Universal Time and Frequency System

Operations and Maintenance Manual

TIMING SOLUTIONS™

Note: The TSC marketing material refers to this system and its components with different names than are used in this manual and on the hardware itself. The UTCG referred to in the marketing material is called the Master Clock Assembly, or MCA. The FEC referred to in the marketing material is the Distribution Assembly or DA.

Universal Time and Frequency System Operations and Maintenance Manual

DOC04300 Revision G

Revision History

Revision	Description	Date	Approved
A	Initial Release	10/06/03	GAR
B	Update system, MCA and DA naming conventions to reflect marketing literature.	3/2/04	GAR
C	Add Ethernet monitoring	9/10/04	GAR
D	Add 4309 and 4310	12/22/04	GAR
E	Integrate CWDM5 information	1/14/05	GAR
F	Add 4310 details, add 4340A	9/12/05	GAR
G	Add 4311 and 4313	1/10/06	GAR

Contents

1: Introduction

Note: The TSC marketing material refers to this systems' components with different names than are used in this manual and on the hardware itself. The UTCG referred to in the marketing material is called the Master Clock Assembly, or MCA. The FEC referred to in the marketing material is the Distribution Assembly or DA.

The Time and Frequency Distribution System is a modular and hierarchical system that you can configure as needed to provide precision time and frequency to various users. The system provides the flexibility to easily modify the inter-connection configuration of the time code distribution system to meet your evolving timing requirements.

The time code signals from the Master Clock Assembly (MCA) output ports feed directly to Time Code Translators (TCTs) or to Distribution Assemblies (DAs) in the first stage of the distribution hierarchy. Depending on local configuration requirements, you can then cable the time code output of each DA either to a second-level DA or directly to a Time Code Translator (TCT).

Each TCT and DA returns a monitor one pulse per second (1 PPS) signal with status information to the MCA or DA output that it is connected to. Using the missing pulse detection (MPD) or Ethernet connection at the TCG, you can monitor the status of TCTs and DAs in the entire system.

1.1 About This Manual

This manual tells you how to install, set up, maintain, and troubleshoot the Time and Frequency Distribution System.

"Chapter 1, Introduction" on page 1 provides a system overview, briefly describing each major component and its constituent modules.

"Chapter 2, Installing and Setting up the Time and Frequency Distribution System" on page 13 describes how to install each major component and set the time.

"Chapter 3, Maintaining the Time and Frequency Distribution System" on page 36 describes how to monitor the synchronization of the MCA's 1 pps signal and how to adjust the time.

"Chapter 4, Troubleshooting the Time and Frequency Distribution System" on page 42 describes in detail the LEDs and alarms on each module and what actions to take, if any, when an LED is lit. It also describes how to replace modules.

"Chapter 5, Warranty and Shipping Information" on page 60 contains information regarding warranty and shipping.

"Appendix A, Specifications" on page 61 contains the detailed specifications for the Time and Frequency Distribution System and for each module.

"Appendix B, Theory of Operation" on page 79 describes how the system works in more detail.

"Appendix C, Parts List" on page 91 contains a list of the Time and Frequency Distribution System parts and part numbers.

1.1.1 Conventions

This manual uses several typographical conventions to help explain how to use the Time and Frequency Distribution System.

Convention	Definition
Bold	Words in **bold** show: ■ Buttons to press ■ Commands to type ■ Non-variable information displayed in response to commands
Note	This symbol means the following information is a note that gives you important information that may affect how you use the Time and Frequency Distribution System
Caution	This symbol means the following information is a caution that warns you about actions that may adversely affect your system.

1.2 Understanding System Components

The Time and Frequency Distribution System comes in two different versions:

■ Multi-mode fiber—For distances up to 2 km between each fiber optic connection. It uses a tan or white plastic divider between the transmit (Tx) and receive (Rx) connectors on the system modules. The part numbers for these modules have either an M or no suffix, for example 4351M or 4300.

■ Single-mode fiber—For distances up to 30 km between each fiber optic connection with two connections on the cable. It uses a blue plastic divider between the Tx and Rx connectors on the system modules. The part numbers for these modules have a suffix of S. Products with CWDM transceivers are identified with a CWDM5 suffix.

Figure 1 shows a basic Time and Frequency Distribution System configuration using a single MCA.
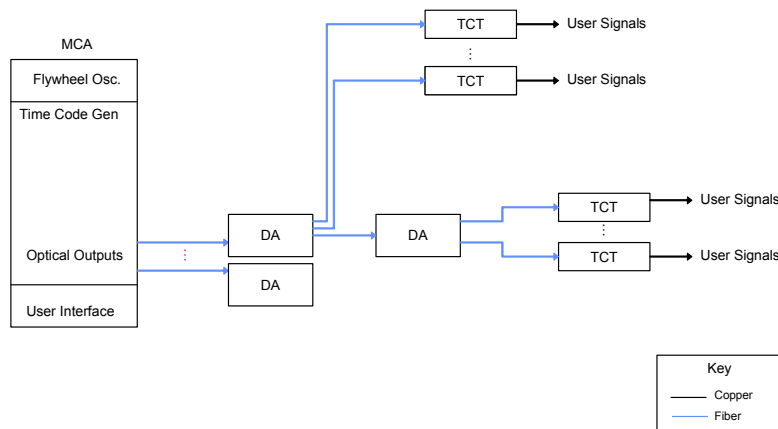
Figure 1: Time and Frequency Distribution System basic configuration

The Time and Frequency Distribution System consists of the following major components:

- Master Clock Assembly (MCA)—Generates the system time code using an external 5, 10, or 100 MHz signal as a phase-lock reference (reference signal). You set the time either manually or using an IRIG-B signal. For more information, see "1.2.1 Understanding the Master Clock Assembly" on page 3.

- Distribution Assemblies (DAs)—Contain modules to receive and distribute the time code via fiber optic cable throughout the location. For more information, see "1.2.2 Understanding the Distribution Assembly" on page 8.

- Time Code Translators (TCTs)—Receive the time code at remote locations from either the MCA or a DA, then supply a range of pulse rates and several possible time code outputs. For more information, see "1.2.3 Understanding the Time Code Translator" on page 10.

For detailed specifications, see "Appendix A, Specifications" on page 61. For detailed theory of operations, see "Appendix B, Theory of Operation" on page 79.

1.2.1 Understanding the Master Clock Assembly

Figure 2 shows the Master Clock Assembly (MCA) modules.

Power Supply—One of two redundant modules.

MCA User Interface (UI)—Displays time and provides interface to set time and leap flags.

Time Code Generator (TCG)—Generates the optical Serial Time Code (STC) and synchronized 1 pps signals.

Flywheel—Provides an internal 100 MHz signal that is phase locked to the reference signal.

Power Supply—One of two redundant modules.

Figure 2: MCA modules

1.2.1.1 Power Supply Modules

The Power Supply modules at either end of the MCA provide redundant power to the MCA. If one Power Supply module fails, the MCA continues to operate. You can then replace the failed module without losing the time setting or disturbing the serial time code outputs.

You can also hot swap either Power Supply module at any time without disturbing the time code output. The right and left Power Supply modules are identical. For more information, see "4.5.1 Replacing a Power Supply Module" on page 53.

The MCA can house a maximum of two Power Supply modules, which you can install in only the extreme left and right slots (slots 1 and 13) in the MCA chassis.

Figure 3 shows the Power Supply module LEDs. For details about troubleshooting the LEDs, see "4.1.1 Power Supply Modules LEDs and Alarms" on page 42.

ALARM—Solid red when module has internal problem or power is disconnected.

ALARM RESET—Press to reset the Power Supply alarm.

+5V—Solid green when 5 V output is good; red if 5 V output is not good.

+12V—Solid green when 12 V output is good; red if 12 V output is not good.

Latches—Squeeze the two handles of each latch and pull the handles outward.
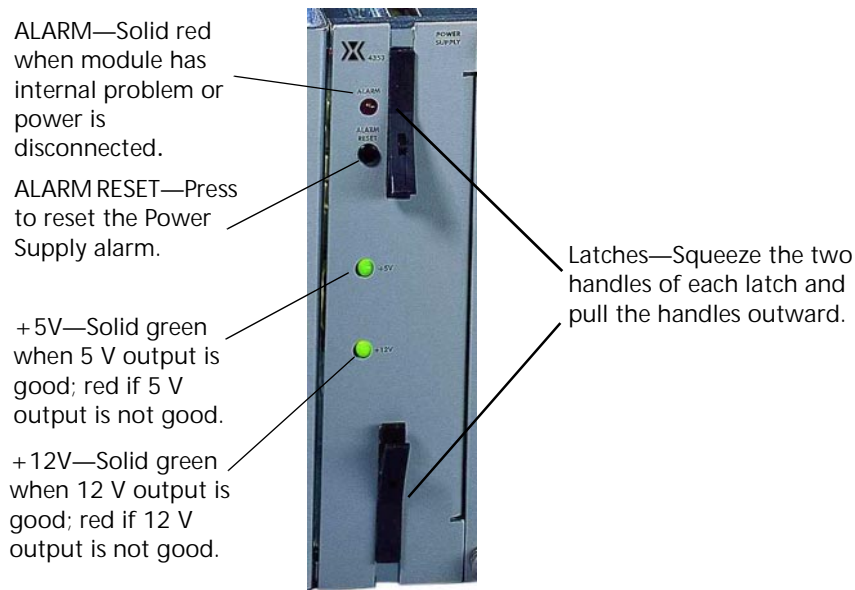
Figure 3: Power Supply module

1.2.1.2 MCA User Interface Module

The MCA User Interface (UI) module provides the time display and the controls for setting and adjusting the time. Should the MCA UI module fail, the system will continue to operate as you replace the module and will synchronize with the TCG module after replacement.

The MCA can house only one MCA UI module, which you can install in only its keyed slot (slot 7 counting from the left) in the MCA chassis.

Figure 4 shows the MCA UI module connectors, buttons, and LEDs. For details about troubleshooting the LEDs and alarms, see "4.1.2 MCA UI Module LEDs and Alarms" on page 43.

TIME DISPLAY—Upper labels are for setting the time and leap second; lower labels are for adjusting the slew.

LEAP YEAR—Solid green when current year is a leap year.

ENABLED—Solid yellow when the functions are enabled.

FUNCTION SELECT—When functions are enabled, press to select the function you want.

Function LEDs—Lit LED shows selected function.

IRIG-B IN—Connect to IRIG-B source to set the time using the IRIG-B source. LED solid when connected to valid IRIG-B signal.

MCA ALARM OUT—Connect to an external system to monitor MCA, Power Supply, and Flywheel alarms.

Latch—Pull the latch handle outward.

Arrow buttons—Enable the functions and set time, slew, and leap second.

APPLY—Press to program current time, slew, or leap second setting.

DISPLAY TIMECODE—Solid green when time code displays above. This is normal operation when the FUNCTION LED is off.

Latch—Pull the latch handle outward.

MCA FAIL—Solid red when the chassis, Power Supply, or Flywheel fails.

ALARM RESET—Press to reset the MCA alarm and send a global reset to all modules in this MCA and all modules connected to this MCA.

Figure 4: MCA UI module

1.2.1.3 Time Code Generator Module

The Time Code Generator (TCG) module receives the programming time from the MCA and generates the Serial Time Code (STC) and synchronized 1 pps signals.

The MCA can house only one TCG module, which you can install in only its keyed slot (slot 11 counting from the left) in the MCA chassis.

Figure 5 shows the TCG module connectors, buttons, and LEDs. For details about troubleshooting the LEDs and alarms, see "4.1.3 TCG Module LEDs and Alarms" on page 44.

TIME CODE—Solid red when module detects a CRC time code error or change in time.

ALARM RESET—Press to reset any TCG alarm.

ENABLE OPTICAL OUTPUTS—Press after initial setup to send the time code out through the fiber optic connectors. LED solid green when connectors are enabled.

COINCIDENCE—Solid red when the difference between the TCG 1 pps signal and the ADV 1PPS IN signal exceeds ±20 ns.

Latch—Pull the latch handle outward.

DISABLED and DISABLE—Press to enable or disable coincidence detection. LED solid yellow when coincidence detection is disabled.

1 PPS SYNC IN—Connect to a 1 pps input signal when initially setting the time. LED blinks when input signal is good.

MPD ALARMS—Solid red when the DA or TCT connected to that fiber optic connector is not sending a 1 pps signal to the TCG.

ADV 1 PPS IN—Connect to another MCA's ADV 1PPS OUT using a 45 ns (9.14 m) cable to compare the 1 pps signals. LED blinks when input signal is good.

OPTICAL I/O—Connect using fiber optic cables with LC connectors to send the time code to DAs or TCTs.

ADV 1PPS OUT—Connect to another MCA's ADV 1PPS IN to compare the 1 pps signals. LED blinks when signal is available at the connector.

Latch—Pull the latch handle outward.

1 PPS OUT—Connect to send a 1 pps signal to other systems.

MPD DISABLE—Press button to enable or disable the corresponding MPD alarm. LEDs solid yellow when corresponding MPD alarm is disabled.

TCG ALARM OUT—Connect to an external system to monitor TCG alarms.

Figure 5: TCG module

1.2.1.4 Flywheel Module

The Flywheel module provides a 100 MHz signal to the TCG. If the system loses the external reference signal, the Flywheel module continues to provide the signal indefinitely, permitting the system to operate. You should, however, re-establish the external reference signal to ensure the MCA is phase locked to the external reference signal.

The MCA can house only one Flywheel module, which you can install in only its keyed slot (slot 12 counting from the left) in the MCA chassis.

Figure 6 shows the Flywheel module connectors, buttons, and LEDs. For details about troubleshooting the LEDs and alarms, see "4.1.5 Flywheel Module LEDs and Alarms" on page 47.
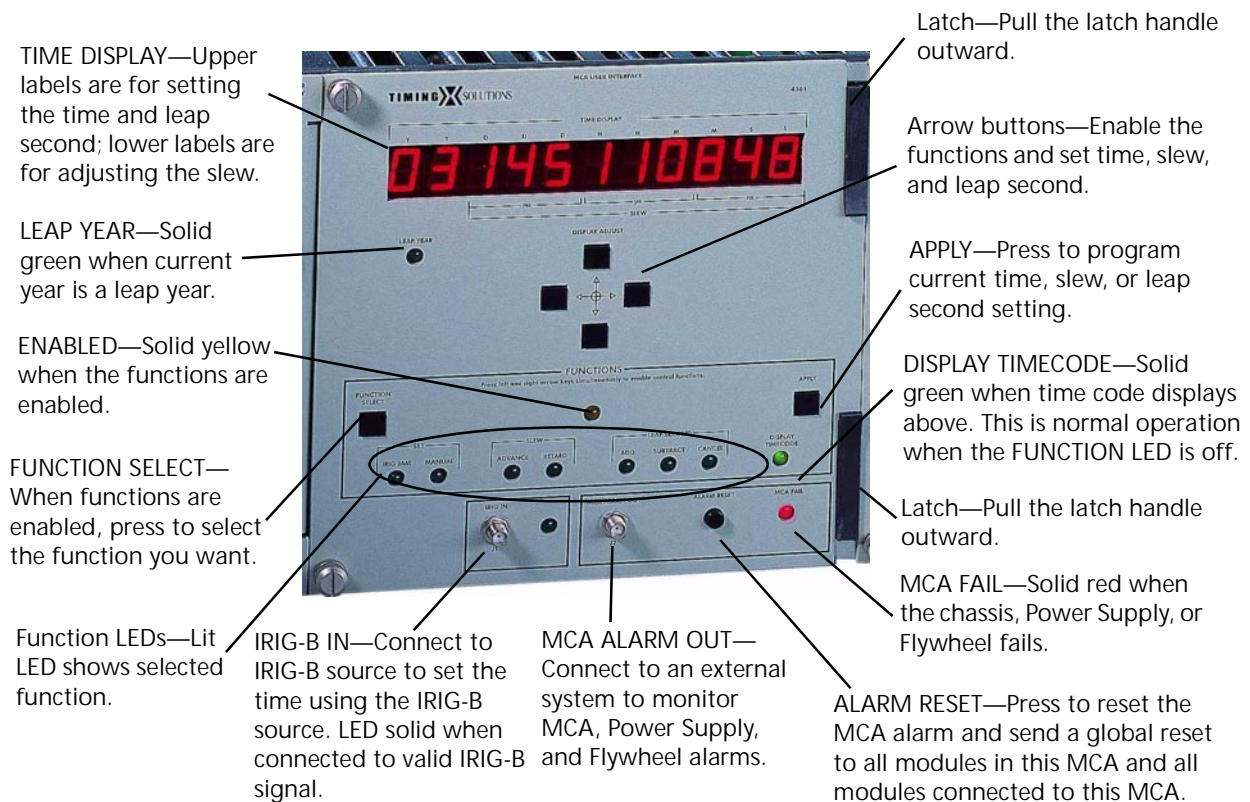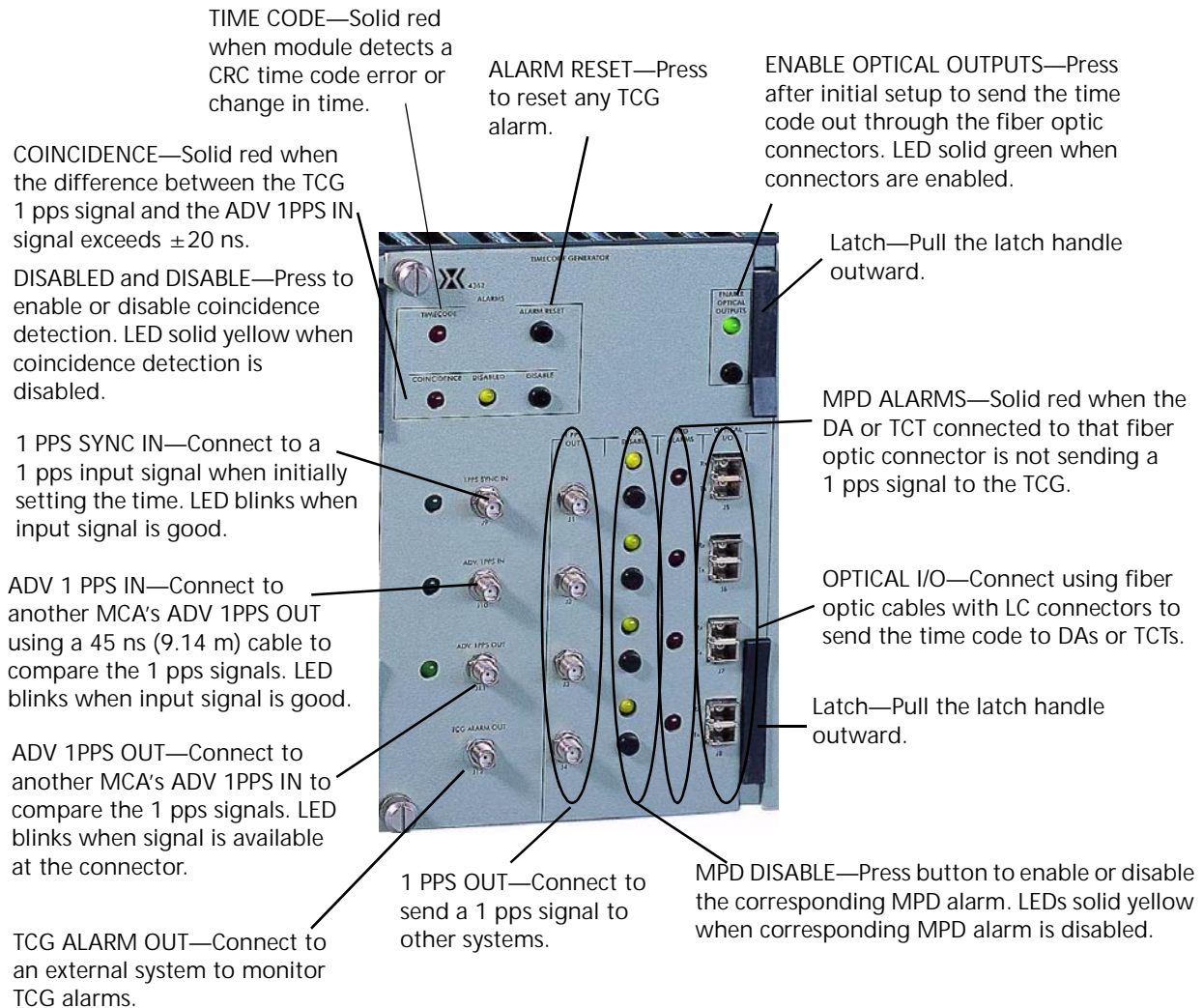
ALARM RESET—Press to reset the Flywheel alarm.

Latch—Pull the latch handle outward.

TCXO LOCK—Green is normal. Red shows the loss of phase lock with the reference signal.

EFC LIMIT—Green is normal. Yellow when the control voltage of the TCXO is within 10% of acceptable range limits.

EFC—Connect to a digital multi-meter to check the control voltage of the TCXO.

INPUT—Green is normal. Red when the module does not detect the external reference signal.

TCXO FREQ. MONITOR—If the internal 100 MHz signal seems unstable, use to test the signal.

Latch—Pull the latch handle outward.

5/10/100 MHz IN—Connect to an external source to receive the reference signal (5, 10, or 100 MHz).
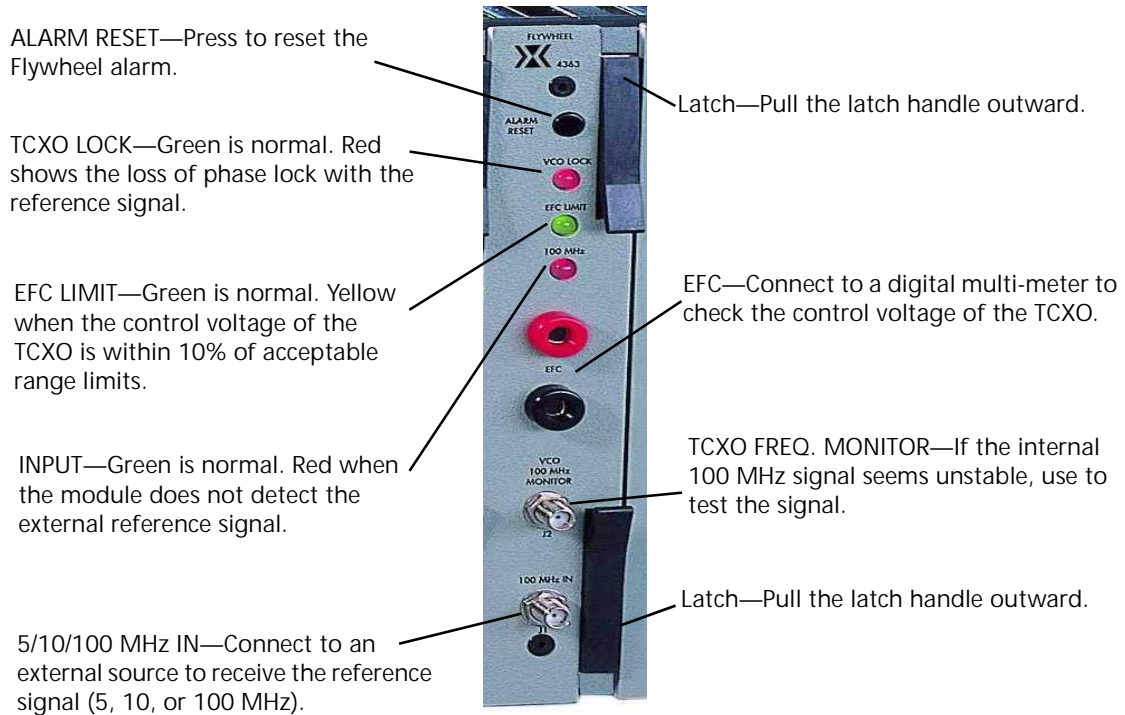
Figure 6: Flywheel module

1.2.2 Understanding the Distribution Assembly

The Time and Frequency Distribution System uses Distribution Assemblies (DAs) that receive the time code from the MCA and distribute it to other DAs or TCTs. Each DA comes with a minimum of one Distribution Input module and two Distribution Output modules. The 14351 series DA can house up to ten hot-swappable Distribution Output modules. The 4340A Fiber Expansion Chassis can house up to eight hot-swappable transceivers.

Figure 7a shows the 14351 DA with ten modules. Figure 7b shows the 4340 DA.

Power Supply—One of two redundant modules.

Distribution Output—Sends the optical time code to another DA or to a TCT Receives optical 1 pps signal from DA input or TCT

Distribution Input—Receives the optical time code from the MCA. Sends optical 1 pps signal to TCG or DA output.

Power Supply—One of two redundant modules.

Figure 7a: 14351 series DA with ten modules

Figure 7b: 4340 series DA with six output transceivers

1.2.2.1 Power Supply Modules

The Power Supply modules at either end of the DA provide redundant power to the DA. If one Power Supply module fails, the DA continues to operate. You can then replace the failed module.

You can also hot swap either Power Supply module at any time. The right and left Power Supply modules are identical. For more information, see "4.6.1 Replacing a Power Supply Module" on page 56.

The DA can house a maximum of two Power Supply modules, which you can install in only the extreme left and right slots (slots 1 and 13) in the 14351 series DA chassis. The power supply modules in the 4340A chassis mount in the rear of the chassis.

Figure 8 shows the Power Supply module LEDs. For details about troubleshooting the LEDs, see "4.2.1 Power Supply Modules LEDs and Alarms" on page 48.
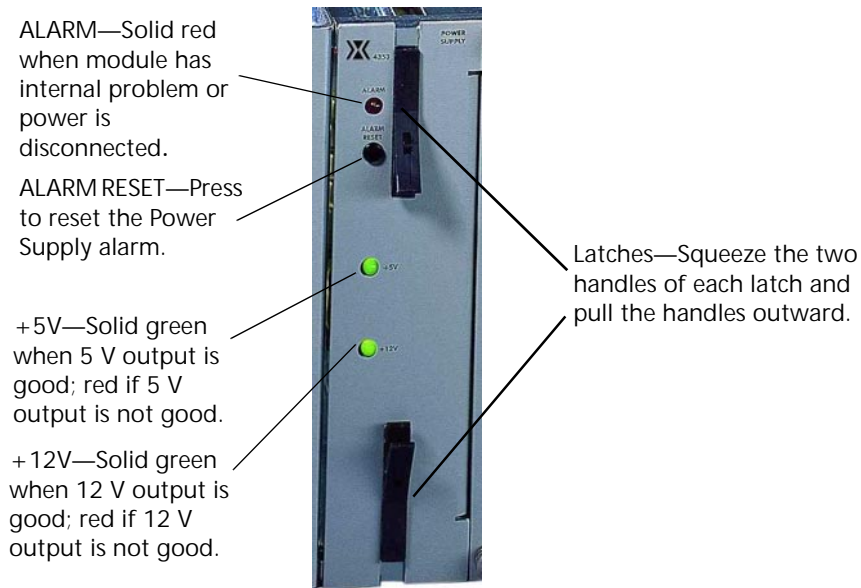
ALARM—Solid red when module has internal problem or power is disconnected.

