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# PRC-002-2 Compliance Using Bitronics® 70 Series Recorders

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## Introduction

The North American Electric Reliability Council (NERC) has defined standards for disturbance monitoring and reporting requirements for transmission and generation systems. The primary standard is the recently approved PRC-002-2 which replaced PRC-002-1 and PRC-018-1. PRC-002-2 establishes requirements for installation of Disturbance Monitoring Equipment (DME) for the purpose of obtaining data to facilitate analysis of Bulk Electric System (BES) disturbances.

DME is required at specific places within the generation and transmission infrastructure and must be capable of monitoring and recording system data pertaining to a wide variety of system or equipment disturbances. DME must provide fault recording (FR), dynamic disturbance recording (DDR), and sequence of event recording (SER). Bitronics 70 Series Monitoring and Recording IEDs (intelligent electronic devices) are compliant with all three recording requirements for DME for the PRC-002-2 standard.

## NERC PRC-002-2 and the Need for Disturbance Monitoring Equipment (DME)

### Key Elements of the Standard

PRC-002-2 requires that transmission owners identify BES buses for which SER and FR data is required per a methodology defined in PRC-002-2 Attachment 1 and notify owners of BES connected elements to those buses that they require SER and/or FR data. They must maintain this list and re-evaluate all BES buses at least once every five calendar years, notifying effected owners of the outcome of the evaluations. Each Responsible Entity must identify BES Elements for which DDR data is required as defined in R5 of the standard. They must maintain this list and re-evaluate all BES elements at least once every five calendar years, notifying effected owners of the outcome of the evaluations.

The requirements and the M87x compliance with those requirements for all three recording modes are summarized on the following tables:

### PRC-002-2 Requirement for SER

Requirement	Reference	Compliance	Notes
Each transmission and generator owner shall have SER data for circuit breaker position (open/close) for each circuit breaker effected under the standard (identified under R1).	R1, R2	✓	Up to 56 without Ethernet and 48 with Ethernet digital inputs per line using M871.

## PRC-002-2 Requirement for Fault Recording

Requirement	Reference	Compliance	Notes
Record phase-to-neutral voltage for each phase of each specified BES bus on monitored line or bus or on Generator Step-up (GSU) transformers.	R1, R3.1	✓	Each M87x can record all three phases on up to two 3-phase lines.
Record each phase current and the residual or neutral current for the following BES elements: <ul style="list-style-type: none"> <li>Transformers with a low-side operating voltage of 100kV or above</li> <li>Transmission lines</li> </ul>	R1, R3.2	✓	Each M871 measures 3-phase currents plus neutral, each M872 measures two sets of 3-phase currents.
FR data as specified in R3 that provides a single record or multiple records that include pre-trigger record length of at least two cycles and a total record length of at least 30 cycles for the same trigger point, or at least two cycles of pre-trigger data, the first three cycles of post-trigger data, and the final cycle of the fault as seen by the fault recorder.	R4.1	+	Pre and post-trigger record configurable up to 2000 cycles.
Record at a minimum rate of 16 samples per cycle.	R4.2	+	128 samples per cycle typical, 256 samples per cycle max.
Have trigger settings for at least the following: <ul style="list-style-type: none"> <li>Neutral (residual overcurrent)</li> <li>Phase undervoltage or overcurrent</li> </ul>	R4.3	+	Can trigger on a > or < threshold on any measured value.

