Relion® 605 series

Self-Powered Feeder Protection REJ603 Application manual

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Document ID: 1MDU07206-YN
Issued: 2012-06-24
Revision: E
Product version: 1.5

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Dangerous voltages can occur on the connectors, even though the auxiliary voltage has been disconnected.

Non-observance can result in death, personal injury or substantial property damage.

Only a competent electrician is allowed to carry out the electrical installation.

National and local electrical safety regulations must always be followed.

The terminals meant for connection to earth must be carefully earthed.

Removal of the equipment panel cover may expose live parts which may contain high voltage potential and touching these may cause personal injury.

The device contains components which are sensitive to electrostatic discharge. Unnecessary touching of electronic components must therefore be avoided.

On removal of terminal connectors for current transformer, there is no automatic CT shorting provision. Do not open the secondary of a live CT since dangerous voltage can occur on the terminal connectors. For safety, secondary of live CT must be shorted before opening terminal connectors.

Breaking the sealing tape on the top rear side of the device will result in loss of warranty and proper operation will no longer be guaranteed.

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Section 1 Introduction

1.1 About this manual

This manual provides basic information on the protection relay REJ603 and presents detailed instructions on how to use the relay. In addition to the instructive part, a short chapter on commissioning of the relay is included.

1.2 The use of the relay

REJ603 is a feeder protection relay mainly designed for the selective short-circuit and earth fault protection of feeders in secondary distribution networks and for protection of transformers in utilities and industries.

REJ603 is a CT-powered protection relay and based on a microprocessor environment. The relay is used in combination with special ring type current transformer. REJ603 relay in combination with circuit breaker can replace the combination of load breaker switch with HV fuses. Thereby providing more improved protection for growing power distribution networks.

1.3 Guarantee

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1.4 Safety indication symbols

This publication includes the following icons that point out safety-related conditions or other important information:

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The warning icon indicates the presence of a hazard which could result in personal injury.

The caution icon indicates important information or warning related

Although warning hazards are related to personal injury, it should be understood that operation of damaged equipment could, under certain operation conditions, result in degraded process performance leading to personal injury or death. Therefore, comply fully with all warning and caution notices.

Section 2 REJ603 Overview

2.1 Relay application

REJ603 relay is intended to be used for the selective short-circuit and earth-fault protection of feeders in secondary distribution networks and for protection of transformers in utilities and industries. The relay is a self-powered Numerical relay, which does not require external auxiliary supply voltage, making it an ideal choice for installation even in remote locations where auxiliary supplies are not available. The relay derives power for its operation from the current transformers. REJ603 is primarily used in Ring Main Units (RMU) within distribution network.

Relay provides earth current measurement through internal calculation or has the provision for measuring it from the external core balance current transformer (CBCT).

The key features of the relay are

- Self-powered three phase non-directional overcurrent and earth-fault protection with DMT and IDMT characteristics
- Dual mode of earth fault measurement - internal vector summation or external CBCT input
- Integrated IDMT curves (IEC and Special) in a single product to cover time co-ordination needs of secondary distribution protection
- Protection blocking by second harmonic measurement for stability during magnetizing inrush of transformers
- Capacitor discharge impulse output for low energy trip coil
- Built-in hand-reset electromagnetic flag for trip indication
- Easy setting by DIP switches, protected by a transparent cover
- Compact design and mounting arrangement suitable for Ring Main Unit (RMU) / secondary switchgear applications
- Test facility for testing entire scheme including primary CT, relay and trip coil
- Signal output for trip indication to external system

2.2 Product version history

Table 1: Product version history

Product version	Release date	Product History
1.0	18.03.2008	Product released
1.0 SP1	01.10.2010	Service Pack released
1.0 HMI	29.10.2010	HMI version release
1.5 Base & HMI	04.04.2012	Version 1.5 released

2.3 Protection functionality

Table 2: Protection functionality

Function	IEC	ANSI
Three phase overcurrent protection, low-set stage	3I>	51
Three phase overcurrent protection, high-set stage	3I>>	50
Earth-fault protection, low-set stage	I_o>	51N
Earth-fault protection, high-set stage	I_o>>	50N
3-phase Transformer Inrush detector	3I_{2f}>	68

2.4 Description of operation

The combined overcurrent and earth-fault relay is a secondary relay to be connected to the current transformers of the protected object. Apart from the measurement (inputs), the relay derives energy required for its own operation and tripping of circuit breaker from the current transformers. There are two LED's on the front panel. When minimum current required for operation is available the green 'Ready' LED glows indicating the relay is in operation. On detection of a fault the relay trips the circuit breaker in accordance with the settings. The relay also does internal health check at regular interval and intimates user in case of any internal relay failure. The internal relay failure is indicated by red 'IRF' LED.

When the phase current exceeds the set operate time at definite time operation or the calculated operate time at inverse time operation elapses, the overcurrent unit operates. In the same way the high-set stage I>> of the overcurrent unit operates when the set operate time elapses.

When the earth-fault current exceeds the set operate time at definite time operation or the calculated operate time at inverse time operation elapses, the earth-fault unit operates. In the same way the high-set stage Io>> of the earth-fault unit operates when the set operate time elapses.

The low-set stage of the overcurrent unit and the low-set stage of the earth-fault unit may be given definite time or inverse definite minimum time (IDMT) characteristic. When the IDMT characteristic is chosen, four standard and three special time/current curves are available. The standard curves comply with the BS142 and IEC 60255 and are named Normal inverse, Very inverse, Extremely inverse, Long-time inverse. Three special curves namely RI-curve, HR Fuse curve, and FR Fuse curve are also provided.

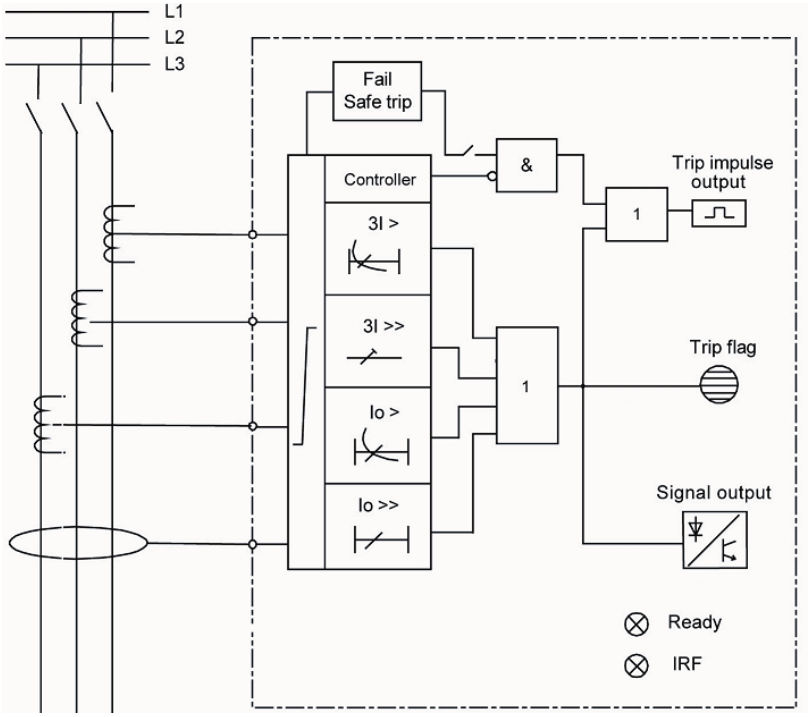


Figure 1: Block diagram of self-powered feeder protection relay REJ603

When overcurrent or earth-fault unit operates, the relay issues a 'trip' command in the form of a low energy impulse to the shunt trip coil of breaker. An electromagnetic flag turns red when the relay operates. The flag can be reset manually when the relay is in energized condition as well in un-energized condition for maximum 3 days at room temperature and in case of insufficient energy flag will not get reset unless sufficient current flows in primary circuit after energisation. 'Trip' flag turns green after reset. The relay has one signaling output which can be used to communicate the trip status to external system.

