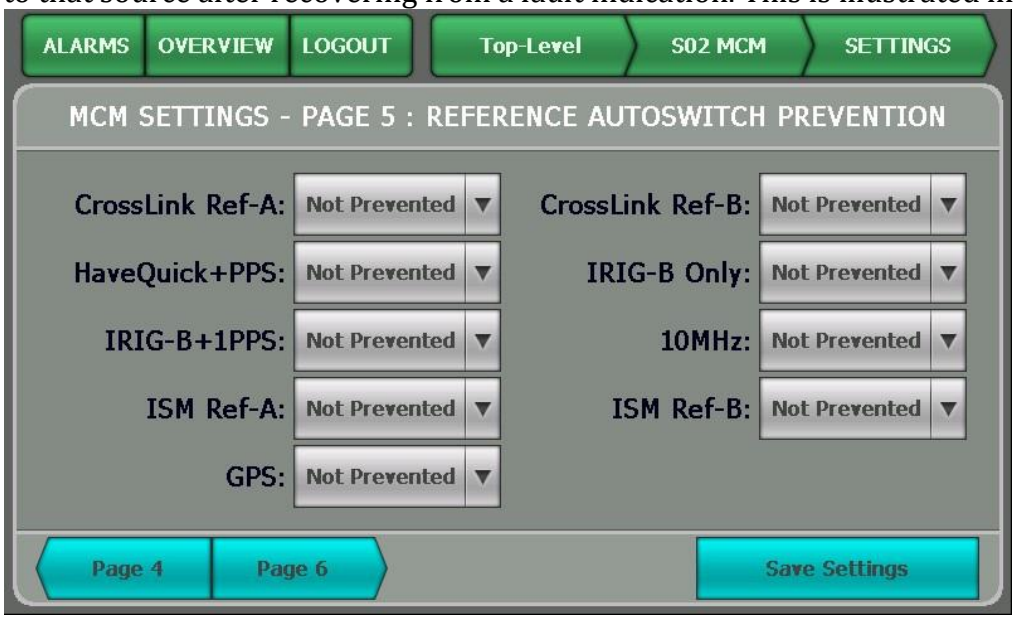



Figure 35 - Master Clock Module Reference AutoSwitch Prevention

#### 3.5.3.6 Master Clock Module Delay Compensation Settings (Page 6)

Use this page (Figure 36) to adjust delay compensation for each individual reference source in nanoseconds. A negative value will retard the phase, and a positive value will advance it.

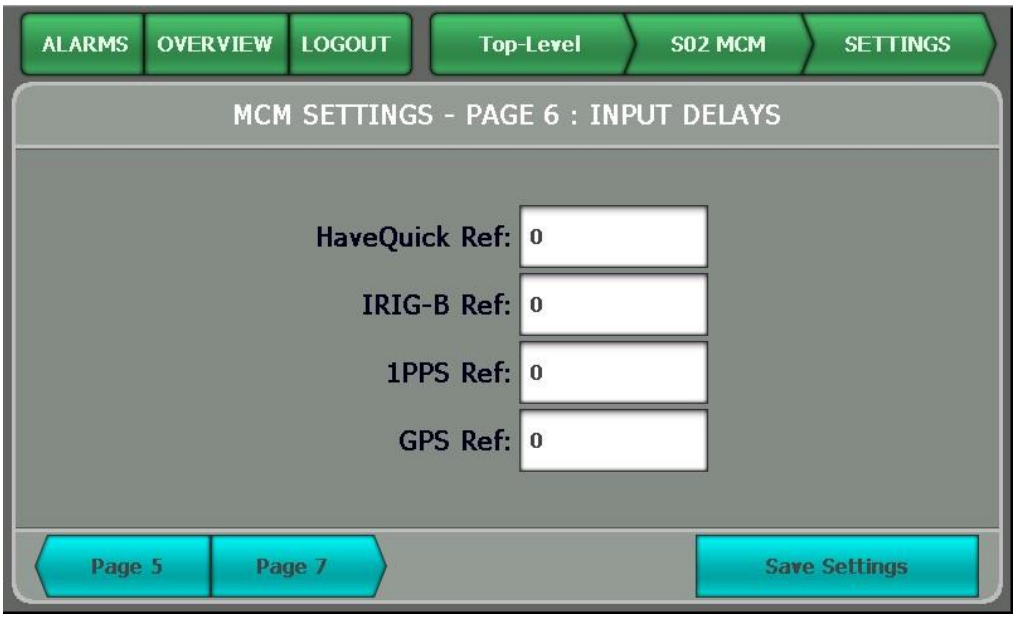



Figure 36 - Master Clock Module Delay Compensation

#### 3.5.3.7 Master Clock Module IP Address Settings (Page 7)

This page (Figure 37) allows the user to adjust the remote management IP address of the Master Clock Module, note that DHCP is not supported and the unit must be given a static IP address. From here the user can also enable or disable each Ethernet port, or adjust the IP address and port for the SNMP Trap. Port 1 is on the front of the Master Clock Module, behind the front panel, and Port 2 is on the rear panel output.

Note that when the Modular Master Clock is powered on, each MCM will check for valid Ethernet activity. If it does not detect an Ethernet cable connected to it, it will automatically disable the port, and the Ethernet port must be manually enabled when an Ethernet cable is connected to it after powering on.


Figure 37 - Master Clock Module IP Address Settings

### 3.5.3.8 Master Clock Module NTP Settings (Page 8)

This page (Figure 38) controls the NTP Authentication settings for the Master Clock Module. Available forms of Authentication are MD5 and SHA-1. The NTP Key is a hex value and must be no longer than 20 characters.

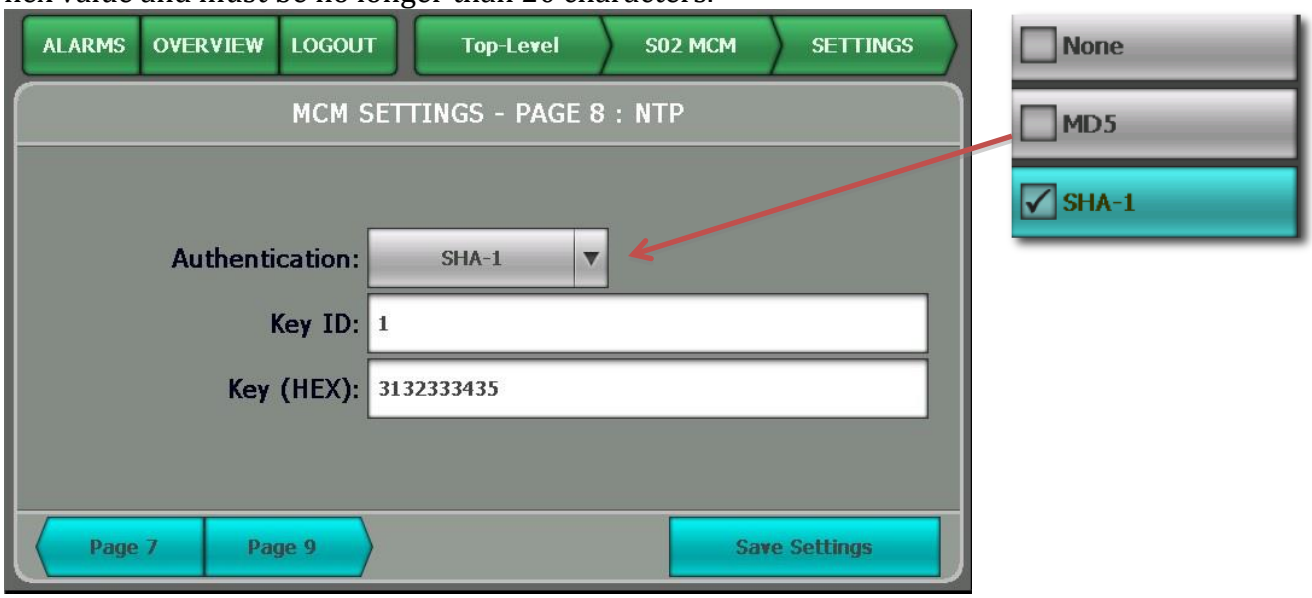



Figure 38 - Master Clock Module NTP Settings

### 3.5.3.9 Master Clock Module SNMP Settings (Page 9)

This page (Figure 39) allows the user to set the authentication and privacy settings for use with SNMPv3 applications. Supported Authentication and privacy methods include MD5 with DES or AES, and SHA-1 with DES or AES. Passwords must be less than 20 characters long.


Figure 39 - Master Clock Module Authentication Settings

#### 3.5.3.10 Master Clock Module Manual UTC Time (Page 10)

From this page (Figure 40), the user can manually enter the time in UTC format. If the Manual UTC time is selected on settings page 2, it will over overwrite all other references. **Please note that if the input reference is set to IRIG-B 120, 121, 122, or 123 only the year must be entered manually on this page.**

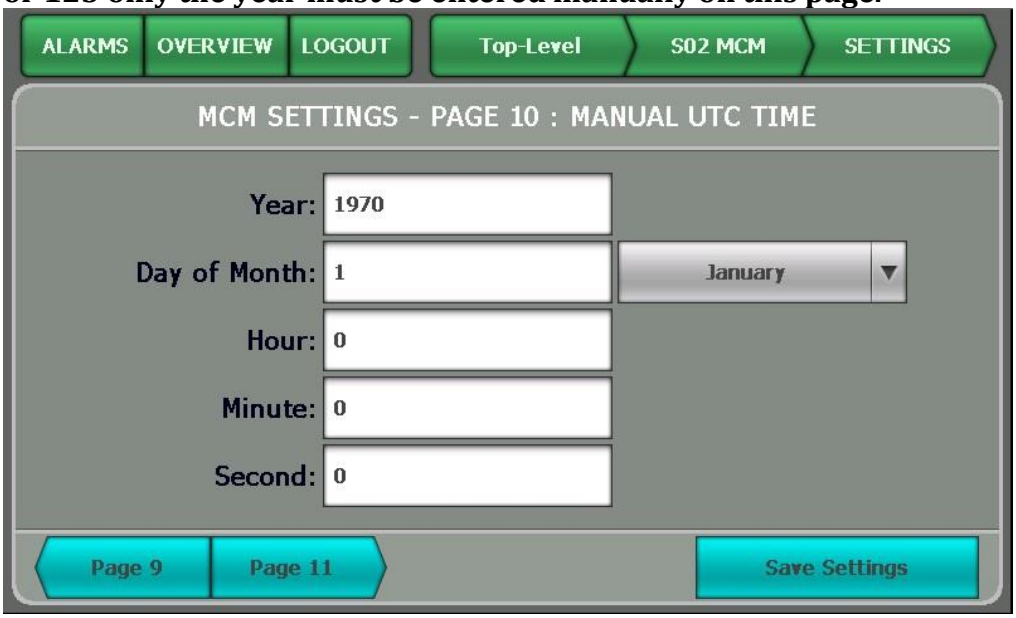



Figure 40 - Master Clock Module Manual UTC Time Entry

#### 3.5.3.11 Master Clock Module Manual Leap Second Entry (Page 11)

Use this page (Figure 41) to manually enter leap second information. A leap second can be "Not Pending," "Pending Positive" or "Pending Negative."

A leap second is a second added to Coordinated Universal Time (UTC) in order to keep it synchronized with astronomical time. UTC is an atomic time scale, based on the performance of atomic clocks that are more stable than the Earth's rotational rate. Astronomical time (UT1), or mean solar time, is based on the rotation of Earth, which is irregular.

Leap seconds have always occurred at the end of December or the end of June, on the last second of the UTC day.

If GPS is used as an input reference, then there is no need to set the leap second manually.

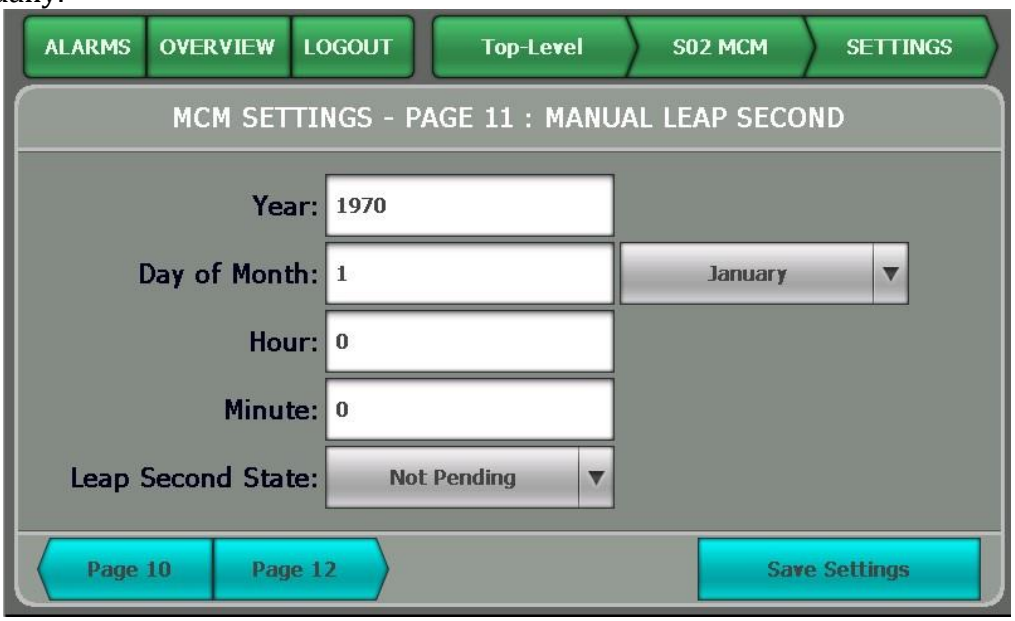



Figure 41 - Manual Leap Second Entry

### 3.5.3.12 Master Clock Module Misc. Settings (Page 12)

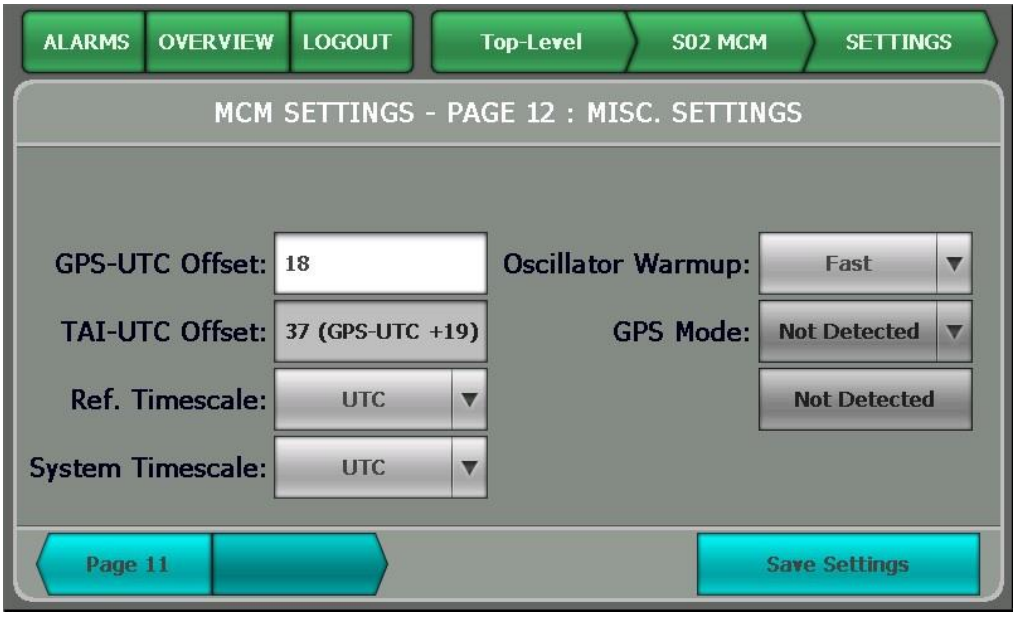



Figure 42 - Master Clock Module Misc. Settings

**NOTE**

The MCM must be configured by the manufacturer to use GPS input.

Use this page (Figure 42) to configure the MCM's GPS receiver.

When the MCM in slot S02 has been configured to use GPS, port J5 on the MCM's rear panel will become a GPS input. When the MCM in slot S07 has been configured for GPS, port J6 will become a GPS input.

Table 2 - MCM Misc Settings

| SETTING | FUNCTION |
|---|---|
| GPS-UTC Offset | The offset between GPS and UTC. |
| TAI-UTC Offset | The current offset between UTC and TAI. |
| Reference Timescale | Timescale of the input reference.<br>The options for Reference Timescale are: **UTC**, **GPS**, and **TAI**. |
| System Timescale | Timescale of the System output time.<br>The options for System Timescale are: **UTC**, **GPS**, and **TAI**. |
| Oscillator Warmup | Allows the user to configure the oscillator warmup time: **Normal** or **Fast**. |

| SETTING | FUNCTION |
|---|---|
| GPS Mode | Sets the mode of the GPS receiver between static and mobile.<br>**Static** is used in fixed installations.<br>**Mobile** is used in vehicle-mounted configurations such as a trailer.<br>**Note:** This configuration will be greyed out and display "**Not Detected**" if there is no GPS receiver configured. |
| Cold Start the GPS | Flushes the current GPS Almanac and Ephemeris from the system's memory and forces it to reacquire the GPS signal.<br>**Note:** This configuration will be greyed out and display "**Not Detected**" if there is no GPS receiver configured. |

### 3.5.4 Master Clock Module Disciplining Graph

The "MCM DISCIPLINING GRAPH" for the Master Clock Module (Figure 43) shows the phase error of the internal oscillator relative to the chosen reference source.

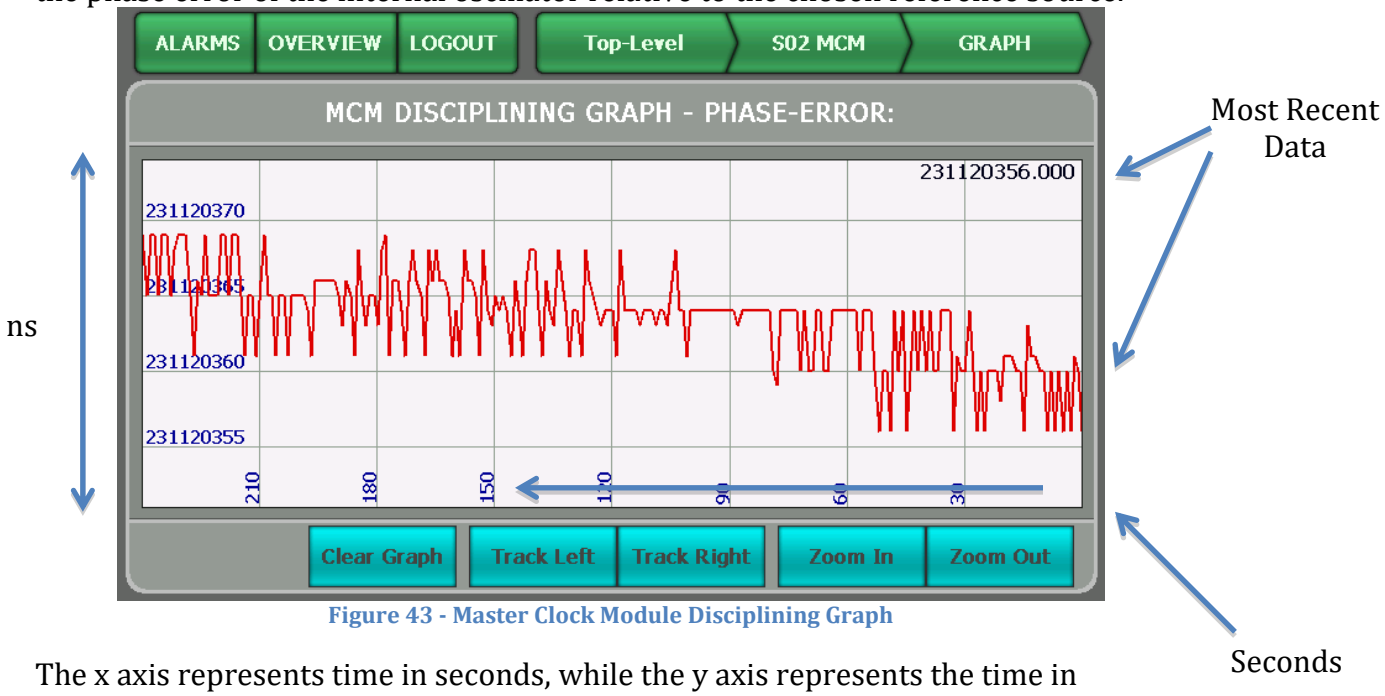



Figure 43 - Master Clock Module Disciplining Graph

The x axis represents time in seconds, while the y axis represents the time in nanoseconds.

### 3.5.5 GPS Info

**NOTE**

The GPS Info screen is only visible on MCMs that have been configured by the manufacturer to use GPS input.

The GPS Info window shows the current status of the GPS receiver, as well as displaying a diagram of the sky showing the current positions of the visible GPS satellites.

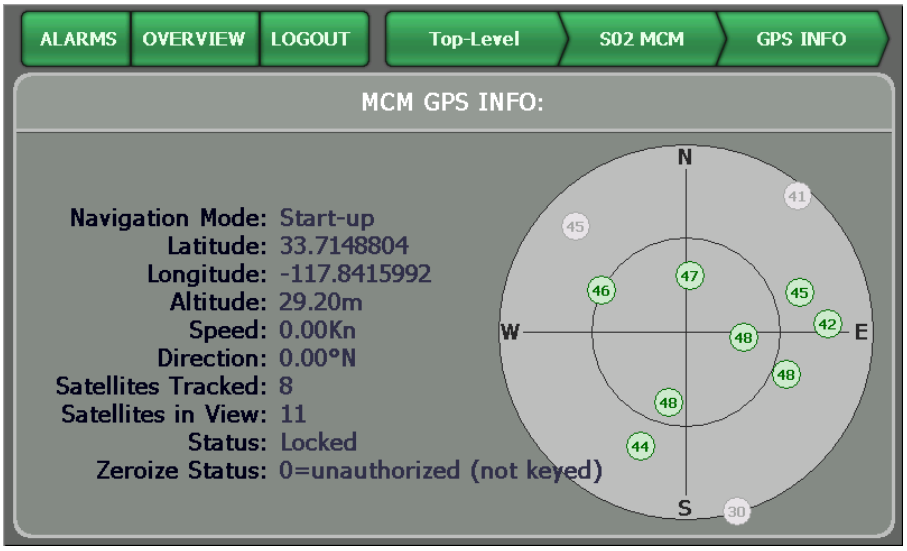



Figure 44 - GPS Information Window

Table 3 - GPS Information Window.

| STATUS FIELD | MEANING |
|---|---|
| Navigation Mode | This is the current Navigation mode of the GPS receiver. After being powered on, this field will be in start-up until the GPS mode setting is changed, at which point it will change to reflect the setting change. |
| Latitude | The current Latitude of the GPS antenna. |
| Longitude | The current Longitude of the GPS antenna. |
| Altitude | The current Altitude of the GPS antenna. |
| Speed | The current speed of the GPS antenna. |
| Direction | The current direction the GPS antenna is moving in. |
| Satellites Tracked | The number of GPS satellites that the MMC's GPS receiver is currently actively tracking. |
| Satellites in View | The total number of GPS satellites currently visible to the MMC's GPS receiver, even if they aren't being actively tracked. |

# 4 Optional Modules

## 4.1 Optical Crosslink Module

The Optical Crosslink Module is a unique feature of the MMC. When installed, it allows a second MMC to be synchronized as a secondary chassis. If both chassis have a primary reference installed (e.g. GPS) then the two MCM's operate as peers. Peering provides additional redundancy, as well as providing additional references to detect failures.

Each Optical Crosslink Module contains two transmitters (Tx) and two receivers (Rx).

From the Module Selection Screen, select the Optical Crosslink Module, listed as “OSM (Crosslink),” this will open the Optical Crosslink status and configuration page. (Figure 45)

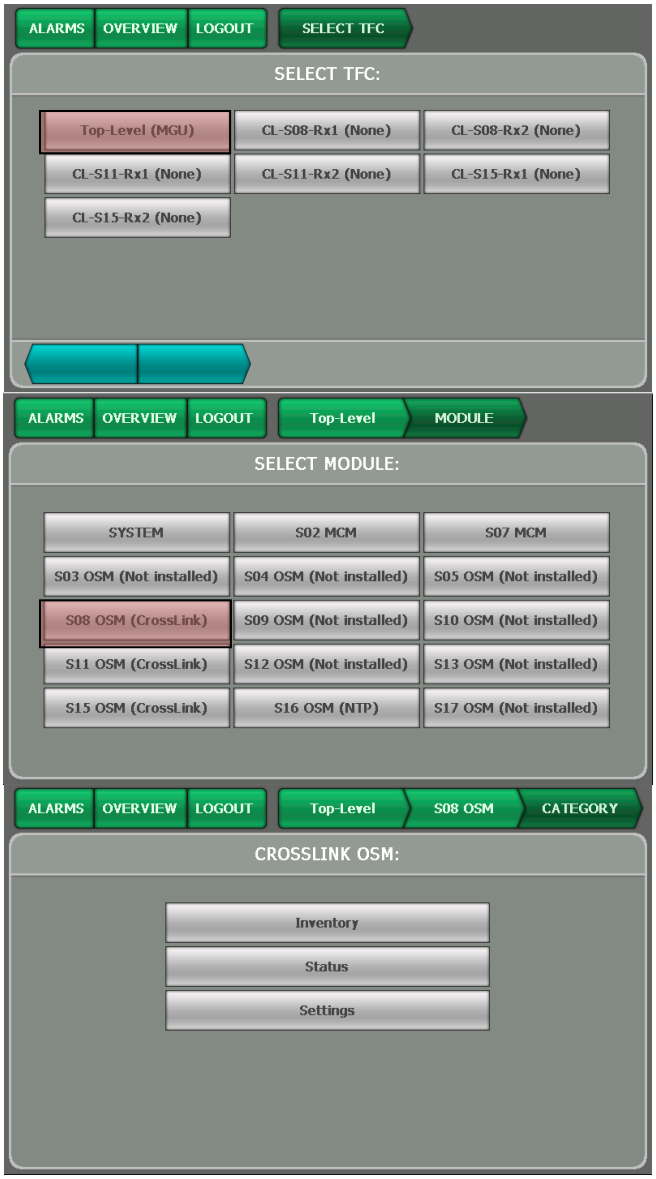



**Figure 45 - Optical Crosslink Status and Configuration Screen**

### 4.1.1 Optical Crosslink Inventory

The "CROSSLINK OSM INVENTORY" screen (Figure 46) provides the user with the Serial Number, Firmware Version, FPGA Version, and Hardware Number for support and inventory purposes.

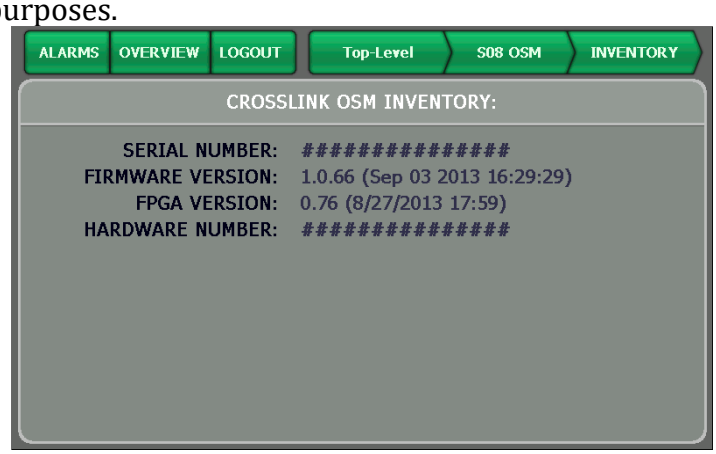



Figure 46 - Crosslink OSM Inventory Screen

### 4.1.2 Optical Crosslink Status

The "CROSSLINK OSM STATUS" screen (Figure 47) shows a list of faults in that particular Crosslink module, as well as the measured delay from the receiver.

