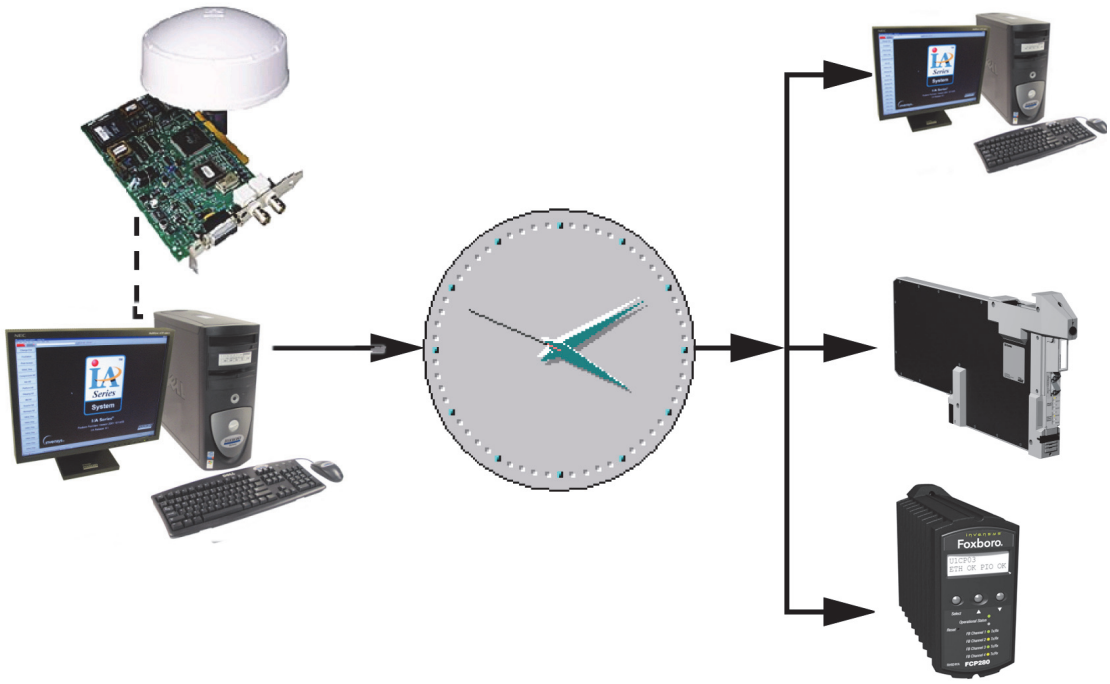
Foxboro Evo™ Process Automation System

Product Specifications

Foxboro® by Schneider Electric

PSS 31S-1TIME

Time Synchronization Overview



Synchronizes time within a Foxboro Evo™ system or I/A Series® system (hereafter referred to as Process Automation systems*) to provide accurate timestamps for event and data reporting throughout the system.*

FEATURES

Time synchronization within a Foxboro Evo system or I/A Series system consists of two product offerings:

- A standard time synchronization system (without a Global Positioning System (GPS)) that synchronizes workstations to within 50 ms.
- An optional time synchronization system (with GPS - externally sourced) that synchronizes concurrent event data from Transient Data Recorder and Analysis (TDR/TDA) and Sequence of Events (SOE) FBMs to within 1-3 millisecond time difference, depending upon configuration. For more information, refer to the section on “Timestamp Accuracy and Precision of SOE Data” in *Time Synchronization User's Guide* (B0700AQ).

OVERVIEW

Time synchronization within a Foxboro Evo or I/A Series system (hereafter referred to as *Process Automation systems*) synchronizes workstations and control stations to provide accurate timestamps for event and data reporting throughout the system.

Transient Data Recorder and Analysis (TDR/TDA), AIM* Historian™, Sequence of Events (SOE), and other application packages can take advantage of the highly accurate time synchronization system.

The standard time synchronization system consists of workstations that determine time from the workstation's internal clock.

The optional time synchronization system consists of workstations that determine time from a Global Positioning System (GPS) antenna/receiver and use the Time Strobe distribution network.

