



DPMS-03

REV.1

DISTRIBUTION PROTECTION MATERIAL SPECIFICATION (DIGITAL FAULT RECORDER)

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#	Date	Revision No.	Revised By	Major Revision Description
1	09/08/2020	1	Ibrahim Sohail Qureshi	Additions & Modifications of the below mentioned Clauses 1.General 2.Applicable Codes & Standards 3. Ratings 4. Communication & Interface 5. Software & Security 6. Recording Functions 7. Data Schedule

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1 Scope

This Distribution Protection Material Specification (DPMS) specifies the minimum Technical Requirements for Design, Engineering, Manufacture, Inspection, Testing, and Performance of Fault Recorder intended to be used in the Distribution System of SEC DBU.

2 Cross References

This Distribution Protection Material Specification (DPMS) shall be read in conjunction with the General Specification number 01-SDMS-01 – Latest Revision, titled “General Requirement for all Equipment / Materials, which shall be considered as integral part of this DPMS.

This DPMS shall also be read in conjunction with Purchase Order or Contract Schedule for Project, as applicable.

3 Applicable Codes and Standards

The latest revision / amendments of the following Codes and Standards shall be applicable for the equipment / material covered in this DPMS. In case of conflict, the manufacturer / vendor may propose equipment / material conforming to one group of industry Codes and Standards quoted hereunder without jeopardizing the requirements of this DPMS.

- | | | |
|-----|---------------|---|
| 3.1 | IEC 60050-191 | International Electro-technical Vocabulary – Chapter 191: Dependability and quality of service. |
| 3.2 | IEC 60068-2 | Environmental testing – Part 2-1: Tests – Test A: Cold; Part 2-2: Tests – Test B: Dry heat; Part 2-14: Tests – Test N: Change of Temperature; Part 2-30: Tests – Test Db: Damp heat, cyclic (12 h + 12 h cycle); Part 2-78: Tests – Test Cab: Damp heat, steady state; and Part 3-4: Supporting documentation and guidance – Damp heat tests. |
| 3.3 | IEC 61000-4 | Electromagnetic compatibility (EMC): Testing and measurement techniques - Part 4-2 Electrostatic discharge immunity test; Part 4-3: Radiated, radio-frequency, electromagnetic field immunity test - Edition |

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3.2; Part 4-4: Electrical fast transient/burst immunity test - Edition 3.0; Part 4-5: Surge immunity test - Edition 3.0; Part 4-6: Immunity to conducted disturbances induced by radio-frequency fields - Edition 4.0; Part 4-7: General guide on harmonics and interharmonics measurements and instrumentation for power supply systems and equipment connected thereto - Edition 2; Part 4-8: Power frequency magnetic field immunity test - Edition 2.0; Part 4-10: Damped Oscillatory Magnetic Field Immunity Test - Edition 1.1; Edition 1: 1993 Consolidated with Amendment 1: 2000; Part 4-12: - Oscillatory Waves Immunity Test - Edition 2.0; Part 4-15: - Flickermeter - Functional and design specifications - Edition 2.0; Part 4-16: Test for immunity to conducted, common mode disturbances in the frequency range 0Hz to 150kHz - Edition 1.2; Part 4-17: Ripple on d.c. input power port immunity test - Edition 1.2; Part 4-29: Voltage Dips, Short Interruptions and Voltage Variations on d.c. Input Power Port Immunity Test and Part 4-30: Power quality measurement methods - Edition 2.0 & First Edition

- | | | |
|-----|-----------------|---|
| 3.4 | IEC 60297-3-101 | Mechanical structures for electronic equipment – Dimensions of mechanical structures of the 482.6 mm (19 in) series – Part 3-101: Sub-racks and associated plug-in units. |
| 3.5 | IEC 60529 | Degrees of protection provided by enclosures (IP Code). |
| 3.6 | IEC 60688 | Electrical measuring transducers for converting A.C. and D.C. electrical quantities to analogue or digital signals. |
| 3.7 | IEC 60721-3-3 | Classification of environmental conditions – Part 3-3: Classification of groups of environmental parameters and their severities – Stationary use at weather-protected locations. |
| 3.8 | IEC 61850 | Communication networks and systems for power utility automation - Edition 2. |
| 3.9 | IEC 61508-3 | Functional safety of electrical/ electronic/ programmable electronic safety-related systems – Part 3: Software requirements - Edition 2.0. |

