SER – SEQUENCE OF EVENTS RECORDING

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SER – SEQUENCE OF EVENTS RECORDING

PART 1  GENERAL

1.01 SECTION INCLUDES
A. This section describes requirements for Sequence of Events Recorder. The Sequence of Events Recorder is a system that gathers hardware and software events from equipment and stores the data into a database for viewing and analysis. The system is useful for trouble shooting problems that may occur at a complex or campus. The goal of SER is to have a system-wide, computerized event log, that presents a list of events, ordered and categorized by various attributes, such as time stamp, priority, name of equipment being monitored, etc.

1.02 SUBMITTALS
A. Shop Drawings. The drawings shall be provided on a job-by-job basis.
B. Product Data. Catalog sheets shall indicate function and data performance.
C. Instruction Bulletins. Instruction bulletins shall provide technical information on the installation, use, and operation of the Sequence of Events software module.

1.03 RELATED SECTIONS
A. N/A.

1.04 OVERVIEW / SYSTEM DESCRIPTION
A. System-wide Faults with Electrical Power Systems. Sequential Events Recording (SER) Systems have long been used by electrical utility companies to facilitate a quick “root-cause-analysis”. A “root-cause-analysis” is a post-mortem analysis of a system-wide fault in an electrical power system. Electrical outages may induce a cascade of tripped circuit breakers and tripped protective relays at various points in an electrical power system. When an electrical outage occurs, it may take many hours to determine the exact cause of the fault. Or, it may even be impossible to to find the exact cause. The electrical power system may not even be put back online until the cause of the fault is determined. The amount of time taken to determine the cause and location of the fault is compounded by several factors:

   - The physical size of a campus or complex where the system resides
   - The amount of low, medium, or high voltage equipment in the system
   - The availability and quality of procedures, describing how to bring the system back online

All of these factors, listed above, can lengthen the time to identify the cause of the fault.

B. One-millisecond Time Stamping for Root-cause-analysis. Time stamping events is of little use in a “root-cause-analysis”, if it fails to truly record the actual sequence of events with millisecond accuracy. Many events can occur within the same second, but their occurrence may differ when compared in milliseconds. Given that electrical faults travel as fast as 186,000 miles per second, one-millisecond time-stamping is necessary, to make a sequential events time stamping system useful. The status from each piece of critical power distribution equipment, such as a circuit breaker or a protective relay, should be hardwired into a sequential events time stamping system, using global positioning satellite system (GPSS) clocks to generate the time stamps, with an accuracy of one millisecond.

C. Use of Deterministic Clock Signals to Resolve Drifting Clock Time. Electronic components, transmitting deterministic clock signals, such as IRIG-B, can provide accurate time stamps, with a
fidelity of one millisecond. Components, such as automated monitor devices and meters, with
deterministic clocks, can eliminates or can greatly reduce the problem of drifting clock times.

D. **System Fidelity.** The following specifications shall be met to maintain the fidelity of an SER
system.
   1. Clocks with no more than 1 millisecond resolution, including time drift
   2. Equipment to provide adequate identification of equipment or components being monitored
   3. Equipment to provide adequate descriptions of events
   4. A single SER system data log to store events

E. **Hardware.** The hardware is to be an integrated collection of devices and components that record,
receive, and capture two-state events, and synchronized time stamps, with an accuracy of one
milliseconds. The hardware may include …
   - Antennas
   - Electronic Clocks
   - Electronic Clock Communication Modules
   - Clock Signal Hardware
   - Rack Mounted Input Cards
   - Enclosures
   - Power and Circuit Monitors
   - Multifunctional Protective Relays
   - Racks
   - Power Supplies
   - Solid State Speciality Trip Indication Relays
   - Data Network Components
   - Computer Hardware

F. **Software.** The software is to provide a log of events, viewable from a web-base client. SER
software is to limit the access and viewing of logged events, by using a security scheme. The
presentation of events may be sorted and filtered based upon event attributes. The software is to
be a real-time service, collecting SER events from a data network. It is to store the events in a
system-dedicated database. Each event, captured by the software, is to have a time stamp, having
an accuracy of one millisecond.

**PART 2 PRODUCTS**
2.01 **SER HARDWARE COMPONENTS**
A. The SER system shall have electronic, automated monitoring devices and meters to monitor and
collect the event statuses of low, medium, and high voltage equipment in a critical power
distribution system. The electronic, automated monitor devices and meters shall have the
following:
   1. Synchronized clocks with drifts of less than one millisecond. (The clocks may have
      specialized cards with the appropriate hardware/firmware to emit deterministic clock signals,
      such as IRIG-B, DCF-77, and 1per10.)
   2. Onboard data logs for storing the event statuses
   3. Modbus RTU or Modbus/TCP interface for communication with an SER software system.
   4. Discrete inputs, sending incoming DC (Direct Current) electrical signals, representing discrete
      statuses of voltage equipment. Components shall sample and emit the discrete states of
voltage equipment as DC electrical signals to the SER electronic, automated monitoring devices and meters.

B. For medium voltage circuit breakers in an SER system, the SER monitor devices shall make accessible the following medium voltage breaker statuses with time stamp (1 ms accuracy) to the SER software system, using a Modbus RTU or Modbus/TCP interface and onboard data logs:
   1. Trip coil relay (interfaced via trip indication relay)
   2. Operator open indication
   3. Operator close indication
   4. Trip indication

C. For medium voltage protected relays in an SER system, the SER monitor devices shall make accessible the ANSI numbers and event descriptors with time stamp (1 ms accuracy) to the SER software system, using a Modbus RTU or Modbus/TCP interface and onboard data logs.