This Product Specification Sheet (PSS) provides an overview of the Time Synchronization system in these sections:

STANDARD PROCESS AUTOMATION SYSTEMS TIME SYNCHRONIZATION

Standard Time Synchronization Features

The standard Process Automation systems time synchronization system features are:

- Master TimeKeeper (MTK) synchronizes to its internal real time clock
- Time is synchronized to within 50 ms on the workstations
- Network Time Protocol (NTP) is used in the workstations
- Control station synchronization is performed by "time-of-day" messages sent by the MTK every 10 minutes to configured control stations
- System messages are logged for timekeeper operation/detected suboptimal conditions
- Time is synchronized using Universal Coordinated Time (UTC)
- Date and time can be manually adjusted using the System Manager or System Management displays
- Time may be displayed in local time
- MTK is automatically switched to a backup MTK in case the primary MTK workstation becomes unavailable.

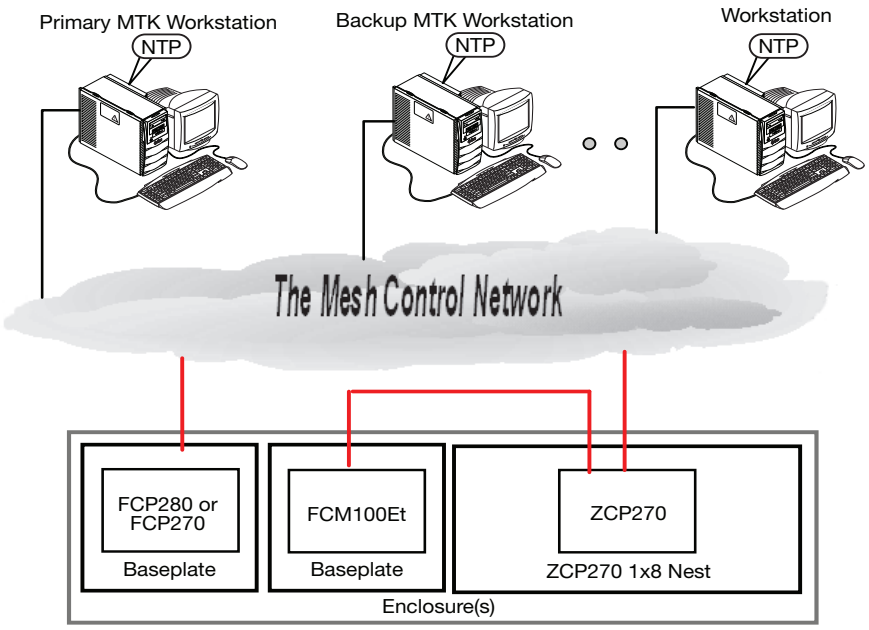


Figure 1. Standard Time Synchronization System

Standard Master TimeKeeper (MTK)

In the standard Process Automation system's Time Synchronization system, an MTK maintains the time source and distributes the system time to the other stations on the control network (see Figure 1). The MTK application software resides in a workstation without a GPS antenna/receiver. The MTK uses the workstation's internal real time clock as a time source to synchronize the stations on the control network.

Every 10 minutes a date and time message is sent to the control processors from the MTK to synchronize time and adjust their time.

One workstation is configured as the primary and one workstation is configured as the backup timekeeper. On the workstations, the timekeeper consists of one component that acts as an MTK or a Slave/Backup TimeKeeper (STK), depending on the station's role. On the other stations including control stations, an STK receives time information from an MTK station and keeps itself synchronized with the MTK station (and therefore with the other stations on the control network).

The workstations on the control network use the NTP application software within the workstation. The MTK uses NTP to distribute the date and time to the workstations on the control network.

For reliability, the active MTK will be switched automatically due to a detected failure of the active MTK's workstation.

Standard Time Adjustments

System time can be adjusted from any workstation manually by an operator. An operator enters the date and time using the System Manager Date and Time tools, or the System Management Display Handler (SMDH) Set Date and Time display. The local time zone can be set using the Windows® Date/Time applet.

Standard Time Synchronization Modes

Normal Operating Synchronization

During normal operation, time is synchronized between the MTK workstation and other workstations to within 50 ms.