## PRC-002-2 Requirement for DDR

Requirement	Reference	Compliance	Notes
Each transmission owner shall have DDR data to determine the following electrical quantities for each BES element it owns per R5: <ul style="list-style-type: none"> <li>One phase-to-neutral or positive sequence voltage.</li> <li>The phase current for the same voltage identified above or the positive sequence current.</li> <li>Real power and reactive power flows expressed on a three phase basis corresponding to all circuits where currents are required.</li> <li>Frequency for any one of the voltages identified above.</li> </ul>	R5, R6, R6.1 - R6.4	✓	Each IED can record all three phases on a line as well as real and reactive power and frequency. M871 can record neutral current. M872 can record two 3-phase lines. Positive and negative sequence components for voltages and currents can be recorded as well.
Each generation owner shall have DDR data to determine the following electrical quantities for each BES element it owns per R5: <ul style="list-style-type: none"> <li>One phase-to-neutral, phase-to-phase, or positive sequence voltage at either the generator step-up transformer (GSU) high-side or low-side voltage level.</li> <li>The phase current for the same voltage identified above, phase current(s) for any phase-to-phase voltages, or the positive sequence current.</li> <li>Real power and reactive power flows expressed on a three phase basis corresponding to all circuits where currents are required.</li> <li>Frequency for any one of the voltages identified above.</li> </ul>	R5, R7, R7.1 - R7.4	✓	Each IED can record all three phases on a line as well as real and reactive power and frequency. M871 can record neutral current, M872 can record two 3-phase lines. Positive and negative sequence components for voltages and currents can be recorded as well.

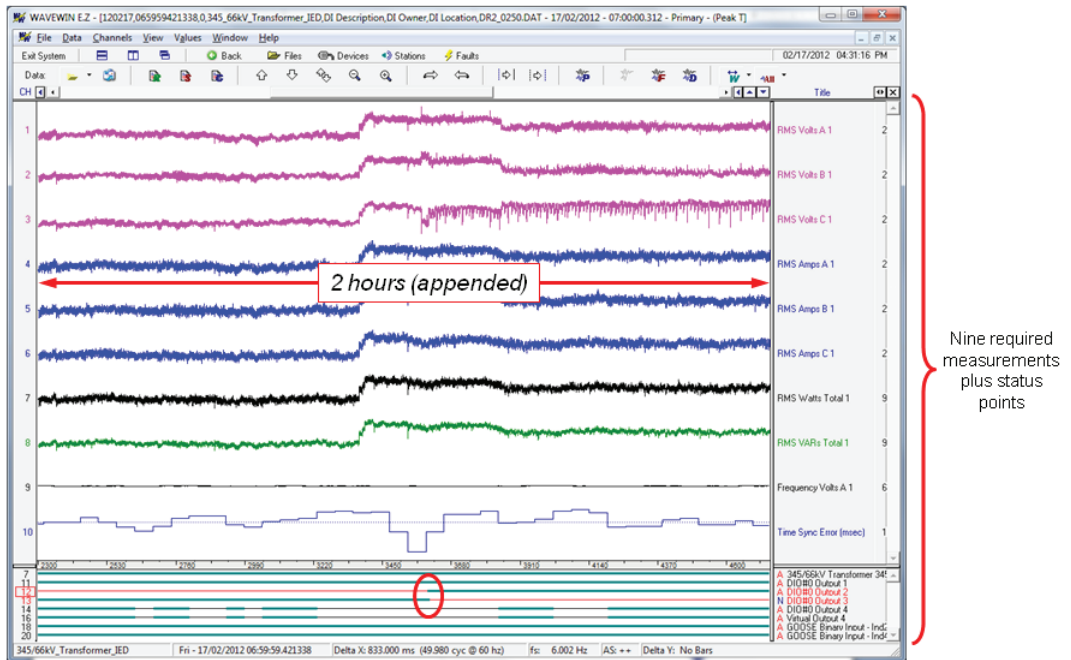
Each transmission and generator owner responsible for DDR data per R5 shall have continuous data recording and storage.	R8	✓	M87x records continuous records using periodic timer triggers. M87x has up to 1GB of non-volatile memory for recording.
Inputs sampling rate of at least 960 samples per second.	R9.1	+	7680 samples per second (60 Hz) used for all RMS calculations.
Output recording rate of electrical quantities of at least 30 times per second	R9.2	✓	Resolution configurable up to 60 times per second.

