DPMS-02

Rev.2

DISTRIBUTION PROTECTION MATERIAL SPECIFICATION

(PROTECTION RELAYS)

MAH

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Revision History

#	Date	Revision No.	Revised By	Major Revision Description
1	17/04/2019	DPMS-02 Rev. 1	Dr. Abdulmonem Idrees	Modifications of Directional Protection Requirements. Modification of CT Parameters and Protection features of Self-Powered Relay. Change of Setting Ranges of some Protection Functions.
2	01/01/2020	DPMS-02 Rev. 2	Dr. Abdulmonem Idrees	RMUs CT specification revised. Clause (8): Table (6): Types Tests Lists revised. 6.11.11 It shall enable zone-1 of the built-in distance protection function when communication link is faulty. Overcurrent/Earth Fault protection shall also be available as a built-in features. 6.12.2 It shall be provided with 5 distance zones and selectable Quadrilateral and MHO (with and without offset) characteristics and shall have independent zone reach settings. 7.1.8 Standard CTs to be used with Self-powered relays according to SEC Requirements are as follows: 13.8kV Level: 75 / 1 A, 5 P 10 , 2.5 VA 33kV Level: 40 / 1 A, 5 P 10 , 2.5 VA 7.1.9 Self-powered relays should be compatible with conventional current transformers and shall have 4 analogue CT inputs (A,B,C,N) to support both measured / calculated EF current.
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1 Scope

This Distribution Protection Material Specification (DPMS – 02) specifies the minimum technical requirements for design, engineering, manufacture, inspection, testing, commissioning and performance of protective relays intended to be used in the Distribution System and must be complied by Manufacturer/Vendor when supplying material or equipment to the SEC DBU. This document also specifies the minimum technical requirements of Self-Powered Relays (refer to Clause 7).

2 Cross References

This Distribution Material Standard Specification 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 – 02 document.

This DPMS document 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 – 02. 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 – 02.

3.1	IEC 60255-1: 2009	Measuring relays and protection equipment – part 1: Common requirements.
3.2	IEC 61869-1: 2007	Instrument transformers – Part 1: General requirements
3.3	IEC 61869-2: 2012	Instrument transformers – Part 2: Additional Requirements for Current transformers
3.4	IEC 61869-3: 2011	Instrument transformers – Part 3: Additional Requirements for Inductive voltage transformers

3.5	IEC 61869-5: 2011	Instrument transformers – Part 5: Additional Requirements for Capacitor voltage transformers
3.6	IEC 60050-191:1990	International Electro-technical Vocabulary – Chapter 191: Dependability and quality of service
3.7	IEC 60050-447:2010	International Electro-technical Vocabulary – Part 447: Measuring relays
3.8	IEC 60068-2-1: 2007	Environmental testing – Part 2-1:Tests –Test A: Cold
3.9	IEC 60068-2-2: 2007	Environmental testing – Part 2-2: Tests – Test B: Dry heat
3.10	IEC 60068-2-14: 2009	Environmental testing – Part 2-14: Tests – Test N: Change of Temperature
3.11	IEC 60068-2-30: 2005	Environmental testing – Part 2-30: Tests – Test Db: Damp heat, cyclic (12 h + 12 h cycle)
3.12	IEC 60068-2-78: 2012	Environmental testing – Part 2-78: Tests – Test Cab: Damp heat, steady state
3.13	IEC 60068-3-4: 2001	Environmental testing – Part 3-4: Supporting documentation and guidance – Damp heat tests.
3.14	IEC 60255-21-1: 1988	Electrical relays – Part 21-1: Vibration, shock, bump and seismic tests on measuring relays and protection equipment – Vibration tests (sinusoidal)
3.15	IEC 60255-21-2: 1988	Electrical relays – Part 21-2: Vibration, shock, bump and seismic tests on measuring relays and protection equipment – Shock and bump tests

3.16	IEC 60255-21-3: 1993	Electrical relays – Part 21-3: Vibration, shock, bump and seismic tests on measuring relays and protection equipment – Seismic tests
3.17	IEC 60255-26: 2013	Measuring relays and protection equipment – Part 26: Electromagnetic compatibility requirements
3.18	IEC 60255-27: 2013	Measuring relays and protection equipment – Part 27: Product safety requirement
3.19	IEC 60255-121: 2014	Measuring relays and protection equipment – Part 121 Functional Requirement for distance Protection
3.20	IEC 60255-127: 2010	Measuring relays and protection equipment – Part 127 Functional Requirement for over/under voltage protection
3.21	IEC 60255-149: 2013	Measuring relays and protection equipment – Part 149 Functional Requirement for thermal electrical relays
3.22	IEC 60255-151: 2009	Measuring relays and protection equipment – Part 151 Functional Requirement for over/under current Protection
3.23	IEC 60255-13: 1980	Electrical relays – Part 13 Biased (percentage) differential relays
3.24	IEC 60255-24: 2013	Measuring Relays and protection equipment-Part24-Common format for transient data exchange (COMTRADE) for power system
3.25	IEC 60297-3-101: 2004	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
3.26	IEC 60529: 2013	Degrees of protection provided by enclosures (IP Code)
3.27	IEC 60688: 2012	Electrical measuring transducers for converting A.C. and D.C. electrical quantities to analogue or digital signals
3.28	IEC 60721-3-3: 2002	Classification of environmental conditions – Part 3-3: Classification of groups of environmental parameters and their severities – Stationary use at weather-protected locations
3.29	IEC 61810-1: 2008	Electromechanical elementary relays – Part 1: General requirements
3.30	IEC 61810-2: 2011	Electromechanical elementary relays – Part 2 Reliability
3.31	IEC 61850 Edition 2 SET	Communication networks and systems in substations.
3.32	IEC 61508-3: 2010	Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 3: Software requirements - Edition 2.0
3.33	IEEE C37.231: 2006	Recommended Practice for Microprocessor Firmware Control
3.34	IEEE C37.90: 2005	Relays and Relay systems associated with electric power apparatus

3.35	IEEE C37.90.1: 2012	Surge withstand capability (SWC) Tests for relays and relay systems associated with electric power apparatus.
3.36	IEEE C37.90.2: 2004	Withstand capability of relay systems to radiated electromagnetic interference from transceivers.
3.37	IEEE C37.94: 2013	N times 64 kilobit per second optical fiber interface

4 Design and Construction Requirement

4.1 Ratings

4.1.1 The ratings of the relay shall comply with IEC 60255-1: 2009.

4.1.2 The relay shall be provided with adequate number of analogue CT inputs and shall be in line with IEC 61869-2: 2012 and rated to 1A or/and 5A . The thermal current rating shall be as shown in table 1.

4.1.3 Table 1: Thermal Current Ratings

#	Rating	Duration
1	4 In	Continuous
2	30 In	For 10 s
3	100 In	For 1 s

4.1.4 The relay shall be provided with adequate number of analogue PT inputs in-line with IEC 61869-3: 2011 and IEC 61869-5: 2011 and rated to (100 - 120 V AC) or (380 – 480 V AC when required) with a continues thermal and withstand voltage up to 2* Un (rated voltage).

4.1.5 The DC power supply of the relay shall be 48V DC / 125 V DC as required by the COMPANY, the operating range shall be 80% - 120%.

4.1.6 The protection relay shall operate reliably between 50Hz to 70Hz system frequency.

4.2 Design and Construction

4.2.1 All protective relays intended to be used the SEC DBU shall be intelligent electronic devices (IED), modular type and numerical relays. Devices shall be configurable with an on-line configurator.

