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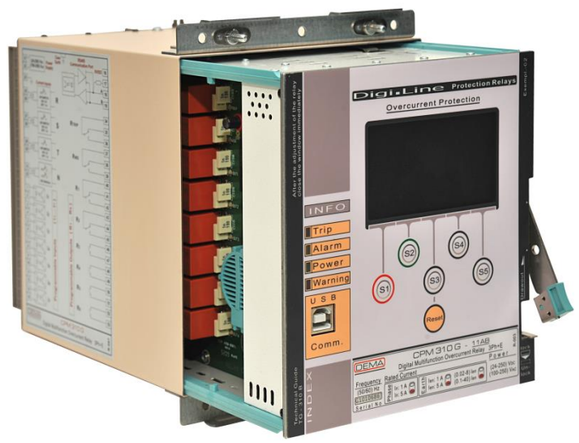
DEMA CPM 310 G
Digital Overcurrent Protection Relay
Quick Guide



INTRODUCTION

DEMA proudly presents the users and modern networks a solid alternative for overcurrent protection with CPM 310 G; with the state-of-art electronic, physical and functional technology for use with (X/5) A or (X/1) A conventional type current transformers. As a DSP based digital multi-function protection & control relay with 3 phase & earth overcurrent protection, DEMA CPM 310 G is tested to fulfill international standards requirements; and provides the users numerous assembly, commissioning and service advantages.

- Wide IEC, ANSI and special type curve support,
- DMT and IDMT support for all overcurrent protection functions,
- Input and alarm functions that eliminates the need to use external alarm systems,
- 7 independent programmable inputs with optic coupling,
- Trip (SPDT), watchdog (SPDT) and 6 independent programmable outputs (2 DPST inverse + 4 SPST closing contacts),
- Measurement functions that eliminate the need to use double-core CTs, external ampere-meters and frequency-meters,
- Compliance with (X/1) A and (X/5) A CTs via dip-switch settings,
- Wide setting ranges; Current » (0.1-40) I_n, DMT » (0.01-150) s, IDMT » (0.025-3.2).
- 2 independent settings groups,
- 3 phase overcurrent protection functions with independent thresholds,
- 3 earth overcurrent protection functions with independent thresholds,
- 2 negative sequence overcurrent functions with independent thresholds,
- Broken conductor function,
- Phase undercurrent protection function,
- Thermal overload protection function with cumulative thermal memory and monitoring,
- 4 shot auto-recloser function that can be customized for each protection function,
- Circuit breaker triggered cold load pickup function,
- Blocking and delaying logic selectivity functions,
- Circuit breaker pole failure alarming function,
- Circuit breaker supervision functions,
- Automatic secondary circuit shorting & under-load unit maneuverability,
- Easy-to-use & self-explained alarm, setting and measurement menus,
- 8 programmable virtual LEDs for annunciation,
- Independent alarm menu, 150 individual event records, faults filter; 5 x 3 s automatic waveform records memory,
- Electromagnetic compatibility (EMC) tested to exceed IEC requirements,
- Precision manufacturing,
- Draw out system that enables easy and secure unit replacement,
- The largest graphics screen in its class: (128 x 64) px,
- Easy-to-use & self-explained menus,
- Wide auxiliary supply range; (24-240) V_{AC} / V_{DC},
- IP52 front side protection, IP20 rear side protection,
- USB port for direct PC communication,
- SCADA ready: RS485 port and MODBUS, IEC 60870-5-103 and DEMCOM protocols support,
- PC software and accessories free of charge,
- Rapid & low cost reparation thanks to the modular electronic construction,
- Expert technical crew and matchless customer support.□

