Addendum & Corrigendum Slip No-01

to the RDSO's Specification No. TI/SPC/PSI/PROTCT/5070 (Rev.1) for Microprocessor Based Numerical Integrated feeder Protection Module Comprising DPR, OCR, WPC, PTFF & Auto Reclosure Relay For 25 kV AC single phase 50 Hz Traction Sub-Station.

New Clause No-15.0 added

"All the provisions contained in RDSO's ISO procedures laid down in document No.- QO-D-7.1-11 dated 19.07.2016 (Titled " Vendor- change in approved status") and subsequent versions/amendments thereof, shall be binding and applicable on the successful vendor/vendors in the contracts floated by Railways to maintain quality of products supplied to Railways".

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Lucknow-226011
Dated: 24.10.2016

TRACTION INSTALLATION DIRECTORATE
कर्षण संस्थापन निदेशालय

सत्यमेव जयते

GOVERNMENT OF INDIA MINISTRY OF RAILWAYS
भारत सरकार, रेल मंत्रालय

TECHNICAL SPECIFICATION
FOR
MICROPROCESSOR BASED NUMERICAL INTEGRATED FEEDER PROTECTION MODULE COMPRISING DPR, OCR, WPC, PTFF & AUTO RECLOSURE RELAY FOR 25 KV AC SINGLE PHASE 50 HZ TRACTION SUB-STATION

SPECIFICATION NO: TI/SPC/PSI/PROTCT/5070 (Rev.1)

विशिष्टि संख्याः टी•आई•/स्पेक/पी•एस•आई•/प्रोटेक्ट/5070 (रिवी•1)

Revised in: (September,2014)

ISSUED BY

Traction Installation Directorate
Research Designs & Standards Organisation,
Manak Nagar,Lucknow-226011.

SPECIFICATION: Technical Specification for Microprocessor based Numerical Integrated Feeder Protection module comprising DPR, OCR, WPC, PTFF & Auto Reclosure Relay for 25 kV AC Traction System.

SPECIFICATION No. TI/SPC/PSI/PROTCT/5070 (Rev.1)

Sl. No.	Date of revision	Rev. No.	Reason of revision	Total Page
1.	-	0	NA	27
2.	Sept., 2014	1	• Implementation of Polygonal characteristic Distance Protection function. • Two stage OCR and its operating time. • Increase the disturbance record storage capacity. • Safety requirement test as per IEC:60255-27, Enclosure Protection Test IP54 as per IEC:60529, Communication standard protocol as per IEC:60870-5-103, Cold test as per IEC60255-1/IEC60068-2-1, Change of temperature as per IEC60255-1/ IEC60068-2-14. • Increase relay LCD size from 16x2 characters to 20x4 characters. • CT and PT primary value setting. • Ambient temperature range change from 0 to 55 °C to -10 to **55** °C. • Settable WPC angle, minimum operating current etc.	26

	Prepared By	Checked By	Approved By
Signature	15.9.14	15.9.14	16/ix/2014
Date			
Designation	SSE-Protection	DD-PSI/TI	Director (OHE-E) /TI

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ANNEXURES

1.0 SCOPE

1.1 This specification applies to the design, manufacture, supply, testing and commissioning of numerical integrated feeder protection module comprising Polygonal characteristic Distance Protection Relay (DPR), Over Current Relay (OCR), Wrong Phase Coupling (WPC), Potential Transformer Fuse Failure (PTFF) & Auto Reclosure Relay for the protection of 25 kV AC traction overhead equipment.

1.2 The feeder protection module shall be complete with all parts and accessories including auxiliary relays, necessary for its efficient operation. All such parts and accessories shall be deemed to be within the scope of this specification whether specifically mentioned herein or not.

1.3 This specification supersedes specification No. TI/SPC/PSI/ PROTCT/5070.

2.0 GOVERNING SPECIFICATION

2.1 The protection module shall, unless otherwise specified, conform to the following standard specifications (latest version) which shall be applied in the manner altered, amended or supplemented by this specification and Indian Electricity Rules, wherever applicable.

(i)	IEC 60255-16	Impedance Measuring Relay.
(ii)	IEC 60255-151	Functional Requirements for Over/Under Current Protection.
(iii)	IEC 60255-5	Insulation coordination of measuring relays and protection equipment- requirements and tests.
(iv)	IEC 60255-1	Measuring relays and protection equipment- Common requirements.
(v)	IEC 60255-21-1	Vibration Tests (Sinusodial)
(vi)	IEC 60255-21-2	Shock and Bump Tests
(vii)	IEC 60255-21-3	Seismic Tests
(viii)	IEC 60255-27	Product Safety Requirement.
(ix)	IEC 60255-26	Electromagnetic Compatibility Requirement.
(x)	IEC 60529	Degrees of Protection provided by enclosures (IP Code)
(xi)	IEC 61810-2	Reliability.
(xii)	IS 2705 (Part II, III&IV)	Protective current transformers.
(xiii)	IS 3156 (Part II/III)	Measuring/protective voltage transformers.
(xiv)	IS 3231 (Part 1 to 3)	Electrical relays for power system protection.
(xv)	IS 8686	Static protective relays.
(xvi)	IEC 60068-2	Environmental tests.

2.2 Any deviation from this specification, proposed by the tenderer calculated to improve the performance, utility and efficiency of the equipment, will be given due consideration provided full particulars of the deviation with justification thereof, are furnished. In such a case the tenderer shall quote according to this specification and the deviations, if any, proposed by him shall be quoted as an alternative/alternatives

3.0 SERVICE CONDITIONS

3.1 The protection module is intended for use in humid tropical climate in any part of India with the following atmospheric conditions:

1.	Maximum ambient temperature	55°C
2.	Minimum ambient temperature	-10 °C
3.	Average ambient air temperature over a period of 24 hours	35°C
3.	Max. Temp attainable by an object exposed to Sun	70 °C
4.	Max. & Minimum relative humidity	100% & 22%
5.	Max. (Basic) wind pressure	200 kg/m^2
6.	Elevation above the mean sea level	To be considered for all complete Indian peninsula
7.	Average annual rainfall	1750 to 6250 mm.
8.	Number of thunderstorm days per annum.	85 days (Apx.)
9.	No. of rainy days per annum	120 days (Max.)
10.	Max no of dust storm days/annum	35 days
11.	Vibrations	Max: 350 micron Average: 30 – 150 micron Time duration: rapidly varying time duration 15–70 ms

3.2 The protection module shall be mounted on control and relay panel that shall be installed in the masonry control room at 25 kV AC traction sub-stations which are normally unmanned. The masonry control room is situated close to the Railway tracks and hence is subjected to vibrations due to running of trains.