ALARM RESET—Press to reset the Power Supply alarm.

+5V—Solid green when 5 V output is good; red if 5 V output is not good.

+12V—Solid green when 12 V output is good; red if 12 V output is not good.

Latches—Squeeze the two handles of each latch and pull the handles outward.

Figure 8: DA Power Supply module

1.2.2.2 Distribution Input Module

The Distribution Input module connects to the MCA or a previous level DA and receives the time code for distribution through the Distribution Output modules.

The DA can house only one Distribution Input module, which you can install in only its keyed slot (slot 7 counting from the left) in the DA chassis.

Figure 9 shows the Distribution Input module connectors, buttons, and LEDs. For details about troubleshooting the LEDs and alarms, see "4.2.2 Distribution Input Module LEDs and Alarms" on page 48.

INVALID TIME CODE—Solid red when module detects an invalid time code.

ALARM RESET—Press to reset the chassis alarm.

CHASSIS ALARM—Solid red when any module in the DA has an alarm.

ALARM OUT—Connect to an external alarm monitor.

Latch—Pull the latch handle outward.

LOSS OF SIGNAL—Solid red when module loses the input signal.

TIME CODE IN and 1 PPS OUT—Connect to the MCA using fiber optic cables with LC connectors to receive the time code and monitor the optical 1 pps signal.

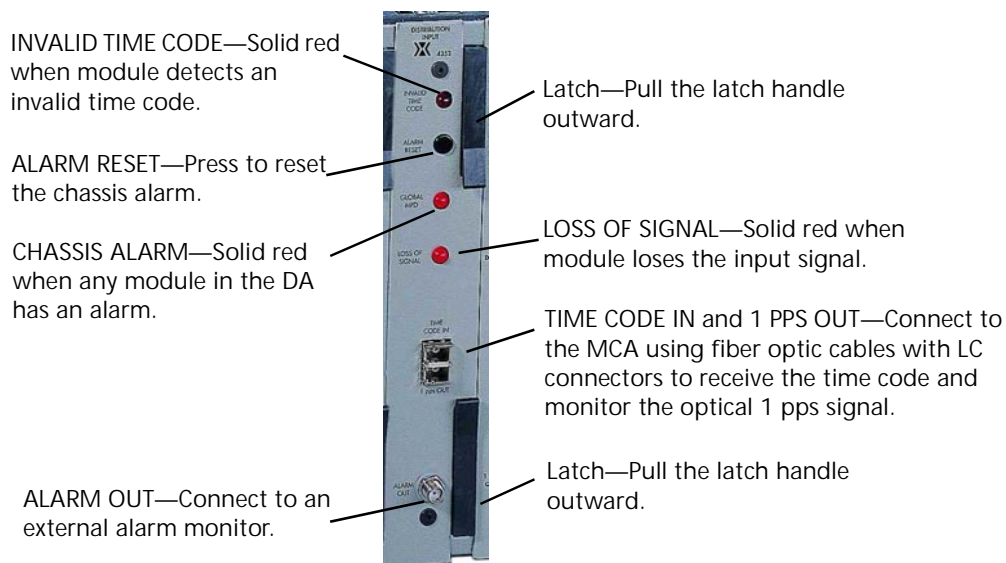Latch—Pull the latch handle outward.

Figure 9: Distribution Input module

1.2.2.3 Distribution Output Modules

The Distribution Output modules connect to TCTs or next level DAs to send the time code and monitor the returned 1 pps signal.

Figure 10 shows the Distribution Output module connectors, buttons, and LEDs. For details about troubleshooting the LEDs and alarms, see "4.2.3 Distribution Output Module LEDs and Alarms" on page 49.
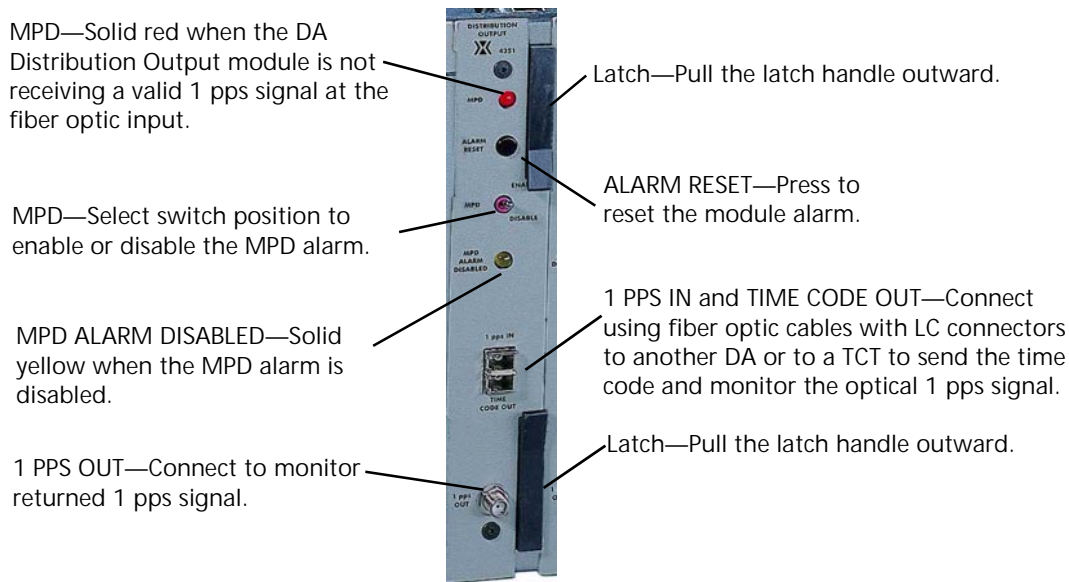

MPD—Solid red when the DA Distribution Output module is not receiving a valid 1 pps signal at the fiber optic input.

MPD—Select switch position to enable or disable the MPD alarm.

MPD ALARM DISABLED—Solid yellow when the MPD alarm is disabled.

1 PPS OUT—Connect to monitor returned 1 pps signal.

Latch—Pull the latch handle outward.

ALARM RESET—Press to reset the module alarm.

1 PPS IN and TIME CODE OUT—Connect using fiber optic cables with LC connectors to another DA or to a TCT to send the time code and monitor the optical 1 pps signal.

Latch—Pull the latch handle outward.

Figure 10: Distribution Output module

1.2.3 Understanding the Time Code Translator

The Universal Time and FrequencySystem uses Time Code Translators (TCTs) to receive the time codes from either the MCA or a DA. The TCTs then supply a range of pulse rates and several possible time code outputs, depending on the modules installed in the TCT.

Detailed specifications for each TCT module are available in "Appendix A, Specifications" on page 61.

1.2.3.1 TCT Chassis

The TCT chassis receives the fiber optic time signal from the MCA and converts it to electrical signals for further distribution. You can install up to four of the modules described in the following sections into each TCT chassis.

If the fiber optic input signal is lost, the Temperature Compensated Crystal Oscillator (TCXO) in the TCT continues to provide an internal 100 MHz reference signal and sends time codes for 12 hours. If the reference signal is not reconnected, after 12 hours, the TCT will suppress all user outputs.

Figure 11 shows the TCT front panel buttons and LEDs. All alarm LEDs stay on only for the duration of the alarm condition, and the returned optical 1 pps signal is suppressed during the alarm condition. You must enable MPD on the MCA or DA Distribution Output module to which the TCT is connected to capture alarms that occur in a TCT.

For details about troubleshooting the LEDs and alarms, see "4.3 TCT LEDs and Alarms" on page 51.
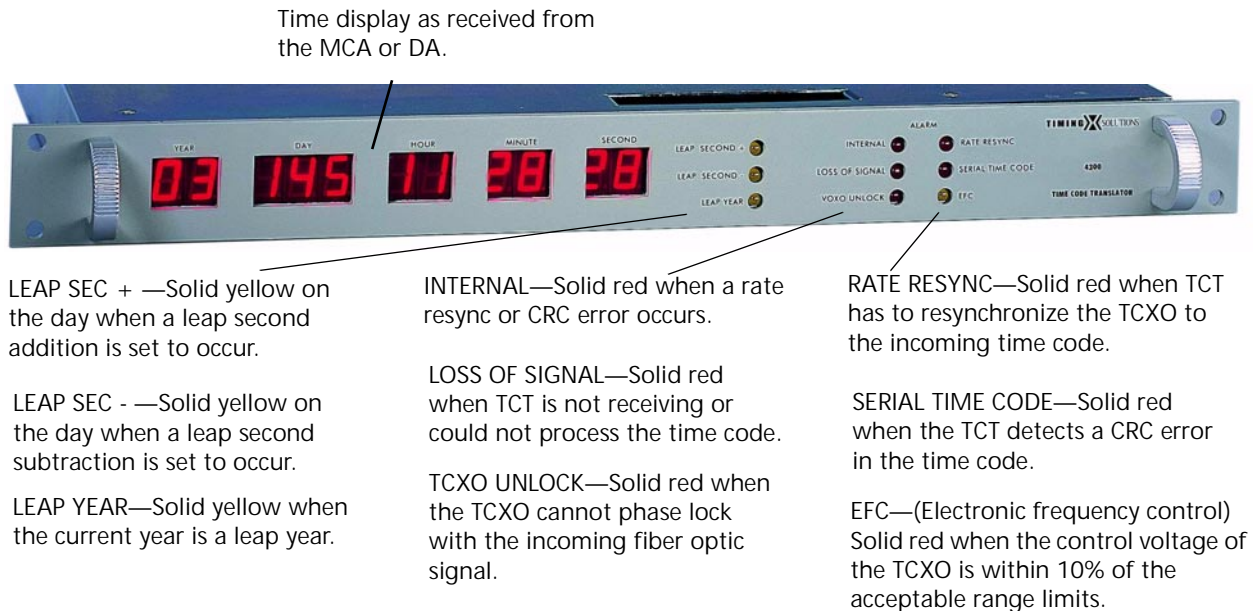
Time display as received from the MCA or DA.

LEAP SEC + —Solid yellow on the day when a leap second addition is set to occur.

LEAP SEC - —Solid yellow on the day when a leap second subtraction is set to occur.

LEAP YEAR—Solid yellow when the current year is a leap year.

INTERNAL—Solid red when a rate resync or CRC error occurs.

LOSS OF SIGNAL—Solid red when TCT is not receiving or could not process the time code.

TCXO UNLOCK—Solid red when the TCXO cannot phase lock with the incoming fiber optic signal.

RATE RESYNC—Solid red when TCT has to resynchronize the TCXO to the incoming time code.

SERIAL TIME CODE—Solid red when the TCT detects a CRC error in the time code.

EFC—(Electronic frequency control) Solid red when the control voltage of the TCXO is within 10% of the acceptable range limits.

Figure 11: TCT front panel

Figure 12 shows the TCT rear panel.

GND—Ground connection

Fiber optic input (Rx) and output (Tx)— Input receives time code from the DA or TCG; output provides a 1 pps signal to the DA or MCA for missing pulse detection.
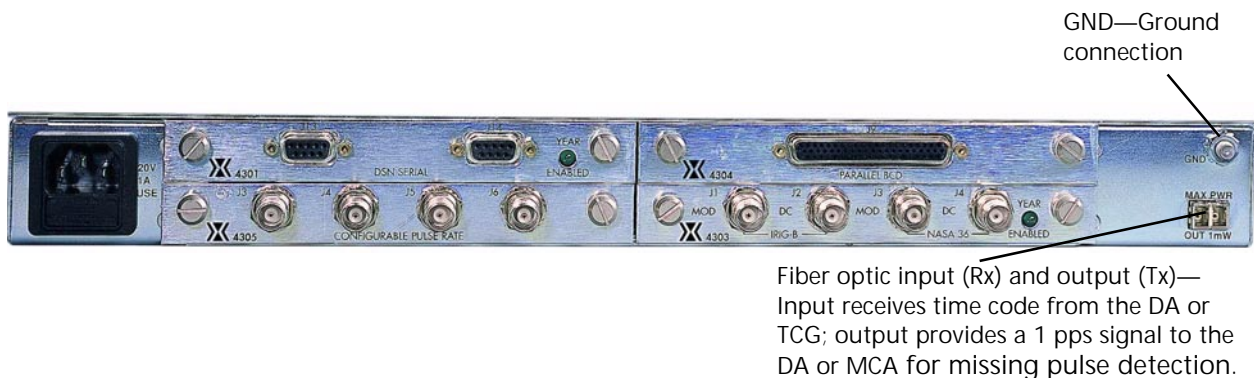
Figure 12: TCT rear panel

1.2.3.2 Dual RS-232 Time Code Output (DSN Serial) Module

This module produces two identical RS-232 time code outputs. It provides the time output once per second, continuously, immediately following the 1 pps on-time signal. The TCT 1 pps outputs enable establishment of time of year to a resolution of better than ±5 nanoseconds, and the RS-232 outputs identify the exact second of the year. The 1 pps signal generated within the TCT is the on-time interrupt (rising edge) to which the output code is synchronized. The time code starts after this edge.

1.2.3.3 Parallel PB-1 Time Code Output Module

This module produces a PB-1 Parallel Binary Coded Decimal (BCD) time output in accordance with IRIG-B STD 205-87. The outputs are on a 62-pin, high-density, D-type connector. ID bits are not included. Leap year and leap second status outputs are also provided. The 1 pps signal generated within the TCT is the on-time interrupt (rising edge) to which the output code is synchronized. The time code starts after this edge.

1.2.3.4 Dual Time Code Output Module

This module generates IRIG-B and NASA 36-bit time codes. It provides modulated and DC level-shift outputs of each code (four outputs on TNC connectors). The 1 pps signal generated within the TCT is the on-time interrupt (rising edge) to which the output code is synchronized. The time code starts after this edge.

1.2.3.5 Parallel BCD Time Code Output Module

This module produces a parallel BCD time output in units-milliseconds through hundreds-of-days on a 62-pin, high-density, D-type connector. You can select normal transistor-transistor logic (TTL) levels (zero = 0 volts and one = +4 volts) or inverted TTL levels (one = 0 volts and zero = +4 volts) via an input at the output connector. Leap year and leap second status outputs are also provided. The 1 pps signal generated within the TCT is the on-time interrupt (rising edge) to which the output code is synchronized. The time code starts after this edge.

1.2.3.6 Configurable Pulse Rate Output Module

This module generates four digital signals, via TNC connectors, capable of driving 50 Ω loads with 2 ns (two-nanosecond) rise times. The rate of the four signals is jumper configurable. The pulse rate options are:

- 1, 10, 100, 1 kpps
- Four 1 pps
- Four 10 pps
- Four 100 pps
- Four 1 kpps
- Four 10 kpps
- Four 100 kpps
- Four 1 Mpps

Coherence of the rising edges to the MCA on-time signal (with propagation delay compensation properly set in the TCT main chassis) is ±5 ns (five nanoseconds) or better.

1.2.3.7 10 MHz Output Module

This module is a quad output radio frequency (RF) module, which provides four isolated (> 100 dB) RF outputs phase locked to the RF supplied to the MCA. The unit operates at 10 MHz with additive phase noise that is comparable to the performance of a high-performance cesium clock. If any of the output signals fail, the rear panel alarm LED will light. The TCT will not suppress the 1 pps signal if this alarm occurs. Fault sensing of signal levels is provided on every output.

1.2.3.8 NTP Server Module

This module provides the UTFS system with NTP server capabilities. Stratum 1 service is provided as long as the MCA is synchronized to a Stratum 0 radio clock.

1.2.3.9 Alarm Input Module

This module is a quad input alarm detection module. Each input can detect an active high or low alarm on any one of the inputs.

1.2.3.10 IRIG-B and IRIG-G Time Code Output Module

There are two IRIG-B 123 formatted, and two IRIG-G 142 formatted outputs provided on TNC connectors for this module.

1.2.3.11 5 MHz and 10 MHz Clean-up Oscillator Output Module

This module provides two 5 MHz and two 10 MHz outputs with better Allan deviation performance than provided by the 4308 module.

2: Installing and Setting up the Time and Frequency Distribution System

> Note: The TSC marketing material refers to this systems components with different names than are used in this manual and on the hardware itself. The UTCG referred to in the marketing material is called the Master Clock Assembly, or MCA. The FEC referred to in the marketing material is the Distribution Assembly or DA.

2.1 Installing the MCA

The MCA ships ready for installation into a standard 19" (48.3 cm) rack.

Required for installation:

- Four rack-mount screws
- Screwdriver for the rack-mount screws
- Access to a power source of 90–240 VAC
- External reference signal source (5, 10, or 100 MHz) and cable with SMA male connector
- SMA torque wrench
- External 1 pps source, such as a portable cesium clock, and cable with SMA male connectors

Figure 13 shows the connections needed for setup.
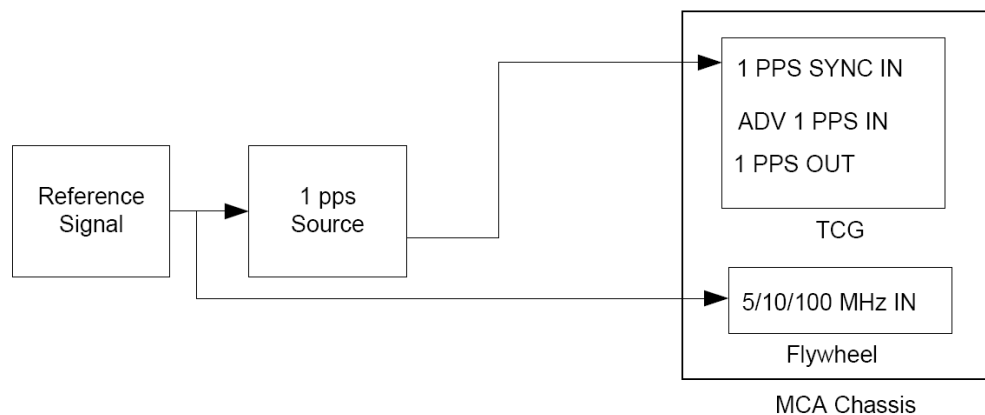
Figure 13: Connection configuration for setup

To install the MCA:

1. Install the MCA in a standard 19" rack using four rack-mount screws.
2. Connect the chassis ground on the back of the MCA to the rack ground.
3. Connect the output from an external reference signal source (5, 10, or 100 MHz) to the 5/10/100 MHz IN connector on the Flywheel module.
4. Connect the output from the external 1 pps source to the 1 PPS SYNC IN connector on the TCG module.
5. Using the torque wrench, tighten the connections to 8 in-lbs.

6. Connect the power cables to the back of each Power Supply module and to a power source.

   ■ The system powers up as soon as you connect it to the power. You may see an alarm on one of the Power Supply modules, which will also cause the MCA FAIL LED to light on the MCA UI module.

7. Press **ALARM RESET** on the Power Supply Module.

   ■ You are now ready to set the time. For more information, see "2.2 Setting the Time" on page 14.

   ■ You can also connect to other equipment for monitoring and other purposes. For more information, see "2.6 Monitoring the System" on page 28.

2.2 Setting the Time

After you install the MCA in a rack and connect the power, reference signal, and external 1 pps source, you are ready to set the time. For information about making these connections, see "2.1 Installing the MCA" on page 13.

Setting the time requires that you complete the following tasks:

1. Set the time using one of the following methods:

   ■ Using IRIG-B jam (see page 14)

   ■ Manually (see page 16)

2. Verify the MCA's 1 pps output signal synchronization (see page 18).

3. Adjust the slew (see page 19).

4. Enable the optical outputs (see page 21).

2.2.1 Setting the Time Using IRIG-B Jam

You can set the time using an external IRIG-B source. You must have the system connected to an external 1 pps source to set the time using IRIG-B jam as described in "2.1 Installing the MCA" on page 13.

Required for this procedure:

■ Torque wrench

■ External IRIG-B source and cable with SMA male connector

■ External 1 pps source, such as a portable cesium clock, and cable with SMA male connectors

Figure 14 shows the connections needed to set the time using IRIG-B jam.
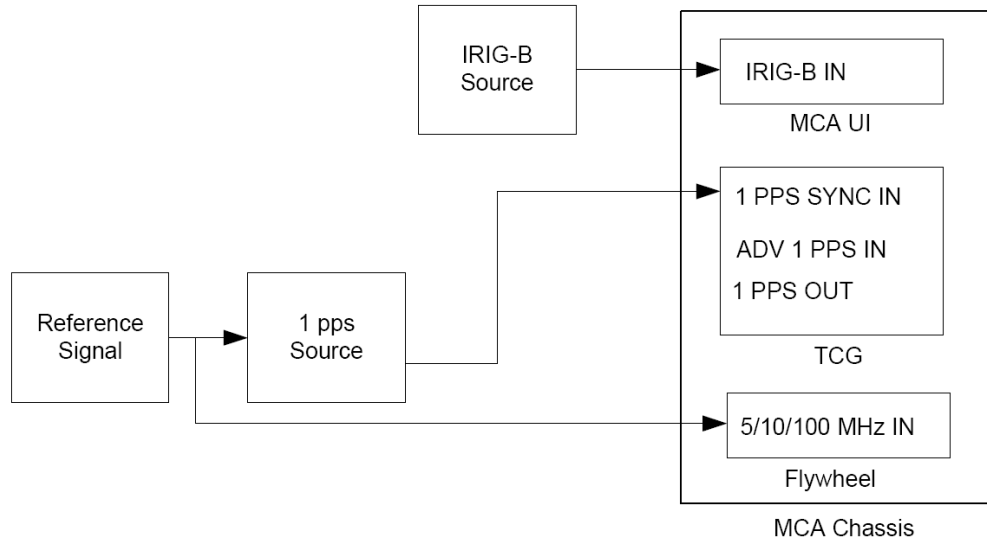
Figure 14: Connection configuration for setting the time using IRIG-B jam

To set the time using IRIG-B jam:

1. Connect an external IRIG-B modulated source to the IRIG-B IN connector on the MCA UI module.

2. Using the torque wrench, tighten the connection to 8 in-lbs.

3. On the MCA UI module, press the **Left** and **Right** arrow buttons simultaneously until the yellow ENABLED LED lights up.

   ■ This enables the settings in the FUNCTIONS section of the MCA UI. The functions time out after two minutes of inactivity.

4. Press **FUNCTION SELECT** until the IRIG-B JAM LED lights up.

   ■ The YEAR LEDs of the time display show dashes, with the right-most YEAR dash blinking. The remaining LEDs are blank.

5. Use the **Up** and **Down** arrows to set the blinking YEAR digit.

6. Press the **Left** arrow to move to the tens of years digit.

7. Use the **Up** and **Down** arrows to set the tens of years digit.

   ■ You must enter valid values in both YEAR digits. Do not leave either value a dash (-).

8. Press **APPLY**.

   ■ The system jams to the time from the IRIG-B source on the rising edge of the next 1 pps pulse. The time display changes to all dashes for about two seconds, then shows the configured time.

   ■ If the system detects a 1 pps pulse but does not detect a valid IRIG-B code, the system remains in the IRIG-B JAM function and reverts the display to the dashes in the YEAR LEDs.

   ■ If the system detects a valid IRIG-B code but does not detect a 1 pps pulse, the system remains in the IRIG-B JAM function waiting for the 1 pps pulse until it detects the pulse, until you press **FUNCTION SELECT**, or until the system times out after two minutes of inactivity.

- To cancel, press **FUNCTION SELECT** before the system detects the next 1 pps pulse. The time display flashes once and reverts the display to the previously programmed time.

9. Check the time display to be sure it shows the correct time.

You are now ready to check the MCA's 1 pps signal synchronization. For more information, see

2.2.2 Setting the Time Manually

You can set the time manually whether or not you have connected the TCG to an external 1 pps source, but using an external 1 pps source is highly recommended.

The system limits the valid values you can enter for each digit in the time display as shown in Table 1.

Table 1: Valid values for time display

Time display digit	Valid values
Y	0–9
Y	0–9
D	0–3
D	0–9
D	0–9
H	0–2
H	0–9
M	0–5
M	0–9
S	0–5
S	0–9

Recommended for this procedure:

- External 1 pps source, such as a portable cesium clock, and cable with SMA male connector

Figure 15 shows the connections needed to set the time manually.
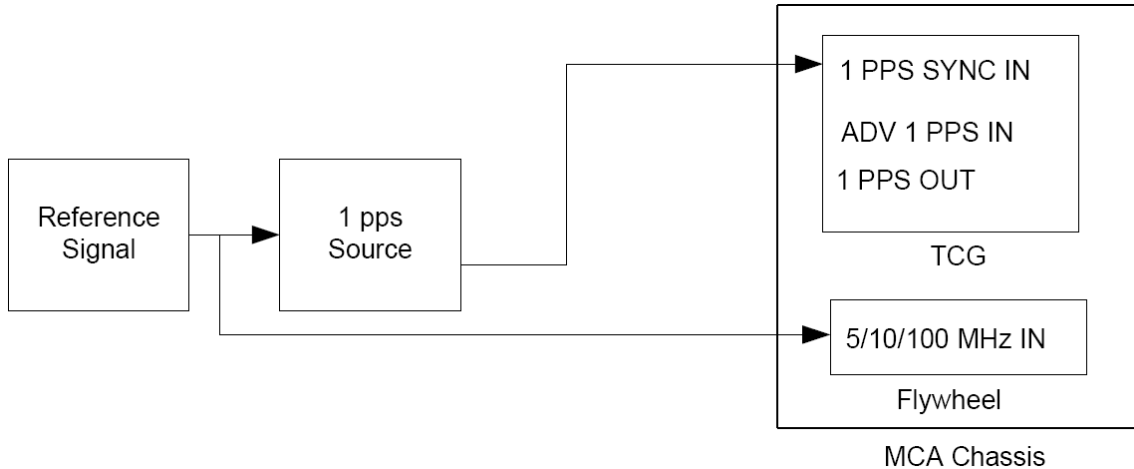
Figure 15: Connection configuration for setting the time manually

To set the time manually:

1. On the MCA UI module, press the **Left** and **Right** arrow buttons simultaneously until the yellow ENABLED LED lights up.