TECHNICAL DESCRIPTION

CPM 310 G – General Specifications

Nominal Current and Frequency Input	1 A / 5 A, 50 Hz / 60 Hz
Current Input Quantity	3 Phase + 1 Earth
Logic Inputs	7 optically isolated programmable inputs
Logic Outputs	CB Trip + Watchdog + 6 programmable outputs
Operating and Storage Temperature Limits	-25 ºC / +70 ºC
Storage Time Limit	3 years in original packing
CPM 310 G – Output Contact Specifications	
Output Contacts – Quantity and Type	4 inverser (SPDT) 4 closing (SPST)
Current Carrying Capacity	8 A_{rms}
Max. Switching Current	16 A_{rms}
Max. Switching Voltage	440 V_{AC}
Max. Switching Power on Closing	2.2 kW / 2.2 kV·A
Max. Switching Power on Breaking	50 W / 2.2 kV·A.
CPM 310 G – Power Supply Specifications	
Nominal Supply Voltage Range	(24 – 240) V_{AC} / V_{DC},
Max. Supply Voltage Range	(21 – 264) V_{AC} / V_{DC},
Stand-by State Power Consumption	4.5 W / 9 V·A
Max. Power Consumption (External devices excluded)	8 W / 15 V·A
CPM 310 G – Physical Specifications	
Case Designation	DRC 144 – S4
Front Side Protection Degree	IP 52
Back Side Protection Degree	IP 20
Mounting Method	Flush Mounting
Main Unit	Withdrawable

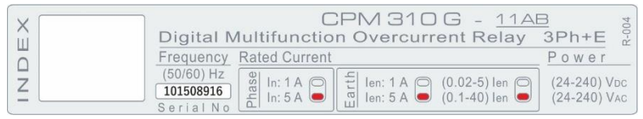
PACKING AND LABELING INFORMATION

Packing Information
Gross Weight: 3.40 kg
Package Ingredients: Each product package has the following material included:

- CPM 310 G Overcurrent Protection Relay — 1 piece
- USB Communications Cable — 1 piece
- Mounting Elements Set — 4 x (custom screws; nuts and washers)
- CPM 310 G Quick Guide (this document)
- A CD that includes DigiConnect PC program and *CPM 310 G Technical Manual.*

Unit Label Information
The unit label is explained and shown below.

Manufacturer Logo	*DEMA*
Product Name	*CPM 310 G*
Product Model	*11AB*
Product Description	*Digital Multifunction Overcurrent Relay, 3Ph + E*
Nominal Frequency	*50 Hz / 60 Hz*
Serial No.	*101508916*
Nominal Phase Current	*(1/5) A*
Nominal Earth Current	*(1/5) A*
Earth Protection Setting Range	*(0.02 - 5) I_{en} / (0.1-40) I_{en}*
Nominal Supply Voltage Range	*(24-240) V_{AC} / V_{DC}* □



MOUNTING CPM 310 G

The cutout drawing needed to prepare the panel cover for flush mounting is given on the backside of this document. The dimensions on the drawing are determined taking standard electrostatic coating thickness into consideration.

Mounting the Relay Case

1. Open the relay cover, preferably drive out the internal unit for easier mounting. If the internal unit is drawn out, take all precautions to prevent dusting and damaging of the unit.
2. Place the case into the cut-out.
3. Use the supplied 4 sets of M4 custom screws, standard M4 nuts and washers to fix the case onto the panel. Drive the screws from the front-side first, then tighten the nuts on the washers from the backside of the panel.
4. Make sure that the supplied custom screws are used for mounting. Using any other screws may result in sealing failure and loss of protection degree of the cover!
5. Make sure that all 4 mounting holes are screwed and tightened. Mounting the case from lesser points may result in mechanical stresses and bending on the case construction due to any possible deformations on the panel. Such inappropriate applications may harden driving the internal unit into or out of the case.
6. Always use torque drivers when working with the relay. Apply (0.69 – 0.82) N·m torque when tightening the nuts.

Inserting the Internal Unit & Mounting the Cover

1. Rotate the lock handle to provide approximately 90° between the handle and the internal unit. Drive the internal unit into the case until the unit fits well, then press the lock button to lock the unit in place. This will ensure healthy electrical connection between the internal unit sockets and the case plugs.
2. Place the bottom part of the cover into its place on the case first, then close the cover on the case. Make sure the cover fits in its place and the sealing is provided between the cover and the case. Tighten the 2 mounting elements integrated on the cover.
1. 0.20 N·m torque is sufficient to provide IP52 protection when tightening the mounting elements on the cover. Never apply torque values higher than 0.29 N·m, as this may damage the mounting elements and may lead the cover out of service. □

CABLING CPM 310 G

Cabling Diagram
The cabling and sample application diagram is given on the backside of this document.

Cabling Material
Cabling material selection is important for all secondary systems. The principles listed below are to be followed to build a robust system.