- Tx faults are never generated
- Rx faults are generated when CrossLink is not receiving valid communications while enabled to receive communications

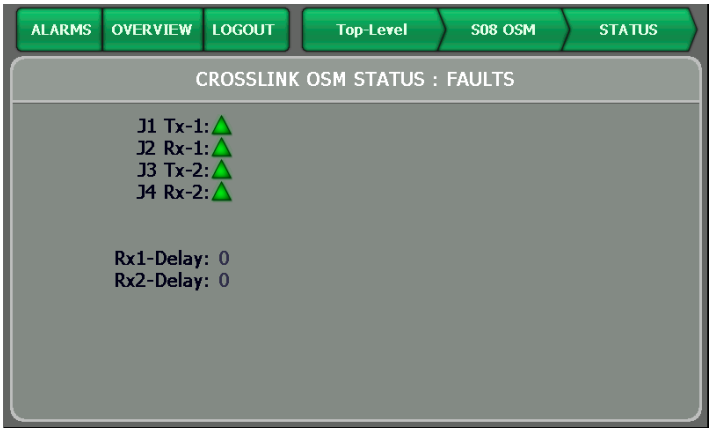



Figure 47 - Optical Crosslink Status Screen

### 4.1.3 Optical Crosslink Settings

The "CROSSLINK OSM SETTINGS" screen (Figure 49) enables the user to adjust the type and mode of each optical receiver, and the propagation delay compensation mode for each optical link. The transmitter port is configured by the function of the chassis. (See 3.4.3.1). However the receiver port needs to be configured correctly so that it can determine what data to expect across the link, and how to interpret it correctly.

The available modes for the Optical Crosslink receiver are:

- Master Generation Unit (MGU)
- Secondary Distribution Unit with Information Assurance Mode Disabled
- Secondary Distribution Unit with Information Assurance Mode Enabled

Note: These settings describe the function that describes the **far end** of the crosslink port that is being configured.

For example, when setting up a secondary distribution unit (SDU) then the equipment on the far end of the crosslink will be an MGU, so the SDU crosslink module should always be configured to expect data from an MGU.

Crosslink Modules installed in an MGU should be configured to expect data from either an MGU (peered crosslink) or an SDU. SDU's can have Information Assurance (IA) Mode Enabled (one-way link from MGU to SDU) or the IA mode disabled (bi-directional link).

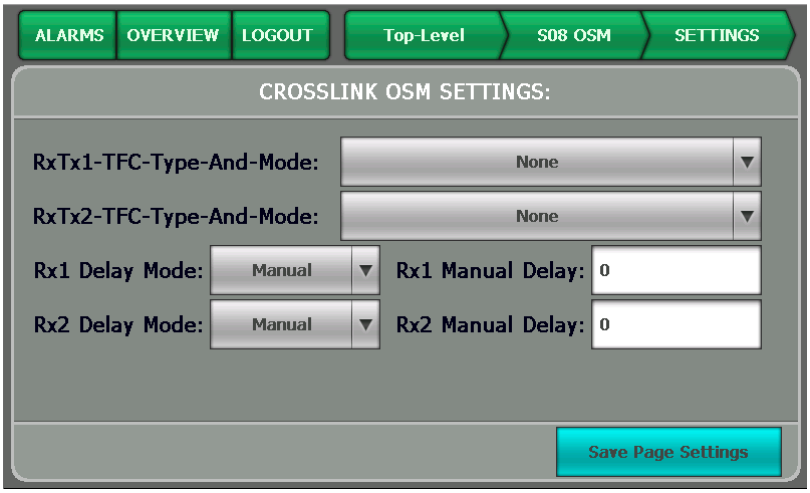



Figure 49 - Optical Crosslink Settings

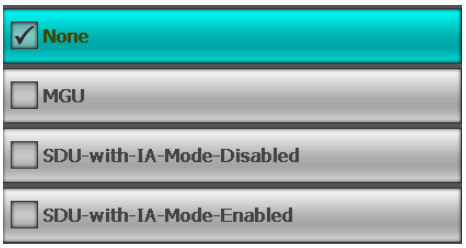



Figure 50 - Type and Mode Selection Dropdown Menu

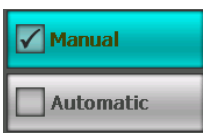



Figure 48 - Receiver Delay Mode

#### 4.1.3.1 Information Assurance Mode

The Modular Master Clock contains an Information Assurance mode, for use of secondary units in restricted or classified areas. When Information Assurance Mode is enabled, the Secondary Distribution Unit will disable the transmitter and not send any status and control messages upstream to the Master Generation Unit, and the Master Generation Unit will not listen for any status or control messages, and will not be able to display alarms regarding the Secondary Distribution unit or the optical crosslink.

## 4.2 NTP Module

The NTP Server module enables the Modular Master Clock to act as an NTP server over an Ethernet network. Designed with security in mind, the NTP server module uses a custom network stack that enables it to ONLY act as an NTP server, and prevent it from being used as a gateway to compromise the entire system.

Select the NTP Module from the Module Selection Screen, to view inventory information, NTP server status, and adjust configuration options. (Figure 51)

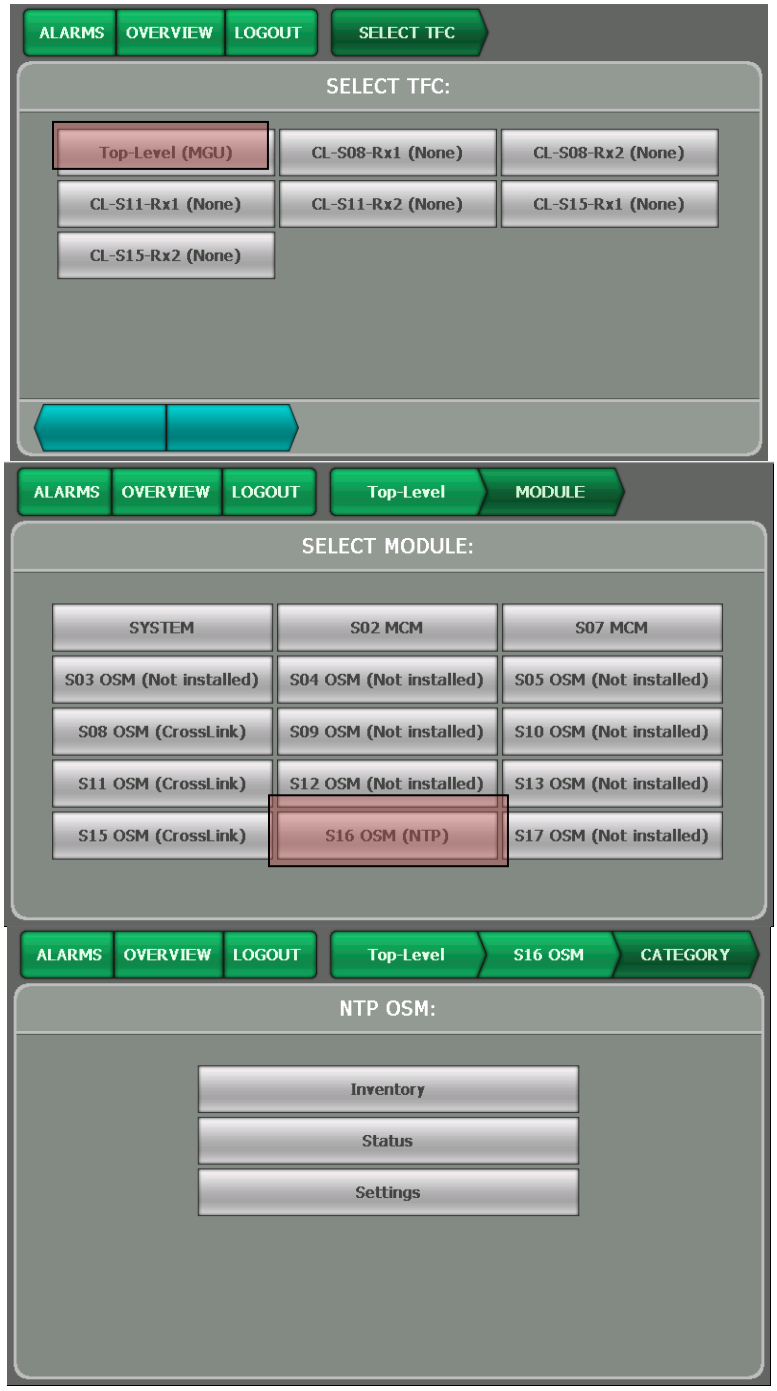



Figure 51 - NTP Module Menu

### 4.2.1 NTP OSM Inventory

The "NTP OSM INVENTORY" screen (Figure 52) displays the NTP Output Signal Module's Serial Number, Firmware Version, FPGA Version, Hardware number, Oscillator Firmware Version, Oscillator Hardware Version, Oscillator Serial Number, as well as the IPv6 addresses of both Ethernet ports.


Figure 52 - NTP OSM Inventory Screen

### 4.2.2 NTP OSM Status

The "NTP OSM STATUS" screen (Figure 53) shows the fault status for both Ethernet ports. A green triangle means that the NTP server is up and running and is available to respond to NTP client requests.

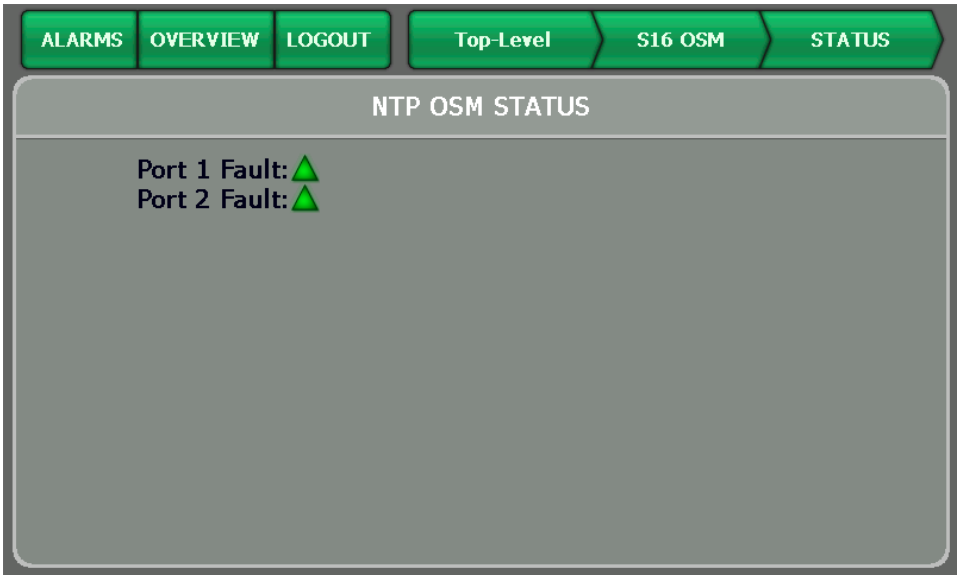



Figure 53 - NTP OSM Status Screen

### 4.2.3 NTP OSM Settings

The "NTP OSM SETTINGS" page (Figure 54) enables the user to change the IP Address, Gateway and Subnet Mask of each NTP port individually, as well as enable NTP Authentication. There are two pages of settings, one for each Ethernet port. Available Authentication settings are MD5 and SHA-1.

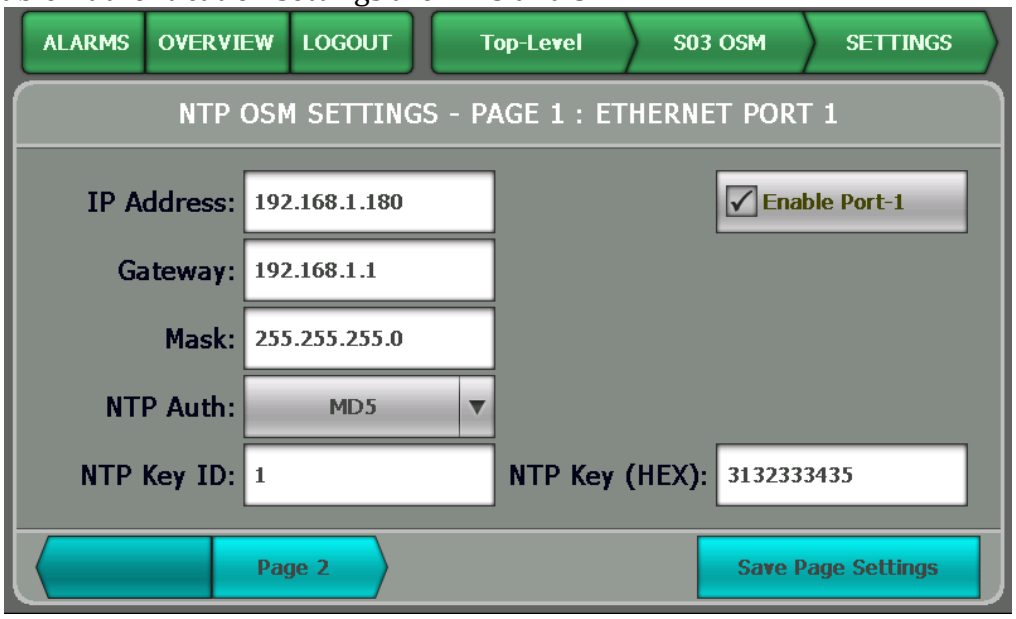



Figure 54 - NTP OSM Settings

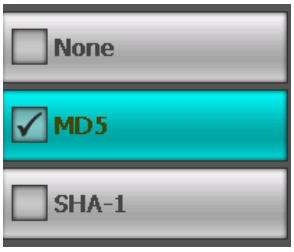



Figure 55 - NTP Authentication Options

## 4.3 PTP Module

The PTP Server module enables the Modular Master Clock to act as a PTP server over an Ethernet network. Designed with security in mind, the PTP server module uses a custom network stack that enables it to ONLY act as a PTP server, and prevent it from being used as a gateway to compromise the entire system.

Select the PTP Module from the Module Selection Screen, to view inventory information, PTP server status, and adjust configuration options. (Figure 56)

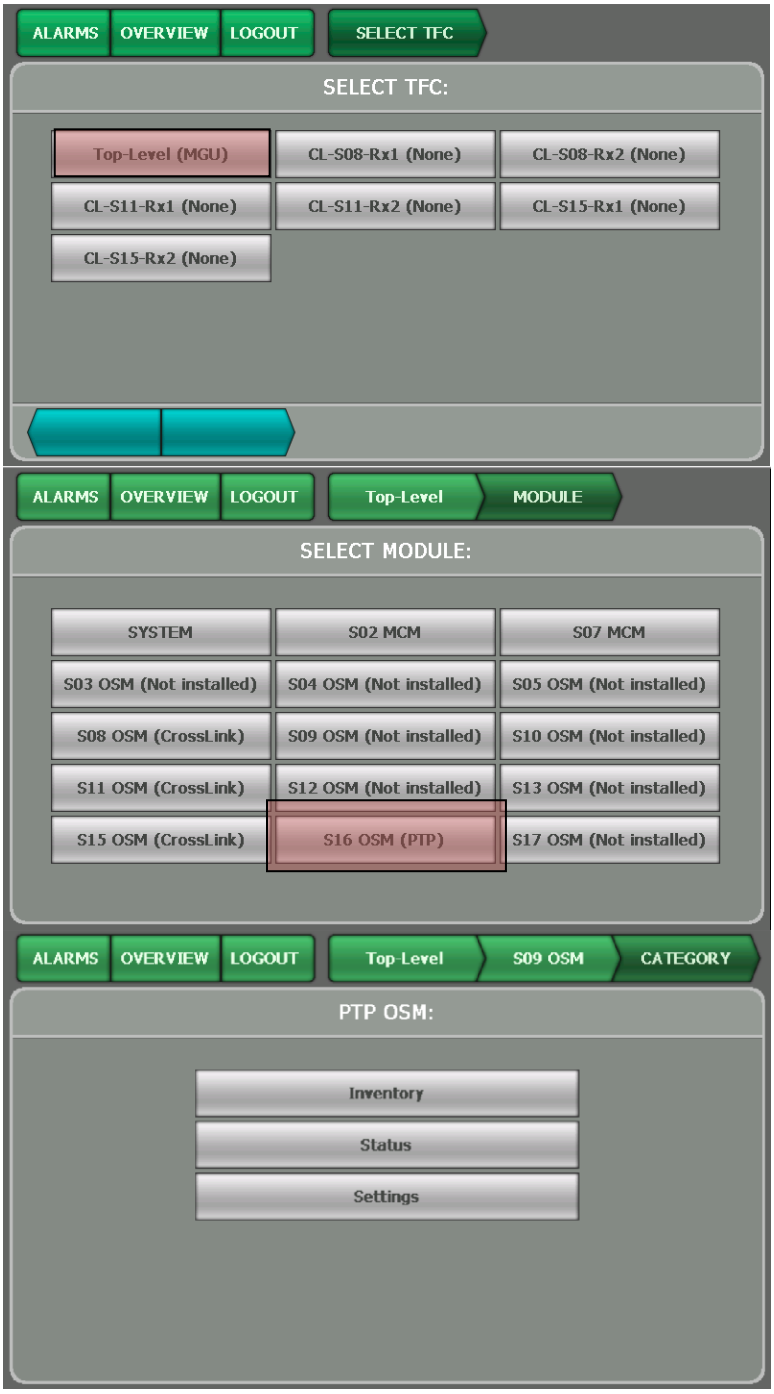



Figure 56 - PTP Module Menu

### 4.3.1 PTP OSM Inventory

The “PTP OSM INVENTORY” screen (Figure 57) displays the PTP Output Signal Module’s Serial Number, Firmware Version, FPGA Version, and Hardware number.


Figure 57 - PTP OSM Inventory Screen

### 4.3.2 PTP OSM Status

#### 4.3.2.1 PTP OSM Status Page 1

Pages one through four of the "PTP OSM STATUS" screen (Figure 58) shows the current status of each Ethernet port. For a detailed explanation of what each status field means, refer to
Table 4 below.


Figure 58 - PTP OSM Status Screen - Page 1

**Table 4 - PTP OSM Status Fields Page 1**

| STATUS FIELD | MEANING |
|---|---|
| Visible Masters | The number of PTP master clocks currently visible on the network to the MMC |
| Current Master | The IP address of the current master clock |
| Port state | The current state of the selected Ethernet port. |
| Sync Tx | The current transmission time of the sync packets |
| Sync Follow-Up Tx | The current transmission time of the sync follow-up packets |
| Announce Tx | The current transmission time of the announcement packets |
| Delay Response Tx | The current transmission time of the delay response measurement packets. |
| Delay Follow-Up Tx | The current transmission time of the delay response follow-up packets. |
| Delay Request Rx | The current receiving time of the delay request packets. |
| Peer Delay Rx | The current receiving time of the peer delay measurement packets. |
| Slave Count Rx | The current receiving time of the slave count packets. |
| Measured Offset | The current measured offset for delay compensation |

#### 4.3.2.2 PTP OSM Status Page 6

Page 6 of the PTP OSM Status Pages (Figure 59) shows the clock status of the PTP OSM. For an explanation of each of the status fields see Table 5 below.

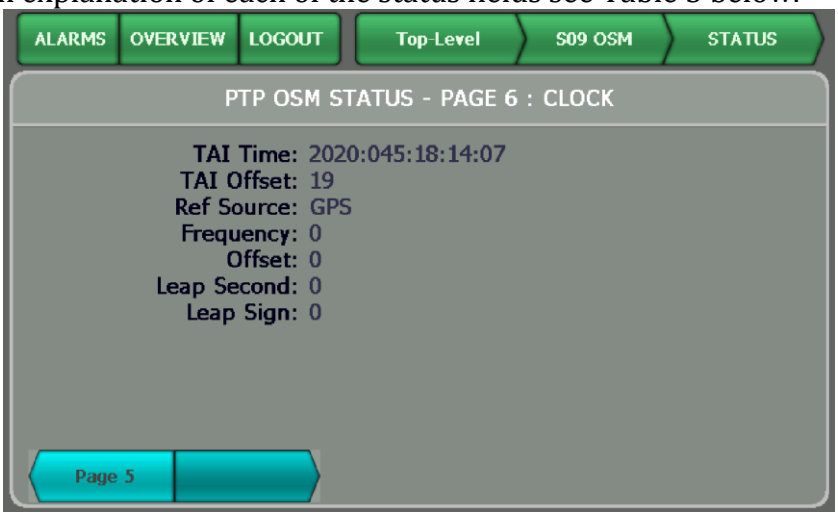



Figure 59 - PTP OSM Status Screen - Page 6

**Table 5 - PTP OSM Status Fields Page 6**

| STATUS FIELD | MEANING |
|---|---|
| TAI Time | The current date and time in International Atomic Time (TAI) |
| TAI Offset | The current offset in seconds from TAI the server is currently running |
| Ref Source | The current reference source for the PTP OSM |
| Frequency | Displays the frequency. |
| Offset | Displays the offset. |
| Leap Second | Displays whether or not a leap second is currently pending. |
| Leap Sign | Displays the Leap Second State.<br>The Leap Second State can be: **Pending Positive**, **Pending Negative**, or **N/A**. |

### 4.3.3 PTP OSM Settings

The "PTP OSM SETTINGS" pages are broken down into nine pages of settings: Pages 1-4 control each of the four PTP ports, while pages 5-8 are for each of the NTP ports, page 9 allows the user to delete any stored PTP profiles.

#### 4.3.3.1 PTP OSM Settings Pages 1-4

Pages 1-4 (Figure 60) allow the user to set the IP address, gateway IP address, subnet mask, speed, and duplex settings for each of the 4 PTP ports, as well as enable or disable Dynamic Host Configuration Protocol (DHCP). From this screen, it is also possible to select which of the stored PTP profiles each Ethernet port is using.

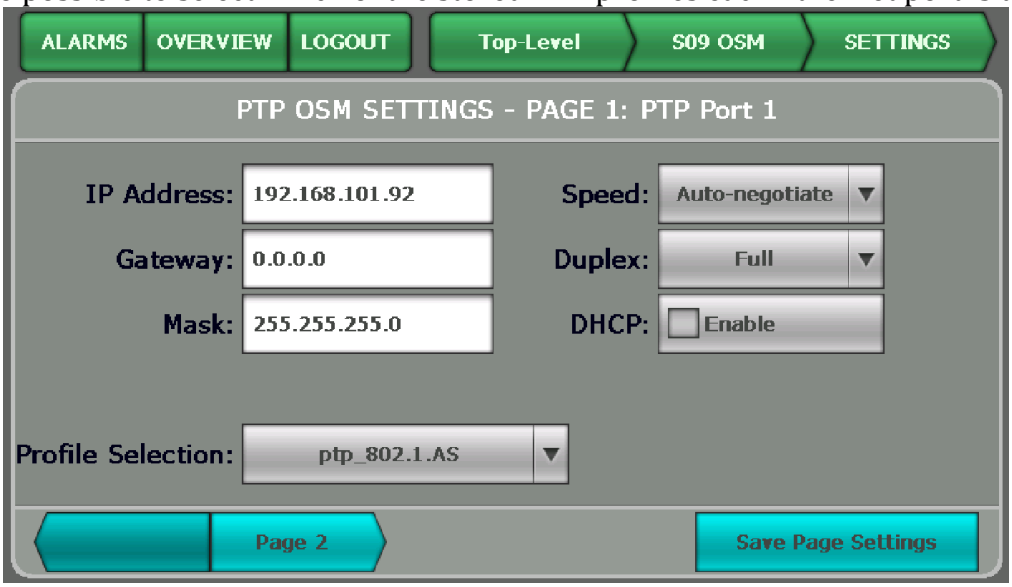



Figure 60 - PTP OSM Settings Pages 1-4 (Page 1 shown)

#### 4.3.3.2 PTP OSM Settings Pages 5-8

Pages 5-8 (Figure 61) allow the user to set the NTP Peer IP, minimum polling time and maximum polling time.

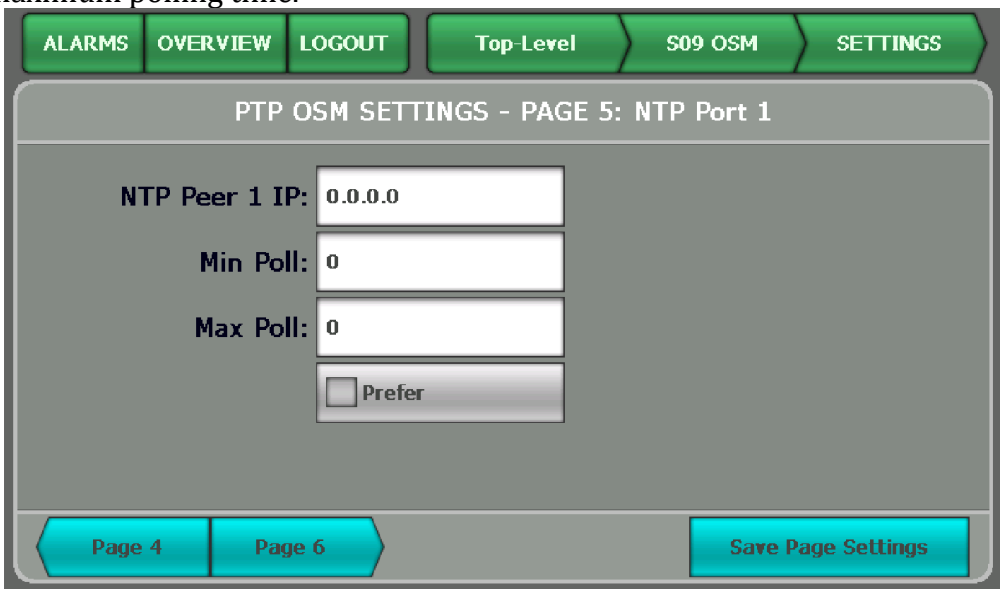



Figure 61 - PTP OSM Settings Pages 5-8 (Page 5 shown)

#### 4.3.3.3 PTP OSM Settings Page 9

Page 9 (Figure 62) of the PTP OSM settings allows the user to delete any of the stored PTP profiles.


Figure 62 - PTP OSM Settings Page 9

## 4.4 Universal Output Signal Module

The Universal OSM provides the ultimate in flexibility. The Universal OSM has 4 outputs, each of which is user-programmable to a wide variety of time code or pulse outputs, including a user configurable pulse interval. This flexibility ensures that an MMC can be reconfigured as requirements change, and fewer modules are needed in comparison to designs where modules are single function. Time code outputs can be configured independently for local time. Passive rear transition modules are available for single ended BNC, or differential connectors. Each output is individually adjustable for propagation delay, ensuring that for high accuracy synchronization different cable lengths can be accommodated.

Available output formats:

- HaveQuick per ICD-GPS-060A / STANAG 4430
- BCD 24-bit
- BCD 40-bit per ICD-GPS-060B
- IRIG-B 120
- IRIG-B 121
- IRIG-B 122
- IRIG-B 123
- IRIG-B 124
- IRIG-B 125
- IRIG-B 126
- IRIG-B 127
- IRIG-B121 with customized CF per Table 6
- IRIG-A 132
- IRIG-A 137
- IRIG-G 142
- IRIG-G 146
- XR3
- 2137
- 1PPS
- 1PPM
- 1PPX

### 4.4.1 Universal OSM Inventory Information

The “UNIVERSAL OSM INVENTORY” screen (Figure 63) allows the user to view the Universal OSM’s Serial Number, Firmware Version, FPGA Version and Hardware Number.


Figure 63 - Universal OSM Inventory

### 4.4.2 Universal OSM Status

The "UNIVERSAL OSM STATUS" page (Figure 64) shows the user the current fault status for each output. The Universal OSM will return a fault if the output of the output signal falls below a certain threshold, or if no output signal is detected.

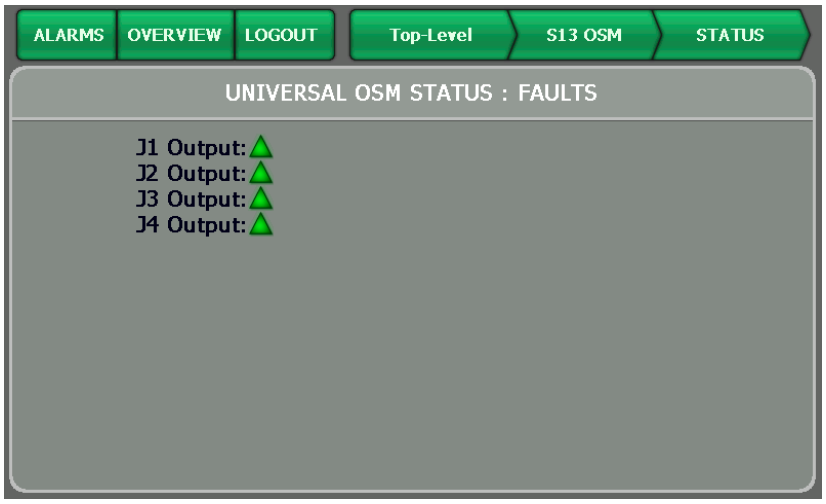



Figure 64 - Universal OSM Status

### 4.4.3 Universal OSM Settings

The "UNIVERSAL OSM SETTINGS" menu (Figure 65) enables the user to adjust the individual outputs to conform to the user's timing needs.

#### 4.4.3.1 Universal OSM Output Types

The first page of the Universal OSM Settings menu (Figure 65) enables the user to adjust each output's timecode format and adjust the output individually. There is also an adjustable pulse output available (1PPX), where the time interval between pulses is user configurable.

