TECHNICAL NOTE

Overview of 1per10 Time Protocol

Summary

1per10 is a precision time protocol used to synchronize Sepam™ digital protection relays in time-critical applications.

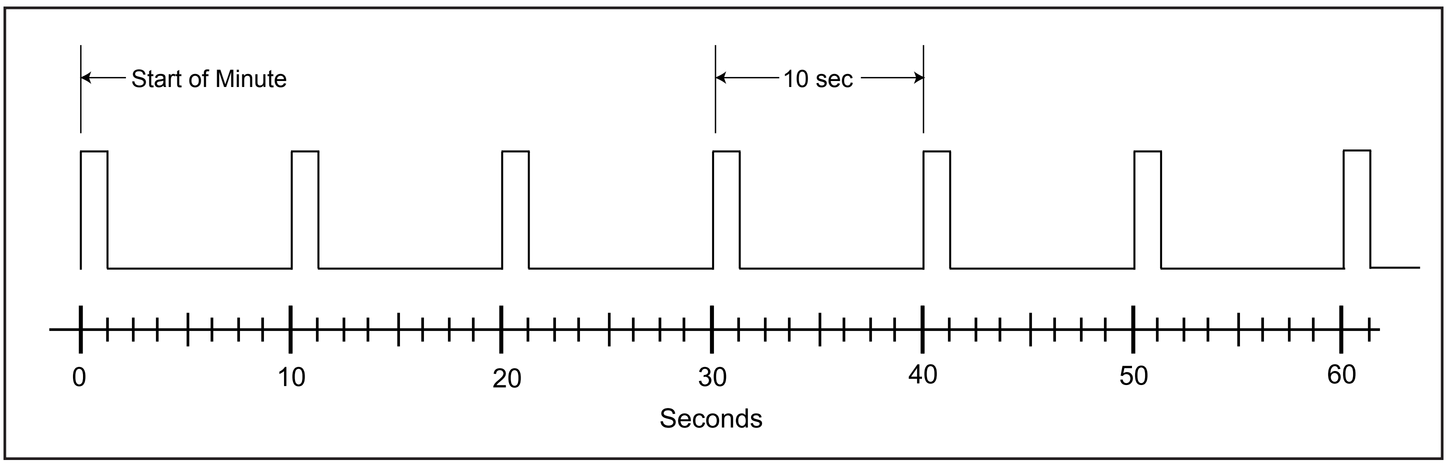
This document describes the protocol, and gives examples of how Cyber Sciences products are used to synchronize devices (Sepam protective relays by Schneider Electric) which require this protocol.

Introduction to 1per10

1per10 (one-pulse-per-ten-seconds) is a simple time protocol that uses one synchronizing pulse every 10 seconds to provide an accurate time reference for power system devices. This protocol is used by Sepam™ digital protection relays from Schneider Electric. The relays can accept any synchronization pulse period from 10 to 60s, by 10 second steps. The shorter the synchronization period, the more accurate the timestamping of status changes; therefore, 1per10 is preferred.

The rising edge of the first 1per10 pulse occurs at the exact start of a minute, and subsequent pulses follow at 10 second intervals. Since only the rising edge is used for synchronization, the width (duration) of the pulse is not important. The figure below shows a typical 1per10 signal.

PROTOCOL DESCRIPTION



One pulse per ten seconds (1per10)

Example

1per10 can be used to set a device's clock with high precision, once the device's own clock has been set initially and its accuracy is known to be within +/- 4 seconds. As an example, consider a device whose clock has been set through some other means and now reads 08:15:59. If it detects a 1per10 sync pulse at this instant, it can safely assume this is the start-of-minute pulse and adjust its clock to exactly 08:16:00.000. It could not be an intermediate pulse (say, the 10 second pulse) because this would make it 08:16:10, which would exceed the error specification of 4 seconds.