Cabling with thin & multi-wire cables:

- Never make a connection without applying ferrules to wire ends!
- Use 18 mm wire end ferrules for all left block terminals, which are numbered from 1 to 32. Using ferrules shorter than 18 mm for terminals nos.1-32 may jeopardize property and human security! Apply this rule strictly, especially for secondary current wire ends.
- Use 8 mm wire end ferrules for all left block terminals, which are numbered from 33 to 58. Using ferrules longer than 8 mm may reduce the dielectric withstand capability of the wiring!
- Provide solid earthing with low earth resistance to the relay. Use ring cable connectors for connections to relay earthing bolts. Make the earthing connection directly to earth. Never earth the device indirectly or over high resistances!
  WARNING!
  Solid earthing is one of the fundamental precautions to provide minimum safety requirements. Before commissioning any electrical system, make sure that earthing process is done correctly according to the relevant standards!
- Use appropriate tools for crimping the ferrules. Preferably use crimping tools with trapezes cross-section crimping type.
- Use appropriate tools for stripping the cables. Preferably use stripping tools with adjustable stripping lengths. Apply the instructions of the ferrule manufacturer when stripping.
- Use appropriate tools for removing the outer coat of multi-core cables, if applicable. Preferably use blades with adjustable cutting depths. Apply the instructions of the cable manufacturer.
- Use torque screwdrivers to tighten the terminal bolts. Apply (0.56 – 0.69) N·m torque to the bolts – torque application lower than 0.56 N·m may lead to open circuits or high contact resistances, while applying excessive torque may damage the terminals!
- Use non-flammable, standards compliant cables.
- Determine the wire cross-sections according to relevant standards and engineering principles.

Cabling with single-core cables

Cabling with single core cables is not recommended for secondary systems. Mechanical aging risks, increasing contact resistance over time, and poor flexibility are the most important cons of single wire cables. If cabling with single wire cables is essential, check all connections with great care and apply routine checking procedures to prevent failures. □

SETTING CPM 310 G

Before commissioning CPM 310 G, settings on dip-switches, CT settings menu, system settings menu, automatic control settings menu and protection menu must be completed. Refer to CPM 310 G User Manual for assistance on these settings. □

COMMISSIONING CPM 310 G

Once the mounting, cabling and setting procedures are completed, CPM 310 G is ready to be commissioned. Before commissioning, conduct the following tests to ensure full functionality of the system. Use appropriate testing tools and devices for the tests and seek professional help if needed.

Auxiliary Supply Tests: Test the auxiliary supply functions and cabling thoroughly.
Function Tests: Test the protection relay functionality and cabling using appropriate test devices, such as high-precision current supplies. Make sure the CB and CT cablings are OK. Take the advantage of self-testing function of CPM 310 G during tests.
Commissioning: Commission the system after all tests are completed with success.□

OPERATING CPM 310 G

Normal Operation

- After the successful commissioning of CPM 310, normal operation conditions are reached; this condition is kept as long as system components operate correctly and load current values are in tolerable limits.
- The purposes of electrical protection systems are; protecting the system components from paranormal conditions and minimizing system damage under those conditions, while providing maximum supply continuity and minimum black outs. These functions of protection systems can be obtained by building the system with good engineering practices (which were briefly described up to here in this document), but also by applying testing, maintenance, and renewal procedures on a regular basis. Even under conditions where high performance is obtained from secondary protection systems, these procedures must be considered to be highly important to be applied to get the maximum from these systems.

Diagnosing the Problem and Performing Maintenance

Even under good practices of maintenance and control, electrical systems may experience faults, overcurrent or device failures caused by mechanical, thermal or electrical stresses. When such a condition occurs, the way to handle it is described below.

- Examination of the problem via the measurement, alarm, event record and fault record menus of CPM 310 G; and via visual and electrical inspection of the system,
- Diagnosing the fault source, analysis of possible causes and performing of corrective actions,
- Applying the pre-commissioning procedures on the treated system.

