

## SER—SEQUENCE OF EVENTS RECORDER GUIDE SPECIFICATION

All or part of this text may be copied and inserted into a project specification, as desired. Sequence of Events Recording (SER) is typically part of CSI Section 26 09 13—Electrical Power Monitoring System (EPMS). As instrumentation, Sequence of Events Recorders may also be referenced within various sections of Section 26 for Medium and Low Voltage power distribution equipment.

### 1. SYSTEM DESCRIPTION

A **Sequence of Events Recording (SER) system** provides a system-wide, computerized event log with a list of all events, ordered and categorized by various attributes, such as timestamp, equipment/circuit name, event type, state change, and time-quality indicator. The SER system enables “root-cause analysis” to identify potential problems before they lead to an outage—or to answer the question “what happened and when?” to minimize downtime if an event does occur. In addition, SER data enables other diagnostics tools, such as measurement of circuit breaker operating count and operating times to compare with benchmarks for preventative maintenance and to support arc flash safety.

SER units shall be equipped with “high-speed” (1 msec resolution, +/- 0.5 msec accuracy) digital inputs for monitoring and recording all state changes (OFF-to-ON and ON-to-OFF), including the following:

- Breaker status: OPEN (via “a” aux. contact, normally-open)
- Breaker status: CLOSED (via “b” aux. contact, normally-closed, redundant to ensure positive indication)
- Breaker trip: TRIPPED (via relay “trip” or breaker “bell alarm” contact)
- Drawout breaker position: Racked OUT/IN (via cell switch, or TOC)
- Electrically-operated breaker OPEN/CLOSE command indication (via switch contacts, allows measurement of operating time)
- Differential relay, ground fault, undervoltage, overvoltage, reverse power, sync check (normal, alarm/tripped), TVSS status
- Auto-transfer status (source1, source2, test)
- UPS switching status (normal, static bypass, maintenance bypass)
- Other alarm conditions (see drawings for monitored points)

Provide one SER at locations that include an advanced Power Quality Meter (PQM) and connect the SER’s trigger output to the PQM to trigger waveform capture with any event. Provide additional SERs as required to monitor status points as shown on the drawings.

### 2. PRECISION TIME SYNCHRONIZATION

**Precision Time Synchronization** shall be provided as shown on the drawings to synchronize all devices in the EPMS accurate to within 100 microseconds of each other sufficient to provide time-stamping of events with 1-msec resolution. The EPMS supplier shall provide the design of the precision time synchronization system as part of the EPMS.

- Precision Time Protocol (PTP).** Precision time synchronization shall be accomplished using PTP (defined by IEEE 1588) over the Ethernet network enabled by CyTime™ Sequence of Events Recorders from Cyber Sciences, Inc., or approved equal.
- PTP Profile.** The PTP precision time synchronization over Ethernet shall be capable of providing the specified accuracy without the need for IEEE 1588-compliant network equipment required for higher accuracy systems. Devices shall support the PTP Profile (based on End-to-End Default Profile defined in IEEE 1588, Annex J) to achieve the specified performance and scalability.
- Precision Time Reference.** The first SER shall accept its time source via IRIG-B or DCF77 (from a GPS receiver/clock) or via NTP or Modbus TCP over Ethernet. This SER shall in turn serve as PTP grandmaster for all other CyTime SERs and other PTP-compatible devices, with automatic synchronization of PTP slaves to within 100 microseconds. A minimum of 200 PTP slaves shall be supported by any device serving as PTP grandmaster.
- Legacy Time Protocol Support.** Devices not capable of supporting PTP directly shall be synchronized to the same time reference using the appropriate PTP Legacy Interface to the SER, using the legacy time protocol supported by the device (Unmodulated IRIG-B, DCF77, 1per10 or ASCII/RS-485).

### 3. SEQUENCE OF EVENTS RECORDERS (SER)

**Sequence of Events Recorders** shall be CyTime™ model SER-32e with 32 digital inputs in base configuration; and accommodate up to two expansion modules supporting 8 digital inputs or 8 relay outputs within each module from Cyber Sciences, Inc., or approved equal. The EPMS supplier shall program each SER with actual equipment and channel names and state descriptions for display on the embedded web pages. Submit names, descriptions, and other information for approval before configuring the SERs.