4.0 TRACTION POWER SUPPLY SYSTEM

4.1 General scheme of traction power supply system.

4.1.1 Power is received from the grid network of the state electricity board at 220kV/132kV/110kV/66kV at individual traction substation (TSS). 25 kV power supply for traction is drawn through a single-phase step down traction transformer. The primary winding of this transformer is connected to any two nominated phases of the incoming three phase lines or to the two incoming phase lines and on the secondary side, either of the two terminals of the 25 kV winding is connected to the traction overhead equipment, while the other is solidly earthed and connected to the running traction rails.

4.1.2 Each transformer shall have its associated circuit breakers on the primary and secondary sides, with a separate set of 25 kV circuit breakers called " feeder Circuit Breakers" for feeding the traction OHE lines.

In certain traction sub–stations on Indian Railways, two traction transformers are operated in parallel to feed the traction supply. Hence the tenderer shall have to take into account increase in fault levels especially for close in faults.

4.1.3 Adjacent TSS is fed from different phases of the three-phase system in rotation. Neutral sections in front of sectioning and paralleling post (SP) are provided in the 25 kV OHE for segregating the different phases. In between the TSS and SP, sub-sectioning and paralleling posts (SSP) are provided for

paralleling the UP and DN line OHE and also for sectionalizing and fault localization.

4.1.4 The supply to the OHE can be switched ON/OFF through interrupters, which do not open automatically on fault but can be closed on to a fault. The fault is cleared by the feeder circuit breaker provided at the traction substation.

4.1.5 Normally power supply from a TSS extends up to the SP on either side of the substation, but in case of an emergency necessitating total shut down of the substation, power supply from adjacent TSS on either side of the failed substation can be extended up to the failed substation by closing the bridging interrupters at the two SPs. Also under certain emergency conditions the supply can be extended beyond the failed TSS up to the next SP.

4.2 Nature of traction load and faults on the system

4.2.1 The traction load is a frequently and rapidly varying one between no load and overload. The TSS equipment is subject to a number of earth faults/short circuits.

4.2.2 The AC electric rolling stock is fitted, for conversion of ac to dc, with single-phase bridge-connected silicon rectifiers with smoothing reactor for feeding the dc traction motors. The rectifiers introduce harmonic currents in the 25 kV Power supply. On few locomotives there are controlled asymmetrical thyristor bridge and GTO Pulse width modulation devices, in place of silicon rectifiers. Typical percentages of harmonics present in the traction current with electric rolling stock are as follows:

Harmonic Generated by IR Locomotives

S.No	Harmonic No.	With Diode Rectifier	With Thyristor	With GTO's
1.	3rd harmonic (150 Hz)	15%	23%	3%
2.	5th harmonic (250 Hz)	6%	14%	2%
3.	7th harmonic (350 Hz)	4%	10%	0.5%
4.	9th harmonic (450 Hz)	-	4%	0.35%
5.	11th harmonic (550 Hz)	-	3%	0.4%
6.	THD's	16.64%	29.15%	3.68%

4.2.3 The average power factor of the electric locomotive and electric multiple units generally vary between 0.7 and 0.8 lagging, without compensation.

4.2.4 In big yards and loco sheds, a large number of locomotives stand idle with only the load of their auxiliaries, drawing fairly large reactive power. The load power factor is therefore, rather low.

4.2.5 On an average the number of faults/short circuits per month per TSS is vary between 10 to 25 but in exceptional cases the number could be more than 100. The magnitude of fault current may vary between 40% and 100% of the dead short- circuit value. However at times the fault current may be much less in case of high impedance faults, bird faults or bond open earth faults shall fall under the category of high impedance earth faults.

4.2.6 Three phase electrical locomotives and EMU'S have been introduced in Indian Railways. These type of locomotive and EMU'S are capable of regeneration during braking.

4.3 Short circuit apparent power of the system

4.3.1 The short circuit apparent power for various system voltages is given below:

Short Circuit Level

Highest system voltage KV	Short circuit apparent power MVA
52	200
72.5	3500
123	6000
145	10000
245	20000

Note: The above Short Circuit levels are indicative only, it may vary place to place.

4.4 Auxiliary power supplies at traction substation

4.4.1 The following power supplies are available at a traction substation.

i) 110 V (+15 & - 30%) dc from a battery.

ii) 240V +/- 20% ac, 50Hz +/- 5%, single phase from a 25/0.24 kV auxiliary transformer.

4.5 Protective relays at the traction sub-stations

4.5.1 For protection of transformer, substation equipment's, shunt capacitor bank, the following relays are provided on control panels housed in the masonry cubicle at the traction substation (TSS).

4.5.1.1 Transformer Protection

(i) Differential relay
(ii) IDMT over-current relays with additional elements of minimum 2 stage independent current and time settable definite time over current relays with enable/disable facility for the primary (HV) as well as for the secondary (LV) side. The IDMT relay on the HV side is also provided with an instantaneous over-current element.
(iii) Instantaneous earth leakage relays on the primary (HV) side as well as on the secondary (LV) side.
(iv) High speed inter-tripping relay.
(v) Auxiliary relays for transformer faults i.e. Bucholz, excessive winding and oil temperature trip and alarm and low oil level alarm.

4.5.1.2 Over head equipment protection

(i) Numerical integrated feeder protection module comprising:
a) Polygonal characteristic distance relay.
b) Wrong phase coupling relay.
c) 2 stage Over Current Relay (stage 1 instantaneous and stage 2 Definite time for over load protection of catenary and contact wire)
d) PT fuse failure relay.
e) Auto reclosure relay.

f) CB trip circuit supervision relays.
g) Contact multiplication function for AP/GP low alarm, AP/GP low trip & lockout

(ii) Vectorial Delta-I relay for detecting high resistive faults.
(iii) Panto flashover prevention relay.

4.5.1.3 Shunt Capacitor Bank Protection

(i) IDMT over-current protection relay with suitable settings.
(ii) Over voltage protection relay.
(iii) Under voltage protection relay with timer to enable the capacitors to discharge before re-closure.
(iv) Current unbalance protection.
(v) Internal fuse for each capacitor element.

4.6 Inter tripping of feeder circuit breakers

4.6.1 In the event of failure of traction substation 25 kV supply is extended from the adjacent substations by closing the bridging interrupters at SPs. Under such emergency feed conditions, wrong phase coupling may be caused at the overlap opposite the failed substation by the pantograph of a passing locomotive, resulting in the tripping of 25 kV feeder breaker at any one of the two substations through wrong phase coupling relay. This may result in the formation of an arc at the overlap due to which the OHE may be damaged. Tripping the feeder circuit breaker at the other substation also can minimize the damage due to the arc. This is achieved by an inter-tripping arrangement through the remote control equipment.

