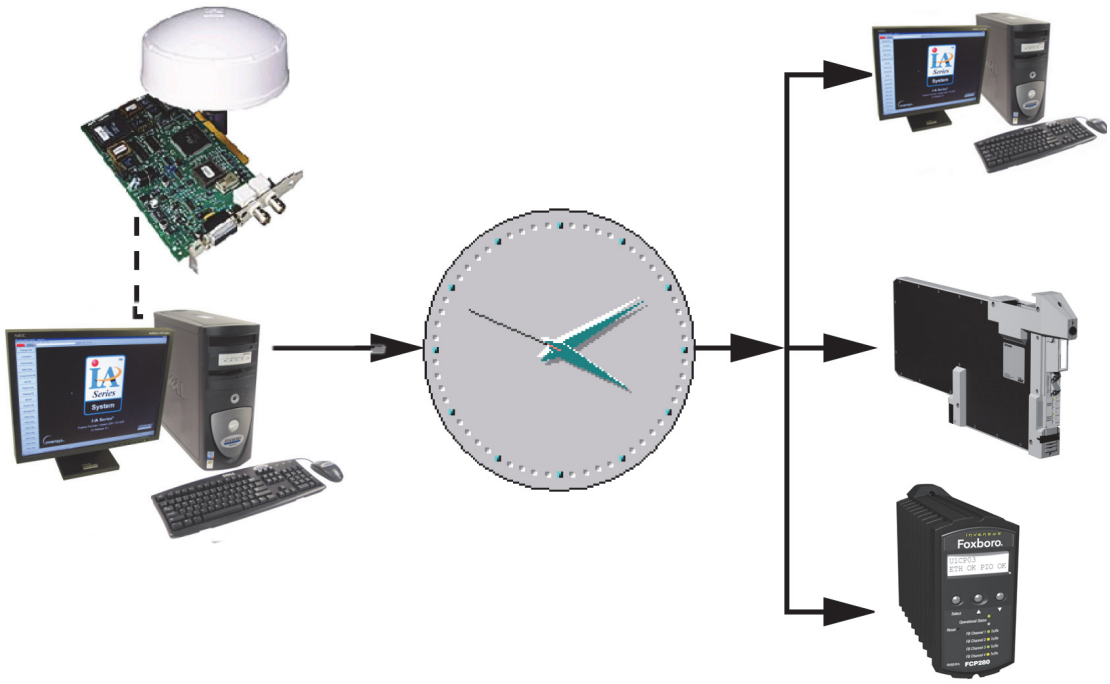
Time Synchronization Overview



Synchronizes time within an I/A Series® system to provide accurate timestamps for event and data reporting throughout the system.

FEATURES

Time synchronization within an I/A Series system consists of two product offerings:

- A standard I/A Series time synchronization system (without a Global Positioning System (GPS)) that synchronizes workstations to within 50 ms
- An optional I/A Series time synchronization system (with GPS) that synchronizes Transient Data Recorder and Analysis (TDR/TDA) and Sequence of Events (SOE) FBMs to within 1 ms.

OVERVIEW

Time synchronization within an I/A Series® system 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 workstations 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 I/A Series Time Synchronization system in the following sections:

STANDARD I/A Series TIME SYNCHRONIZATION

Standard I/A Series Time Synchronization Features

The standard I/A Series time synchronization system features are:

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

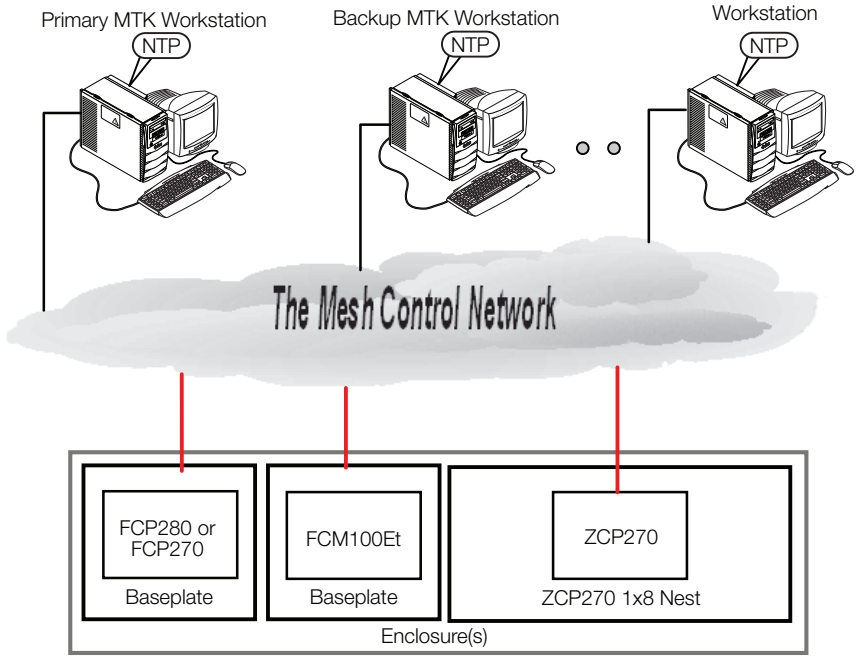


Figure 1. Standard I/A Series Time Synchronization

Standard I/A Series Master TimeKeeper

In the standard I/A Series Time Synchronization system, a Master TimeKeeper (MTK) maintains the time source and distributes the system time to all 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 workstations internal real time clock as a time source to synchronize all stations on the control network.

Every 10 minutes a date and time message is sent to all 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 all workstations, the timekeeper consists of one component that acts as a Master TimeKeeper (MTK) or Slave TimeKeeper (STK), depending on the station's role. On all 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 all other stations on the control network).

All workstations on the control network use the Network Time Protocol (NTP) application software within the workstation. The MTK uses NTP to distribute the date and time to all workstations on the control network.

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

Standard I/A Series 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 I/A Series 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

If the operator changes the time via System Manager or SMDH, time gaps can be introduced in the time being sent out by the MTK.

If the time difference is less than 1000 seconds, NTP gradually adjusts the time on workstations. If the time difference is greater than 1000 seconds, the time is set directly.

If the time is manually set from System Manager or SMDH, a system message is generated.

OPTIONAL I/A Series TIME SYNCHRONIZATION

Optional I/A Series Time Synchronization Features

The optional time I/A Series Time Synchronization system features are:

- MTK synchronizes to the GPS time
- Time is synchronized to within 1 ms on all 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
- Time is synchronized to within 50 ms on all workstations

- Network Time Protocol (NTP) is used in all 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 Universal Coordinated Time (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 in case of primary MTK failure
- Optional use of medium-distance Multi-Mode Fiber (MMF) Optic-compatible hubs for distribution of time pulses to remote sites. With an MMF-compatible hub, 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 hubs for distribution of time pulses to remote sites. With an SMF-compatible hub, 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 I/A Series Time Synchronization Master TimeKeeper

The optional I/A Series Time Synchronization system is a Master TimeKeeper (MTK) with a Global Positioning System (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 all other stations on the control network.

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

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

The MTK uses the Network Time Protocol (NTP) to distribute the date and time to all 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.

For reliability, the TimeKeeper subsystem allows the active MTK to switch automatically from one workstation to another due to a 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 failure of the active MTK station.

Optional I/A Series Time Synchronization Time Strobe Networks - Extended and Site-Wide

The Optional I/A Series Time Strobe distribution network provides three basic configurations for delivering the GPS time pulse from the Master TimeKeeper (see Figure 2).

Extended Time Strobe Network Without Hubs

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) multi-mode fiber optic (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 Hubs

In this network configuration, the Time Strobe distribution network uses multi-mode fiber optic (MMF) cables and MMF-compatible Time Strobe Distribution Hubs to spread the GPS time pulses to up to five TSCs. The GPS time pulse is sent to a MMF-compatible hub, which distributes the time pulses to other MMF-compatible hubs 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 (hub-to-hub, hub-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 Hubs which use single-mode fiber optic (SMF), simplex cables to connect to up to five 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.

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

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

Optional I/A Series Time Synchronization Time Adjustments

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

Optional I/A Series Time Synchronization System Messages

The MTK sends system status and failure messages to printers and historians.