In case of controller failure, the relay would offer short circuit protection for currents greater than 20*Is maximum. Such a redundancy is achieved through intelligent feature called failsafe. This feature can be enabled / disabled through a dip switch.

There are two possible ways to give an output trip command as shown in figure 2.

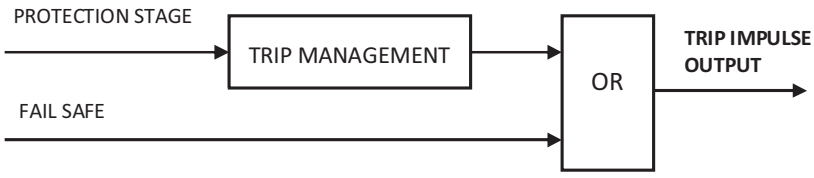


Figure 2: Output trip arrangement for REJ603

The protection system, comprising of, CT's, relay and low-energy trip-coil can be tested for its integrity by using the test winding of the current transformer, which is brought into the relay test terminals.

For deriving the operational power, the relay requires minimum current flow of 0.9 times the minimum setting current "Ismin" in at least one phase or 0.4 times the minimum setting current "Ismin" in all three phases.

In case of insufficient power to relay either READY or IRF or both LED will blink.

Table 3: Minimum current requirement for relay operation

CT Type: (Ismin – Ismax)	Min. current required in any one phase for relay operation	Min. current required in three phase for relay operation
REJ603-CT1: 8A-28A	7.2A	3.2A
REJ603-CT2: 16A-56A	14.4A	6.4A
REJ603-CT3: 32A-112A	28.8A	12.8A
REJ603-CT4: 64A-224A	57.6A	25.6A
REJ603-CT5: 128A-448A	115.2A	51.2A

Section 3 Technical Data

3.1 Dimensions

Table 4: Dimensions of relay

Description	Value
Width	96 mm
Height	160 mm
Depth	150 mm
Weight	~ 0.8 Kg (without HMI) ~ 0.9 Kg (with HMI)

3.2 Energizing inputs

Table 5: Energizing inputs

Description		Value
Rated frequency		50/60 Hz ± 5 Hz
Phase inputs	Nominal primary current	
	CT type	Setting range of reference current Is (Ismin - Ismax)
	REJ603-CT1	8 – 28 A
	REJ603-CT2	16 – 56 A
	REJ603-CT3	32 – 112 A
	REJ603-CT4	64 – 224 A
	REJ603-CT5	128 – 448 A
	Thermal withstand capability • Continuously • For 1 s • For 3 s	 2.5 x Ismax 25 kA primary current 20 kA primary current
	Dynamic current withstand: • Half-wave	 62.5 kA primary current
Earth input	Rated current, In	1 A
	Thermal withstand capability • Continuously • For 1 s	 4 A 100 A
	Dynamic current withstand: • Half-wave	 250 A
	Input impedance	< 100 mΩ

3.3 Trip impulse output

Table 6: Trip impulse output

Description	Value
Rated output voltage	24 V
Pulse duration	50 ms
Energy	100 mJ

3.4 Signal output

Table 7: Signal output (Solid State)

Description	Value
Rated output voltage	48 V DC
Maximum current	5 mA
Pulse duration	60 ms

3.5 Setting range and accuracy

Table 8: Setting possibility of rated current I_s

CT1	8	9	10	11	12	13	14	15	16	17	18	20	22	24	26	28
CT2	16	18	20	22	24	26	28	30	32	34	36	40	44	48	52	56
CT3	32	36	40	44	48	52	56	60	64	68	72	80	88	96	104	112
CT4	64	72	80	88	96	104	112	120	128	136	144	160	176	192	208	224
CT5	128	144	160	176	192	208	224	240	256	272	288	320	352	384	416	448

3.6 Protection function

3.6.1 Low set three-phase non-directional over current protection, stage I> / 51

Table 9: Settings of Low-set over current protection stage

Description	Value
Measuring range	0.9 x I_{smin} ...20 x I_{smax}
Setting range of pick-up current I >	0.9...2.5 x I_s
Settting resolution (steps)	I_s x 0.9...2.5, 31 steps with DIP switches, infinite Fine resolution 0.05 through HMI (optional)
Accuracy of pick-up current	±5.0% of set value in the temperature range 0...70ºC ±7.5% of set value in the temperature range -40...70ºC

Description	Value
Operate time delay (DMT) 't >'	0.05...3.0 sec
Setting resolution (steps)	0.05, 0.07, 0.1, 0.15, 0.2, 0.25, 0.3, 0.4, 0.6, 0.8, 1.0, 1.4, 1.8, 2.2, 2.6, 3.0 Fine resolution 0.01 through HMI (optional)
Operation time accuracy	±1% or 10 ms, whichever is greater
Operating curve type	IEC 60255-3: Normal Inverse, Very Inverse, Extremely Inverse, Long time Inverse Special Curves: RI Inverse, HR-Fuse, FR-Fuse
Time multiplier setting 'k'	0.05...3.0
Setting resolution (steps)	0.05, 0.07, 0.1, 0.15, 0.2, 0.25, 0.3, 0.4, 0.6, 0.8, 1.0, 1.4, 1.8, 2.2, 2.6, 3.0 Fine resolution 0.01 through HMI (optional)
Operation time accuracy IEC and RI characteristics HR, FR curve characteristics	 class E(5) ±35 ms, whichever is greater ±20% of set value or ±35 ms, whichever is greater

3.6.2 High set three-phase non-directional over current protection, stage I>> / 50

Table 10: Settings of High-set over current protection stage

Description	Value
Setting range of pick-up current I >>	1...20 x I_s
Setting resolution (steps)	I_s x 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 14,16, 18, 20, infinite Fine resolution 1.0 through HMI (optional)
Operation accuracy	±5% of set value in the temperature range 0...70ºC ±7.5% of set value in the temperature range -40...70ºC
Operate time delay (DMT) 't >>'	0.04...3.0 sec
Setting resolution (steps)	0.04, 0.07, 0.1, 0.15, 0.2, 0.25, 0.3, 0.4, 0.6, 0.8, 1.0, 1.4, 1.8, 2.2, 2.6, 3.0 Fine resolution 0.01 through HMI (optional)
Operation time accuracy	±1% or 10 ms, whichever is greater