Recommissioning

Whether initial or post maintenance, commissioning must be done according to the procedure described in the former section. Undesired black outs must be held as opportunities to test the entire system, which are hardly found under normal service conditions. The preventive actions taken before commissioning supports the performance of the system, and maximizes the benefits of well-engineered secondary protection systems. □

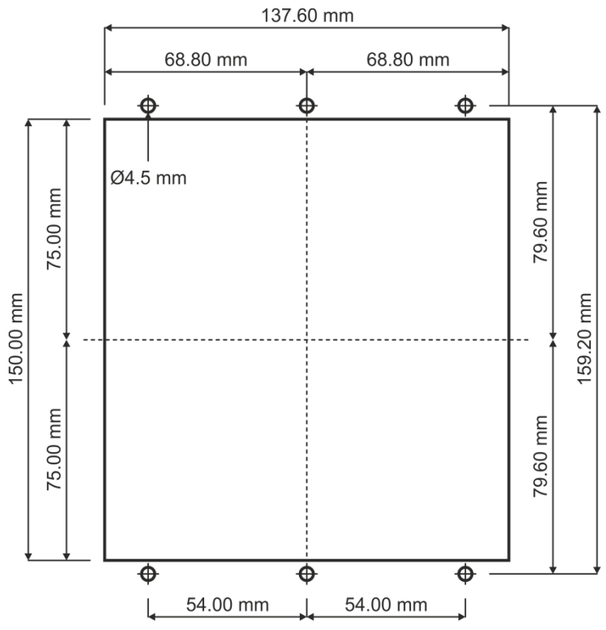
TESTING, MAINTENANCE AND REPARATION OF CPM 310 G

Under normal service conditions, no testing or maintenance action is required for CPM 310 G. If under a supernormal condition CPM 310 G becomes unstable or out of service, testing, maintenance or reparation of the unit may become essential.

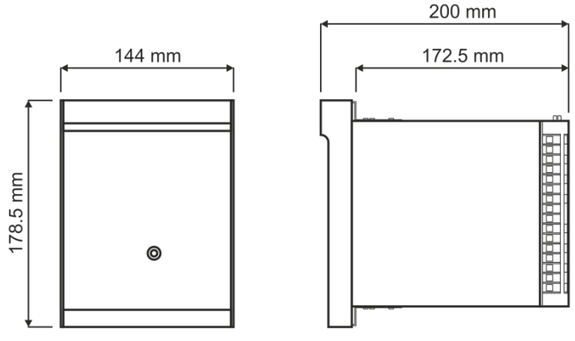
Test Procedure for CPM 310 G

- Primarily, supply auxiliary power to CPM 310 G to initiate the test process. If the auxiliary power is supplied by local devices, test them to ensure the healthy supply. If CPM 310 G does not start up and there is no “Power” LED signal; possible causes are supply circuit faults or the burn out of CPM 310 G fuse. Analyze those possibilities and take the corrective actions; if the problem is caused by the CPM 310 G fuse, replace it by a new one with specifications Ø5 mm x 20 mm T2A. Examine the possible causes of supply overcurrent that made the fuse burn.
- If there is no possibility of employing an appropriate relay test device for testing CPM 310 G, use the Function Test option from the relay menus. Function Test option generates imaginary overcurrent and conditions, and tests the functions in services to find out whether the relay is functioning in the desired way or not. If any protection function is active, function test will result in tripping of the circuit breaker; consider this and set appropriate trip settings to “passive” temporarily to prevent tripping of the primary circuit.
- If detailed tests are required to be carried out, use of a high-sensitivity, low-error relay test device is essential. In this case, trip time delays should be measured independently to confirm the correct operation of the relay. Tests must include the measurements for protection function trip delays, positive and negative sequence current measurements; broken conductor and thermal overload functionalities, input and output configurability.
- In case a failure is figured out on CPM 310 G, or no specific failures are found while the relay is not operating correctly, get in touch with DEMA Relay technical services. □