4.2.2 The relay shall be marked according to IEC 60255-27:2013.

4.2.3 The connection terminals shall be screw type sized to 4 mm² or double leaf-spring-crimp contact 2.5 mm² for CT connection and up to 2.5 mm² or double leaf-spring-crimp contact 1.5 mm² for other connections.

4.2.4 Standard communication port shall be provided at the front of the IED for PC connection for configuration, parameter set and retrieve the data/files from the relay (USB, RJ45, RS232, … etc.). The port should provide at least 2kV electrical isolation. Service Standard port shall be provided at the rare of the relay. ST-connector or LC-connector or SC connector ports for FO connection shall be provided at the rare of the relay Relays shall provide at least one Ethernet port. There must be a provision of having multiple Ethernet ports as multiple ports may be required subject to the nature of automation design. The Ethernet port can either be an 100Base FX multimode fiber port or 10/100BaseT RJ45 port.

4.2.5 The IED shall be rack or panel mounted and shall be able to fit into protection panel, the dimensions shall be according to IEC 60297-3-101:2004. (except the relays which applicable for MV switchgear it shall be flush mounted).

4.2.6 Enclosure protection of the equipment shall meet the requirements of IEC60529:2013.

4.2.7 Product safety requirements shall include the dielectric tests and thermal short time ratings shall meet the requirements of IEC 60255-27: 2013.

4.2.8 It is recommended that the relay case be provided with CT shorting contacts to insure the CT circuit remain short-circuited when the relay is withdrawn out, the ratings of such contacts shall be as mentioned in table 1 above.

4.2.9 Protection IEDs and Supplied Material shall be in accordance with the SEC Distribution Unified List of Approved Relays, however, Relay & Material List shall be approved by COMPANY Engineer for respective Projects.

5 General Requirements

5.1 The relay shall be provided with CT supervision and VT supervision features as long as it is support CT and VT inputs, these features can be built-in or programmable logic inside the relay.

5.2 The relay shall be provided with dual trip circuit supervision feature for two independent tripping circuits suitable for three phase circuit breaker, these features can be built-in or programmable logic inside the relay.

5.3 The relay shall be provided with circuit breaker condition monitoring.

5.4 The relay communication system shall be compatible to IEC 61850 edition 2 and comply with the latest revision of TES-P-107.01 and TES-P-107.02.and applicable SEC DBU Standards

5.5 The relay shall have a built-in real-time calendar and clock and shall be able to be synchronized with the station GPS via IEC 61850 LAN and support IRIG-B.

5.6 The front of the relay shall be provided with a local HMI including LCD display, keypad push-buttons and programmable LEDs along with status & alarm LEDs as per function requirement.

5.7 The front keypad push-buttons shall facilitate reading/changing of protection settings and retrieving the electrical measurement values. The changing of relay settings shall be entered into a "history setting log" and needs a password which complies to NERC-CIP. Any attempt to enter the relay shall be recorded in a "security log".

5.8 The LCD display of the relay shall have a suitable size and resolution.

5.8.1 SAS Application: Where feeder management application is required (BCPU), the IED shall support graphical mimic feature and facilitate local operation of the switchgear and consequently display the current status of the switchgear on the LCD as required by the COMPANY.

5.8.2 Non-SAS Application: Normal IEDs without BCPU feature can be utilized.

5.9 The operation performance of the relay shall not be affected by harmonics and DC components.

5.10 The relay shall be provided with adequate number of binary inputs as per the required application and the inputs shall be configurable to protection and control functions. At least 20% of spare inputs shall be provided.

5.11 The relay shall be provided with adequate number of binary output contacts as per the required application and the outputs shall be configurable to the protection and control functions. At least 20% of spare contacts shall be provided.

5.12 The relay shall be provided with adequate number of heavy duty output contacts for direct tripping of circuit breaker, the ratings shall be as per IEC 60255-1:2009.

5.13 The relay shall be provided with measuring data of all electrical quantities for load profile recording.

5.14 The relay shall have at least (2) password levels and (4) setting groups user selectable.

5.15 The Relay shall at least store (10) fault records (text form) in a nonvolatile memory and support the COMTRADE format, the fault record data shall be accessible from the Local HMI and the data communication channels.

5.16 The relay shall be provided with disturbance recorder with analog inputs depending on the number of the relay current and voltage inputs with a configurable sampling rate of at least 1 kHz. The disturbance recorder shall support at least (20) binary digital inputs. It shall respond to the internal protection functions triggering, binary input, limit of violation of the analog quantities, manual triggering and data communication channel triggering as well as periodic triggering. All these triggering features shall be user selectable.

5.17 The storage capacity of the disturbance recorder shall store at least (10) fault at the highest sampling rate of at least 1 kHz when the analogue and binary inputs are fully utilized. The time intervals shall be adjustable for the pre-fault and post-fault. The records shall be stored in a buffer

and support the COMTRADE format and shall be locally accessible by the (PC) and remotely via data communication channels.

5.18 The Relay shall be provided with sequential event recorder with a minimum storage capacity of (1000) events.

5.19 The relay shall be provided with a non-volatile memory to store event records, fault records 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.

5.20 The relay shall have continuously self-supervision and watchdog features and issue alarm signal when it's not ready.

5.21 All protection and control functions of the relay shall be configurable to enabled/disabled and blocked/unblocked. All the required functions shall be stored in the relay. Functionality of the relay shall be selectable, i.e. function can be added or removed.

5.22 Cyber security must be incorporated into the design of the devices right from the start. Measures in the hardware shall ensure that key data and communication is stored in absolute security. Communication stacks that are hardened against cyber-attacks, a multistage access concept in operation and permanent logging of all access attempts and of critical cyber security actions. Unused Ethernet services shall be able to be switched off.

5.23 One operating program shall be available for the family of devices of the same production range. The program shall include the possibility to do the configuration, the parameterization, the settings, the communication structure, data/fault retrieving & analysis, graphical display, programmable logical functions, testing of the device and parameterization for IEC61850 shall be possible as well.

5.24 Communication between relays for protection purposes (inter-trips, differential relay etc.) is to be by optical fiber or copper pilot . The interface between the protection relays and the protection signaling communication equipment (Tele-protection device) shall be either hard wired connections or it shall be over the substation LAN using IEC 61850-8-1, Edition 2 GOOSE messaging.

6 Protection Functions

The relay shall be manufactured with adequate number of protection functions as per the requirements of the intended application.

6.1 NON DIRECTIONAL THREE PHASE OVERCURRENT PROTECTION (50/51):

6.1.1 The non-directional three phase overcurrent protection shall have low and high set levels with independent current and time settings.

6.1.2 It shall support definite time characteristics and inverse definite minimum time for overcurrent according to ANSI/IEEE and IEC curves and shall be user selectable.

6.1.3 This function shall have at least four (4) independent stages user selectable.

6.1.4 2nd Harmonic Blocking Function shall be available to block Phase Overcurrent Protection upon detection of inrush currents.

6.1.5 The high set over current shall be able to operate within one cycle, while the low set shall be able to operate within one and half cycle.

6.1.6 The non-directional overcurrent protection function shall comply with IEC60255-151 2009.

6.1.7 The current setting range shall be (0.05 – 20In) in steps of 0.01In each.

6.1.8 Time Multiplier setting shall be (0.05 - 2) in steps of 0.01.

6.2 NON DIRECTIONAL EARTH FAULT PROTECTION (50/51N)

6.2.1 The non-directional earth fault protection derived and/or measured shall have low and high set levels with independent current and time settings.

6.2.2 It shall support definite time characteristics and inverse definite minimum time for overcurrent according to ANSI/IEEE and IEC curves and shall be user selectable.