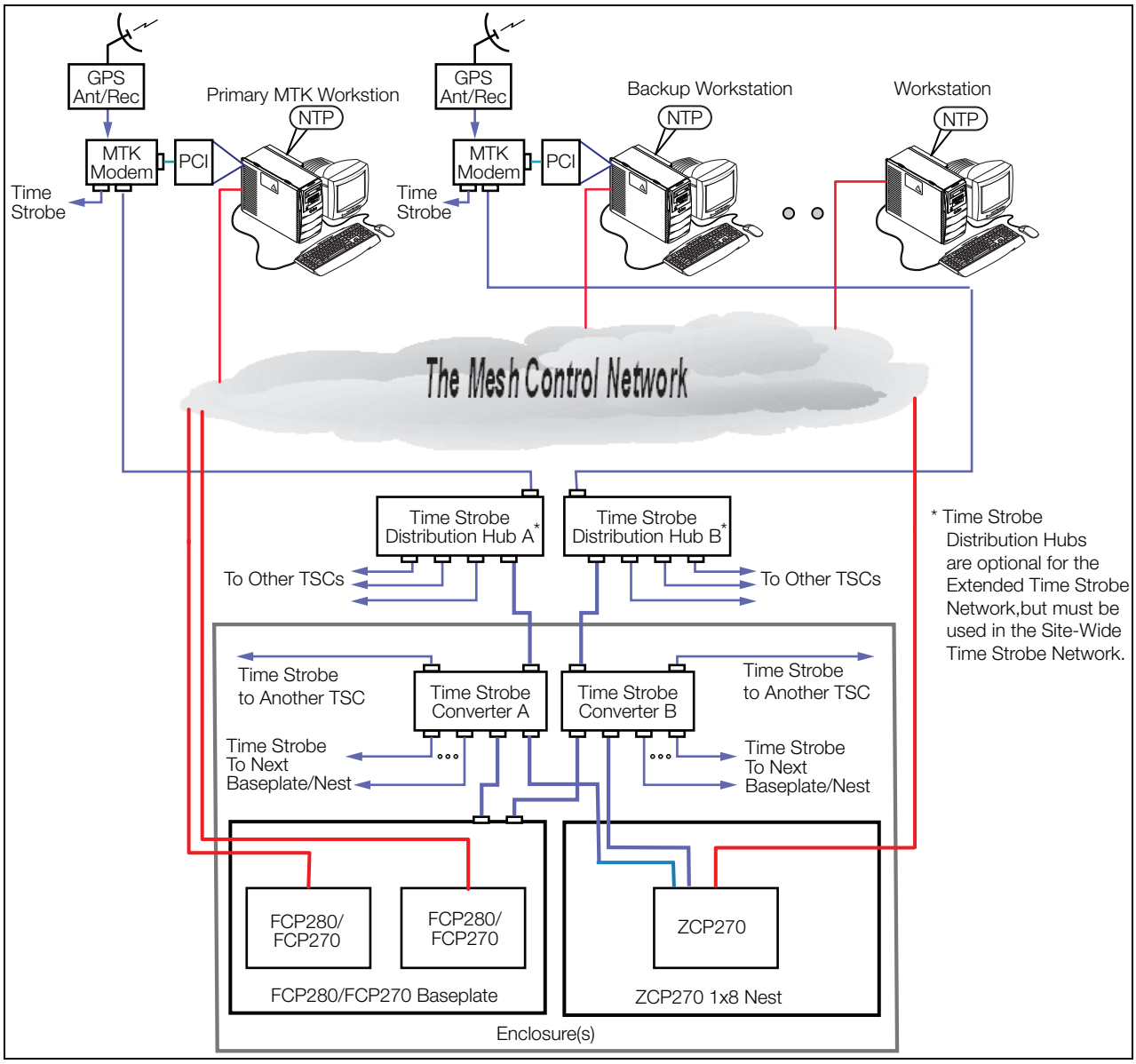


Figure 2. Optional I/A Series Time Synchronization

I/A Series Time Strobe Network Equipment

The optional time strobe (that is, time pulse) is distributed via the hardware described below. The UTC time of day is distributed to the various controllers through The Mesh control network. The hardware modules in the optional I/A Series Time Strobe Network are the:

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

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 Time Strobe Converters (TSCs) or to the Time Strobe hub for transmission throughout plant locations.

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

Time Strobe Converters

The Time Strobe Converters (TSCs) provides 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 provides 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.

In a system with ZCP270s, both the ZCP270 and its associated FCM100Ets must receive a time strobe signal.

Time Strobe Distribution Hubs (Optional)

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

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

An SMF-compatible Time Strobe Distribution Hub is available for use in the Site-Wide Time Strobe Network. It has one MMF input port and five 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 required for each TSC module.

Optional I/A Series Time Synchronization Modes

Normal Operating Synchronization

During normal operation,

- Time is synchronized between TDR/TDA and SOE FBMs to within 1 ms
- 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.

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) fail.