4.6.2 For the purpose of calculation, the values of loop impedance with earth return for the OHE are taken as under:

OHE Line Impedance

OHE impedance value for normal 25 kV AC OHE (65mm2 catenary and 107 mm^2 contact wire)

1.	One OHE without BT and RC	0.41 ∠70 ° Ohms/km
2.	Two OHEs without BT and RC	0.24 ∠70 ° Ohms/km
3.	One OHE with BT and RC	0.70 ∠70 ° Ohms/km
4.	Two OHEs with BT and RC	0.43 ∠ 70 ° Ohms/km

4.7 Traction Power Transformer

The traction transformer shall be 21.6 MVA or 30 MVA, 220 or 132 or 100 or 22/25 kV single-phase transformers with maximum of 12.5 % impedance. The traction transformers shall be designed to carry short time overloads as the traction loads may exceed the rating for short periods.

Rating of the power transformer

Rated capacity for	Rated secondary current of the Transformer	
	30 MVA	21.6 MVA
Continuous	1111 Amps	800 Amps
15 Min	150% i.e 1666.5 Amps	150% i.e 1200 Amps
5 Min	200% i.e. 2222 Amps	200% i.e. 1600 Amps
Ability to withstand short circuit	Thermal : 5 second Dynamic : 0.25 second	Thermal : 5 second Dynamic : 0.5 second

5.0 DESIGN FEATURES

5.1 Constructional Features

5.1.1 The integrated microprocessor based numerical 25 kV feeder protection module comprising of Polygonal characteristic distance protection, Wrong Phase Coupling (WPC), 2 stage (Stage 1 instantaneous & Stage 2 Definite time) Over Current Relay (OCR) , Potential Transformer Fuse Failure (PTFF) Alarm and Trip, Auto Reclosure Relay, CB Trip Circuit Supervision Relay, Breaker backup (LBB) and contact multiplication function for Annunciation and Telesignalling of AP/GP low alarm and AP/GP low trip & lock of feeder CB shall be incorporated in the same module.

5.1.2 Protection module shall have individual LED indication of each protection function i.e. DPR, WPC, Instantaneous OCR, Definite time OCR, PTFF Alarm, PTFF Trip, Breaker backup (LBB), Auto Reclosure bypass on high set current & Auto Reclosure lock out. In addition to these the LEDs for power ON, relay fail, feeder CB AP/GP low Alarm, feeder CB AP/GP low trip & lock, CB Trip circuit fail etc. shall also be provided. External reset facility to reset Auto reclosure lockout from local and remote shall be available.

5.1.3 The measuring technique adopted should be based on digital numeric processing techniques. The analogue input received from CT and PT shall be transformed into a digital signal by using suitable A/D converter. The digital signal so obtained may be processed (with suitable signal analysis) to extract the fundamental and various harmonic contents.

5.1.4 The Protection module shall have in-built contact multiplication relays for each protection and monitoring function. It shall be ensured that atleast two (02) numbers of auxiliary contacts for each protection and monitoring function shall be available on the Relay for indication/annunciation and telesignalling functions.

5.1.5 The Protection module shall be of the draw-out (Plug-in), switch board type, back - connected and suitable for semi-flush or flush mounting. Facility shall be provided for automatic shorting CT terminals when the module is draw-out. The enclosure class of module/relays shall be IP 54 as per IEC 60529.

5.1.6 The current coils/input module of relay shall be rated for 5 amps and capable of withstanding $3I_n$ continuously and short time rating shall be $40I_n$ for 1 sec. where I_n is rated current. The voltage coil shall be rated for 110V AC and capable to withstand 1.15 times of rated voltage continuously and 1.5 times for 3 seconds.

5.1.7 The Protection module shall conform to the test voltage Class -III as per IS: 8686–1977/IS 3231/IEC:60255-5 or latest and product safety requirements as per IEC:60255-27.

5.1.8 The Protection module shall be designed for continuous service (auxiliary supply) voltage of 110 V DC and shall be capable of satisfactory operation up to at least for +15 % and - 30 % fluctuations in voltage.

5.1.9 The Protection module shall have name plates with rating data, serial number and manufacturer’s name marked on them. The metal case shall be provided with separate earthing terminals.

5.1.10 The Protection module should have facility to record actual waveform of current and voltage alongwith all digital and logical status during fault condition. At a time up to 200 such waveforms for currents & voltage shall

be storable and shall be retrievable through RS 232 serial communication port or any other superior type of front end standard communication port with optical interface to limit EMI, accessories and firmware for communication through a Laptop computer and/or suitable external printer. The duration of each disturbance record for current and voltage shall be at least 50 cycles (45 prior to and 5 after trip executed by relay-post fault). The disturbance record shall be triggered from trip operation of relay. Such waveforms shall also be retrievable at RCC through SCADA, suitable software along with compatible protocol for this purpose shall be made available in the relay as well as notebook computer. Relay shall also have a feature for transferring R-X values to RCC through SCADA, relay manufacturer to match the software and protocol to suit the existing SCADA system of any make/firm.

5.1.11 Suitable software shall be supplied along with the Protection module to download and interpret the waveform and other data stored in the relays. The software shall be capable of analyzing the peak, RMS and average values of currents and voltage, Harmonic analysis of current and voltage waveforms and determination of fault clearing time, Resistance, Reactance, Impedance, and Phase angle of waveforms. The accuracy of measurements shall be 1ms for time, 0.1 KV for voltages and 0.1 KA for currents. The software shall also be capable of communicating with the relay and viewing and modifying the settings through laptop computer and SCADA.

5.1.12 The Protection module manufacturers shall provide full support for up gradation of the software time to time to maintain the satisfactory performance throughout the useful life of the relay. The software should run on one of the current operating systems.

5.1.13 Protection module shall provide date and time stamping up to 1ms level for each fault. Relay shall have facility for clock synchronization through SCADA or any other similar synchronization facility like GPS etc.

5.1.14 The Protection module shall be capable of storing minimum 5000 events serially with date and time stamp of 1ms accuracy. The events should includes tripping of different protection elements, relay pickup, relay reset, relay blocked due to harmonics or any other restraints, Auto reclosure acted, Auto reclosure lockout, Auto reclosure bypass, CB trip, CB close, changed of status input, relay setting changed, Relay fail, trip circuit monitoring etc. The events shall be retrievable through an external laptop/PC as well as through SCADA system at RCC.