Synchronization during MTK Takeover

Switching an active MTK to a backup MTK, or vice versa, can cause a time difference of up to 50 ms. Each workstation controls its own incremental time adjustments and individually closes the gap to the MTK time.

Synchronization for Time Differences

Time adjustment varies depending on the version of I/A Series software or Control Core Services software.

For workstations or servers with I/A Series software previous to v8.3:

- The time on all workstations or servers is gradually adjusted by NTP if the time discrepancy is less than 1000 seconds. If the time discrepancy is greater than 1000 seconds, the time is set directly to the time entered via and I/A Series system management application.

For workstations or servers with I/A Series software v8.3-v8.8, or Control Core Services software v9.0 or later:

- The time on all workstations or servers is set directly to the time entered via any system management application within approximately 35 seconds.

A system message is generated in the SMON_log that it is monitoring the TimeKeeper.

As of I/A Series software v8.4.2:

- Any time changes are distributed system-wide within 20 seconds.

Time Update Frequency to FBMs

FBMs receive the time updates from their control processors (CPs) every five seconds. For ZCP270s, the time is sent every five seconds to their FCM100E/Ets, which in turn send the time to their FBMs. For 200 Series digital FBMs that support SOE/TDR and have their time synchronized by FCP280s, FCP270s, or ZCP270/FCM100E/Ets, data will be synchronized to within 1-3 milliseconds time difference when compared to data from other time synchronized CPs with 200 Series FBMs that support SOE/TDR. For 200 Series analog FBMs that support TDR, the accuracy of their data is within ±10ms. For more information, refer to the section on “Timestamp Accuracy and Precision of SOE Data” in *Time Synchronization User's Guide* (B0700AQ).

OPTIONAL PROCESS AUTOMATION SYSTEMS GPS TIME SYNCHRONIZATION

Optional Time Synchronization Features

The optional Process Automation systems Time Synchronization system features are:

- MTK synchronizes to the GPS time.
- Time is synchronized to within 1 ms on the TDR/TDA and SOE FBMs whose controllers ((Field Control Processors (FCP280 or FCP270), Z-module Control Processors (ZCP270), and Fieldbus Communications Modules (FCM100Et)) receive the time strobe, depending upon your configuration. For more information, refer to the section on “Timestamp Accuracy and Precision of SOE Data” in *Time Synchronization User's Guide* (B0700AQ).
  This allows for up to a 2 ms difference between FBMs on different CPs.
- Time is synchronized to within 50 ms on the workstations.
- NTP is used in the workstations.

- Control stations with time strobe hardware are synchronized by the “time at the next pulse” message sent by the MTK every minute.
- Control stations without time strobe hardware are synchronized by “time-of-day” messages sent by the MTK every 10 minutes.
- Time strobe network can be installed as a single or redundant network.
- System messages are logged for timekeeper operation.
- Time is synchronized using UTC.
- Time/Date applet can be used to set the workstation to display local time.
- Automatic establishment and synchronization of time is based on GPS time (time cannot be adjusted from System Management displays).
- MTK is automatically switched to a backup MTK if there is a detected primary MTK failure.
- Optional use of medium-distance Multi-Mode Fiber (MMF) Optic-compatible extenders for distribution of time pulses to remote sites. With an MMF-compatible extender, GPS-derived time pulses can be received from up to 2 km (1.2 mi) away over MMF, simplex cables.
- Optional use of Site-Wide Single-Mode Fiber (SMF) Optic-compatible extenders for distribution of time pulses to remote sites. With an SMF-compatible extender, GPS-derived time pulses can be received from up to 10 km (6.2 mi) away over SMF, simplex cables. Once the pulse is received by a custom module at a remote site, the pulse can be distributed to multiple targets over economic MMF cable.

Optional Time Synchronization Master TimeKeeper

The optional Process Automation systems Time Synchronization system is an MTK with a GPS antenna/receiver and a Time Strobe distribution network (see Figure 2). The MTK application software resides in a workstation that distributes the system time to the other stations on the control network.