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- 3.10 IEEE C37.231 Recommended Practice for Microprocessor Firmware Control.
- 3.11 IEEE C37.232 Common Format for Naming Time Sequence Data File (COMTRADE).
- 3.12 IEEE C37.111 Measuring Relays and protection equipment – Part 24: Common format for transient data exchange (COMTRADE).

4 Design and Construction Requirement

4.1. General

- 4.1.1 Digital Fault Recorder shall be Numerical, Modular and IED. Future Extensions shall be possible by Expansion Modules; Such Expansions of Digital Fault Recorders shall not cause deterioration of Operating Parameters and the Record Quality of the Fault Recorder.
- 4.1.2 Digital Fault Recorder shall be Panel Mounted and the Dimensions shall be according to IEC 60297-3-101.
- 4.1.3 Enclosure Protection of the Digital Fault Recorder shall meet the requirements of IEC 60529:2013, with Protection Class IP50 for the front of the device.
- 4.1.4 Analogue and Digital Inputs, and the Power Supply shall be galvanically isolated.
- 4.1.5 Connection Terminals shall be Ring Lug Type sized 4mm² for CT Connection, and 2.5mm² for Other Connections.
- 4.1.6 Digital Fault Recorder shall accommodate Dual Power Supply Modules.
- 4.1.7 Digital Fault Recorder shall be provided with adequate number of Digital Inputs as specified in the data schedule and the inputs shall be user configurable.
- 4.1.8 Digital Fault Recorder shall be provided with Binary Outputs as per the required applications and the outputs shall be user configurable.
- 4.1.9 Unless otherwise specified in the PTS, Digital Fault Recorder shall be provided with Minimum 32 Analog Inputs.
- 4.1.10 Digital Fault Recorder shall be equipped with the Fast Fault Recording Modules for Power System Faults.

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- 4.1.11 Digital Fault Recorder shall be equipped with the Slow Fault Recording Modules.
- 4.1.12 Two Record Modules as stated in Clause 4.1.10 and 4.1.11 shall record simultaneously.
- 4.1.13 Pre-Fault, Fault and Post-Fault Periods shall be User Configurable.
- 4.1.14 Digital Fault Recorder shall provide Fault Location i.e. Distance to Fault.
- 4.1.15 Digital Fault Recorder shall be provided with Sequential Event Recorder Feature with tag time of 1ms resolution.
- 4.1.16 Digital Fault Recorder shall be equipped with Phasor Measurement Unit (PMU) Feature if specified in PTS.
- 4.1.17 Digital Fault Recorder shall be equipped with Power Quality Measurement Feature if specified in PTS.
- 4.1.18 Digital Faults Recorder must include an Anti-Aliasing Feature.
- 4.1.19 Digital Fault Recorder shall be capable of being triggered by Protection Functions, Digital Input Status Change, Violation of Analog Quantities Limits, Manual Triggering and Data Communication Channel Triggering as well as Periodic Triggering. Triggering Features shall be User Selectable.
- 4.1.20 Digital Fault Recorder shall support Cross-Triggering Feature with other Fault-Recording Units.
- 4.1.21 Digital Fault Recorder shall have appropriate Test Facilities for Testing and Calibration without Equipment Outages. Test Facilities similar to Field Test (FT) Switches shall be provided on the Panel Front.
- 4.1.22 Microprocessor of Digital Inputs Module shall be capable to scan Each Digital Input at 1ms interval and provide Selectable Debounce from 4 to 255ms.
- 4.1.23 Time Tagged Transitions (with 1ms time resolution) for Digital Inputs shall be reported in chronological order and Non-Time Tagged Transitions shall be provided in Separate FIFO Buffer (with Minimum 256 Events per Module) and reported upon request.
- 4.1.24 Digital Inputs Module shall include Software Debouncing to verify that a Digital Point has actually changed and the Debouncing Levels shall be configured as requested.
- 4.1.25 Digital Inputs Module shall be capable for Chattering Filtering.