The available timecode formats for the Universal Output Signal Module are:

- HaveQuick per ICD-GPS-060A / STANAG 4430
- BCD 24-bit
- BCD 40-bit per ICD-GPS-060B
- IRIG-B 120
- IRIG-B 121
- IRIG-B 122
- IRIG-B 123
- IRIG-B 124
- IRIG-B 125
- IRIG-B 126
- IRIG-B 127
- IRIG-B121 with customized CF per Table 6
- IRIG-A 132
- IRIG-A 137
- IRIG-G 142
- IRIG-G 146
- XR3
- 2137
- 1PPS
- 1PPM
- 1PPX

#### 4.4.3.2 Output Cable Delay Compensation

Each output can include a propagation delay compensation function to enable precise alignment of output signals at the end of varying cable lengths. These delays must be measured using a time domain reflectometer (TDR), or calculated from cable specifications and measured length.

The output delay settings are in nanoseconds, and must be adjusted in increments of five nanoseconds. A negative delay value will advance the output signal.

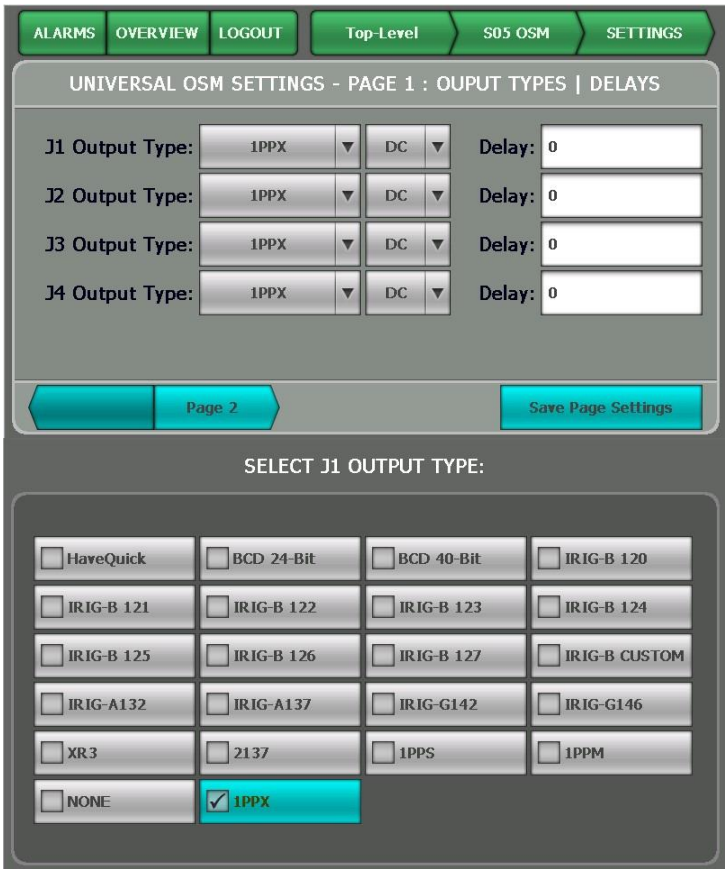



Figure 65 - Universal OSM Output Types and Delays

#### 4.4.3.3 Universal OSM Output Local Time and Pulse Interval

Pages 2 through 5 of the OSM settings (Figure 66) are used to adjust each output's local time settings. The Time Zone Offset and the Daylight Savings Time Offset are both expressed in minutes. The DST start and end dates are used to conform the output signal to the days that daylight savings time begins and ends in the location the Modular Master Clock is set up in.
Each MCM can have its own separate Local Time setting, selecting the "Use Master MCM Local Time" checkbox will instruct that OSM to use the local time settings from the Primary Master Clock Module, unselecting it will allow that OSM to use its own local time setting.

For the 1PPX (pulse per x seconds) output type, these pages are also where the configuration for the pulse interval is done. This output allows the user to adjust the time interval between pulse outputs, done in 1 second increments. The range of the PPX interval is between 1 to 3600 seconds.


Figure 66 - Universal OSM Local Time Settings

Table 6 - Custom IRIG control functions

| IRIG B Position ID | Designation | Explanation |
|---|---|---|
| P50 | Year, BCD 1 | Last 2 digits of year in BCD |
| P51 | Year, BCD 2 | IBID |
| P52 | Year, BCD 4 | IBID |
| P53 | Year, BCD 8 | IBID |
| P54 | Not Used | Unassigned |
| P55 | Year, BCD 10 | Last 2 digits of year in BCD |
| P56 | Year, BCD 20 | IBID |
| P57 | Year, BCD 40 | IBID |
| P58 | Year, BCD 80 | IBID |
| P59 | P6 | Position Identifier #6 |
| P60 | Leap Second Pending (LSP) | Becomes 1 up to 59s before leap second insert |
| P61 | Leap Second (LS) | 0= Add Leap Second, 1 Delete Leap Second |
| P62 | Daylight Saving Pending (DSP) | Becomes 1 up to 59s before DST change |
| P63 | Daylight Savings time (DST) | Becomes 1 during DST |
| P64 | Time Offset Sign | Time offset sign 0=+, 1=- |
| P65 | Time offset binary 1 | Offset from coded UTC IRIG-B time to local time. IRIG coded time plus time offset (including sign) equals local time at all times (offset will change during daylight savings) |
| P66 | Time offset binary 2 | |
| P67 | Time offset binary 4 | |
| P68 | Time offset binary 8 | |

| | | |
|---|---|---|
| P69 | P7 | Position Identifier #7 |
| P70 | Time Offsets – 0.5 hr | 0 = none, 1 = additional 0.5 h time offset |
| P71 | Time Quality | 4 b code representing approx. clock time error<br>0000 = clock locked, maximum accuracy<br>1111 = clock failed, data unreliable. |
| P72 | Time Quality | |
| P73 | Time Quality | |
| P74 | Time Quality | |
| P75 | Parity | Parity on all preceding data bits |
| P76 | Not Used | Unassigned |
| P77 | Not Used | Unassigned |
| P78 | Not Used | Unassigned |
| P79 | P8 | Position Identifier #8 |

## 4.5 Low Phase Noise Analog Module

The Low Phase Noise Analog Output Module (LPN) provides 4 factory-selectable low phase noise reference frequency outputs at 1, 5, or 10MHz.
Available controls for the LPN Analog Output Module include viewing the inventory and status information for it. (Figure 67)

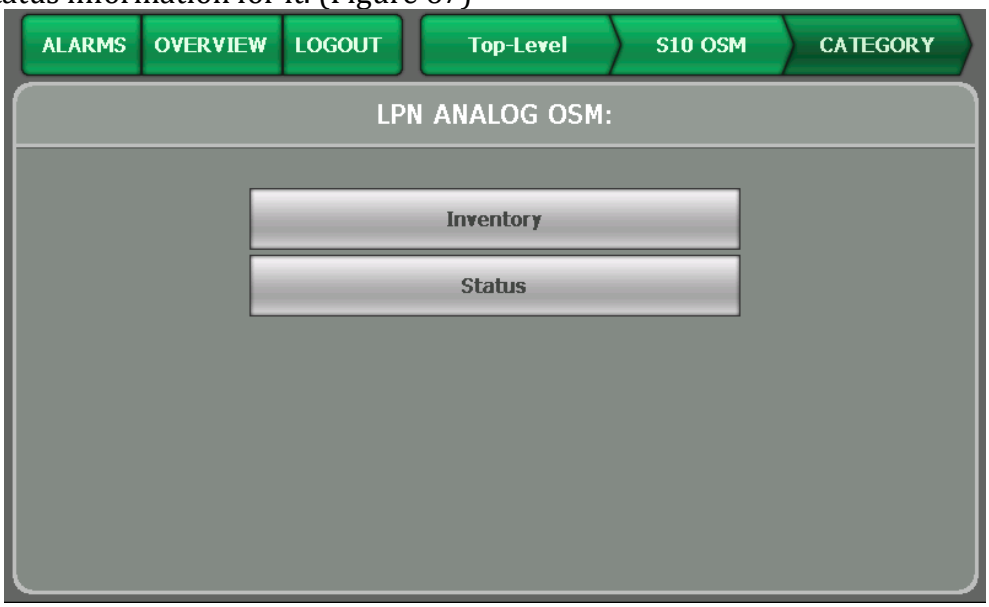



Figure 67 - Low Phase Noise Analog Module Root Menu

### 4.5.1 LPN Analog Inventory Information

The Inventory screen for the Low Phase Noise Analog Output Module displays the Serial Number, Firmware Version, FPGA Version, and Hardware Number for the module. (Figure 68)

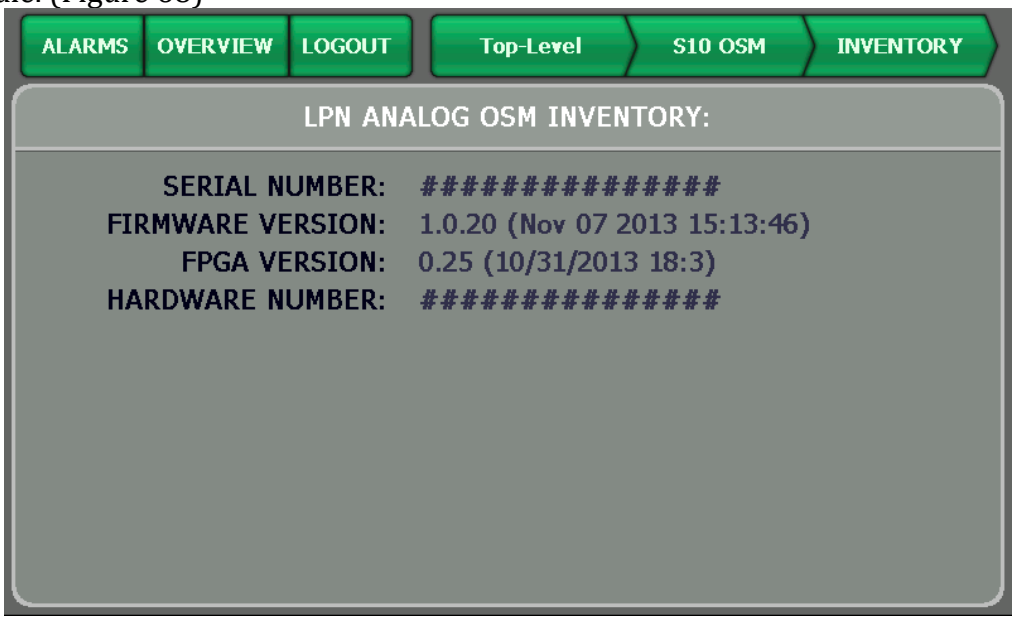



Figure 68 - LPN Analog Module Inventory Screen

### 4.5.2 LPN Analog Status Page

The Status page for the LPN Analog Output Module (Figure 69) shows the current fault status and output type of the Low Phase Noise Analog Output Module. The LPN Analog module contains a peak detector on each output, and it will return a fault if the output falls below a preset threshold.

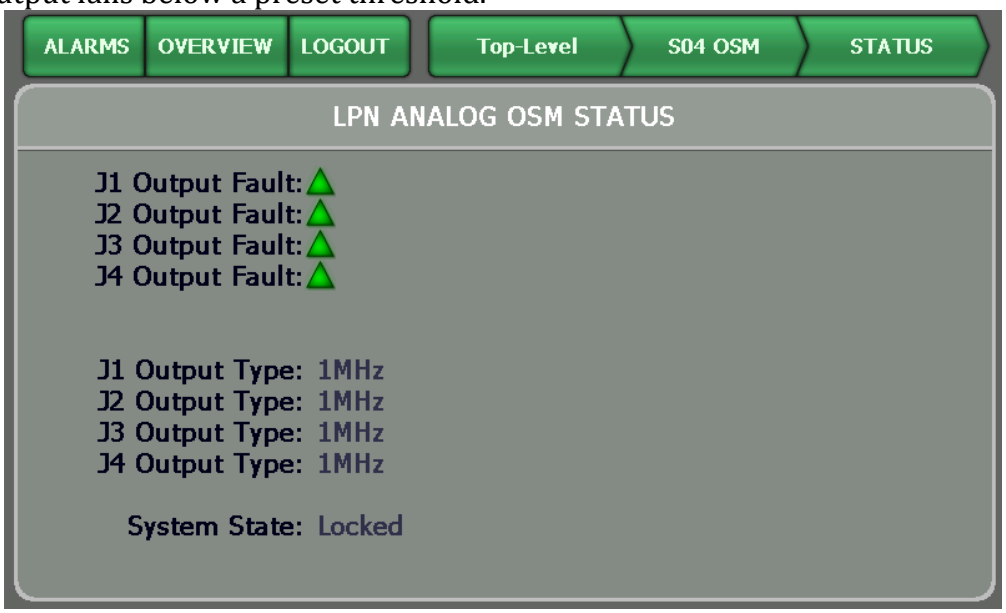



Figure 69 - Low Phase Noise Analog Status Page

## 4.6 Analog Distribution Module

The Analog Distribution Module provides four low phase noise reference frequency outputs at 40MHz.

Available controls for the Analog Output Distribution Module include viewing the inventory and status information for it. (Figure 67)

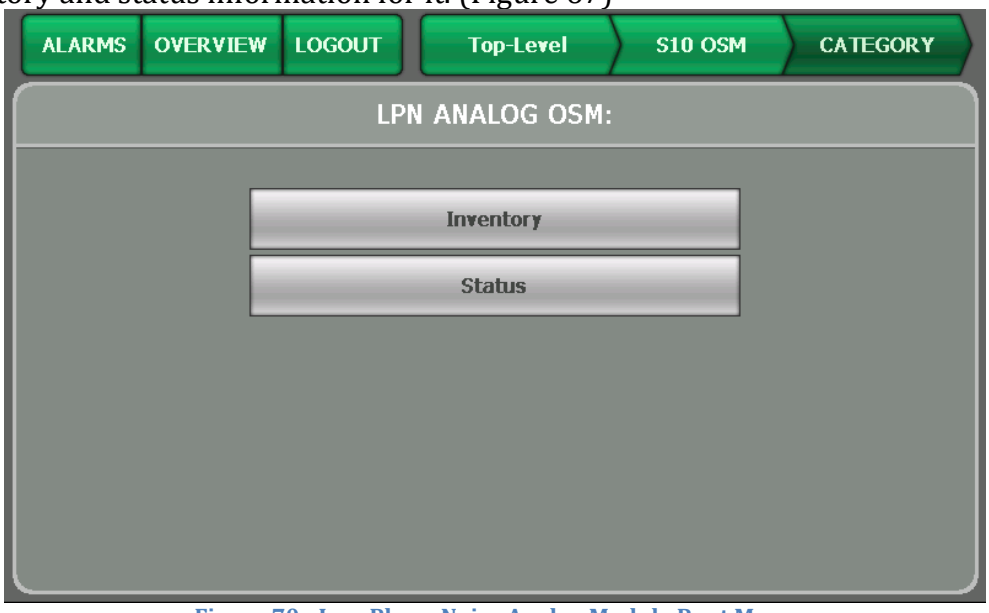



Figure 70 - Low Phase Noise Analog Module Root Menu

### 4.6.1 Analog Distribution Inventory Information

The Inventory screen for the Analog Distribution Module displays the Serial Number, Firmware Version, FPGA Version, and Hardware Number for the module. (Figure 68)

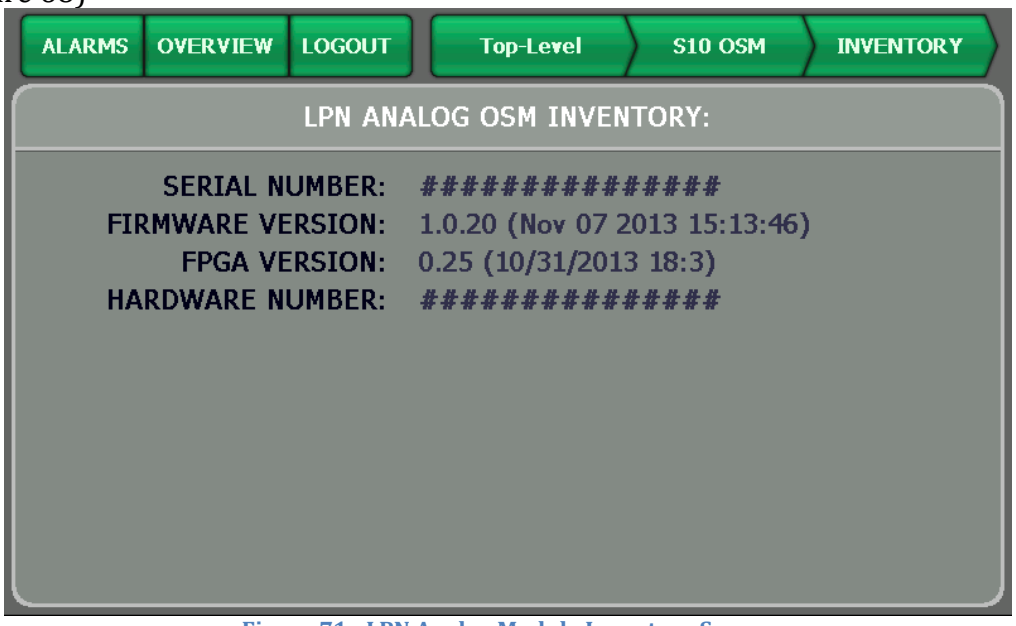



Figure 71 - LPN Analog Module Inventory Screen

### 4.6.2 Analog Distribution Module Status Page

The Status page for the Analog Output Distribution Module (Figure 69) shows the current fault status and output type of the Low Phase Noise Analog Output Module. The Analog Distribution Module contains a peak detector on each output, and it will return a fault if the output falls below a preset threshold.

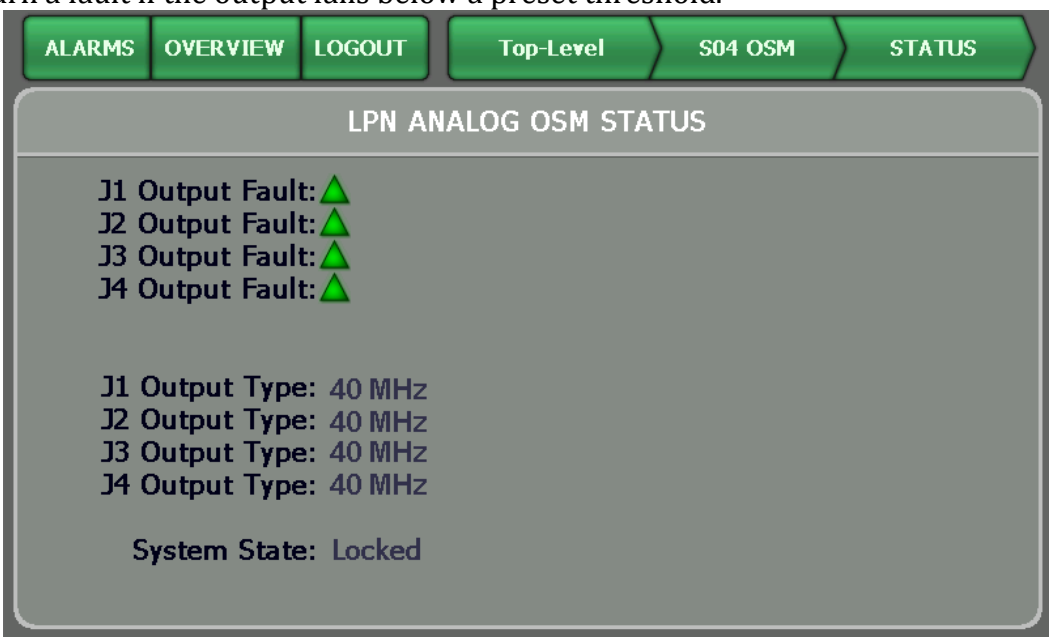



Figure 72 - Low Phase Noise Analog Status Page

## 4.7 Telecom Synthesizer Output Signal Module

The Telecom Output Signal Module provides 4 programmable output frequencies on the range 250Hz to 33MHz. The frequency scheme ensures that telecom frequencies on multiples of 8 kHz are exact. The minimum step sizes are multiples of 125 Hz.

### 4.7.1 Telecom OSM Inventory Information

The Inventory information screen displays the Serial Number, Firmware Version, FPGA Version, and the Hardware Number. (Figure 73)


Figure 73 - Telecom OSM Inventory Page

### 4.7.2 Telecom OSM Status

The Telecom OSM Status page (Figure 74) displays the Fault Status for each of the four outputs on the Telecom Output Signal Module. The Telecom Synthesizer Output Signal Module contains a peak detector on each output, and it will return a fault if the output falls below a certain threshold.
The format output for each port is:
J1: Sine wave
J2: Square wave
J3, J4: RS422

The system status shows the state of the phase locked loop that is part of the module. The various states are

- Warm-up (should be present only for 5 minutes after power-on)
- Acquiring (displayed while loop is stabilizing)
- Locked (normal operating state)

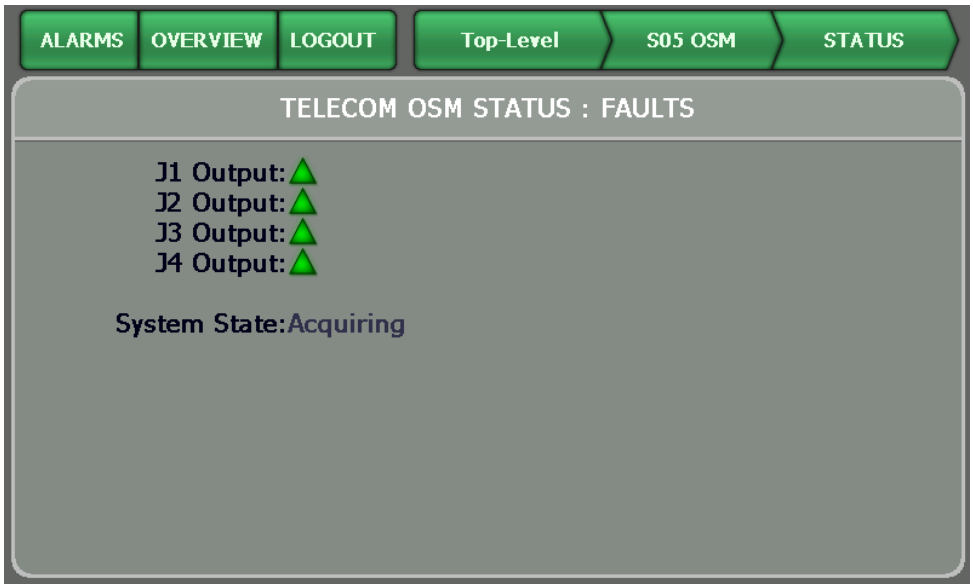



Figure 74 - Telecom OSM Status Page

### 4.7.3 Telecom OSM Settings

The Telecom OSM settings page (Figure 75) enables the user to adjust the output frequency of the Telecom OSM, the available frequencies for use with this module range from 250Hz to 33MHz, any frequency entered will be rounded
To adjust the output frequency, enter the desired frequency in Hz in the Output Frequency field.

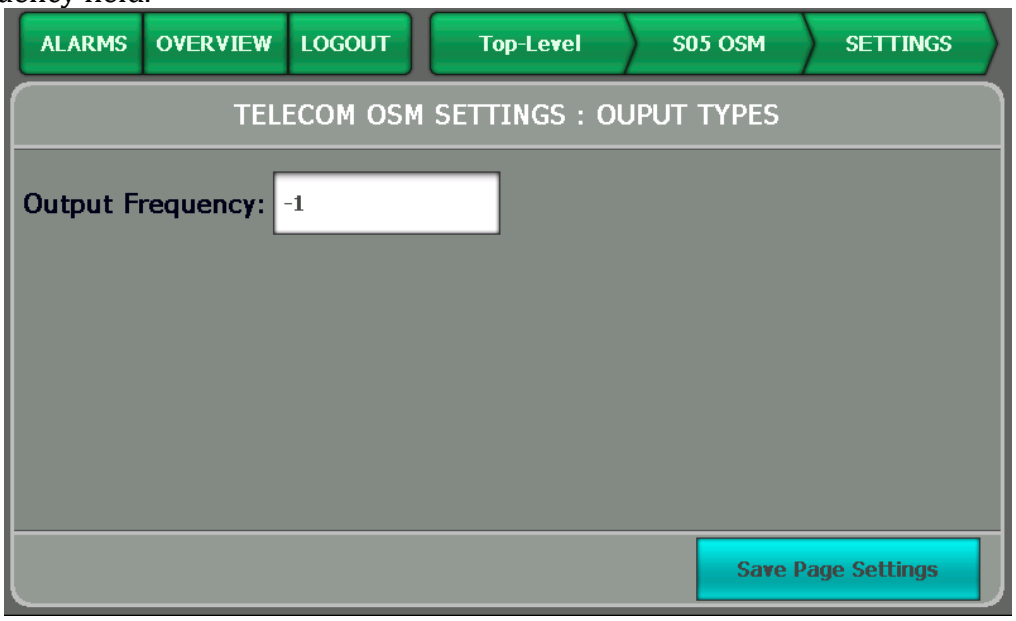



Figure 75 - Telecom OSM Settings

## 4.8 1PPS-RS422 Input Signal Module

The Input Signal Module (ISM) allows the MCM to be disciplined with two additional input references. This module is able to take two (2) 1PPS input references, and two (2) NMEA input messages via RS-422, and sends these signals to the MCM for additional reference selection. Each additional input time code must be paired with a 1PPS input to synchronize.

With this module, reference selection for the MCM is done as usual in the MCM Settings Page 3 (Figure 33 - Master Clock Module Reference Selection). The additional references will show as ISM Ref-A and ISM Ref-B. Reference selection can still be switched between Automatic and Manual mode.

While this is an Input Signal Module, it also has two (2) time code outputs (J3). The output format is user configurable; it can be set to ZDA, or Brandywine's proprietary I-24 serial message.

For steps to set up the ISM, please see Section 5.4 Setting up an Input Signal Module (ISM).

### 4.8.1 1PPS-RS422 ISM Inventory

The Inventory page (Figure 76) allows the user to view the 1PPS-RS422 ISM's Serial Number, Firmware Version, FPGA Version, and Hardware Number.


Figure 76 - 1PPS-RS422 ISM Inventory

### 4.8.2 1PPS-RS422 ISM Status

The Status page (Figure 77) displays the current fault status of the 1PPS reference sources, and the RS422 Rx lines. It also displays the phase error in nanoseconds of the 1PPS inputs, and the time received from the RS422 Rx lines.


Figure 77 - 1PPS-RS422 ISM Status

### 4.8.3 1PPS-RS422 ISM Settings

The Settings page (Figure 78) enables the user to adjust delay compensation for each 1PPS input reference source, as well as the format of the RS422 output time messages. The delay compensation value is measured in nanoseconds, and must be adjusted in increments of five nanoseconds.

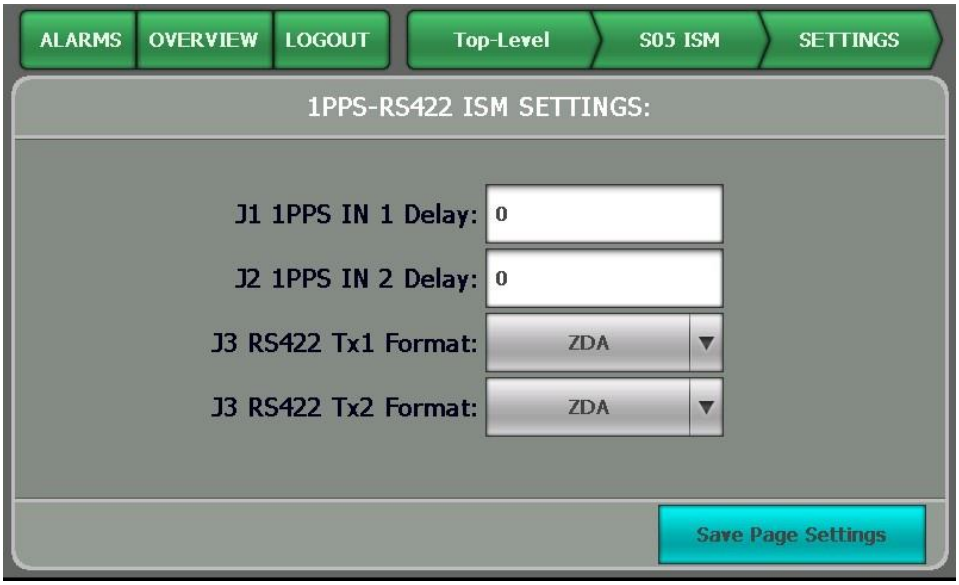



Figure 78 - 1PPS-RS422 ISM Settings

## 4.9 PTP Switch Output Signal Module

The PTP Switch Output Signal Module (PTPSW OSM) enables the Modular Master Clock to act as a PTP/NTP server over an Ethernet network. PTP will comply to PTPv2 (IEEE 1588-2008). By default, the PTP server is configured for L2 Ethernet, E2E, Domain 0, and PTP Server disabled. Select the PTPSW Module from the Module Selection Screen, to view inventory information, status, and adjust configuration options. The module will display as “PTP _SW” from the Top Level (Figure 79).