On workstations, the TimeKeeper subsystem consists of one component that acts as an MTK or STK, depending on the station’s role. On the other stations including control stations, an STK receives time information from an MTK workstation.

The MTK synchronizes the slave stations by using the GPS time. The MTK gets its UTC date and time from the GPS receiver.

The MTK uses the NTP to distribute the date and time to the workstations on the control network. The STKs on workstations receive the date and time from the MTK and synchronize by adjusting their real-time clock.

Once each minute, the MTK station sends over the control network a “time at the next pulse will be” message. When a controller receives the next time strobe, it adjusts its time as specified by the MTK message. If the controller does not have a time strobe, it adjusts its time by the standard time-of-day message issued by the MTK every 10 minutes.

FCP280, FCP270s, and FCM100Ets that have a time strobe synchronize TDR/TDA and SOE FBMs to within 1 ms, depending upon your configuration. For more information, refer to the section on “Timestamp Accuracy and Precision of SOE Data” in *Time Synchronization User's Guide* (B0700AQ).

For reliability, the TimeKeeper subsystem allows the active MTK to switch automatically from one workstation to another due to a detected failure on the active MTK’s workstation. In systems with a functioning GPS sourced MTK, the MTK is switched

to another GPS sourced MTK before switching to any other MTK. Any GPS sourced workstation is given priority over non-GPS sourced workstations in the event of an automatic takeover due to a detected failure of the active MTK station.

Optional Time Synchronization Time Strobe Networks - Extended and Site-Wide

The optional externally sourced Time Strobe distribution network provides three basic configurations for delivering the GPS time pulse from the MTK (see Figure 2).

Extended Time Strobe Network Without Extenders

In this network configuration, the Time Strobe distribution network sends the GPS time pulses directly to up to two Time Strobe Converters (TSCs) over 2 km (1.2 mi) MMF, simplex cables. The TSCs send the time pulses to the appropriate controllers, as well as to other TSCs daisy-chained to them.

Extended Time Strobe Network With Extenders

In this network configuration, the Time Strobe distribution network uses MMF cables and MMF-compatible Time Strobe Distribution Extenders to spread the GPS time pulses to up to six TSCs. The GPS time pulse is sent to a MMF-compatible extender, which distributes the time pulses to other MMF-compatible extenders or MMF-compatible TSCs. These TSCs can daisy-chain to other compatible TSCs over MMF cable, and also, with their eight RS-422 time strobe outputs, connect to local controllers.

Each MMF connection (extender-to-extender, extender-to-TSC, TSC-to-TSC) can be up to 2 km (1.2 mi) in length.

Site-Wide Time Strobe Network

In this network configuration, the Time Strobe distribution network sends the GPS time pulses to Time Strobe Distribution Extenders which use SMF simplex cables to connect to up to six SMF-compatible TSCs over distances of up to 10 km (6.2 mi). These TSCs can daisy-chain to other compatible TSCs over MMF, simplex cable, and they also have eight RS-422 time strobe outputs to connect to local controllers.

MMF connections have the same length restriction mentioned previously.

This configuration is optimal for an expansive plant, where time is needed to be distributed to small clusters apart from the central control room.

Optional Time Synchronization Time Adjustments

Time cannot be adjusted from Foxboro System Management displays. The local time zone can be set using the Windows Date/Time applet. The base time on the stations remains the UTC time.

Optional Time Synchronization System Messages

The MTK sends messages about the system status and detected failures to printers and historians.

