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TESLA 3000 DFR/DDR Compliance with NERC PRC-002-RFC-01

This document describes the compliance of TESLA 3000 DFR/DDR recording / monitoring device with the NERC PRC – 002 – RFC-01 standard. The requirements and the compliance are explained as referred to the standard.

Introduction

The TESLA 3000 DFR is a multi-time frame recording system used to monitor electrical power systems at various voltage levels which includes 600V to 69kV (Generation and Distribution), 110kV, 130kV, 200kV, 500kV (Transmission). It can record up to 36 analog channels and 64 digital (status) channels and store up to 1000 recordings. Up to four recorders can be operated as a cooperative group to achieve greater numbers of channels. It can record data simultaneously in three time domains: high speed transient fault (up to 384 samples/ cycle), low speed dynamic swing (up to 30 minutes), and continuous trend (10 second to 1 hour intervals). A wide variety of triggers are available to initiate recording. The recording system consists of a recorder, analog input isolation modules and TESLA Control Panel Windows user interface software. There are various analog input isolation modules available to interface to signal sources. Modules are available to connect to standard signals found in a typical electric power substation including secondary ac voltage and current and low level dc voltage and current signals. These modules can generally be installed up to 4000 ft from the recorder unit, allowing them to be located near the source of the signals being monitored. The TESLA Control Panel Windows user interface software provides tools to configure the recorder, trigger, retrieve and manage records and display real time measured values. TESLA Control Panel also includes RecordGraph, an intuitive graphical record display and analysis software tool. An optional central station program - RecordBase - is available to automatically collect and store records from multiple recorders. RecordBase provides fast network-based access to collected records through distributed RecordBase View desktop clients (refer Figure 1).

Phasor Measurement Unit (PMU) functionality is an optional software product feature in the TESLA. The PMU module can be installed as a field upgrade. The PMU functionality complies with IEEE C37.118 – 2005 [1] . Up to 12 user selectable phasors - as individual phase quantities or three-phase positive, negative or zero sequence phasors or summated

phasors- can be transmitted via Ethernet, Serial port, or Modem at rates up to 60 frames each second. The PMU functionality is designed to work simultaneously with the existing DFR features such as triggering, recording, and trending. This means, simultaneously you can connect to the DFR using the Control Panel software and view Metering, Modify configuration settings, transfer records over Modem and stream PMU data over Ethernet or vice-versa.

Comparison of TESLA 3000 DFR Requirements as per PRC-002-RFC-01

Continuous Recording Capability (CDR) is an additional feature, which is implemented in TESLA 3000 DFR as per NERC's standard PRC-002-01 (PRC-002-RFC-01), PRC-018. The comparison of implementation as per PRC -002-RFC-01 is as follows:

Section R1.2 :

SOE recording equipment shall be capable of determining and recording the time that an input is received to within ¼ of an electrical cycle (or less) of input change of state.

TESLA 3000 DFR exceeds R1.2 since it can determine and record time of inputs with in 2mS (for 60 Hz system), and 2.5mS (for 50Hz system) of input change of state.

Section R1.3:

SOE recording equipment shall have time stamp capability to record seconds to at least three decimal places (i.e. ss.000).

TESLA 3000 DFR exceeds R1.3 since it can time stamp recorded data with 6 decimal places.

Section R2.2

R2.2.1 The three phase to neutral voltages on
R2.2.1.1 the monitored line or "outer" buses for breaker-and a-half bus arrangements, or
R2.2.1.2 the monitored line for ring bus arrangement, or
R2.2.1.3 the monitored bus for other bus arrangements
R2.2.2 The three phase currents and the residual or neutral currents of each monitored line and transformer.

R2.2.3 Polarizing currents, if used
R2.2.4 Frequency
R2.2.5 Megawatts and megavars

TESLA 3000 DFR measures all the phase voltages (A,B,C) and Currents (A,B,C and N if desired), and using these quantities, user can configure all the above channels such as neutral voltage, neutral currents, MW, MVAR, summation (ring bus application), polarizing current etc. More than 200 derived or calculated channels can be configured for analysis and triggering.

Section R2.3

R2.3.1 Fault recording equipment shall record at least two-cycles of pretrigger data.

TESLA 3000 DFR exceeds this requirement and user can configure pre trigger from 1 to 60 cycles

R2.3.2 Fault recording equipment shall record any one of the following:
- **A post trigger record length of at least 50 cycles, or**
- **The first three cycles of an event and the final cycle of an event, using either a single continuous record or multiple triggered records**

TESLA 3000 DFR exceeds this requirement and the user can have up to 900 cycles of post fault recording and the recording can be extended to cover all the triggers up to 1800 cycles.

R2.3.3 Fault recording equipment shall have a minimum recording rate of 16 samples per cycle.

TESLA 3000 DFR exceeds this requirement and the user can configure different sample rates such as 32, 64, 96, 128, 256 (18 channels), and 384 (9 channels) samples per cycle.

R2.3.4 Fault recording equipment triggering parameters shall include one or more of following:
- **negative sequence voltage**
- **negative sequence current**
- **zero sequence current (tertiary or residual)**
- **under voltage**
- **over voltage**
- **over current**

and also one or more of the following:

- **DC trip buses**

- **circuit breaker contact opening**
- **protective relay operation**

TESLA 3000 DFR exceeds this requirement and the user can set the trigger for more than 200 different derived channels including the above stated once as per the standard.

Section R3.3

R3.3.1 Bus Voltage (at least one per voltage level of 200 kV or above at each DDR location)
R3.3.2 Frequency (at least one per DDR location)
R3.3.3 Line Current
R3.3.4 MW and MVAR flows expressed on a three-phase basis (per each monitored line or transformer)

TESLA 3000 DFR exceeds the above requirements.

Section R3.4

R3.4.1 Any new DDRs shall have the capability of continuous recording.

TESLA 3000 DFR meets the above requirement

R3.4.2 Existing DDRs which do not have continuous recording capability shall be triggered according to the following:

R3.4.2.1 DDRs shall be capable of rate-of-change of frequency and rate-of-change of voltage triggers.

R3.4.2.2 Oscillation triggers, if available, shall be set to trigger for low frequency oscillations in 0.1 to 4.0 Hz range.

R3.4.2.3 DDRs shall be capable of recording minimum record lengths of not less than three minutes.

TESLA 3000 DFR meets the above requirement simultaneously with R3.4.1

R3.4.3 Sample data at a rate of at least 960 samples per second and shall record the RMS value of electrical quantities at a rate of at least 6 records per second.

TESLA 3000 DFR exceeds the above requirement. See attached table for number of channels and the retention days (number of days the data can be stored on the TESLA 3000 DFR flash disk memory)

Number of channels *	Sample rate (RMS records per second per channel)						
	6	**10**	**12**	**15**	**20**	**30**	**60**
36	38	22	19	15	11	7	3.8
24	56	33	28	22	16	11	5.5
18	73	44	36	29	22	14	7
12	106	63	53	42	31	21	10
9	136	81	68	54	40	27	13

No. of days the continuous data can be stored on the TESLA 3000 DFR

Sample rate – RMS records per second per channel

6 records per sample is the requirement from NERC and TESLA 3000 DFR can store depending on the number of channels up to 136 days of data

Please contact ERLPhase or visit www.erlphase.com for TESLA 3000 DFR data sheets and other products.