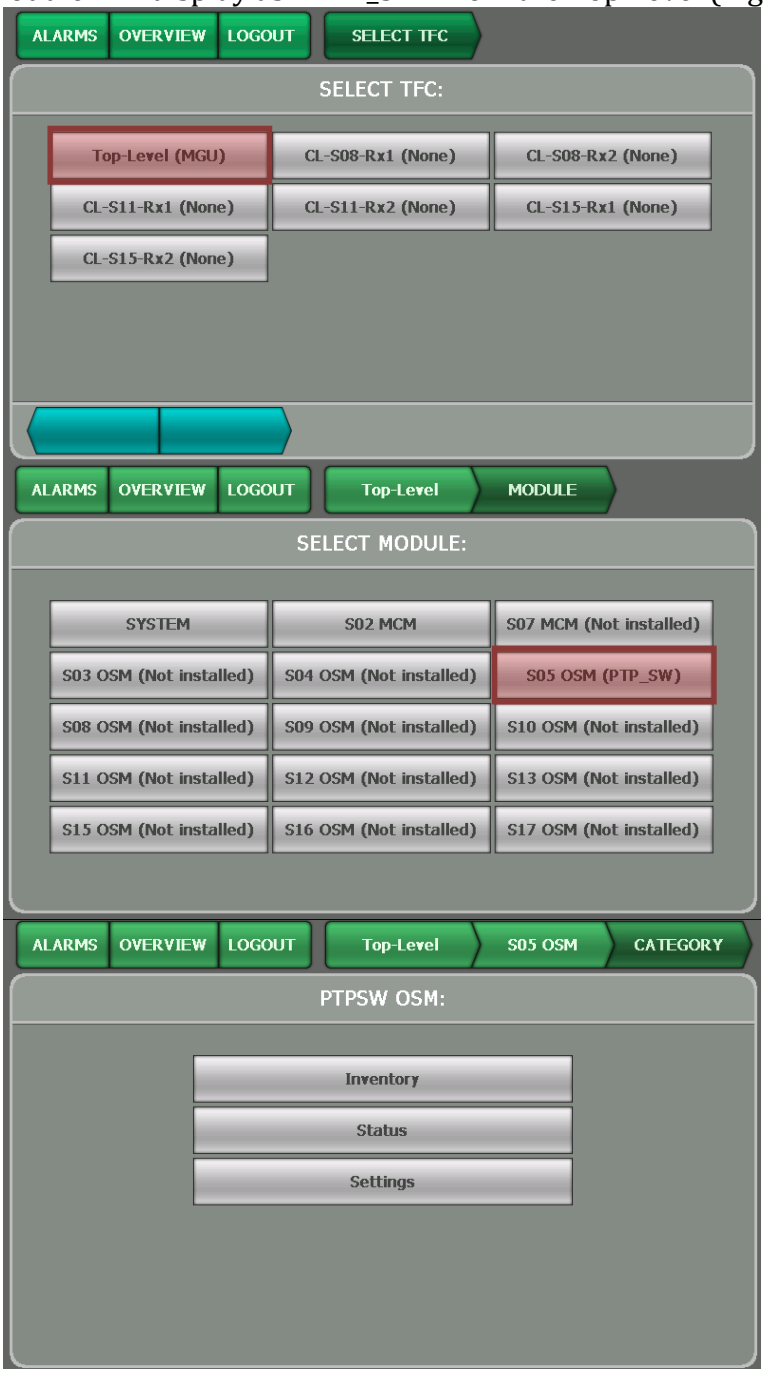



Figure 79 - PTPSW Module Menu

### 4.9.1 PTPSW OSM Inventory

The Inventory page (Figure 80) displays the Serial Number, Firmware Version, FPGA Version, and the Hardware Number.


Figure 80 - PTPSW OSM Inventory

### 4.9.2 PTPSW OSM Status

This Status page (Figure 81) displays general information about the PTP Server.

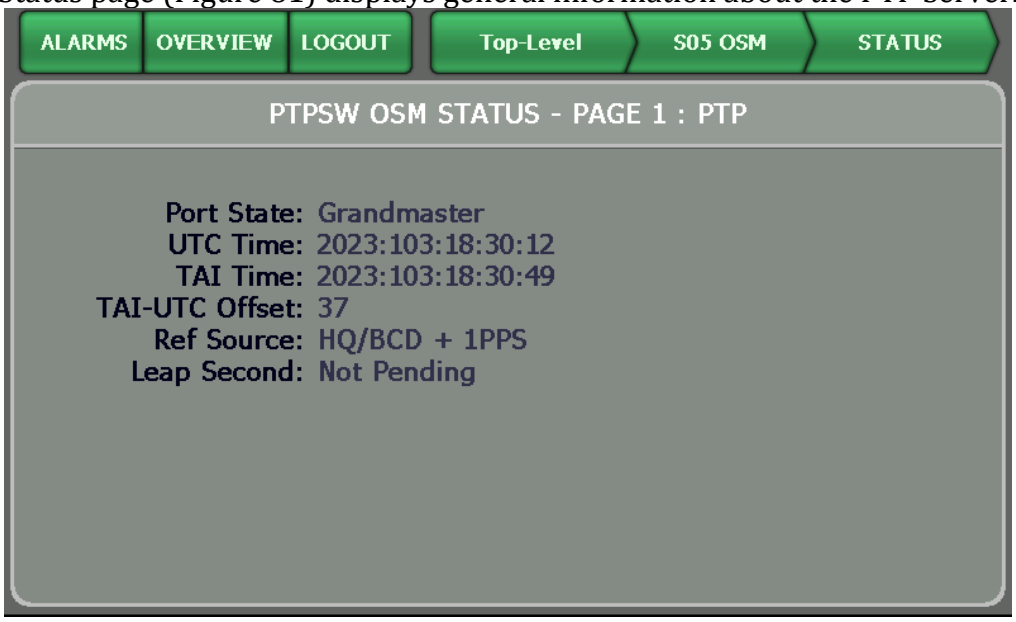



Figure 81 - PTPSW OSM Status

### 4.9.3 PTPSW OSM Settings

The PTPSW OSM Module Settings Page enables the user to change the IP address of the PTP Server, IP address of the Management/NTP port, Management/NTP Gateway, Management/NTP Mask, and also allows the PTP server to be enabled/disabled. The following Settings page(s) allows for the configuration of the

PTP Transport Layer, PTP Delay Mechanism, Domain, PTP Time Scale, as well as the configuration of the NTP settings. The PTP server is configured for L2 Ethernet, E2E, Domain 0, and PTP Server Disabled by default.

#### 4.9.3.1 PTPSW OSM Settings Page 1

This page (Figure 82) allows the user to change the IP address of the PTP Server, IP address of the Management/NTP port, Management/NTP Gateway, and Management/NTP Mask. This page also allows the user to enable/disable the PTP server.

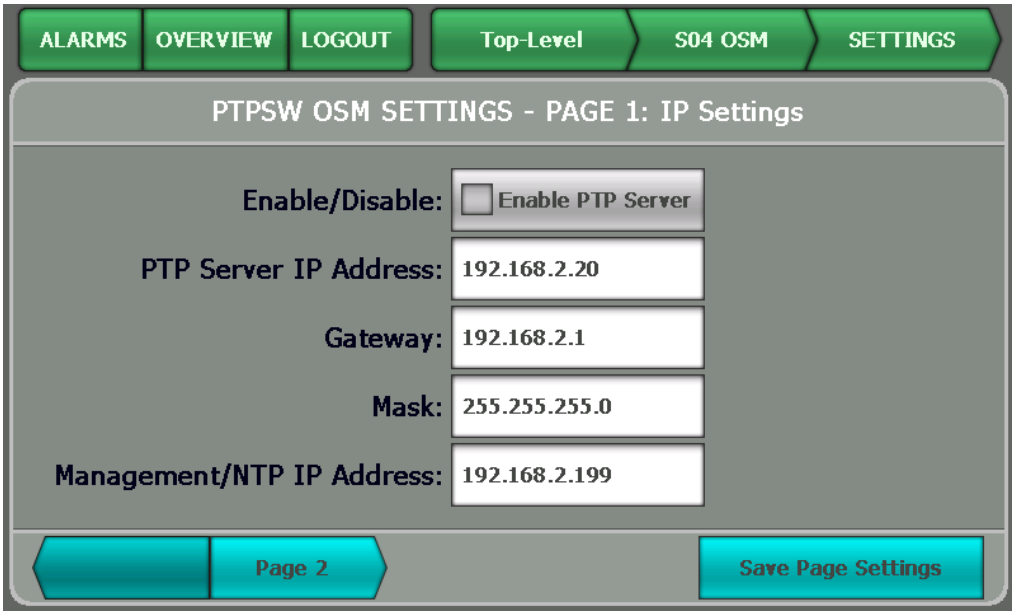



Figure 82 - PTPSW OSM Settings Page 1: IP Settings

#### 4.9.3.2 PTP SW OSM Settings Page 2

This page (Figure 83) allows for the configurations of the PTP Transport Layer, PTP Delay Mechanism, Domain, and PTP Time Scale.

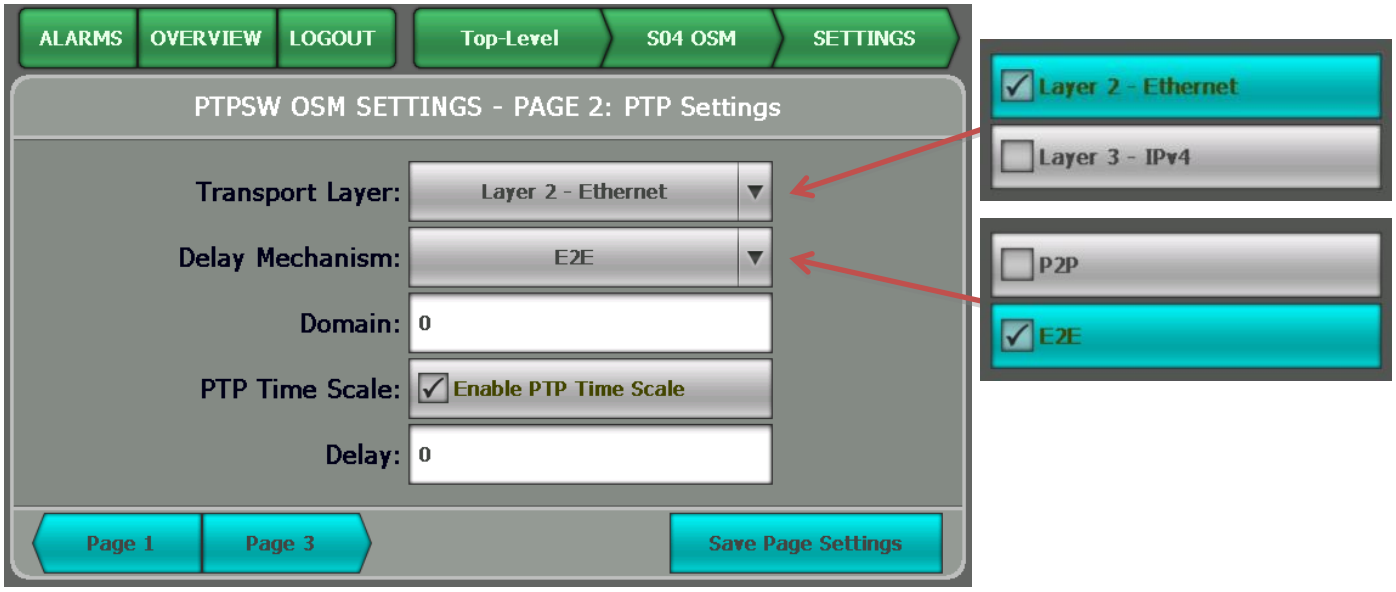



Figure 83 - PTPSW OSM Settings Page 2: PTP Settings

**Transport Layer –** Please refer to IEEE Std 1588-2008: Section 7.4.1
**Delay Mechanism –** Please refer to IEEE Std 1588-2008: Section 8.2.5.4.4
**Domain –** Please refer to IEEE Std 1588-2008: Section 7.1.
**PTP Time Scale –** Please refer to IEEE Std 1588-2008: Section 7.2.1
**Enabled**: PTP Timescale
**Disabled**: ARB Timescale

#### 4.9.3.3 PTP SW OSM Settings Page 3

This page (Figure 84) controls the NTP Authentication settings for the PTPSW OSM. Available forms of Authentication are MD5 and SHA-1. The NTP Key is a hex value and must be no longer than 20 characters.

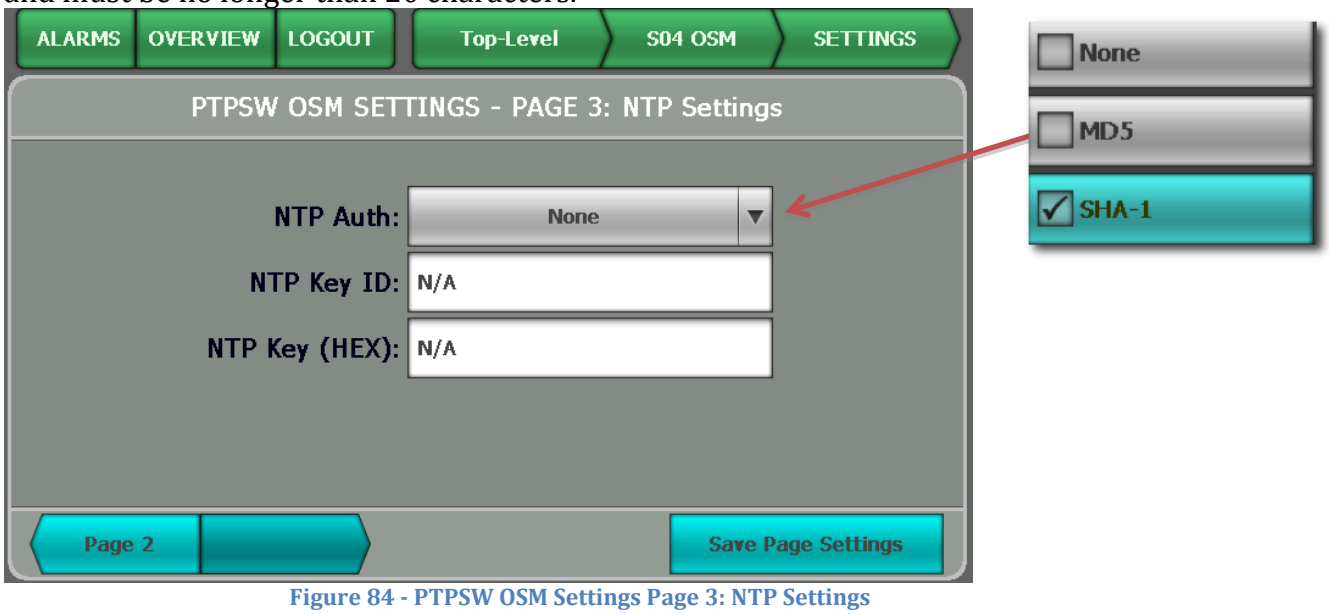



Figure 84 - PTPSW OSM Settings Page 3: NTP Settings

# 5 Operation

## 5.1 Setting up two systems as Dual-Redundant Master Clocks

With two units, the Modular Master Clock can be set up as dual-redundant master clocks that will cross-check each other for the high-accuracy and high-availability timing.

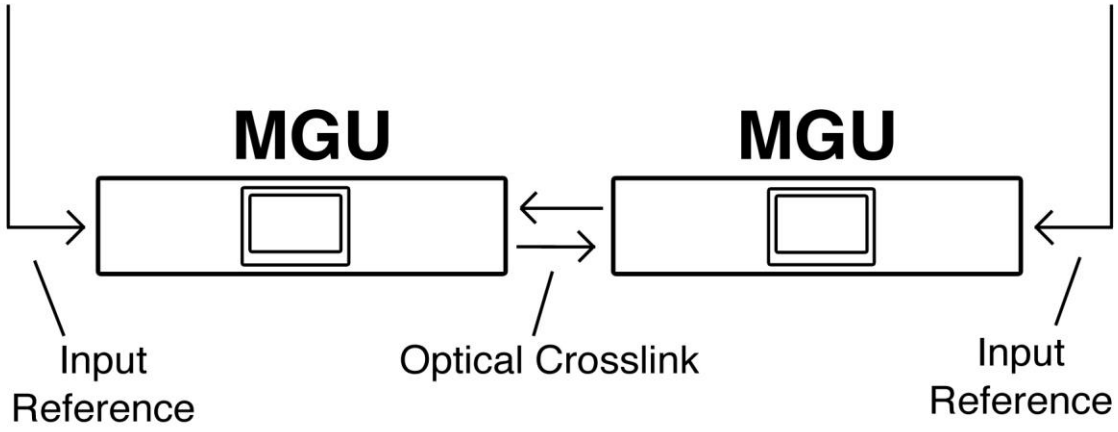



Figure 85 - Dual Master Configuration Diagram

To set this up this configuration:

1. Connect two Modular Master Clocks to each other using a duplex fiber optic cable.
2. Note the OSM slot ID and port number on each MMC.
3. On each MGU
    a. Go into the top-level unit from the Unit Selection Screen
    b. Select SYSTEM from the Module Section Screen
    c. Go to the settings page
    d. Under TFC Type, select “MGU”
    e. Select “Save Settings”
    f. Return to the Module Selection Screen
    g. Select the OSM slot with crosslink used in step 2
    h. Go to the settings page
    i. Select the port that was connected the other Modular Master Clock to as noted in step 2.
        i. Ports J1 and J2 are listed as “RxTx1-TFC-Type-And-Mode”
        ii. Ports J3 and J4 are listed as “RxTx2-TFC-Type-And-Mode”
    j. Select “MGU”
    k. Verify that Propagation delay is set to “Automatic”
    l. Select “Save Settings”

4. Repeat this procedure for the other Modular Master Clock.

## 5.2 Setting up a Hierarchical Master and Secondary Configuration with normal operations

Any number of Modular Master Clocks can be set up as a master and secondary configuration, with a single or dual-redundant Modular Master Clock setup acting as the master system.

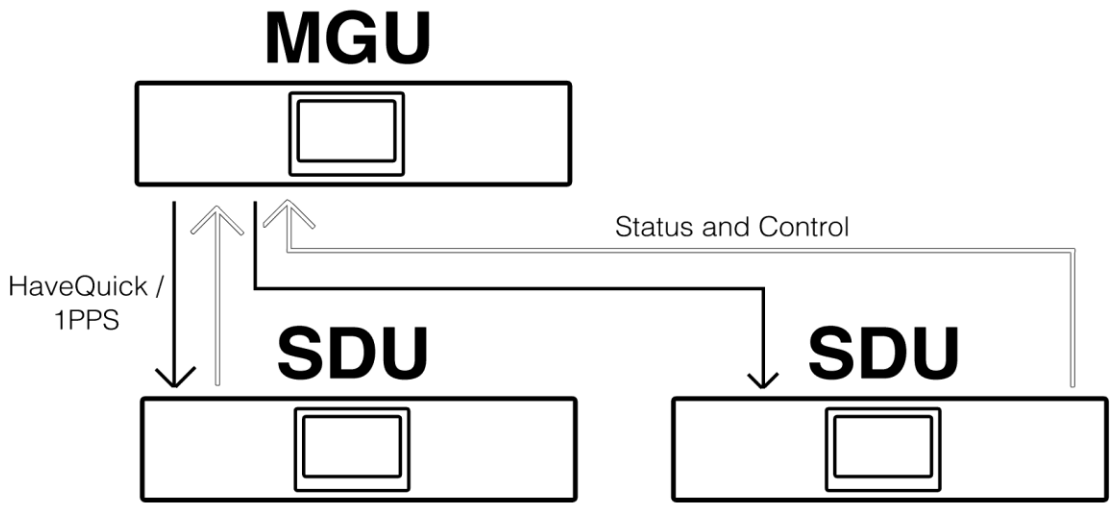



Figure 86 - MMC Hierarchical Configuration Crosslink Diagram

To do this:

1. Connect a duplex fiber optic cable between the two units,
2. Note the OSM slot and port number on each unit.
3. **On the unit to be set up as a MASTER:**
    a. Select "Top-Level (MGU)" from the root "SELECT TFC" screen
    b. Select SYSTEM from the "SELECT MODULE" screen
    c. Go to the settings page
    d. Under TFC Type, select "MGU"
    e. Select "Save Settings"
    f. Return to the Module Selection Screen
    g. Select the crosslink card that was connected the fiber optic cable to
    h. Go to the settings page
    i. Select the port that was connected the other Modular Master Clock to.
        i. Ports J1 and J2 are listed as "RxTx1-TFC-Type-And-Mode"
        ii. Ports J3 and J4 are listed as "RxTx2-TFC-Type-And-Mode"
    j. Select "SDU with Information Assurance Disabled"
    k. Verify that Propagation delay is set to "Automatic"
    l. Select "Save Settings"

4. **On the unit to be set up as a SECONDARY:**
    a. Select "Top-Level (SDU)" from the root "SELECT TFC" screen
    b. Select SYSTEM from the Module Section Screen

c. Go to the settings page
d. Under TFC Type, select “SDU”
e. Ensure that the IA Mode checkbox is not checked.
f. Select “Save Settings”
g. Return to the Module Selection Screen
h. Select the crosslink card that was connected the fiber optic cable to
i. Go to the settings page
j. Select the port that was connected the other Modular Master Clock to.
    i. Ports J1 and J2 are listed as “RxTx1-TFC-Type-And-Mode”
    ii. Ports J3 and J4 are listed as “RxTx2-TFC-Type-And-Mode”
k. Select “MGU”
l. Verify that Propagation delay is set to “Automatic”
m. Select “Save Settings”

## 5.3 Setting up a Hierarchical System with Information Assurance mode enabled

The optical crosslinking capabilities for the Modular Master Clock have a unique feature called information assurance mode. In this mode the Master System will optically transmit the timing reference, but it will not expect to receive any status or control information from the secondary unit. This ensures that the flow of information over the optical crosslink only moves in one direction, enabling it to be used in secure areas, with the master generation unit in a non-secure area, and a secondary distribution unit in a secure area.

**Please note that enabling IA Mode does not disable the Ethernet ports on the Master Clock Modules.**

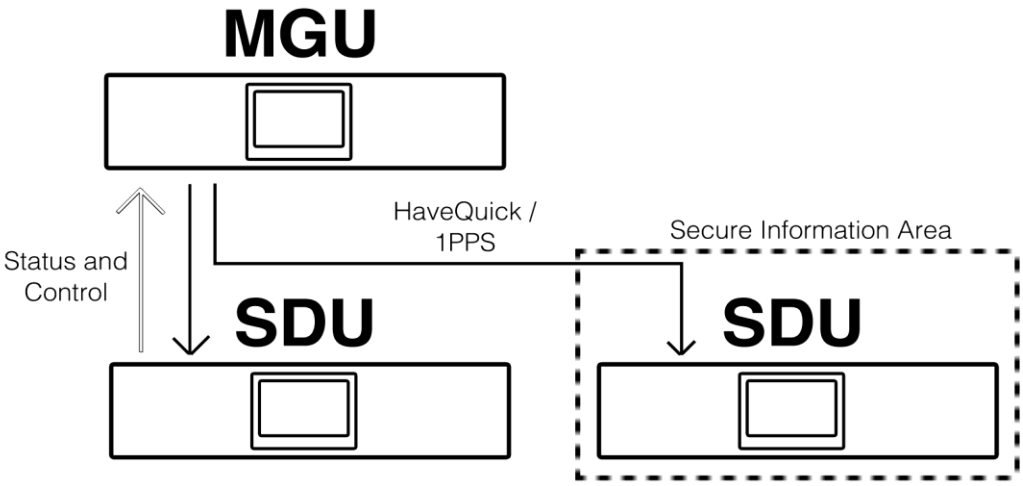



Figure 87 - MMC Hierarchical Crosslink Configuration with Information Assurance Diagram

To do this:

1. **On the unit to be set up as a master:**
    a. Connect two Modular Master Clocks to each other using a fiber optic cable.
    b. Select “Top-Level (MGU)” from the root “SELECT TFC” screen
    c. Select SYSTEM from the Module Section Screen
    d. Go to the settings page
    e. Under TFC Type, select “MGU”
    f. Select “Save Settings”
    g. Return to the Module Selection Screen
    h. Select the crosslink card that was connected the fiber optic cable to
    i. Go to the settings page
    j. Select the port that was connected the other Modular Master Clock to.
        i. Ports J1 and J2 are listed as “RxTx1-TFC-Type-And-Mode”
        ii. Ports J3 and J4 are listed as “RxTx2-TFC-Type-And-Mode”
    k. Select “SDU with Information Assurance Enabled”
    l. Select “Save Settings”

2. **On the unit to be set up as a secondary:**
    a. Select “Top-Level (SDU)” from the root “SELECT TFC” screen
    b. Select SYSTEM from the Module Section Screen
    c. Go to the settings page
    d. Under TFC Type, select “SDU”
    e. Ensure that the box labeled “IA Mode” is checked.
    f. Select “Save Settings”
    g. Return to the Module Selection Screen
    h. Select the crosslink card that was connected the fiber optic cable to
    i. Go to the settings page
    j. Select the port that was connected the other Modular Master Clock to.
        i. Ports J1 and J2 are listed as “RxTx1-TFC-Type-And-Mode”
        ii. Ports J3 and J4 are listed as “RxTx2-TFC-Type-And-Mode”
    k. Select “MGU”
    l. Verify that Propagation delay is set to “manual”
    m. Enter the measured or calculated propagation delay
    n. Select “Save Settings”

## 5.4 Setting up an Input Signal Module (ISM)

With the 1PPS-RS422 Input Signal Module (ISM), the Modular Master Clock can be disciplined with two additional input references. These inputs are expected to be a NMEA time code over RS-422. Each time code source signal must be paired with a 1PPS to synchronize the MCM.

To set up this configuration:

1. Note the Slot ID of the ISM.
2. Connect a NMEA source signal to J3 Rx-1 via 15 Pin D-Sub connector, and a 1PPS source to J1.
3. Through the front display, select “Top-Level” from the root “SELECT TFC" screen
4. Select “S02 MCM” or “S07 MCM” from the “SELECT MODULE” screen.
5. Select “Settings”. Then, go to “MCM Settings - Page 2: Reference Inputs (cont.)” (Figure 32).
6. Under ISM Ref-A:
    a. Select the Slot ID the ISM is installed in (Step 1).
    b. Select J1 + J3 Rx-1.
7. To use this reference source, ensure the ISM Ref-A reference input is checked in MCM Settings Page 1: Reference Inputs (Figure 30).
8. Once this is done, configuration of Reference Selection and Mode Switch (Figure 33), Reference AutoSwitch Priorities (Figure 34), and Reference AutoSwitch Prevention (Figure 35) are done as usual in the respective MCM Settings pages.
9. Repeat this procedure for the second input reference, ISM Ref-B, using selection “J2 + J3 Rx-2”, if needed.