DIMENSIONAL AND CUTOUT DRAWINGS

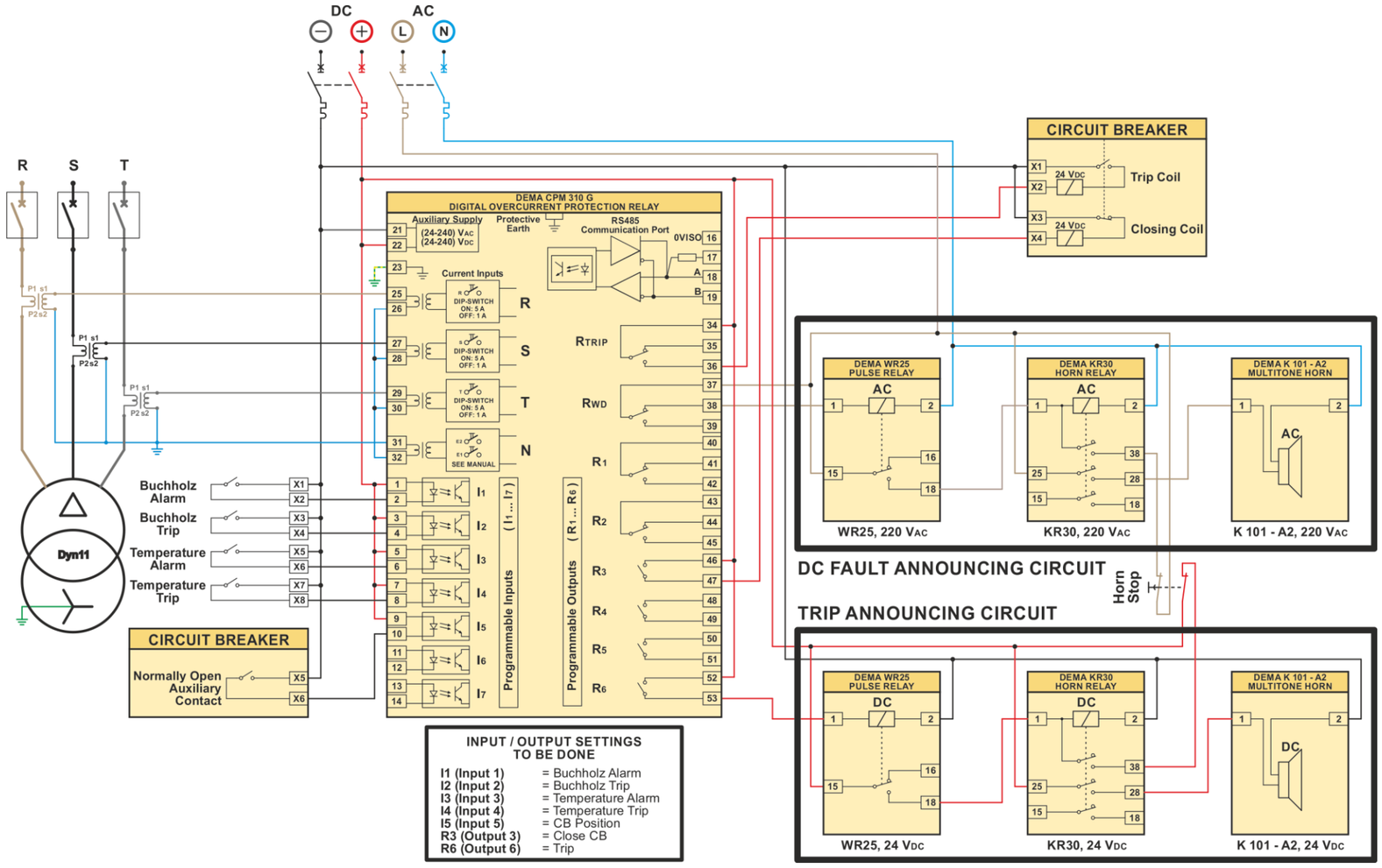


DRC 144 - S4 Cutout Drawing



DEMA CPM 310 G General Dimensions

CPM 310 G CIRCUIT AND SAMPLE APPLICATION DIAGRAMS



SAMPLE CALCULATIONS AND SETTINGS

Project

Project : It is required that the protection and alarming system of an oil-immersed type power transformer with characteristics 2,500 kV·A, (34.5 / 0.4) kV, 50 Hz is erected, using DEMA CPM 310 G. Protection current transformers are selected as type 5P10, (60/5) A. System must be configured so that the CB control and position indication is achieved via the relay; additionally, it must be alarmed by means of an acoustic alarm system if by any reason the relay is out of service. The power transformer operator should be informed means of an acoustic alarm system, if the power transformer goes through an alarm state or tripped out of service. The neutral current of the upstream power transformer is restricted via resistor banks.