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4.1.26 Digital Inputs Module shall be capable of Report Limiting stating the minimum number of State Transitions Recorded for sending the report. Minimum Number of State Transitions shall be configurable per Point.

4.2. Ratings

- 4.2.1 Digital Fault Recorder Ratings shall comply with IEC 60255-1.
- 4.2.2 DC Supply of the Digital Fault Recorders shall be compatible with 48V / 125V DC System with operating range 80% - 120%; depending on PTS Requirements.
- 4.2.3 Digital Fault Recorder Analogue CT Inputs shall be in-line with IEC 61869-1 and IEC 61869-2 and rated 1A or/and 5A.
- 4.2.4 Thermal Current Rating shall be 70A for continuous and 200A for 1 sec.
- 4.2.5 Digital Fault Recorder Analogue PT Inputs shall be in-line with IEC 61869-1, IEC 61869-3 and IEC 61869-5 and rated 120V AC.
- 4.2.6 Signal to Noise Ratio shall be higher than 80dB.
- 4.2.7 Digital Fault Recorder Analogue Input Accuracy of Current and Voltage shall be 0.1% of reading.
- 4.2.8 Digital Fault Recorder Analogue Current Input at full scales shall be more than 70A r.m.s at specified resolution value.
- 4.2.9 Digital Fault Recorder Analogue Voltage Input at full scales shall be 600V r.m.s at specified resolution.

4.3. Display

- 4.3.1 Digital Fault Recorder shall be fitted with a LCD Screen displaying Current Status of Recorder and the Time of Activation; OR with an Industrial Computer.
- 4.3.2 LCD of the Digital Fault Recorder shall have suitable size and resolution.

4.4. Communication And Interface:

- 4.4.1 Communication Port(s) shall be provided at the front of the Digital Fault Recorder for Configuration, Parameter Settings and Data / Files Retrieval (RJ45, RS232, USB ... etc.). Service Port shall be provided at the rear of the Fault Recorder. ST/LC-Connector Ports shall be provided for FO Connection at the rear of the Digital Fault Recorder.
- 4.4.2 Digital Fault Recorder shall comply with IEC 61850 Edition-2 and IEC 62439-3.

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- 4.4.3 Digital Fault Recorder shall have a built-in Real-Time Calendar and Clock, and shall be equipped for Synchronization with Station GPS, IRIB-B and Network Time Protocol (NTP). It should be capable to synchronize with High Accuracy TCXO (Temperature-Controlled Crystal Oscillator) Standard Clock in case of GPS Fail.
- 4.4.4 Digital Fault Recorder Time Synchronization shall not exceed 1ms.
- 4.4.5 Digital Fault Recorder shall support COMTRADE Format. Fault Record Data shall be accessible from Local HMI and Data Communication Channels.
- 4.4.6 Digital Fault Recorder shall be provided with facility for Configuration & Programming via Local HMI.
- 4.4.7 Fault Recorder Units shall be capable for interface and integration to each other with Suitable Communication Interface and Display Records of Other Units simultaneously in One Fault Recorder Unit. Minimum (but not limited to) Four (04) Units shall be designed for interface, communication and integration to each other.
- 4.4.8 Main processor of Digital Fault Recorder shall support Multiple Masters, Multiple Database, Data Concentration, Communication Gateway or Sub Master Scheme, in addition to supporting High Level Data Link Control (HDLC) providing both Connection-Oriented and Connectionless Services.