APPLICATIONS OF 1PER10 IN PRODUCTS BY OTHERS

Sepam Relays (Series 20/40/80) from Schneider Electric

Sepam Relays

Sepam relays from Schneider Electric have an internal clock that can be set via software and synchronized via an external 1per10 pulse to achieve precise timestamping of events. Logic input I21 (I103 for Series 80) may be designated for this purpose using Sepam setup software. The following are excerpts from the Sepam instruction manual.

In the initialization phase, the resetting process (switching of Sepam into "synchronous" mode) is based on the difference between Sepam's current time and the nearest ten-second period. Resetting is allowed if the difference is less than or equal to 4 seconds, in which case Sepam switches to "synchronous" mode: when the next synchronization pulse is received, the clock is reset to the nearest ten second period.

The synchronization pulse period (one pulse per 10 seconds) is determined automatically by Sepam when it is energized. It is based on the first two pulses received. The synchronization pulse must therefore be operational <u>before</u> Sepam is energized.

If Sepam is in "correct time and synchronous" status, and the difference between the nearest ten second period and the receipt of the synchronization pulse is greater than 4 seconds for two consecutive synchronization pulses, it switches into non-synchronous status and generates a "not synchronous" event. Likewise, if Sepam is in "correct time and synchronous" status, and does not receive a synchronization pulse for 200 seconds, it generates a "not synchronous" event.

Note: Sepam module MES114 provides logic inputs (digital inputs), one of which is used for external time sync. This Sepam accessory is rated for 24 to 250 Vdc, and so it is compatible with the 1per10 signal distributed at 24 Vdc. If MES114E (rated 125 Vdc) or MES114F (rated 250 Vdc) are used instead, then the 24 Vdc 1per10 signal must be converted to 125 or 250 Vdc using an interposing relay, to match the higher voltage rating of the module used.

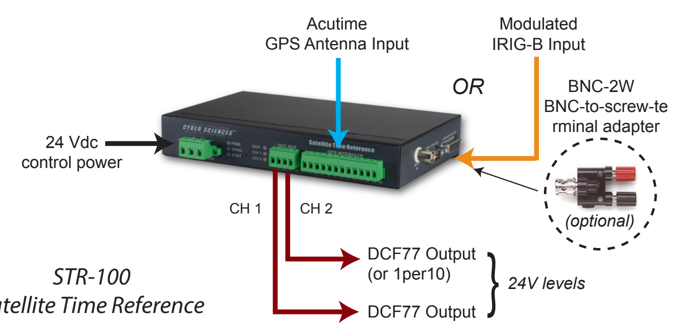
For more information about Sepam and application considerations for external time synchronization, please contact Schneider Electric.

APPLICATIONS OF 1per10 IN CYBER SCIENCES PRODUCTS

If Modulated IRIG-B input is used, the STR-100 must be configured with the current year during initial setup. The full date/time (including the year) is transmitted via its DCF77 outputs.

STR-100 Satellite Time Reference

The Cyber Sciences STR-100 Satellite Time Reference accepts a GPS smart antenna input or a modulated IRIG-B signal (type B122). The STR-100 then outputs a DCF77 signal on two channels (CH1 and CH2), with accuracy of 100 microseconds. To select 1per10 protocol, the channel 2 output must be configured for 1per10 instead of DCF77 (default). Refer to the STR-100 instruction bulletin for more details.