5.1.15 Operation counters shall be provided for each protection function with resetting facility.

5.1.16 The Protection module shall have compact farm and every effort shall be made to minimize the hardwiring within the module and maximum components shall be on the PCBs. The SMT (surface mounted technology) PCBs shall only be used. Suitable conformal coating to be provided on the PCBs.

The contact multiplication shall as far as possible be done through software. For this purpose only one set of NO/NC auxiliary contact from each switchgear shall be terminated on the C&R panel terminal block.

5.1.17 The design shall be fail-safe and while designing the Protection module, adequate redundancy shall be provided in various functional elements.

5.1.18 The Protection module shall have self-diagnostic features. Suitable displays for confirming the module healthiness or defects shall be available for alarm at TSS and telesignal at RCC through SCADA. Trip contact of relay fail shall also be available to trip circuit breaker.

5.1.19 The modules shall be of industry standard design for continuous operation in the traction substation environment which besides the other environmental requirements being in the vicinity of the Railway tracks. The entire system may be considered as a protection system.

5.1.20 Protection module shall have high contrast backlit LCD display of size at least 20 x 4 LCD characters for display of relay status, settings, on line parameter (current, voltage, Impedance & Phase angle) etc. The parameters of the module shall be settable through a membrane keypad. Manufacturer shall clearly indicate/furnish the sampling rate, accuracy and range of above measurements at the time of design & development to RDSO.

5.1.21 Provision shall be available to reset the indicating LEDs of protection module from relay and from RCC through SCADA. For this purpose suitable switch and NO/NC contact shall be provided in the module.

5.1.22 The size of the module shall be suitable for flush mounting design for fitting on existing/new control and relay panels. The actual size shall be decided at the time of design approval.

5.1.23 The relay settings and stored data shall not get corrupted/erased/changed in the event of auxiliary / control supply voltage i.e. 110 V DC failure.

5.1.24 SCADA system is available for Railway traction application. For its full utilization in controlling / monitoring of protection system, Protection module shall be capable of communicating with the RTU or other IED's based on standard IEC 60870-5-103 protocol for transfer of information stored in relays to the RTU. The relay shall have necessary hardware and firmware interface for this purpose.

The relay module should be capable of supporting following main functions of SCADA (even if some of these may be required in future).

(i) User interface for the interaction with the control system and the controlled process.
(ii) Automatic supervision and control.
(iii) Alarm and event handling.
(iv) Data acquisition, calculating and reporting.
(v) Parameter setting.
(vi) Disturbance data upload.

5.1.25 Suitable password protection shall be provided on the Protection module to avoid unauthorized changes in the relay settings.

5.1.26 The making & breaking capacity and rated current of output contacts of the relays shall be adequate to operate the associated output relays/circuit breaker. Suitable snubber to be provided across the coil.

5.1.27 The module shall also be capable to display I (fault current), V (voltage), R (resistance), X (reactance), Phase angle, fault clearing time and fault date & time (wherever applicable) of latest 200 faults at relay LCD, if it is not possible to display these parameters simultaneously on LCD display, then these parameters may accommodate in two or more window and displaying by pressing scroll Key. The CT's & PTs provided at TSS may have different ratio, hence to display the actual value (line value) of I, V, R, X etc. the CT primary current shall be settable in the range of 100 to 3000A in the

steps of 50A and PT primary voltage shall be settable in the range of 20000V to 30000V in steps of 500V. On line current, voltage, Impedance and phase angle shall also be displayed on relay LCD.

5.1.28 The complete protection function shall be incorporated in single module. For external connection one NO/NC contacts for each protection elements to trip circuit breaker and One set of NO/NC contacts for each protection and monitoring function shall be available for the purpose of telesignalling to RCC through SCADA and other for Annunciation at control and relay panel.

5.1.29 The terminal code of the module shall be marked on the side or back of the relay, where they are visible easily.

5.1.30 The rating of relay terminals terminal shall be 10 A continuous and 150 A for at lest one second at 110 V D.C.

5.1.31 The relays shall be insensitive to permissible overload and transient condition including magnetizing inrush current of locomotive transformers and shall be suitably designed to compensate the effect of fault arc resistance.

5.1.32 The relays shall be immune to distorted power frequency waveforms caused by the harmonics, phase shifts and transient faults and work on the principle of fundamental waveform extraction. The relays shall be immune to electro-magnetic interference and comply with IEC tests as mentioned in clause 7.2 (xix). The relay manufacturer shall study the effect of harmonics present in the existing Railway traction supply system and its effect on the relay pick up values & operating time of the relay and suitable methodology shall be adopted to eliminate the effect of harmonics.

5.1.33 The relay shall be immune to reverse power flow in case of regenerative current going back into the grid.

5.1.34 The relay shall be suitable for operation from the 25 kV current transformers and potential transformer of the following particulars:

Current Transformer

1.	Rated system voltage (phase to ground)	Normal: 25 kV Maximum: 30 kV Minimum: 19 kV
2.	Rated transformation ratio	1000-500/5 A or 1500-750/5 A or 3000-1500/5A
3.	Rated burden	60 VA
4.	Rated accuracy limit factor	15
5.	Class of accuracy	5P class as per IS:2705 (Pt.III) 1981

Potential Transformer

1.	Rated system voltage	Normal: 25 kV Maximum: 30 kV Minimum: 19 kV
2.	Rated transformation ratio	27500/110V
3.	Rated burden	100VA
4.	Rated accuracy limit factor	-
5.	Accuracy class	1.0 as per IS:3156 (Part-II) & 3P as per IS:3156 (Part-III)-1992

5.1.35 The relays shall generally conform to following standards.

1.	Dielectric Withstand	2kV, 50 Hz for 1 min between circuit to earth/circuit to circuit (IEC 60255-5, IS: 3231, IS: 12083 Pt.II)
2.	Contact data	
a.	Current carrying capacity	5 Amps Continuously at 110 V DC/ 230 V AC
b.	Making & carry 250 V ac, 50 Hz for 3 seconds:	30 Amps
c.	Breaking: 220V, 50-60 Hz Cos Ø 0.4 220 V dc, L/R = 45 mili sec	 5A 0.5 A
4.	Auxilary power consumption at 110V DC	<15 W – De energised <30 W – Energised
5.	VA burden a) PTcircuit b) CTcircuit	 Less than 5VA Less than 3VA
6.	Resetting time	150 ms to 200 ms

6.0 Rating and other parameters

6.1 Polygonal characteristic distance protection

6.1.1 The relay shall be developed on the principle of discrimination of the argument of the impedance. Relay shall have Polygonal type impedance characteristics having forward as well as reverse reach. The relay should be able to reliably distinguish between faults and loads. In case relay is having more operational zones other then forward and reverse then their detailed use and implementation logic in terms of railway protection system shall be submitted by relay manufacturer at the time of design and drawings finalization.