**Note:** Port J1 is always paired with J3 Rx-1, and Port J2 with J3 Rx-2

| Connector | Type | Function |
|---|---|---|
| **J3** | 15 Pin DSub<br>NorComp 171-015-202-001 | |
| **Pin 1** | | RS422 Tx+ 1 |
| **Pin 2** | | GND |
| **Pin 3** | | RS422 Rx- 1 |
| **Pin 4** | | RS422 Tx+ 2 |
| **Pin 5** | | GND |
| **Pin 6** | | RS422 Rx- 2 |
| **Pin 7** | | NC |
| **Pin 8** | | NC |
| **Pin 9** | | RS422 Tx- 1 |
| **Pin 10** | | RS422 Rx+ 1 |
| **Pin 11** | | GND |
| **Pin 12** | | RS422 Tx- 2 |
| **Pin 13** | | RS422 Rx+ 2 |
| **Pin 14** | | GND |
| **Pin 15** | | NC |

Table 7 - 1PPS-RS422 ISM Pin J3 Connections

# 6 Maintenance

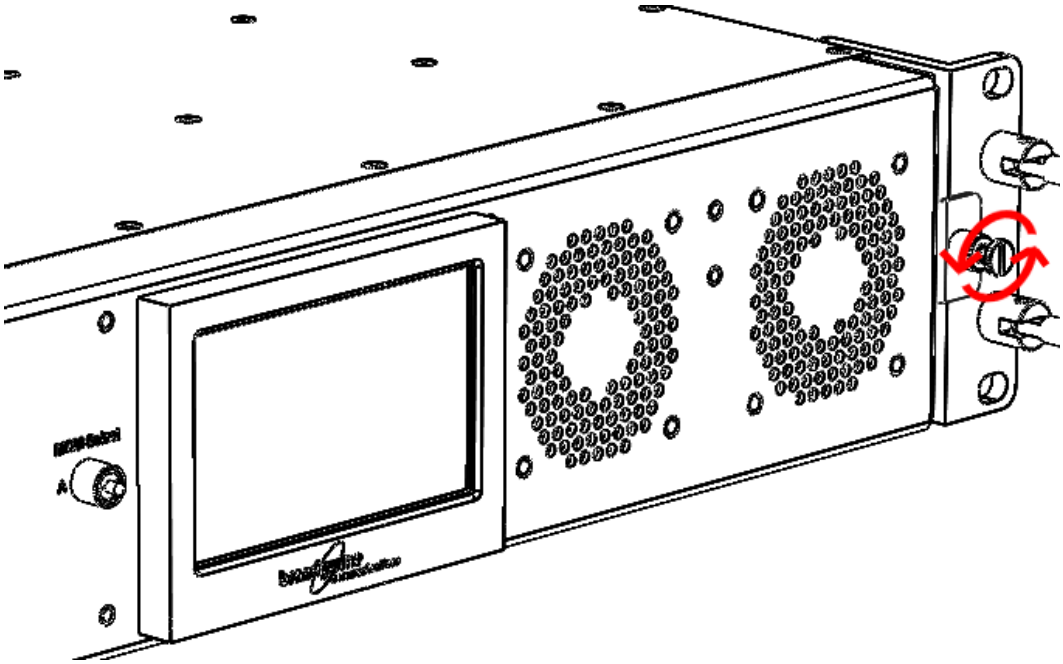
## 6.1 Preventive Maintenance

The MMC does not require scheduled preventative maintenance during normal operation.
If the unit is to be operated in dusty environments, then the optional fan filters are available.
If the optional fan filters are in use, then these should be removed and cleaned/replaced every 6-12 months as needed.

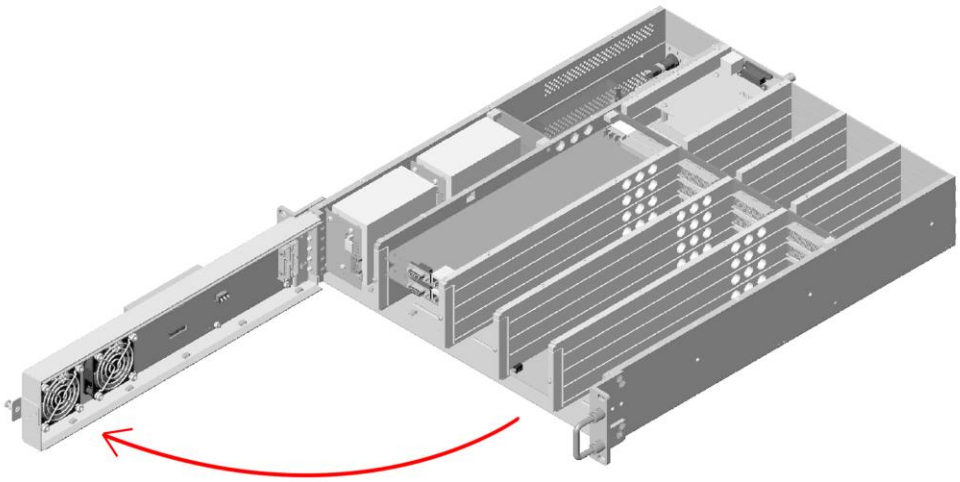
## 6.2 Removing a Module

1. Observe all necessary precautions for handling electrostatic discharge sensitive devices when performing these steps.

2. Unscrew the front panel retaining screw located on the right-hand side of the unit.

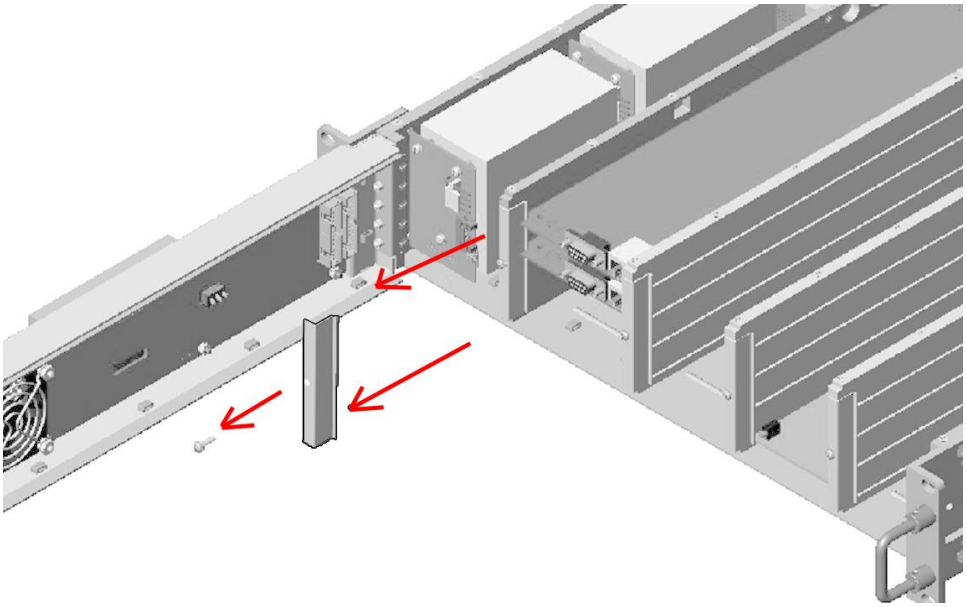


3. Swing open the front panel assembly

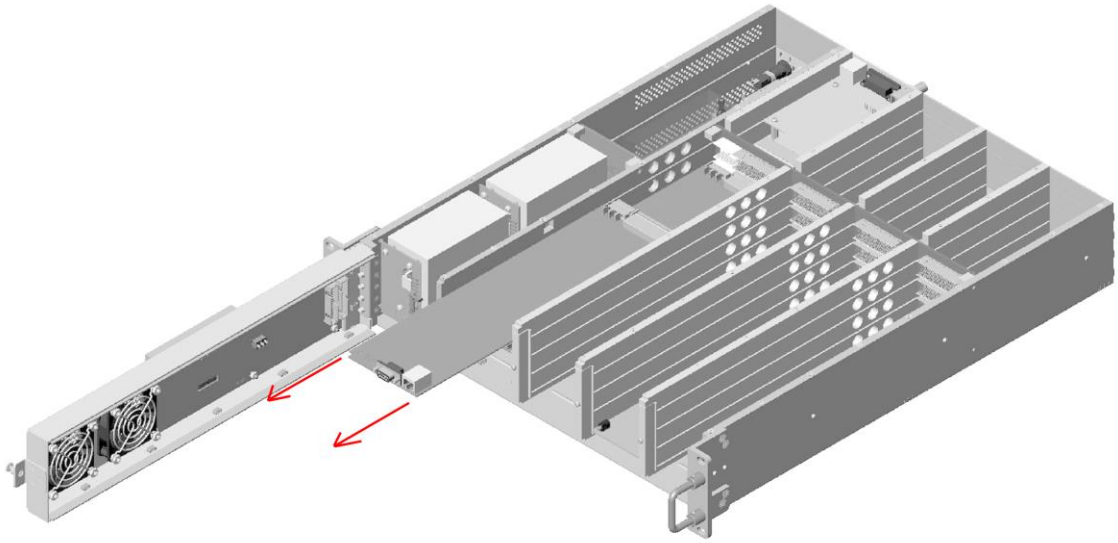


4. Unscrew the front panel retainer on the left side of the module to be replaced.

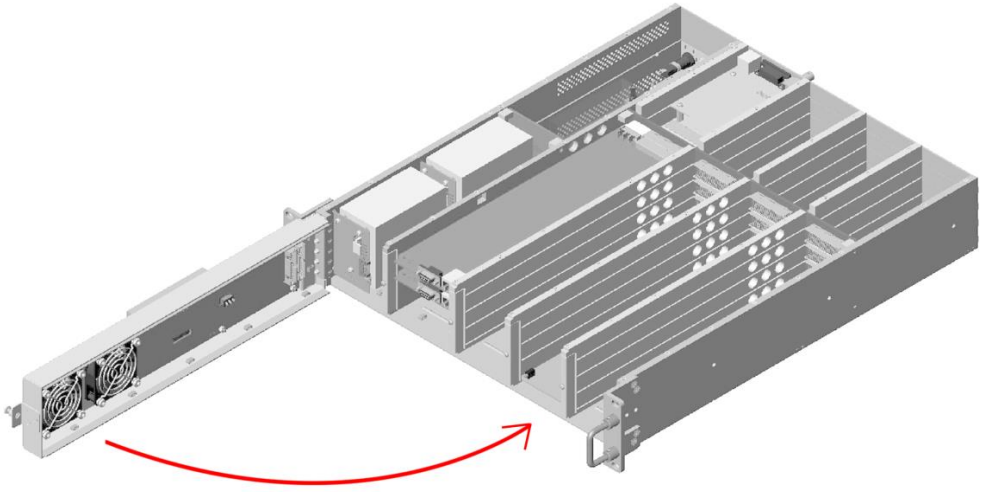
***Note: The retainer securing screw need only be loosened to allow the retainer to be removed. This allows the screw to be retained in the chassis without danger of falling into the unit.***



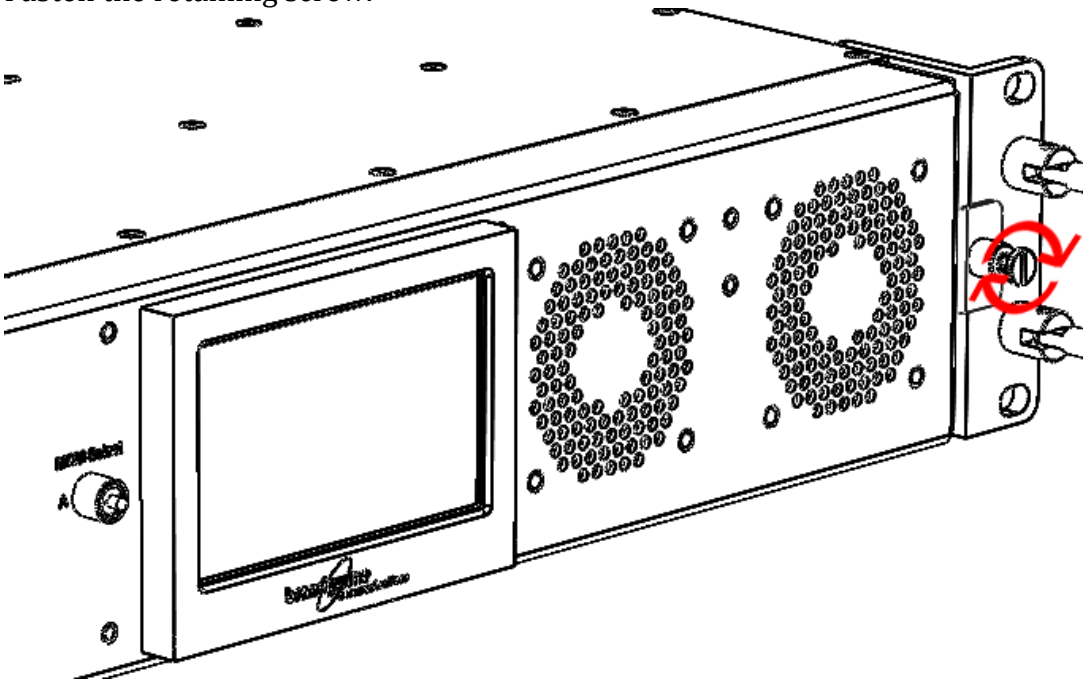
5. Carefully remove the card from the front panel assembly. If needed, an optional removal tool (P/N 800000016) is available from Brandywine Communications. The removal tool has a peg that is carefully inserted in a small hole in the front of the module being removed.



6. Swing the front panel assembly closed



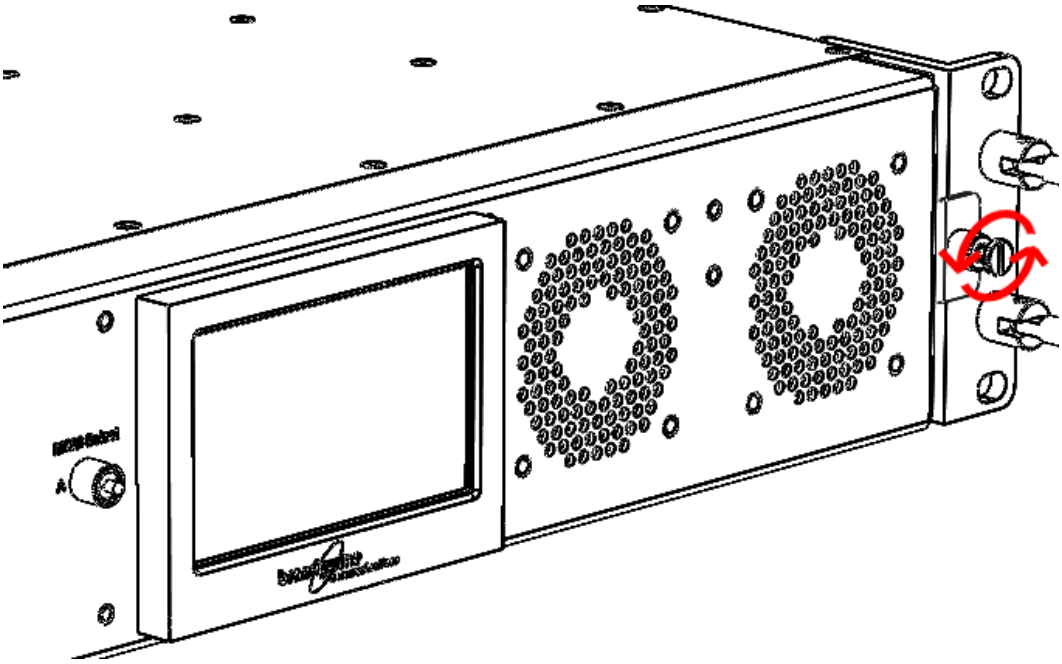
7. Fasten the retaining screw.



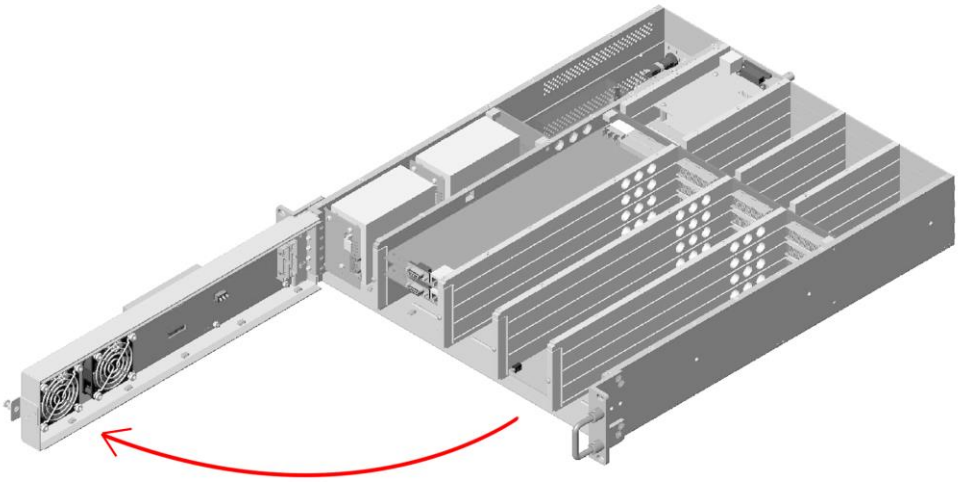
## 6.3 Installing a Module

1.  Observe all necessary precautions for handling electrostatic discharge sensitive devices when performing these steps.
2. Unscrew the front panel retaining screw located on the right-hand side of the unit.

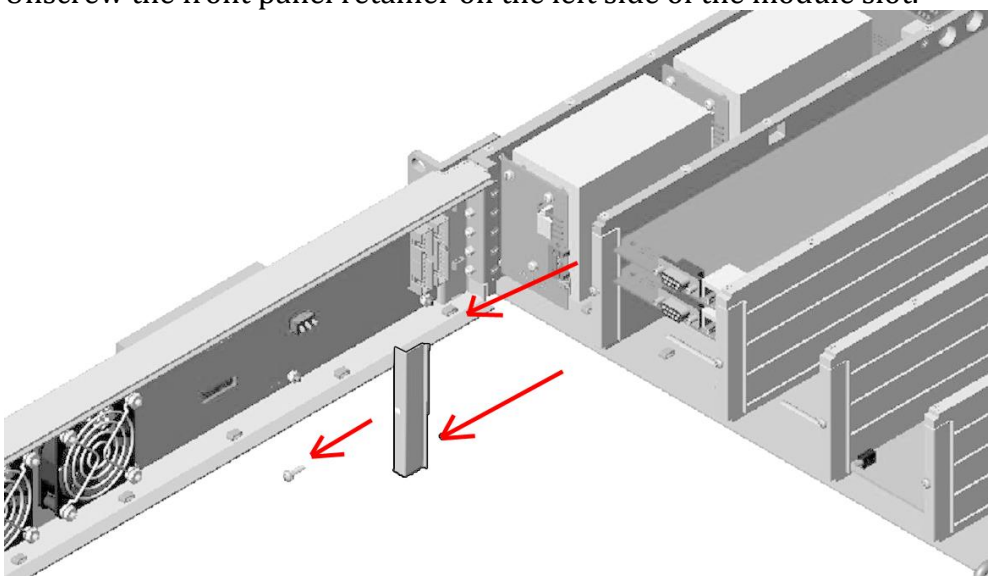
***Note: The retainer securing screw need only be loosened to allow the retainer to be removed. This allows the screw to be retained in the chassis without danger of falling into the unit.***



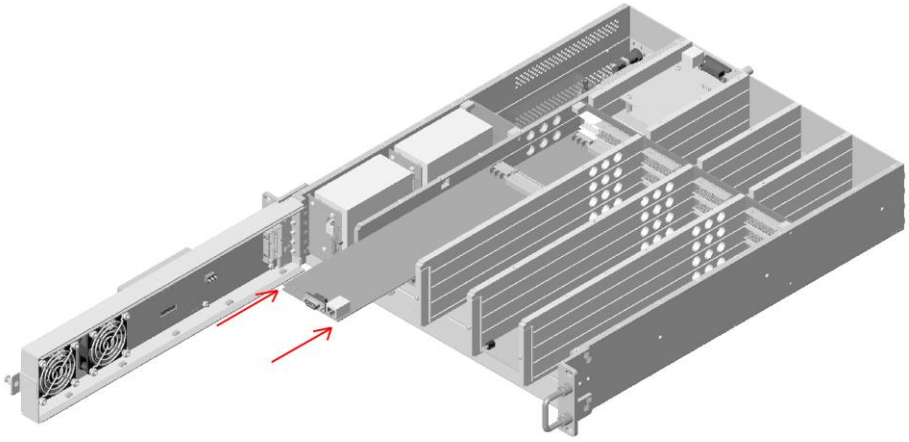
3. Swing open the front panel assembly



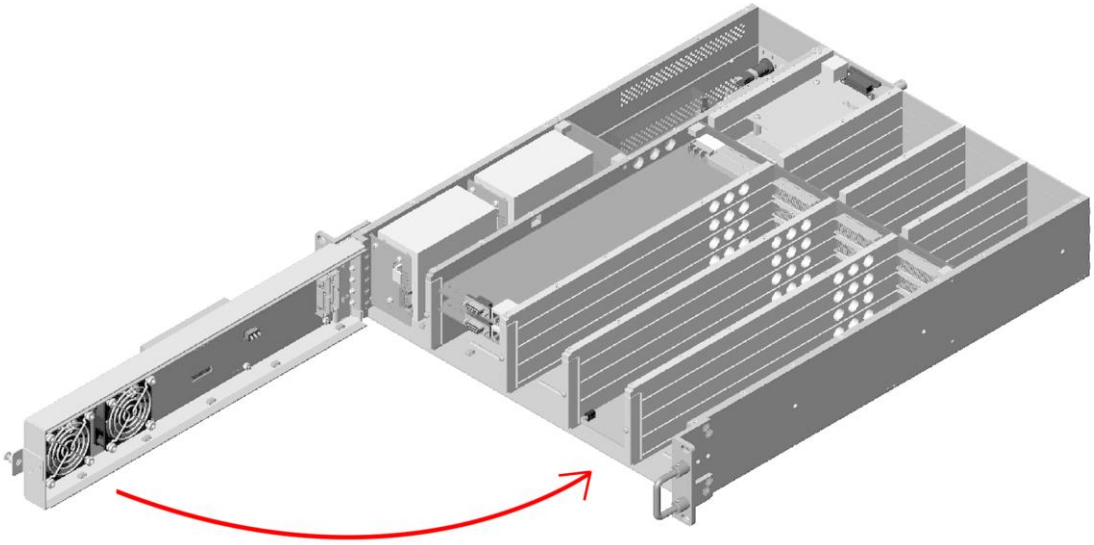
4. Unscrew the front panel retainer on the left side of the module slot.



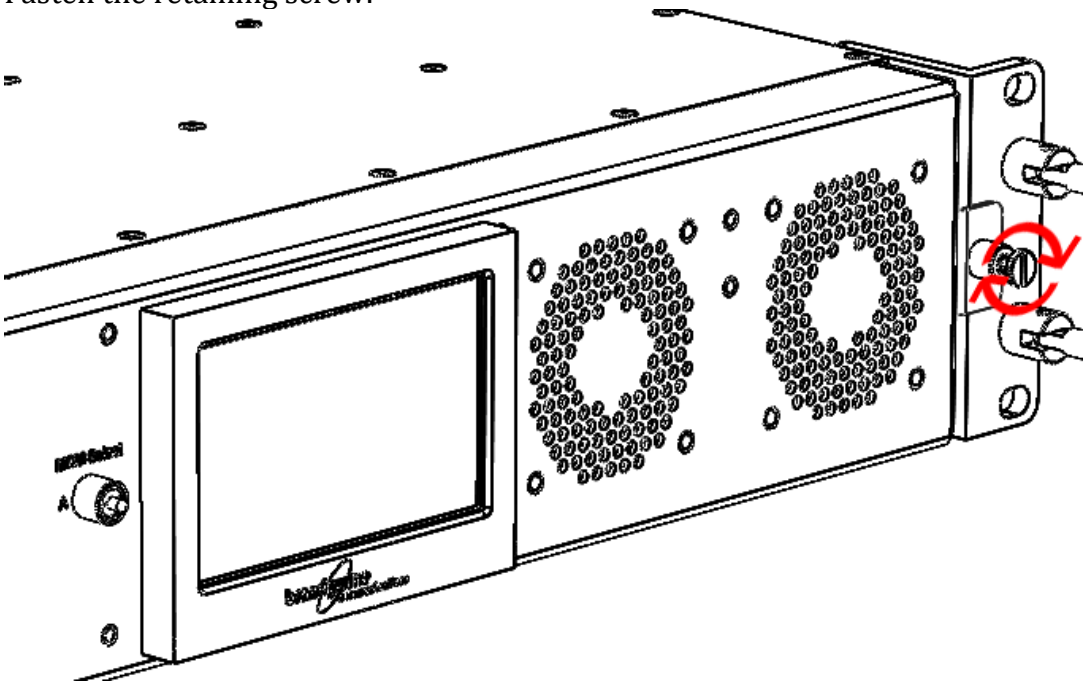
5. Align the card with the grooves in the modular master clock, and carefully insert the card into the front panel assembly.



6. Swing the front panel assembly closed



7. Fasten the retaining screw.



## 6.4 Removing a Rear Panel Card

1. Observe all necessary precautions for handling electrostatic discharge sensitive devices when performing these steps.
2. Unscrew the two retaining screws holding the rear panel card in place
3. Carefully remove the rear panel card from the Modular Master Clock
4. Insert a rear panel blank in the place of the card
5. Screw in the two rear panel screws to hold the rear panel card in place

## 6.5 Installing a Rear Panel Card

1. Observe all necessary precautions for handling electrostatic discharge sensitive devices when performing these steps.
2. Unscrew the two retaining screws holding the rear panel blank in place
3. Carefully remove the rear panel blank from the Modular Master Clock
4. Align the card with the grooves in the Modular Master Clock
5. Insert the rear panel card into the Modular Master Clock
6. Screw in the two rear panel screws to hold the rear panel card in place

## 6.6 Replacing a Rubidium Oscillator Module

**WARNING**

**Chemical Hazard**

Within the Modular Master Clock, there are two Rubidium Oscillator Modules (RbOM) that use Rubidium 87. Rubidium 87 is considered a hazardous material if released into the environment.

In case of inadvertent rupturing of the glass cell containing the Rubidium due to inadvertent mishandling of the RbOM, broken glass would be heard when gently shaking the RbOM module and the following should be observed;

- Never open the metal container containing the RbOM.
- Wear gloves and pick-up any damaged RbOM mechanically for disposal. Dispose gloves when disposal is completed.
- Do not subject the RbOM to any water any liquid
- Keep the RbOM away from foodstuff, beverages.

If damaged RbOM is inadvertently opened, do not inhale/ingest and avoid any contact with its contents. Drink water if ingested. Wash skin with soap and water if contacted. If contents of RbOM get into personnel's eyes, rinse eyes immediately with plenty of water for 15 minutes.

**CAUTION**

Replacing a rubidium oscillator module requires that the system be powered off prior to service.

Observe all necessary precautions for handling electrostatic discharge sensitive devices when performing these steps.

The Rubidium Oscillator Module(s) (RbOM) are mounted on the left sidewall of the chassis.

1. Record the following information prior to removal. This information is stored on the RbOM, and will need to be re-entered
    a. MMC password
    b. NTP MD5/SHA-1 key for MCM and any other NTP modules installed in chassis
2. Determine whether the RbOM to be replaced is part of the MCM installed in Slot 2 or Slot 7. (See Figure 88 - Rubidium Oscillator Diagram)
3. Power off the MMC
4. To access the RbOM remove the top cover to the front left of the chassis

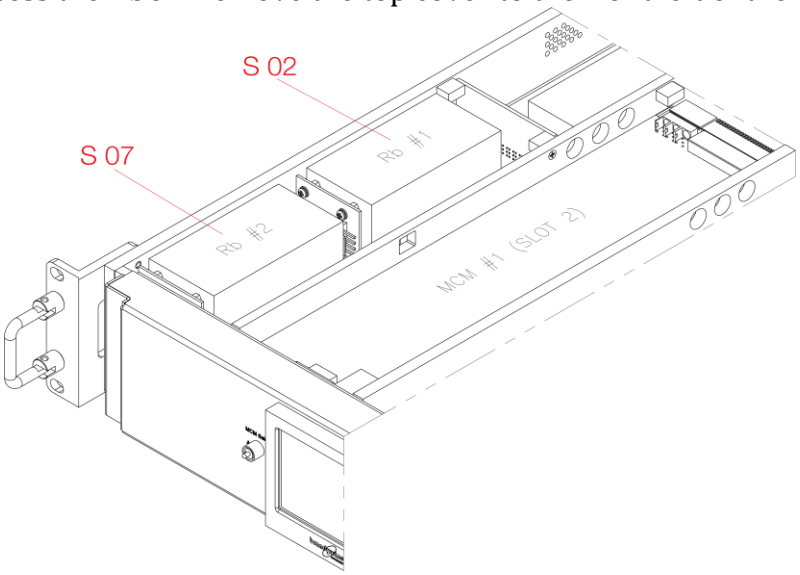



Figure 88 - Rubidium Oscillator Diagram

5. Identify correct RbOM to be replaced.
6. Carefully unscrew 4 screws on sidewall and free RbOM from sidewall.
7.  Gently lift the RbOM to allow easier access to the connecting cables or disconnection. Be careful not to place strain on the cables and connections.
8. Disconnect the power cable from RbOM
9. Disconnect the ribbon cable from RbOM
10. Disconnect the coaxial cable from RbOM
11. Install the replacement RbOM in the reverse sequence. (steps 11-3)
12. Use the front panel switch to select the MCM that had the RbOM replaced.
13. Re-enter password, MD5/SHA-1 keys from step 1.

## 6.7 Uploading New Firmware to the Modular Master Clock

See the section titled “Updating Firmware and FPGA” for the instructions on how to do this.

# 7 Troubleshooting

The Modular Master Clock is capable of extensive alarm and status reporting. These alarms are listed in Table 8 together with likely causes, and potential solutions.