3.6.3 Low set non-directional earth-fault protection, stage Io> / 51N

Table 11: Settings of Low-set earth-fault protection stage

Description	Value
Nominal value of earth current • Internal measurement • External measurement	 I_s I_n : 1 A
Measurement range	0.9 x I_{smin} ...20 x I_{smax} / 0.1...20 x I_n
Setting range of pick-up current I_0 >	0.1...1 x I_s / 0.1 - 1 x I_n
Setting resolution (steps)	I_s or I_n x 0.1…1.0 (31 steps) with DIP switches, infinite Fine resolution 0.025 through HMI (optional)
Operation accuracy Internal measurement External measurement	 ±3.0% of set value in the temperature range in the temperature range 0...70^{0}C ±7.5% of set value in the temperature range in the temperature range - 40...70^{0}C ±5% of set value in the temperature range in the temperature range 0...70^{0}C ±20% of set value in the temperature range in the temperature range - 40...70^{0}C
Operate time delay (DMT) 'to >'	0.05...3.0 sec
Setting resolution (steps)	0.05, 0.07, 0.1, 0.15, 0.2, 0.25, 0.3, 0.4, 0.6, 0.8, 1.0, 1.4, 1.8, 2.2, 2.6, 3.0 Fine resolution 0.01 through HMI (optional)
Operation time accuracy	±1% or 10 ms, whichever is greater
Operating curve type	IEC 60255-3: Normal Inverse, Very Inverse, Extremely Inverse, Long time Inverse Special Curves: RI Inverse, HR-Fuse, FR-Fuse
Time multiplier setting 'k'	0.05...3.0
Setting resolution (steps)	0.05, 0.07, 0.1, 0.15, 0.2, 0.25, 0.3, 0.4, 0.6, 0.8, 1.0, 1.4, 1.8, 2.2, 2.6, 3.0 Fine resolution 0.01 through HMI (optional)
Operation time accuracy IEC and RI characteristics HR, FR curve characteristics	 class E(5) ±35 ms, whichever is greater ±20% of set value or ±35 ms, whichever is greater

3.6.4 High set non-directional earth-fault protection, stage I_o>> / 50N

Table 12: Settings of High-set earth-fault protection stage

Description	Value
Setting range of pick-up current I_0 >>	1...20 x I_s / 1...20 x I_n
Setting resolution (steps)	I_s or I_n x 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 14, 16,18, 20, infinite Fine resolution 1.0 through HMI (optional)
Operation accuracy Internal measurement External measurement	 ± 3.0% of set value in the temperature range in the temperature range 0...70ºC ± 7.5% of set value in the temperature range in the temperature range -40...70ºC ± 5.0% of set value in the temperature range in the temperature range 0...70ºC ± 20% of set value in the temperature range in the temperature range -40...70ºC
Operate time delay (DMT) 't >>'	0.04...3.0 sec
Setting resolution (steps)	0.04, 0.07, 0.1, 0.15, 0.2, 0.25, 0.3, 0.4, 0.6, 0.8, 1.0, 1.4, 1.8, 2.2, 2.6, 3.0 Fine resolution 0.01 through HMI (optional)
Operation time accuracy	±1% of 10 ms, whichever is greater

3.6.5 Three phase inrush detection 3I_{2f}> / 68

Table 13: Settings of transformer inrush detector function

Description	Value
Start value (Ratio of the 2nd to the 1st harmonic leading to restraint)	5%...50% in steps of 5%

3.7 Switch-on to fault characteristic

Table 14: Switch-on to fault characteristics timings

Description	Value
At minimum value of pick-up current and minimum operate time, minimum value of tripping time when switch-on to fault	80 ms

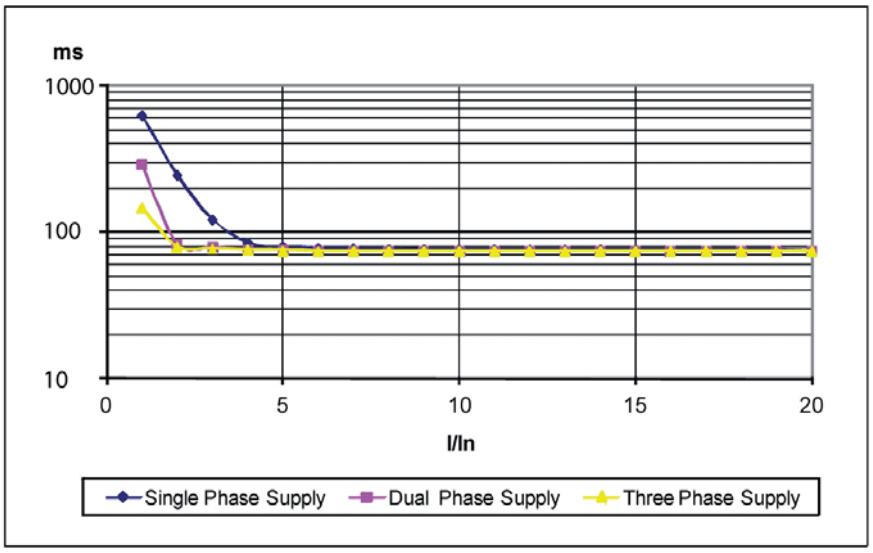


Figure 3: Switch-on to fault characteristic for REJ603

3.8 Degree of protection by enclosure

Table 15: Degree of protection

Description	Value
Front side	IP 54
Sides with connection terminal	IP 20

3.9 Environmental conditions and test

Table 16: Environmental conditions

Description	Value
Operating temperature range	-25...+55ºC
Short-time service temperature range	-40...+70ºC (<16h)
Relative humidity	<93%
Atmospheric pressure	86...106 kPa

Description	Value
Altitude	up to 2000 m
Transport and storage temperature range	-40...+70ºC

3.10 Product safety

Table 17: Product safety

Description	Value
LV directive	2006/95/EC
Standard	EN 60255-27 (2005)
	EN 60255-1 (2009)

3.11 EMC compliance

Table 18: EMC compliance details

Description	Value
EMC directive	2004/108/EC
Standard	EN 50263 (2000)
	EN 60255-26 (2007)

3.12 RoHS compliance

Table 19: RoHS compliance details

Description	Value
Complies with RoHS directive 2002/95/EC	

Section 4 Protection characteristics

4.1 Time / current characteristics

REJ603 relay has two-stage non-directional overcurrent and earth-fault protection. The relay supports Definite time and IDMT characteristics for both phase and earth-fault protection. The operation of the low-set overcurrent stage I> and the low-set earth-fault stage Io> is based on definite time or inverse time characteristic, as selected by the user. The high-set stage has instantaneous and definite time characteristics.

When IDMT characteristic has been selected, the operating time of the stage will be a function of the current; the higher the current, the shorter the operating time. The stage includes seven time/current curve sets – four according to the BS 142 and IEC 60255 standards namely normal inverse, very inverse, extremely inverse and long-time inverse and three special curves, named RI type curve, HR fuse curve and FR fuse curve.