4.5. Software And Security:

- 4.5.1 Digital Fault Recorder shall have at least Four (04) Password Levels and Four (04) Setting Groups that shall be user selectable.
- 4.5.2 Cyber Security shall be incorporated into the Digital Fault Recorder Design. Hardware shall be designed to ensure that Key Data and Communication are stored in absolute security. Communication Stacks shall be hardened against cyber-attacks. Multistage Access Concept in Operation and Permanent Logging of all access attempts and of critical cyber security actions shall be implemented. Unused Ethernet services shall be disabled.
- 4.5.3 One Operating Program Software shall be available for the Same Production Range. Software shall include the required features for Configuration, Parameterization, Settings, Communication Structure, Data / Fault Retrieval & Analysis, Graphical Display, Programmable Logical Functions, Device Testing and Parameterization of the

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Communication Protocols. Software shall be capable to Manage & Analyze All Possible Features in the Digital Fault Recorders.

- 4.5.4 Digital Fault Recorder shall have Self-Supervision and Watchdog Features and issue Alarm Signal if not ready.
- 4.5.5 Digital Fault Recorder shall be provided with a non-volatile memory for storage of Events, Faults and Disturbance Records, and shall be provided with different kind of Log Buffers (i.e. Operational Events, Fault Recording, Setting History, Security, Device Diagnosis and User Defined Logs).
- 4.5.6 Digital Fault Recorder memory shall be sufficient to store Disturbance Data for at least One (01) Year without Data Compression.
- 4.5.7 Software shall be auto calibrated for Analogue Inputs.
- 4.5.8 Digital Fault Recorder disturbance shall be automatically uploaded (User Configurable Event Triggering) to the Substation Engineering Workstation (For SAS Substation) and to the Regional Master Station (As Available).

4.6. Marking:

- 4.6.1 Digital Fault Recorder shall be marked and labelled in accordance to IEC 60255-27.
- 4.6.2 In addition to Standard Information of the Digital Fault Recorder the Name Plate shall contain the following information:
 - Saudi Electricity Company
 - Order No.
 - Contract No.

5 Recording Functions**5.1. Fast Fault Recording:**

Fast Fault Recording is utilized for Direct Recording of Analog Currents and Voltages measured by the Digital Fault Recorder at High Sampling Frequency along with Digital Inputs Status to display Power System Faults & Transients.

- 5.1.1. Analog Signals shall be recorded with a Configurable Sampling Rate of 100Hz - 15.36kHz with Configurable Resolution (Analog Digital Conversion) not less than 16 bit.
- 5.1.2. Pre -Fault Periods shall be configurable from 100ms up to 5s.

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- 5.1.3. Post-Fault Periods shall be configurable up to 30s.
- 5.1.4. Length of Fault Duration shall be set as Actual Event Time.
- 5.1.5. Common mode rejection (bandwidth) >100dB.
- 5.1.6. Trigger Conditions shall be defined as per Company Requirements. Fault Recorder shall be capable of being triggered by the following (not limited to) User Specified Sensor Library for System Recording:
 - a. External Manual Trigger (Local OR Remote).
 - b. Event Channel Level OR Edge Sensor (Dry / Wet Contact).
 - c. Level Sensor of Power Quantities (Over / Under for Voltage, Current, Frequency, etc.).
 - d. Negative or Zero Sequence Current / Voltage (RMS).
 - e. Rate of Change, Voltage, Current, Frequency, and Power.
 - f. Power Swing, Power Step (DC step).
 - g. Logical Combination Sensors, programmable (using Several Sensors of Several Channels)
 - h. Configurable Periodic Intervals.
 - i. Cross-Triggering between Fault Recorder Units.

5.2. Slow Fault Recording:

- 5.2.1. Analog Signals shall be recorded with a Configurable Sampling Rate of 0.2Hz - 120Hz with Configurable Resolution (Analog Digital Conversion) up to 24 bit.
- 5.2.2. Pre -Fault Periods shall be configurable from 100ms up to 60 s.
- 5.2.3. Post-Fault Periods shall be configurable up to 1800s.
- 5.2.4. Length of Fault Duration shall be set as Actual Event Time.
- 5.2.5. Trigger Conditions shall be defined as per Company Requirements. Fault Recorder shall be capable of being triggered by the conditions stated under Clause 5.1.6.