### Table 8 - Faults/Troubleshooting guide

| List of Alarms | Active After [1] | Latched After[2] | Threshold Value | Internal Test | Potential Fault/Solution if alarm cannot be cleared |
|---|---|---|---|---|---|
| Oscillator Comms | >20 Sec | >10 min | If no packets received within 4 sec | # Data Packet Received from RB Board | Faulty Rubidium Oscillator Module<br>Faulty Master Clock Module |
| Oscillator Lock | >20 Sec | >10 min | 225 or more consecutive good counts will report a lock<br>5 or more consecutive bad counts will trigger a fault and prevent a lock. | Controlled by good and bad count thresholds | Faulty Rubidium Oscillator Module |
| Oscillator PLL Limit | >20 Sec | >10 min | count>5 or RBDacValue<1048575 * 0.01 or RBDacValue>1048575 * 0.99 | PollStatusFailedResponse, PollTempFailedResponsecount thresholds or RBDacValue | If both MCM1 and MCM2 show similar errors then Reference has consistent frequency error<br>Rubidium Oscillator Module has aged to adjustment limit. Remove and replace/factory recalibrate |
| Oscillator Temperature Limit | >20 Sec | >10 min | Temp<45°C \|\| Temp>85°C | Temperature after RB Warmup Completed | Check Fan airflow for obstructions<br>Check ambient temperature is <55degC |
| Internal PPS | >20 Sec | >10 min | 2001 msec | Wait for the FPGA 1PPS interrupt to occur or timeout | Check Rubidium Oscillator Module connections<br>Faulty Rubidium Oscillator Module<br>Faulty Master Clock Module |
| CrossLink Ref-A | >20 Sec | >10 min | !FreqPpsRefUsableCLRefA \| !TimeRefUsableCLRefA | Check for CLRefA Frequency PPS and Time Ref Usable Status, Lockable, and Monotonic | Indicates that the synchronizing reference being received over the optical link from the remote MGU is unusable. For the signal to be useable, the reference synchronizing the far end MGU must be valid, ( 1PPS must be present, time must be monotonic, not set disabled, and TFOM must be <4).<br>Verify status of far end MGU reference |
| CrossLink Ref-B | >20 Sec | >10 min | !FreqPpsRefUsableCLRefB \| !TimeRefUsableCLRefB | Check for CLRefB Frequency PPS and TimeRef Usable Status, Lockable, and Monotonic | Indicates that the synchronizing reference being received over the optical link from the remote MGU is unusable. For the signal to be useable, the reference synchronizing the far end MGU must be valid, ( 1PPS must be present, time must be monotonic, not set disabled, and TFOM must be <4).<br>Verify status of far-end MGU reference |
| HQ Input | >20 Sec | >10 min | !TimeRefUsableHaveQuick | Check for HaveQuick Time Ref Usable Status, Monotonic, HQTFomLock, !HQPpsFreqInflectionAlarm, !HQPpsFreqVsInitialRbAlarm, !HQPpsPhasePopAlarm | Indicates that the HaveQuick/1PPS reference is not useable. The reasons why it may not be useable are any of the following:<br>Time is not monotonic<br>TFOM>4<br>Frequency of reference vs Rb has changed by >5E-10 (5mHz)<br>Frequency compared Rb factory value has changed by >1.25E-9 (12.5 mHz)<br>Reference Phase has changed by >60ns from previous value.<br>Faulty MCM if this fault shows on only one MCM<br>Check external GPS receiver reference if fault shows on both MCM<br>Deselect Have Quick /1PPS reference if not in use |

[1] Alarms are not monitored or detected prior to this period after Power On Reset

[2] Alarms are not latched during this period to allow alarms due to system warm-up to automatically clear as the system warms up and synchronizes to its reference(s)

| List of Alarms | Active After [1] | Latched After[2] | Threshold Value | Internal Test | Potential Fault/Solution if alarm cannot be cleared |
|---|---|---|---|---|---|
| IRIG-B Input | >20 Sec | >10 min | !FreqPpsRefUsableIrigB \| !TimeRefUsableIrigB | Check for IRIG-B Time Ref Usable Status, Monotonic, IRIG-BTFomLock | Indicates that the IRIG reference is not useable. The reasons why it may not be useable are any of the following:<br>Time is not monotonic<br>TFOM>4<br>IRIG B input is not present<br>Faulty MCM if this fault shows on only one MCM<br>Check IRIG B reference<br>Deselect IRIG B reference from MCM setup menu if not being used. |
| 1PPS Input | >20 Sec | >10 min | !FreqPpsRefUsablePpsExt | Check for Ext PPS Usable Status | Indicates the 1PPS reference input is flagged unusable.<br>Check external 1PPS is present<br>Check external 1PPS level, termination<br>Check external 1PPS frequency<br>Faulty MCM if this fault shows on only one MCM<br>Deselect 1PPS reference from MCM setup menu if not being used. |
| 10MHz Input | >20 Sec | >10 min | !RMGetFreqPpsRefUsable10Mhz | Check for 10MHz Usable Status | Indicates the external 10MHz reference input is flagged unusable.<br>Check external 10MHz is present<br>Check external 10MHz level, termination<br>Check external 10MHz frequency<br>Faulty MCM if this fault shows on only one MCM<br>Deselect 10MHz reference from MCM setup menu if not being used. |
| GPS Input | >20 Sec | >10 min | !FreqPpsRefUsableGps | Check for GPS Time Ref Usable Status, Monotonic, Locked, GPS-PPS Available | Indicates the internal GPS reference input is flagged unusable.<br>Check GPS antenna, antenna cable, antenna location<br>Deselect GPS reference from MCM setup menu if not being used/not installed.<br>Replace MCM |
| ISM Ref-A | >20 Sec | >10 min | !FreqPpsRefUsableISMRefA \| !TimeRefUsableISMRefA | Check for ISM Ref-A Time Ref Usable Status, Monotonic | Indicates that the ISM Ref-A is not usable. The reasons why it may not be usable are any of the following:<br>NMEA time is not monotonic<br>1PPS input on J1 is not present<br>Deselect ISM Ref-A reference from MCM setup menu if not being used. |
| ISM Ref-B | >20 Sec | >10 min | !FreqPpsRefUsableISMRefB \| !TimeRefUsableISMRefB | Check for ISM Ref-B Time Ref Usable Status, Monotonic | Indicates that the ISM Ref-B is not usable.<br>NMEA time is not monotonic<br>1PPS input on J2 is not present<br>Deselect ISM Ref-B reference from MCM setup menu if not being used. |
| First 1PPS Output | >20 Sec | >10 min | >1024ms | FPGA re-triggable monostable with a timeout | No 1PPS output on J1.<br>Remove cable from J1 and clear alarms. If alarm clears then cable is shorted<br>Manually select alternate MCM. If alarm clears, then failure is on first MCM.<br>If alarm persists with no cable and is on both MCM's then fault is internal to chassis wiring/backplane |
| Second 1PPS Output | >20 Sec | >10 min | >1024ms | FPGA re-triggable monostable with a timeout | No 1PPS output on J2.<br>Remove cable from J2 and clear alarms. If alarm clears then cable is shorted<br>Manually select alternate MCM. If alarm clears, then failure is on first MCM.<br>If alarm persists with no cable and is on both MCM's then fault is internal to chassis wiring/backplane |

| List of Alarms | Active After [1] | Latched After[2] | Threshold Value | Internal Test | Potential Fault/Solution if alarm cannot be cleared |
|---|---|---|---|---|---|
| HQ Output | >20 Sec | >10 min | >1024ms | FPGA re-triggable monostable with a timeout | No Have Quick output on J4.<br>Remove cable from J4 and clear alarms. If alarm clears then cable is shorted<br>Manually select alternate MCM. If alarm clears, then failure is on first MCM.<br>If alarm persists with no cable and is on both MCM's then fault is internal to chassis wiring/backplane |
| IRIG-B Output | >20 Sec | >10 min | <1.6V $_{AVG}$ | FPGA RF Voltage Detector | No IRIG B output on J3.<br>Remove cable from J3 and clear alarms. If alarm clears then cable is shorted<br>Manually select alternate MCM. If alarm clears, then failure is on first MCM.<br>If alarm persists with no cable and is on both MCM's then fault is internal to chassis wiring/backplane |
| BCD Output | >20 Sec | >10 min | >1024ms | FPGA re-triggable monostable with a timeout | No BCD output on J8.<br>Remove cable from J8 and clear alarms. If alarm clears then cable is shorted<br>Manually select alternate MCM. If alarm clears, then failure is on first MCM.<br>If alarm persists with no cable and is on both MCM's then fault is internal to chassis wiring/backplane |
| 5MHz Output | >20 Sec | >10 min | <1.6V $_{AVG}$ | FPGA RF Voltage Detector | No 5 MHz output on J5.<br>Remove cable from J5 and clear alarms. If alarm clears then cable is shorted or wrongly terminated (should be 50 ohm)<br>Manually select alternate MCM. If alarm clears, then failure is on first MCM.<br>If alarm persists with no cable and is on both MCM's then fault is internal to chassis wiring/backplane |
| 10MHz Output | >20 Sec | >10 min | <1.6V $_{AVG}$ | FPGA RF Voltage Detector | No 10 MHz output on J6.<br>Remove cable from J6 and clear alarms. If alarm clears then cable is shorted<br>Manually select alternate MCM. If alarm clears, then failure is on first MCM.<br>If alarm persists with no cable and is on both MCM's then fault is internal to chassis wiring/backplane |
| This TFC vs CLRefA HQ+PPS Phase Mismatch | >45 Min | >45 Min | (HQPpsPhaseError - CLRefAHQPpsPhaseError) > 60 ns | (HQPpsPhaseError - CLRefAHQPpsPhaseError) > 60ns and HQPpsTimeMismatchThisVsCLRefA | There is a phase difference >60ns between the MGU reference and the reference driving the MGU at the far end of Crosslink A. The amount of phase difference can be seen on MCM Status Screen 4 (**Error! Reference source not found.**).<br>Verify that propagation delay compensation has been correctly implemented for the entire timing chain at both MGU's, including antenna cables, GPS delays, and other interconnect cables |
| This TFC vs CLRefB HQ+PPS Phase Mismatch | >45 Min | >45 Min | (HQPpsPhaseError - CLRefBHQPpsPhaseError) > 60 ns | (HQPpsPhaseError - CLRefBHQPpsPhaseError) > 60ns and HQPpsTimeMismatchThisVsCLRefB | There is a phase difference >60ns between the MGU reference and the reference driving the MGU at the far end of Crosslink B. The amount of phase difference can be seen on MCM Status Screen 4 (**Error! Reference source not found.**).<br>Verify that propagation delay compensation has been correctly implemented for the entire timing chain at both MGU's, including antenna cables, GPS delays, and other interconnect cables |

| List of Alarms | Active After [1] | Latched After[2] | Threshold Value | Internal Test | Potential Fault/Solution if alarm cannot be cleared |
|---|---|---|---|---|---|
| CLRefA vs CLRefB HQ+PPS Phase Mismatch | >45 Min | >45 Min | (CLRefAHQPpsPhaseError - CLRefBHQPpsPhaseError) > 60 ns | (CLRefAHQPpsPhaseError - dCLRefBHQPpsPhaseError) > 60ns and HQPpsTimeMismatchCLRefAVsCLRefB | There is a phase difference >60ns between the MGU reference driving Crosslink A and the MGU reference driving Crosslink B. The amount of phase difference can be seen on MCM Status Screen 4 (**Error! Reference source not found.**).<br>Verify that propagation delay compensation has been correctly implemented for the entire timing chain at both MGU's, including antenna cables, GPS delays, and other interconnect cables |
| This TFC vs CLRefA HQ+PPS Freq Mismatch | >45 Min | >45 Min | >5E-10 | Frequency Delta of 5 parts in the 10th | There is an apparent frequency difference >5E-10 between the HQ/1PPS reference driving this MGU and the MGU reference driving Crosslink A. Possible causes:<br>GPS receiver error/spoofing<br>Sudden temperature shift on one MGU<br>GPS antenna reconfiguration |
| This TFC vs CLRefB HQ+PPS Freq Mismatch | >45 Min | >45 Min | >5E-10 | Frequency Delta of 5 parts in the 10th | There is an apparent frequency difference >5E-10 between the HQ/1PPS reference driving this MGU and the MGU reference driving Crosslink B. Possible causes:<br>GPS receiver error/spoofing<br>Sudden temperature shift on one MGU<br>GPS antenna reconfiguration |
| CLRefA vs CLRefB HQ+PPS Freq Mismatch | >45 Min | >45 Min | >5E-10 | Frequency Delta of 5 parts in the 10th | There is an apparent frequency difference >5E-10 between the MGU reference driving Crosslink A and the MGU reference driving Crosslink B. Possible causes:<br>GPS receiver error/spoofing<br>Sudden temperature shift on one MGU<br>GPS antenna reconfiguration |
| This TFC HQ+PPS vs RB Startup Freq Mismatch | >45 Min | >45 Min | HQPPS vs RB Nominal Initialization Freq > 1.25E-9 | (HQPpsFreqFIRFilteredValue - InitialRbNormalizedFIRFilterdValue) > 1.25E-9 | The GPS reference driving this TFC/MCM appears to have a frequency error >1.25E-9 compared to the rubidium oscillator factory setting. Possible causes<br>GPS receiver error/spoofing<br>Sudden temperature shift on one MGU<br>GPS antenna reconfiguration<br>Rubidium Oscillator Failure |
| CLRefA HQ+PPS vs RB Startup Freq Mismatch | >45 Min | >45 Min | CLRefA HQPPS vs RB Nominal Initialization Freq > 1.25E-9 | (CLRefAHQPpsFreqFIRFilteredValue - InitialRbNormalizedFIRFilterdValue) > 1.25E-9 | The GPS reference driving the TFC connected through crosslink A appears to have a frequency error >1.25E-9 compared to this TFC rubidium oscillator factory setting. Possible causes<br>GPS receiver error/spoofing<br>Sudden large temperature shift on one MGU<br>GPS antenna reconfiguration<br>Rubidium Oscillator Failure |
| CLRefB HQ+PPS vs RB Startup Freq Mismatch | >45 Min | >45 Min | CLRefB HQPPS vs RB Nominal Initialization Freq > 1.25E-9 | (CLRefBHQPpsFreqFIRFilteredValue - InitialRbNormalizedFIRFilterdValue) > 1.25E-9 | The GPS reference driving the TFC connected through crosslink B appears to have a frequency error >1.25E-9 compared to this TFC rubidium oscillator factory setting. Possible causes<br>GPS receiver error/spoofing<br>Sudden large temperature shift on one MGU<br>GPS antenna reconfiguration<br>Rubidium Oscillator Failure |

| List of Alarms | Active After [1] | Latched After[2] | Threshold Value | Internal Test | Potential Fault/Solution if alarm cannot be cleared |
|---|---|---|---|---|---|
| This TFC HQ+PPS Frequency Inflection | >45 Min | >45 Min | >5E-10 | Frequency Delta of 5 parts in the 10th | The GPS reference driving this TFC/MCM appears to have a frequency error >5E-10 compared to its frequency over the last several hours. Possible causes<br>GPS receiver error/spoofing<br>Sudden temperature shift on the MGU<br>GPS antenna reconfiguration<br>GPS constellation change<br>Rubidium Oscillator Failure |
| CLRefA HQ+PPS Frequency Inflection | >45 Min | >45 Min | >5E-10 | Frequency Delta of 5 parts in the 10th | The GPS reference connected to this TFC/MCM through Crosslink A appears to have a frequency error >5E-10 compared to its frequency over the last several hours. Possible causes<br>GPS receiver error/spoofing<br>Sudden temperature shift on the MGU<br>GPS antenna reconfiguration<br>GPS constellation change<br>Rubidium Oscillator Failure |
| CLRefB HQ+PPS Frequency Inflection | >45 Min | >45 Min | >5E-10 | Frequency Delta of 5 parts in the 10th | The GPS reference connected to this TFC/MCM through Crosslink B appears to have a frequency error >5E-10 compared to its frequency over the last several hours. Possible causes<br>GPS receiver error/spoofing<br>Sudden temperature shift on the MGU<br>GPS antenna reconfiguration<br>GPS constellation change<br>Rubidium Oscillator Failure |
| This TFC HQ+PPS Phase Pop | >45 Min | >45 Min | HQPpsPhasePop>60ns \|\| HQPpsTimePop | Check External PPS for Phase Pop and HaveQuick Time difference | The 1PPS driving this TFC has jumped in phase by >60ns. Possible causes<br>GPS receiver error/spoofing<br>Incorrect cable termination on 1PPS<br>GPS antenna reconfiguration<br>GPS constellation change |
| CLRefA HQ+PPS Phase Pop | >45 Min | >45 Min | CLRefAHQPpsPhasePop>60ns \|\| CLRefAHQPpsTimePop | Check CLRefA HQPPS for Phase Pop and HaveQuick Time difference | The 1PPS driving the TFC connected to this MGU/SDU via Crosslink A has has jumped in phase by >60ns. Possible causes<br>GPS receiver error/spoofing<br>Incorrect cable termination on 1PPS<br>GPS antenna reconfiguration<br>GPS constellation change |
| CLRefB HQ+PPS Phase Pop | >45 Min | >45 Min | CLRefBHQPpsPhasePop>60ns \|\| CLRefBHQPpsTimePop | Check CLRefB HQPPS for Phase Pop and HaveQuick Time difference | The 1PPS driving the TFC connected to this MGU/SDU via Crosslink B has has jumped in phase by >60ns. Possible causes<br>GPS receiver error/spoofing<br>Incorrect cable termination on 1PPS<br>GPS antenna reconfiguration<br>GPS constellation change |
| Auto-Switch Reference Time Pop | >45 Min | >45 Min | Reference Time ≠ System Time | Check Reference Time vs System Time during Reference Auto-Switching | When the MCM switched from one input reference to the next priority reference, the time changed.<br>Causes could be different references that are in error<br>Clear alarm to accept the new time |

| List of Alarms | Active After [1] | Latched After[2] | Threshold Value | Internal Test | Potential Fault/Solution if alarm cannot be cleared |
|---|---|---|---|---|---|
| Alarm Buzzer On | >10 min | >10 min | Latch during System Faults until user Turn Off Buzzer | Check if Buzzer needs to be latched on | This is a global alarm that indicates that there is an alarm present on the system. Not all alarms are considered buzzer alarms – the complete list is in Appendix B – List of Possible Buzzer Alarms . If the audible buzzer is enabled, then the audio buzzer will be active. This can be cleared see 3.2.1. |
| FPGA Comms | On Power-Up | >10 min | FPGA ID String Match | Check if FPGA Loaded Correctly | Mismatch between expected FPGA ID and actual ID.<br>Possible causes:<br>Firmware or FPGA has not been loaded correctly.<br>Faulty MCM remove and replace the affected MCM |
| Slot-1 Power | N/A | N/A | Power read Input from Power Supply | Check for Slot-1 Power | No Power available from Power supply installed in slot 1<br>Possible<br>Power supply is switched off – check switch setting<br>No AC supply installed in Slot 1<br>No AC power - Check power source, check power cord<br>  Blown Fuse – remove power cord first for safety; then check fuse<br>Power Supply Failure - remove and replace |
| Slot-6 Power | N/A | N/A | Power read Input from Power Supply | Check for Slot-6 Power | No Power available from Power supply installed in slot 6<br>Possible causes<br>Power supply is switched off – check switch setting<br>No AC supply installed in Slot 6<br>No AC power - Check power source, check power cord<br>  Blown Fuse – remove power cord first for safety; then check fuse<br>Power Supply Failure - remove and replace |
| Fan-1 | On Power-Up | >10 min | Count<25/sec | Tachometer Count | Fan 1 has slowed below normal operation speed or stopped<br>Possible causes<br>Fan1 has obstruction – open front door and check for damage/debris<br>Fan 1 has failed – remove and replace |
| Fan-2 | On Power-Up | >10 min | Count<25/sec | Tachometer Count | Fan 2 has slowed below normal operation speed or stopped<br>Possible causes<br>Fan2 has obstruction – open front door and check for damage/debris<br>Fan 2 has failed – remove and replace |

# 8 Updating Firmware and FPGA

The MMC uses a simple utility program to update the firmware and FPGA inside the unit.

1. Prior to beginning, the following things are needed:

   a. Software utilities "GPNTSModuleUpdate.exe," BWIPConfig.exe (optional)

   b. New firmware/FPGA code files as required

      i. 925000110 MMC MCM App_v#.#.##.bwc (MCM firmware)
      927000110 MMC MCM FPGA_v##.bin (MCM FPGA)

      ii. 925000111 MMC OSM Universal_v#.#.##.hex (Universal OSM firmware)
      927000111 MMC OSM Universal FPGA_v##.bin (Universal OSM FPGA)

      iii. 925000112 MMC OSM NTP App_v#.#.##.bwc (NTP OSM firmware)
      927000112 MMC OSM NTP FPGA_v#.bin (NTP OSM FPGA)

      iv. 925000113 MMC OSM CrossLink_v#.#.##.hex (Crosslink OSM firmware)
      927000113 MMC OSM CrossLink FPGA_v#.#.bin (Crosslink OSM FPGA)

      v. 925000114 MMC OSM Analog_v#.#.##.hex (Low Noise Analog OSM firmware)
      927000114 MMC OSM Analog FPGA_v#.## (Low Noise Analog OSM FPGA)

      vi. 925000115 MMC OSM Telecom_v#.#.##.hex (Telecom OSM firmware)
      927000115 MMC OSM Telecom_v#.##.bin (Telecom OSM FPGA)

      vii. 925000116 MMC Rubidium Board_v#.#.##.hex (Rubidium Oscillator Module firmware)

      *Note: The MMC Rubidium Board does not have a FPGA chip onboard.*

      viii. 925601401 MMC ISM 1PPS-RS422_v#.#.#.bwc (1PPS-RS422 ISM firmware)

      927601401 MMC ISM 1PPS-RS422_v#.#.bin (1PPS-RS422 ISM FPGA)

   c. A Windows computer, a network switch, two Ethernet cables.

   d. Connect one Ethernet cable from the MCM-2's (or MCM-7's) maintenance port (Port 1) to a network switch's port. Connect another Ethernet cable from the computer Ethernet port to another network switch's port.

   e. Make sure that the computer has the same network subnet as the MCM-2's IP address (maintenance port). It may be necessary to go into the network setup of the computer to set a compatible fixed IP address.

   f. The password of the MMC unit in required.

   g. Alternatively, it is possible to connect an Ethernet cable directly from a Windows PC to a Modular Master Clock. To do that, make sure the PC being used is set to use a static IP address within the same IP and subnet range as the Modular Master Clock

2. Use the front panel display to set the IP address of Port 1 to an address that is compatible with the computer (in the same IP and subnet range).

3. Use BWIPSetup to verify that the Windows computer can see the Modular Master Clock over the network.

**Be sure to disconnect MMCView prior to uploading firmware.**


Figure 89 - Setting IP of Maintenance Port

4. Launch the MMCModuleUpdate.exe.
5. Enter the Port1's IP address (192.168.1.230) into the MCM IP-Address textbox.
6. Leave the MCM Password textbox blank (Default password) or enter the unit password if one has been set.
7. Select the desired module from the Module Slot Number drop-list as shown in Figure 90 - Firmware Update - Module Selection.

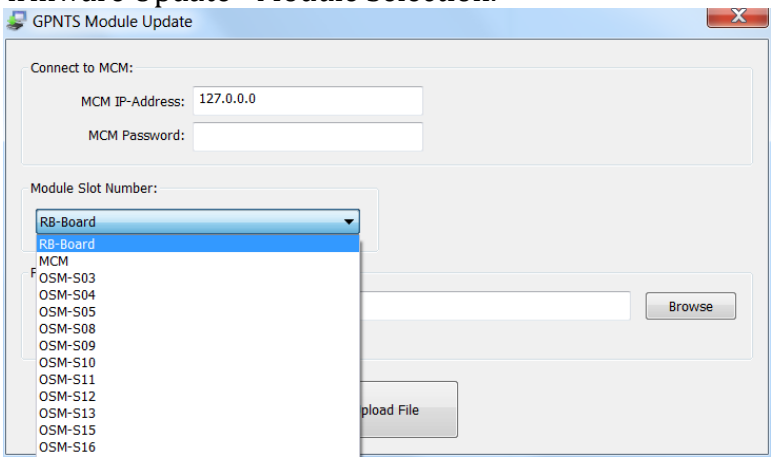



Figure 90 - Firmware Update - Module Selection

8. Click the Browse button to browse for the appropriate firmware file with .bwc or .hex file extension.
   An example of this for an MCM module is shown in Figure 91.

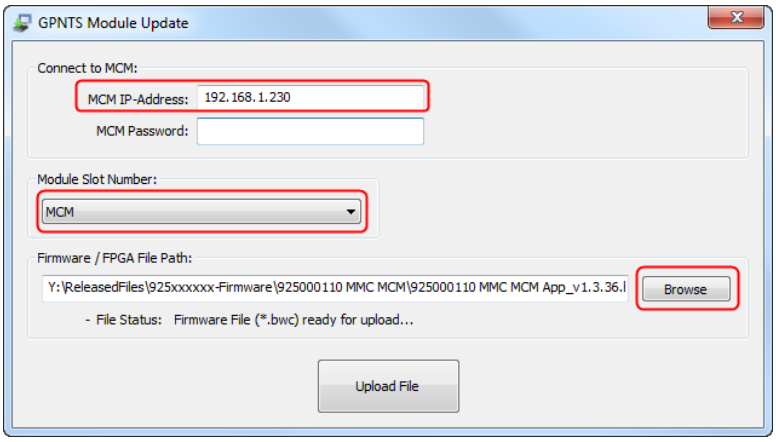



Figure 91 - Example of MCM firmware upload

8. Click the Upload File button when ready. Wait about one minute.
9. If an FPGA file (.bin) must be loaded as well, click the **No** button (Figure 92). Do **not** reset the unit until the FPGA has been uploaded as well.
10. If only firmware is being uploaded (no FPGA) then click the Yes button (Figure 94) to reset the MCM when the firmware is loaded successfully.

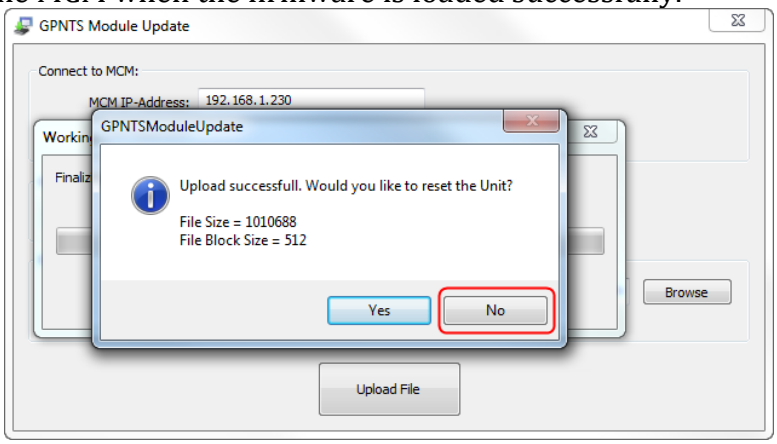



Figure 92 - Upload Firmware - Reset

11. If a new FPGA file must be uploaded as well, then repeat steps 4 through 9.
12. Click the Browse button to browse for the appropriate FPGA file with .bin file extension (Figure 93).
13. Click the Upload File button when ready. Wait about one minute.
14. When complete click the **Yes** button (Figure 94) to reset the module.
    a. If the unit does not automatically restart after loading firmware, manually power it off and power it back on again to load the new firmware.

b. Once the unit can been restarted, verify that the new firmware and/or FPGA has been installed and loaded by viewing the "Inventory" screen of the MMC, either via the front panel display or via MMCView.