D. For multifunction electronic relays in an SER system, the SER monitor devices shall make accessible ANSI function codes or events with time stamp (1 ms accuracy) to the SER software system, using a Modbus RTU or Modbus/TCP interface and onboard data logs.

E. Medium voltage circuit breakers in an SER system shall have E-Max brand trip indication relays (TIR) hardwired in series with the trip coils. Each solid-state relay shall be inserted between the MV protective relay and the trip coil in each medium voltage breaker. The output contacts on the TIR shall be hardwired to an electronic, automated monitoring device or meter (such as a PowerLogic® Circuit Monitor 4000 or a Telemecanique Quantum® processor with a Monaghan SER x53 Card. Time stamps for medium voltage breakers shall be for the beginning and completion of breaker trips. The TIR shall energize when the shunt trip coil energizes. The TIR shall release when the shunt trip coil de-energizes. The electronic, automated monitor device or meter shall make accessible the breaker trip information with time stamps (1 ms accuracy) to the SER software system, using a Modbus RTU or Modbus/TCP interface and onboard data logs. The electronic, automated monitor device or meter shall access the circuit breaker statuses via “a” and/or “b” contacts.

F. For an electronic, automated monitoring device having osillographical capability, the time stamps (1ms accuracy) of the osillographical functions shall match the events that invoked the waveform. PowerLogic® Circuit Monitor 4000 is an example of an electronic, automated monitoring device having osillographical capability.

G. Low-voltage circuit breakers in an SER system shall be hardwired via bell alarm and auxiliary contacts.

H. SER monitor devices shall make accessible the following low-voltage breaker statuses with time stamp (1 ms accuracy) to the SER software system, using a Modbus RTU or Modbus/TCP interface and onboard data logs:
   1. Open indication
   2. Close indication

**2.02 SER SOFTWARE**

A. Shall run as a real-time service, automatically initiated by a supporting electronic, automated processing system or computer system.

B. Shall support Modbus/RTU or Modbus/TPC communications to access logged events from SER monitor devices.

C. Shall have a web-based client for setup and viewing.

D. Shall have its own dedicate, stand-alone database, such that it is used for storing system configuration data, information about the monitoring devices, event logs, and system diagnostic data.
E. Shall recognize and communicate with electronic, automated monitoring devices or meters that monitor, collect, and log event statuses from equipment, as specified in section 2.01, “SER Hardware Components”. The following are some examples of SER monitoring devices that the SER software system may communicate with:
1. PowerLogic® Circuit Monitor 4000
2. General Electric™ Multilin® 489, 745, & 750/760
3. Monaghan Protime
4. Monaghan SER x53 Card in a Telemecanique™ Quantum® processor
5. Monaghan 984 SER Card in a Telemecanique™ Quantum® processor

F. Shall implement a software feature for assigning administrative and user groups in relation to access rights of system setup and maintenance and data viewing and printing.

G. Shall not poll devices if one of the following conditions exist:
1. SER device out-of-service
2. Communication Loss

H. Shall collect, at a minimum, 350 events per minute, from multiple devices:

I. Shall have an event log for users to view events, logged by various SER-recognizable monitor devices.

J. Shall have the following event attributes for viewing in an event log:
1. Data/Time Stamp w/1ms Resolution
2. Quality of Date/Time Stamp
3. Event Description
4. State/Value
5. Priority
6. Name of Equipment or Component Being Monitored (such as circuit breaker or relay switch)
7. Event Locality (Location of Monitored Equipment or Component)

K. Shall be able to sort events in an event log, using the following event attributes as sorting keys:
1. Data/Time Stamp w/1ms Resolution
2. Quality of Date/Time Stamp
3. Priority
4. Event Description
5. State/Value
6. Name of Equipment or Component Being Monitored (such as circuit breaker or relay switch)
7. Event Locality (Location of Monitored Equipment or Component)

L. Shall be able to filter events in an event log, using the following event attributes:
1. Time Range Using Date/Time Stamps
2. Quality of Date/Time Stamp
3. Priority
4. Event Description
5. State/Value
6. Name of Equipment or Component Being Monitored (such as circuit breaker or relay switch)
7. Event Locality (Location of Monitored Equipment or Component)

M. Shall print a report of any filtered or sorted events from an event log, both browser and formatted print.

N. Shall have a system diagnostic log for users to view device progress points, events, and errors relating to the health and status of the SER system and its monitoring devices.

O. Shall have the following system diagnostic message attributes for viewing in a system diagnostic log:
1. Date/Time Stamp with 1 ms Resolution
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2. Message Type – Progress Point, System Event, or Error
3. Message
P. Shall be able to sort system diagnostic messages in a system diagnostic log by date and time.
Q. Shall be able to filter system diagnostic messages in a system diagnostic log by the following attributes:
   1. Time Range with Using Data/Time Stamps
   2. Message Type – Progress Point, System Event, or Error
R. Shall print a report of any filtered or sorted system diagnostic messages from a system diagnostic log, both browser and formatted print.
S. Shall have upgrades that are backward compatible.
T. Shall have an export utility to upgrade older versions of the SER system.
U. Shall have instruction bulletins to guide the user in the installation and operation of SER.
V. Shall have graphical user interface (GUI) screens, with Help Context, providing descriptive information to the user on installing or operating SER.

PART 3 EXECUTION
3.01 INSTALLATION OF SER
A. The contractor, as designated by the customer, shall wire and mount all SER monitoring devices according to the drawings and literature, as provided by the customer and the manufacturers.
B. The contractor, as designated by the customer, shall setup the SER software system, using the manufacturer’s instruction bulletins for assistance and as a guide.
C. The contractor shall test the SER hardware and software system to ensure that it is fully functional and operational. Successful test shall be where the user can view the event logs of all equipment or components being monitor and can sort, filter, and print the event logs.

END OF SECTION