4.1.1 IEC characteristics

The relationship between current and time for standard normal inverse, very inverse, extremely inverse and long-time inverse complies with the BS 142.1966 and IEC 60255-3 standards and can be expressed as follows:

$$t = \frac{(K * \beta)}{(\frac{I}{Iset})^{\alpha} - 1}$$

where,

t = operate time in seconds
K = time multiplier
I = measured current value
I set = set start current value
The slope of the time/current characteristics shall be determined by the constants α and β as indicated below:

Table 20: Values of constant α and β

Slope of the time/current curve set	α	β
Normal inverse	0.02	0.14
Very inverse	1.0	13.5
Extremely inverse	2.0	80.0
Long time inverse	1.0	120.0

4.1.2 RI type characteristics

The RI-type characteristic is a special characteristic used mainly in combination with existing mechanical relays. The characteristic is based on the following mathematical expression:

$$t = \frac{K}{\alpha - \beta(Iset/I)}$$

where,

t = operate time in seconds

K = time multiplier

I = measured current value

I set = set start current value

α = 0.339

ß = 0.236

4.1.3 HR Fuse and FR Fuse type characteristics

The HR and FR Fuse type characteristic is a special characteristic used mainly in combination with fuses. The characteristic is based on the following mathematical expression:

HR Fuse type characteristic is based on the following mathematical expression:

$$t = 10\ (\log(2 * (I/Iset) * (-3.832) + 3.66)) * (\alpha/0.1)$$

FR Fuse type characteristic is based on the following mathematical expression:

$$t = 10\ \left(\log\left((I/Iset) * (-7.16) + 3.0\right)\right) * (\alpha/0.1)\ \ for\ \ I/Iset = 1 - 2$$

$$t = 10\ \left(\log\left((I/Iset) * (-5.4) + 2.47\right)\right) * (\alpha/0.1)\ for\ I/Iset = 2 - 2.66$$

$$t = 10\ \left(\log\left(\left(\frac{I}{Iset}\right) * (-4.24) + 1.98\right)\right) * \left(\frac{\alpha}{0.1}\right)\ for\ \frac{I}{Iset} > 2.66$$

$$t = 10\ \left(\log\left((I/Iset) * (-5.4) + 2.47\right)\right) * (\alpha/0.1)\ for\ I/Iset = 2 - 2.66$$