15. If uploading an MCM, move the Ethernet cable to the desired MCM and repeat steps 3-14 as needed.

16. Repeat steps 3-8 or 3-14 as required for additional modules.

**For network security reasons, ping has been disabled. The Modular Master Clock, the system will not respond to any ping queries from another device on the network.**

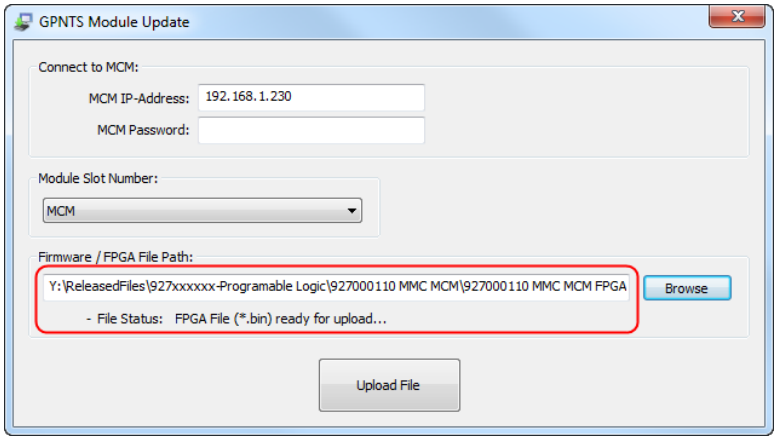



Figure 93 - Upload FPGA file

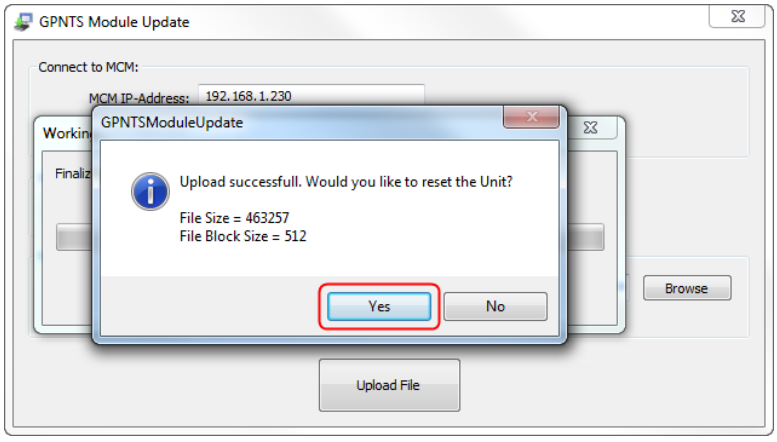



Figure 94 - Upload FPGA and Reset

## 8.1 Updating Firmware and FPGA for PTPSW OSM

Updating firmware and FPGA for the PTP Switch Output Signal Module (PTPSW OSM) is done differently than the other available modules. Please take the following steps:

1. Prior to beginning, the following are needed:
    a. Software utilities:
        - BWCUpdateClient
        - WinSCP (or equivalent)
        - Putty (or equivalent)
    b. New firmware/FPGA tar file as required
        - 925000322_v#_#_#.tar.gz
2. Boot the Modular Master Clock with the PTPSW OSM installed.
3. Configure the Management IP Address (Figure 95).

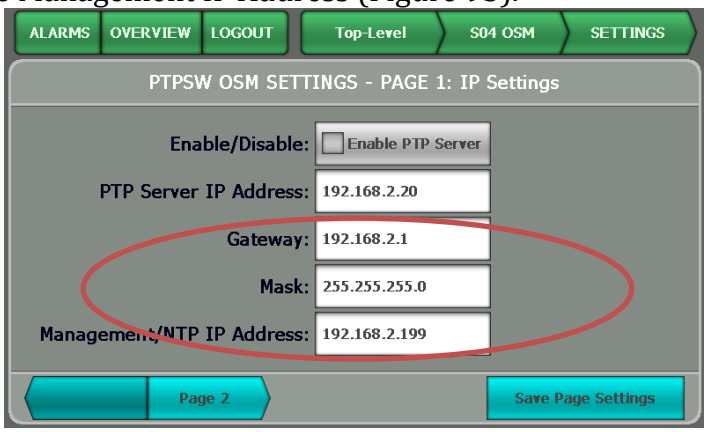



Figure 95 - PTPSW OSM IP Settings

4. Connect one of the Ethernet ports of the rear card to the network specified by the Management IP.

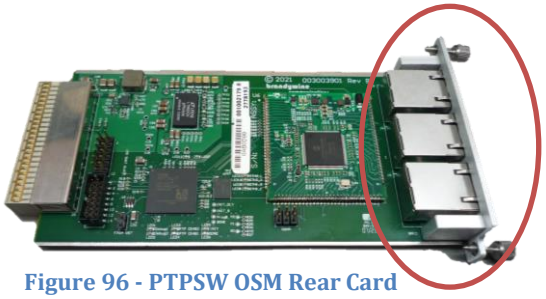


Figure 96 - PTPSW OSM Rear Card

5. Connect a PC to the same network as the Management IP.
6. Run WinSCP or equivalent (WinSCP is a Windows Utility to transfer files via SCP)
7. Configure to connect to the PTPSW OSM Management IP (i.e. Management IP at 192.168.2.199).
    - Transfer Protocol: SCP
    - Username: root
    - Password: #BRANDY1

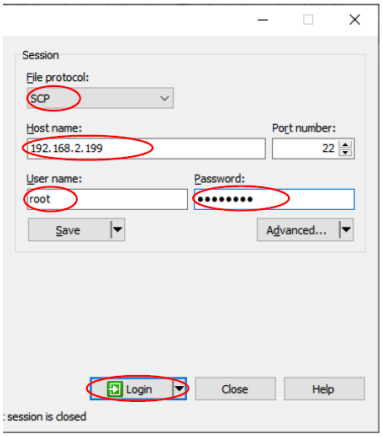



Figure 97 – Connect to PTPSW OSM

8. Transfer the new firmware package.tar.gz to the PTPSW OSM.

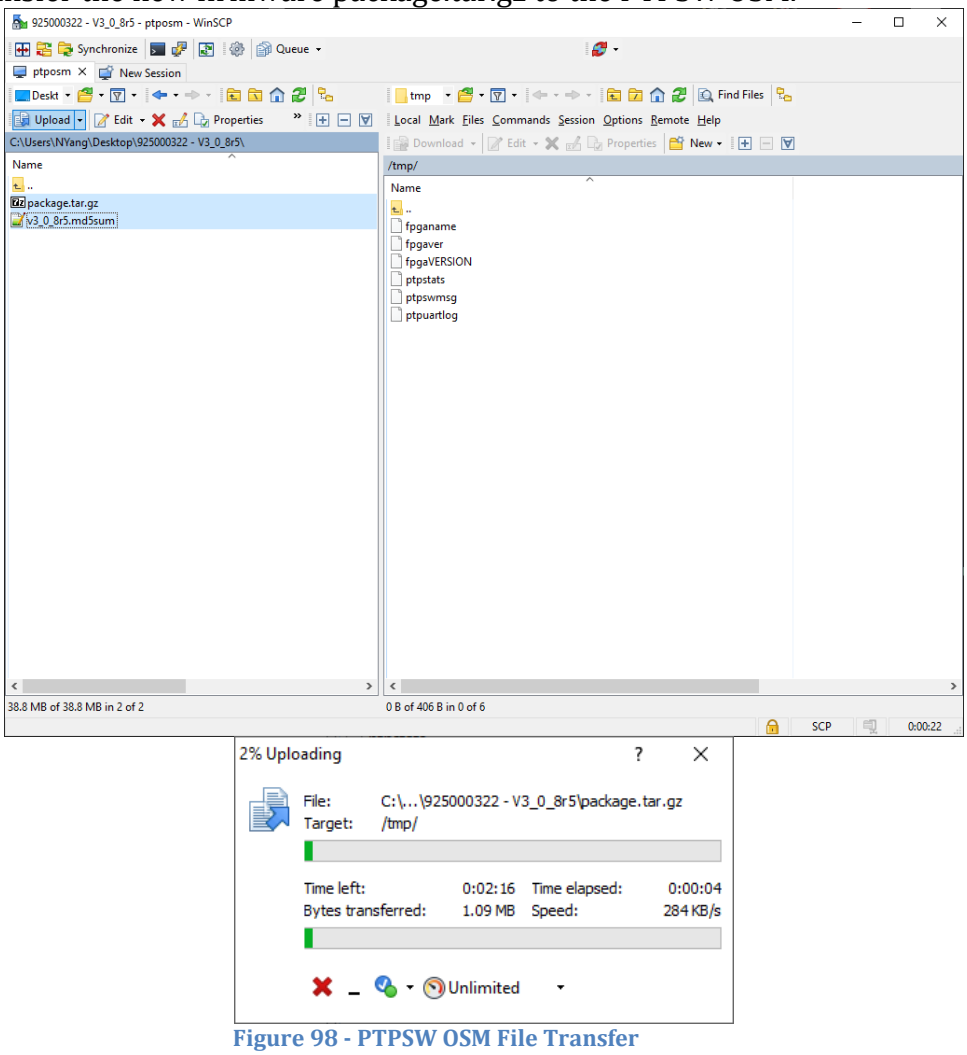



Figure 98 - PTPSW OSM File Transfer

9. SSH to the PTPSW OSM
   a. Open Putty or equivalent SSH utility

b. Connect to the PTPSW OSM (if prompted to accept new key, accept)
    - Username: root
    - Password: #BRANDY1

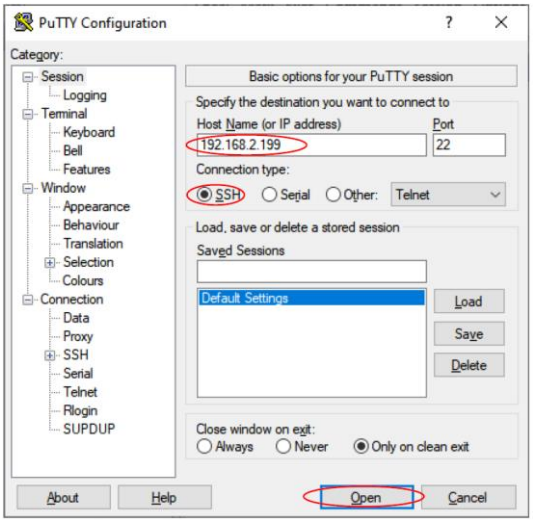



**Figure 99 - SSH to the PTPSW OSM**

10. Update firmware using the BWCUpdateClient utility
    a. Go to the tmp directory
        *# cd /var/tmp*
    b. Rename tar file to package.tar.gz if named differently from package.tar.gz
        *# mv 925000322_V#_#_#_R#.tar.gz package.tar.gz*
    c. Verify md5 checksum with given checksum
        *# md5sum package.tar.gz*
        *Compare the value with the one in the V#_#_#_R#.md5sum file*
    d. Current booted bank can be checked
        *# BWCUpdateClient status*
    e. Update code
        *# BWCUpdateClient update package file /var/tmp*
    f. PTPSW OSM will automatically reboot when done
    g. Reconnect SSH when PTPSW OSM is booted
    h. Current booted bank can be checked
        *# BWCUpdateClient status*
        *If the bank in Step D was Bank A*
            *kernel_A*
            *fdt_A*
            *fpga_A*
            *filesystem_A*
        *Then now should be Bank B*
            *kernel_B*
            *fdt_B*
            *fpga_B*
            *filesystem_B*
        *If the bank in Step D was Bank B, then now should be Bank A*

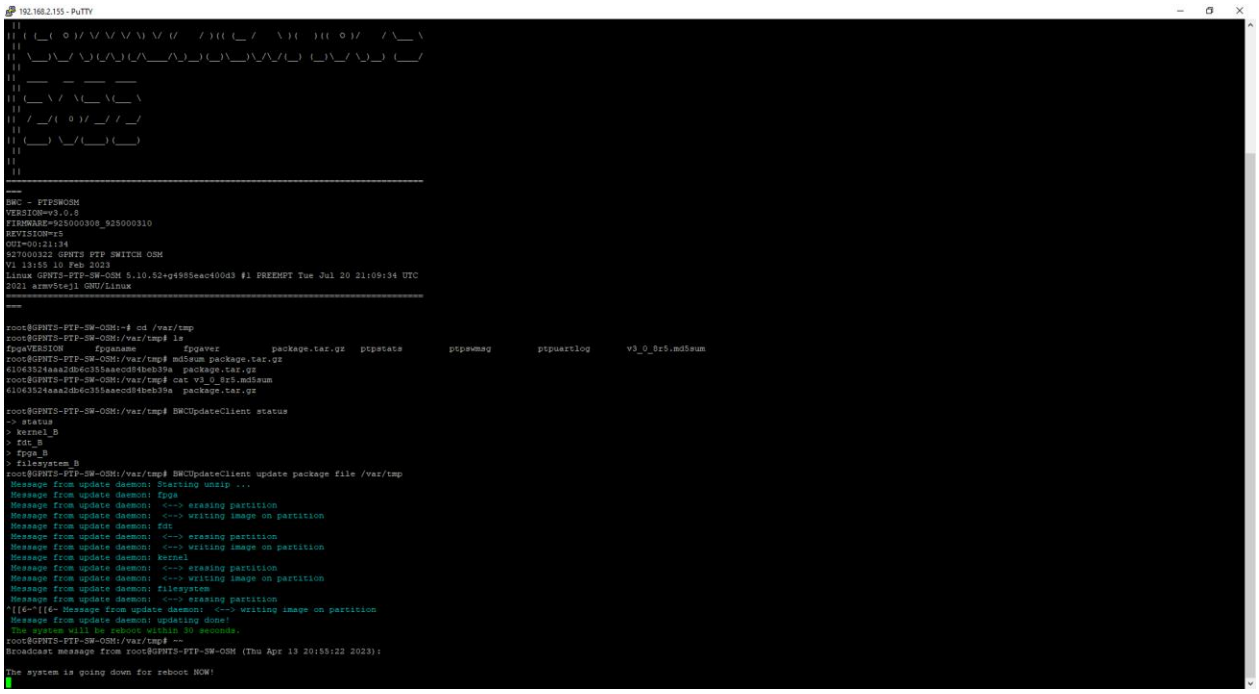



Figure 100 - PTPSW OSM Update Example

**Note:** Additional reboot of the module is needed if you want to update the code again.

# 9 Support Information

All Brandywine Communications products come with a one-year warranty.

If the unit is still exhibiting problems not covered by the above troubleshooting guide, contact us for technical support at support@brandywinecomm.com or call us at 714-755-1050.

If it becomes necessary to return the unit to the factory for repairs, call us at 714-755-1050 extension 113 to arrange an RMA.

# 10 Appendix A – Event List

The list below shows all the possible events that the MMC will log to the event viewer screen

"Front-Panel-Display Auto-logout"
"Front-Panel-Display User Login"
"Front-Panel-Display User Logout"
"User Changed Front-Panel-Display Password"
"HaveQuick Reference - Now Available"
"HaveQuick Reference - Now Monotonic"
"HaveQuick Reference - No Longer Monotonic"
"HaveQuick Reference - TFOM Locked"
"HaveQuick Reference - TFOM No Longer Locked"
"HaveQuick Reference - No Longer Available"
"HaveQuick Reference - Now Usable"
"HaveQuick Reference - No Longer Usable"
"Ext PPS Reference - Now Available"
"Ext PPS Reference - No Longer Available"
"Ext PPS Reference - Now Usable"
"Ext PPS Reference - No Longer Usable"
"10MHz Reference - Now Available"
"10MHz Reference - No Longer Available"
"10MHz Reference - Now Usable"
"10MHz Reference - No Longer Usable"
"IRIG B Reference - Now Available"
"IRIG B Reference - Now of type IEEE-1344"
"IRIG B Reference - TFOM Locked"
"IRIG B Reference - TFOM No Longer Locked"
"IRIG B Reference - No Longer of type IEEE-1344"
"IRIG B Reference - Now Monotonic"
"IRIG B Reference - No Longer Monotonic"
"IRIG B Reference - No Longer Available"
"IRIG B Reference - Now Usable"
"IRIG B Reference - No Longer Usable"
"Other MCM - Now Available"
"Other MCM - Now Lockable"
"Other MCM - No Longer Lockable"
"Other MCM HQ+PPS - Now Lockable"
"Other MCM HQ+PPS - Now Monotonic"
"Other MCM HQ+PPS - No Longer Monotonic"
"Other MCM HQ+PPS - No Longer Lockable"
"Other MCM - No Longer Available"
"Other MCM - Now Usable"
"Other MCM - No Longer Usable"
"Other MCM HQ+PPS - Now Usable"
"Other MCM HQ+PPS - No Longer Usable"
"CrossLink RefA - Now Available"
"CrossLink RefA - Now Lockable"
"CrossLink RefA - Now Monotonic"
"CrossLink RefA - No Longer Monotonic"
"CrossLink RefA - No Longer Lockable"
"CrossLink RefA MCM S02 - Now Lockable"
"CrossLink RefA MCM S02 HQ+PPS - Now Monotonic"
"CrossLink RefA MCM S02 HQ+PPS No Longer Monotonic"

"CrossLink RefA MCM S02 HQ+PPS - No Longer Lockable"
"CrossLink RefA MCM S07 HQ+PPS - Now Lockable"
"CrossLink RefA MCM S07 HQ+PPS - Now Monotonic"
"CrossLink RefA MCM S07 HQ+PPS No Longer Monotonic"
"CrossLink RefA MCM S07 HQ+PPS - No Longer Lockable"
"CrossLink RefA - No Longer Available"
"CrossLink RefA - Now Usable"
"CrossLink RefA - No Longer Usable"
"CrossLink RefA MCM S02 HQ+PPS - Now Usable"
"CrossLink RefA MCM S02 HQ+PPS - No Longer Usable"
"CrossLink RefA MCM S07 HQ+PPS - Now Usable"
"CrossLink RefA MCM S07 HQ+PPS - No Longer Usable"
"CrossLink RefB - Now Available"
"CrossLink RefB - Now Lockable"
"CrossLink RefB - Now Monotonic"
"CrossLink RefB - No Longer Monotonic"
"CrossLink RefB - No Longer Lockable"
"CrossLink RefB MCM S02 - Now Lockable"
"CrossLink RefB MCM S02 HQ+PPS - Now Monotonic"
"CrossLink RefB MCM S02 HQ+PPS No Longer Monotonic"
"CrossLink RefB MCM S02 HQ+PPS - No Longer Lockable"
"CrossLink RefB MCM S07 HQ+PPS - Now Lockable"
"CrossLink RefB MCM S07 HQ+PPS - Now Monotonic"
"CrossLink RefB MCM S07 HQ+PPS No Longer Monotonic"
"CrossLink RefB MCM S07 HQ+PPS - No Longer Lockable"
"CrossLink RefB - No Longer Available"
"CrossLink RefB - Now Usable"
"CrossLink RefB - No Longer Usable"
"CrossLink RefB MCM S02 HQ+PPS - Now Usable"
"CrossLink RefB MCM S02 HQ+PPS - No Longer Usable"
"CrossLink RefB MCM S07 HQ+PPS - Now Usable"
"CrossLink RefB MCM S07 HQ+PPS - No Longer Usable"
"Rubidium - Now Locked"
"Rubidium - No Longer Locked"
"This TFC HQ+PPS Frequency Inflection Alarm ON"
"CLRef-A HQ+PPS Frequency Inflection Alarm ON"
"CLRef-B HQ+PPS Frequency Inflection Alarm ON"
"HQ+PPS Normalized to Current Rb Frequency"
"HQ+PPS Frequency FIR Cascade Equalized"
"HQ+PPS vs Rb Startup Freq Mismatch Alarm ON"
"CLRef-A HQ+PPS Normalized to Current Rb Frequency"
"CLRef-A HQ+PPS Frequency FIR Cascade Equalized"
"CLRef-A HQ+PPS v Rb Startup Freq Mismatch Alarm ON"
"CLRef-B HQ+PPS Normalized to Current Rb Frequency"
"CLRef-B HQ+PPS Frequency FIR Cascade Equalized"
"CLRef-B HQ+PPS v Rb Startup Freq Mismatch Alarm ON"
"This TFC HQ+PPS Phase-pop Alarm ON"
"CLRef-A HQ+PPS Phase-pop Alarm ON"
"CLRef-B HQ+PPS Phase-pop Alarm ON"
"TFC Settings changed"
"MCM-S02 Settings changed"

"MCM-S07 Settings changed"
"Not receiving packets from Other MCM"
"PI Coefficients set to Coarse"
"PI Coefficients set to Fine"
"Starting Frequency Calculation"
"PI Freq Threshold exceeded - (Recalculate Slope)"
"PI Phase Error Threshold exceeded - (Jam Sync)"
"PI Acquiring to Reference"
"PI Locked to Reference"
"PI in Holdover"
"Osc Freq Scalar Calibrate -> FAILED"
"Osc Temp Comp Calibrate -> FAILED"
"Reseting Touch Display"
"Alarm Buzzer On for This MCM Fault Status Change"
"Other MCM no longer Installed"
"Other MCM now Installed"
"Alarm Buzzer On for Other MCM Fault Status Changed"
"Alarm Buzzer On for This TFC Fault Status Changed"
"CLRef-A Prevented from Ref Auto Selection"
"CLRef-B Prevented from Ref Auto Selection"
"CrossLink Ref-A OSM is no longer Installed"
"CrossLink Ref-A OSM is now Installed"
"CrossLink Ref-A is no longer Readable"
"CrossLink Ref-A is now Readable"
"CrossLink Ref-B OSM is no longer Installed"
"CrossLink Ref-B OSM is now Installed"
"CrossLink Ref-B is no longer Readable"
"CrossLink Ref-B is now Readable"
"Rubidium Stored TFC Data Set"
"Setting TFCInventory for MCM to RB TFCInventory"
"Setting TFCSettings for MCM to RB TFCSettings"
"Set TFCInventory for Offline to Online MCM"
"Set TFCSettings for Offline to Online MCM"
"Switched Reference to CrossLink Ref-A"
"Switched Reference to CrossLink Ref-B"
"Switched Reference to 1PPS Ext"
"Switched Reference to Irig B"
"Switched Reference to 10MHz"
"Set Freq Correction State for Slope Calc"
"Set Freq Correction State for PI Loop"
"Rubidium Temp Pop - Reset Filter"
"Ext PPS Pop - Reset Filter"
"IrigB Pop - Reset Filter"
"Other MCM Pop - Reset Filter"
"Other MCM HQ+PPS Pop - Reset Filter"
"CrossLink Ref-A Pop - Reset Filter"
"CrossLink Ref-B Pop - Reset Filter"
"CLRef-A MCM-S02 HQ+PPS - Reset Filter"
"CLRef-A MCM-S07 HQ+PPS - Reset Filter"
"CLRef-B MCM-S02 HQ+PPS - Reset Filter"
"CLRef-B MCM-S07 HQ+PPS - Reset Filter"
"10MHz Pop - Reset Filter"
"Frequency Calculation End"
"Nominal DAC Value has been Saved"
"Rubidium Aging Value has been Saved"
"Manual Reference CrossLink Ref-A selected"
"Manual Reference CrossLink Ref-B selected"
"Manual Reference HQ and 1PPS selected"
"Manual Reference IRIG-B selected"
"Manual Reference IRIG-B + 1PPS selected"

"Manual Reference 10MHz selected"
"Auto-selection Reference CrossLink Ref-A selected"
"Auto-selection Reference CrossLink Ref-B selected"
"Auto-selection Reference HQ + 1PPS selected"
"Auto-selection Reference IRIG-B selected"
"Auto-selection Reference IRIG-B and 1PPS selected"
"Auto-selection Reference 10MHz selected"
"Setting System Time to Time Ref None"
"Setting System Time to Time Ref CrossLink Ref-A"
"Setting System Time to Time Ref CrossLink Ref-B"
"Setting System Time to Time Ref HaveQuick time"
"Setting System Time to Time Ref IRIB-B time"
"Setting System LeapSecInfo to Reference CL REF-A"
"Setting System LeapSecInfo to Reference CL REF-B"
"Setting System LeapSecInfo to Reference IRIG-B"
"TFC Vs CLRef-A HQ+PPS Phase Mismatch Alarm ON"
"TFC Vs CLRef-A HQ+PPS Phase Mismatch Alarm OFF"
"TFC Vs CLRef-B HQ+PPS Phase Mismatch Alarm ON"
"TFC Vs CLRef-B HQ+PPS Phase Mismatch Alarm OFF"
"ClRef-A Vs CLRef-B HQ+PPS Phase Mismatch Alarm ON"
"ClRef-A Vs CLRef-B HQ+PPS Phase Mismatch Alarm OFF"
"TFC Vs CLRef-A HQ+PPS Freq Mismatch Alarm ON"
"TFC Vs CLRef-A HQ+PPS Freq Mismatch Alarm OFF"
"TFC Vs CLRef-B HQ+PPS Freq Mismatch Alarm ON"
"TFC Vs CLRef-B HQ+PPS Freq Mismatch Alarm OFF"
"ClRef-A Vs CLRef-B HQ+PPS Freq Mismatch Alarm ON"
"ClRef-A Vs CLRef-B HQ+PPS Freq Mismatch Alarm OFF"
"Master Auto-Switch Enable"
"Master Auto-Switch not Enable"
"Manual Master MCM Slot-02 Set"
"Manual Master MCM Slot-07 Set"
"This MCM Alarm Buzzer ON"
"This MCM Alarm Buzzer OFF"
"This MCM CrossLink Ref-A Fault ON"
"This MCM CrossLink Ref-A Fault OFF"
"This MCM CrossLink Ref-B Fault ON"
"This MCM CrossLink Ref-B Fault OFF"
"This MCM FPGA Fault ON"
"This MCM FPGA Fault OFF"
"This MCM 10MHz Input Fault ON"
"This MCM 10MHz Input Fault OFF"
"This MCM 1PPS Input Fault ON"
"This MCM 1PPS Input Fault OFF"
"This MCM HaveQuick Input Fault ON"
"This MCM HaveQuick Input Fault OFF"
"This MCM IRIGB Input Fault ON"
"This MCM IRIGB Input Fault OFF"
"This MCM Internal 1PPS Fault ON"
"This MCM Internal 1PPS Fault OFF"
"This TFC v CLRefA HQPPS Phase Mismatch Fault ON"
"This TFC v CLRefA HQPPS Phase Mismatch Fault OFF"
"This TFC v CLRefB HQPPS Phase Mismatch Fault ON"
"This TFC v CLRefB HQPPS Phase Mismatch Fault OFF"
"CLRefA v CLRefB HQPPS Phase Mismatch Fault ON"
"CLRefA v CLRefB HQPPS Phase Mismatch Fault OFF"
"This TFC v CLRefA HQPPS Freq Mismatch Fault ON"

"This TFC v CLRefA HQPPS Freq Mismatch Fault OFF"
"This TFC v CLRefB HQPPS Freq Mismatch Fault ON"
"This TFC v CLRefB HQPPS Freq Mismatch Fault OFF"
"CLRefA v CLRefB HQPPS Freq Mismatch Fault ON"
"CLRefA v CLRefB HQPPS Freq Mismatch Fault OFF"
"HQ-PPS v Initial Rubidium Freq Fault ON"
"HQ-PPS v Initial Rubidium Freq Fault OFF"
"HQ-PPS CLRefA v Initial Rubidium Freq Fault ON"
"HQ-PPS CLRefA v Initial Rubidium Freq Fault OFF"
"HQ-PPS CLRefB v Initial Rubidium Freq Fault ON"
"HQ-PPS CLRefB v Initial Rubidium Freq Fault OFF"
"HQ-PPS Freq Inflection Fault ON"
"HQ-PPS Freq Inflection Fault OFF"
"HQ-PPS CLRefA Freq Inflection Fault ON"
"HQ-PPS CLRefA Freq Inflection Fault OFF"
"HQ-PPS CLRefB Freq Inflection Fault ON"
"HQ-PPS CLRefB Freq Inflection Fault OFF"
"HQ-PPS Phase Pop Fault ON"
"HQ-PPS Phase Pop Fault OFF"
"HQ-PPS CrossLink Ref-A Phase Pop Fault ON"
"HQ-PPS CrossLink Ref-A Phase Pop Fault OFF"
"HQ-PPS CrossLink Ref-B Phase Pop Fault ON"
"HQ-PPS CrossLink Ref-B Phase Pop Fault OFF"
"Oscillator Board Comms Fault ON"
"Oscillator Board Comms Fault OFF"
"Oscillator Board Lock Fault ON"
"Oscillator Board Lock Fault OFF"
"Oscillator Board PLL Fault ON"
"Oscillator Board PLL Fault OFF"
"Oscillator Board Temperature Limit Fault ON"
"Oscillator Board Temperature Limit Fault OFF"
"10MHz Output Fault ON"
"10MHz Output Fault OFF"
"1PPS-A Output Fault ON"
"1PPS-A Output Fault OFF"
"1PPS-B Output Fault ON"
"1PPS-B Output Fault OFF"
"5MHz Output Fault ON"
"5MHz Output Fault OFF"
"BCD Output Fault ON"
"BCD Output Fault OFF"
"HaveQuick Output Fault ON"
"HaveQuick Output Fault OFF"
"IRIGB Output Fault ON"
"IRIGB Output Fault OFF"
"Unit is now MGU"
"Unit is now SDU"
"IA-Mode Enabled"
"IA-Mode Disabled"
"Online MCM HQ Ref now Usable"
"Online MCM HQ Ref not Usable"
"Offline MCM HQ Ref now Usable"
"Offline MCM HQ Ref not Usable"
"Fan1 Fault On"
"Fan1 Fault Off"
"Fan2 Fault On"
"Fan2 Fault Off"
"Offline MCM LS Epoch Time POSIX Changed"
"Offline MCM LS State - Not Pending"
"Offline MCM LS State - Pending Positive"
"Offline MCM LS State - Pending Negative"
"Offline MCM LS Info Last Set By Crosslink Ref-A"
"Offline MCM LS Info Last Set By Crosslink Ref-B"
"Offline MCM LS Info Last Set By IRIG-B"