   ■ This enables the settings in the FUNCTIONS section of the MCA UI. The functions time out after two minutes of inactivity.

2. Press **FUNCTION SELECT** until the MANUAL LED lights up.

   ■ The YEAR and DAY LEDs of the time display show dashes, with the right-most DAY digit blinking. The HOUR, MINUTE, and SECOND LEDs all show zeros.

3. Use the **Up** and **Down** arrows to set the blinking day of YEAR digit.

4. Continue using the arrows to set the remaining YEAR, HOUR, MINUTE, and SECOND digits as needed.

   ■ Use the **Left** and **Right** arrows to move left and right in the time display. The selected digit blinks. Use the **Up** and **Down** arrows to set the selected digit.

   ■ You must set at least the DAY and YEAR digits.

5. Do one of the following:

   ■ If you have a 1 pps external source connected, press **APPLY** to set the time at the next 1 pps pulse.

   • The system jams to the configured time on the rising edge of the next 1 pps pulse. After detecting the 1 pps pulse, the time display changes to all dashes for about two seconds, then shows the configured time.

   • To cancel, press **FUNCTION SELECT** before the system detects the next 1 pps pulse.

   ■ If you do not have a 1 pps external source connected, approximately two seconds *before* the time you want to set, press and hold **APPLY** for five seconds.

   • The system takes about two seconds to jam to the configured time as if it had received a 1 pps pulse. The time display changes to all dashes for about two seconds, then shows the configured time.

6. Check the time display to be sure it shows the correct time.

You are now ready to check the 1 pps signal synchronization. For more information, see "2.2.3 Checking the MCA's 1 pps Signal Synchronization" on page 18.

2.2.3 Checking the MCA's 1 pps Signal Synchronization

After you set the time, you can compare the MCA's 1 pps output signal with the 1 pps signal of an external source to determine whether you need to adjust the slew of the MCA. You want this initial synchronization to be ±5 ns. Once you check the synchronization, you can adjust the slew.

Required for this procedure

- Torque wrench

- Two cables of the same length with SMA male connectors

- External 1 pps source, such as a portable cesium clock, and cable with SMA male connector

- Oscillocope or time interval counter

Figure 16 shows the connections needed to check the 1 pps signal synchronization.
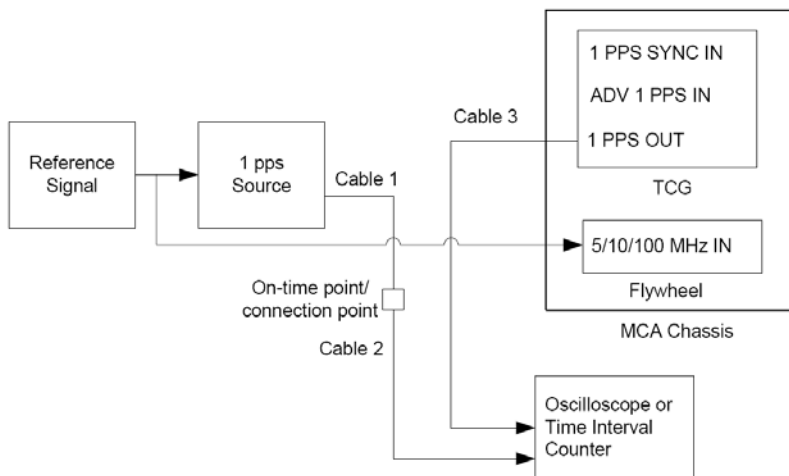
Figure 16: Connection configuration to check the 1 pps signal synchronization

To check the 1 pps synchronization:

1. If connected, disconnect the cable from the 1 PPS SYNC IN connector on the TCG module.

   - This is Cable 1 in Figure 16.

2. Connect the cable that you just disconnected into a second cable.

   - This is Cable 2 in Figure 16.

3. Connect the other end of the second cable to the oscilloscope or time interval counter.

4. Connect one end of a third cable, that is the same length as Cable 2, to one of the 1 PPS OUT connectors on the TCG module.

   - This is Cable 3 in Figure 16.

5. Connect the other end of Cable 3 to the oscilloscope or time interval counter.

6. Using the torque wrench, tighten the connections to 8 in-lbs.

7. Compare the 1 pps signals and determine the difference between them.

   ■ If the difference between the signals is less than ±5 ns, you do not need to adjust the slew. You can continue the installation as described in "2.2.4 Adjusting the Slew and Enabling Coincidence Detection" on page 19 starting with step 10.

   ■ If the difference between the signals exceeds ±5 ns, you must adjust the slew. For more information, see "2.2.4 Adjusting the Slew and Enabling Coincidence Detection" on page 19 starting with step 1.

2.2.4 Adjusting the Slew and Enabling Coincidence Detection

Once you set the time either using IRIG-B jam or manually and check the 1 pps synchronization, you can adjust the slew. Adjusting the slew makes sure that the 1 pps external signal and the internal 1 pps signal are synchronized to within ±5 ns of each other.

You can also enable coincidence detection to monitor the synchronization of the internal 1 pps signal to the external 1 pps signal.

Figure 17 shows the connections needed to adjust the slew.
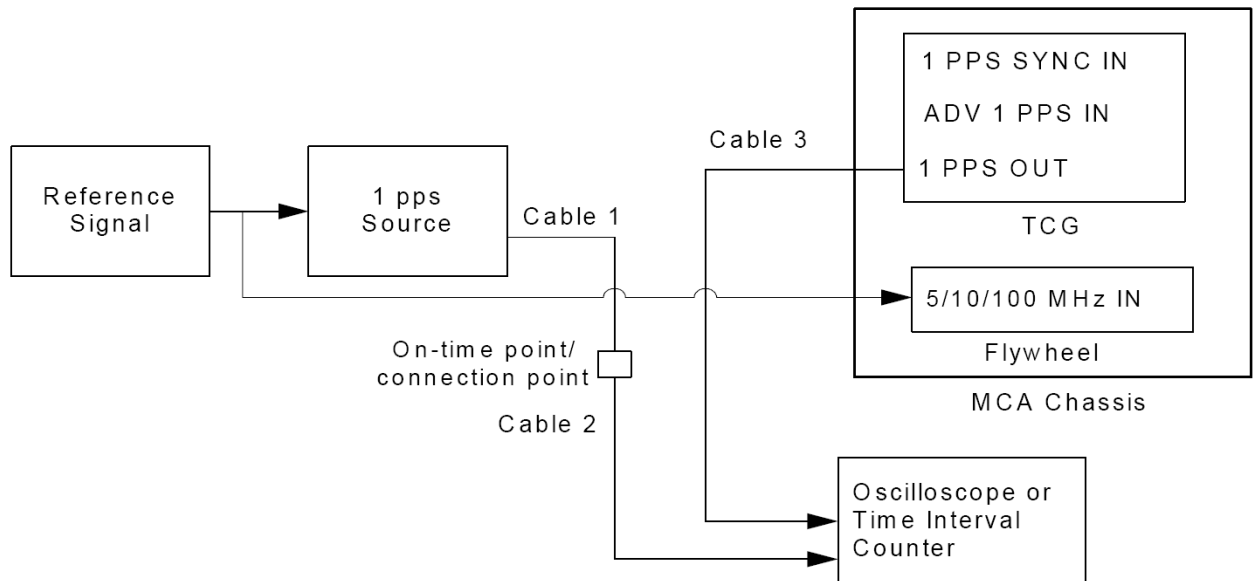
Figure 17: Connection configuration for adjusting the slew

To adjust the slew and enable coincidence detection:

1. On the MCA UI module, press the **Left** and **Right** arrow buttons simultaneously until the yellow ENABLED LED lights up.

   ■ This enables the settings in the FUNCTIONS section of the MCA UI. The functions time out after two minutes of inactivity.

2. Press **FUNCTION SELECT** until the correct SLEW LED lights up.

   - Use the ADVANCE slew function when the internal 1 pps signal is behind the external signal. Use the RETARD slew function when the internal 1 pps signal is ahead of the external signal.

   - The ms, μs, and ns digits in the time display all show zeros with the second from the right ns digit (tens of nanoseconds) blinking. The remaining LEDs are blank.

3. Use the **Up** and **Down** arrows to set the blinking tens of ns digit.

   - The minimum slew setting is 10 ns. The maximum slew setting is 100 ms.

4. Continue using the arrows to set the remaining slew digits as needed.

   - Use the **Left** and **Right** arrows to move left and right in the time display. The selected digit blinks. Use the **Up** and **Down** arrows to set the selected digit.

5. Press **APPLY**.

   - Slew values are relative. Once you press **APPLY**, the display returns to all zeros.

6. Check the 1 pps synchronization again, using the same technique you used originally.

7. If necessary, repeat steps 1 through 6 until the 1 pps signals are synchronized to within ±5 ns.

8. Disconnect the first cable from the second cable and connect the first cable to the ADV 1 PPS IN connector.

   - This should directly connect the 1 pps external source to the ADV 1 PPS IN connector on the TCG module. You no longer need the second cable.

9. Disconnect the third cable from the 1 PPS OUT connector and from the oscilloscope or time interval counter.

   - You no longer need the third cable.

10. For continuous 1 pps signal monitoring, press the **DISABLED** button next to the COINCIDENCE LED on the TCG module to enable coincidence detection on the MCA.

    - The DISABLED LED next to the COINCIDENCE LED should no longer be lit. The COINCIDENCE LED will light if the difference between two 1 pps signals exceeds ±20 ns.

11. If the COINCIDENCE LED lights, adjust the slew.

    - For more information, see "3.3.1 Adjusting the Slew" on page 38.

You are now ready to enable the optical outputs.

2.2.5 Enabling the Optical Outputs

Once you have adjusted the slew, if needed, you can enable the optical outputs that send the time code to the connected DAs and TCTs.

Required for this procedure:

- Correct type of fiber optic cable with LC connectors (paired cable) for each fiber optic connection you need:

  - Part numbers with no suffix or an M suffix require multi-mode cable. These modules also have a tan or white plastic divider between the Tx and Rx fiber optic connectors.

  - Part numbers with an S suffix require single-mode cable. These modules also have a blue plastic divider between the Tx and Rx fiber optic connectors.

Figure 18 shows the connections needed for normal operation after you enable the fiber optic outputs.
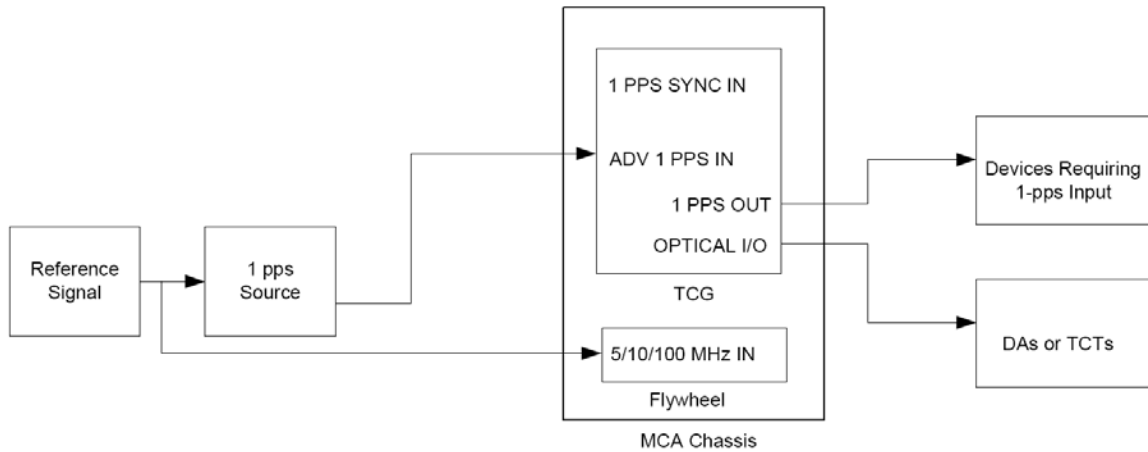
Figure 18: Connection configuration for normal operation

To enable the outputs:

1. Remove the fiber optic transceiver plug from each OPTICAL I/O connector you plan to use.

2. Connect a fiber optic cable to each connector.

3. On the MCA UI module, press **ENABLE OPTICAL OUTPUTS**.

   - This starts sending the time code through the fiber optic connectors.

You are now ready to connect the MCA to one or more DAs or TCTs. For more information, see "2.4 Installing a DA" on page 24 or "2.5 Installing a TCT" on page 25.

If you are setting up an additional MCA as a hot backup, see "2.3 Installing a Hot Backup MCA" on page 22.

2.3 Installing a Hot Backup MCA

If you are installing a second MCA, you can monitor the 1 pps signals of the two MCAs using the ADV 1 PPS IN and ADV 1 PPS OUT connections on the MCAs. This lets you continuously monitor the synchronization of the 1 pps signals of the two MCAs.

This configuration also gives you a hot backup MCA. Should the first MCA fail, you can quickly move the fiber optic connections to the second MCA and continue sending the correct time codes throughout the system.

The ADV 1 PPS OUT connectors provide the 1 pps signal 45 ns before the 1 PPS OUT connector. You must use SMA cables that are about 9.14 m long when making a connection from ADV 1 PPS OUT to ADV 1 PPS IN to compensate for this difference.

Required for this procedure:

- Torque wrench
- One cable with SMA male connectors
- One 9.14-m cable with SMA male connectors
- Oscilloscope or time interval counter

Figure 19 shows the connections needed to synchronize and monitor two MCAs.
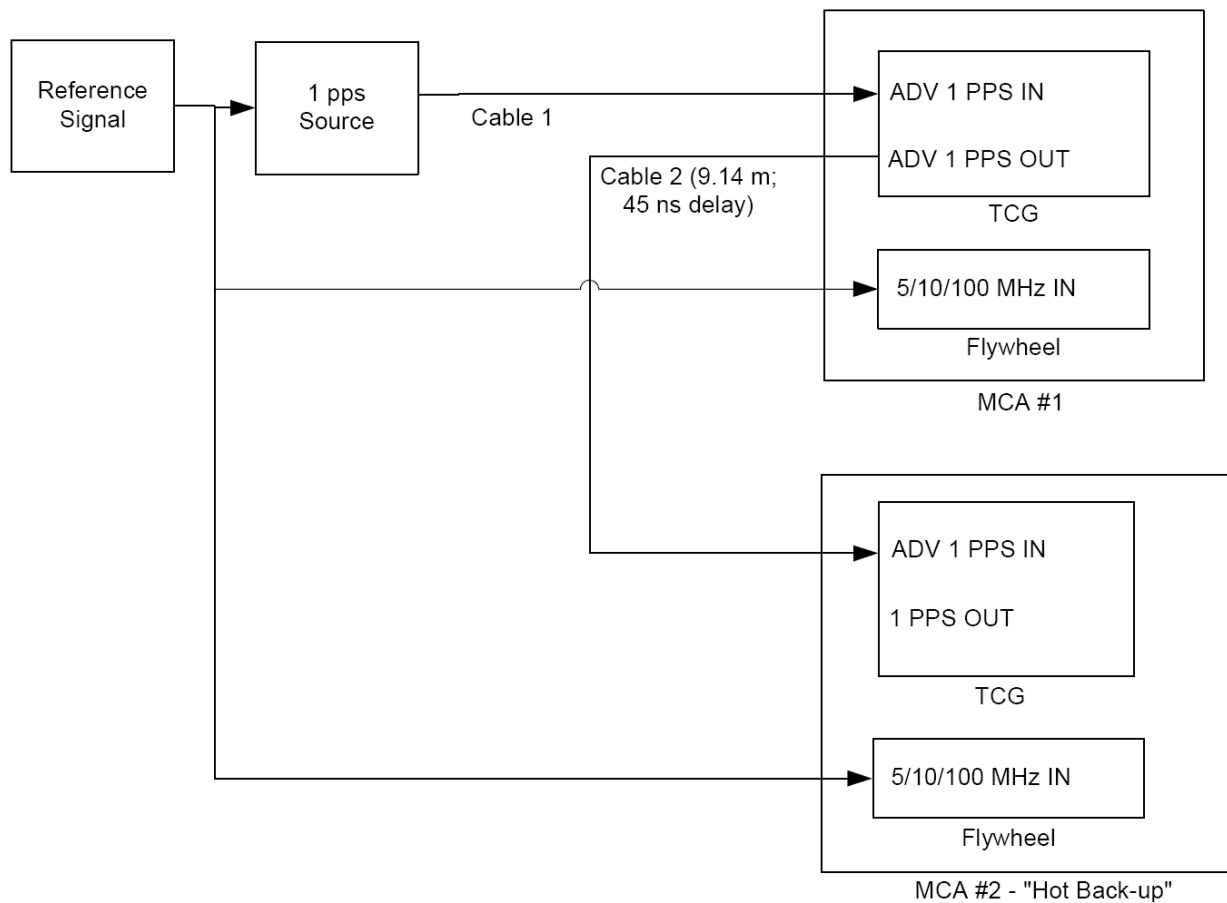
Figure 19: Connection configuration for synchronizing and monitoring two MCAs

To synchronize and monitor two MCAs:

1. Install the first MCA, set the time, check the 1 pps synchronization, and adjust the slew.

   - For more information see "2.1 Installing the MCA" on page 13 and "2.2 Setting the Time" on page 14.

2. Install the second MCA and set the time the same way you set the time on the first MCA, then check the 1 pps synchronization and adjust the slew.

   - For more information see "2.1 Installing the MCA" on page 13 and "2.2 Setting the Time" on page 14.

3. Connect one end of one cable to the ADV 1 PPS IN connector on the TCG module of the first MCA.

   - This is Cable 1 in Figure 19. The cable must be the same length used to set up the MCA.

4. Connect the other end of the cable to the external 1 pps source.

5. Connect one end of the 9.14 m cable to the ADV 1 PPS OUT connector on the TCG module of the first MCA.

   - This is Cable 2 in Figure 19.

6. Connect the other end of the 9.14 m cable to the ADV 1 PPS IN connector on the TCG module of the second MCA.

7. Using the torque wrench, tighten all connections to 8 in-lbs.

8. On the TCG modules of both MCAs, press the **DISABLED** button next to the COINCIDENCE LED to enable coincidence detection.

   - The DISABLED LED next to the COINCIDENCE LED should no longer be lit. The COINCIDENCE LED will light if the difference between two 1 pps signals exceeds ±20 ns. For information about troubleshooting the alarm, see "4.1.4 Coincidence Detection with Two MCAs" on page 46.

You are now ready to connect the MCAs to one or more DAs or TCTs. For more information, see "2.4 Installing a DA" on page 24 or "2.5 Installing a TCT" on page 25.

2.4 Installing a DA

The Time and Frequency Distribution System can use DAs that receive the time code from the MCA and distribute it to TCTs. Each DA comes with a minimum of one Distribution Input module and two Distribution Output modules. The 14351 series DAs can house up to ten hot-swappable Distribution Output modules, whereas the 4340 series DA can accommodate up to eight hot-swappable SFP transceivers.

The DA chassis ships ready for installation into a standard 19" (48.3 cm) rack.

Required for installation:

- Four rack-mount screws
- Screwdriver for the rack-mount screws
- Access to a power source of 90–240 VAC
- Correct type of fiber optic cable with LC connectors (paired cable) for each connection you need:
  - Part numbers with no suffix or an M suffix require multi-mode cable. These modules also have a tan or white plastic divider between the Tx and Rx fiber optic connectors.
  - Part numbers with an S suffix require single-mode cable. These modules also have a blue plastic divider between the Tx and Rx fiber optic connectors.
- Fiber optic cable with LC connectors (paired cable) connected to another DA or TCG module as described in this section and "2.1 Installing the MCA" on page 13
  - Be sure that the ENABLE OPTICAL OUTPUTS LED on the TCG is lit. If not, press the **ENABLE OPTICAL OUTPUTS** button to enable the outputs as described in "2.2.5 Enabling the Optical Outputs" on page 21.

To install a DA:

1. Install the DA in a standard 19" rack using four rack-mount screws.
2. Connect the chassis ground on the back of the DA to the rack ground.
3. Connect the power cable to the back of each Power Supply module and to a power source.
4. Connect the fiber optic cable that is receiving the time code from the MCA or DA to the TIME CODE IN and 1 PPS OUT connector on the 14352 series DA's Distribution Input module, or to the INPUT transceiver on the 4340 series DA.
5. On the 4352 Distribution Input module, press **ALARM RESET** to reset the LOSS OF SIGNAL LED. The 4340A is reset by the **ALARM RESET** on the 4361 MCA User Interface, or by the **$pgr** command.
6. On the MCA that you connected this DA to, press the **MPD DISABLE** button next to the OPTICAL I/O connector you used.
   - This enables the alarm that detects whether the connected DA is sending back a 1 pps signal and status. The alarm LED lights when the MCA is not receiving a return 1 pps signal or good status.

7. Connect a fiber optic cable to each 1 PPS IN and TIME CODE OUT connector on each 4351 Distribution Output module that will provide time code to a next level DA or TCT, or to the OUTPUT transceiver on the 4340 series DA.

   ■ As you install the next level DA or the TCTs, ensure that the other end of the cable is properly connected to a DA input or TCT and that it is powered on.

8. Enable MPD on each 4351 series DA Distribution Output module by moving the toggle switch on the module to enable. If you are using a 4340A series DA, disconnect any unused OUTPUT transceivers to disable unused outputs.

2.5 Installing a TCT

You must install TCTs to receive the time code, convert it to selected electrical outputs, and send it to users.

Installing a TCT requires that you complete the following tasks:

1. Install the TCT in a rack (see page 25).

2. Set the fiber optic cable delay adjustment (see page 26).

2.5.1 Installing a TCT in a Rack

The TCT chassis ships without any modules. You must install the modules that you need in the back of the TCT. You can install up to four modules in each TCT. For more information about the available modules, see "1.2.3 Understanding the Time Code Translator" on page 10.

The TCT chassis ships ready for installation into a standard 19" (48.3 cm) rack.

Required for installation:

■ Modules to install in the TCT

■ Four rack-mount screws

■ Screwdriver for the rack-mount screws

■ Access to a power source of 90–240 VAC

■ Proper cables for the modules on the back of the TCT

   • For more information, see "Appendix A, Specifications" on page 61.

■ Fiber optic cable with LC connectors (paired cable) connected to the MCA or DA that is sending the time code as described in "2.1 Installing the MCA" on page 13 and "2.4 Installing a DA" on page 24

   • Be sure that the ENABLE OPTICAL OUTPUTS LED on the TCG is lit. If not, press the **ENABLE OPTICAL OUTPUTS** button to enable the outputs as described in "2.2.5 Enabling the Optical Outputs" on page 21.

■ #2 Phillips screwdriver

■ Rack-mount slide kit from General Devices, part number CC3041-00-S220 (Optional)

To install a TCT:

1. Slide each module that you need into a slot in the back of the TCT and tighten the thumbscrews.

2. If you are using the rack-mount slide kit, install the rails according to the instructions in the kit.

   ■ Using the kit lets you slide the TCT in and out of the rack to access the back of the TCT.

3. Install the TCT in a standard 19" rack using four rack-mount screws.

4. Connect the chassis ground on the back of the TCT to the rack ground.

5. Connect the power cable to the back of the TCT and to a power source.

   ■ The TCT runs a self-test in the following sequence:

      • All numeric LEDs show the number 8 and all other LEDs light.

      • The hexadecimal address of each slot in the back of the TCT displays in the YEAR, HOUR, MINUTE, and SECOND numeric LEDs.

      • The settings of the TCT's delay adjustment switches display in the YEAR, HOUR, MINUTE, and SECOND numeric LEDs.

      • The time code displays.

6. Connect the fiber optic cable that is receiving the time from the MCA or DA to the fiber optic connector on the back of the TCT.

7. On the MCA or DA that the TCT is connected to, press **MPD DISABLE** or set the MPD switch to ENABLED for the fiber optic connector you used.

   ■ This enables the alarm that detects whether the TCT is sending back a 1 pps signal. The alarm LED lights when the MCA or DA is not receiving a return 1 pps signal.

8. Connect the proper cables to the modules on the back of the TCT.

You are now ready to set the fiber optic cable delay adjustment.

2.5.2 Setting the Delay Adjustment on the TCT

The TCT has a delay adjustment setting that lets you adjust the TCT 1 pps signal to account for the path delay from the MCA that is sending the time code to the TCT.

Required for this procedure:

■ #2 Phillips screwdriver

■ External 1 pps source, such as a portable cesium clock, and cable with SMA male connector (same source that you used to set the time on the MCA)

■ Oscilloscope or time interval counter

Figure 20 shows the access panel on the top of the TCT.
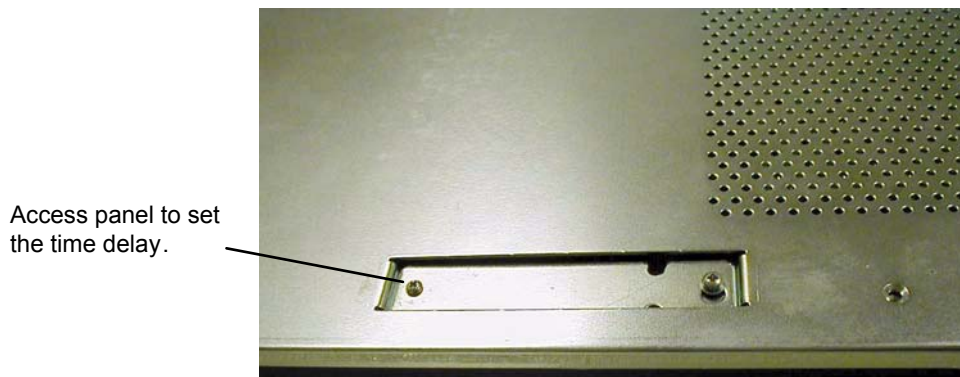
Figure 20: TCT top view

Figure 21 shows the connections needed to set the delay adjustment.
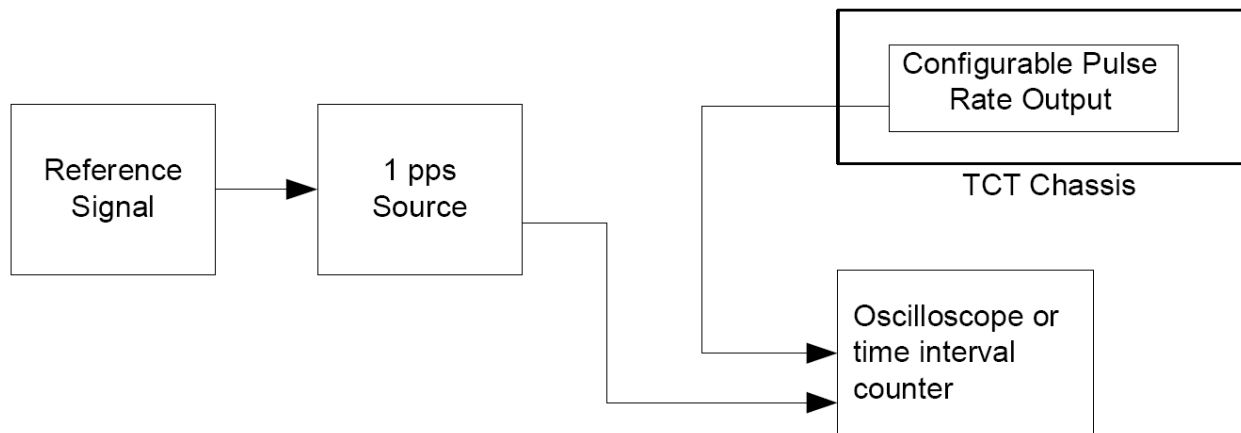
Figure 21: Connection configuration for setting the TCT delay adjustment

To set the time delay adjustment:

1. With the front panel of the TCT facing you, use the #2 Phillips screwdriver to loosen the left screw on the delay adjustment access panel that is on top of the TCT.