4.1.4 Normal inverse-time characteristics curve

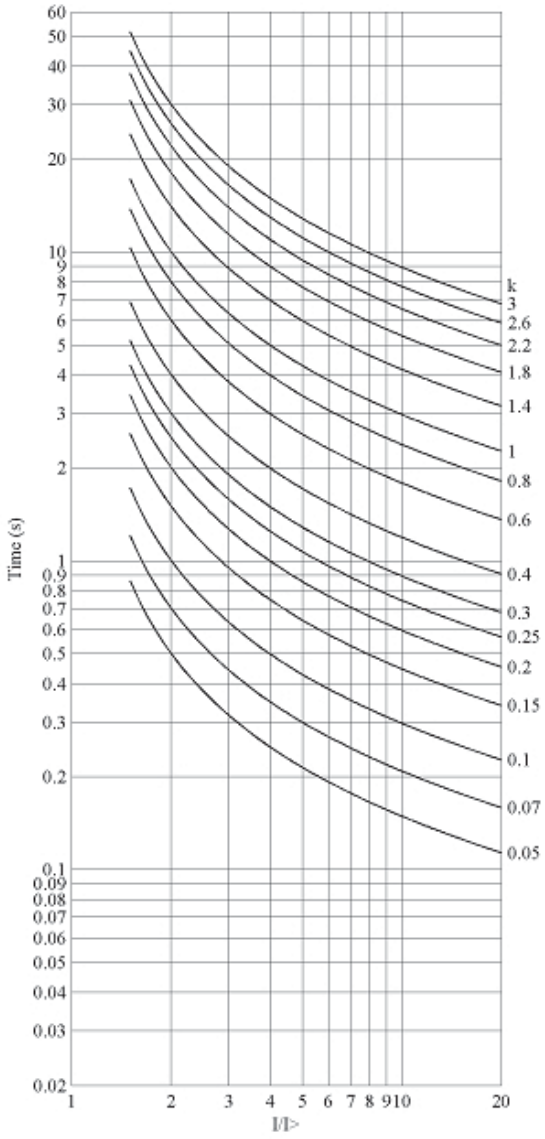


Figure 4: Normal inverse-time characteristics of relay REJ603

4.1.5 Extremely inverse-time characteristics

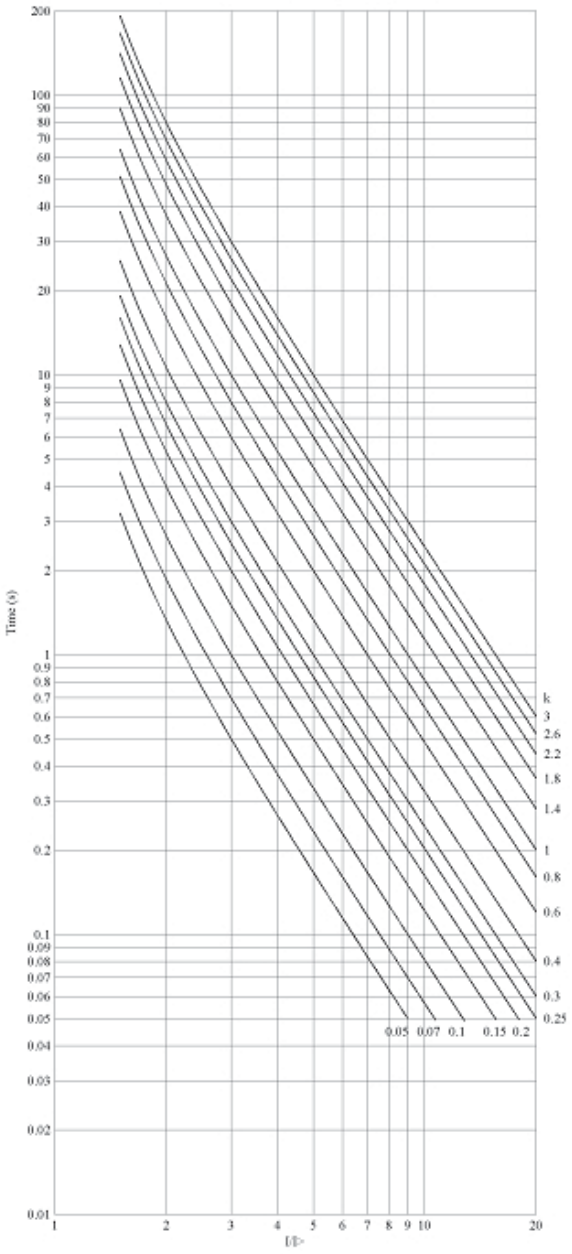


Figure 5: Extremely inverse-time characteristics of relay REJ603

4.1.6 Very inverse-time characteristics curve

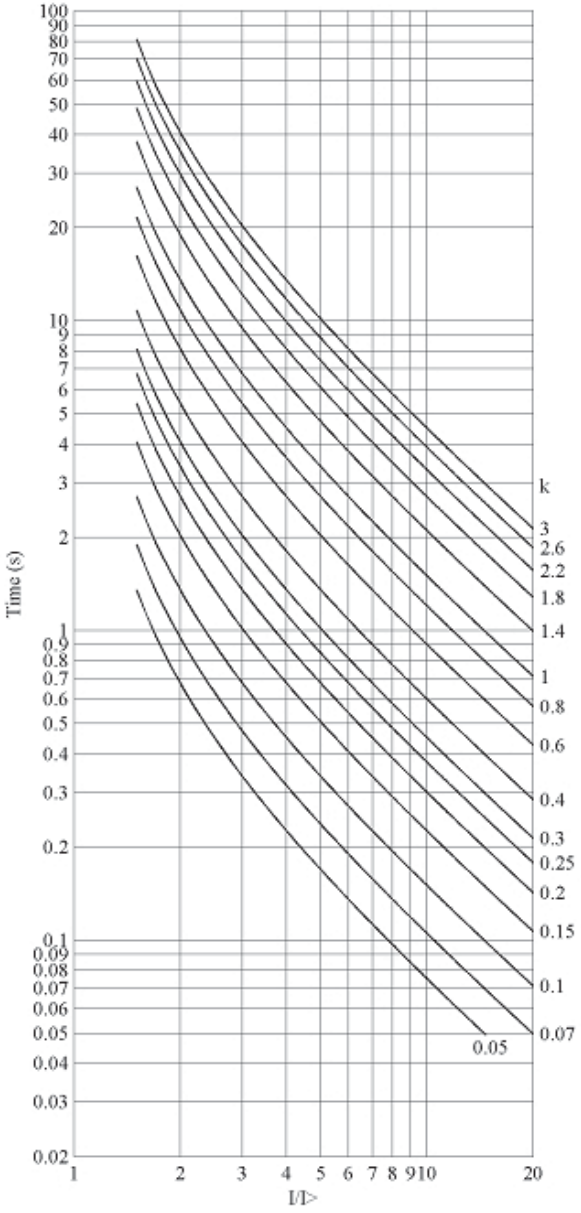


Figure 6: Very inverse-time characteristics of relay REJ603

4.1.7 Long-time inverse-time characteristics curve

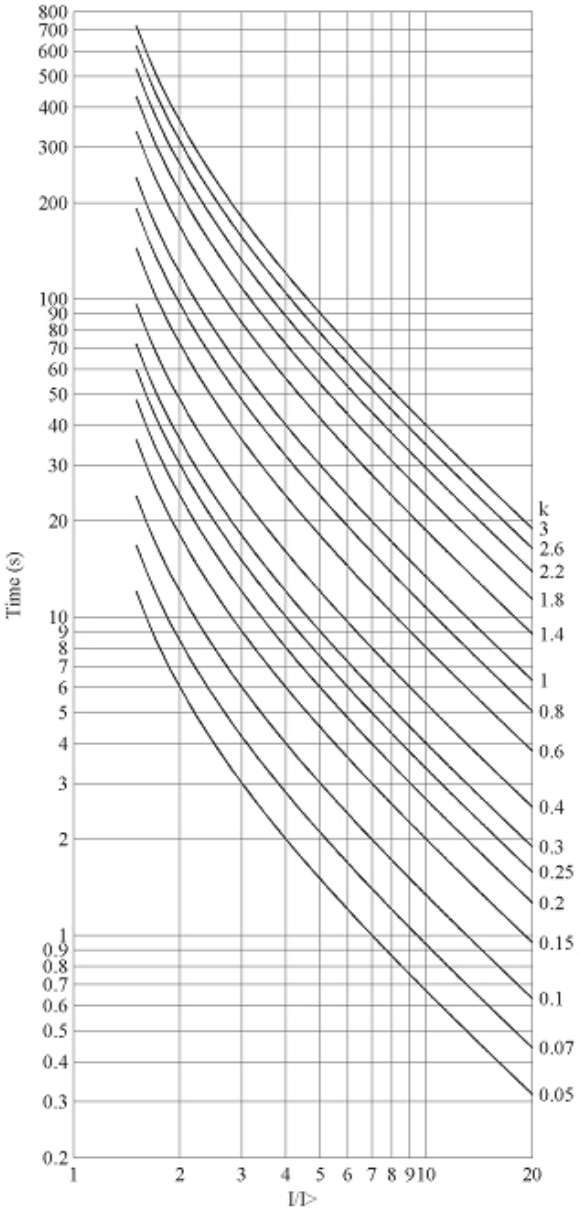


Figure 7: Long-time inverse-time characteristics of relay REJ603

4.1.8 RI type inverse-time characteristics curve

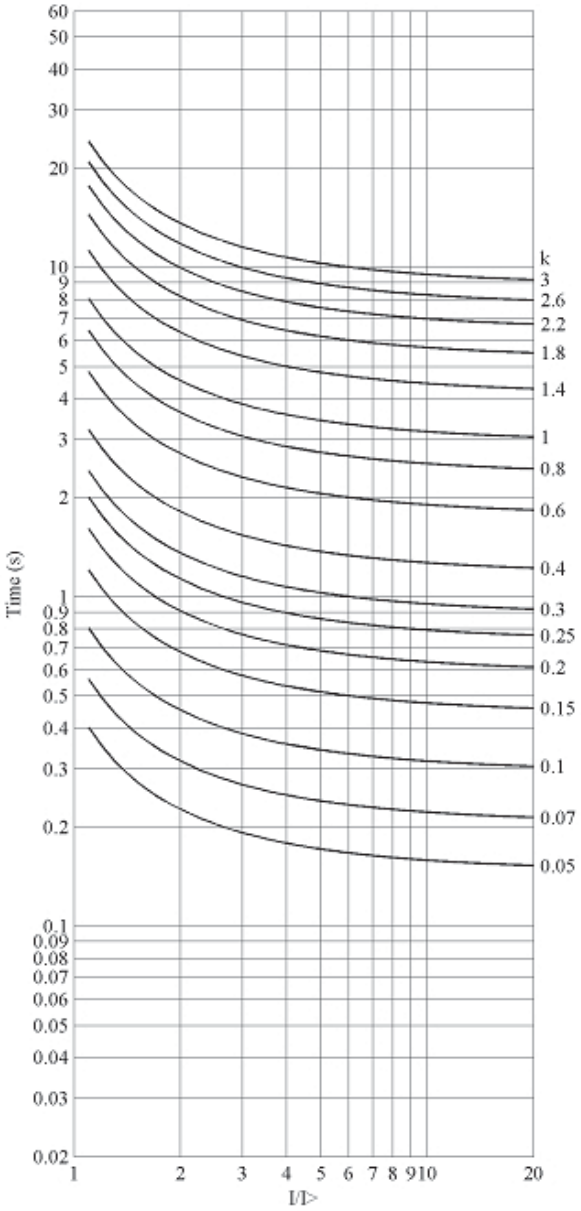


Figure 8: RI type inverse-time characteristics of relay REJ603

4.1.9 HR Fuse characteristics curve

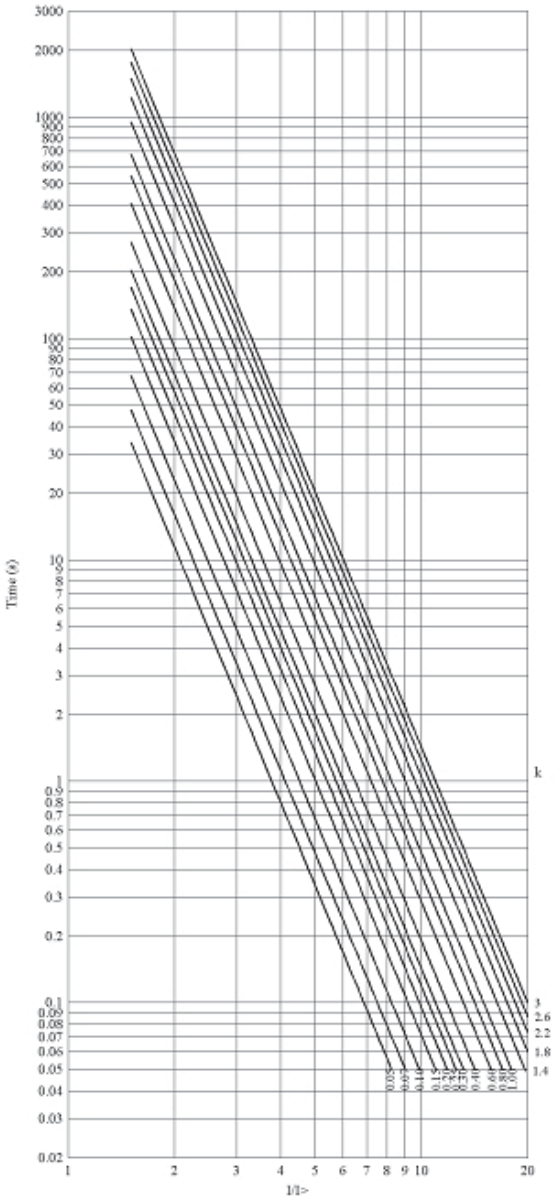


Figure 9: HR Fuse characteristics of relay REJ603

4.1.10 FR Fuse characteristics curve

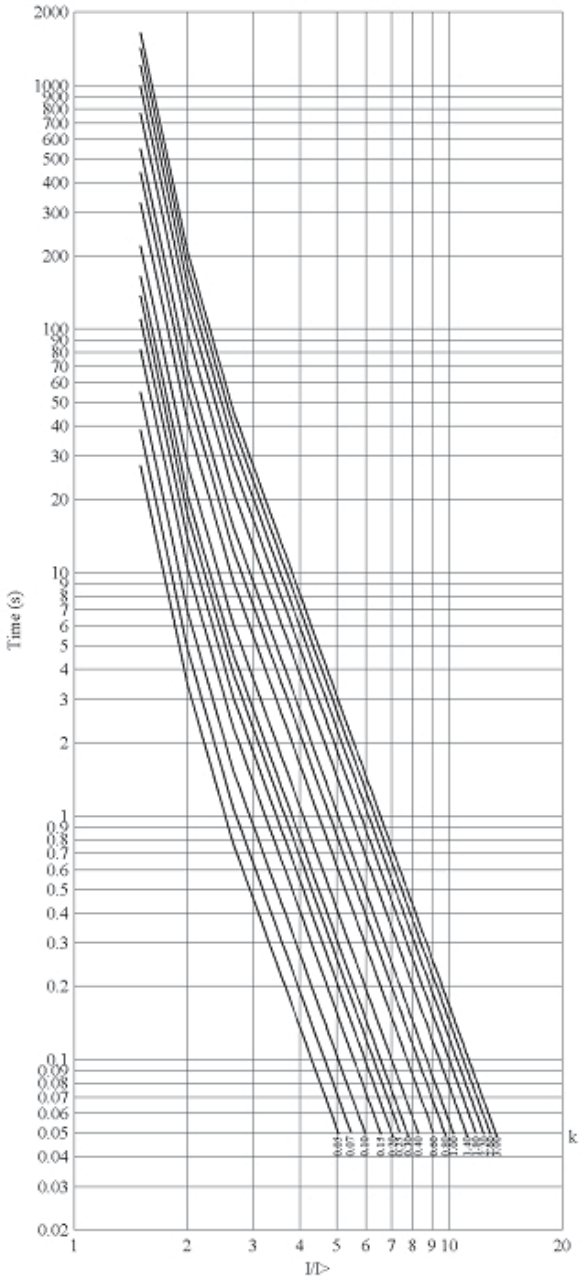


Figure 10: FR Fuse characteristics of relay REJ603

Section 5 Application Example

5.1 Purpose

This application guide presents generally accepted methods of calculation of over current and earth fault relay settings and its time coordination. The following sections detail an individual protection functions in REJ603 relay in addition to where and how they may be applied. Emphasis is given on practical application.

5.2 Description

REJ603 is a self-powered numerical relay, primarily used within distribution network. Before proceeding with over current and earth fault relay settings & coordination, the individual load or branch circuit protection should be applied in accordance with local electricity authority. Some of the definitions, which will be used in application example, shall be as below:

Start current:

It is a minimum value of current at which relay senses the over current and starts its operation. Start current setting is referred as I>, I>>, Io>, Io>>. Relay must start at the latest when the current exceeds 1.3 times the set start current.

Definite Minimum Time characteristic (DMT):

During fault condition, relay once starts, operates only after set definite minimum time irrespective of magnitude of fault current. The time settings is referred as t>, t>>, to>, to>>.

Inverse Definite Minimum Time characteristic (IDMT):

During fault condition, relay once starts; the operating time varies with the magnitude of fault current. Greater the magnitude of fault current lesser is the time of operation depending on the value k. Suitable characteristics can be selected from the options available in REJ603. Its time multiplier setting is referred as k, ko.

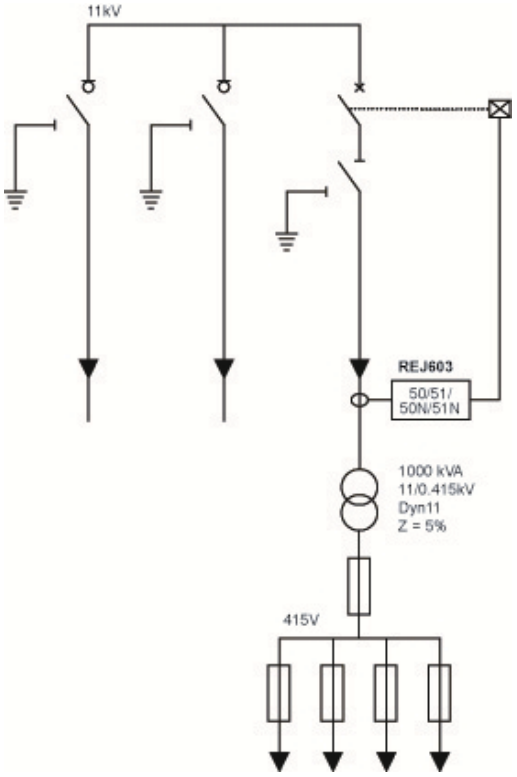


Figure 11: Basic circuit diagram of CCV type Ring Main Unit

5.3 Setting calculation

5.3.1 Selection of CT

Selection of the CT depends on the rated current of the transformer. The same is calculated as shown below:

$$In = \frac{Sn}{\sqrt{3} \times Un}$$

where
In = Rated full load current of the power transformer
Sn = Rated power of the power transformer
Un = Rated phase – phase voltage of the power transformer

Therefore,

$$\text{In} = \frac{\text{Sn}}{\sqrt{3}\times\text{Un}} = \frac{1000\ \text{kVA}}{\sqrt{3}\times 11\ \text{kV}} = 52.49\ \text{A}$$

From the measuring CTs table given in technical data, following CT is selected:

CT Type	Range	Current Ratio	Ip min for relay operation	O/C range	E/F measurement range	
					Internal	External
REJ603-CT3	32A-112A	28.8/0.075	28.8A	28.8A - 2240A	3.2A - 2240A	0.1*In – 20.0*In

Setting Range for I_s

I_s – 32, 36,40, 44, 48, 52, 56, 60, 64, 68, 72, 80, 88, 96, 104, 112

REJ603 can measure a short circuit current of a circuit up to 20 times of the highest CT rated current. This means for CT selected above, REJ 603 can measure current up to 112 A x 20 = 2240 A.