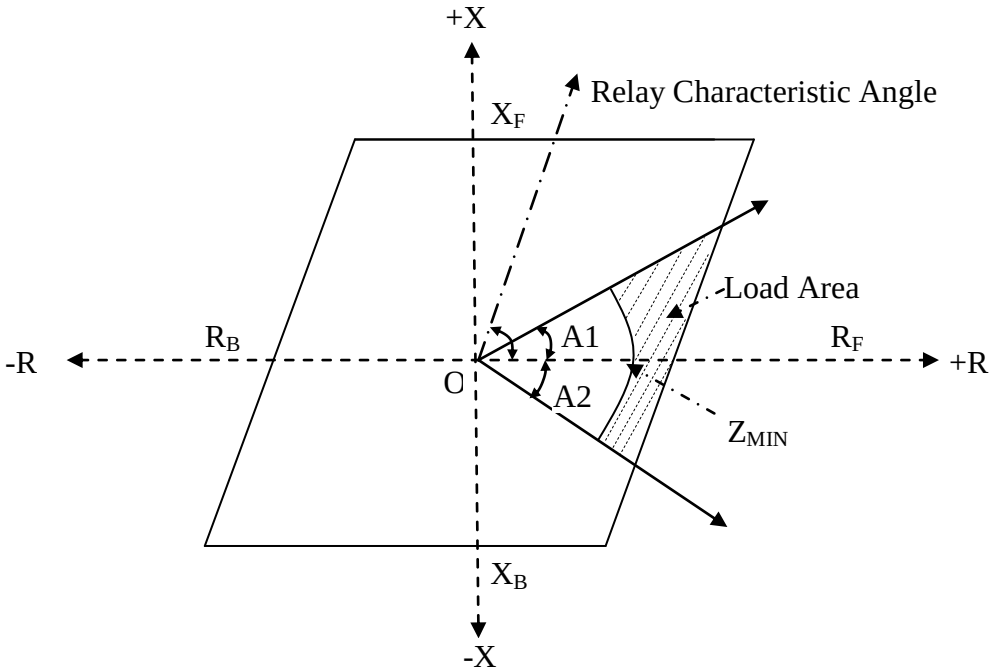
6.1.2 The errors in the parameters display on relay LCD shall not be more than $\pm$ 5%. for Voltage, Current, Impedance, Resistance, Reactance, Phase angle etc.

6.1.3 The relay shall also be capable of changing the fault angle (relay characteristic angle) over a range of 50 to 90 degrees in steps of 1 degree.

6.1.4 The operating value errors of the relay shall not be more than $\pm$ 5 % including for voltage input to the relay from 125 volts down to 0.5 Volts and current 0.5 to 100 Amps, the frequency variations of 47 to 52 Hz and the ambient temperature variation over the range –20 ^{O}C to + 50 ^{O}C.

6.1.5 The relay shall have settable minimum operating current. If current less than set value of minimum operating current then relay should not execute trip command even though impedance measured by relay fall inside set polygonal on R-X plane characteristic. Minimum operating Current shall be settable in the range of 0.1 to 1.0 Amp in the steps of 0.1 Amp.

6.1.6 Relay shall be polygonal on R-X plane characteristics having forward as well as reverse reach. The forward and backward Resistance (R) and Reactance (X) shall be settable individually. To avoid malfunction of relay due to load encroachment, the load impedance area of the polygonal shall be settable for non tripping in case impedance falls in this area. The following setting range of polygonal shall be available on the relay.



Relay Characteristic

Setting	Range and steps
Forward Resistance (RF)	0.01 – 99.99 Ω in steps of 0.01 Ω
Backward Resistance (RB)	0.01 – 99.99 Ω in steps of 0.01 Ω
Forward Reactance (XF)	0.01 – 99.99 Ω in steps of 0.01 Ω
Backward Reactance (XB)	0.01 – 99.99 Ω in steps of 0.01 Ω
Angle (A1)	00 – 70 deg in steps of 1 deg
Angle (A2)	00 – 70 deg in steps of 1 deg
Zmin	0.01 – 99.99 Ω in steps of 0.01 Ω
Relay Characteristic Angle	50 to 90 degree in steps of 1 degree

6.1.7 Relay shall have local breaker backup protection (LBB) feature for each protection function i.e. DPR, OCR, WPC and PT fuse failure trip; the relay shall continuously monitor the status of closing of the feeder CB. In case the feeder CB is not tripped after a preset time interval settable in the range of 0 to 1000 ms, in steps of 10 ms after initiating the trip command then another trip command shall be executed to trip upstream circuit breaker. At least 2 NO contact of LBB shall be available to trip upstream circuit breaker.

6.1.8 The relay shall have an optional feature to add a fault locator with an accuracy of +/-5 % or alternatively it should be an in built feature of relay module.

6.1.9 The relay shall be blocked for operation in case 2^{nd} harmonic component in current exceeds more than set value. The percentage of second harmonic for block the operation shall be settable from 5 to 20 % in steps of 1%.

6.1.10 The relay shall discriminate correctly between faults in the forward and reverse directions on the event of voltage input to the relay falling down to 0 V. To maintain a correct polarizing (directional reference) signal for the distance element and to enable fast operating time under conditions of close-up faults, the relay shall utilize memory polarization. The polarizing signal shall be derived from sufficient samples of the pre-fault voltage held in memory.

6.1.11 A "Switch onto fault" feature (SOTF) shall be provided in the relay to provide high speed tripping (of the order of one cycle) in case the breaker is closed onto an existing fault on the line. It shall use level detector logic for clearing close-up existing faults and/or a distance comparator principle for clearing faults existing at remote end.

6.1.12 The total operating time of the distance protection relay shall be in the range of 30 ± 10 ms under any circumstances.

6.2 Wrong phase coupling relay

An impedance relay for protection against wrong phase coupling which shall operate on the principle that the relay identifies a wrong phase coupling condition when the impedance lies between 11 ohm to 38 ohm (however the lower limit of impedance shall be settable in the range of 2 to 15 ohm and upper limit shall be settable in the range of 20 to 60 ohm in steps of 1 ohm) and its angle lies in the second quadrants between 100^{o} to 150^{o} (however the lower and upper angle shall be individually settable between 90^{0} to 180^{0} in steps of 1^{0}) in the R-X plane. All parameters expressed are in secondary values. The relay shall be immune to the regenerative currents produced by electric loco/EMU's, the regenerative current shall be settable in between 0 to

3 Amp in steps of 0.1 Amp. The operating time of the relay shall be 30 ± 10 ms. The relay manufacturer shall provide the actual logic developed for detecting the wrong phase coupling condition. The operating value error of WPC shall not exceed ± 5 %.