"Offline MCM LS Info Last Set By MANUAL"
"Offline MCM LS Info Last Set By NONE"
"Offline MCM Reference CrossLink Ref-A selected"
"Offline MCM Reference CrossLink Ref-B selected"
"Offline MCM Reference HQ + 1PPS selected"
"Offline MCM Reference IRIG-B selected"
"Offline MCM Reference IRIG-B and 1PPS selected"
"Offline MCM Reference 10MHz selected"
"Offline MCM State changed to Warm-UP"
"Offline MCM State changed to Ready"
"Offline MCM State changed to Acquiring"
"Offline MCM State changed to Locked"
"Offline MCM State changed to Hold-Over"
"Offline MCM Stratum changed to 1"
"Offline MCM Stratum changed to 2"
"Offline MCM Stratum changed to 3"
"Offline MCM Stratum changed to 4"
"Offline MCM Stratum changed to 5"
"Offline MCM Stratum changed to 6"
"Offline MCM Stratum changed to 7"
"Offline MCM Stratum changed to 8"
"Offline MCM Stratum changed to 9"
"Offline MCM Stratum changed to 10"
"Offline MCM TFOM changed to <= 3"
"Offline MCM TFOM changed to >= 4"
"Offline MCM UTC Time Last Set By Crosslink Ref-A"
"Offline MCM UTC Time Last Set By Crosslink Ref-B"
"Offline MCM UTC Time Last Set By HaveQuick"
"Offline MCM UTC Time Last Set By IRIG-B"
"Offline MCM UTC Time Last Set By MANUAL"
"Offline MCM UTC Time Last Set By NONE"
"Online MCM SlotID changed to S02"
"Online MCM SlotID changed to S07"
"Online MCM LS Epoch Time POSIX Changed"
"Online MCM LS State - NOT PENDING"
"Online MCM LS State - PENDING POSITIVE"
"Online MCM LS State - PENDING NEGATIVE"
"Online MCM LS Info Last Set By Crosslink Ref-A"
"Online MCM LS Info Last Set By Crosslink Ref-B"
"Online MCM LS Info Last Set By IRIG-B"
"Online MCM LS Info Last Set By MANUAL"
"Online MCM LS Info Last Set By NONE"
"Online MCM Reference CrossLink Ref-A selected"
"Online MCM Reference CrossLink Ref-B selected"
"Online MCMReference HQ + 1PPS selected"
"Online MCM Reference IRIG-B selected"
"Online MCM Reference IRIG-B and 1PPS selected"
"Online MCM Reference 10MHz selected"
"Online MCM Reference ISM Ref-A selected"
"Online MCM Reference ISM Ref-B selected"
"Online MCM State changed to Warm-UP"
"Online MCM State changed to Ready"
"Online MCM State changed to Acquiring"

"Online MCM State changed to Locked"
"Online MCM State changed to Hold-Over"
"Online MCM Stratum changed to 1"
"Online MCM Stratum changed to 2"
"Online MCM Stratum changed to 3"
"Online MCM Stratum changed to 4"
"Online MCM Stratum changed to 5"
"Online MCM Stratum changed to 6"
"Online MCM Stratum changed to 7"
"Online MCM Stratum changed to 8"
"Online MCM Stratum changed to 9"
"Online MCM Stratum changed to 10"
"Online MCM TFOM changed to <= 3"
"Online MCM TFOM changed to >= 4"
"Online MCM UTC Time Last Set By Crosslink Ref-A"
"Online MCM UTC Time Last Set By Crosslink Ref-B"
"Online MCM UTC Time Last Set By HaveQuick"
"Online MCM UTC Time Last Set By IRIG-B"
"Online MCM UTC Time Last Set By MANUAL"
"Online MCM UTC Time Last Set By NONE"
"Slot1 Has Power"
"Slot1 Has No Power"
"Slot6 Has Power"
"Slot6 Has No Power"
"TFC Fault ON"
"TFC Fault OFF"
"Module-S02 Fault ON"
"Module-S02 Fault OFF"
"Module-S03 Fault ON"
"Module-S03 Fault OFF"
"Module-S04 Fault ON"
"Module-S04 Fault OFF"
"Module-S05 Fault ON"
"Module-S05 Fault OFF"
"Module-S07 Fault ON"
"Module-S07 Fault OFF"
"Module-S08 Fault ON"
"Module-S08 Fault OFF"
"Module-S09 Fault ON"
"Module-S09 Fault OFF"
"Module-S10 Fault ON"
"Module-S10 Fault OFF"
"Module-S11 Fault ON"
"Module-S11 Fault OFF"
"Module-S12 Fault ON"
"Module-S12 Fault OFF"
"Module-S13 Fault ON"
"Module-S13 Fault OFF"
"Module-S15 Fault ON"
"Module-S15 Fault OFF"
"Module-S16 Fault ON"
"Module-S16 Fault OFF"
"Module-S17 Fault ON"
"Module-S17 Fault OFF"
"TFC Type Changed to NONE"
"TFC Type Changed to MGU"
"TFC Type Changed to SDU IA-DISABLE"
"TFC Type Changed to SDU IA-ENABLE"
"Module-S02 Changed to NONE"
"Module-S02 Changed to MCM"
"Module-S07 Changed to NONE"
"Module-S07 Changed to MCM"
"Module-S03 Changed to NONE"
"Module-S03 Changed to Universal OSM"
"Module-S03 Changed to NTP OSM"
"Module-S03 Changed to CrossLink OSM"
"Module-S03 Changed to LPN Analog OSM"
"Module-S03 Changed to Telecom OSM"
"Module-S03 Changed to 1PPS-RS422 ISM"
“Module-S03 Changed to PTPSWOsm”
"Module-S04 Changed to NONE"
"Module-S04 Changed to Universal OSM"
"Module-S04 Changed to NTP OSM"
"Module-S04 Changed to CrossLink OSM"

"Module-S04 Changed to LPN Analog OSM"
"Module-S04 Changed to Telecom OSM"
"Module-S04 Changed to 1PPS-RS422 ISM"
“Module-S04 Changed to PTPSWOsm”
"Module-S05 Changed to NONE"
"Module-S05 Changed to Universal OSM"
"Module-S05 Changed to NTP OSM"
"Module-S05 Changed to CrossLink OSM"
"Module-S05 Changed to LPN Analog OSM"
"Module-S05 Changed to Telecom OSM"
"Module-S05 Changed to 1PPS-RS422 ISM"
"Module-S05 Changed to PTPSWOsm”
"Module-S08 Changed to NONE"
"Module-S08 Changed to Universal OSM"
"Module-S08 Changed to NTP OSM"
"Module-S08 Changed to CrossLink OSM"
"Module-S08 Changed to LPN Analog OSM"
"Module-S08 Changed to Telecom OSM"
"Module-S08 Changed to 1PPS-RS422 ISM"
"Module-S08 Changed to PTPSWOsm”
"Module-S09 Changed to NONE"
"Module-S09 Changed to Universal OSM"
"Module-S09 Changed to NTP OSM"
"Module-S09 Changed to CrossLink OSM"
"Module-S09 Changed to LPN Analog OSM"
"Module-S09 Changed to Telecom OSM"
"Module-S09 Changed to 1PPS-RS422 ISM"
"Module-S09 Changed to PTPSWOsm”
"Module-S10 Changed to NONE"
"Module-S10 Changed to Universal OSM"
"Module-S10 Changed to NTP OSM"
"Module-S10 Changed to CrossLink OSM"
"Module-S10 Changed to LPN Analog OSM"
"Module-S10 Changed to Telecom OSM"
"Module-S10 Changed to 1PPS-RS422 ISM"
"Module-S10 Changed to PTPSWOsm”
"Module-S11 Changed to NONE"
"Module-S11 Changed to Universal OSM"
"Module-S11 Changed to NTP OSM"
"Module-S11 Changed to CrossLink OSM"
"Module-S11 Changed to LPN Analog OSM"
"Module-S11 Changed to Telecom OSM"
"Module-S11 Changed to 1PPS-RS422 ISM"
"Module-S11 Changed to PTPSWOsm”
"Module-S12 Changed to NONE"
"Module-S12 Changed to Universal OSM"
"Module-S12 Changed to NTP OSM"
"Module-S12 Changed to CrossLink OSM"
"Module-S12 Changed to LPN Analog OSM"
"Module-S12 Changed to Telecom OSM"
"Module-S12 Changed to 1PPS-RS422 ISM"
"Module-S12 Changed to PTPSWOsm”
"Module-S13 Changed to NONE"
"Module-S13 Changed to Universal OSM"
"Module-S13 Changed to NTP OSM"
"Module-S13 Changed to CrossLink OSM"

"Module-S13 Changed to LPN Analog OSM"
"Module-S13 Changed to Telecom OSM"
"Module-S13 Changed to 1PPS-RS422 ISM"
"Module-S13 Changed to PTPSWOsm"
"Module-S15 Changed to NONE"
"Module-S15 Changed to Universal OSM"
"Module-S15 Changed to NTP OSM"
"Module-S15 Changed to CrossLink OSM"
"Module-S15 Changed to LPN Analog OSM"
"Module-S15 Changed to Telecom OSM"
"Module-S15 Changed to 1PPS-RS422 ISM"
"Module-S15 Changed to PTPSWOsm"
"Module-S16 Changed to NONE"
"Module-S16 Changed to Universal OSM"
"Module-S16 Changed to NTP OSM"
"Module-S16 Changed to CrossLink OSM"
"Module-S16 Changed to LPN Analog OSM"
"Module-S16 Changed to Telecom OSM"
"Module-S16 Changed to 1PPS-RS422 ISM"
"Module-S16 Changed to PTPSWOsm"
"Module-S17 Changed to NONE"
"Module-S17 Changed to Universal OSM"
"Module-S17 Changed to NTP OSM"
"Module-S17 Changed to CrossLink OSM"
"Module-S17 Changed to LPN Analog OSM"
"Module-S17 Changed to Telecom OSM"
"Module-S17 Changed to 1PPS-RS422 ISM"
"Module-S17 Changed to PTPSWOsm"
"Auto Master MCM set Slot S02"
"Auto Master MCM set Slot S07"
"Module-S03 Settings Changed"
"Module-S04 Settings Changed"
"Module-S05 Settings Changed"
"Module-S08 Settings Changed"
"Module-S09 Settings Changed"
"Module-S10 Settings Changed"
"Module-S11 Settings Changed"
"Module-S12 Settings Changed"
"Module-S13 Settings Changed"
"Module-S15 Settings Changed"
"Module-S16 Settings Changed"
"Module-S17 Settings Changed"
"GPS Reference - Now Available"
"GPS Reference - Now Monotonic"
"GPS Reference - No Longer Monotonic"
"GPS Reference - Now Locked"
"GPS Reference - No Longer Locked"
"GPS Reference - No Longer available"
"GPS-PPS Reference - Now Available"
"GPS-PPS Reference - No Longer Available"
"GPS Reference - Now Usable"
"GPS Reference - No Longer Usable"
"GPS-PPS Pop - Reset Filter"
"Switched Reference to GPS"
"Manual Reference GPS selected"
"Auto-selection Reference GPS selected"
"Setting System Time to Time Ref GPS time"
"Online MCM Reference GPS selected"
"This MCM GPS Input Fault ON"
"This MCM GPS Input Fault OFF"
"ISM Ref A - Detected"
"ISM Ref A - Not Detected"
"ISM Ref A - Now Available"
"ISM Ref A - No Longer Available"
"ISM Ref B - Detected"
"ISM Ref B - Not Detected"
"ISM Ref B - Now Available"
"ISM Ref B - No Longer Available"
"ISM Ref A - Now Available"
"ISM Ref A - Now Monotonic"

"ISM Ref A - No Longer Monotonic"
"ISM Ref A - Now Usable"
"ISM Ref A - No Longer Usable"
"ISM Ref B - Now Available"
"ISM Ref B - Now Monotonic"
"ISM Ref B - No Longer Monotonic"
"ISM Ref B - Now Usable"
"ISM Ref B - No Longer Usable"
"Switched Reference to ISM Ref A"
"Switched Reference to ISM Ref B"
"ISM Ref A Pop - Reset Filter"
"ISM Ref B Pop - Reset Filter"
"Manual Reference ISM Ref-A selected"
"Manual Reference ISM Ref-B selected"
"Auto-selection Reference ISM Ref-A selected"
"Auto-selection Reference ISM Ref-B selected"
"System Vs ISM Ref-A Reference Time Pop Alarm ON"
"System Vs ISM Ref-B Reference Time Pop Alarm ON"
"Online MCM UTC Time Last Set By ISM Ref-A"
"Online MCM UTC Time Last Set By ISM Ref-B"
"Offline MCM Reference ISM Ref-A selected"
"Offline MCM Reference ISM Ref-B selected"
"Offline MCM UTC Time Last Set By ISM Ref-A"
"Offline MCM UTC Time Last Set By ISM Ref-B"
"Setting System Time to Time Ref ISM Ref-A"
"Setting System Time to Time Ref ISM Ref-B"
"This MCM ISM Ref-A Fault ON"
"This MCM ISM Ref-A Fault OFF"
"This MCM ISM Ref-B Fault ON"
"This MCM ISM Ref-B Fault OFF"
"Outputs Disabled, TFOM >= 7 on Start-Up"
"Outputs Enabled, TFOM < 7 on Start-Up"

# 11 Appendix B – List of Possible Buzzer Alarms

The alarms listed below are linked to the audible buzzer.

"FPGA Comms Fault"
"RB-Board Comm Fault"
"RB-Board Lock Fault"
"RB-Board PLL Fault"
"B-Board Temp Fault"
"Internal PPS Fault"
"CL-Ref-A Fault"
"CL-Ref-B Fault"
"Input HQ Fault"
"Input IRIG-B Fault"
"Input PPS Fault"
"Input 10MHz Fault"
"Input GPS Fault"
"Output PPS-A Fault"
"Output PPS-B Fault"
"Output HQ Fault"
“Output IRIG-B Fault"
"Output BCD Fault"
"Output 5MHz Fault"
"Output 10MHz Fault"
"This TFC vs CLRefA HQ+PPS Phase Mismatch Fault"
"This TFC vs CLRefB HQ+PPS Phase Mismatch Fault"
"CLRefA vs CLRefB HQ+PPS Phase Mismatch Fault"
"This TFC vs CLRefA HQ+PPS Frequency Mismatch Fault"
"This TFC vs CLRefB HQ+PPS Frequency Mismatch Fault"
"CLRefA vs CLRefB HQ+PPS Frequency Mismatch Fault"
"This TFC HQ+PPS vs RB Startup Frequency Mismatch Fault"
"CLRefA HQ+PPS vs RB Startup Frequency Mismatch Fault"
"CLRefB HQ+PPS vs RB Startup Frequency Mismatch Fault"
"This TFC HQ+PPS Frequency Inflection Fault"
"CLRefA HQ+PPS Frequency Inflection Fault"
"CLRefB HQ+PPS Frequency Inflection Fault"
"This TFC HQ+PPS Phase Pop Fault"
"CLRefA HQ+PPS Phase Pop Fault"
"CLRefB HQ+PPS Phase Pop Fault"
"Fan-1 Fault"
"Fan-2 Fault"
"Module-S03 Fault"
"Module-S04 Fault"
"Module-S05 Fault"
"Module-S08 Fault"
"Module-S09 Fault"
"Module-S10 Fault"
"Module-S11 Fault"
"Module-S12 Fault"
"Module-S13 Fault"
"Module-S15 Fault"
"Module-S16 Fault"
"Module-S17 Fault"
“ISM Ref-A Fault”
“ISM Ref-B Fault”

## 12 Appendix C – List of Possible Alarms

The list below indicates all possible alarms that the MMC can generate.

"Alarm Buzzer On"
"FPGA Comms Fault"
"RB-Board Comm Fault"
"RB-Board Lock Fault"
"RB-Board PLL Fault"
"RB-Board Temp Fault"
"Internal PPS Fault"
"CL-Ref-A Fault"
"CL-Ref-B Fault"
"Input HQ Fault"
"Input IRIG-B Fault"
"Input PPS Fault"
"Input 10MHz Fault"
"Input GPS Fault"
"Output PPS-A Fault"
"Output PPS-B Fault"
"Output HQ Fault"
"Output IRIG-B Fault"
"Output BCD Fault"
"Output 5MHz Fault"
"Output 10MHz Fault"
“ISM Ref-A Fault”
“ISM Ref-B Fault”
"This TFC vs CLRefA HQ+PPS Phase Mismatch Fault"
"This TFC vs CLRefB HQ+PPS Phase Mismatch Fault"
"CLRefA vs CLRefB HQ+PPS Phase Mismatch Fault"
"This TFC vs CLRefA HQ+PPS Frequency Mismatch Fault"
"This TFC vs CLRefB HQ+PPS Frequency Mismatch Fault"
"CLRefA vs CLRefB HQ+PPS Frequency Mismatch Fault"
"This TFC HQ+PPS vs RB Startup Frequency Mismatch Fault"
"CLRefA HQ+PPS vs RB Startup Frequency Mismatch Fault"
"CLRefB HQ+PPS vs RB Startup Frequency Mismatch Fault"
"This TFC HQ+PPS Frequency Inflection Fault"
"CLRefA HQ+PPS Frequency Inflection Fault"
"CLRefB HQ+PPS Frequency Inflection Fault"
"This TFC HQ+PPS Phase Pop Fault"
"CLRefA HQ+PPS Phase Pop Fault"
"CLRefB HQ+PPS Phase Pop Fault"
"SDU (CL-S2_to_S17-Rx1) Fault" excluding slot 6,7,14

"SDU (CL-S2_to_S17-Rx2) Fault" excluding slot 6,7,14

"Fan-1 Fault"
"Fan-2 Fault"
"S2_or_S7 CrossLink Ref-A Prevented"
"S2_or_S7 CrossLink Ref-B Prevented"
"S2_or_S7 HaveQuick + 1PPS Prevented"
"S2_or_S7 IRIG-B Only Prevented"
"S2_or_S7 IRIG-B + 1PPS Prevented"
"S2_or_S7 10MHz Prevented"

# 13 Appendix D – Factory Reset

To restore the Modular Master Clock to the factory default settings (Please note that this will only work with version 4.2.58 or later of the software):

1. Close any MMCView sessions and power off the Modular Master Clock.
2.  Observe all necessary precautions for handling electrostatic discharge sensitive devices when performing these steps.
3. Open the front panel of the unit as described in section 6.2 of this document.
4. Remove the Master Clock Module to be reset from slots 2 or 7 using the MMC Module Removal Tool (P/N 800000016)
5. Locate the P2 jumper block behind the serial connector on the Master Clock Module

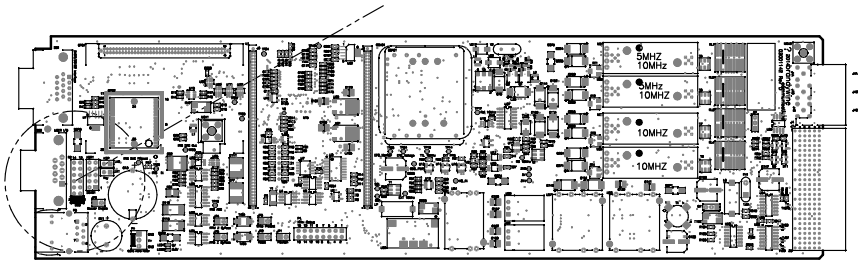



Figure 101 - Master Clock Module

6. Move the two debug jumpers from the transport position, which closes pins 2 and 4, and 6 and 8 (Figure 102 - Serial Port Jumpers in Transport Position) to the active position, which closes pins 1 and 2, and 5 and 6, (Figure 103 - Serial Port Jumpers in Active Position) to enable the front serial port.

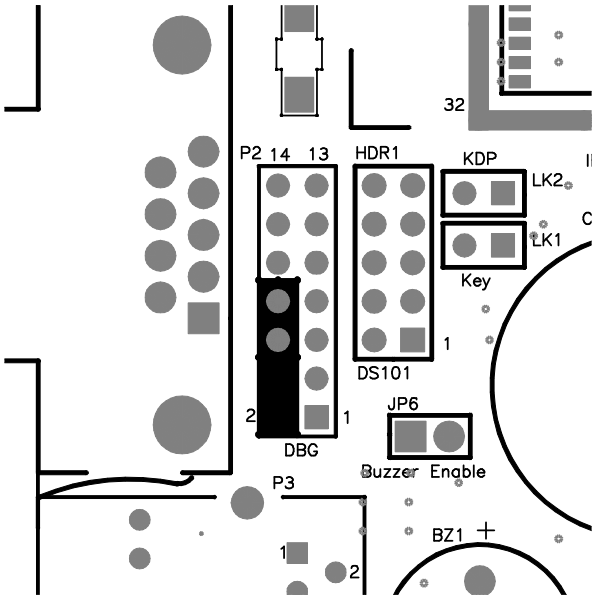



Figure 102 - Serial Port Jumpers in Transport Position

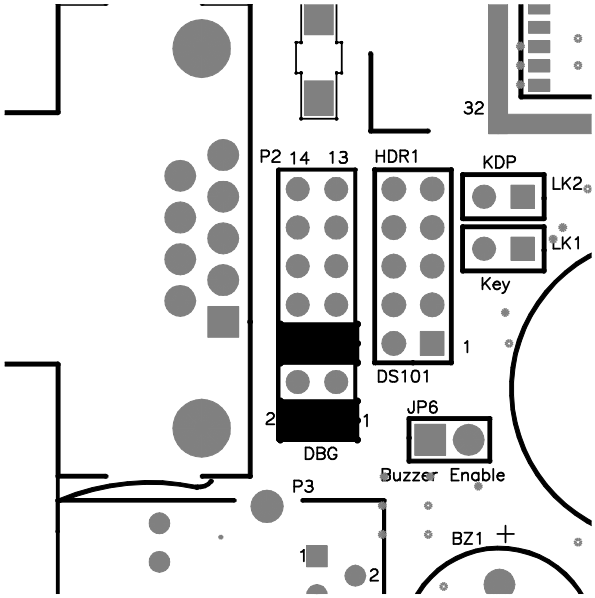



Figure 103 - Serial Port Jumpers in Active Position

7. Re-insert the Master Clock Modules into the chassis by following the steps outlined in section 6.3 of this document.
8. Power on the Modular Master Clock
9. Connect to the serial port on the front of the Master Clock Module using a straight DB-9 serial port cable, and a terminal program with the following settings:
   Baud Rate: 115200, Parity: None, Data: 8-Bit, Stop: 1-Bit.
10. Press Esc to open the MCM Menu.

```
MCM MENU:
        1: Reset to factory defaults
        2: Reboot
ENTER MENU OPTION>
```

Figure 104 - Master Clock Module Serial Menu

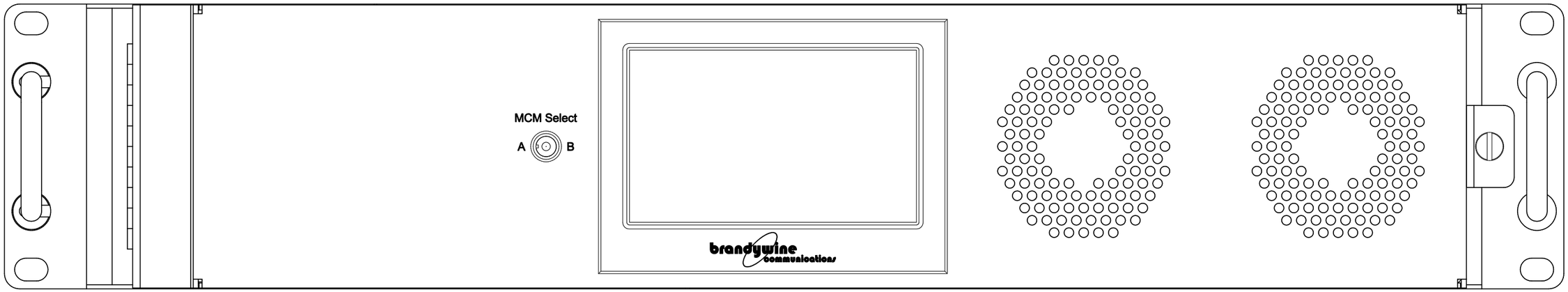
11. Enter the command "1" to reset the unit.
12. The unit will have the following settings applied:
    a. Password will be blank
    b. Front and rear IP Addresses will be restored to a known state of 192.168.1.181 and 192.168.1.182
    c. The GPS receiver will perform a cold-start

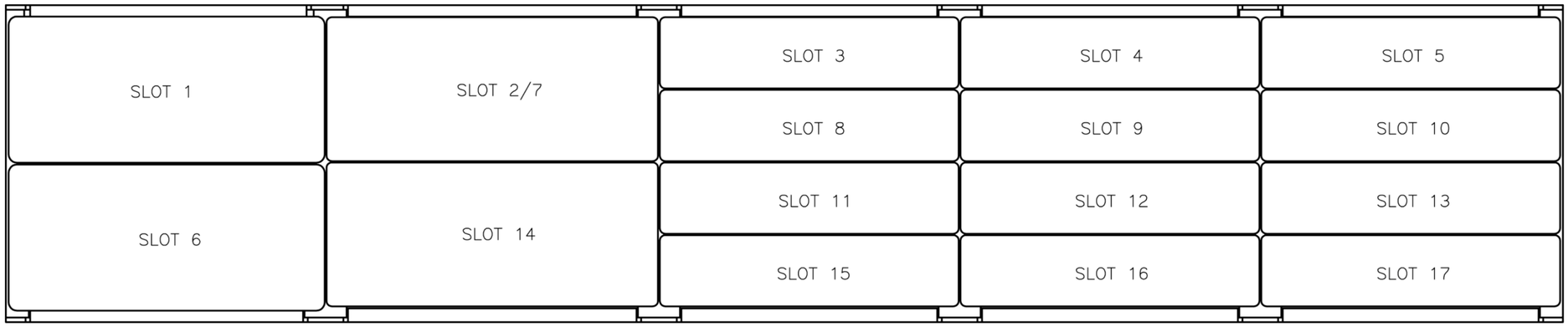
**CAUTION:**
**A factory reset of one of the Master Clock Modules will set the password of the other Master Clock Module to blank to prevent a system conflict of having two different passwords. A separate factory reset operation of the other Master Clock Module must still be performed to reset the IP address and cold start the GPS of the other unit.**

13. Remove the serial cable from the master clock module and reset the jumpers to the transport position.
14. Repeat the procedure to reset the other Master Clock Module.

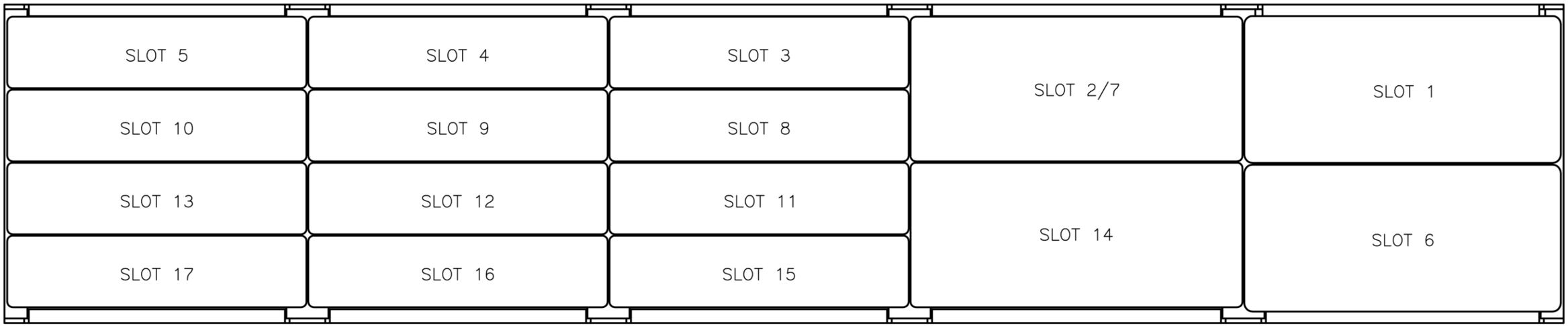
**CAUTION:**
**Change the IP addresses of the first Master Clock Module after you reset it to prevent an IP Address Conflict once the second Master Clock Module has been reset**

## 14 Front Panel Drawing



## 15 Rear Panel Drawings




Rear View