5.3.2 Fault level calculation

$$\text{The three phase fault MVA on 0.415kV bus is } = \frac{1000\ \text{kVA}}{\%\text{Z}\ /\ 100} = \frac{1000\ \text{kVA}}{0.05}$$

$$= 20000\ \text{kVA} = 20\ \text{MVA}$$

The 0.415kV system is solidly grounded

$$\text{Thus 3 phase fault current on 0.415kV bus is } = \frac{20000}{\sqrt{3}\ \text{x}\ 0.415} = 27.83\ \text{kA}$$

$$\text{Reflected 3 phase fault current on 11kV } = \frac{27.83\ \text{kA x}\ 0.415\ \text{kV}}{11\ \text{kV}} = 1.049\ \text{kA}$$

Thus with CT 3 (32A-112A) the fault current can be measured clearly by REJ603. Relay can withstand 2.5 x Highest CT rated current continuously and thus care should be taken that continuous load current should be lower than 2.5 x Is i.e. 2.5 x 112 A = 280 Amp.

Now the technical data for relay setting calculation is as follows:

Transformer Technical details: 1 MVA, 11kV, Dyn11, Z = 5%

CT selected is REJ603-CT3 as data indicated earlier.

Relay REJ 603 is used on power transformer 11kV side and is connected to CT 3 secondary with Is selected as 80.

0.415kV fault current reflected on 11kV side of the power transformer is 1.049 kA i.e. 1049 Amp.

Consider fault current at 11 kV base as 9 kA.

5.3.3 Calculation of setting of high-set O/C

When applying overcurrent protection to the 11kV side of the power transformer it is usual practice to apply a high set instantaneous overcurrent protection (50) in addition to the time delayed low set over current protection (51). Typically this will be set to approximately 1.4 times the reflected 0.415kV fault level such that it will operate only for 11kV side fault. As REJ603 is compliant design against Harmonic distortion and inrush current, this high set overcurrent protection will not operate during transformer energizing condition.

$$Reflected\ 3\ phase\ fault\ current\ on\ 11kV\ = \frac{27.83\ kA\ x\ 0.415\ kV}{11\ kV} = 1.049\ kA$$

I>> unit set at = 1.4 x 1049 / 80 = 18.3575

I>> unit set at 19 x Is i.e. it's primary operating current will be 19 x 80 = 1520 Amp

I>> unit start current is greater than reflected fault current of 0.415kV on 11Kv and less that fault current at 11kV i.e. 9kAmp,

Operate time t>> is set at 0.05 Sec

High set overcurrent protection will operate instantaneously for fault on 11 kV side of the power transformer wherein fault current is 9 kA and will not operate for the fault on 0.415 kV side of the power transformer.

5.3.4 Calculation of setting of low-set O/C

Full load current of the transformer is 52.49 Amp.

Adopted CT Is is 80.

Set I> start current at 1.5 x Transformer full load current.

$$I > set\ at\ = \frac{1.5\ x\ 52.49}{80} = 0.9841$$

Set I> at 1.0 x Is i.e. it's primary operating current is 1.0 x 80 = 80 Amp.

Primary protection device for fault on 0.415kV is fuse.

Considering the operating time of fuse as 50 mSec. Then REJ 603 acts as back up protection for 0.415 kV fault.

The criteria for assumption of desired operating time depends on the size of the electrical distribution system and location of the protection device.

In this example, desired operating time of low set overcurrent protection (51) is considered as 200 mSec. for fault on 0.415 kV as well as for the fault on 11 kV assuming that the fuse will act as a primary protection for the fault on 0.415 kV side. Thus (51) will act as a backup to fuse provided on 0.415kV and to the (50) on 11kV.

For fault on 0.415kV :

3 phase fault current of 0.415kV reflected on 11 kV bus = 1049 Amp

With $I > set\ at\ 1.0xIs, the\ PSM = \frac{\text{Fault current}}{\text{Primary Operating current}} = \frac{1049}{1 \text{ x } 80}$

$= 13.11$

Thus I / I> = 13.12

Consider Normal Inverse Characteristic :

$$t = \frac{(K * \beta)}{(\frac{I}{Iset})^{\alpha} - 1}$$

Slope of the time/current curve set	α	β
Normal inverse	0.02	0.14

Operating time at k = 1.0

$$t\ (s)\ = \frac{1.0\ x\ 0.14}{(13.12)^{0.02} - 1} = 2.65\ Sec.$$

Desired operating time is 0.20 sec and thus k set at 0.08

With k = 0.08, time of operation of I> protection unit is 0.212 sec

Fault on 11 kV :

Considered 3 phase fault current on 11 kV is 9 kAmp

$$\frac{I}{I>} = \frac{9000}{80} = 112.5\ which\ is\ greater\ than\ 20.$$

Thus I / I > = 20
Operating time for k = 1 is 2.267 sec.

With k = 0.08 , time of operation of I> protection unit is 0.181 Sec.
Thus,
I > set at 1.0 x Is = 1.0 x 80 = 80 Amp.
k set at 0.08 with Normal Inverse Characteristic.

5.3.5 Calculation of setting of high-set E/F

As the transformer vector group is Dyn11, the single phase earth fault on 0.415kV will not reflect as earth fault on 11 kV delta winding of the transformer.

Single phase to earth fault current in 11kV System is considered as 400 A.

When applying earth fault protection to the 11kV side of the power transformer it is usual practice to apply a high set instantaneous earth fault protection (50N) in addition to the time delayed low set earth fault protection (51N).

Io>> unit set at 4.0xIs i.e. it's primary operating current will be 4.0x80 = 320A

Operate time to>> is set at 0.05 Sec.

High set earth fault protection will operate instantaneously for fault on 11kV side of the power transformer wherein fault current is considered as 400A.

5.3.6 Calculation of setting of Low-set E/F

Single phase to earth fault current in 11kV System is considered as 400A.

Adopted CT Is is 80.

Set Io> at 1.0 x Is i.e it's primary operating current is 1.0 x 80 = 80 Amp.

Desired operating time of the low set earth fault protection (51N) is considered as 200 msec for fault on 11 kV. It will be acting as a backup protection for 50N.

For fault on 11 kV:

1 phase fault current on 11 kV bus = 400 A.

$$\text{With Io} > \text{set at 1.0xIs, the PSM} = \frac{\text{Fault current}}{\text{Primary Operating current}} = \frac{400}{1 \text{ x } 80} = 5.0$$

Thus I / I> = 5.0
Consider Normal Inverse Characteristic:

$$t = \frac{(K * \beta)}{(\frac{I}{Iset})^{\alpha} - 1}$$

Slope of the time/current curve set	α	β
Normal inverse	0.02	0.14

Operating time at k = 1.0

$$t\,(s) = \frac{1.0\ x\ 0.14}{(\ 5.0\ )0.02 - 1} = 4.28\ Sec.$$

Desired operating time is 0.20 sec and thus ko set at 0.05

With k = 0.05, time of operation of Io> protection unit is 0.214 Sec

Thus,

Io > set at 1.0 x Is = 1.0 x 80 = 80 Amp.

k set at 0.05 with Normal Inverse Characteristic.

$$\text{With Io} > set\ at\ 1.0xIs, the\ PSM = \frac{\text{Fault current}}{\text{Primary Operating current}} = \frac{400}{1\ \text{x}\ 80}$$
$$= 5.0$$

Thus I / I> = 5.0

Consider Normal Inverse Characteristic:

$$t = \frac{(K * \beta)}{(\frac{I}{Iset})^{\alpha} - 1}$$

Slope of the time/current curve set	α	β
Normal inverse	0.02	0.14

Operating time at k = 1.0

$$t\,(s) = \frac{1.0\ x\ 0.14}{(\ 5.0\ )0.02 - 1} = 4.28\ Sec.$$

Desired operating time is 0.20 Sec. and thus ko set at 0.05

With k = 0.05 , time of operation of Io> protection unit is 0.214 Sec.