6.3 Over current relay

Two stage over current relay (stage 1- instantaneous and stage 2- definite time) shall be provided. The current setting of OCR shall be settable individually in the range of 20% to 1000% in steps of 1% . The operating time of instantaneous OCR shall not be more than 25 ms. The operating time of stage 2 OCR shall be settable in the range of 1 sec to 900 sec in steps of 1 sec. The operating value error of OCR shall not exceed ± 5 %.

The over current relay shall have also a feature to block trip command if 2nd harmonic component in current exceeds more than set value. Setting to enable / disable the 2nd harmonic blocking function shall be provided for over current relay.

6.4 PT fuse failure relay

The PT voltage shall be continuously monitored by the relay, in case of blowing out of the PT fuse:

6.4.1 PTFF alarm logic

When PT voltage is less than set voltage and line current is less than set current for set time delay and Feeder CB is in closed position then PTFF alarm contact shall be closed. The time shall be settable from 0 to 10 sec in steps of 500 ms.

6.4.2 PTFF trip logic

Conditions when PT voltage is less than the set value but the current is more than the set current, then PTFF trip contact shall be closed to trip the feeder CB, the operating time of PTFF trip element shall not exceed 30±10 ms.

The PT voltage shall be settable in the range of 0 to 20 volts in steps of 1 volt and current shall be settable in the range of 0 to 5Amp in the steps of 0.1 Amp.

6.5 Auto reclosure relay

6.5.1 Whenever a feeder circuit breaker is tripped due to operation of the following feeder protective relays, namely distance, wrong phase, Delta-I, Backup DPR, PTFF trip, instantaneous and Definite time over current relays, the auto reclosure relay shall close the feeder circuit breaker after a pre-set dead time of 0.5 second (adjustable from 0.1to 1 seconds). If the breaker trips again due to persistence of fault during the reclaim time 30 seconds (settable 6 to 60 seconds) the auto-reclosing relay shall get locked out. The auto reclosure relay shall have also a feature to enable / disable the reclosure function in case of Wrong Phase Coupling relay acted. In other word, the auto reclosure function shall be configurable as per user requirement, in case of wrong phase coupling relay acted.

Auto Reclosure shall also have a feature to block / Trigger auto reclosure function by external status input from RCC and external relay contact.

6.5.2 It shall be possible to reset the locked out state either locally or through remote control. Necessary contacts for telesignalling the locked-out state and for resetting the same shall be provided for interfacing with the remote control equipment. Irrespective of whether the auto reclosing scheme

is in the normal condition or in the locked out condition, it shall be possible to operate the circuit breaker locally as well as through remote control.

6.5.3 A single shot high-speed auto-reclosing scheme shall work in conjunction with the Master Trip relay to operate the feeder circuit breaker. The auto-reclosing scheme shall be designed for a dead time adjustable between 0.1 and 1 second in steps of 0.1 second (normally to be set at 0.5 second) and a reclaim time adjustable between 6 and 60 seconds (normally to be set at 30 seconds, the operating duty of feeder circuit breaker being 0-0.3s –CO –30 s- CO). Relay shall have the built-in logic to check change in status of CB (from close to open) prior to initiate autoreclose command within dead time.

6.5.4 The auto reclosure shall be bypassed in the event of high current earth faults settable in the range of 10A to 100A in steps of 1A Enable / Disable facility for this feature shall also be provided by the tenderer.

7.0 TESTS

7.1 General

7.1.1 Only after all the design and drawings have been approved and clearance given by Research Design and Standards Organization (RDSO)/Chief Electrical Engineer (CEE) to this effect, the manufacturer shall take up manufacture of the prototype unit for RDSO inspection. It is to be clearly understood that any changes required to be done in the prototype unit shall be done expeditiously.

7.1.2 Before giving the call to RDSO for inspection and testing of the prototype of the equipment, the manufacturer shall submit a detailed test schedule consisting of schematic circuit diagrams for each of the tests and nature of the test, venue of the test and the duration of the test and the total number of the days required to complete the tests at one stretch.

7.1.3 Once schedule is approved, the tests shall be done accordingly. However, during the process of type testing or even later, RDSO representative reserves the right to conduct any additional test(s) besides those specified therein, on any equipment/sub-system or system so as to test the equipment to his satisfaction or for gaining additional information and knowledge. In case of dispute or any disagreement arises between the manufacturer and RDSO during the process of testing as regards the type test results, it shall be brought to the notice of the Director General (Traction Installation), RDSO as the case may be, whose decision shall be final and binding.

7.1.4 In the event of the tests not being carried through to completion at one stretch for any reason attributable to the successful tenderer/ manufacturer and it is required for the representative of the purchaser/ Director General (Traction Installation), Research Designs And Standards Organization, Luck now, to go again or more number of times to the works of the successful tenderer/ manufacturer or other place(s) for continuing and/or completing the test on the prototype(s) of the equipment, the successful tenderer/ manufacturer shall reimburse to the purchaser/ Director General (Traction Installation), Research Designs & Standards Organization, Lucknow. The cost of the representative having to visit the works or other place(s) for the test more than once. The cost as claimed by the purchaser/ Director General (Traction Installations),Research Designs & Standards Organization, Lucknow shall be paid through demand draft to the concerned accounts officer of the Purchaser/Director General (Traction

Installation), Research Designs and Standards Organization, Lucknow, shall be advised to the successful tenderer manufacturer.

7.1.5 All type & routine tests relevant to protection module shall be conducted as per the latest version of IEC 60255-16, IEC-60255-151, IEC-60255-5, IEC-60255-1, IEC-60255-26, IEC-60255-27, IEC-60255-21 IS-3231 part 1 to 3 and IS: 8686 and as modified or amplified as under:

7.2 TYPE TESTS

The protection relays shall be type tested as per IS:3231, IS: 12083 IS:8686, IEC as mentioned above. The following type tests shall be carried out on the prototype relays.