5.3. Event Recording:

Event Recording shall provide information pertaining to Time, Level Status, Duration of Limit Value Violations and a Classification of Events with at least 2000 Events.

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5.4. Phasor Measurement Unit:

Phasor Measurement Unit (PMU) shall be fully compliant with IEEE C37.118-2005 Standard. Digital Fault Recorder shall provide Phasors for Each Analogue Input with the possibility to select Positive, Negative & Zero Sequence Components.

5.5. Power Quality Measurement:

Power Quality Measurement shall be compliant to IEC 61000-4-30 Standard (Class A). It shall be capable to measure the below mentioned parameters on continuous basis:

- a. RMS Voltage - Phase to Phase OR Phase to Neutral
- b. RMS Current, Active, Reactive, Apparent and Distorted Power. (1 & 3-Phase)
- c. Power Factor. (1 & 3-Phase)
- d. Voltage THD & Current TDD.
- e. Voltage & Current Harmonics and Inter-harmonics.
- f. Unbalance, Negative Sequence, Positive Sequence and Zero Sequence Values.
- g. Flickers.
- h. Frequency.

Voltage Dips (Sags), Swells & Interruptions shall be stored in a log. It shall be possible to Trigger the Recording for such situations.

6 Tests

Tests shall be conducted in accordance with IEC or Equivalent ANSI/IEEE Standards.

Test Results shall be provided to SEC DBU for Review and Approval.

6.1. Type Test

Prescribed Test in the applicable IEC and IEEE Standards shall be performed on the First Unit of every new design. Latest IEC and IEEE Revision / Amendments of the Codes and Standards of the Applicable Type Tests shown in Table 1 shall be applied along with RTDS and Functional Tests.

Table 1 : Type Test

No.	Test Item	Standard
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1	Dimensions of Enclosure and Visual Inspection	IEC 60297-3-101
2	Product Safety Requirement (Including Thermal Short Time Rating)	IEC 60255-27
3	EMC Requirements	IEC 61000-4 Series
4	Enclosure Protection	IEC 60529 (2013) IEC 60255-27 (2013)
5	Climatic Environmental Requirements: - Cold - Dry Heat - Change of Temperature - Damp Heat	IEC 60068-2-1 IEC 60068-2-2 IEC 60068-2-14 IEC 60068-2-78 IEC 60068-2-30
6	Mechanical Requirements: - Shock - Vibration - Bump - Seismic	IEC 60255-21-1 IEC 60255-21-2 IEC 60255-21-3

6.2. Routine Test

Prescribed Test in the applicable IEC Standard shall be performed. Latest Revision / Amendments of the following Codes and Standards shall be applied along with Functional Tests.

Table 2 : Routine Test

No.	Test Item	Standard
1	Dielectric Test	IEC 60255-27
2	Dimensions of Enclosure and Visual Inspection	IEC 60297-3-101 (2004)
3	Overvoltage Category Class III	IEC 60255-27
4	Insulation Measurement	IEC 60255-27

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7 Data Schedule

DIGITAL FAULT RECORDERS

SEC Enquiry No.

Date

SEC Purchase Order No. or Contract No.

Date

SEC PTS No. / Project Title with J.O. No.

REFERENCE SECTION NO.	DESCRIPTION	'A'	'B'	'C'
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3.0 APPLICABLE CODES STANDARD

Applicable Standards	Industry			
Manufacturer		*		
Type		*		
Model/Version No.		*		

4.0 DESIGN AND CONSTRUCTION REQUIREMENT

4.1	General			
	Digital Fault Recorder Housing			
	Frequency Response			
	Dimension (W.L.H) mm			
	Weight (Kg)			
	Terminal Type	Ring Lug		
	Number of LEDs (Fixed)	*		

A'- SEC DBU SPECIFIED DATA/PARAMETER.