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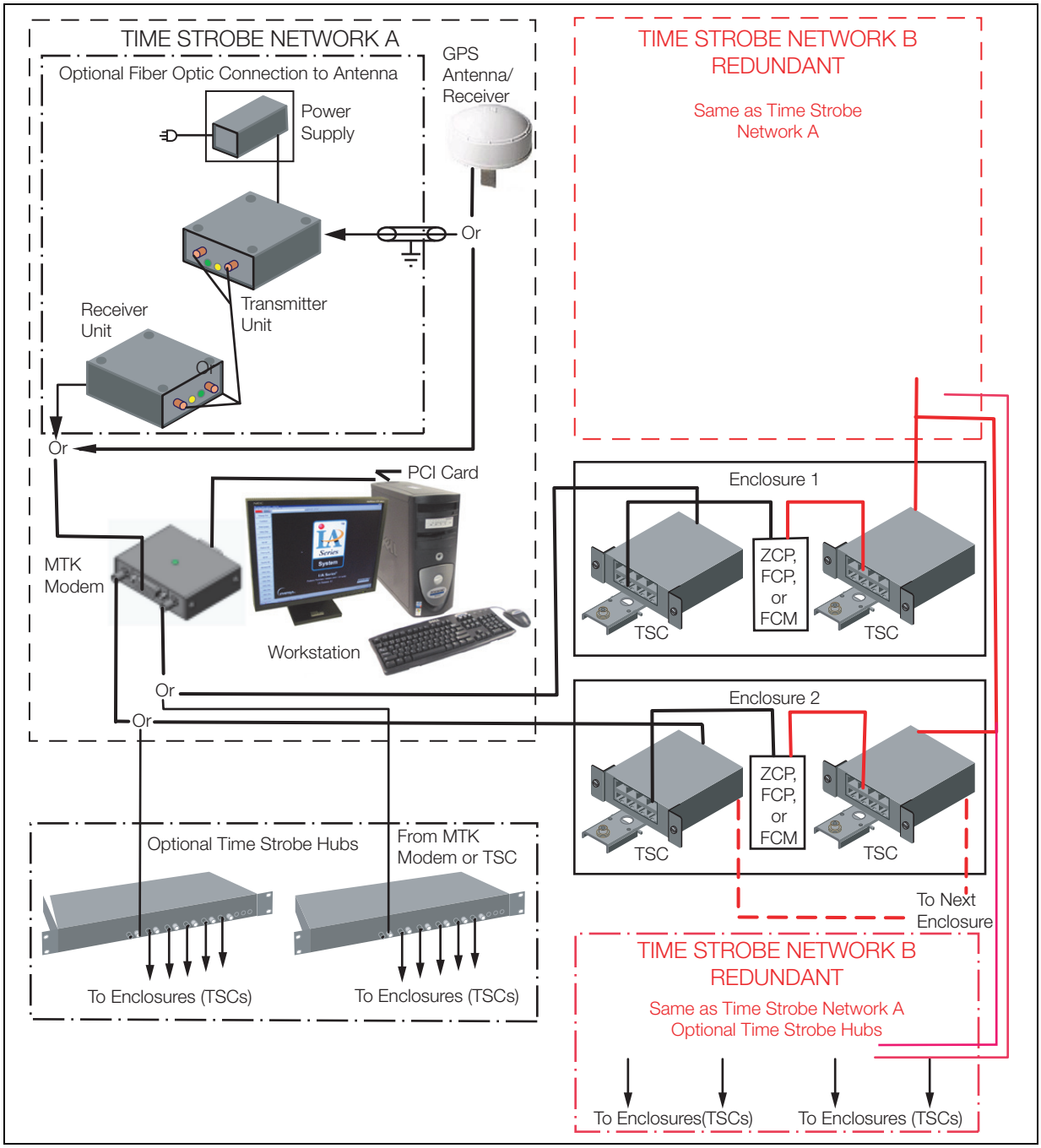

Figure 3. Time Strobe Network Equipment

BACKUP CONFIGURATIONS

For the MTK to continue functioning after a 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 internal clock source) for the primary MTK workstation and the backup MTK workstation.

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

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

Table 1. 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	Internal Clock	None
	Additional Backup MTKs	Internal Clock	None
3	Primary MTK	Internal Clock	None
	First Backup MTK	Internal Clock	None
	Additional Backup MTKs	Internal Clock	None

I/A SERIES TIME SYNCHRONIZATION SYSTEM REQUIREMENTS

The optional I/A Series Time Synchronization capability is only supported on:

- Workstation with Windows 7® and I/A Series software V8.8 and later
- Workstation 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 21H-4C2 B3	Time Synchronization Equipment
PSS 21H-2W1 B3	DIN Rail Mounted Subsystem Overview
PSS 21H-2W6 B4	DIN Rail Mounted Modular Baseplates

I/A Series® workstation software is supported only on the workstation hardware and configurations shipped from Foxboro® I/A Series system manufacturing. I/A Series system software undergoes rigorous qualification testing with specific software and hardware configurations to ensure it meets the demanding requirements for process automation. Any use of non-supported computers for I/A Series workstation software is not covered by our standard warrantee or support agreements unless specifically addressed and documented. Exception to this policy includes support for some I/A Series engineering tools (i.e. IACC, FoxCAE™ tool, etc). Details on what platforms are approved for use for these tools are documented in their respective Product Specification Sheets.

nvensys
10900 Equity Drive
Houston, TX 77041
United States of America
http://invensys.com

Global Customer Support
Inside U.S.: 1-866-746-6477
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