(i) Visual and Dimension measurement
(ii) Operating characteristics tests including verification of all relay functions/features including operating time, reset time, operating and reset value.
(iii) Quadrature test (for DPR)
    (1) Fundamental wave characteristics
    (2) Distorted wave characteristics
    (3) Excising current characteristics
    (4) Minimum operating current
(iv) Insulation resistance test as per IEC 60255-27.
(v) Measurement of burden (VA).
(vi) Measurement of power consumption (watts).
(vii) Over load test.
(viii) Impulse voltage withstand test applicable to test voltage class III as per IEC:60255-5/60255-27.
(ix) Temperature rise test.
(x) Effect of DC voltage variation (110 V DC +15 % / -30 %).
(xi) Making and breaking capacity tests of contacts as per IEC 60255-1.
(xii) Dielectric test as per IEC 60255-27.
(xiii) Vibration test- as per IEC 60255-21-1, Class 1, Frequency 10-150 Hz, acceleration $1g_n$ in all 3 axis, 20 sweep @ 1 octave/minute.
(xiv) Endurance test-Mechanical endurance test for 10000 operations as per IEC 60255-1.
(xv) Product safety requirements test as per IEC:60255-27.
(xvi) Enclosure Protection Test IP 54 as per IEC:60529.
(xvii) Communication standard protocol as per IEC:60870-5-103
(xviii) Environmental test
    (1) Dry heat test as per IEC 60255-1/IEC60068-2-2 (This will test from +20 to +70 ^{0}C)
    (2) Dry heat test at maximum storage temperature as per IEC 60255-1/ IEC60068-2-2
    (3) Cold test as per IEC60255-1/IEC60068-2-1 (This will test from -25 to +25 ^{O}C)
    (4) Cold test at minimum storage temperature as per IEC 60255-1/ IEC60068-2-1
    (5) Change of temperature as per IEC60255-1/ IEC60068-2-14 (this will test from -25 to + 55 ^{O}C)
    (6) Damp heat test, steady state as per IEC 60068-2-78
    (7) Damp heat test, cyclic as per IEC 60068-2-30

xix) EM Compatibility tests

(1) 1 MHz burst immunity tests as per IEC60255-26& IEC61000-4-18 :Common Mode : 2.5kV Differential mode : 1kV Duration : 2 sec
(2) Electrostatic Discharge Immunity Test as per IEC60255-26& IEC61000-4-2 Contact Discharge 6kV, Air Discharge 8kV
(3) Radiated, radio-frequency, electromagnetic field immunity test as per IEC60255-26& IEC61000-4-3Frequency Range: 80MHz – 1000MHz, Modulation: 80% AM @1kHz, Field Strength 10V/m
(4) Electrical fast Transient/ burst Immunity Test as per IEC60255-26& IEC61000-4-4.
(5) Surge immunity Test as per IEC60255-26 & IEC61000-4-5.
(6) Immunity to Conducted disturbances induced by radio frequency field as per IEC60255-26& IEC61000-4-6.
(7) Voltage dips, short interruptions and voltage variations on d.c. input power port immunity tests as per IEC60255-26 & IEC61000-4-29.
(8) Power Frequency Immunity Test as per IEC60255-26 & IEC61000-4-8.
(9) Ripple in d.c. input power port immunity test as per IEC60255-26& IEC61000-4-17.

Only after clear written approval of the results of the tests on the prototype is communicated by RDSO/Purchaser to the manufacturer, he shall take up bulk manufacture of the equipment – which shall be strictly with the same material and process as adopted for the prototype. In no circumstances shall material other than those approved in the design/drawings and/or the prototype be used for bulk manufacture on the plea that they had been obtained prior to the approval of the prototype.

7.3 Routine/Acceptance tests

The following tests shall be done by purchaser/ its representative.

7.3.1 Visual Checks
7.3.2 Operating value
7.3.3 Operating time
7.3.4 Insulation Resistance
7.3.5 Dielectric test
7.3.6 Functional test

8.0 RATING PLATE

8.1 The rating plate shall contain the following information:

(1) Name and Type
(2) Rated CT secondary current
(3) Rated PT voltage.
(4) Rated frequency.
(5) Rated control voltage
(6) Year and month of manufacture
(7) Manufacture number
(8) Name or abbreviation of manufacturer.

9.0 ERECTION, TESTING AND COMMISSIONING

9.1 The erection and commissioning of relay shall be done by the successful tenderer who shall arrange all tools, plants, instruments and other material required for the purpose at his own cost. Tests shall be carried out during erection/commissioning of the relay at the site. The successful tenderer shall be required to submit to the purchaser the details of the checks and tests to be carried out during erection and commissioning. Tests shall be carried out on the relay in the presence of the purchaser's representatives to check the erection and commissioning of the relay.

9.2 Three sets of the test report shall be supplied by the manufacturer to the purchaser for records and reference.

10.0 TECHNICAL DATA AND DRAWINGS

10.1 The tenderer shall furnish guaranteed performance data, technical and other particulars for the equipment offered in the Performa attached as Annexure-3.

10.2 The tenderer shall furnish their compliance or otherwise against each clause/sub-clause of the technical specification. If the tenderer wishes to deviate from the provision of any clause/sub -clause, he shall furnish the full details with justification for such deviation.

10.3 The tenderer shall also furnish relay setting procedure and specimen calculations for the recommended relay setting. The range of setting available, calibrated in terms of different configuration of OHE like single line/ double line/ 3/ 4 lines along with adjustments available for intermediate setting explained in detail.

10.4 Successful tenderer shall be required to submit detailed outline dimensioned drawings, cut out drawings, terminals details, technical details, working principle in terms of block diagrams and front view drawings along with LEDs and other details for the equipment offered as per railways standard in A4/A3 sizes to RDSO approval.

11.0 OPERATION, MAINTENANCE INSTRUCTIONS

11.1 The relay shall be a maintenance free relay generally not needing any maintenance, however the tenderer shall mention a maintenance schedule which shall be detailed enough to guarantee failure free service of the relay to the tenderer. The supplier shall supply free of cost Instruction Manuals for operation and maintenance of the equipment in 2 hard copies and one soft copy on CD to the consignee. The manuals shall contain full particulars of various components, full-dimensioned drawings and circuit diagrams.

11.2 The Successful tenderer shall develop a maintenance schedule and a trouble shooting chart for effective, reliable and trouble free relay operation. The basic maintenance schedule along with the troubleshooting, diagnostic chart shall be submitted to RDSO and approved by RDSO prior to commissioning of the relay for the first time at the sight.

12.0 SPARES AND SPECIAL TOOLS

The tenderer shall quote separately for the spares recommended to maintain the equipment for a period of at least 5 years. The tenderer shall also quote separately for supply of special tools, if any, required for trouble free operation and maintenance. Spare parts/special tools as ordered shall be delivered along with the supply of relays. The purchaser reserves the right to buy the special tools from the tenderer or not.