### PRC-002-2 General Requirements for SER, FR, and DDR

Requirement	Reference	Compliance	Notes
Time synchronize all SER and FR data for relevant BES buses under R1 and DDR data for the BES elements identified under R5 to Coordinated Universal Time (UTC) with or without a local time offset and with device clock accuracy within +/- 2 ms of UTC.	R1, R5, R10	✓	Input Delay Time (from terminals): <100µs; supports IRIG-B, SNTP time synchronization.
Each transmission and generator owner shall provide upon request all SER and FR data for relevant BES buses under R1 and DDR data for the BES elements identified under R5 to the Responsible Entity, Regional Entity or NERC in accordance with the following: <ul style="list-style-type: none"> <li>Data will be retrievable for the period of 10-calendar days, inclusive of the day the data was recorded.</li> <li>Provide this data within 30-calendar days of the request.</li> <li>Provide SER data in ASCII Comma Separated Value (CSV) format per Attachment 2.</li> <li>Provide FR and DDR data in electronic files formatted in conformance with C37.111 (IEEE Standard for Common Format for Transient Data Exchange (COMTRADE), revision C37.111-1999 or later.</li> <li>Data files will be named in conformance with C37.232, IEEE Standard for Common Format for Naming Time Sequence Data Files (COMNAME), revision C37.232-2011 or later.</li> </ul>	R1, R5, R11	✓	M87x has sufficient memory (up to 1GB) to record more than 10 days of DDR, FR and SER records. FR and DDR records are stored in COMTRADE format, and files are named per COMNAME on IED. No off-line conversion is required. The SER data is native on the IED in CSV format.

With a memory option of up to 1GB, there is more than adequate storage to meet the required number of recordings. The M87x offer the ability to record both the time sync status as well as the time sync error for the DDR. The biggest advantage for a 70 Series recorder is as a one-unit-per-line device it can be retrofitted into existing substations much more easily and cost effectively than adding a full-size DFR.

While the first two recording modes are more widely available, DDR function is comparatively novel, more demanding, and generally only available from newer DFRs such as 70 Series.



Two-hour DDR record from M87x

Although some modern protective relays may be able to be configured to provide the SOE points and waveform capture required for PRC-002-2, none provide the combination of continuous recording and memory storage required by DDR.

The recording method of continuous 1 – 2 hour DDR records done in the M87x and the ability to store up to 15 days of records before overwriting offers several advantages:

- Only need to use bandwidth to extract records when requested by the Responsible Entity as opposed to automatically retrieving records that are not of interest or using constantly streaming synchrophasor data
- Easy to find the specific records for the time period of interest so no need to search through long recordings and extract large files

### Why This Matters Now?

Being able to comply with the PRC-002-2 requirements is becoming increasingly important for transmission and generation operators as the time to comply is already at hand.

### Bitronics 70 Series

The 70 Series of IEDs consists of the M87x modular family. The M87x family provides greater flexibility and increased I/O capability in a modular design. With multi-mode recording and ability to make high speed, high accuracy measurements, the M87x provide information necessary to analyze:

- Network faults such as short circuits, underfrequency, over/under voltage, etc.
- Reactions of the protective devices
- Dynamic response of the network
- Long-term trends
- Substation equipment performance
- Sequence of Events time stamped to 1ms



70 Series serves SCADA metering and automation, control, and disturbance recording applications in the substation including PRC-002-2 compliance. The 70 Series IEDs can provide automation where electromechanical relays are still employed or can complement digital relays by providing additional recording capability while providing enterprise-wide access to important event files without jeopardizing the security of the protection system. There is a split-core CT option for the M871 that simplifies retrofit in these applications and removes the need for an outage.

70 Series IEDs provide additional features to reduce installation costs for faster PRC-002-2 compliance including:

- IEDs sized for single or dual line for maximum flexibility and scalability
- Wide-range temperature and universal power supply and wiring
- Flexible mounting
- Configurable ports and protocols
- Split-core CTs that don't require an outage to break into existing 5A circuits



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