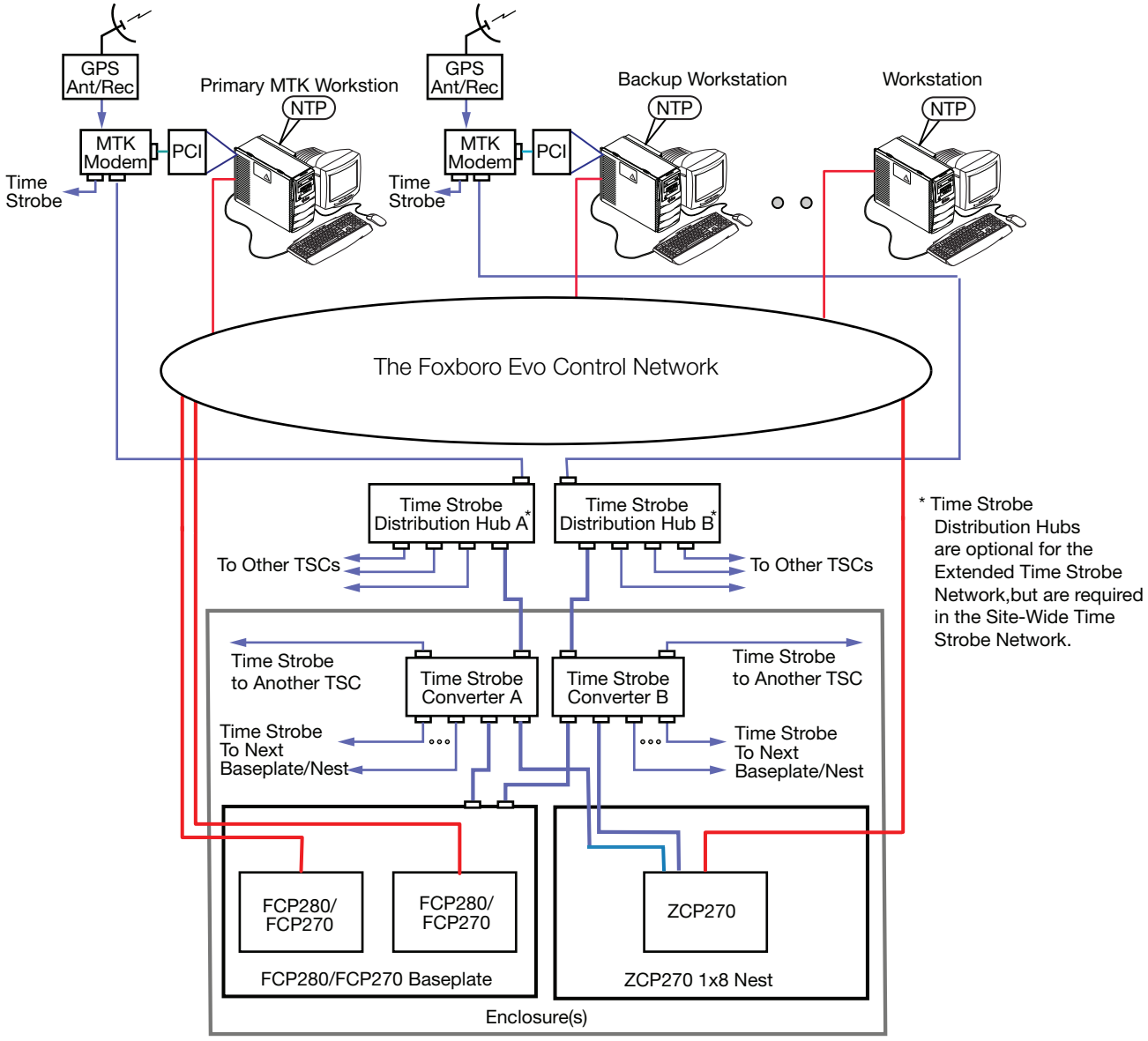


Figure 2. Optional Time Synchronization System

Time Strobe Network Equipment

The optional time strobe (time pulse) is distributed via the hardware. The UTC time of day is distributed to the various controllers through switch networks, including The Foxboro Evo Control Network, formerly known as The Mesh control network. The hardware modules in the optional Process Automation systems Time Strobe Network are the:

- GPS Antenna/Receiver system
- Time Strobe Generator (PCI card)
- MTK modem
- TSCs
- Time Strobe Distribution Extenders

Figure 3 shows the hardware modules in a redundant Time Strobe network.

GPS Antenna/Receiver System

The GPS receiver uses an omni-directional antenna to detect satellite signals that specify the time and satellite position. The GPS receiver determines the satellite's time by decoding the signals simultaneously from at least four of the GPS satellites.

The antenna system contains the GPS receiver and an optional fiber Isolator to drive signals to the Time Strobe Generator card through a copper cable or an optional fiber optic connection to the antenna.