   ■ You want the screw head to be about 1/8" above the top surface of the TCT.

2. Loosen the right screw enough to move the panel cover so that the larger part of the hole in the cover aligns with the screw head.

3. Using a small screwdriver in the panel cover notch, lift the panel cover off the right screw and slide the cover out of the way.

4. Connect the external 1 pps source to the oscilloscope or time interval counter.

5. Connect the Configurable Pulse Rate Output module on the back of the TCT to the oscilloscope or time interval counter using a short cable.

   ■ To provide the best 1 pps alignment, you should use a cable equivalent in length to the one that was used for setting the MCA.

6. Compare the 1 pps signals and determine the amount of delay between the two signals.

7. Using the #2 Phillips screwdriver, set the delay adjustment switches to compensate for the delay.

   ■ Small arrows on the delay adjustment switches show the current setting. You want the difference between the two 1 pps signals to be ±5 ns.

   ■ You can set the delay adjustment in increments of 10 ns. The maximum delay adjustment is 199,990 ns. If you set the 100 μs switch to a setting other than 1, the system ignores the setting and uses 100 μs for that switch setting.

8. Check the 1 pps signals again on the oscilloscope or time interval counter and make further adjustments as necessary.

9. Disconnect the TCT from the oscilloscope or time interval counter.

10. Replace the cover on the delay adjustment panel and tighten the screws.

11. Clear the MPD alarms on the MCA or 4351 DA the TCT is connected to.

    ■ If the TCT is connected to the MCA, press **MPD DISABLE** next to the fiber optic connector the TCT is connected to twice (once to disable MPD and clear the alarm; the second time to enable MPD again) or press **ALARM RESET** on the TCG module.

    ■ If the TCT is connected to a 4351 DA, press **ALARM RESET** on the Distribution Output that the TCT is connected to, then press **ALARM RESET** on the Distribution Input of the DA.

The TCT is now ready to send the synchronized time code to other systems from the installed modules.

2.6 Monitoring the System

The MCAs and DAs have various monitoring connections as described in the following sections:

■ "2.6.1 Monitoring the MCA" on page 28

■ "2.6.2 Monitoring the DA Alarms" on page 30

2.6.1 Monitoring the MCA

The MCA has the following additional connections that you can use for monitoring as needed:

■ MCA UI module

  • MCA ALARM OUT—Use to monitor the MCA alarm using an external computer. For more information, see "2.6.1.2 Monitoring the MCA Alarm" on page 29.

■ TCG module

  • ADV 1 PPS IN—Use with another nearby MCA and 9.14 m cable to monitor the 1 pps signals. For more information, see "2.3 Installing a Hot Backup MCA" on page 22.

  • ADV 1 PPS OUT—Use with another nearby MCA and 9.14 m cable to monitor the 1 pps signal. For more information, see "2.3 Installing a Hot Backup MCA" on page 22.

- TCG ALARM OUT—Use to monitor the TCG alarm using an external computer. For more information, see "2.6.1.1 Monitoring the TCG Alarm" on page 29.

■ Flywheel module

- EFC—Use to check the control voltage of the TCXO. For more information, see "4.4 Checking the Control Voltage of the Flywheel Module's TCXO" on page 52.

- TXCO FREQ. MONITOR—This connector is a single-ended output transformer coupled from the Flywheel TCXO 100 MHz PECL output. You can use this output to investigate the stability of the internal 100 MHz signal if there is any question about its stability.

2.6.1.1 Monitoring the TCG Alarm

You can monitor the TCG alarm, which includes only alarms in the TCG module.

For information about troubleshooting the alarms, see "4.1.3 TCG Module LEDs and Alarms" on page 44.

Required for this procedure:

■ Torque wrench

■ Cable with SMA male connector

■ Computer system set up to monitor Time and Frequency Distribution System alarms

To monitor the TCG alarms:

1. Connect the cable to the TCG ALARM OUT connector on the TCG module.

    ■ For details about the connector, see "A.1 Time and Frequency Distribution System Specifications" on page 61.

2. Connect the other end of the cable to a system set up for monitoring the alarms.

3. Using the torque wrench, tighten the both connections to 8 in-lbs.

2.6.1.2 Monitoring the MCA Alarm

You can monitor the MCA alarm, which includes any alarm in the MCA, Flywheel, or Power Supply modules.

For information about troubleshooting the alarms, see "4.1.2 MCA UI Module LEDs and Alarms" on page 43.

Required for this procedure:

■ Torque wrench

■ Cable with SMA male connector

■ Computer system set up to monitor Time and Frequency Distribution System alarms

To monitor the MCA alarms:

1. Connect the cable to the MCA ALARM OUT connector on the MCA UI module.

    ■ For details about the connector, see "A.1 Time and Frequency Distribution System Specifications" on page 61.

2. Connect the other end of the cable to a system set up for monitoring the alarms.

3. Using the torque wrench, tighten both connections to 8 in-lbs.

2.6.2 Monitoring the DA Alarms

You can monitor the DA alarm, which includes any alarm in the Distribution Input, Distribution Output, or Power Supply modules.

For information about troubleshooting the alarms, see "4.2 DA LEDs and Alarms" on page 47.

To monitor the 4352 DA alarms:

1. Connect the cable to the ALARM OUT connector on the 4352 Distribution Input module.

   ■ For details about the connector, see "A.1 Time and Frequency Distribution System Specifications" on page 61.

2. Connect the other end of the cable to a system set up for monitoring the alarms.

3. Using the torque wrench, tighten both connections to 8 in-lbs.

To monitor the 4340 DA alarms, use the Ethernet commands listed in section 2.6.3.1.

2.6.3 Monitoring via the Ethernet connection

Part numbers TSC 4362BM(or S) (TCG), 4340 and 4300BM(or S) (TCT) provide the capability to monitor the system via an Ethernet connection on the TCG. The 4362B contains a Lantronix® Xport™ Ethernet to RS-232 converter, which provides the systems Ethernet connection.

The TCG ships from the factory with a default IP address of 0.0.0.0, which enables DHCP. If the network has a DHCP server, it will automatically assign the unit an IP address, gateway address, and subnet mask when the unit starts up.

To monitor multiple TCGs remotely through their Ethernet connections without DHCP re-assigning IP addresses, you must assign each unit a static IP address. You identify which unit is the source of an alarm by its IP address. Each unit has its own unique hardware address, labeled MAC address, on a label on the rear panel. Follow the instructions in this section to manually assign a unit's static IP address.

Note

For more detailed information, see the *Xport™ User Manual.* Section 3.3 discusses several different ways that you can assign IP addresses. Chapter 4 explains how to configure a static IP address. You can download the *Xport™ User Manual* from the Lantronix® Web site as an Adobe® Acrobat® PDF file. Go to:
http://www.lantronix.com/products/eds/xport/XPort_UM_900-270.pdf

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If you want to configure a static IP address of many different TCGs, you can install the Lantronix® DeviceInstaller software. This software is available only by downloading from the Lantronix® Web site. Go to: http://www.lantronix.com/support/utils/dst/index.html. Alternatively you may use your companies IT protocol to determine the IP address assigned to a particular hardware address, then set a static address.

To manually assign the static IP address using the Lantronix® DeviceInstaller software:

1. Obtain the following network information from your system administrator for each 4362B you want to install:

   IP Address: _____ _____ _____ _____

   Subnet Mask: _____ _____ _____ _____

   Gateway: _____ _____ _____ _____

2. Connect a Windows® PC to the same local subnet as the TCG.

3. Install and start the Lantronix® DeviceInstaller software.

4. Click the **Search Network** icon and search for XPORT devices connected to the network, press save and then exit.

5. Click the IP icon or select **Assign IP Address** on the **Tools** menu.

   ■ The hardware device number and IP address appear in the *Assign IP Address* dialog box.

5. Type the new IP address for the appropriate "**Hardware or Ethernet address**" and click **Set IP address.**

   ■ The new IP address appears in the Lantronix® DeviceInstaller window.

6. Test the IP address by pinging the TCG Xport™ on the Lantronix Xport Installer window. Click the **Ping** icon or select **Ping Device** on the **Tools** menu.

   ■ The *Ping Device* window should show the IP address of the TCG Xport™ device, and it should show successful replies if the IP address has been configured correctly.

7. Exit the browser.

To change the IP address using telnet:

1. Telnet to the assigned address, port 9999. Press enter within five seconds to enter the setup mode.

2. Select Option 0

3. Set the IP address and follow on screen commands to save the setting

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ℹ **Note**

If you move the system to a different network hub after setting up the static IP address, the host computer may not be able to make a connection. You may need to release the IP address lease on your operating system.

2.6.3.1 Commands for Ethernet Monitoring

Commands are shown in bold in this manual. The commands are sent as ASCII text over the Ethernet connection to the TCG via a telnet session to port 10001. Response returned from a command is ASCII text. To see the full set of commands available, hit the enter key or <CR> <LF>. If no command is sent to the unit after two minutes, the MCA time is pushed to the port in the following format:

     <CR> <LF> MCA TIME : XX XXX XX XX XX

Decimal numbers with decimal separators represent the address of each node in the system. The TCG outputs are addressed 1 through 4. The address is built up as status is sent back through levels of DA hierarchy until arriving at a TCG fiber input. TCTs connected directly to the TCG will have an address length of one decimal character. Each level of DA hierarchy will add one decimal number to the front of the address it received. Each of the eight DA chassis output transceivers is numbered 1 through 8.

Binary status is defined as 1 for true and 0 for false on alarms and status.

$dms *<CR> (Display MCA Status)* :
returns data stream consisting of MCA status. The response for this command represents the status at that point in time, with minimal delay in status response. Figure 21A shows an example of the address scheme.

The response to this command is as follows:

	OE	*STC*	*CDD*	*MPDD [4:1]*
Switch	*x*	*x*	*x*	*xxxx*
Alarm	*-*	*x*	*x*	*xxxx*

Where <u>OE</u> reports the status of the Fiber Optic Enable switch on the TCG.
<u>STC</u> is the status of the Serial Time Code alarm on the TCG
<u>CDD</u> is the status of the Coincidence Detection Disable switch and alarm on the TCG
<u>MPDD</u> is the status of the Missing Pulse Detect Disable switch and alarm for each of the four TCG outputs.
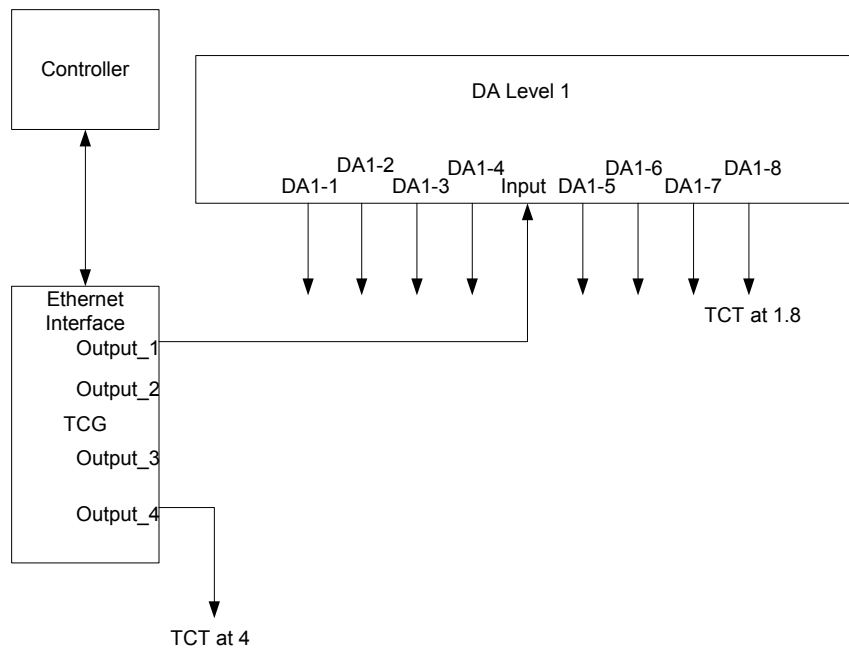
Figure 21A Node addressing

Example using Figure 21A configuration, where the TCT at output_4 of the TCG has an alarm:

$dms response:

	OE	*STC*	*CDD*	*MPDD [4:1]*
Switch	*1*	*-*	*1*	*1001*
Alarm	*-*	*0*	*0*	*1000*

Optical outputs are enabled

There is no STC alarm present

Coincidence Detection (CD) is enabled, there is no CD alarm

Missing Pulse Detect is enabled on channels 1 and 4, and channel 4 has an alarm

$dfs *<CR> (Display Full Status)* :

returns data stream consisting of full system status. The response for this command should represent the status at that point in time, with a few seconds delay in status response in a full system.

The following response would be provided for the system shown in figure 1:

```
                 OE STC CDD MPDD[4:1]
Switch       1   -   1    1110
Alarm        -   0   0    0001
DA 1    PI:STC   P1: EMPT  P2:EMPT  P3:EMPT  P4: EMPT
            P5:EMPT  P6:EMPT  P7:PNS   P8:TCT
        S1:P    S2:P    FB:P
TCT 1.8  000000 0000 5555
TCT 4    100000 0000 5555
```

Note:

Switch and Alarm have the same definitions as the **$dms** command. **DA** (Distribution Assembly, also referred to as Fiber Expansion Chassis) means there is a DA connected to an output. **TCT** means there is a TCT connected to an output. The number following **DA** or **TCT** in the response is the TCG port which the device is connected. Addressing is defined with decimal point separators between levels of the system. **P** prefixes are the status of each DA transceiver socket, with the following definitions:

- **STC** means there is a valid Serial Time Code being received on the Input to the DA.
- **EMPT** means there is no transceiver sensed in the DA output.
- **PNS** means there is a transceiver present with no signal.

If you have an unused output of a DA, the transceiver should be unplugged to eliminate the alarm condition that it reports back to the TCG. **S1** and **S2** are the status of the appropriate power supplies in the DA.

TCT x   aaaaaa bbbb ccc

Where x is the node address

aaaaaa is the binary status of INTERNAL, LOSS OF SIGNAL, VCXO UNLOCK, RATE RE_SYNC, STC CRC and EFC alarms.

bbbb is the binary alarm status of the modules in slots 4 through 1.

cccc is for future expansion

In this example, a DA is connected to port 1 of the TCG. A TCT is connected to port 8 of the DA which is connected to port 1 of the TCG. An additional TCT is connected directly to port 4 of the TCG.

$ssa *#####*
Set the slew advance on the TCG, from 10 ns to 100 ms, in ns units

$ssr *#####*
 Set_slew_retard 10 ns to 100 ms, in ns units

$lsa *DDD*

Set leap second add to occur at midnight of day DDD

$lss DDD
Set leap second subtract to occur at midnight of day DDD

$lsc
Cancel leap second add or subtract

$pgr
Partial Global reset of TCG and connected TCTs. At this time the MCA and Flywheel can not be reset.

$dmt
 Display MCA Time returns YY:DDD:HH:MM:SS

$dls
Reports the day set for leap second add or subtract.
SUBTRACT 123 reported for leap second subtract for day 123.

$deo
 Disables electrical outputs. TCTs will go into an internal alarm condition and display all dashes on the display. Electrical outputs can be re-enabled via the *$eeo* command.

$eeo
 Re-enables electrical outputs after a *$deo* command was sent.

3: Maintaining the Universal Time and Frequency System

Note: The TSC marketing material refers to this systems components with different names than are used in this manual and on the hardware itself. The UTCG referred to in the marketing material is called the Master Clock Assembly, or MCA. The FEC referred to in the marketing material is the Distribution Assembly or DA.

3.1 Monitoring the MCA 1 pps Synchronization

You can continuously monitor the MCA's 1 pps synchronization in two ways:

- Set up coincidence detection that compares the 1 pps signals between two MCAs that are near each other. For information about this setup, see "2.3 Installing a Hot Backup MCA" on page 22.

- Set up coincidence detection that compares the internal 1 pps signal to an external 1 pps signal. For information about this setup, see "2.2.4 Adjusting the Slew and Enabling Coincidence Detection" on page 19.

3.2 Checking the MCA 1 pps Synchronization

You can use an external 1 pps source, such as a cesium clock or other 1 pps standard signal, to check and synchronize the 1 pps signal.

If you do not monitor the 1 pps synchronization continuously, you should check it periodically in accordance with your organization's standards.

Required for this procedure:

- Torque wrench
- Two cables of the same length with SMA male connectors
- External 1 pps source, such as a portable cesium clock
- Oscillocope or time interval counter

Figure 22 shows the connections needed to check the 1 pps signal synchronization.
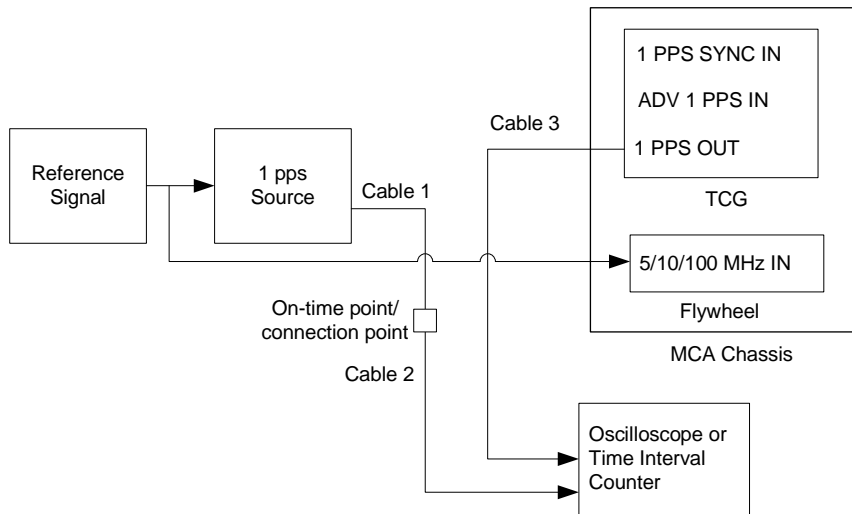
Figure 22: Connection configuration to check the 1 pps signal synchronization

To check the 1 pps synchronization:

1. If connected, disconnect the cable from the ADV 1 PPS IN connector on the TCG module.

    - This is Cable 1 in Figure 22.

2. Connect the cable that you just disconnected into a second cable.

    - This is Cable 2 in Figure 22.

3. Connect the other end of the second cable to the oscilloscope or time interval counter.

4. Connect one end of a third cable, that is the same length as the second cable, to one of the 1 PPS OUT connectors on the TCG module.

    - This is Cable 3 in Figure 22.

5. Connect the other end of the third cable to the oscilloscope or time interval counter.

6. Using the torque wrench, tighten all connections to 8 in-lbs.

7. Compare the 1 pps signals and determine the difference between the two signals.

8. Adjust the slew on the MCA if the difference between the two signals exceeds ±20 ns.

    - For more information, "3.3.1 Adjusting the Slew" on page 38. You want the difference between the two 1 pps signals to be ±5 ns.

9. Check the 1 pps signals again on the oscilloscope or time interval counter and make further slew adjustments as necessary.

10. Reconnect the cables for the appropriate monitoring configuration.

    - See Figure 18 on page 21 or Figure 19 on page 22.

11. On the MCA UI module, press **ALARM RESET** to globally reset all alarms on the system.

    - This also resets the MPD alarms on any DAs connected to this MCA.

3.3 Adjusting the Time

You can make the following types of adjustments to the time:

- Adjust the slew to resynchronize the 1 pps signal with an external source
- Set a leap second

Leap years are preprogrammed into the Universal Time and Frequency System and require no action.

3.3.1 Adjusting the Slew

When you find that the MCA 1 pps signal is out of sync with the external 1 pps signal, you can use the slew setting to resynchronize the 1 pps signals. However, before you adjust the slew, you should make sure that the Flywheel module does not have any alarms and that the TCG module is receiving a proper 1 pps signal.

To adjust the slew:

1. Follow the steps in "3.2 Checking the MCA 1 pps Synchronization" on page 36 to determine the amount of slew needed.
2. Check the Flywheel and TCG modules for any alarms.
   - If it has an alarm, press **ALARM RESET**. If the alarm persists, troubleshoot the alarm as described in "4.1.5 Flywheel Module LEDs and Alarms" on page 47 and "4.1.3 TCG Module LEDs and Alarms" on page 44.
   - If it has no alarms, continue with the next step.
3. On the MCA UI module, press the **Left** and **Right** arrow buttons simultaneously until the yellow ENABLED LED lights up.
   - This enables the settings in the FUNCTIONS section of the MCA UI. The functions time out after two minutes of inactivity.
4. Press **FUNCTION SELECT** until the correct SLEW LED lights up.
   - Use the ADVANCE slew function when the internal 1 pps signal is behind the external signal. Use the RETARD slew function when the internal 1 pps signal is ahead of the external signal.
   - The ms, μs, and ns digits in the time display all show zeros with the second to the right ns digit (tens of nanoseconds) blinking. The remaining LEDs are blank.
5. Use the **Up** and **Down** arrows to set the blinking ns digit.
   - The minimum slew setting is 10 ns. The maximum slew setting is 100 ms.
6. Continue using the arrows to set the remaining slew digits as needed.
   - Use the **Left** and **Right** arrows to move left and right in the time display. The selected digit blinks. Use the **Up** and **Down** arrows to set the selected digit.
7. Press **APPLY**.
   - Slew values are relative. Once you press **APPLY**, the display returns to all zeros.

8. Check the 1 pps synchronization again.

   ■ For more information, see "3.1 Monitoring the MCA 1 pps Synchronization" on page 36.

9. If necessary, repeat steps 3 through 8 until the 1 pps signals are synchronized within ±5 ns.

   ■ The TCTs that are connected to the system will report a resync alarm. This alarm will be latched by the next level DA or MCA and will cause an MPD alarm there.

10. On the MCA UI module, press **ALARM RESET** to clear all alarms system-wide caused by adjusting the slew.

3.3.2 Setting a Leap Second

You can set a leap second when necessary. At midnight on the day you set, the system adds or subtracts the leap second.

You can set up the leap second in advance, but only for the current year. You can set only one add or subtract leap second. If you set a leap second and later set the leap second again, whether add or subtract, the new setting overwrites the previous setting.

You can also cancel a leap second. For more information, see "3.3.2.1 Canceling a Leap Second" on page 40.

The system limits the valid values you can enter for each digit in the time display as shown in Table 2. In addition, the valid day values are 1–365 for non-leap years and 1–366 for leap years.

Table 2: Valid values for leap second settings

Time display digit	Valid values
D	0–3
D	0–9
D	0–9

To set a leap second:

1. On the MCA UI module, press the **Left** and **Right** arrow buttons simultaneously until the yellow ENABLED LED lights up.

   ■ This enables the settings in the FUNCTIONS section of the MCA UI. The functions time out after two minutes of inactivity.

2. Press **FUNCTION SELECT** until the correct LEAP SECOND LED lights up.

   ■ Use the ADD function to add a leap second. Use the SUBTRACT function to subtract a leap second.

   ■ The DAY digits in the time display all show dashes with the right-most DAY digit blinking. The remaining LEDs are blank.

3. Use the **Up** and **Down** arrows to set the blinking DAY digit.

4. Continue using the arrows to set the remaining DAY digits.

   ■ Use the **Left** and **Right** arrows to move left and right in the time display. The selected digit blinks. Use the **Up** and **Down** arrows to set the selected digit.

5. Press **APPLY**.

   ■ If you entered an invalid day (>366 or a day prior to the current day), the time display returns to the dashes in the DAY digits. Enter a valid day and press **APPLY**.

   ■ If you entered a valid day, the ADD or SUBTRACT LED will blink slowly until the system applies the leap second on the set day.

3.3.2.1 Canceling a Leap Second

If you have set up a leap second, you can cancel it anytime before midnight on the set day.

To cancel a leap second:

1. On the MCA UI, press the **Left** and **Right** arrow buttons simultaneously until the yellow ENABLED LED lights up.

   ■ This enables the settings in the FUNCTIONS section of the MCA UI. The functions time out after two minutes of inactivity.

2. Press **FUNCTION SELECT** until the LEAP SECOND CANCEL LED lights up.

   ■ The DAY digits in the time display all show the previously set day and the ADD or SUBTRACT LED lights up, based on the previous setting. The remaining LEDs are blank.

3. Press **APPLY**.

   ■ The system cancels the leap second and returns to the time display.

4: Troubleshooting the Time and Frequency Distribution System

> Note: The TSC marketing material refers to the systems' components with different names than are used in this manual and on the hardware itself. The UTCG referred to in the marketing material is called the Master Clock Assembly, or MCA. The FEC referred to in the marketing material is the Distribution Assembly or DA.

The **ALARM RESET** button, for each module equipped with one, also acts as an LED test. Pressing and holding the button will light all LEDs on the module. If an LED is not lit, you should replace the module.

The LED colors show the status of the system:

- Green or not lit—Good. No action needed, except with 4340A which means no transceiver or power supply is disabled.