STR-100 Satellite Time Reference

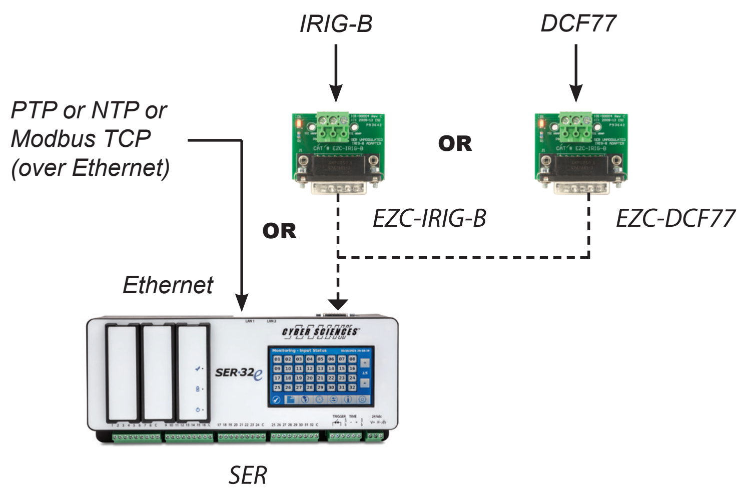
APPLICATIONS OF 1per10 IN CYBER SCIENCES PRODUCTS (cont.)

CyTime SER-32e (or SER-3200/2408-PTP)

CyTime™ Sequence of Event Recorders (SER-32e, SER-3200 and SER-2408) accept a variety of time source options and then sync with each other using PTP. A PTP slave can also output a legacy protocol to devices that do not support PTP, such as 1per10 for Sepam relays. Other time-sync input and output options are also supported for more flexibility and interoperability with other devices.

SER Time Source Options (Time-Sync IN)

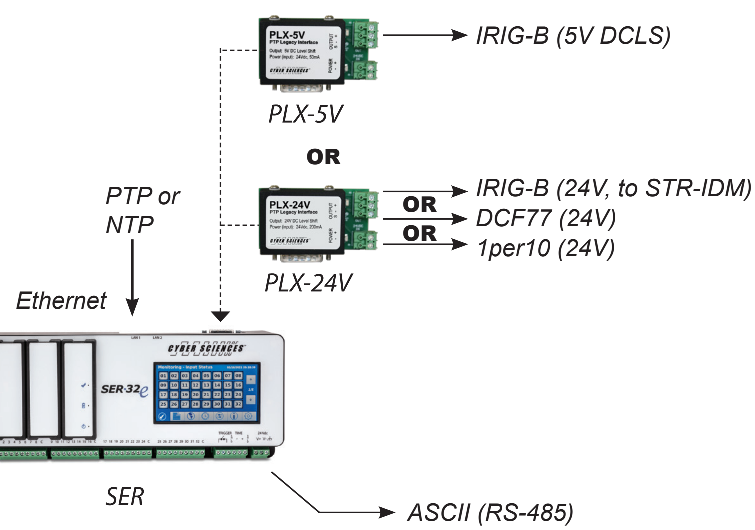
Time source options via PTP, NTP or Modbus TCP use the SER-32e (or SER-3200/2408) built-in Ethernet interface (RJ-45). IRIG-B or DCF77 inputs require an adapter (EZC-IRIG-B or EZC-DCF77) as shown.



SER as Time-sync Hub (Time-Sync OUT)

When PTP is selected as time source, the SER also serves as a "PTP time-sync hub" for non-PTP devices, generating the time-sync protocol needed: IRIG-B, DCF77, 1per10 (via PLX adapter) or ASCII (via built-in RS-485 port), as shown below.

Note: Only one protocol can be selected for output via the PLX connector (IRIG-B, DCF77 or 1per10). However, for maximum flexibility, the ASCII / RS-485 output is enabled by default any time an SER is set to use PTP or NTP (SER-32e only) for time source (IN) or time-sync (OUT).



PRECISION TIME PROTOCOL (PTP) per IEEE 1588

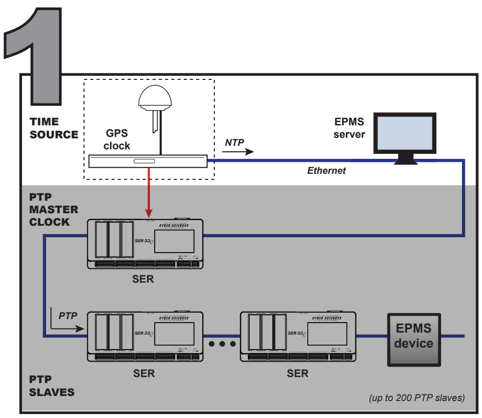
For More Info on PTP:

Tech Note: Hi-res Time Sync using PTP/1588 (TN-100)

Time Synchronization as Easy as 1-2-3

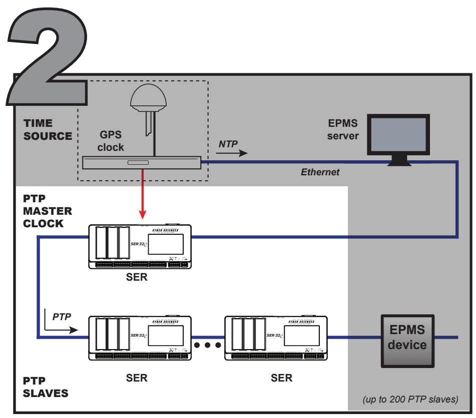
PTP (Precision Time Protocol defined in IEEE 1588) takes advantage of hardware-assisted timestamping to achieve sub-millisecond time synchronization over an Ethernet network. Cyber Sciences offers simple, scalable system architectures using PTP as the means to distribute a precise time reference to all devices that support PTP. CyTime™ Sequence of Event Recorders accept a variety of time-source options, and sync with each other automatically over Ethernet, using PTP. In addition, an SER can serve as a "PTP time sync hub" for devices that do not yet support PTP.

Simple, building-block options are shown below. The first CyTime SER accepts a time reference signal (such as IRIG-B or DCF77), then serves as PTP master clock for all other SERs as well as other devices which support PTP. For a device that does not support PTP, a nearby SER outputs the protocol needed (e.g., 1per10) effectively making this device "PTP-enabled" as well.



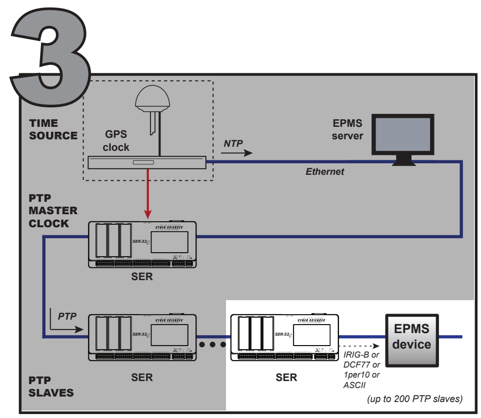
Choose a Time Source

Set the first SER's time from a web browser, EPMS software or NTP server. Optionally, add a GPS antenna/receiver to provide an external time reference traceable to UTC (Coordinated Universal Time), to compare data from other sites or organizations (e.g., electric utilities).



Sync all SERs with Each Other (PTP)

Configure the first SER to output PTP (PTP grandmaster clock); all other SERs on the same Ethernet network sync with each other automatically (within 100 µsec). No special Ethernet switches. No additional setup. Simple, affordable, scalable.