6.2.3 This function shall have at least four (4) independent stages user selectable.

6.2.4 The high set earth fault shall be able to operate within one cycle, while the low set shall be able to operate within one and half cycle.

6.1.5 2nd Harmonic Blocking function shall be available to block Earth Overcurrent Protection upon detection of inrush currents.

6.2.6 The non-directional earth fault protection function shall comply with IEC60255-151 2009.

6.2.7 The current setting range shall be (0.05 – 20In) in steps of 0.01In each.

6.2.8 Time Multiplier setting shall be (0.05 - 2) in steps of 0.01.

6.3 SENSITIVE EARTH FAULT PROTECTION (51N SEF)

6.3.1 The directional and non-directional earth fault protection derived and/or measured shall have low and high set levels with independent current and time settings.

6.3.2 It shall support definite time characteristics and inverse definite minimum time for overcurrent according to ANSI/IEEE and IEC curves and shall be user selectable.

6.3.3 The high set earth fault shall be able to operate within one cycle, while the low set shall be able to operate within one and half cycle.

6.3.4 The non-directional earth fault protection function shall comply with IEC60255-151 2009.

6.3.5 The current setting range shall be (0.005 – 0.1In) in steps of 0.01In each.

6.3.6 Time Multiplier setting shall be (0.01 - 2) in steps of 0.01.

6.4 DIRECTIONAL THREE PHASE OVERCURRENT PROTECTION (67):

6.4.1 The directional three phase overcurrent protection shall have low and high set levels with independent current and time settings.

6.4.2 It shall support definite time characteristics and inverse definite minimum time for overcurrent according to ANSI/IEEE and IEC curves and shall be user selectable.

6.4.3 Directionality shall be determined by voltage based Polarization. Characteristic angle (RCA) (-90^0 to 90^0) for phase fault and ground fault protection.

6.4.4 The directional over current function shall not operate for any fault in restraint direction.

6.4.5 The directional over current function shall be provided with a memory function to secure a reliable and correct directional operation in case of a close three-phase short circuit.

6.4.6 This function shall have at least four (4) independent stages user selectable.

6.4.7 The high set over current shall be able to operate within one cycle, while the low set shall be able to operate within one and half cycle.

6.4.8 The current setting range shall be (0.05 – 20In) in steps of 0.01In each.

6.5 DIRECTIONAL EARTH FAULT PROTECTION (67N):

6.5.1 The directional Earth Fault protection shall have low and high set levels with independent current and time settings.

6.5.2 It shall support definite time characteristics and inverse definite minimum time for overcurrent according to ANSI/IEEE and IEC curves and shall be user selectable.

6.5.3 The residual current and polarization voltage shall be used for the operation and directional characteristics of the protection function.

6.5.4 There shall be several options for voltage based direction determination (i.e. residual voltage, negative sequence voltage, zero sequence power, … etc.).

6.5.4 The directional earth fault function shall not operate for any fault in restraint direction.

6.5.5 This function shall have at least four (4) independent stages user selectable.

6.5.6 The high set earth fault shall be able to operate within one cycle while the low set shall be able to operate within one and half cycle.

6.5.7 The current setting range shall be (0.05 – 20 In) in steps of 0.01In each.

6.6 THREE-PHASE THERMAL OVERLOAD PROTECTION (49):

6.6.1 The Thermal overload protection function shall provide standard method of calculating the temperature rise due to the load current to be added to the ambient temperature.

6.6.2 The protection shall have alarm level that give early warning using thermal model with settable time constant.

6.6.3 Re-energizing of the feeder after the thermal overload operation shall be inhibited when the cooling time in progress, the cooling time shall be estimated by the thermal model.

6.6.4 The temperature shall be stored in a nonvolatile memory and restored in case of the relay restarted.

6.6.5 The Thermal overload protection function shall comply with IEC60255-149:2013.

6.7 PHASE UNBALANCE PROTECTION (NEGATIVE SEQUENCE OVERCURRENT PROTECTION) (46):

6.7.1 This protection shall detect the unbalance currents due to series faults in Over Head Lines and to protect the capacitor against unbalance conditions.

6.7.2 It shall support definite time characteristics and/or inverse definite minimum time for overcurrent according to ANSI/IEEE and IEC curves and shall be user selectable.

6.7.3 The phase unbalance protection function shall be able to detect the unsymmetrical feeder currents.

6.7.4 The current setting range shall be (0.01 – 20 In) in steps of 0.01In each.

6.8 THREE PHASE OVER/UNDER VOLTAGE PROTECTION AND NEUTRAL OVER VOLTAGE (27/59 &59N):

6.8.1 This function shall be provided with a voltage selection setting for phase-to-phase or phase-to-neutral voltages.

6.8.2 It shall support definite time characteristics and inverse definite minimum time curve saturation of the under/over voltage according to ANSI/IEEE and IEC curves and shall be user selectable.

6.8.3 The over/under voltage functions shall be equipped with filters and render the Relay to follow the potential levels of the phase quantities of fundamental frequency only. Spurious signals are to be effectively kept away.

6.8.4 This function shall have minimum two (2) stages of over voltage and four (4) stages of under voltage with independent voltages setting and independent timers and user selectable.

6.8.5 The over/under voltage protection function shall comply with IEC60255-127:2010.

6.8.6 Neutral over voltage protection / neutral voltage displacement (59N) shall be able to detect the earth fault for isolated and grounded systems.

6.8.7 The voltage setting range shall be (0.1 – 1.6Un) in steps of 0.01Un.

6.8.8 Under voltage protection shall be able to block in case of sharp voltage dip with user selectable setting.

6.8.9 Over/Under voltage shall block itself when the VT fuse failure is detected.

6.9 OVER/UNDER FREQUENCY PROTECTION (81):

6.9.1 This function shall detect the under frequency, over frequency and rate of change of frequency (df/dt).

6.9.2 All the frequency functions, over/under frequency and rate of change of frequency shall be independently operated.

6.9.3 Two (2) stages of over frequency and four (4) stages of under frequency shall be provided with independent setting of frequencies and operating times.

6.9.4 Over/Under Frequency shall block itself when the input voltage collapsed or a VT fuse failure is detected.

6.9.5 Each stage shall have a separate timer.

6.9.6 The setting range shall be (50Hz to 70Hz in steps of 0.01Hz).

6.10 CIRCUIT BREAKER FAILURE PROTECTION (50BF/50NBF)

6.10.1 The breaker-failure protection (BFP) shall generally comprise fault detector units, timing units, relay logic unit and other associated DC schemes and wiring, etc.

6.10.2 The circuit breaker protection function shall be initiated by trip signals from any protection functions. The initiation signals can be external through binary inputs or internally. In addition to the binary signals the BF start signal should be possible to be sent/received as GOOSE message.

6.10.3 The same levels of current detection shall be used for both protection stages and shall be set within a predefined setting range. The function shall be provided with two independent timers for trip purposes, stage (1) for repeating tripping of its own breaker through both of the tripping coils and stage (2) for tripping logic operation of the electrically-adjacent breakers.

6.10.4 The BF protection shall support high current mode and low current mode (using circuit breaker status), the input currents for this function shall be settable phase currents and/or residual current.

6.10.5 The setting current range shall be (0.1 – 2In) in steps of 0.01In.

6.11 LINE DIFFERENTIAL PROTECTION (87L):

6.11.1 Line differential protection shall be optical-pilot longitudinal and phase segregated differential protection.

6.11.2 Line differential protection shall allow instantaneous tripping of single or/and three phase short circuits at the two ends. Where required a protection of multi-terminal lines, the line differential protection version shall be suitable for Multi-terminal lines up to 4 ends.