- Yellow—Caution. Check the item as described in the following sections.

- Red—Failed or no signal. Check the item immediately as described in the following sections.

The following sections describe each LED and how to troubleshoot the failure.

4.1 MCA LEDs and Alarms

The following sections describe the MCA module LEDs and alarms, including possible actions to take.

4.1.1 Power Supply Modules LEDs and Alarms

Table 3 describes all of the MCA Power Supply module LEDs, alarms, and possible actions as applicable. After resolving the cause of the alarm, press **ALARM RESET** on the affected module to reset the alarm LEDs.

Table 3: MCA Power Supply LEDs and alarms

LED label	Color	Function	Possible Actions
ALARM	Red	Solid when module has an internal problem or power is disconnected.	■ If both of the +5V and +12V LEDs are *not* lit, check the power cable and power source and resolve any power problems. ■ If one or both of the +5V and +12V LEDs is red, replace the module.
+5V	Green	Solid when 5-volt output is good.	N/A
	Red	Solid when module has an internal problem.	Replace the module.

LED label	Color	Function	Possible Actions
+12V	Green	Solid when 12-volt output is good.	N/A
	Red	Solid when module has an internal problem.	Replace the module.

4.1.2 MCA UI Module LEDs and Alarms

Table 4 describes all of the MCA UI module LEDs, alarms, and possible actions as applicable. After resolving the cause of the alarm, press **ALARM RESET** on the affected module to reset the alarm LEDs. Pressing **ALARM RESET** on the MCA UI module resets all alarms throughout the system, except the MCA or DA Power Supply modules.

Table 4: MCA UI LEDs and alarms

LED label	Color	Function	Possible actions
LEAP YEAR	Green	Solid when current year is a leap year.	N/A
ENABLED	Yellow	Solid when time adjustment functions below LED are enabled.	N/A
IRIG-B JAM	Green	Solid when IRIG-B jam function is selected.	N/A
MANUAL	Green	Solid when manual time set function is selected.	N/A
ADVANCE	Green	Solid when slew advance function is selected.	N/A
RETARD	Green	Solid when slew retard function is selected.	N/A
ADD	Green	Solid when add leap second function is selected. Blinks slowly when a leap second addition is pending.	N/A
SUBTRACT	Green	Solid when subtract leap second function is selected. Blinks slowly when a leap second subtraction is pending.	N/A
CANCEL	Green	Solid when cancel leap second function is selected.	N/A
DISPLAY TIMECODE	Green	Solid when functions are not active and time code displays above. This is normal operation. Off when another function is selected.	N/A
IRIG-B IN	Green	Solid when connected to a valid IRIG-B modulated signal.	N/A

LED label	Color	Function	Possible actions
MCA FAIL	Red	Off during normal operation. Solid when the MCA, Power Supply, or Flywheel fails.	1. Check the Power Supply module and resolve any problems with it. 　• See "4.1.1 Power Supply Modules LEDs and Alarms" on page 42. 2. Check the Flywheel module and resolve any problems with it. 　• See "4.1.5 Flywheel Module LEDs and Alarms" on page 47. 3. If MCA FAIL is still red after pressing **ALARM RESET**, replace the MCA UI module.

4.1.3 TCG Module LEDs and Alarms

Table 5 describes all of the TCG module LEDs, alarms, and possible actions as applicable. After resolving the cause of the alarm, press **ALARM RESET** on the affected module to reset the alarm LEDs.

Table 5: TCG LEDs and alarms

LED label	Color	Function	Possible actions
TIME CODE	Red	Solid when module detects a CRC time code error or change in time.	1. If you changed the time, press **ALARM RESET** to clear the alarm. 2. Verify that the MCA UI module is functioning properly by observing that there are no alarms on a TCT connected to the MCA, then changing the slew and verifying the correct change on the TCG 1 pps signal. 　• If the MCA UI is working properly and you did not change the time, replace the TCG. 　• If the MCA UI is not working properly, replace the MCA UI module.
COINCIDENCE	Red	Solid when the difference between the TCG 1 pps signal and the ADV 1PPS IN signal exceeds ±20 ns.	1. If the Flywheel module does not have an alarm, verify that the external 1 pps signal has not drifted or was temporarily not present at the input to the TCG. 2. If all potential errors with the external 1 pps signal have been eliminated, replace the TCG module if the 1 pps signals are verified to be within ±20 ns.
DISABLED	Yellow	Solid when coincidence function is disabled.	Use the **DISABLE** button to enable or disable coincidence detection.
ENABLE OPTICAL OUTPUTS	Green	Solid when optical output connectors are enabled.	Use the **ENABLE OPTICAL OUTPUTS** button to enable the optical output connectors.

LED label	Color	Function	Possible actions
1 PPS SYNC IN	Green	Blinks when receiving a good 1-pps input signal.	If the LED is not blinking when connected to an external 1 pps source, check that the 1 pps input signal is 10 μs wide and 0 to 3.3 volts in amplitude. If the signal is good, replace the TCG module.
ADV 1 PPS IN	Green	Blinks when receiving a good 1-pps input signal.	If the LED is not blinking when connected for coincidence monitoring, check that the ADV 1 PPS IN input signal is 10 μs wide and 0 to 3.3 volts in amplitude. If the signal is good, replace the TCG module.
ADV 1 PPS OUT	Green	Blinks when a signal is available at the connector.	■ If the LED is not blinking when connected for coincidence monitoring, disconnect the cable. If the LED blinks, replace the cable. ■ If the LED is not blinking without a cable connected and you have set the time, replace the TCG module.
MPD DISABLE	Yellow	Solid when MPD function is disabled for the fiber optic connector to the right.	Use the **MPD DISABLE** button to enable or disable MPD for the 1 PPS IN fiber optic connector.
MPD ALARMS	Red	Solid when the DA or TCT connected to that fiber optic connector is not transmitting a 1 pps signal back to the TCG.	1. Check that the connected DA or TCT has AC power. 2. Check for alarms on the DA or TCT and resolve them. • See "4.2 DA LEDs and Alarms" on page 47 and "4.3 TCT LEDs and Alarms" on page 51. 3. If no other alarms are present, move the returned fiber optic 1 pps (Rx) cable to another TCG input. 4. Verify that the 1 pps is on the fiber by enabling the MPD for the appropriate input. 5. If the 1 pps signal is on the fiber, replace the TCG module. 6. If the 1 pps signal is not on the fiber at the TCG, disconnect the TCT or DA returned 1 pps cable at the Tx output and connect it to another TCT or DA. • If the 1 pps signal is good on the cable when connected to a known good DA or TCT, replace the original DA or TCT. • If the 1 pps signal is *not* good on the cable, replace the cable. • If another Distribution Input module or TCT is not available, use a power meter to check the power level at the 1 pps output of the suspect DA or TCT, which should be a minimum of −18 dBm for single-mode cable and a minimum of −22 dBm for multi-mode cable.

4.1.4 Coincidence Detection with Two MCAs

When you are using two MCAs set up for coincidence detection as described in "2.3 Installing a Hot Backup MCA" on page 22, use Table 6 to troubleshoot any COINCIDENCE alarms.

Figure 23 shows the connections needed to monitor two MCAs.
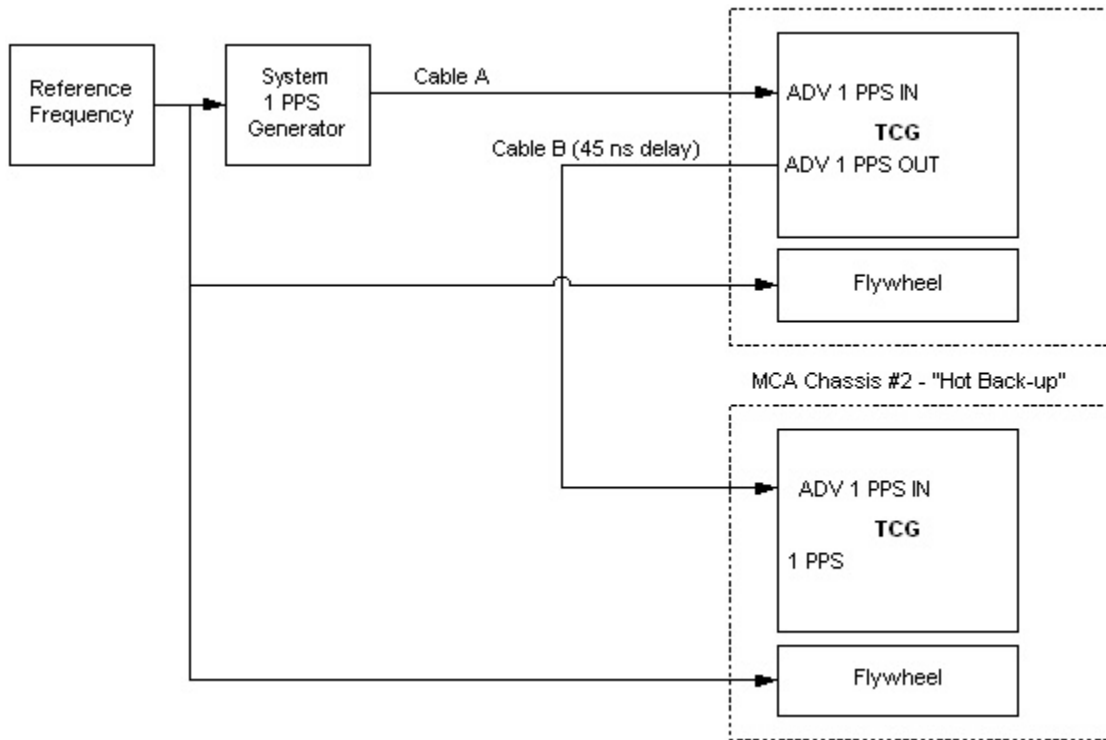
Figure 23: Connection configuration for synchronizing and monitoring two MCAs

Table 6: Coincidence detection troubleshooting with two MCAs

Alarm location	Meaning	Possible Actions
MCA #1 COINCIDENCE alarm only	External 1 pps source has drifted more than 20 ns.	Correct the problem with the external 1 pps source.
MCA #2 COINCIDENCE alarm only	MCA #2 has drifted more than 20 ns.	■ Check for any Flywheel module alarms on MCA #2. 　• If there are alarms, see "4.1.5 Flywheel Module LEDs and Alarms" on page 47. 　• If there are no Flywheel alarms and no one has adjusted the slew on MCA #2, replace the TCG module of MCA #2.
MCA #1 and #2 COINCIDENCE alarms	MCA #1 has drifted more than 20 ns.	■ Check for any Flywheel module alarms on MCA #1. 　• If there are alarms, see "4.1.5 Flywheel Module LEDs and Alarms" on page 47. 　• If there are no alarms and no one has adjusted the slew on MCA #1, replace the TCG module of MCA #1.

4.1.5 Flywheel Module LEDs and Alarms

Table 7 describes all of the Flywheel module LEDs, alarms, and possible actions as applicable. After resolving the cause of the alarm, press **ALARM RESET** on the affected module to reset the alarm LEDs.

Table 7: Flywheel LEDs and alarms

LED label	Color	Function	Possible actions
TCXO LOCK	Green	Solid when TCXO is phase locked with the reference signal.	N/A
	Red	Solid when TCXO is not phase locked with the reference signal.	■ Check that the reference signal is 5, 10, or 100 MHz. • If you found a problem with the reference signal, fix the problem. • If the signal is good, replace the Flywheel module.
EFC LIMIT	Green	Solid when internal control voltage is within the acceptable range.	N/A
	Yellow	Solid when internal control voltage is within 10% of the range limits (0 and 3.3 volts).	Replace the TCXO or the Flywheel module.
INPUT	Green	Solid when receiving a good 5, 10, or 100 MHz reference signal.	N/A
	Red	Solid when *not* receiving a good 5, 10, or 100 MHz reference signal.	1. Check that the reference signal is 5, 10, or 100 MHz. 2. If the signal is good, replace the Flywheel module.

4.2 DA LEDs and Alarms

The following sections describe the DA module LEDs and alarms, including possible actions to take.

4.2.1 4353 Power Supply Module LEDs and Alarms

Table 8 describes all of the 4353 DA Power Supply module LEDs, alarms, and possible actions as applicable. After resolving the cause of the alarm, press **ALARM RESET** on the affected module to reset the alarm LEDs.

Table 8: DA Power Supply LEDs and alarms

LED label	Color	Function	Possible Actions
ALARM	Red	Solid when module has an internal problem or power is disconnected.	■ If both of the +5V and +12V LEDs are not lit, check the power cable and power source and resolve any power problems. ■ If one or both of the +5V and +12V LEDs is red, replace the module.
+5V	Green	Solid when 5-volt output is good.	N/A
	Red	Solid when module has an internal problem.	Replace the module.
+12V	Green	Solid when 12-volt output is good.	N/A
	Red	Solid when module has an internal problem.	Replace the module.

4.2.2 DA input LEDs and Alarms

Table 9 describes all of the DA input LEDs, alarms, and possible actions as applicable. After resolving the cause of the alarm, press **ALARM RESET** on the affected 4352 module or the MCA UI to reset the alarm LEDs, or send a $pgr from the Ethernet port. This table also addresses the 4340 DA where applicable.

Table 9: DA Input LEDs and alarms

LED label	Color	Function	Possible Actions
INVALID TIME CODE (4352) or INPUT (4340)	Red	Solid when module detects an invalid time code (4352) or no input signal (4340).	1. See if LOSS OF SIGNAL is also lit (4352). • If it is lit, the module is not receiving the time code signal. Check that the fiber optic cable is connected to the module and that the MCA or DA sending the signal is working properly. • If it is *not* lit, continue with the next step. 2. Connect the fiber optic cable coming into the DA input into another DA Input or TCT to see if it is receiving the time code properly. • If the time code is valid, replace the suspect Distribution Input module or transceiver in the 4340A. • If the time code is not valid, check for alarms on the MCA and resolve them. See "4.1 MCA LEDs and Alarms" on page 42. • If another DA input or TCT is not available, use a power meter to check the power level at the previous level transmitter, which should be a minimum of −18 dBm for single-mode cable and a minimum of −22 dBm for multi-mode cable.

LED label	Color	Function	Possible Actions
CHASSIS ALARM (4352)	Red	Solid when any module in the DA has an alarm.	1. Check the Power Supply modules for alarms and resolve them. 　• See "4.2.1 Power Supply Modules LEDs and Alarms" on page 48. 2. Check the Distribution Output modules for alarms and resolve them. 　• See "4.2.3 Distribution Output Module LEDs and Alarms" on page 49. 3. If all of the above are working properly, but the CHASSIS ALARM remains red, replace the Distribution Input module.
LOSS OF SIGNAL (4352)	Red	Solid when module loses the time code signal.	1. See if INVALID TIME CODE is also lit. 　• If it is *not* lit, the module is not receiving the time code signal. Check that the fiber optic cable is connected to the module and that the MCA or DA sending the signal is working properly. 　• If it is lit, continue with the next step. 2. Connect the fiber optic cable coming into the Distribution Input module into another Distribution Input module or TCT to see if it is transmitting the time code properly. 　• If the time code is valid, replace the Distribution Input module. 　• If the time code is not valid, check for alarms on the MCA and resolve them. See "4.1 MCA LEDs and Alarms" on page 42. 　• If another Distribution Input module or TCT is not available, use a power meter to check the power level at the previous level transmitter, which should be a minimum of -18 dBm for single-mode cable and a minimum of -22 dBm for multi-mode cable.
INPUT (4340)	Off	Off when no transceiver is detected.	Ensure a transceiver is fully plugged into the INPUT socket on the rear of the 4340. If the transceiver is plugged in, replace the transceiver with a known good transceiver.

4.2.3 DA Output LEDs and Alarms

Table 10 describes all of the DA output LEDs, alarms, and possible actions as applicable. After resolving the cause of the alarm, press **ALARM RESET** on the affected 4351 module or the MCA UI to reset the alarm LEDs, or send a $pgr from the Ethernet port to reset the alarm LEDs. This table also addresses the 4340 DA where applicable.

Table 10: Distribution Output LEDs and alarms

LED label	Color	Function	Possible Actions

LED label	Color	Function	Possible Actions

MPD (4351) or OUTPUT (4340)	Red	Solid when the DA or TCT connected to the fiber optic connector is not sending back a valid 1 pps signal.	1. Check that the connected DA or TCT has AC power.
			2. Check for alarms on the DA or TCT and resolve them.
			  • See "4.2 DA LEDs and Alarms" on page 47 and "4.3 TCT LEDs and Alarms" on page 51.
			3. If no other alarms are present, move the returned fiber optic 1 pps (Rx) cable to another DA or TCG input.
			4. Verify that the 1 pps is on the fiber by enabling the MPD for the appropriate input.
			5. If the 1 pps signal is on the fiber, replace the DA Output module (4351) or transceiver (4340).
			6. If the 1 pps signal is not on the fiber, disconnect the TCT or DA returned 1 pps cable at the Tx output and connect it to a known good TCT or DA.
			  • If another DA input or TCT is not available, use a power meter to check the power level at the suspect DA Input or TCT, which should be a minimum of −18 dBm for single-mode cable and a minimum of −22 dBm for multi-mode cable.
			  • If the 1 pps signal is good on the cable when connected to another DA or TCT, replace the suspect DA or TCT.
			  • If the 1 pps signal is *not* good on the cable, replace the cable.
			6. If this will be an unused output of the 4340, disconnect the unused transceiver from the appropriate output of the 4340.

MPD ALARM DISABLED (4351)	Yellow	Solid when MPD function is disabled.	Toggle **MPD** to enable or disable MPD for the fiber optic connector. If changing the switch position does not result in the correct response, replace the Distribution Input module.
OUTPUT (4340)	Off	Off when no transceiver is detected.	Ensure the correct type transceiver is fully plugged into the appropriate OUTPUT socket on the rear of the 4340. If the transceiver is plugged in, replace the transceiver with a known good transceiver.

4.3 TCT LEDs and Alarms

Table 11 describes all of the TCT LEDs, alarms, and possible actions as applicable. After resolving the cause of the alarm, press **ALARM RESET** on the affected module to reset the alarm LEDs.

Table 11: TCT LEDs and alarms

LED label	Color	Function	Possible Actions
LEAP SEC +	Yellow	Solid on the day when a leap second addition is set to occur.	N/A
LEAP SEC –	Yellow	Solid on the day when a leap second subtraction is set to occur.	N/A
LEAP YEAR	Yellow	Solid when current year is a leap year.	N/A
INTERNAL	Red	Solid when a rate resync or CRC error occurs. Stays solid only during the error event, then goes off, but the connected MCA or DA will show an MPD alarm.	1. Check for alarms on the MCA providing the time code and resolve them. • See "4.1 MCA LEDs and Alarms" on page 42. • If the MCA has no alarms and no other TCTs connected to the MCA show the problem, replace the TCT chassis. 2. Connect the fiber optic cable coming into the TCT to another TCT to see if it is transmitting the time code properly. • If another TCT is not available, use a power meter to check the power level at the output of the DA or MCA the TCT is connected to, which should be a minimum of –18 dBm for single-mode cable and a minimum of –22 dBm for multi-mode cable.
LOSS OF SIGNAL	Red	Solid when TCT is not receiving the time code or it could not process the time code. Stays solid only during the error event, then goes off, but the connected MCA or DA will show an MPD alarm.	See steps for INTERNAL LED.
TCXO UNLOCK	Red	Solid when the TCXO cannot phase lock with the incoming time code signal. Stays solid only during the error event, then goes off, but the connected MCA or DA will show an MPD alarm.	See steps for INTERNAL LED.

LED label	Color	Function	Possible Actions
RATE RESYNC	Red	Solid when the FPGA has to resynchronize the TCXO to the incoming time code signal. Stays solid only during the error event, then goes off, but the connected MCA or DA will show an MPD alarm.	See steps for INTERNAL LED.
SERIAL TIME CODE	Red	Solid when the TCT detects a CRC error in the time code. Stays solid only during the error event, then goes off, but the connected MCA or DA will show an MPD alarm.	See steps for INTERNAL LED.
EFC	Yellow	Solid when the TCXO control voltage is within 10% of the acceptable range limits.	Replace the TCXO or TCT chassis.

4.4 Checking the Control Voltage of the Flywheel Module's TCXO

Over time, the crystal in the TCXO ages and will reach a control voltage that can no longer maintain the 100 MHz signal. You can check the control voltage using a digital multi-meter as needed.

If the EFC LIMIT LED is yellow, it means that the control voltage is within 10% of the acceptable control voltage range limits. You should check the control voltage.

Caution

Use a suitable antistatic strap and observe all industry-standard electrostatic discharge (ESD) precautions when handling modules.

Required for this procedure:

- Digital multi-meter with male banana-style connectors

To check the Flywheel control voltage:

1. Connect the multi-meter to the black and red EFC connectors on the Flywheel module.

2. Check that the voltage reading is between 0 and 3.3 volts.

3. If the control voltage is within 10% of either end of the range, plan to replace the Flywheel module or the TCXO.

4.5 Replacing MCA Modules

All MCA modules are hot swappable, that is, you can replace them without powering down the MCA. However, the system will lose the time code if you replace either the TCG or Flywheel module. After you replace these modules, you must power cycle the MCA and reset the time.

4.5.1 Replacing an MCA Power Supply Module

The MCA has two Power Supply modules. If one Power Supply module fails, the system continues to operate properly. You can hot swap the failed module, that is, replace it without powering down the MCA.

The modules are keyed and can only go into the correct slot in the MCA chassis (slots 1 and 13 counting from the left).

⚠️ **Caution**

Use a suitable antistatic strap and observe all industry-standard electrostatic discharge (ESD) precautions when handling modules. Do not remove the cover, there are no user serviceable parts inside.

To replace a Power Supply module:

1. Disconnect the power cable from the back of the Power Supply module.
2. On each latch of the Power Supply module, squeeze the handles together and pull the latch handles outward.
3. Slide the module out of chassis.
4. Slide the new module into the chassis.
5. Push the latch handles down toward the front of the module.
6. Reconnect the power cable to the back of the module.
7. If the system is powered on, press **ALARM RESET** on the Power Supply.

4.5.1.1 Replacing a Power Supply Fuse

If you know that a local event caused blown fuses throughout a rack, you can replace the fuse in each Power Supply module.

⚠️ **Caution**

Use a suitable antistatic strap and observe all industry-standard electrostatic discharge (ESD) precautions when handling modules.

Required for this procedure:

- Small flat-head screwdriver
- Replacement fuse for a standard IEC 320 power entry module with fuse (5 x 20 mm, 1-amp, 250-volt fuse)

To replace a fuse:

1. Disconnect the power cable from the back of the Power Supply module.
2. Using a small screwdriver, open the fuse cover on the back of the Power Supply module.
3. Replace the old fuse.

4. Close the fuse cover.

5. Reconnect the power cable to the back of the module.

4.5.2 Replacing an MCA UI Module

You can hot swap the MCA UI module, that is, replace it without powering down the MCA. If the MCA UI module fails, the system continues to operate properly.

The modules are keyed and can only go into the correct slot in the MCA chassis (slots 7 counting from the left).

⚠ **Caution**

Use a suitable antistatic strap and observe all industry-standard electrostatic discharge (ESD) precautions when handling modules.

To replace an MCA UI module:

1. Loosen the two thumbscrews on the left side of the module.

2. Pull the two latch handles on the right side of the module outward.

3. Slide the module out of the chassis.

4. Slide the new module into the chassis

5. Push the latch handles down toward the front of the module.

6. Tighten the thumbscrews.

   - The module starts and runs a self-test, then displays the time.

4.5.3 Replacing a TCG Module

If you have to replace the TCG module, you will lose the time code signal to the rest of the system. You can replace the module without powering down the MCA.

The modules are keyed and can only go into the correct slot in the MCA chassis (slot 11 counting from the left).

⚠ **Caution**

Use a suitable antistatic strap and observe all industry-standard electrostatic discharge (ESD) precautions when handling modules.

To replace a TCG module:

1. Disconnect the cables from the front panel.

2. Loosen the two thumbscrews on the left side of the module.

3. Pull the two latch handles on the right side of the module outward.

4. Slide the module out of the chassis.

5. Slide the new module into the chassis

6. Push the latch handles down toward the front of the module.

7. Tighten the thumbscrews.

8. Disconnect the power from both Power Supply modules.

9. Reconnect the power to both Power Supply modules.

10. Reconnect the cables to the front panel.

11. Reset the time.

   ■ For more information, see "2.2 Setting the Time" on page 14.

4.5.4 Replacing a Flywheel Module

If you have to replace the Flywheel module, you will lose the time code signal to the rest of the system. You can replace the module without powering down the MCA.

The modules are keyed and can only go into the correct slot in the MCA chassis (slot 12 counting from the left).

⚠ **Caution**

Use a suitable antistatic strap and observe all industry-standard electrostatic discharge (ESD) precautions when handling modules.

To replace the Flywheel module:

1. Disconnect the cables from the front panel.

2. Pull the two latch handles on the right side of the module outward.

3. Slide the module out of the chassis.

4. Slide the new module into the chassis

5. Push the latch handles down toward the front of the module.

6. Reconnect the cables to the front panel.

7. Disconnect the power from both Power Supply modules.

8. Reconnect the power to both Power Supply modules.

9. Reset the time.

   ■ For more information, see "2.2 Setting the Time" on page 14.

4.6 Replacing DA Modules or Transceivers

All DA modules and 4340 transceivers are hot swappable, that is, you can replace them without powering down the DA. However, a failure or replacement of the DA Input module or transceiver will interrupt the time code signal to all DA Output modules or transceivers in the DA. To replace an INPUT or OUTPUT transceiver on the 4340 series DA, perform the following steps:

1. Remove the fiber cables from the transceiver

2. Pull out and down on the bail latch

3. Gently pull the transceiver from it's housing

4.6.1 Replacing a Power Supply Module

The DA has two Power Supply modules. If one Power Supply module fails, the system continues to operate properly. You can hot swap the failed module, that is, replace it without powering down the DA.

In the case of the 4353, the modules are keyed and can only go into the correct slot in the DA chassis (slots 1 and 13 counting from the left).

⚠️ **Caution**

Use a suitable antistatic strap and observe all industry-standard electrostatic discharge (ESD) precautions when handling modules. Do not remove the cover, there are no user serviceable parts inside.