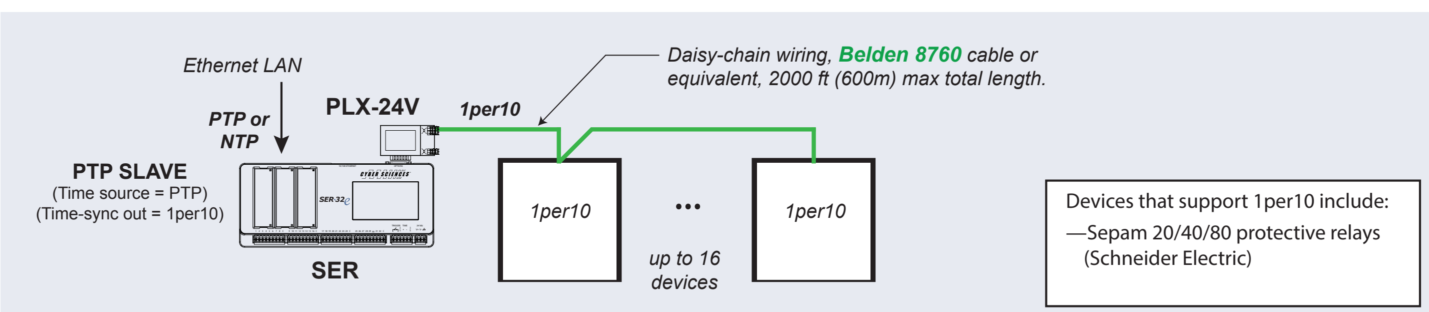
Sync Other EPMS Devices

Sync SERs with other EPMS devices using PTP over Ethernet, all within 100 µsec. No PTP? No problem! For devices that do not yet support PTP, a CyTime SER (PTP slave) can serve as a "time-sync hub" to output the legacy protocol needed (IRIG-B, DCF77, ASCII, or 1per10).

SYNCHRONIZING SEPAM RELAYS (via 1per10)

Time-sync Output: 1per10

The PTP Legacy Interface PLX-24V is used to output 1per10 (at 24 Vdc). The 1per10 output is set via the SER Time Setup web page. 1per10 is used by Sepam 20/40/80 protective relays from Schneider Electric.



EPMS SYSTEM EXAMPLE (Sync Sepam from STR-100)

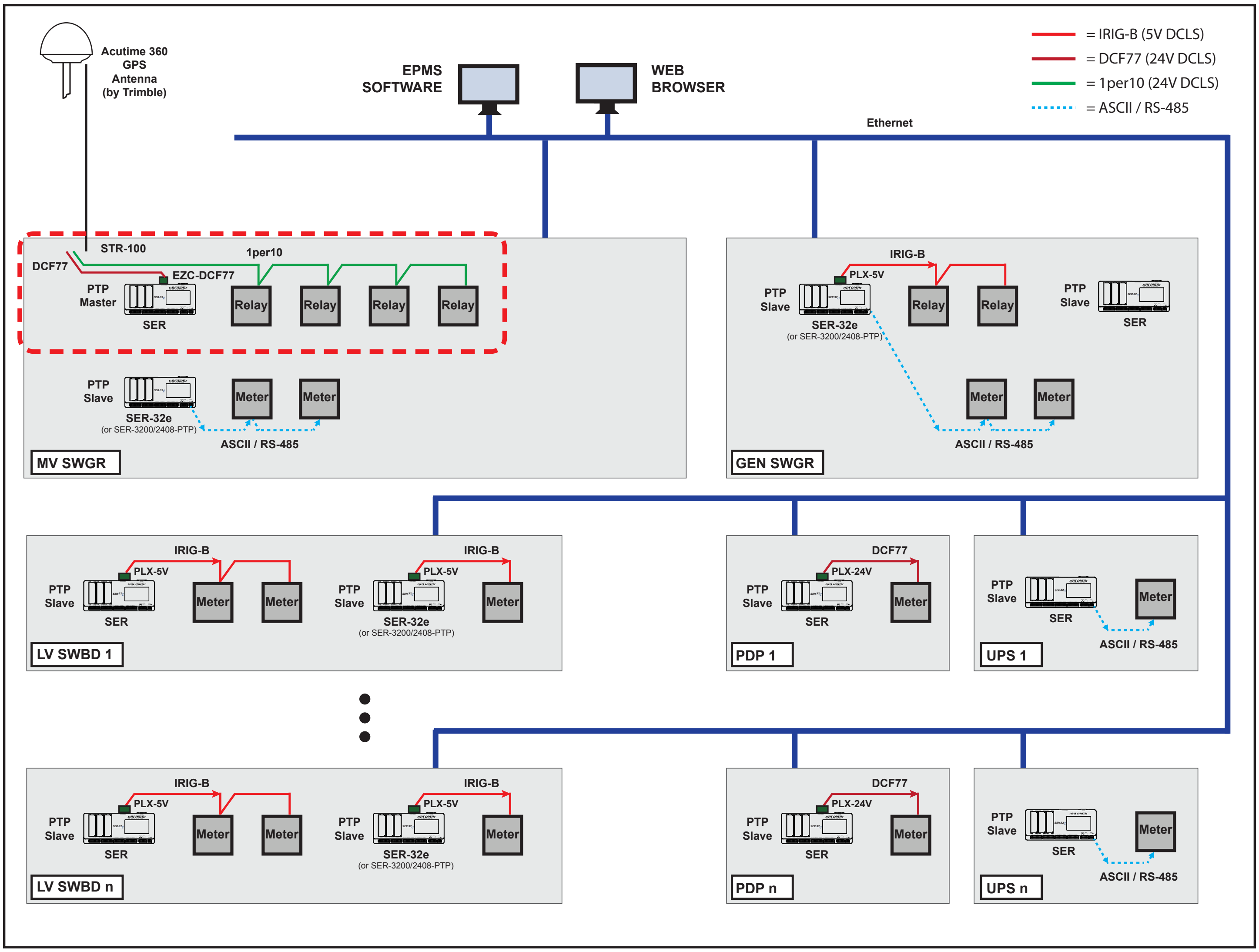
An EPMS (Electrical Power Management System) example is shown below that uses PTP for time synchronization over Ethernet, and other protocols as needed.