'B'- BIDDER/SUPPLIER/VENDOR/CONTRACTOR PROPOSED DATA/PARAMETERS.

'C'- REMARKS SUPPORTING THE PROPOSED DEVIATION IN COLUMN 'B'.

(*)- DATA/PARAMETER TO BE PROVIDED/PROPOSED BY THE BIDDER/SUPPLIER/
VENDOR/CONTRACTOR IN COLUMN 'B'.

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REFERENCE SECTION NO.	DESCRIPTION	'A'	'B'	'C'
	Number of LEDs (Programmable)	*		
	CT Short Facility	Yes / No		
	No. of Analog Inputs	*		
	Digital Inputs	*		
	No. of Digital Inputs	*		
	Operating voltage & Range	*		
	Number of Fixed Contacts	*		
	Number of Programmable Contacts	*		
	Temperature and Humidity			
	Ambient Temperature			
	a. In Service	*		
	b. For Storage	*		
	c. During Transport	*		
	d. During Start-up	*		
	Relative Humidity	*		
	Degree of Protection			
4.2	Rating			
	CT Input (A)	1/5		
	VT Input (V)	120		

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REFERENCE SECTION NO.	DESCRIPTION	'A'	'B'	'C'
	Current Input (VA)	*		
	Current Accuracy at Full Scale %	0.1		
	Voltage Input (VA)	*		
	Voltage Accuracy at Full Scale %	0.1		
	Thermal Overload Current Continuous (I_{TH})			
	Thermal Overload Current for 1sec (I_N)			
	Voltage Analog Input			
	Auxiliary Supply Continuous $*(V_N)$			
	Rated of Auxiliary DC Voltage (V)	48 OR 125VDC		
	Tolerance %	*		
	Maximum Ripple	*		
	Power Consumption (W)	*		
	Common Mode Rejection Ratio	*		
	Battery Backup Type	*		
4.3	Display Type and Character	*		
	Communication Port	*		

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REFERENCE SECTION NO.	DESCRIPTION	'A'	'B'	'C'
	Available Protocol	*		
	Front Port Type & No.	*		
	Rear Port Type & No.	*		
	Time Synchronization	Yes / No		
	Facilities through HMI	*		
4.4	Communication Interfaces and			
	Printer Provided	Yes / No		
	Printer Type	*		
	Laptop Provided	Yes / No		
4.5	Software and Security			
	Name of Software			
	Self-Supervision Facility	Yes		
	Watchdog Contacts	Yes		
	Triggering	*		
5.0 RECORDING FUNCTIONS				
5.1	Fast Fault Recording Function			
	Sampling Rate	*		
	Recording Resolution	*		
	Pre Fault Time (sec)	*		



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REFERENCE SECTION NO.	DESCRIPTION	'A'	'B'	'C'
	Post Fault Time (sec)	*		
	Maximum Fault Record Length	*		
5.2	Slow Fault Recording Function			
	Sampling Rate	*		
	Duration of Fault	*		
	Recording Length (sec)	*		
	Pre Fault Time (sec)	*		
	Post Fault Time (sec)	*		
	Triggering	*		
	Calculated Values	*		
	Fault Records No.	*		
5.3	Events Recording Capacity	*		
5.4	Phasor Measurement Unit	Yes / No		
5.5	Power Quality Measurement	Yes / No		
6.0 TESTS				
	Optional OR Special Test Requirements (if any)			

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- A. ADDITIONAL TECHNICAL INFORMATION OR FEATURES TO BE FURNISHED BY SEC DBU
- B. ADDITIONAL SUPPLEMENTARY DATA OR FEATURES PROPOSED BY BIDDER/VENDOR/SUPPLIER/CONTRACTOR
- C. OTHER PARTICULARS TO BE FILLED BY BIDDER/VENDOR/SUPPLIER/CONTRACTOR

Actual Manufacturer of
Equipment / MaterialVendor / Supplier /
ContractorName of the Company
Location AddressName and Signature of
Authorized
Representative and
DateOfficial Seal / Stamp of
the Company & Date