To replace a 4353 Power Supply module:

1. Disconnect the power cable from the back of the Power Supply module.
2. On each latch of the Power Supply module, squeeze the handles together and pull the latch handles outward.
3. Slide the module out of chassis.
4. Slide the new module into the chassis.
5. Push the latch handles down toward the front of the module.
6. Reconnect the power cable to the back of the module.
7. If the system is powered on, press **ALARM RESET** on the Power Supply.

   - The ALARM LED should no longer be lit. If it is, see "4.2 DA LEDs and Alarms" on page 47.

4.6.1.1 Replacing a 4353 Power Supply Fuse

If you know that a local event caused blown fuses throughout a rack, you can replace the fuse in each Power Supply module.

⚠️ **Caution**

Use a suitable antistatic strap and observe all industry-standard electrostatic discharge (ESD) precautions when handling modules.

Required for this procedure:

- Small flat-head or Phillips screwdriver
- Replacement fuse for a standard IEC 320 power entry module with fuse (5 x 20 mm, 1-amp, 250-volt fuse)

To replace a fuse:

1. Disconnect the power cable from the back of the Power Supply module.
2. Using a small screwdriver, open the fuse cover on the back of the Power Supply module.
3. Replace the old fuse.
4. Close the fuse cover.

4: Troubleshooting the Time and Frequency Distribution System

5. Reconnect the power cable to the back of the module.

4.6.2 Replacing a 4352 Distribution Input Module

If you have to replace the Distribution Input module, you will lose the time code signal to the DA's Distribution Output modules and any connected DAs and TCTs. You can replace the module without powering down the DA.

The Distribution Input module is keyed and can only go into the correct slot in the DA chassis (slot 7 counting from the left).

⚠ **Caution**

Use a suitable antistatic strap and observe all industry-standard electrostatic discharge (ESD) precautions when handling modules.

To replace the Distribution Input module:

1. Disconnect the fiber optic cable from the Distribution Input module.
2. Pull the two latch handles on the right side of the module outward.
3. Slide the module out of the chassis.
4. Slide the new module into the chassis.
5. Push the latch handles down toward the front of the module.
6. Reconnect the fiber optic cable.
7. If the system is powered on, press **ALARM RESET** to clear the LEDs.
   - The ALARM LED should no longer be lit. If it is, see "4.2 DA LEDs and Alarms" on page 47.

4.6.3 Replacing a 4351 Distribution Output Module

If you have to replace a Distribution Output module, you will lose the time code signal to any connected DA and TCT. You can replace the module without powering down the DA.

The modules are keyed and can only go into the correct slots in the DA chassis.

⚠ **Caution**

Use a suitable antistatic strap and observe all industry-standard electrostatic discharge (ESD) precautions when handling modules.

To replace a Distribution Output module:

1. Disconnect the fiber optic cable from the Distribution Output module.
2. Pull the two latch handles on the right side of the module outward.
3. Slide the module out of the chassis.
4. Slide the new module into the chassis.
5. Push the latch handles down toward the front of the module.
6. Reconnect the fiber optic cable.

7. Set the **MPD** switch to ENABLE.

8. If the system is powered on, press **ALARM RESET** to clear the LEDs.

   ■ The MPD LED should no longer be lit. If it is, see "4.2 DA LEDs and Alarms" on page 47.

4.7 Replacing TCT Modules

⚠ **Caution**

The TCT modules are *not* hot swappable. You must disconnect the power from the TCT before removing or installing modules.

You can install any combination of up to four modules in the back of each TCT. The modules can go into any slot. Viewed from the rear, slot 1 is the upper left, slot 2 is upper right, Slot 3 is lower left and slot 4 is lower right. If you have empty slots in your TCT, use blank panels on those slots to keep out dust.

⚠ **Caution**

Use a suitable antistatic strap and observe all industry-standard electrostatic discharge (ESD) precautions when handling modules.

To replace TCT modules:

1. Disconnect the power cable from the back of the TCT.

2. Disconnect any cables from the module you want to replace.

3. Loosen the thumbscrews on the module you want to replace.

4. Slide the module out.

5. Slide the new module in.

6. Tighten the thumbscrews.

7. Reconnect the cables the to new module.

8. Reconnect the power cable to the back of the TCT.

4.7.0.1 Replacing the TCT Fuse

If you know that a local event caused blown fuses throughout a rack, you can replace the fuse in each power supply.

⚠ **Caution**

Use a suitable antistatic strap and observe all industry-standard electrostatic discharge (ESD) precautions when handling modules.

Required for this procedure:

■ Small flat-head or Phillips screwdriver

- Replacement fuse for a standard IEC 320 power entry module with fuse (5 x 20 mm, 1-amp, 250-volt fuse)

To replace a fuse:

1. Disconnect the power from the TCT.

2. Using a small screwdriver, open the fuse cover on the back of the TCT power supply.

3. Replace the old fuse.

4. Close the fuse cover.

5. Reconnect the power.

5 Warranty and Shipping Information

This chapter provides information on how to contact Timing Solutions Corporation for warranty service, as well as shipping guideline.

5.1 Warranty Information

The product carries a warranty from Timing Solutions Corporation for a period of 1 year from date of shipment. Repair should be obtained by contacting Timing Solutions Corporation at (303) 939-8481, fax (303) 443-5152. Written correspondence may be addressed to Timing Solutions Corporation; 4775 Walnut Street, Suite 1B; Boulder, CO 80301.

5.2 Shipping Information

If you need to ship a module back for any reason, including returning equipment to Timing Solutions for warranty service, follow these shipping instructions. Failure to follow these instructions may damage your product.

5.2.1 Packing Procedures

The module should always be shipped in a carton with packaging sufficient to protect the module during shipment. An MCA or DA chassis may be shipped with all modules in place. No cables or connectors may be attached to the front or rear of the chassis. The module or chassis should be wrapped in approved ESD protective bags to protect against electrostatic discharge.

Appendix A: Specifications and TCT Module Details

> Note: The TSC Marketing material refers to this system's components with different names than are used in this manual and the hardware itself. The UTCG referred to in the marketing material is called the Master Clock Assembly, or MCA. The FEC referred to in the marketing material is the Distribution Assembly or DA.

A.1 Time and Frequency Distribution System Specifications

Table 12 lists the general specifications applicable to the entire system.

Table 12: Time and Frequency Distribution System general specifications

Item	Specification
Holdover, Flywheel or TCT	■ Maximum shift of 0.35 Hz on loss of input signal. ■ Long term drift ±0.37 ppm or ±37 Hz over 24 hours.
Jitter, relative to source supplied to Flywheel	■ MCA and TCT 1 pps outputs: $< \pm 200$ ps at 1 sigma ■ Distribution Output module recovered 1 pps: $< \pm 200$ ps at 1 sigma
Clock slewing	Slew step size is in decade increments from 10 ns (ten nanoseconds) to 100 ms (one hundred milliseconds) inclusive, both advance and retard.
Skew	■ 1 pps output relative to another in the same assembly: $< \pm 2$ ns (two nanoseconds) ■ 1 pps variations from one TCT to another or one DA chassis to another: $< \pm 2$ ns (two nanoseconds)
Offset	End-to-end deviation due to nominal environmental perturbations of 15–40 °C $< \pm 5$ ns (five nanoseconds)
All electrical 1 pps outputs	■ 50 Ω SMA female connections ■ Pulse width: 10 µs ■ Skew: $< \pm 2$ ns ■ Rise time: < 2 ns ■ Fall Time: < 10 ns ■ Vtop: +2.8 to 5 V pk ■ Vbase: 0.2 ± 0.2 VDC ■ Jitter: < 200 ps
Multi-mode fiber optic connections	LC connectors for all fiber optic connections capable of functioning with up to 2 km of 62.5/125 multi-mode fiber optic cable.
Single-mode fiber optic connections	LC connectors for all fiber optic connections capable of functioning with up to 30 km of 1300 nm single-mode fiber optic cable.
CWDM5 fiber optics	LC connectors for all fiber optic connections capable of functioning with up to 70 km of single-mode fiber optic cable. The loss link budget is 20dB.

Item	Specification
Hot swappable modules	All modules except TCT output modules are hot swappable without damage. If the Flywheel or TCG is hot swapped, the power to the chassis must be cycled to regain operation.
Operating temperature	0–50 °C
Operating humidity	0–90% non-condensing
Operating altitude	Up to 3,048 m (10,000 feet)
Mean Time to Repair (MTTR)	Five minutes to replace one module.
Temperature coefficient	■ MCA: 15 ps/°C ■ TCT: 21.7 ps/°C ■ DA: 16 ps/°C
Alarm outputs	Ground-isolated SMA female connectors. Center conductor is connected to an opto-isolated switch capable of passing 0.5 mA from a detector with a 5 V source voltage and a 10 kΩ series resistor. Output is shorted when no alarm is present.
Power supplies	Dual redundant hot-swappable power supplies in MCA and DA chassis. Input voltage to all chassis is 90–240 VAC. Current requirements are: ■ TCT: 0.15 A ■ MCA: 0.15 A ■ DA full: 0.275 A
Mean Time between Failure (MTBF)	■ Flywheel: greater than 100,000 hours ■ TCG: greater than 100,000 hours ■ MCA UI: greater than 40,000 hours ■ Power Supply: greater than 100,000 hours ■ TCT: greater than 100,000 hours
Change in entire system delay due to temperature variations in the range 15 – 40 °C or changing modules in the path	Less than ± 5 ns typical
Switches and connectors	Gold plated contacts on all user switches and connectors.

Table 13 lists the specifications applicable to specific system components.

Table 13: Time and Frequency Distribution System specifications by module

Component/Module	Item	Specification
MCA and TCT Flywheels	TCXO phase locked loop	■ Thermal stability: ±10 ppm/°C ■ Phase noise: < -40 dBc at 1 Hz < -55 dBc at 10 Hz < -85 dBc at 100 Hz < -110 dBc at 1000 Hz
	Holdover	■ Maximum shift of 0.35 Hz on loss of input signal. ■ Long term drift: ±0.37 ppm or ±37 Hz over 24 hours.
	Jitter, relative to source supplied to Flywheel	■ MCA and TCT 1 pps outputs: $< \pm200$ ps at 1 sigma ■ Distribution Output module recovered 1 pps: $< \pm200$ ps at 1 sigma
MCA chassis	Clock slewing	Slew step size is in decade increments from 10 ns (ten nanoseconds) to 100 ms (one hundred milliseconds) inclusive, both advance and retard.
	Coincidence detection	Alarm output if ADV 1 PPS input is more than ±20 ns from the TCG 1 PPS OUT.
MCA Flywheel	Input requirements	■ 5, 10, or 100 MHz signal ■ Maximum 16 dBm ■ 50 Ω input impedance ■ Voltage Standing Wave Ratio (VSWR): < 1.2
DA chassis	Change in DA chassis delay due to temperature variations in the range 15 – 40 °C or changing modules in the path	Less than ± 2 ns
	Delay through DA chassis input to output module	25 ns typical
TCT chassis	TCT optical to electrical variation 1 pps to optical input	$<\pm5$ ns
	TCT advance switch settings	10 ns increments through 199,990 ns

A.2 TCT Module Addresses

The TCT chassis communicates differently with each module, depending on the modules address. Table 14 lists the addresses for each TCT module. Addresses are fixed in each module type.

Table 14: TCT module addresses

Module	Address
Configurable Pulse Rate Output	SEL:43210 = 00000 (Address bits with pullups in FPGA) TTL: DCBA control bits are user jumper selectable inputs with pull-ups in FPGA so that a jumper = 0. ■ 0000 Quad 1 pps ■ 0001 Quad 10 pps ■ 0010 Quad 100 pps ■ 0011 Quad 1 kpps ■ 0100 Quad 10 kpps ■ 0101 Quad 100 kpps ■ 0110 Quad 1 Mpps (dual 1 Mpps Rate Output Module) ■ 0111 spare for future versions ■ 1000 Quad 1 pps, 20 µs wide active high pulse ■ 1001 Quad 1 pps, 100 µs wide active high pulse ■ 1111 1/10/100/1000 pps (highest volume requires no jumpers) ■ 1010–1110 spare for future versions
Dual RS-232 Time Code Output	SEL:43210 = 00001
Dual Time Code Output	SEL:43210 = 00010
Parallel BCD Time Code Output	SEL:43210 = 00011
Parallel PB-1 Time Code Output	SEL:43210 = 00100
Production test card	SEL:43210 = 00101
1, 5 or 10 MHz Output	SEL:43210 = 00110 (address bits with pullups in FPGA) TTL: DCBA control bits are fixed jumper selectable inputs with pullups in the FPGA. ■ 1111 10-MHz output ■ 1110 5-MHz output ■ 1101 1 MHz output
Alarm input	SEL:43210 = 01000
NTP Server	SEL:43210 = 01001
IRIG-B and IRIG-G Output	SEL:43210 = 01010
5 and 10 MHz Clean-up Oscillator	SEL:43210 = 01011
Future	SEL:43210 = 00111, 01100-11101 open
Serial expansion	SEL:43210 = 11110 expansion address for future growth. Board IDs will be read serially from boards with this primary address.
Limited expansion	SEL:43210 = 11111 expansion address for future growth. Boards will not be observed by the FPGA if they have this primary address.

A.3 Dual RS-232 Time Code Output (DSN Serial) Module Specifications

This module produces two identical RS-232 time code outputs. It provides the time output once per second, continuously, immediately following the 1 pps on-time signal. The TCT 1 pps outputs enable establishment of time of year to a resolution of better than ±5 nanoseconds, and the RS-232 outputs identify the exact second of the year. The 1 pps signal generated within the TCT is the on-time interrupt (rising edge) to which the output code is synchronized. The time code starts after this edge.

Figure 24 shows the face plate for the RS-232 Time Code Output module.
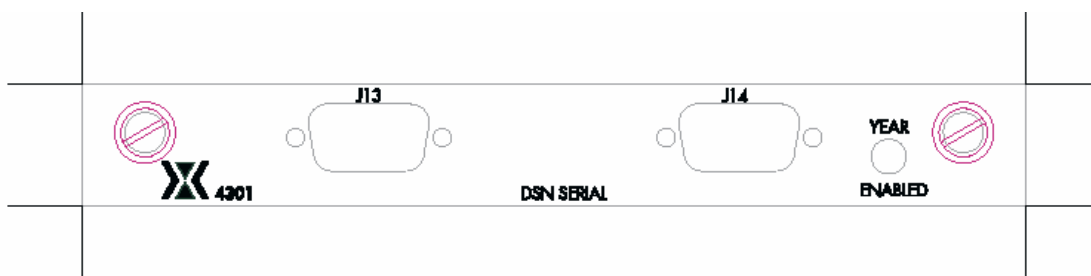
Figure 24: Dual RS-232 Time Code Output module

Table 15 lists the specifications for the Dual RS-232 Time Code Output module.

Table 15: Dual RS-232 Time Code Output module specifications

Characteristic	Description
Description	Time output is provided once per second continuously. Two identical DB-9 outputs are provided.
Time Encoded	Binary coded decimal (BCD) days (DDD), hours (HH), minutes (MM) and seconds (SS). Format is the most significant digit (MSD). Four-digit year is a jumper-configurable option.
Reporting Byte	This byte (R) reports days per year and leap second status (see "A.3.1 Reporting Byte Definitions" on page 66).
Checksum	Two-digit or three-digit value of checksum (cc). The two-digit checksum is computed by making a summation of the hex values of all ASCII characters in each message and discarding the most significant (carry) character (if there is a carry). The remaining two characters are the checksum. (See "A.3.2 Three-character Checksum" on page 67 for three-digit checksum details.)
Message Format (without year)	DDDHHMMSSRCC (CR), most significant digit (MSD) first
Message Format (with year)	YYYYDDDHHMMSSRCCC (CR), MSD first
Character Format	Start bit, 7 data bits, odd parity bit, Stop bit
Parity Definition	If the output character contains an odd number of ones, the parity bit is set to a zero. If the character contains an even number of ones, the parity bit is set to a one. This maintains an odd number of ones.

Characteristic	Description
Baud Rates	The module has an internal baud rate switch with selections for at least 9600 and 19,200 baud.
On Time and Message Timing	Each second on time is established by the 1 pps output from a configurable pulse rate module installed in the TCT (see "A.7 Configurable Pulse Rate Output Module Specifications" on page 74). The falling edge of the start bit of the first character in the serial string occurs within 50 to 200 μs after 1 pps on time.
Number of outputs	Each module has two identical RS-232 outputs. Additional RS-232 modules can be added to the TCT to obtain additional outputs.
Connector Type	Type DB-9 female
Pin Connections	Transmitted data is on pin 2 and ground on pin 5.
RS-232 Levels	Driver levels are ±9 V when loaded with a typical RS-232 receiver 5 kΩ load; ±6 V under worst-case conditions.
Address	SEL:43210 = 00001

A.3.1 Reporting Byte Definitions

Table 16 lists the reporting byte definitions for the Dual RS-232 Time Code Output module.

Table 16: Reporting byte definitions

Output char	Days per year	Leap second arming	TCT holdover
0	365	None	Inactive
1	365	Subtract	Inactive
2	365	Add	Inactive
3	366	None	Inactive
4	366	Subtract	Inactive
5	366	Add	Inactive
6	365	None	Active
7	365	Subtract	Active
8	365	Add	Active
9	366	None	Active
A	366	Subtract	Active
B	366	Add	Active
C	--	--	
D	--	--	
E	--	--	
F	--	--	

A.3.2 Three-character Checksum

The three-character checksum is computed by making a summation of the hex values of all ASCII characters in each message.

Following is an example of the checksum calculation:

```
YYYY DDD HH MM SS R       CCC
2094 361 48 57 59 B       2F1
```

Table 17 lists the checksum character descriptions and values.

Table 17: Checksum character descriptions and values

Character description	Character value	ASCII hex value
Y	2	32
Y	0	30
Y	9	39
Y	4	34
D	3	33
D	6	36
D	1	31
H	4	34
H	8	38
M	5	35
M	7	37
S	5	35
S	9	39
R	B	42
	Total	2F1

A.4 Parallel PB-1 Time Code Output Module Specifications

This module produces a PB-1 Parallel Binary Coded Decimal (BCD) time output in accordance with IRIG-B STD 205-87. The outputs are on a 62-pin, high-density, D-type connector. ID bits are not included. Leap year and leap second status outputs are also provided. The 1 pps signal generated within the TCT is the on-time interrupt (rising edge) to which the output code is synchronized. The time code starts after this edge.

Figure 25 shows the face plate for the PB-1 Time Code Output module.
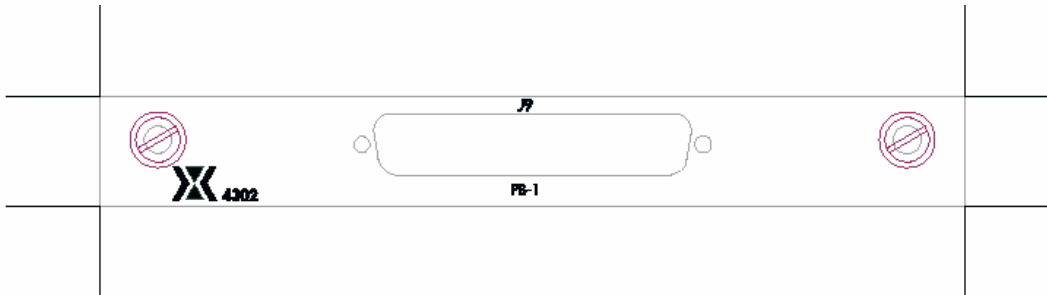
Figure 25: PB-1 Time Code Output module

Table 18 lists the specifications for the Parallel PB-1 Time Code Output module.

Table 18: Parallel PB-2 Time Code Output module specifications

Characteristic	Description
Output time format	Parallel Binary PB-1 (IRIG-B STD 205-87) 27-bit binary milliseconds of the day; 9-bit binary day of year; Parity bits P1 and P2; and Read Enable pulse.
Leap Year flag	Logic one during 366-day year; zero during 365-day year.
Leap Sec Subtract (LSS) flag	At one level when time code has initiated TCT for subtracting one second at next 24-hour rollover, otherwise zero level. The sequence for LSS is 57:58:00:01.
Leap Sec Add (LSA) flag	At one level when time code has initiated TCT for adding one second at next 24-hour rollover, otherwise zero level. The sequence for LSA is 57:58:59:60:00:01.
Transition times	All bits settle within 100 ns (one hundred nanoseconds) of TCT internal on-time.
Baseline	0.2 ± 0.2 VDC (zero level)
Amplitude	4.0 ± 0.5 VDC (one level)
Read Enable, active low	A read-enable pulse is generated each millisecond to allow data sampling by user devices. Pulse width is 10 μs (ten microseconds), with trailing edge being used for data sampling. The leading edge of the read-enable pulse is coincident with TCT on time.
Output drive	Outputs are designed to drive 700 Ω and sink 8 mA minimum.

Characteristic	Description
Output short circuit	No module suffers damage as a result of applying a short circuit to any line for a period of 10 minutes.
Output connector	Connector is type DB62 female socket
Address	SEL:43210 = 00100

A.4.1 PB-1 Code Output Pin Connections

Table 19 lists the module output pin connections.

Table 19: PB-1 code output pin connections

Pin	Signal	Pin	Signal
1	Leap year set	32	Binary milliseconds 2^{18}
2	Leap Second Add	33	Binary milliseconds 2^{19}
3	Leap Second Subtract	34	Ground
4	Zero state always	35	Binary milliseconds 2^{20}
5	Binary milliseconds 2^{0}	36	Binary milliseconds 2^{21}
6	Binary milliseconds 2^{1}	37	Ground
7	Ground	38	Binary milliseconds 2^{22}
8	Binary milliseconds 2^{2}	39	Binary milliseconds 2^{23}
9	Binary milliseconds 2^{3}	40	Ground
10	Ground	41	Binary milliseconds 2^{24}
11	Binary milliseconds 2^{4}	42	Binary milliseconds 2^{25}
12	Binary milliseconds 2^{5}	43	Ground
13	Ground	44	Binary milliseconds 2^{26}
14	Binary milliseconds 2^{6}	45	Binary days 2^{0}
15	Binary milliseconds 2^{7}	46	Ground
16	Ground	47	Binary days 2^{1}
17	Binary milliseconds 2^{8}	48	Binary days 2^{2}
18	Binary milliseconds 2^{9}	49	Ground
19	Ground	50	Binary days 2^{3}
20	Binary milliseconds 2^{10}	51	Binary days 2^{4}
21	Binary milliseconds 2^{11}	52	Ground

Pin	Signal	Pin	Signal
22	Ground	53	Binary days 2^5
23	Binary milliseconds 2^{12}	54	Binary days 2^6
24	Binary milliseconds 2^{13}	55	Ground
25	Ground	56	Binary days 2^7
26	Binary milliseconds 2^{14}	57	Binary days 2^8
27	Binary milliseconds 2^{15}	58	Ground
28	Ground	59	Read enable
29	Binary milliseconds 2^{16}	60	Ground
30	Binary milliseconds 2^{17}	61	Parity 1 (milliseconds and days, odd)
31	Ground	62	Parity 2 (milliseconds only, odd)

A.5 Dual Time Code Output Module Specifications

This module generates IRIG-B and NASA 36-bit time codes. It provides modulated and DC level-shift outputs of each code (four outputs on TNC connectors). The 1 pps signal generated within the TCT is the on-time interrupt (rising edge) to which the output code is synchronized. The time code starts after this edge.

Figure 26 shows the face plate for the Dual Time Code Output module.
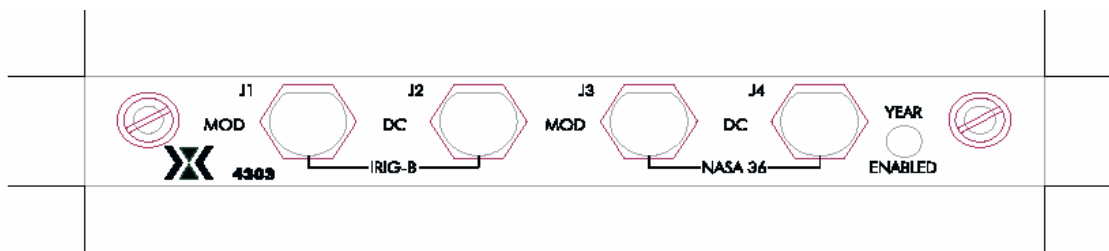
Figure 26: Dual Time Code Output module

Table 20 lists the specifications for the Dual Time Code Output module.

Table 20: Dual Time Code Output module specifications

Characteristic	Description
IRIG-B Code Format (without year)	IRIG-B Standard 200-98
IRIG-B Code Format (with year)	See "A.5.1 Year Information in the IRIG-B code" on page 71.

Characteristic	Description
Modulated Code Outputs	■ Frequency: 1 kHz. ■ Level: Fixed, 5 ± 0.5 Vpp into 50 Ω. ■ Modulation ratio: Fixed 3.3:1. ■ Drive: 50 Ω. ■ Coherence: Carrier crossing within 10 μs (ten microseconds) of TCT on-time. The time code starts after the rising edge of the 1 pps signal generated by the pulse module described in "A.7 Configurable Pulse Rate Output Module Specifications" on page 74.
DC Code Outputs	■ zero level: 0.2 ± 0.2 VDC. ■ One level: 4.5 ± 0.5 VDC. ■ Drive: 50 Ω. ■ Coherence: Output transitions within 0 to +50 ns (fifty nanoseconds) of TCT on time.
Connectors	All connectors are TNC.
Address	SEL:43210 = 00010

A.5.1 Year Information in the IRIG-B code

When the year information is enabled, the standard IRIG-B code is modified as follows:
Index Count 50 = Unit Years 1
Index Count 51 = Unit Years 2
Index Count 52 = Unit Years 4
Index Count 53 = Unit Years 8
Index Count 54 = 1'b0
Index Count 55 = Ten Years 1
Index Count 56 = Ten Years 2
Index Count 57 = Ten Years 4
Index Count 58 = Ten Years 8
Index Count 59 = Ref Cycle
Index Count 60 = Hund Years 1
Index Count 61 = Hund Years 2
Index Count 62 = Hund Years 4
Index Count 63 = Hund Years 8
Index Count 64 = 1'b0
Index Count 65 = Thou Years 1
Index Count 66 = Thou Years 2
Index Count 67 = Thou Years 4
Index Count 68 = Thou Years 8
Index Count 69 = Ref Cycle

A.6 Parallel BCD Time Code Output Module Specifications

This module produces a parallel BCD time output in units-milliseconds through hundreds-of-days on a 62-pin, high-density, D-type connector. You can select normal transistor-transistor logic (TTL) levels (zero = 0 volts and one = +4 volts) or inverted TTL levels (one = 0 volts and zero = +4 volts) via an input at the output connector. Leap year and leap second status outputs are also provided. The 1 pps signal generated within the TCT is the on-time interrupt (rising edge) to which the output code is synchronized. The time code starts after this edge.