Time Source. An STR-100 Satellite Time Reference outputs 1per10 to the Sepam protective relays. The STR-100 industrial-grade specs allow it to be mounted directly into the MV switchgear, typically in an instrument compartment. The STR-100 accepts a GPS input from a Trimble Acutime 360 smart antenna.

The STR-100 also outputs a DCF77 time signal to one or more CyTime SERs. This provides flexibility to configure one or more SERs as a standby PTP master clock for redundancy if desired.

Time Distribution. The first SER serves as PTP grandmaster for all other CyTime SERs (PTP slaves), and so all SERs are synchronized automatically, within 100 µsec.

Time Conversion. Time sync of other EPMS devices (via IRIG-B, DCF77 or ASCII) are shown for illustration purposes.



EPMS SYSTEM EXAMPLE—High-def time-sync over Ethernet using PTP; STR-100 outputs DCF77 to first SER, 1per10 to Sepam protective relays

EPMS SYSTEM EXAMPLE (Sync first SER via IRIG-B, relays via 1per10)

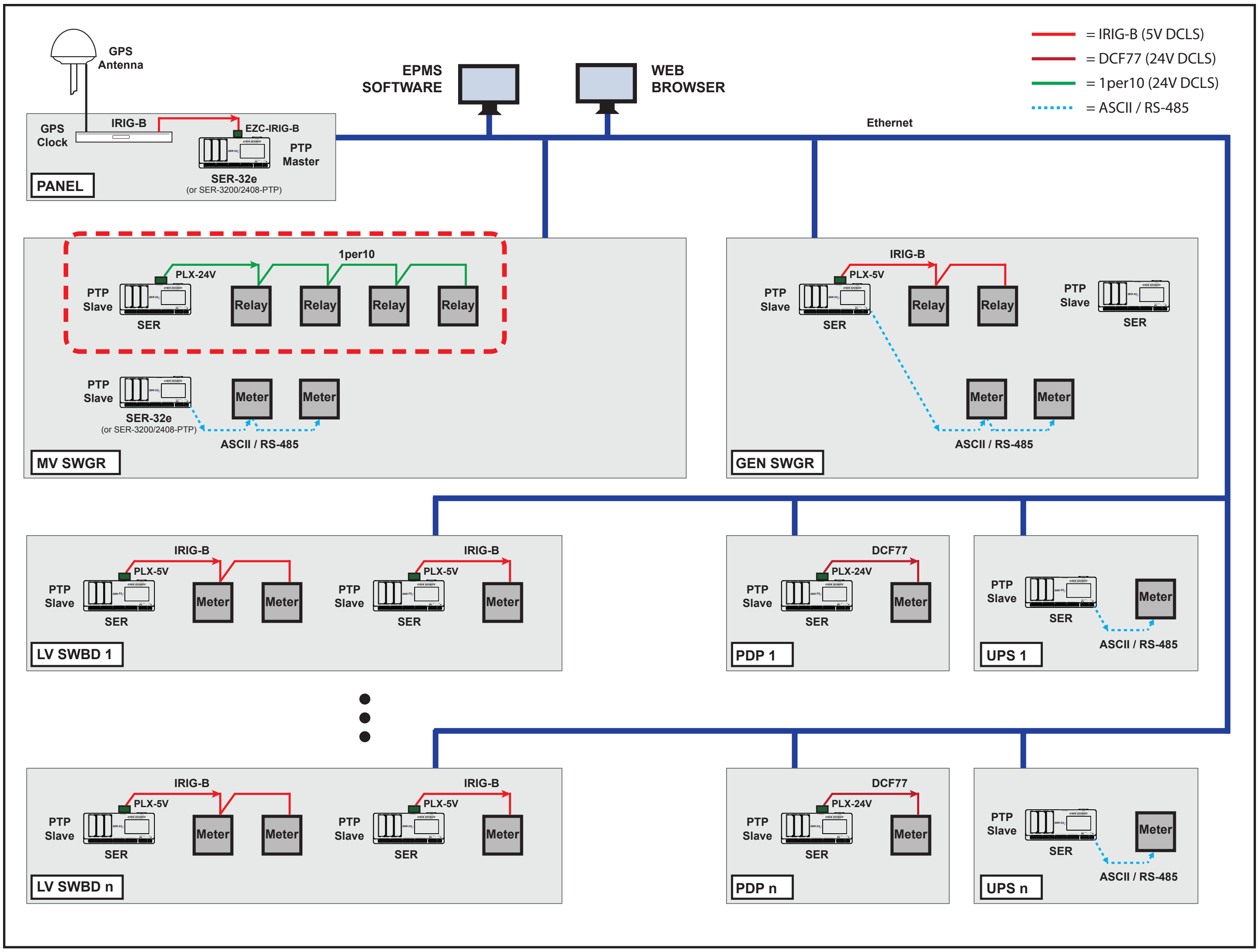
The next example uses a GPS clock as time source (IRIG-B) but the protective relays in the MV switchgear require 1per10 protocol (Sepam 20/40/80 relays).

Time Source. The first CyTime SER (PTP master) is located in the same panel as the GPS clock and accepts IRIG-B as its precision time source.