13.0 TRAINING OF INDIAN RAILWAY'S ENGINEERS

The offer shall include the training of two engineers of the Indian railways free of cost at the manufacturers works in India and at the maintenance depots/workshops on a railway systems or other public utility where numerical protection module of similar/identical design are in operation. The total duration of training for each engineer shall be 2 weeks of which approximately 1 week will be at the manufacturers works and 1 week on a Railway system or other public utility. The cost of travel to the place and back and boarding will be borne by the Indian Railways.

14.0 WARRANTY

14.1 The relay supplied against a purchase order/contract in which this specification is quoted, irrespective of origin individual equipment (imported / indigenous) shall be guaranteed for trouble - free and satisfactory performance for a period of 24 months from the date of supply or 18 months from the date of commissioning at the traction sub station of IR, whichever period is earlier, details of warranty clause, the extent of responsibility and other relevant aspects shall be included in the purchase order or the contract. The tenderer shall furnish detailed terms and conditions in this regard in his offer.

ANNEXURE - 1

List of abbreviations

Abbreviation	Full Form of the Abbreviation
A	Amperes
BT	Booster Transformer
GTO	Gate Turn Off Thyristors
IDMT	Inverse Definite Minimum Time lag
IOL	Insulated Overlap
LCD	Liquid crystal diode
LED	Light emitting diode
NC	Normally closed.
NO	Normally open
OHE	Over Head Equipment
RC	Return Conductors.
SP	Sectioning Post
SR	Self Reset
SSP	Sub Sectioning Post
TrD	Traction Distribution
TRS	Traction Rolling stock
TSS	Traction Sub Stations
DPR	Distance protection relay
WPC	Wrong phase coupling
OCR	Over current relay
PTFF	Potential transformer fuse failure

ANNEXURE - 2

DEFINITIONS AND EXPLANATIONS

Item	**Definition**
Tenderer	The vendor, supplier who intends to quote for the tender floated by the purchaser. The agency who shall quote for tender floated by the tenderer.
Purchaser	The person / agency who has floated the tender for execution of the work on or behalf of the president of India.
Operation time	Period of time from a fault occurs till the output-contact of the relay closes.
Making capacity	The maximum current and volt -amperes the contact is able to make successfully under specified conditions without significant damage to the contact.
Breaking capacity	The maximum current and volt - amperes that the contact is able to interrupt successfully under specified conditions without significant damage to contact.
Normally open contact (NO)	A contact, which is open when the relay is de-energised.
Normally closed contact (NC)	A contact, which is closed when the relay is de-energised.
Contract	Means the contract resulting from the acceptance by the purchaser of the tender either in whole or part
Equipment	Means all or any equipment considered necessary by the purchaser engineers for the satisfactory operation as a whole of the installation including structure, foundations etc.
Railway	Means Railway(s) in whose territorial jurisdiction the work is to be carried out and includes the Government of India, Ministry of Railways (Railway Board), and /or general manager of the railways concerned

ANNEXURE - 3

SCHEDULED OF GURANTEED PARTICULARS

Sl. No.	Description	Manufacturer details	Unit of measurement
Microprocessor based Integrated numerical feeder protection module			
1.0	Name of manufacturer		
2.0	Relay Identification number		
3.0	Distance protection relay		
3.1	Range and steps of setting		Ohms
(i)	XF		
(ii)	XB		
(iii)	RF		
(iv)	RB		
(v)	Relay characteristic angle		Degree
(vi)	Minimum operating current		Amp
(vii)	Minimum impedance		Ohms
(viii)	Angle A1		Degree
(ix)	Angle A2		Degree
(x)	2^{nd} Harmonic		%
3.2	Operating time		m-sec
3.3	Error in operating value.		%
3.4	Error in operating time		%
3.5	Resetting time		m-sec
4.0	OCR		
4.1	Range and steps of setting of stage 1-Inst. OCR		A
4.2	Operating time		m-sec
4.3	Range and steps of setting of stage 2-Definite time OCR		A
4.4	Setting range and steps of operating time of stage 2 OCR		m-sec
4.5	Error in operating value.		%
4.6	Error in operating time		%
4.7	Resetting time		m-sec
5.0	Wrong phase coupling relay		
5.1	Range and steps of setting of minimum Z		Ohm
5.2	Range and steps of setting of maximum Z		Ohm
5.3	Range and steps of setting of lower angle		degree
5.4	Range and steps of setting of upper angle		degree
5.5	Operating time		m-sec

5.6	Error in operating value. a) Impedance b) Angle		 % degre
5.7	Error in operating time		m-sec
5.8	Resetting time		m-sec
6.0	PT fuse failure		
6.1	Setting range and steps a) Voltage b) current		 Volt A
6.2	Setting range and steps of PTFF alarm time		m-sec
6.3	Operating time PTFF trip		m-sec
6.4	Error in operating value.		%
6.5	Error in operating time		m-sec
7.0	Auto reclosure relay		
7.1	Range and steps of time setting a) Dead time b) Reclaim time		Second / m-sec
7.2	Error in operating time a) Dead time b) Reclaim time		%
8.0	DC power consumption of the module		Watts
9.0	Short time current carrying capacity of the current coil for 1 sec		Amps
10	Whether regeneration immunity shall be provided for the relay		
11	Thermal withstand capability		Amps
12	Particulars of output relay (a) Make (b) Rating (c) NO, NC Contact details		 Amps Number
12.1	Rated making & breaking capacity of contacts		Amps
13	Rated D.C. voltage variation range for which relay operation is guaranteed		Volts
14	Rated relay voltage for the D.C. circuit		Volts
15	Whether 2nd harmonic restraint feature provided		
16	Whether switch on to fault (SOTF) feature is provided?		
17	Whether synchronous polarization feature is provided?		
18	Whether the module draw out type ?		

19	VA burden CT circuit PT circuit		 VA VA
20	Over load capacity of CT circuit PT circuit		 A V
21	Insulation resistance with 1000 V Megger voltage		ohm
22	Dimension of module a) Length b) Width c) Breadth d) Weight		 mm mm mm Kg
23	Over voltage withstand capacity of PT circuit		V
24	Ambient temperature range for satisfactory working		
25	Rated CT current		Amp
26	Rated PT voltage		V
27	IP class		
28	Number of events of faults wave form stored in memory		
29	Number of pre and post cycle fault waveform stored in memory.		
30	Whether the suitable software supplied/available to interpret the fault waveform?		
31	Sampling rate of voltage and current a) For fault assessment b)For recorded fault waveform		
32	IEC standard communication protocol		