Figure 27 shows the face plate for the Parallel BCD Time Code Output module.
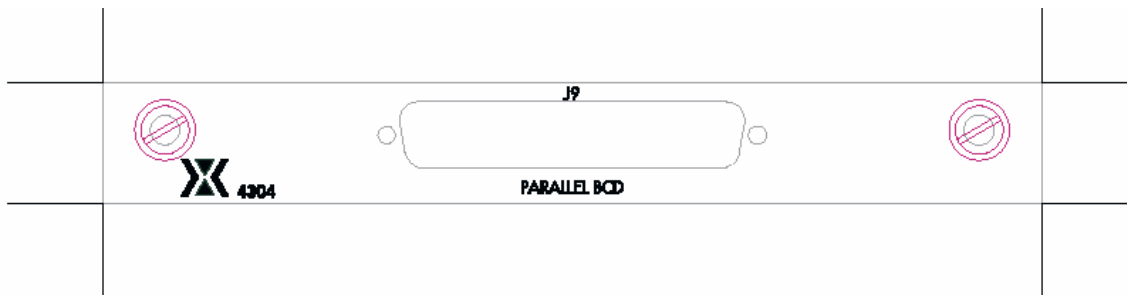
Figure 27: Parallel BCD Time Code Output module

Table 21 lists the specifications for the Parallel BCD Time Code Output module.

Table 21: Parallel BCD Time Code Output module specifications

Characteristic	Description
Output time format	Parallel BCD units-milliseconds (UMS) through hundreds-of-days (HD)
Leap Year flag	Logic one during 366-day year; zero during 365-day year.
Leap Sec Subtract flag	At one level when time code has initiated TCT for subtracting one second at next 24-hour rollover, otherwise zero level.
Leap Sec Add flag	At one level when time code has initiated TCT for adding one second at next 24-hour rollover, otherwise zero level.
Transition times	All bits settle within 100 ns (one hundred nanoseconds) of TCT internal on time.
Baseline	0.2 ± 0.2 VDC (zero level for Normal mode; one level for Inverted).
Amplitude	4.0 ± 0.5 VDC (one level for Normal mode; zero level for Inverted).
Read Enable, active low	A read-enable pulse is generated each millisecond to allow data sampling by user devices. Pulse width is 10 µs (ten microseconds), with trailing edge being used for data sampling. The leading edge of the read-enable pulse is coincident with TCT on time.
Normal/Inverted selection	Applies to all logic levels (data and flags). With no jumper installed, logic levels are in the Normal mode. Connect pin 61 in the mating cable connector to ground to invert levels.

Characteristic	Description
Output drive	Outputs are designed to drive five TTL loads.
Output short circuit	No module will suffer damage as a result of applying a short circuit to any line for a period of 10 minutes.
Output connector	Connectors are type DB62.
Address	SEL:43210 = 00011

A.6.1 Parallel BCD Output Pin Connections

Table 22 lists the module output pin connections.

Table 22: Parallel BDC output pin connections

Pin	Signal	Pin	Signal
1	Leap year set	32	Units of seconds D
2	Leap second add	33	Tens of seconds A
3	Leap second subtract	34	Tens of seconds B
4	Zero state always (hardwired)	35	Tens of seconds C
5	Ground	36	Units of minutes A
6	Ground	37	Units of minutes B
7	Ground	38	Units of minutes C
8	Ground	39	Units of minutes D
9	Ground	40	Tens of minutes A
10	Ground	41	Tens of minutes B
11	Ground	42	Tens of minutes C
12	Ground	43	Units of hours A
13	Ground	44	Units of hours B
14	Ground	45	Units of hours C
15	Ground	46	Units of hours D
16	Ground	47	Tens of hours A
17	Units of milliseconds A	48	Tens of hours B
18	Units of milliseconds B	49	Units of days A
19	Units of milliseconds C	50	Units of days B
20	Units of milliseconds D	51	Units of days C
21	Tens of milliseconds A	52	Units of days D
22	Tens of milliseconds B	53	Tens of days A

Pin	Signal	Pin	Signal
23	Tens of milliseconds C	54	Tens of days B
24	Tens of milliseconds D	55	Tens of days C
25	Hundreds of milliseconds A	56	Tens of days D
26	Hundreds of milliseconds B	57	Hundreds of days A
27	Hundreds of milliseconds C	58	Hundreds of days B
28	Hundreds of milliseconds D	59	Read enable
29	Units of seconds A	60	Ground
30	Units of seconds B	61	Logic level select
31	Units of seconds C	62	Ground

A.7 Configurable Pulse Rate Output Module Specifications

This module generates four digital signals, via TNC connectors, capable of driving 50 Ω loads with 2 ns (two-nanosecond) rise times. The rate of the four signals is jumper configurable. The pulse rate options are:

- 1, 10, 100, 1 kpps
- Four 1 pps
- Four 10 pps
- Four 100 pps
- Four 1 kpps
- Four 10 kpps
- Four 100 kpps
- Four 1 Mpps

Coherence of the rising edges to the MCA on-time signal (with propagation delay compensation properly set in the TCT main chassis) is ±5 ns (five nanoseconds) or better.

Figure 28 shows the face plate for the Configurable Pulse Rate Output module.
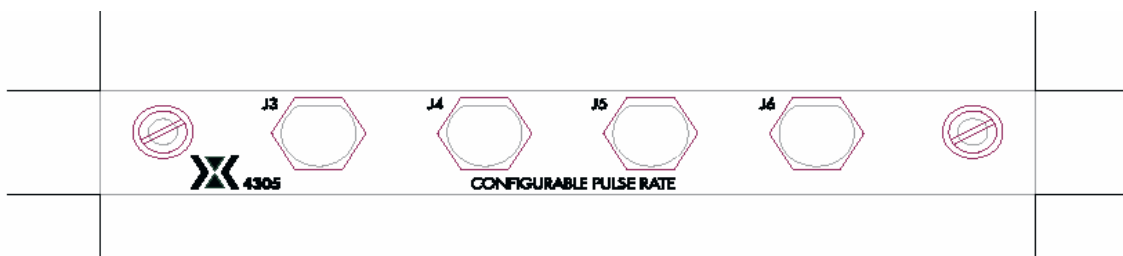
Figure 28: Configurable Pulse Rate Output module

Table 23: Configurable Pulse Rate Output module specifications

Characteristic	Description
Number of outputs	Four
Rates	1 pps, 10 pps, 100 pps, 1 kpps, 10 kpps, 100 kpps, and 1 Mpps
Pulse width	10 μs standard, jumper configurable 20μs or 100 μs, 1 pps only
Rise time	2 ns (two nanoseconds) or less; 10% to 90%
Fall time	10 ns (ten nanoseconds) or less; 10% to 90%
Baseline	0.2 ± 0.2 VDC
Amplitude	4.0 ± 0.5 VDC
Skew	Maximum offset difference between any two outputs is less than ±2 nanoseconds at 50% point of rising edge.
Jitter	Pulse jitter of less than 200 ps
Output drive	Outputs can drive a 50-Ω resistive load through co-axial cable.
Output short circuit	No module will suffer damage as a result of applying a short circuit to any line for a period of 10 minutes.
Output connectors	Connectors are TNC.
Address	SEL:43210 = 00000 (Address bits with pullups in FPGA)
Configuration bits	TTL: DCBA control bits are jumper selectable inputs with pullups in FPGA so that a jumper = 0. ■ 0000: Quad 1 pps ■ 0001: Quad 10 pps ■ 0010: Quad 100 pps ■ 0011: Quad 1 k pps ■ 0100: Quad 10 k pps ■ 0101: Quad 100 k pps ■ 0110: Quad 1 M pps (dual 1 Mpps Rate Output Module) ■ 0111: spare for future versions ■ 1000: Quad 1 pps, 20 μs wide active high pulse ■ 1001: Quad 1 pps, 100 μs wide active high pulse ■ 1111: 1/10/100/1000 PPS (highest volume requires no jumpers) ■ 1010–1110: spare for future versions

A.8 10 MHz Output Module

This module is a quad output radio frequency (RF) module, which provides four isolated (> 100 dB) RF outputs phase locked to the RF supplied to the MCA. The unit operates at 10 MHz with additive phase noise that is comparable to the performance of a high-performance cesium clock. If any of the output signals fail, the rear panel alarm LED will light. The TCT will not suppress the 1 pps signal if this alarm occurs. Fault sensing of signal levels is provided on every output.

Figure 29 shows the face plate for the 10 MHz Output module.
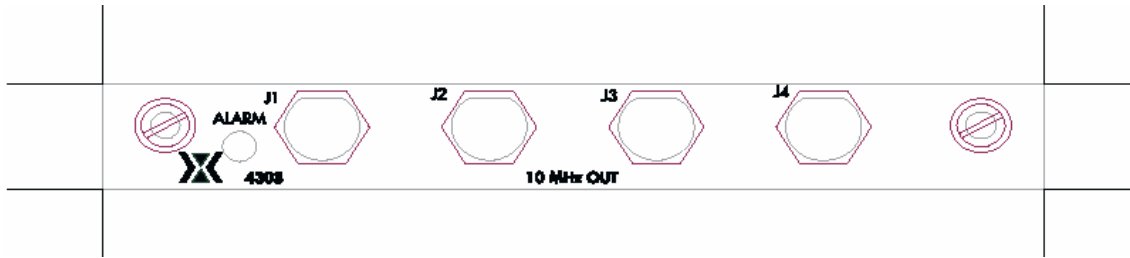
Figure 29: 10 MHz Output module

Table 24 lists the specifications for the 10 MHz Output module.

Table 24: 10 MHz Output module specifications

Characteristic	Description
Width	1 TCT module slot
Connectors	Four TNC female
Outputs	10 MHz
Output Level	1 V RMS (13 dBm)
SSB Phase Noise	1 Hz: −115 dBc 10 Hz: −125 dBc 100 Hz: −125 dBc 1 kHz: −135 dBc 10 kHz+: −140 dBc
Allan Deviation	Averaging time Allan deviation 0.1 s: 5 E-12 1 s: 4 E-12 10 s: 4 E-12 100 s: 8 E-13 1000 s: 4 E-13 10,000 s: 1.5 E-13 100,000 s: 4 E-14
Output Impedance	50 ± 5 Ω
Output Isolation	> 100 dB
Harmonic Distortion	<−40 dBc
Address	SEL:43210 = 00110
Configuration bits	TTL: DCBA control bits are fixed jumper selectable inputs with pullups in the FPGA. ■ 1111: 10 MHz output ■ 1110: 5 MHz output ■ 1101: 1 MHz output

A.9 TSC 4309 NTP Server Module

This module provides the UTFS system with NTP server capabilities. The module can be installed in any slot of the TSC 4300 series TCT. The TCT must be connected to a TCG either directly or through a fiber expansion chassis and be receiving serial time codes before it can provide time. The module provides standard NTP v4 server functionality over the Ethernet connection located on the module panel. After power up, the alarm LED will turn on for a few minutes until the server is ready to provide NTP service.

The module's IP address is set to 192.168.0.1 at the factory. A web browser can be used to access the device's web page to change the IP address, net mask and default router. If the unit is incorrectly re-configured and you can not find the device on the network, you will need to reset the device to the factory default address. To reset to the default IP address, follow these steps:

1. Power off the TCT in which the module is installed.

2. Using proper ESD precautions, remove the 4309 module from the TCT and install a jumper on JP1-1 on the 4309 PCB near the panel.

3. Reinstall the 4309 module and power up the TCT. Wait for the 4309 alarm LED to turn on and then off after a few minutes.

4. Remove the 4309 module and remove the jumper that was installed in the above step.

5. Reinstall the module in the TCT. The module should now have an IP address of 192.168.0.1.

NTP client software is available for free on the internet for most operating systems. UNIX users can find information on how to set up a computer for NTP client capability on the www.ntp.org web site. Windows users can refer to the document http://download.microsoft.com/download/2/0/f/20f61625-7b2a-4531-b007-1c714f1e51b7/wintimeserv.doc for information on the windows time service or to the web site http://geodsoft.com/howto/timesync/ for a description of NTP for windows and some of the client software available on the internet.

A.10 TSC 4310 Alarm Input Module

This module provides the UTFS system with TTL level alarm monitoring capabilities. The inputs can be used to monitor distribution amplifiers that provide TTL alarm outputs. The module can be installed in any slot of the TSC 4300 series TCT. Jumpers are installed on JP1 to provide active low alarm inputs. Active high inputs can be obtained by removing the appropriate jumper on block JP1. Alarms provided by this module are latched in the TCT and indicated as internal alarms on the TCT front panel.

A.11 TSC 4311 IRIG-B and IRIG-G output module

This module provides two IRIG-B and two IRIG-G modulated outputs on BNC connectors, in formats IRIG-B 123 and IRIG-G 142.

A.12 TSC 4313 5 and 10 MHz clean-up oscillator

This dual height module provides two 5 MHz and two 10 MHz outputs on BNC connectors.

Table 25 lists the specifications for this module.

Table 25: 5 and 10 MHz Clean-up Oscillator Output module specifications

Characteristic	Description	
Width	1 TCT module slot	
Height	2 TCT module slots	
Connectors	Two BNC female for each output frequency	
Outputs	2 each 5 MHz and 10 MHz	
Output Level	1 V RMS (13 dBm)	
SSB Phase Noise	5 MHz Output: Offset Phase Noise 0.1 Hz: -102 dBc 1 Hz: -112 dBc 10 Hz: -135 dBc 100 Hz: -149 dBc 1 kHz: -155 dBc	10 MHz Output: Offset Phase Noise 0.1 Hz: -90 dBc 1 Hz: -105 dBc 10 Hz: -130 dBc 100 Hz: -142 dBc 1 kHz: -148 dBc
Allan Deviation	Averaging time Allan deviation 0.1 s: 4 E-12 1 s: 6 E-13 10 s: 6 E-14 100 s: 2 E-14 1000 s: 2 E-14 10,000 s: 1 E-14	
Output Impedance	50 ± 5 Ω	
Output Isolation	> 70 dB	
Harmonic Distortion	<–40 dBc	

Appendix B: Theory of Operation

The Universal Time and Frequency System architecture includes two MCAs, one or more DAs, and multiple TCTs. The MCA has a built-in 1 pps coincidence detector for clock slip detection. The architecture provides for use of a hot back-up MCA for 1 pps monitoring and redundancy.

The Universal Time and Frequency System relies on a precision, external timing reference; this system only distributes time. End users receive the time code from TCTs that are placed near equipment requiring timing signals.

The basic system includes one MCA and up to two levels of DA as shown in Figure 30.
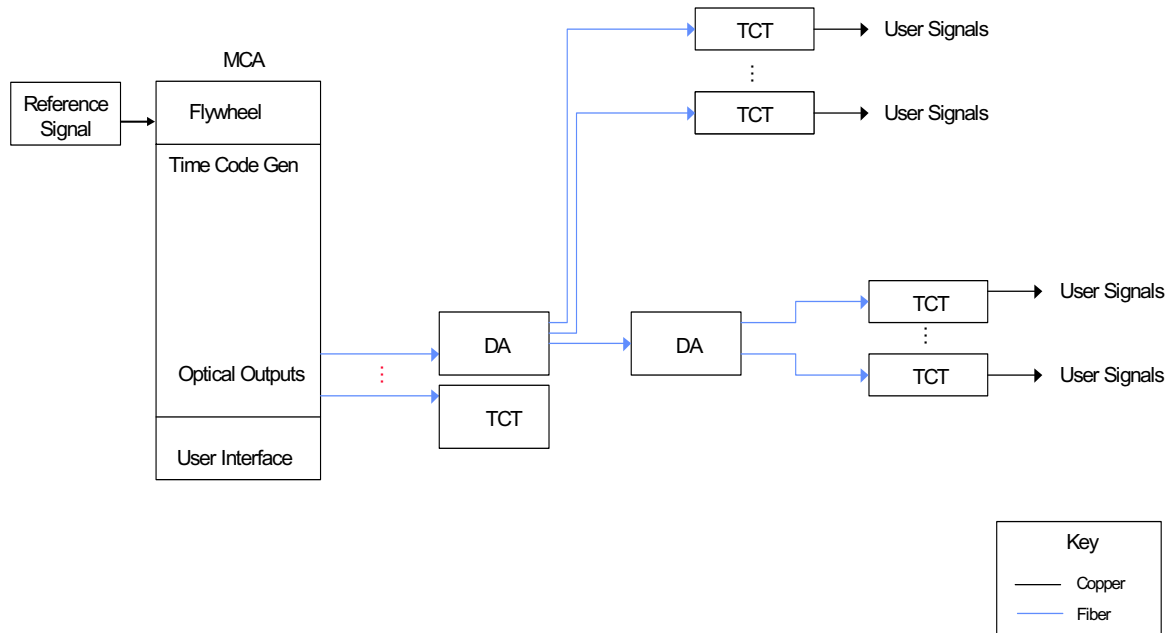
Figure 30: Universal Time and Frequency System basic configuration

Figure 31 shows a configuration with two MCAs.
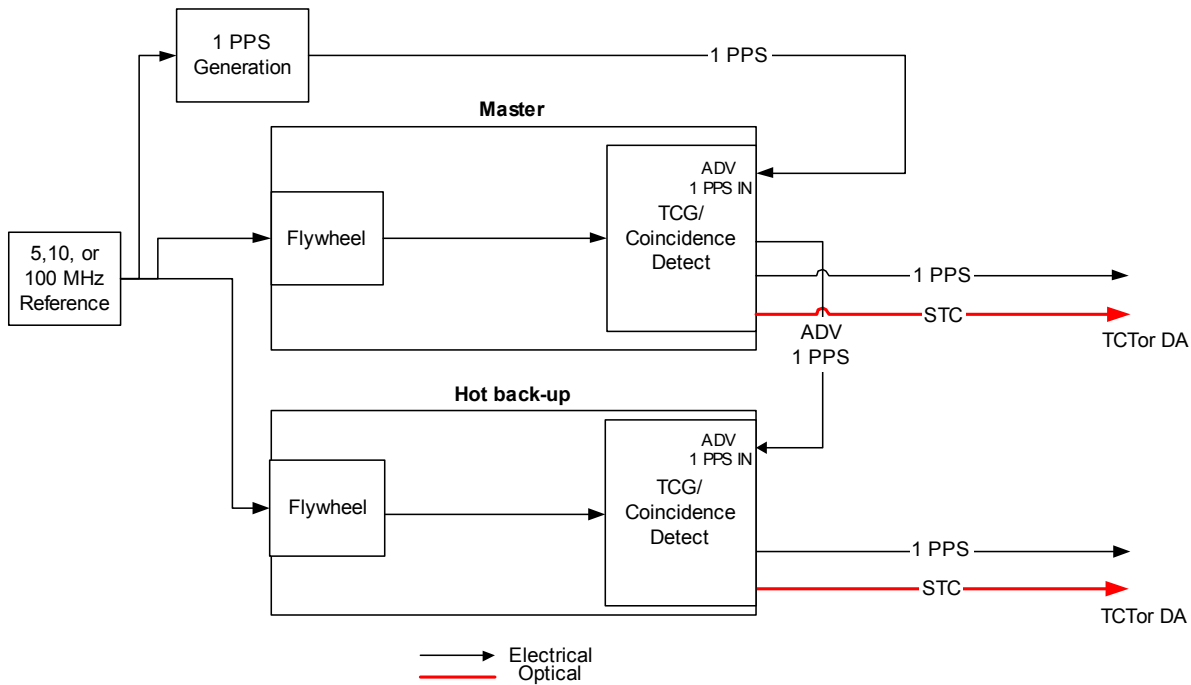
Figure 31: Universal Time and Frequency System using two MCAs

B.1 MCA Overview

The MCA includes components for time generation, verification, control, and distribution.

The Flywheel module's TCXO phase locks to a 5, 10, or 100 MHz reference signal from an external source, such as a maser, and provides the reference input to the TCG module.

The TCG module includes a 1 PPS SYNC IN connection for initially setting the time. The TCG produces the time code and 1 pps signal for distribution via four fiber optic connections. It also includes four 1 pps electrical outputs and a built-in coincidence detector for comparison to an external 1 pps signal.

The TCG module contains one Field Programmable Gate Array (FPGA) that performs the following functions:

- 100 MHz pps Binary Counter capable of slew adjustments of up to ±100 ms and synchronized to 1 PPS SYNC IN and 100 MHz from the Flywheel module

- BCD Station Time Counter Chain increments on pps terminal count

- MCA UI to TCG serial command decoding

- STC encoding

The TCG can detect drift relative to an external 1 pps signal. You may need to adjust the slew to set ADV 1 PPS IN within ±5 ns of external 1 pps signal. The coincidence alarm sets when the TCG 1 pps signal is offset more than 20 ns from the ADV 1 PPS IN signal.

MCA UI module provides the user interface programmed in a microcontroller and the IRIG-B input for initially setting the time.

The microcontroller for MCA UI provides the following functions:

- Monitors button presses
- Controls the LED display
- Extracts the time code from IRIG-B waveform and provides it to the TCG
- Sends the time to TCG on initial setup
- Receives the programmed time from TCG

B.1.1 Flywheel Module Functions

The Flywheel module phase locks the internal 100 MHz signal to an external 5, 10, or 100 MHz reference signal and provides flywheel capability for the MCA when the reference signal is not present.

The Flywheel module includes the following alarms:

- TCXO UNLOCK—Once the external signal has been locked by the PLL, an edge detection circuit is enabled in the FPGA. The initial external signal rising edge will fall within one of four phase detecting "bins", representing each 90 degrees of phase from 0-360. Once the initial rising edge has been placed in a bin, it may fall into one adjacent bin before the circuit is fully locked. After this point, the subsequent rising edge must always appear in one of these two bins. If the rising edge is ever found to be in one of the other bins, the LED will light.

- EFC LIMIT—12 bit Analog-to-digital (A/D) converter samples the TCXO control voltage every 100 ms. If any sample is greater than 0xE65 or less than 0x199, the LED is set.

- INPUT—Set when input activity fails. The FPGA continuously compares the phase of the external clock with that of the internal TCXO. Both clocks are connected to independent 13 bit counters. If the difference between the two counters over a 50 μs period is greater than 2, the clocks are considered to be out of phase and the input LED will light.

- Holdover—Holdover is a mode that is entered when the TCXO UNLOCK or INPUT alarm is present.

  - ±0.37 ppm holdover performance over 24 hours (approximately 16 ms over 12 hour period)

  - Transition into holdover less than 0.35 Hz offset

B.1.2 TCG Module Functions

The TCG creates the optical time code signal and transmits it to the connected DAs and TCTs. The time code transmits data from the MCA to the DAs and TCTs and provides a signal for clock recovery.

The time code signal format is designed to optimize clock recovery performance. The time code waveform is pulse-width modulated with an embedded 25 MHz clock as shown in Figure 32. Communications waveforms are suppressed carrier. The clock recovery performance is improved by transmitting the clock along with the data.
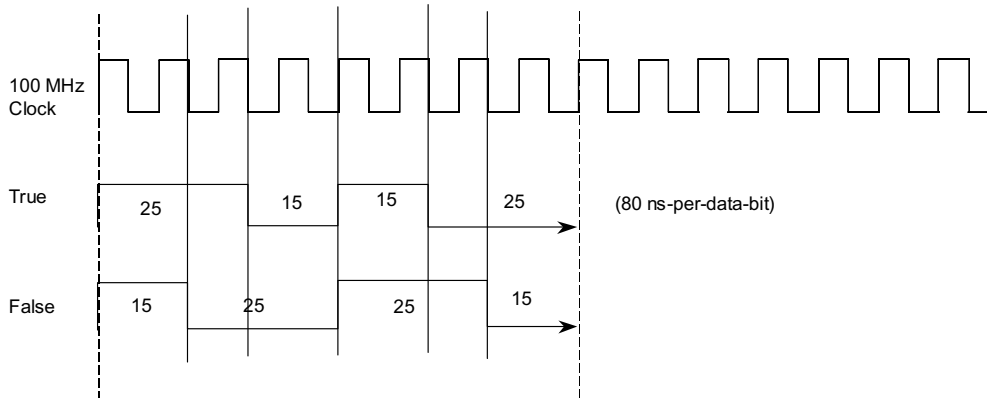
Figure 32: Serial Time Code format

Every positive going edge of the data is an edge of a 25 MHz clock, and no edges are missing. This makes clock generation within FPGAs and pps construction easier and cleaner. A simple divide by two produces a 50% duty cycle clock at 12.5 MHz.

The 50% duty-cycle Serial Time Code (STC) minimizes jitter and phase drift through the fiber optic transceivers. The STC contains a 100 MHz spur at –14 dBc and the TCT can phase lock a 100 MHz TCXO to the STC without frequency dividers.

Table 25 shows the serial time code bit stream that is sent down the fiber to the TCTs.

Table 25: Serial time code bit stream

Byte	Function
1	Frame sync pattern
2	Two-digit year
3	Two most significant digits of day of year (DOY), BCD encoded
4	Least significant digit of DOY and most significant digit of hour, BCD encoded
5	Least significant digit of hour, BCD encoded
6	Two-digit minute, BCD encoded
7	Two-digit second, BCD encoded
8	Eight flag bits: global reset, leap year, leap second add today, leap second subtract today, and four undefined bits 0 (4) GR,LY, LSA, LSS
9	Reserved, 00
10	Reserved, 00
11,12	CRC-16 computed on bytes 1-10
13–1,562,500	Fill bytes with all bits equal to 0

Appendix B: Theory of Operation

The TCG has 1 pps coincidence detection with an alarm to detect a slip of more than two cycles on either the master MCA or the external 1 pps signal. This function is implemented in the FPGA as shown in Figure 33.