Time Distribution (PTP). The first SER serves as PTP grandmaster for all other CyTime SERs (PTP slaves), synchronized within 100 µsec of each other.

Time Conversion. Conveniently, the CyTime SER located in the MV switchgear (PTP slave) outputs 1per10 to the protective relays. Redundant cabling between the GPS clock's enclosure and the MV switchgear is avoided. This is especially crucial if the MV switchgear is outdoors or in a different building than the control panel.

The examples for time sync of other EPMS devices (via IRIG-B, DCF77 or ASCII) are the same as in the previous example.



EPMS SYSTEM EXAMPLE—High-def time-sync over Ethernet using PTP; first SER is in same panel as GPS clock (IRIG-B time source); relays use 1per10

REFERENCES

References

[1] Sepam Series 20 instruction bulletin (typical of other models). Document number PCRED301005. Schneider Electric.

[2] Kennedy, Robert A., P.E., "GPS Time Synchronization: How precision timing and sequence of events recording will make the Smart Grid even smarter," *Electrical Construction & Maintenance (EC&M)* magazine, August 19, 2011, pp. 18-20.

http://ecmweb.com/computers-amp-software/gps-time-synchronization

[3] Brown, PE, Bill, and Mark Kozlowski, "Power System Event Reconstruction Technologies for Modern Data Centers," Square D Critical Power Competency Center. Aug. 2006.

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