Time Strobe Generator

The Time Strobe Generator is a PCI card that resides in a workstation. It receives the antenna system's output, provides time data to the workstation, and passes a time strobe through to the MTK modem. The MTK modem module connects to the Time Strobe Generator card and modifies the card's electrical time strobe outputs to drive two fiber optic outputs.

The PCI card (Time Strobe Generator) can maintain the stream of time strobe signals even if it does not receive signals from the GPS antenna system. It reverts to a highly accurate internal clock if the GPS signals are not available.

MTK Modem

The Time Strobe Generator card generates and transmits a periodic time pulse using RS-422 signal levels. The MTK modem converts the signal for transmission to the TSCs or to the Time Strobe extender for transmission throughout plant locations.

Fiber optic cable is used for the transmission of the time strobe signals from the MTK modem to the TSC modules or Time Strobe extenders, or between TSC modules.

Time Strobe Converters (TSCs)

The TSCs provide the conversion and a copper connection of the accurate time strobe pulse from an MTK station to the controllers. The TSC output connects directly to a ZCP270 controller or to baseplates that can house an FCP280, FCP270, or FCM100Et. TSCs provide a fiber optic output for continuation of the time strobe signal, if needed, to the next TSC.

Two types of TSC are available - TSCs with MMF-compatible inputs for use in the Extended Time Strobe Network, and TSCs with SMF inputs for use in the Site-Wide Time Strobe Network. Both types of TSC have an MMF fiber output for daisy chaining to another TSC.

Time Strobe Distribution Extenders (Optional)

The optional Time Strobe Distribution Extenders (Ethernet hubs) distribute the time strobe to multiple enclosures throughout the plant. Time Strobe extenders can receive their inputs from an MTK modem.

Two types of extenders are available. An MMF-compatible Time Strobe Distribution Extender is available for use in the Extended Time Strobe Network. It has seven ports - one for the input and six for the outputs. It can be daisy-chained to additional MMF-compatible extenders.

An SMF-compatible Time Strobe Distribution Extender is available for use in the Site-Wide Time Strobe Network. It has one MMF input port and six SMF ports for the outputs. It can only connect its outputs to SMF-compatible TSCs.

Redundant Capability

Primary and backup MTKs can be used in an optionally redundant MTK system. Each provides its time strobe signals to the control stations. Both use independent PCI-bus based Time Strobe Generator cards. At least two TSC modules are used for connecting controller stations to primary and backup MTK stations (see Figure 3). In a redundant time strobe distribution system, any TSC module can be removed without affecting the other path of the time strobe signal to the controller stations. TSC modules can be withdrawn/replaced while the system is under power. One power supply source is needed for each TSC module.

Optional Time Synchronization Modes

Normal Operating Synchronization

During normal operation,

- Time is synchronized between TDR/TDA and SOE FBMs to within 1 ms, depending upon your configuration. For more information, refer to the section on “Timestamp Accuracy and Precision of SOE Data” in *Time Synchronization User's Guide* (B0700AQ).
- Time is synchronized between the workstations to within 50 ms.
- Control stations that are not connected to a time strobe are sent a time-of-day message by the MTK workstation every 10 minutes.

An FCM100E/Et can continue to maintain time synchronization (and collect SOE and TDR data if configured to do so) even if it loses the time strobe signal from its ZCP270. The FCM100E/Et uses its internal clock to send time updates to the FBMs every five seconds.

If the GPS connection to a ZCP270 becomes unavailable, but the ZCP270 and FCM100E/Et both continue to run, the ZCP270 reverts to the time provided by the MTK and sends these MTK time updates to the FCM100E/Et.

If the FCM100E/Et’s GPS becomes unavailable, the ZCP270 time is used eventually, whether it derives from the GPS or MTK. With no time strobes arriving, the FCM100E/Et will run on its internal clock for a while, then change over to the ZCP270 time (whether derived from an MTK or GPS).

Synchronization during MTK Takeover

When switching an active GPS sourced MTK to another GPS sourced MTK, there is no gap in synchronization during the takeover.