- A. **Event Recording.** The Event Recorder shall be equipped with “high-speed” (1-msec resolution, +/- 0.5 msec accuracy) digital inputs for up to 48 channels to monitor and record all state changes (OFF-to-ON and ON-to-OFF). To ensure reliable operation and avoid over-sensitive, “nuisance” event recording, each input channel shall be individually configurable as follows:
  - 1. Filter (minimum time delay to avoid false events caused by noise)
  - 2. Debounce (temporarily disable event recording following an event, to prevent generation of multiple event records for a single state change)
  - 3. Chatter (max. number of events for a given input channel, to avoid filling memory with erroneous events associated with a faulty input signal)
  - 4. Scan Status (0 = disabled, 1 = enabled)
  - 5. Channel Description (32 characters)
  - 6. OFF-state Description (16 characters)
  - 7. ON-state Description (16 characters)
  - 8. Inverted (0 = normal, 1 = inverted—reports status opposite the sensed state)
  - 9. Trigger Output (0 = disabled, 1 = enabled)
- B. **Event Log.** The Event Recorder shall monitor the status of all input/output channels and record up to 8192 events in non-volatile memory, accessible from multiple masters. Each event record shall contain descriptive information as follows:
  - 1. Date/time stamp (1-msec resolution)
  - 2. Channel name
  - 3. Event type
  - 4. Input/output status
  - 5. Time quality
  - 6. Unique sequence number
  - 7. Delta time between events
- C. **Relay Outputs.** The Event Recorder [model SER-32e] shall have two expansion modules capable of supporting eight (8) relay outputs per module, controllable remotely (open/close) over an Ethernet network using Modbus TCP.
- D. **Discrete Trigger Output.** The Event Recorder shall have a discrete output, configurable to trigger an action coincident with an event, such as waveform capture (WFC) by a compatible power meter.
- E. **Data Logs for EPSS Test-Compliance Reports.** The Event Recorder shall have sixteen (16) configurable data logs with group assignments to facilitate reporting of Emergency Power Supply System (EPSS) testing. When any group member (input or output) changes state, all members’ states are recorded.
- F. **Operations Counters.** The Event Recorder shall maintain counters for each channel to count all transitions (OFF-to-ON and ON-to-OFF), as well as date/time of last reset, individually per channel.
- G. **Ethernet Network Communications.** The Event Recorder shall support Ethernet network communications using Modbus TCP and embedded web server. The device shall automatically sense network operating parameters, such as network speed (10/100 Mbps) and wiring polarity. The number of simultaneous TCP connections shall be 44, including 32 reserved for Modbus TCP sockets. Additionally, RESTful API support shall be provided as a secure channel to access data from Event Recorders.
- H. **Web Interface.** The Event Recorder shall feature an embedded web server to allow monitoring and setup over an Ethernet network using a standard web browser. The following functionality shall be provided via the web interface, over a network:
  - 1. Status Monitoring page shall display ON/OFF status of each input (and output).

2. Events Monitoring page shall display event log, with sortable columns for date/time, channel, type, status, time quality, delta time (calculated time between events) and unique event sequence number.
  3. Data web page shall display all counters and last-reset date/times for each channel. A separate Resets web page allows counters to be reset individually or all at once.
  4. Test page shall provide a means for performing a simulation test to override status of inputs to test application software.
  5. Setup pages shall allow the user to change setup parameters and store them in device non-volatile memory.
  6. Diagnostics page shall provide device information and statistics to aid analysis and troubleshooting.
- I. **Time Source (Time IN).** The Event Recorder shall accept a precision time reference signal from a Global Positioning System (GPS) receiver or other device as follows:
1. PTP (per IEEE 1588) (E2E Default Profile per IEEE 1588, Annex J).
  2. NTP (Network Time Protocol, version 4).
  3. IRIG-B time code (Unmodulated, 5Vdc nominal DCLS, accepts codes B004 through B007).
  4. DCF77 precision time reference (24 Vdc nominal).
  5. Inter-device, RS-485 multi-point time signal from another SER (master or slave).
  6. SNTP (from NTP network time server). Primary and secondary NTP servers can be specified.
  7. Modbus TCP (periodic update by supervisory software, over the network)
- J. **Time Sync Master (Time OUT).** The Event Recorder shall be capable of serving as a time sync master:
1. **PTP grandmaster.** Outputs PTP using Simple PTP Profile (E2E Default Profile per IEEE 1588, Annex J).
  2. **PTP Legacy Interface.** When time source is PTP, the SER shall output one of the following legacy protocols:
    - a. IRIG-B (Unmodulated, 5V DCLS). Uses PLX-5V wiring accessory.
    - b. IRIG-B (distributed at 24 Vdc, and then stepped down to 5 Vdc): PLX-24V to STR-IDM IRIG-B Distribution Module.
    - c. DCF77 (24V DCLS). Uses PLX-24V wiring accessory.
    - d. 1per10 (One pulse every ten seconds, 24 Vdc). Uses PLX-24V wiring accessory.
    - e. ASCII/RS-485 (ASCII + Quality time-code over RS-485). Uses SER native RS-485 port.
- K. **Local Display/Keypad.** The Event Recorder shall have a backlit LCD display and keypad or touchscreen to display key data to facilitate commissioning. Displayed items shall include status of inputs/outputs, time sync, current date/time, and device settings. Local setup of Ethernet communications shall also be supported.
- L. **DB15 to Screw-terminal Adapter.** As an option to facilitate wiring of the precision time input and output, an adapter shall be provided to connect to the Event Recorder's DB15 connector and offer a screw-type terminal to facilitate wiring and a diagnostics LED to indicate the presence (or absence) of a valid IRIG-B or DCF77 signal, to assist in commissioning.
- M. **DIN-rail Mounting.** The Event Recorder shall be designed for standard DIN-rail mounting (EN 50022, 35 mm x 15 mm).
- N. **Multiple Masters.** The Event Recorder shall be capable of operating with multiple masters. At least 32 simultaneous Modbus TCP sockets shall be supported. In addition, multiple, secure web browsing sessions (HTTPS) shall be possible.
- O. **Regulatory Compliance.** The Event Recorder shall be tested to applicable standards as follows:
1. UL-Listed per component requirements for UL-508, NRAQ-cULus (UL 61010-1, UL 61010-2-201).
  2. FCC compliance: FCC Part 15 Subpart B, Class A Digital Device, Radiated Emissions.
  3. CE mark (EN 61010-1, EN 61010-2-201)
  4. RoHS-compliant, Lead-free, and Halogen-free. Compliant with California Proposition 65 and Conflict Minerals requirements. (Environmental and sustainability.)
  5. The Sequence of Events Recorder shall be designed and manufactured in the USA.
- P. **Technical Specifications.** The Event Recorder shall meet or exceed the following:

1. Inputs. Rated for 24Vdc.
2. Outputs. Rated for 24Vdc, 500mA to 1A.
3. Control power. Nominal rating of 24Vdc, 7VA burden.
4. Operating temperature. -25C to +70C.

END OF SECTION