TCG FPGA

100Mhz

TCG Sys Timers

TC Early PPS Out

PPS Out

Other TCG Early PPS In

Level   Pulse

MyTCG PPS OutQ[3:0]

Q[0]   Q[1]   Q[2]   Q[3]

OTCG_PPS_LED

100Mhz

TC Early PPS Out

PPS Out

Other TCG Early PPS In

OTCG_PPS_LED (Case 1)

OTCG_PPS_LED (Case 2)

MyTCG PPS OutQ[3:0]   Q[0]   Q[1]   Q[2]   Q[3]

Note : CD Error Set when no OTCG_PPS_LED in Q[0] and Q[1] and Q[2] and Q[3].
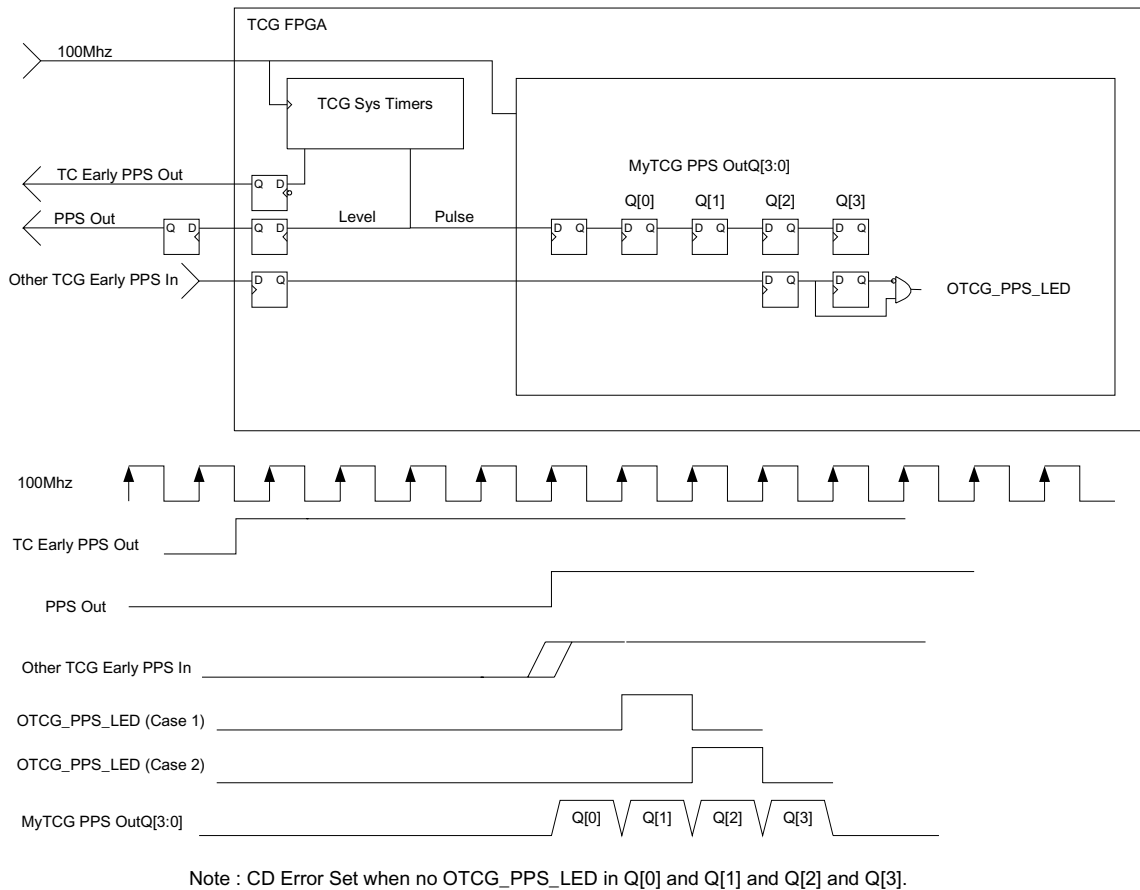
Figure 33: Coincidence detection in the FPGA

B.1.3 MCA and DA Power Supply Modules

The MCAs and DAs have dual power supplies to provide redundant power. Failure in one Power Supply module does not result in loss of performance. The Power Supply modules are hot swappable. An alarm sets if a Power Supply module is plugged into chassis without AC power connected.

Figure 34 shows the Power Supply module block diagram.
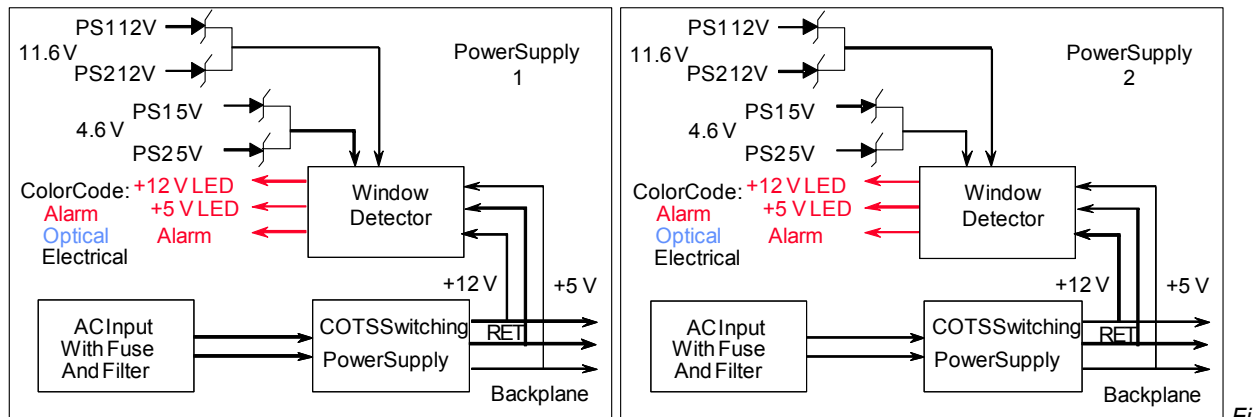
gure 34: Power Supply module block diagram

B.2 DA Functions

The DA is an intermediate unit that receives the optical time code from the MCA and provides the optical time code to the TCTs. The 14351 series uses the same chassis and redundant Power Supply modules as the MCA.

The DA receives the optical time code in a Distribution Input module or transceiver in the center of the chassis. The clock and data are monitored in an FPGA to verify integrity. The unit alarms if it detects an invalid time code using cyclic redundancy check (CRC). The fiber optic receiver provides a loss of signal alarm.

An FPGA on the Distribution Input module provides the following functions:

- Decodes the STC with CRC verification and alarm

- Detects loss of signal (LOS) and generates an alarm

- Combines alarms from the Power Supply modules and missing pulse detection (MPD) from the Distribution Output modules to provide a chassis alarm

The DA sends the optical time code to TCTs (or another DA) using Distribution Output modules or transceivers that receive the electrical time code from the Distribution Input module or transceiver via the chassis backplane. The 14351 series DA can hold a maximum of ten Distribution Output modules per DA chassis, whereas the 4340A can accommodate up to eight transceivers.

Each Distribution Output module or transceiver receives an optical 1 pps return from the TCT (or DA) that it is providing time code to. Each Distribution Output module or transceiver monitors the presence of the returned 1 pps signal and sets an alarm if it is missing.

The DA can have either multi- and single-mode transceiver modules or transceivers for both input and output. No damage will occur if single-mode and multi-mode are inadvertently interconnected. Single mode modules have part numbers with an S suffix.

Figure 35 shows a block diagram of the Distribution Input module.
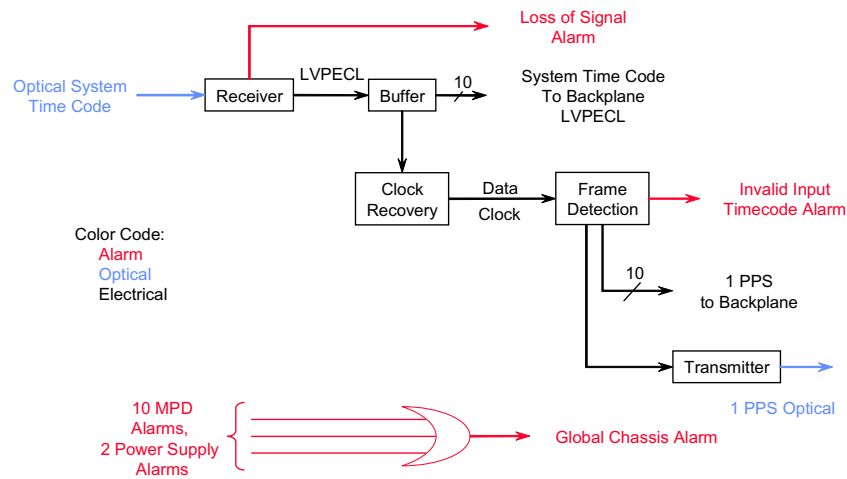
Figure 35: Distribution Input module block diagram

Figure 36 shows a block diagram of the Distribution Output module.
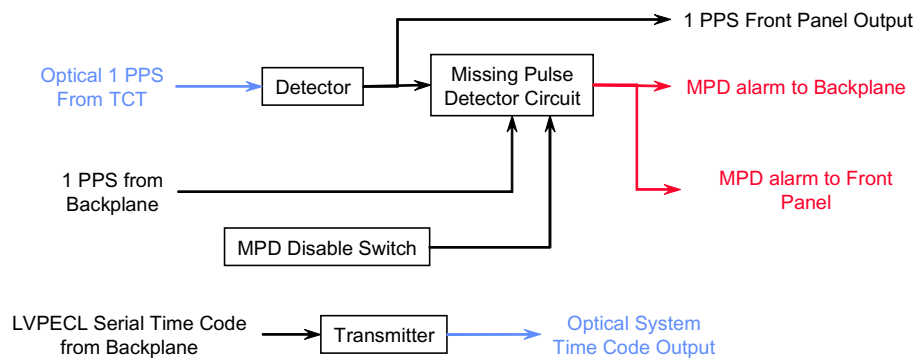
Figure 36: Distribution Output module block diagram

B.3 TCT Functions

The TCT receives the optical time code from the MCA or a DA and produces user signals via plug-in modules in the rear of unit. The plug-in modules are not hot-swappable units. All user outputs are electrical signals.

The TCT recovers the clock from the serial time code and uses the recovered clock as a reference to a phase-locked loop. The phase-locked loop uses the same circuit and TCXO as the MCA. The TXCO provides approximately 16 ms holdover performance (over 12 hour period).

The optical 1 pps return (from the TCT to the MCA or DA) monitors the TCTs. The optical 1 pps signal is suppressed during a TCT alarm condition. All user outputs are disabled after 12 hours of the alarm condition, with the exception of EFC alarm which will not disable the outputs.

The TCT has one FPGA that provides the following:

- PPS recovery and STC frame extraction with CRC-16 checking

- 12-hour shutdown timer

- Parallel BCD code conversions

- Serial Time Code Generator for supplying time codes to the plug-in modules

- Delay compensation of 0 to 199.99 μs with 10 ns resolution adjustable via switch control

The TCT has the following alarms:

- LOSS OF SIGNAL—Current state of fiber optic Rx signal detect output. It stays lit for the duration of the signal loss.

- TCXO UNLOCK—Reflects the state of Hold Mux Control and is set when bit synchronization to the incoming signal is lost for 100 consecutive clocks. It stays lit for duration of the TCXO unlock and clears when 32 consecutive sync symbols are received [Symbols : "0" - 11001110, "1" - 11101100].

- RATE RESYNC—Mismatch of TCT 1 pps signal with new 1 pps signal derived from Rx time code. A mismatch triggers a timer that holds the LED lit for one second.

- SERIAL TIME CODE—CRC error detected. This triggers a timer that holds the LED lit for one second.

- EFC—A/D samples of TCXO control voltage made every 100 ms. If any sample is greater than 0xE65 or less than 0x199, a timer is triggered that holds the LED lit for one second.

Figure 37 shows a block diagram of the TCT main printed wiring assembly (PWA).
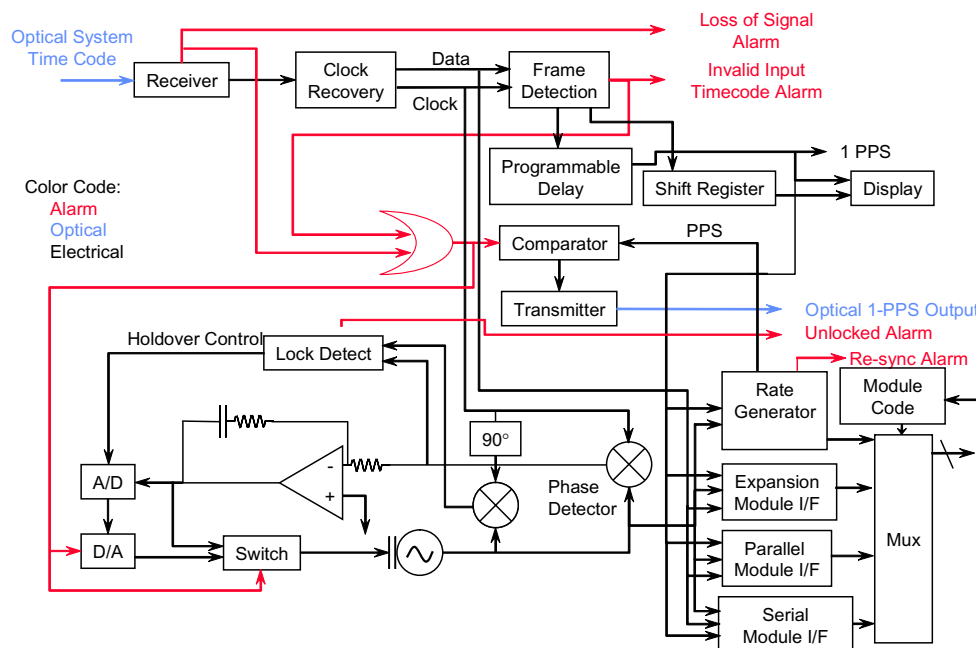
Figure 37: TCT main PWA block diagram

Appendix B: Theory of Operation

B.3.1 TCT Holdover Control

TCT holdover control is contained in the FPGA on the main TCT PWA. Figure 38 shows the details of the TCT holdover control. Holdover mode is entered during any TCXO UNLOCK or LOSS OF SIGNAL alarm condition.
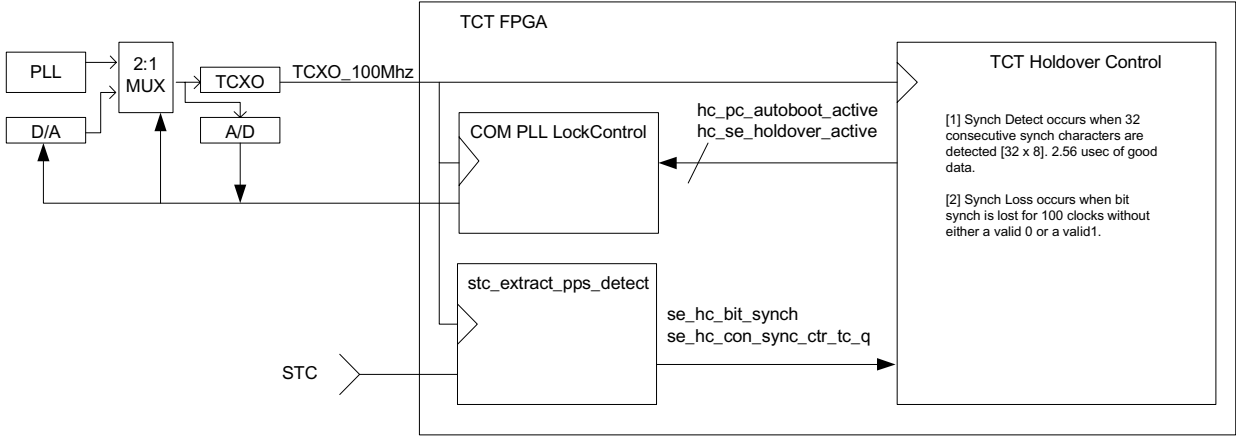
Figure 38: TCT holdover

The EFC voltage for TCXO control is stored every second during lock and used as the TCXO hold voltage in holdover. The D/A is set using a routine to ensure its output voltage during holdover matches the one second prior EFC voltage in holdover.

B.3.2 Dual RS-232 Time Code Output (DSN Serial) Module

The FPGA on the main PWA provides the TTL serial time code to this module. You can select the baud rate and year enabled via jumper settings on the PWA. Figure 39 shows a block diagram of the Dual RS-232 Time Code Output module.
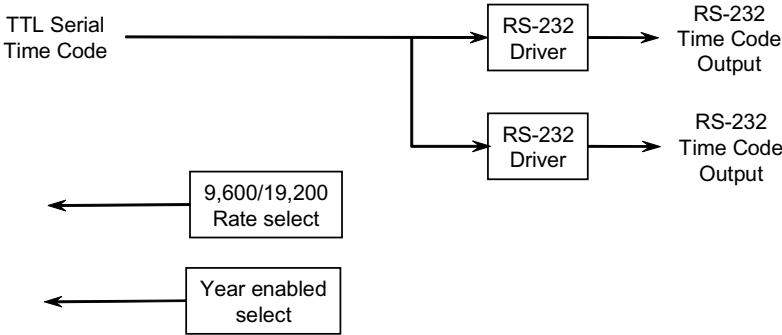
Figure 39: Dual RS-232 Time Code Output module block diagram

B.3.3 Parallel PB-1 Time Code Output Module

The TCT main PWA FPGA provides the time code formatted for serial delivery to this module. This module receives the serially delivered time code and places it into shift registers for delivery to the 62-pin D-sub connector. Figure 40 shows a block diagram of the Parallel PB-1 Time Code Output module.
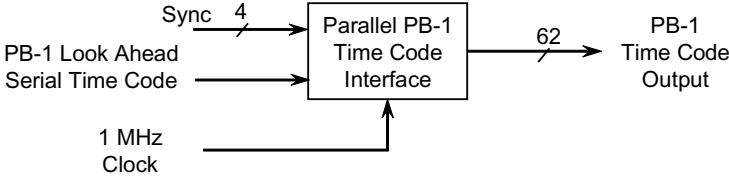
Figure 40: Parallel PB-1 Time Code Output module block diagram

B.3.4 Dual Time Code Output Module

The FPGA on the main PWA provides the formatted time codes to this module. IRIG-B and NASA-36 MOD are digital representations of the waveform that will be converted in this module for delivery to the rear panel connectors. You can select the year enabled via jumper setting on the PWA. Figure 41 shows a block diagram of the Dual Time Code Output module.
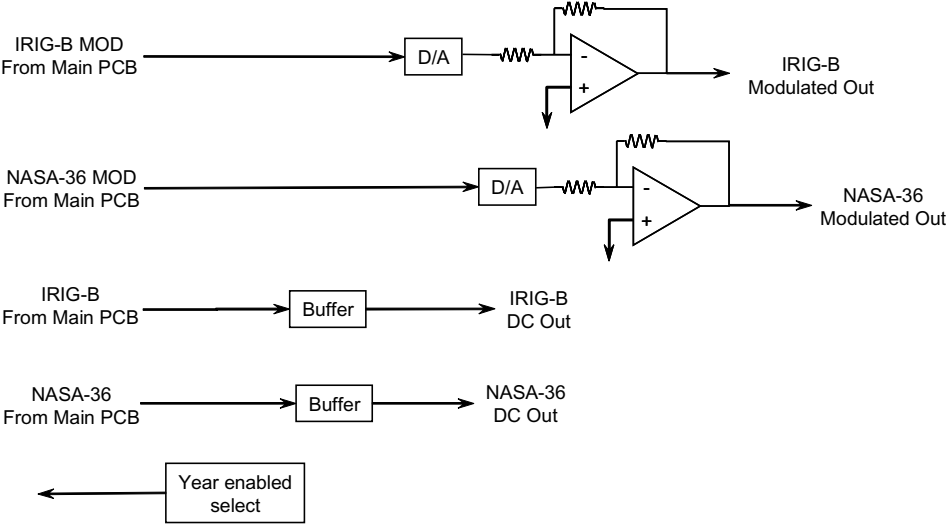
Figure 41: Dual Time Code Output module block diagram

B.3.5 Parallel BCD Time Code Output Module

The TCT main PWA FPGA provides the time code formatted for serial delivery to this module. This module receives the time code and places it into shift registers for delivery to the 62-pin D-sub connector. Figure 42 shows a block diagram of the Parallel BCD Time Code Output module.
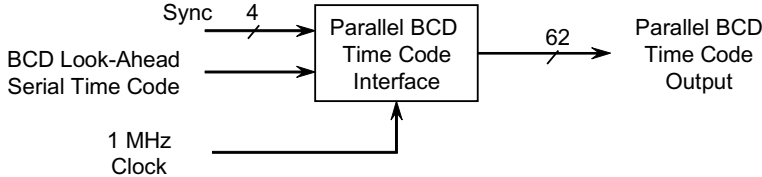
Figure 42: Parallel BCD Time Code Output module block diagram

B.3.6 Configurable Pulse Rate Output Module

The TCT main PWA FPGA provides the pps signals to this module. Figure 43 shows a block diagram of the Configurable Pulse Rate Output module. Jumpers enable configuration of the pulse rates shown in Table 26.
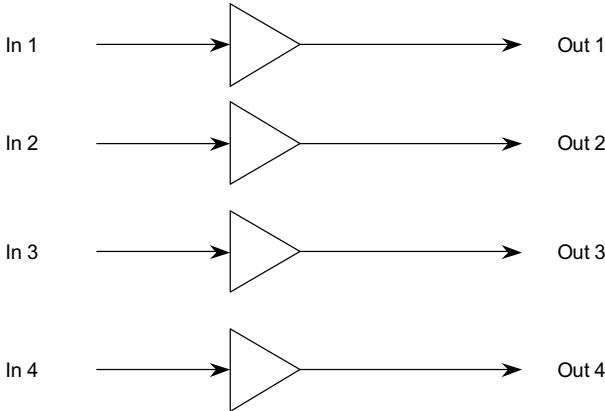
Figure 43: Configurable Pulse Rate Output module block diagram

The configuration with no jumpers results in 1, 10, 100, 1 kpps on the outputs.

Any one of seven pulse rates, 1 pps to 1 Mpps may be selected using the code jumpers. The selected rate is connected to all four output connectors.

Table 26: Available pulse rates

Code	Rate
0000	Quad 1 pps
0001	Quad 10 pps
0010	Quad 100 pps
0011	Quad 1 kpps
0100	Quad 10 kpps

Code	Rate
0100	Quad 10 kpps
0101	Quad 100 kpps
0110	Quad 1 Mpps (dual 1 Mpps Rate Output Module)
0111	Spare for future versions
1111	1/10/100/1000 pps (highest volume; requires no jumpers)
1000	Quad 1 pps, 20 µs wide active high pulse
1001	Quad 1 pps, 100 µs wide active high pulse
1010-1110	Spare for future versions

B.3.7 4310 – Alarm Input Module

This module provides the capability to monitor TTL alarms provides by other devices. There are four input BNC connectors. Internal jumpers allow the user to set individual inputs for active high or low input alarm sensing. All alarms are latched by the TCT as internal alarms.

B.3.8 4311 - IRIG-G and IRIG-B output module

The FPGA on the main PWA provides the formatted time codes to this module. Two modulated IRIG-B and two modulated IRIG-G outputs are provided rear panel BNC connectors. You can select IRIG year enabled via jumper setting on the PWA.

B.3.9 4313 - 5 and 10 MHz clean-up oscillator

The 4313 module provides two each 5 MHz and 10 MHz outputs on BNC connectors.

Appendix C: Parts List

Table 27 lists the part numbers for the Time and Frequency Distribution System.

Table 27: Parts list

Part	Part number
TCT chassis, multi-mode	4300
TCT chassis, single-mode	4300S
TCT chassis, CWDM 1510 nm	4300-CWDM5
TCT chassis, multi-mode, 4362BM compatible	4300BM
TCT chassis, single-mode, 4362BS compatible	4300BS
TCT chassis, single-mode, 4362B-CWDM5 compatible	4300B-CWDM5
Dual Time Code RS232 Output module	4301
PB-1 Parallel Time Code Output module	4302
Dual Time Code Output module (IRIG-B and NASA 36)	4303
Parallel BCD Time Code Output module	4304
Configurable Pulse Rate Output module	4305
TCT blank panel	4307
10 MHz Output module	4308
NTP Module	4309
Alarm Input Module	4310
IRIG-B and IRIG-G Output module	4311
5 and 10 MHz clean-up oscillator	4313
DA Chassis, 1 U	4340A
MCA/DA chassis	4350
DA Output Module, multi-mode	4351M
DA Output Module, single-mode	4351S
DA Input Module, single-mode	4352S
DA Input Module, multi-mode	4352M
Power Supply	4353
DA blank panel	4354
MCA UI	4361
TCG, multi-mode	4362

Part	Part number
TCG, multi-mode, Ethernet monitoring	4362BM
TCG, multi-mode	4362S
TCG, multi-mode, Ethernet monitoring	4362BS
TCG, CWDM5, single transceiver	4362-CWDM5
TCG, CWDM5, single transceiver, Ethernet monitoring	4362B-CWDM5
TCG, CWDM5, two transceivers, Ethernet monitoring	4362B-CWDM52
TCG, CWDM5, three transceivers, Ethernet monitoring	4362B-CWDM53
TCG, CWDM5, four transceivers, Ethernet monitoring	4362B-CWDM54
Flywheel	4363
MCA complete, consists of the modules listed below	14361M
MCA/DA chassis	4350
MCA UI	4361
TCG	4362
Flywheel	4363
Power Supply	4353
DA complete, consists of the modules listed below	14351M-10
MCA/DA chassis	4350
Ten DA Output modules, multi-mode	4351M
DA Input module, multi-mode	4352M
Power Supply	4353

Glossary

AC	alternating current
A/D	analog to digital
BCD	binary coded decimal
cc	checksum
CRC	cyclic redundancy check
DA	Distribution Assembly
DOY	day of year
EFC	Electronic Frequency Control
ESD	electrostatic discharge
FPGA	Field Programmable Gate Array
IRIG	Inter Range Instrument Group
LC	type of fiber-optic connector
LED	light-emitting diode
LSA	leap second add
LSS	leap second subtract
LY	leap year
MCA	Master Clock Assembly
MPD	Missing Pulse Detector
MSD	most significant digit
MTBF	mean time between failure

PLL	Phase Locked Loop
PWA	printed wiring assembly
SMA	type of radio-frequency connector
STC	Serial Time Code
TCG	Time Code Generator
TCT	Time Code Translator
TCXO	Temperature Compensated Crystal Oscillator
TNC	type of coaxial connector
TTL	Transistor-to-transistor logic
UI	User Interface
VDC	volts direct current
VSWR	voltage standing wave ratio

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