Synchronization for Time Discrepancies

There are no time discrepancies unless both GPS/MTK(s) become unavailable.

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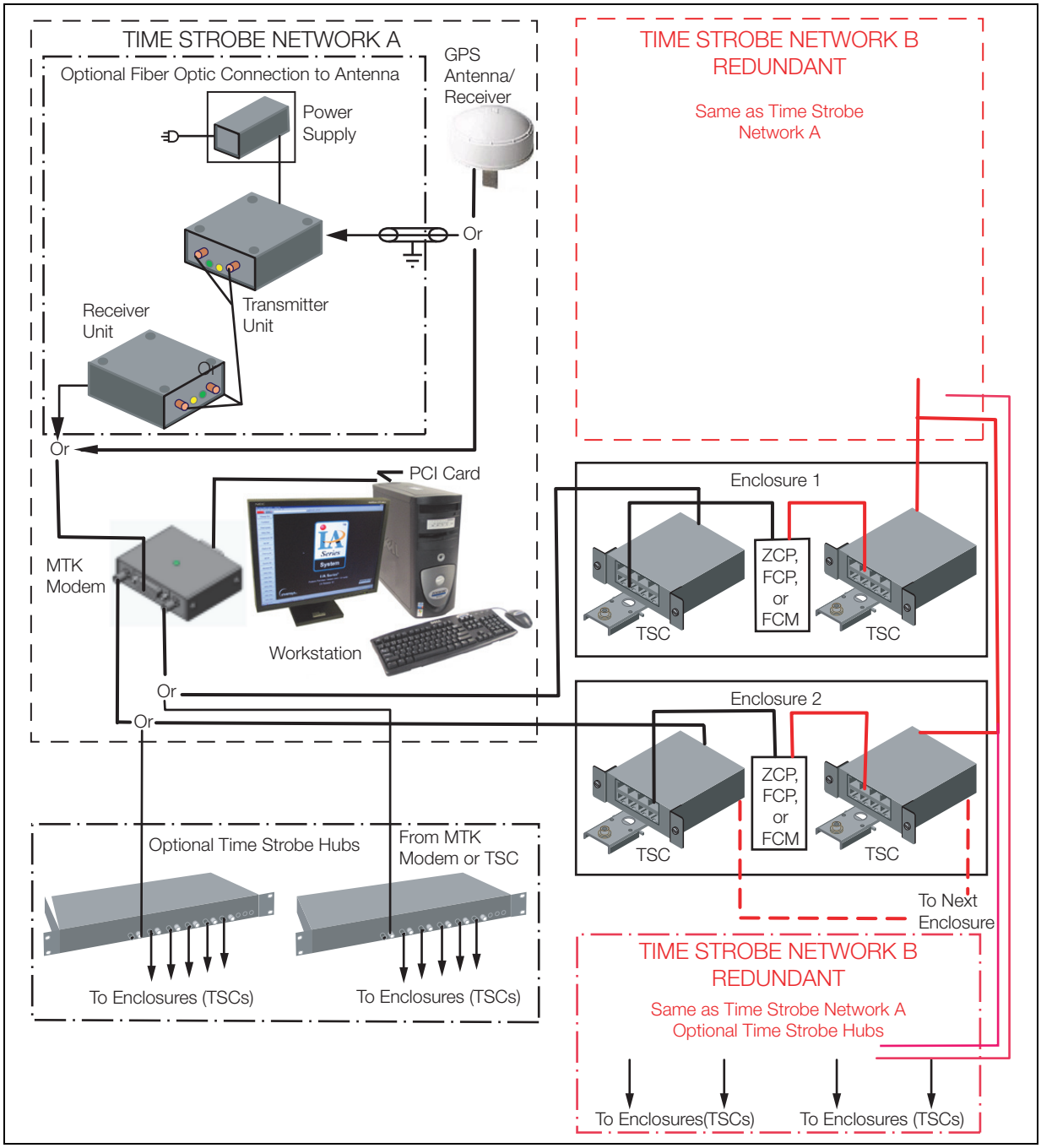

Figure 3. Time Strobe Network Equipment

BACKUP CONFIGURATIONS

For the MTK to continue functioning after the detected failure of the workstation where the MTK is running, there are backup configurations to allow another workstation to take over as the MTK. Backup configurations provide module redundancy for the Timekeeper subsystem.