6.11.3 The protection shall be designed for fast operation and suitable for protection of MV overhead lines and underground cables in solidly or through resistance grounded power system.

6.11.4 Two communication modules shall be provided with optical ports using IEEE C37.94 Standard for the communication between the line differential protection relays at each line end supporting direct fiber connection (up to 100km) and connection via optical-to-electrical multiplexer. In addition to data communication between the line differential protection function, the communication modules shall be able to transmit/receive the inter-tripping between local and remote substations and the tele-protection signals of the distance protection, this feature shall comply with the latest Edition of the Company Standard TES-P-108.04.

6.11.5 The line differential protection function shall be biased and with CT saturation detection. The differential protection shall have two stages, a very precise sensitive stage and a very fast high set stage. Inrush current detection shall be provided and prevent false tripping for both stages.

6.11.6 This function shall be provided with charging current compensation. The relay shall have slope percentage restraint characteristics.

6.11.7 The line differential shall be stable and accurate when a series capacitor compensator is installed in the line.

6.11.8 This protection function shall be programmable to trip the circuit breakers in all ends of the feeder when operated.

6.11.9 The line differential protection function shall be blocked when the CT supervision feature detected a fault (open or short circuit) in the secondary circuit of the CT.

6.11.10 The line differential protection shall continuously monitor its communication link with the remote ends and shall block itself when a failure in the communication link is detected.

6.11.11 It shall enable zone-1 of the built-in distance protection function when communication link is faulty. Overcurrent/Earth Fault protection shall also be available as a built-in features.

6.11.12 Proper transient biasing shall be incorporated(to restrict the operating characteristics) during CT saturation in the event of heavy faults in the adjacent sections or even very close to the zone of Protection.

6.11.13 This protection function shall be designed to detect all kinds of phase to Ground faults, phase-phase faults and 3-phase faults with or without earth and shall be stable for the through faults.

6.11.14 The operating time shall be within one cycle.

6.11.15 The differential setting range shall be (0.05 – 20In) in steps of 0.01In.

6.12 DISTANCE PROTECTION FUNCTION (21/21N):

6.12.1 The distance protection shall consist of high speed, non-switched, full scheme communication assisted numerical relays with independent measuring elements for all types of phase-phase and phase to Earth fault.

6.12.2 It shall be provided with 5 distance zones and selectable Quadrilateral and MHO (with and without offset) characteristics and shall have independent zone reach settings.

6.12.3 All zones shall be selectable as forward, reverse or non-directional.

6.12.4 The distance protection shall be suitable for long and short overhead interconnected / sub-transmission lines and underground cables.

6.12.5 The relay shall be suitable for 1-phase and/or 3-phase tripping and suitable to provide enabling & blocking outputs for single phase and/or three phase Auto-Reclosing.

6.12.6 The Distance Protection shall be suitable for operation on a system with X/R ratio ≥ 30

6.12.7 The protection shall support parallel line and load current compensation feature and the operation of the relay shall not be affected with series capacitor compensator if it is installed in the line.

6.12.8 The distance protection scheme shall include but not limited to the following additional functions/features as shown in table 2.

6.12.9 Table 2: Additional features of Distance Protection

#	Additional Features
1	It shall be provided with sensitive directional earth fault function for high resistive faults.
2	Switch-on-to-fault feature –External Triggering (SOTF)
3	Voltage circuit supervision
4	Power swing blocking function (with selectable zones)
5	Out of step tripping function for facilitating islanding in case of requirement.
6	Faulty phase identification with load encroachment

6.12.10 Single-phase, sensitive, for directional comparison earth fault protection for high resistance ground faults using tele-protection scheme via fiber optics, with echo-back feature for open-end line and weak in-feed using the permissive overreach scheme as an aided trip scheme.

6.12.11 SOTF feature shall initiate 3-phase instantaneous tripping and block the auto-reclosing relay.

6.12.12 The distance protection function shall be provided with VT fuse failure blocking internally and/or via binary input signal.

6.12.13 Distance protection shall be provided with power-swing blocking feature. The timer range of the power swing blocking unit shall be either adjustable or fixed but in any case it shall be capable of performing its duty under very high speed power swings. The power swing blocking units shall be provided with selection

features to select any of the following blocking zones/modes as shown below in table 3.

6.12.14 Table 3: Blocking Zone/Mode

#	Blocking Zone/Mode
1	Blocking of all 3-zones
2	Blocking of zone-3
3	Blocking of zone-2 & 3
4	Blocking of zone-1 only
5	Unblocking any of selected modes
6	Block power swing blocking

6.12.14 The characteristics of power swing blocking function shall support dual quadrilateral method or swing center voltage method.

6.12.15 Each zone characteristic shall be such as to allow for fault impedances for various types of faults and shall not encroach into the load.

6.12.16 The ground fault protection of all zones (zone-1, zone-2, zone-3 and zone-4) shall be provided with Residual compensation or both positive & zero sequence resistance and reactance independently settable for each zone.

6.12.17 The operating time of zone-1 protection shall not be unduly increased due to CVT transients.

6.12.18 The transient performance CVT as per IEC 61869-5: 2011 shall provide protection stability & security for close-in faults in both directions.

6.12.19 It shall be supplemented with positive sequence memory voltage for use in case of close-up three- phase faults and shall be active for more than 100 ms. The directional performance shall be

maintained on reverse direction 3-phase close-up fault when the relay is supplied from CVT.

6.12.20 Communication type signal assistance shall be employed for simultaneous clearance of fault between two ends of the line in zone-1 time.

6.12.21 The distance protection shall be designed to any of the following inter-tripping schemes as shown in table 4.

6.12.22 Table 4: Inter-tripping Schemes

#	Inter-tripping scheme
1	Permissive under reach schemes
2	Permissive overreach schemes
3	Overreach blocking schemes
4	Zone-1 extension schemes
5	Basic 3-zone distance
6	Weak in-feed and echo-back feature

6.12.23 Tele-protection communication scheme shall be the through same communication link that used for the line differential protection function.

6.12.24 The distance relay shall be stable during line charging current suitable for lines equipped with series capacitor compensator.

6.12.25 The protection function shall detect and correctly operate during the revolving faults without mal-operation as well as for current reversal conditions.

6.12.26 Two-sided Integrated fault locator feature shall be provided and calculate the distance-to-fault. The result shall be specified in ohms, miles, kilometers or in percent of the line length and shall be user selectable.

6.12.27 The Ohmic setting ranges at 1A rating for all zones shall be from 0.2 to 240 ohms/phase (When 5 Amp rating is applied, the ohmic setting shall be divided by 5). The characteristic angle for phase, neutral & mutual (where fitted) shall be adjustable from 45^0 to 90^0 in 1^0 steps for each zone separately.

6.12.28 The distance protection function shall comply with IEC60255-121: 2014.

6.12.29 The operating time shall be one cycle for (zone 1) fault.

6.13 AUTO-RECLOSING FUNCTION (79):

6.13.1 This function is only applicable for overhead lines/feeders, it shall be blocked for underground cable line/feeder. Minimum number of shots shall be 5 shots.

6.13.2 The initiation signal of the AR function shall be selectable from the protection functions of the relay.

6.13.3 The thermal overload and switch on to fault protection functions shall be settable to block the auto-reclosing function if operated and unblock the AR function when resettled.

6.13.4 The AR functions shall have a settable dead time delay start from initiation of the AR function.

6.13.5 When the AR is initiated, a reclose command shall be issued after the dead time if there is no blocking signal and the circuit breaker is ready.