Settings

1. To fulfill the requirements of the project, do the cabling according to the application diagram above.
2. Once the cabling is done and auxiliary power is supplied to the relay, drive the internal unit of the relay out. As the nominal secondary current of protection current transformer is 5A, dip-switch settings must remain as the default ON-ON-ON-ON-ON setting; check it. After checking, drive the internal unit inside the case and lock it.
3. The protection current transformer is selected as (60/5) A. Go to the CT Settings Menu, set Primary Nominal Phase Current and Primary Nominal Earth Current parameters to 60 A and Secondary Nominal Phase Current parameter to 5A and Secondary Nominal Earth Current parameter to T1-5A
4. The following settings should be done under the Automatic Control Settings Menu:
   Programmable Input Settings
   a. Input 1 : Buchholz Alarm.
   b. Input 2 : Buchholz Trip.
   c. Input 3 : Temperature Alarm.
   d. Input 4 : Temperature Trip.
   e. Input 5 : CB Position.
   Programmable Output Settings
   a. Output 3 : Close CB.
   b. Output 6 : Trip, Buchholz Alarm, Temperature Alarm.

   Other options in the menu are left unmodified.
5. The following protections should be activated to provide appropriate protection for the power transformer: thermal overload, phase overcurrent and short circuit, earth overcurrent and short circuit.

Iθ> Thermal Overload Protection

T_e thermal constant is selected considering the manufacturer instructions and the average ambient temperature. In this project, T_e will be assumed as 20 min, which is a valid value for most applications. Trip threshold translation constant k will be taken as 1.10, thermal overload trip heating $\%\Theta_{Trip} = \%100$ and thermal overload alarm heating $\%\Theta_{Alarm} = \%80$. The rated current of the power transformer is calculated as:

$$I_{rTR} = \frac{S_{rTR}}{\sqrt{3} \times U_n} = \frac{2500\ kV \cdot A}{\sqrt{3} \times 34.5\ kV} \cong 41.84\ A$$

The ratio of the PT rated current over CT primary nominal current (and the set value for Iθ>) is:

$$I\Theta >= 1.0 \times I_{rTR} = \frac{41.84\ A}{60\ A} \cong 0.70\ I_n, T_e = 20\ min, k = 1.1, \%\Theta_{trip} = \%100$$

I> Phase Overcurrent Protection

Protection characteristic IEC SI, TMS = 0.40 will be appropriate. If the threshold of phase overcurrent protection is taken as1.3 I_{rTR}, the setting value is calculated as follows:

$$I >= 1.3 \times I_{rTR} \cong 0.91\ I_n, IEC\ SI, tI >= 0.40$$

Note: If Iθ> (thermal overload protection) is not planned to be activated, I> (Phase Overcurrent 1st Threshold Protection) value should be set as 1.0 I_{rTR} (0.70 I_n) instead of 1.3 I_{rTR} (0.91 I_n).

I>> Phase Short Circuit Protection

Protection characteristic DMT = 0.05 s will be appropriate. To prevent the pickup current of the PT reach the I>> threshold, I>> can be set to 7I_{TR} practically.

$$I >> = 7.0 \times I_{rTR} = 4.9\ I_n, DMT, tI >>= 0.05\ s$$

Ie> Earth Overcurrent Protection

It is common that HV/MV substations set Ie> to (80 – 100) A, MV substations to (50 – 60) A, and end-users to (10 – 30) A in resonantly earthed networks; applications may vary with countries and networks. In this sample, the PT is taken as an end user and will be protected against earth overcurrent with Ie> = 15 A. As the protection zone is valid for virtually lower values, tIe> = 1 s delay will be appropriate.

$$I_e >= (15\ A\ /\ 60\ A) I_{en} = 0.25\ I_{en}, DMT, tIe >= 1\ s$$

Ie>> Earth Short Circuit Protection

If the earth short circuit protection threshold of the supply side feeder is assumed as 50 A primary, it is appropriate to set the Ie>> to a value %10 below. tIe>> will be set as DMT 0.05 s.

$$I_e >> = (45\ A\ /\ 60\ A) I_{en} = 0.75\ I_{en}, DMT, tIe >>= 0.05\ s$$