The difference between the configurations is the source of time (GPS source versus NTP or internal clock source) for the primary MTK workstation and the backup MTK workstation.

Any GPS sourced workstation is given priority over an NTP or internal clock sourced workstation in the event of an automatic takeover due to a detected failure of the active MTK workstation.

Table 1 shows the default backup configurations supported by the Timekeeper subsystem. If the primary MTK becomes unavailable, the backup strategy provides for a new workstation to take over as the active MTK.

Table 1. Default Master TimeKeeper Backup Configurations

Configuration	Workstation	Time Source	Sync Pulse Generator Hardware
1	Primary MTK	GPS	Time Strobe Generator installed
	First Backup MTK	GPS	Time Strobe Generator installed
	Additional Backup MTKs	Internal Clock	None
2	Primary MTK	GPS	Time Strobe Generator installed
	First Backup MTK	NTP	1 to 3 External NTP Sources[(a)]
	Additional Backup MTKs	Internal Clock	None
3	Primary MTK	NTP	1 to 3 External NTP Sources[(a)]
	First Backup MTK	NTP	1 to 3 External NTP Sources[(a)]
	Additional Backup MTKs	Internal Clock	None
4	Primary MTK	NTP	1 to 3 External NTP Sources[(a)]
	First Backup MTK	Internal Clock	None
	Additional Backup MTKs	Internal Clock	None
5	Primary MTK	Internal Clock	None
	First Backup MTK	Internal Clock	None
	Additional Backup MTKs	Internal Clock	None

(a) TimeKeeper needs IP addresses of up to three NTP Time Synchronization Sources or their DHCP names. If the network on which the NTP server is running is supplying addresses via DHCP, then DHCP names need to be used in the system configurator instead of IP addresses.

OPTIONAL PROCESS AUTOMATION SYSTEMS NTP TIME SYNCHRONIZATION

When a system is configured to use an external NTP source to synchronize the MTK:

- The System Timekeeper process in the MTK monitors NTP communications with the NTP servers, and sends messages to the System Monitor log if three successive polls to all NTP servers become unavailable.
- NTP polling can take from 64 to 1024 seconds. Therefore, in some cases, it can take up to 51.2 minutes to detect a loss of synchronization.
- NTP version 4 needs to be used.
- In its failure mode, the System Timekeeper process checks NTP servers every 10 seconds to determine when they recover.
- A backup MTK becomes a Primary MTK if the backup MTK has the NTP synchronization pulse but the primary MTK does not.

PROCESS AUTOMATION SYSTEMS TIME SYNCHRONIZATION SYSTEM REQUIREMENTS

The optional Process Automation systems GPS Time Synchronization capability is only supported on:

- Workstations with Windows 10® and Server 2016 support the External NTP Sync.
- Workstations with Windows 7® and I/A Series software V8.8 or Foxboro Evo Control Core Services v9.0 and later.
- Workstations with Windows XP® and I/A Series software V8.0 - V8.7.

FOR MORE INFORMATION

For additional information, refer to the Product Specification Sheets listed in Table 2.

Table 2. Related Product Specification Sheets

PSS Number	Title
PSS 31H-4C2	Time Synchronization Equipment
PSS 31H-2SOV	Standard 200 Series Subsystem Overview
PSS 31H-2SBASPLT	Standard 200 Series Baseplates

Foxboro Evo™ Control Core Services and I/A Series® workstation software is supported only on the workstation hardware and configurations shipped from Foxboro® manufacturing, as listed in the most recent Control Core Services release notes. Control Core Services undergo rigorous qualification testing with specific software and hardware configurations to help ensure it meets the demanding requirements for process automation. Any use of non-supported computers for Control Core services software is not covered by our standard warrantee or support agreements unless specifically addressed and documented. The exception to this policy includes support for some Control Core Services engineering tools (e.g. IACC, FoxCAE™ tool). Details on what platforms are approved for use for these tools are documented in their respective Product Specification Sheets.

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