6.13.6 The AR function shall be blocked during a settable reclaim time which start from the last shot of the AR, also shall be blocked if the circuit breaker is not ready or if there is a pre-configured external blocking signal.

6.13.7 The AR function shall be configurable to lockout the circuit breaker closing in the following conditions as stated in table 4.

6.13.8 Table 5: Conditions of Auto-recloser to lockout the closing CB

#	Case or Condition for lockout of CB closing
1	unsuccessful auto-reclosing
2	close time-out and the circuit breaker didn't close
3	A new shot is initiated during the discrimination time
4	The protection trip signal has been active longer than the dead time

6.13.9 The AR function shall be suitable for three pole circuit breaker.

6.13.10 The three pole AR function shall be released by a synchrocheck signal internally from incorporated synchrocheck function or externally via binary input signal.

6.14 TRANSFORMER PERCENTAGE BIASED DIFFERENTIAL PROTECTION (87T)

6.14.1 Transformer differential protection function shall be suitable for all types of phase and earth faults. It shall operate on percentage biased differential principle.

6.14.2 It shall be suitable for two winding transformer and three winding where required.

6.14.3 The differential protection shall be stable on all external faults. The relay shall discriminate between in-zone and out-of-zone faults within 5 ms.

6.14.4 It shall not be affected by DC components of through current or under conditions of CT saturation. The relay shall be suitable for its application to rating of the transformer being protected. The relay shall be provided with second harmonic restraint feature to ensure stability of relay during magnetization inrush condition.

6.14.5 The above harmonic restraint feature shall be adequate to make relay immune to inrush due to sympathetic and relaxation transients.

6.14.6 The differential protection shall be provided with unrestrained instantaneous function with a suitable setting range and adjustable at site.

6.14.7 The differential protection function shall be provided with a choice for 2nd and 5th harmonic restraint or blocking features such that, it shall not mal-operate under over-excitation conditions.

6.14.8 The differential protection shall be provided with zero sequence filtering function to prevent mal-operation for external earth faults. The transformer differential protection shall be suitable for star connected CTs with neutral earthed in bus bar side or transformer

side and the feature of the CT polarity changing shall be user selectable.

6.14.9 The differential protection function shall have dual slope percentage restraint characteristics.

6.14.10 The transformer differential function shall comply with IEC 60255-13: 1980.

6.14.11 The differential protection shall operate within one cycle.

6.14.12 The differential setting range shall be (0.05 – 4In) in steps of 0.01In.

6.15 RESTRICTED EARTH FAULT RELAY (64REF)

6.15.1 This protection shall be used for earth fault protection of solidly and resistance grounded windings of MV transformers.

6.15.2 This function shall be independent and applied for each transformer winding.

6.15.3 The REF function shall be based on High Impedance Principle and shall be designed for being stable under all external faults utilizing Stabilizing Resistor with suitable wattage.

6.15.4 This function shall not be affected by harmonics and DC components present in the through fault currents under CT saturation.

6.15.5 The transformer restricted earth fault function shall comply with IEC 60255-13: 1980.

6.15.6 The restricted earth fault shall operate within 30 ms.

6.16 SYNCHROCHECK FUNCTION (25)

6.16.1 Synchrocheck function shall monitor the voltage, frequency, and phase-angle differences between bus bar and line sides.

6.16.2 The setting of the differences of voltage, frequency and phase angle shall be user selectable.

6.16.3 The input voltage for this function shall user selectable phase-phase or phase-neutral voltage.

6.16.4 Synchrocheck function shall be provided with built-in voltage selection feature and shall be suitable for single bus bar, double bus bar, one and half circuit breaker system where its required.

6.16.5 Synchrocheck shall be configurable under all operation conditions such as live line – live bus bar, live line – dead bus bar, dead line – live bus bar, and dead line – dead bus bar.

6.16.6 For one and half circuit breaker configuration, two Synchrocheck functions are required.

6.16.7 Synchrocheck functions shall be blocked when a VT fuse failure is detected.

6.16.8 Synchrocheck functions shall have independent timers.

6.17 Broken Conductor (46BC)

6.17.1 This function shall start and operates when the unbalance current exceed the set limit.

6.17.2 To prevent faulty operation at least one phase current shall be zero.

6.17.3 The time characteristic shall be according to definite time.

6.17.4 Broken Conductor ratio shall be in the range (0.1 – 1).

6.18 ARC Flash Protection

6.18.1 ARC flash protection shall be based on following selectable operation principle:

1. Light Mode Only.

2. Light with Phase & Ground Fault Current Measurement.

6.18.2 The operating phase current setting range shall be (0.5 – 20In) in steps of 0.01In each.

6.18.3 The operating residual current setting range shall be (0.05 – 8In) in steps of 0.01In each.6.18.4 Maximum trip time of ARC Flash Protection should not exceed 15 ms.

6.18.5 The relay shall support at least 3 light sensors each for cable, breaker and bus compartments.

6.19 High Impedance bus bar Protection

6.19.1 High impedance bus bar protection shall be phase segregated with built-in CT supervision feature.

6.19.2 High impedance bus bar protection shall be blocked when the CT supervision alarm is detected.

6.19.3 Current Transformer shorting device shall be provided with the high impedance bus bar protection to shorten the current when the CT supervision function is operated.

6.19.4 Bus bar protection shall operate within one cycle in case of internal faults (at 2*Iset).

6.19.5 The differential setting range shall be (0.05 – 2In) in steps of 0.01 In.

6.20 Neutral unbalance protection

6.20.1 Neutral unbalance protection with unbalance compensation is provided against internal faults related to capacitor element/unit failures and against arcing faults within the bank.

6.20.2 This protection shall be used to monitor the neutral unbalance current or voltage.

7 Self-Powered Relays

7.1 General Requirements:

7.1.1 The relay shall be of microprocessor based IED.

7.1.2 Self-powered relay should consist of LCD/ LED screen that indicates the settings, measurement and fault data. It must be equipped with backlight feature for convenience of maintenance personnel to access the relay in the dark easily.

7.1.3 All the components, hardware, input/output devices of the relay shall comply with relevant IEC or equivalent standards.

7.1.4 The relay shall use thoroughly tested hardware as per IEC or equivalent standards. Relay should have acquired at least two (2) years of field experience in a major electric utility.

7.1.5 All the input/output units of the relay shall be capable of making/breaking currents (with any transients) and withstand voltages (normally intended/harmonic over voltages).

7.1.6 The degree of protection of the relay enclosure shall be of class IP 54 or better. Relay shall be suitable for outdoor installations in extreme heat of 70 ^{0}C and dusty conditions without affecting its normal performance.

7.1.7 Self-Powered Relays should be Dual Powered (C.T. Powered + Auxiliary Powered). Its operation should not be battery or USB dependent.

7.1.8 Standard CTs to be used with Self-powered relays according to SEC Requirements are as follows:

- 13.8kV Level: 75 / 1 A, 5 P 10 , 2.5 VA
- 33kV Level: 40 / 1 A, 5 P 10 , 2.5 VA

7.1.9 Self-powered relays should be compatible with conventional current transformers and shall have 4 analogue CT inputs (A,B,C,N) to support both measured / calculated EF current.

7.1.10 Disturbance records shall comply with the specifications mentioned under General Requirements Clause (5).

7.1.11 Relay should have at least two configurable binary inputs, two configurable binary outputs, one dedicated watchdog contact and one impulse trip output for tripping breaker with low energy trip coil.

7.1.12 Self-Powered Relay should consists of (4) configurable function LEDs.

7.1.13 Self-Powered Relay should be provided such that RMU Circuit Breaker trip circuit can be checked offline (on a dead condition).

7.1.14 Self-Powered Relay should be easily removed for maintenance or replacement with CT shortening and grounding facility.

7.1.15 Self-Powered Relay Battery should be used to energize the device when CT Power or USB Power is not available. It should be Lithium Battery with not less than 10 years life time.

7.1.16 Front side communication port shall be provided for setting implementation and Disturbance records retrieval.

7.1.17 Rear side communication port shall be provided to continuously monitor the relay from a remote PC or SCADA system. Relay shall support the protocols: IEC 60870-5-103/104, MODBUS RTU, DNP3.0 or as required by the company.

7.1.18 Relay impedance shall allow proper operation of Self-Powered Relay in all operating conditions. It shall always be far less than CT burden (i.e. 2.5 VA). Relay Impedance Curve shall be provided in the relay manual.

7.1.19 Switch On To Fault (SOTF) functions shall be available and the SOTF curve shall be provided in the relay manual.

7.2 APPLICATION:

7.2.1 Self-powered relays are intended to be a part of Ring Main Units (RMU) or any secondary distribution switchgears.

7.2.2 The relay shall be:

7.2.1.1 Suitable for operating on 60 Hz.
7.2.1.2 Suitable for all types of grounding system.
7.2.1.3 Provided with local / remote trigger indicator for the CB tripped with fault indication.

7.3 SENSITIVITY

7.3.1 Minimum current for Relay power on should be as follows:

7.3.1.1 (80 mA) secondary current in all three phases.

7.3.1.2 (120 mA) secondary current in two phases.

7.3.2.3 (180 mA) secondary current in single phase.

7.4 PROTECTION FUNCTIONS AND SETTING RANGES

7.4.1 The protection features includes at least:

7.4.2 Time-delayed Phase Overcurrent Protection: (51 P)

I> (0.1 – 2) In

TMS = (0.01 – 1.5) with 0.01 resolution.

7.4.3 Instantaneous phase overcurrent protection: (50 P)

I>> (0.1 – 20) In

T = 0 second.

7.4.4 Time-delayed Earth Fault Protection which can be either derived from line CTs or measured through residual connection: (51 N)

Ie> (0.05 – 0.8) In

TMS = (0.01 – 1.5) with 0.01 resolution.

7.4.5 Instantaneous Earth Fault Protection which can be either derived or measured from line CTs: (50 N)

Ie>> (0.1 – 10) In

T = 0 second.

7.4.6 Inrush detection for stability during transformer charging

I(2f) / I = 5 % - 35 %

7.4.7 Thermal overload protection (49)

Self-Powered shall be provided with thermal overload protection.

7.4.8 Switch On To Fault (SOTF).

SOTF Curve shall be provided in the relay manual.

8 Protective Relays Tests

8.1Type Test

Prescribed test in the applicable IEC and IEEE Standards shall be performed on the first unit of every new design. Certified test reports of type test performed on identical equipment acceptable to National Grid SA may be submitted for review and acceptance in lieu of the required type tests above. Table 6 below shows the applicable type tests the latest IEC 60255-1: 2009. The latest revision/amendments of the following Codes and Standards shall be applied.

8.2 Table 6: Type Test.

No.	Test Item	Standard
1	Dimensions of Enclosure and visual inspection	IEC 60297-3-101 (2004)
2	Functional requirements: - Steady-state simulation. - Dynamic simulation.	IEC 60255-121 (2014), IEC 60255-127 (2010), IEC 60255-149 (2013), IEC 60255-151 (2009), IEC 60255-13 (1980) IEC 60255-1 (2009)
3	Product safety requirement (including thermal short time rating)	IEC 60255-27 (2013)
4	EMC Requirements: - Emission - Immunity	IEC 60255-26 (2013)
5	Energizing quantities: - Burden - Change of auxiliary energizing quantity	 IEC 60255-1 (2009) IEC 60255-26 (2013)
6	Contact performance.	IEC 61810-2 (2011)
7	Communication requirements	IEC 61850 Edition 2
8	Climatic environmental requirements: - Cold - Dry heat - Change of temperature - Damp heat	IEC 60068-2-14 (2009), IEC 60068-2-1 (2007), IEC 60068-2-2 (2007), IEC 60068-2-78 (2012), IEC 60068-2-30 (2005), IEC 60255-27 (2013)
9	Mechanical requirements: - Shock - Vibration - Bump - Seismic	IEC 60255-21-1 (1988), IEC 60255-21-2 (1988), IEC 60255-21-3 (1993)
10	Enclosure protection	IEC 60529 (2013), IEC 60255-27 (2013)
11	Software Test	IEC 61508-3 (2010)

8.3 Routine Test

Routine test is conformity test made on each individual device during or after manufacture. Prescribed test in the applicable IEC Standard shall be performed in the corresponding equipment. Table 7 below shows the applicable routine tests according to IEC 60255-1: 2009. the latest revision/amendments of the following Codes and Standards shall be applied.

8.4 Table 7: Routine Test

No	Test Item	Standard
1	Dimensions of Enclosure and visual inspection	IEC 60297-3-101 (2004)
2	Functional requirements: - Steady-state simulation - Dynamic simulation	IEC 60255-121 (2014), IEC 60255-127 (2010), IEC 60255-149 (2013), IEC 60255-151 (2009), IEC 60255-13 (1980) IEC 60255-27 (2013)
3	Product safety requirement (including thermal short time rating)	IEC 60255-27 (2013)

9.0 DATA SCHEDULE:

PROTECTIVE RELAYS

SEC Enquiry No._____ date_____
SEC Purchase Order No. or Contract No._____ date_____
SEC PTS No./Project Title with J.O. No._____

REFERENCE DESCRIPTION 'A' 'B' 'C' SECTION No.				
3. APPLICABLE CODES / STANDARDS				
	Applicable Industry standards			
	Manufacturer*			
	Type/*			
	Model/Version No.	*		
4. DESIGN AND CONSTRUCTION REQUIREMENT				
4.1 Rating				
4.1.2	CT input (A)	1 / 5		
4.1.3	VT input (V)	120		
	Relay Burden rated	*		
	Current input (VA)	*		
	Voltage input (VA)	*		
	Thermal overload (I_{th}) current capability :			
	Continuous *(I_n)	4		
	10 s*(I_n)	30		
	1 s*(I_n)	100		
	Thermal withstand (V_{th}) :			
	Continuous *(V_n)	*		
	@10 s*(V_n)			

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'.

REFERENCE	DESCRIPTION	'A'	'B'	'C'
SECTION No.				
4.1.4	Auxiliary supply			
	Rated of Auxiliary DC Voltage (V)	125/48		
	Tolerance %			
	Maximum ripple	< 15%		
	Power consumption (w)	*		
	Relay Time to power Up	*		
	Relay interruption withstand (ms) without de-energizing.	*		
	Battery backup type	*		
	Relay housing	*		
		*		
4.1.5	Frequency Range			
4.2 Design and Construction				
4.2.5	Dimension (W.L.H) Mm	*		
	Weight (Kg)	*		
	Terminal Type			
	CT terminal	*		
	Opto input terminal	*		
	Output terminal	*		
	Case earth terminal	*		
	Temperature and humidity			
	Ambient temp			
	a. In service	*		
	b. For storage	*		
	c. During transport	*		
	d. During start-up	*		
	Relative humidity	*		
	Name of Software	*		
	With-drawable	*		
4.2.6	Degree of Protection	*		

REFERENCE	DESCRIPTION	'A'	'B'	'C'
SECTION No.				
4.2.8	CT short facility	Yes		
	Display type and character.	Yes		
	Communication Port	*		
5. GENERAL REQUIRMENTS				
5.4	Protocol available	IEC 61850		
	Front port Type & No.	*		
	Rear Port Type & No.	2		
5.5	Time synchronization	*		
	Facilities through HMI	*		
5.6	LEDs			
	Number of LEDs Fixed	*		
	Number of LEDs Programmable	*		
	Whether suitable for any communication scheme.	*		
5.10	Binary inputs			
	No. of Binary inputs	*		
	Operating voltage	*		
	Maximum dc current for operation	*		
	Pickup delay (sec)	*		
	Drop off delay (Sec)	*		
5.11	Output Contacts			
	Number of Fixed contacts	*		
	Number of Programmable contacts	*		
	Switching capacity:			
	Make Watt	*		
	Breaking Capacity			
	AC Resistive	*		
	DC: W resistive	*		
	DC inductive @ (L/R = 40ms) w	*		

REFERENCE	DESCRIPTION	'A'	'B'	'C'
SECTION No.				
	AC inductive at (cosϕ = 0.7) VA	*		
5.11	Durability:			
	Loaded contact: operations (min)	*		
	Unloaded contact: operations(minimum)	*		
	Operate Time ms	*		
	Reset Time ms	*		
	Watchdog contacts	Yes		
5.16	Disturbance recorder			
	Sampling Rate	*		
	Total Duration of fault recording.	*		
	Pre fault and post fault time.	*		
	No. Of records.	*		
	Duration of each record	*		
	No. of analog channel.	*		
	No. of digital channel	*		
	Fault records			
	No. of fault Records	*		
5.18	Events recording capacity.	*		
	Self-supervision facility.	*		
6. PROTECTION FUNCTIONS				
6.1 6.2 6.3 6.4 6.5	Number of groups	*		
Time-delayed OC & EF(51P, 51N)	O/C Current Setting	*		
Instantaneous OC & EF(51P, 51N)	Range (A)			
SEF	E/F Current Setting	*		
Directional OC & EF(67P, 67N)	Range (A)			
	Time Delay of DT(s)	*		
	Operating Level	*		
	Accuracy			
	Reset Current level	*		
	Reset Time	*		
	Relay Characteristic	*		

REFERENCE	DESCRIPTION	'A'	'B'	'C'
SECTION No.				
	Angle (RCA) in (°) (Where Applicable)	*		
	Second harmonic blocking	*		
	Operating time of IDMT	*		
	Accuracy of Operating time	*		
	Minimum operating time of High	*		
6.6 Thermal overload (49)	Operate levels	*		
	Setting Range	*		
	Operating Level accuracy	*		
	Time Constant Setting	*		
	Operate time	*		
	Alarm Level	*		
	Thermal alarm pick-up: Accuracy	*		
	Thermal overload pick-up:	*		
	Cooling time (s)	*		
6.7 Phase Unbalance (46)				
	Current Setting Range Is	*		
	DT Operate Level	*		
	DT Operate Level accuracy	*		
	DT Delay Setting td	*		
	DT Operate time Td	*		
	Td accuracy	*		
	IT Char Setting	*		
	IT Setting Range	*		
	Tm Time Multiplier	*		

8.0 DATA SCHEDULE
PROTECTIVE RELAYS

REFERENCE	DESCRIPTION	'A'	'B'	'C'
SECTION No.				
6.7 Phase Unbalance (46)	Char Operate Level Is,	*		
	Char Operate Level Is accuracy	*		
	Overshoot Time < ms	*		
6.8 Under voltage (27)	Setting Range Vs	*		
	Hysteresis Setting %	*		
	Delay Setting td	*		
	td Accuracy	*		
	DT Pick-up: Setting	*		
	DT Pick-up: Setting Accuracy	*		
	IDMT Pick-up accuracy	*		
	Drop-off Accuracy	*		
	Reset Level:	*		
	Accuracy IDMT characteristic shape:	*		
	Reset:	*		
6.8 Overvoltage (59)	measurement			
	curve characteristic	DT/IDMT		
	DT Pick-up: Setting	*		
	DT Accuracy ±1%	*		
	IDMT Pick-up: Setting accuracy	*		
	Drop-off: setting accuracy	*		
	Definite time operation	*		
	Definite time Accuracy	*		
	± ms or % of operating Time	*		
	IDMT characteristic	*		
	Reset Time	<75 ms		
6.8 Neutral displacement / residual Overvoltage (59N)	Current Setting	*		
	Range Is			
	DT Operate Level	*		
	DT Operate Level accuracy	*		
	DT Delay Setting Td	*		
	DT Operate time Td	*		
	Td accuracy	*		
	IT Char Setting	*		
	IT Setting Range	*		

8.0 DATA SCHEDULE
PROTECTIVE RELAYS

REFERENCE	DESCRIPTION	'A'	'B'	'C'
SECTION No.				
	Tm Time Multiplier	*		
	Char Operate Level Is	*		
	Char Operate Level Is accuracy	*		
	Overshoot Time < ms	*		
	Accuracy	*		
	Pick-up:			
	Accuracy	*		
	Drop-off:			
	Overshoot Time < ms	*		
6.9 Over/Under	Under Voltage Guard	Yes/No		
Frequency (81)	Setting Range Hz	*		
	Hysteresis Setting	*		
	Operate Level	*		
	Operate Time Typical	*		
	Vs Operate Delay	*		
6.9 Frequency protection (81Rate-of-change)	Operate value, pickup Hz/S	*		
	Pickup accuracy	*		
	Operate time, pickup	*		
	Reset time, pickup	*		
6.10 Circuit Breaker Fail (50BF)	Modes of operation	*		
	Setting Range Is	*		
	No of Stage Time Delays	2		
	Timer 1 setting	*		
	Timer 2setting	*		
	Operate Level accuracy @100%	*		
	Disengaging time < ms	*		
	Operate time following Delay accuracy	*		
6.11 Phase current line differential protection (87L)	Current differential setting Range Idiff>	*		
	Idiff> accuracy	*		
	High current Range Idiff>>	*		

8.0 DATA SCHEDULE
PROTECTIVE RELAYS

REFERENCE SECTION No.	DESCRIPTION	'A'	'B'	'C'
	Restrained characteristic	*		
	Slope setting range	*		
6.11 Phase current line differential protection (87L)	K1 setting range	*		
	Instantaneous Operation: < ms	*		
	Reset time: < ms	*		
	Drop-off time	*		
	Two ended scheme operation: (ms)	*		
	Three/four ended scheme operation time (ms)	*		
6.12 Distance protection (21/21N)	1-Full-scheme distance protection, distance characteristic	Quadrilateral /MHO		
	Number of zones	5 zones With selectable Direction		
	Minimum operate current setting	*		
	Positive sequence reactance setting Ω/phase	*		
	Positive sequence resistance setting Ω/phase	*		
	Positive sequence impedance angle (°)	*		
	Phase–ground loop setting Range	*		
	Zero sequence reactance setting Ω/phase	*		
	Zero sequence resistance setting Ω/phase	*		
	Angle for positive sequence impedance, phase–phase elements degrees	*		
	Fault resistance, phase-ground Ω/loop	*		

8.0 DATA SCHEDULE
PROTECTIVE RELAYS

REFERENCE	DESCRIPTION	'A'	'B'	'C'
SECTION No.				
	Magnitude of ground return compensation factor KN	*		
	Angle for ground compensation factor KN degrees	*		
	Dynamic overreach CCVT's and 0.5<SIR<30	*		
	zone 1 time setting (s)	*		
	zone 1 time setting accuracy	*		
	zone 2 time setting(s)	*		
	zone 2 time setting accuracy	*		
	zone 3 time setting(s)	*		
	zone 3 time setting accuracy	*		
	zone4 time setting(s)	*		
	zone 4 time setting accuracy	*		
	zone 5 time setting(s)	*		
	zone 4 time setting accuracy	*		
	Operate time of Z1	*		
	Reset ratio	*		
	Reset time	*		
	2- Scheme of communication logic for distance protection			
	Scheme type	-Inter-trip -PUTT -POTT -Blocking -Weak Infeed		
	Time setting for blocking communication Scheme sec	*		
	Time blocking accuracy	*		
	Time of a send signal s	*		
	Time of send Iter-trip/PUTT/POTT/WI signal	*		

8.0 DATA SCHEDULE
PROTECTIVE RELAYS

REFERENCE	DESCRIPTION	'A'	'B'	'C'
SECTION No.				
	Operation mode of unblocking logic	-Off -No Restart -Restart		
	3-switch onto fault logic			
	Operate voltage, detection of dead line V	*		
	Operate voltage accuracy	*		
	Operate current, detection of dead line	*		
	Operate Current accuracy	*		
	4- 78Power swing detection			
	Reactive reach setting Ω/phase	*		
	Reactive reach setting accuracy	*		
	Resistive reach setting Ω/loop	*		
	Resistive reach setting accuracy	*		
	Time setting sec	*		
	Time setting accuracy	*		
	5- Sensitive Directional Earth Fault			
	Current Setting Range (mA)	*		
	Accuracy Current	*		
	Operating Time Setting Range (ms)	*		
	Tele-protection Scheme	POTT and Week Infeed		
	Reset ratio	*		
	Reset time	*		
6.13 Auto-reclose (79)	Number of re-closures shot	*		
	Operating Mode	*		
		*		

8.0 DATA SCHEDULE
PROTECTIVE RELAYS

REFERENCE	DESCRIPTION	'A'	'B'	'C'
SECTION No.				
	Blocking time after manual closing	*		
	Blocking time after dynamic blocking	*		
	No. of Single Pole Shot	*		
	No. of Three Pole Shot	*		
	1 Pole Dead Time:	*		
	Dead Time 1:	*		
	Dead Time 2:	*		
	Dead Time 3:	*		
	Dead Time 4:	*		
	CB Healthy Time:	*		
	Reclaim Time:	*		
	AR Inhibit Time:	*		
	Check Sync Time:	*		
	Accuracy Timers:	*		
	Setting			
6.14 Transformer differential protection (87T)	Restrained characteristic	Dual slope		
	K1	*		
	K2	*		
	Differential current			
	Range IDIFF > (A)	*		
	Pickup values accuracy	*		
	High-current stage			
	IDIFF >> (A)	*		
	IDIFF >> accuracy	*		
	Operating Time of IDIFF > (ms)	*		
	Operating Time of IDIFF >> (ms)	*		
	2nd harmonic setting			
	Range	*		
	3rd harmonic setting			
	Range	*		
	5th harmonic setting			
	Range	*		
	Pick up time of Harmonic (ms)	*		

8.0 DATA SCHEDULE
PROTECTIVE RELAYS

REFERENCE	DESCRIPTION	'A'	'B'	'C'
SECTION No.				
6.15 Restricted Earth Fault (64REF)	Setting Range of	*		
	Operate Level (A)	*		
	Operate Level accuracy	*		
	Time Delay Range (ms)	*		
	Time Delay accuracy	*		
	Minimum Operate Time (ms)	*		
6.17 check Synchronism (25)	Accuracy Timers: Setting	*		
	Operating modes	Sync-check conditions: LL/LB LL/DB DL/LB DL/DB		
	Upper threshold voltage Setting range	*		
	threshold voltage Accuracy	*		
	Setting range accuracy	*		
	Phase angle difference,	*		
	$\Delta\phi$ Setting range	*		
	$\Delta\phi$ accuracy	*		
	Frequency difference, Δf	*		
	Setting range			
	Δf accuracy	*		
	Operate time of circuit	*		
	breakers,			
	Time Setting range	*		
	time delay accuracy			
	Setting range accuracy	*		
	Phase angle difference,	*		
	$\Delta\phi$ Setting range			
	$\Delta\phi$ accuracy	*		
	Voltage difference, ΔU	*		

8.0 DATA SCHEDULE
PROTECTIVE RELAYS

REFERENCE	DESCRIPTION	'A'	'B'	'C'
SECTION No.				
6.18 ARC Flash Protection	Phase Pickup value	*		
	Ground Pickup value	*		
	Operation mode	*		
	Pickup Accuracy	*		
	Trip time	*		
	Reset time	*		
	Pickup Accuracy			
6.19 Bus bar Differential protection (87B)	Current differential setting Idiff>			
	Idiff> accuracy	*		
	Restrained characteristic	*		
	K setting range	*		
	Operating time (ms)	*		
	Reset time (ms)	*		
	Drop-off time	*		
	Number of feeders	*		
	Number of bus section & couplers	*		
	End Fault Current Setting Range (A)	*		
	End Fault Time Setting Range (ms)	*		

8.0 DATA SCHEDULE
PROTECTIVE RELAYS

REFERENCE	DESCRIPTION	'A'	'B'	'C'
SECTION No.				
7. Self-Powered Relays	O/C Current Setting Range	*		
	E/F Current Setting Range	*		
	Time Multiplier	*		
	Minimum Relay Power on Current	*		
	Reset Time	*		
8 TESTS				
	1.Electrical tests	*		
	2.EMC tests for interference immunity	*		
	3.EMC tests for interference emission	*		
	4.Mechanical stress tests	*		
	5.Enviromental stress tests	*		
	6.Safty Tests	*		

8.0 DATA SCHEDULE
PROTECTIVE RELAYS

A. ADDITIONAL TECHNICAL INFORMATION OR FEATURES TO BE FURNISHED BY SEC

B. ADDITONAL SUPPLEMENTARY DATA OR FEATURES PROPOSED BY BIDDER/VENDOR / SUPLLIER/CONTRACTOR

C. OTHER PARTICULARS TO BE FILLED BY BIDDER/VENDOR / SUPLLIER/CONTRACTOR

	Actual Manufacturer of Equipment/Material	Vendor/Supplier/Contractor
Name of the company location address		
Name and signature of authorized representative and date		
Official seal/stamp of the company & date		

10. Revision Table

The below table includes the most important revisions in this version.

#	Item revised (Section/Clause #)	Revision type (addition/modification / deletion)	Revision/Justifications (revision content)
1	Table (6)	Deletion	RMUs CT specification revised. Clause (8): Table (6): Types Tests Lists revised. IEEE Tests removed.
2	6.11.11	Addition	It shall enable zone-1 of the built-in distance protection function when communication link is faulty. Overcurrent/Earth Fault protection shall also be available as a built-in features.
3	6.12.2	Modification	It shall be provided with 5 distance zones and selectable Quadrilateral and MHO **(with and without offset)** characteristics and shall have independent zone reach settings.
5	7.1.8	Modification	Standard CTs to be used with Self-powered relays according to SEC Requirements are as follows: 13.8kV Level: 75 / 1 A, 5 P 10 , 2.5 VA 33kV Level: 40 / 1 A, 5 P 10 , 2.5 VA
6	7.1.9	Addition	Self-powered relays should be compatible with conventional current transformers and shall have 4 analogue CT inputs (A,B,C,N) to support both measured / calculated EF current.

Table 8: Table of new modifications/changes to Rev. 1.