Thus,

Io > set at 1.0 x Is = 1.0 x 80 = 80 Amp.

k set at 0.05 with Normal Inverse Characteristic.

Section 6 Relay setting

6.1 Setting

The relay settings are done through DIP switches available on the front panel of the relay. The relay is supplied with a factory-set default settings.

6.2 Switch setting matrix

The relay setting matrix is available on the terminal side of the relay and the same is explained below. There are six, 8-pole DIP switches on the front panel. The setting is done by adjusting these switches corresponding to the setting matrix/ table.

Table 21: Switch setting matrix

Descript of parameter	Switch block	Switch number
Rated CT current	S1	1-4
Earth fault measurement	S1	5
t> / k selection	S2	1-4
to> / k selection	S2	5-8
I> selection	S3	1-5
Characteristic selection for Phase O/C	S3	6-8
Io> selection	S4	1-4
Characteristic selection for Earth E/F	S4	6-8
I>> selection	S5	1-4
t>> selection	S5	5-8
Io>> selection	S6	1-4
to>> selection	S6	5-8

6.2.1 Rated CT and earth current measurement selection

The rated CT current, Is is set by adjusting the switch S1/1-4

S1-1	OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF	ON
S1-2	OFF	OFF	ON	ON	OFF	OFF	ON	ON	OFF	OFF	ON	ON	OFF	OFF	ON	ON
S1-3	OFF	OFF	OFF	OFF	ON	ON	ON	ON	OFF	OFF	OFF	OFF	ON	ON	ON	ON
S1-4	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	ON	ON	ON	ON	ON	ON	ON	ON
CT1	8	9	10	11	12	13	14	15	16	17	18	20	22	24	26	28
CT2	16	18	20	22	24	26	28	30	32	34	36	40	44	48	52	56
CT3	32	36	40	44	48	52	56	60	64	68	72	80	88	96	104	112
CT4	64	72	80	88	96	104	112	120	128	136	144	160	176	192	208	224
CT5	128	144	160	176	192	208	224	240	256	272	288	320	352	384	416	448

Earth current measurement: The internal or external CT is selected by switch S1/ 5

S1-5	OFF	ON
Earth fault measurement	by internal calculation	by external input

6.2.2 Operation time selection for low-set overcurrent and earth-fault

t> / k selection, switch S2/ 1-4

S2-1	OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF	ON
S2-2	OFF	OFF	ON	ON	OFF	OFF	ON	ON	OFF	OFF	ON	ON	OFF	OFF	ON	ON
S2-3	OFF	OFF	OFF	OFF	ON	ON	ON	ON	OFF	OFF	OFF	OFF	ON	ON	ON	ON
S2-4	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	ON	ON	ON	ON	ON	ON	ON	ON
t>/k	0.05	0.07	0.1	0.15	0.2	0.25	0.3	0.4	0.6	0.8	1	1.4	1.8	2.2	2.6	3

to> / k selection, switch S2/ 5-8

S2-5	OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF	ON
S2-6	OFF	OFF	ON	ON	OFF	OFF	ON	ON	OFF	OFF	ON	ON	OFF	OFF	ON	ON
S2-7	OFF	OFF	OFF	OFF	ON	ON	ON	ON	OFF	OFF	OFF	OFF	ON	ON	ON	ON
S2-8	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	ON	ON	ON	ON	ON	ON	ON	ON
to>/k	0.05	0.07	0.1	0.15	0.2	0.25	0.3	0.4	0.6	0.8	1	1.4	1.8	2.2	2.6	3

6.2.3 Operation characteristic / start current selection for low-set overcurrent

I > selection, switch S3/1-5

S3-1	OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF	ON
S3-2	OFF	OFF	ON	ON	OFF	OFF	ON	ON	OFF	OFF	ON	ON	OFF	OFF	ON	ON
S3-3	OFF	OFF	OFF	OFF	ON	ON	ON	ON	OFF	OFF	OFF	OFF	ON	ON	ON	ON
S3-4	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	ON	ON	ON	ON	ON	ON	ON	ON
S3-5*	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF
S3-5**	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON
I>*	0.9	0.95	1	1.05	1.1	1.15	1.2	1.25	1.3	1.35	1.4	1.45	1.5	1.55	1.6	1.65
I>**	1.7	1.75	1.8	1.85	1.9	1.95	2.0	2.05	2.1	2.15	2.2	2.25	2.3	2.4	2.5	E

CI – characteristic curve selection for phase, switch S3/6-8

S3-6	OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF	ON
S3-7	OFF	OFF	ON	ON	OFF	OFF	ON	ON	OFF	OFF	ON	ON	OFF	OFF	ON	ON
S3-8	OFF	OFF	OFF	OFF	ON	ON	ON	ON	OFF	OFF	OFF	OFF	ON	ON	ON	ON
CI	DMT	NI	EI	VI	LI	RI	HR	FR	NA	NA	NA	NA	NA	NA	NA	NA

6.2.4 Operation characteristic / start current selection for low-set earth-fault

I_0 > selection, switch S4/1-5

S4-1	OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF	ON
S4-2	OFF	OFF	ON	ON	OFF	OFF	ON	ON	OFF	OFF	ON	ON	OFF	OFF	ON	ON
S4-3	OFF	OFF	OFF	OFF	ON	ON	ON	ON	OFF	OFF	OFF	OFF	ON	ON	ON	ON
S4-4	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	ON	ON	ON	ON	ON	ON	ON	ON
S4-5*	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF
S4-5**	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON
Io>*	0.1	0.13	0.15	0.18	0.2	0.23	0.25	0.28	0.3	0.33	0.35	0.38	0.4	0.43	0.45	0.48
Io>**	0.5	0.53	0.58	0.6	0.63	0.65	0.68	0.7	0.73	0.75	0.8	0.85	0.9	0.95	1	E

CE – characteristic curve selection for earth, switch S4/6-8

S4-6	OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF	ON
S4-7	OFF	OFF	ON	ON	OFF	OFF	ON	ON	OFF	OFF	ON	ON	OFF	OFF	ON	ON
S4-8	OFF	OFF	OFF	OFF	ON	ON	ON	ON	OFF	OFF	OFF	OFF	ON	ON	ON	ON
CI	DMT	NI	EI	VI	LI	RI	HR	FR	NA	NA	NA	NA	NA	NA	NA	NA

6.2.5 Operation time / start current selection for high-set overcurrent

I>> selection, switch S5/1-4

S5-1	OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF	ON
S5-2	OFF	OFF	ON	ON	OFF	OFF	ON	ON	OFF	OFF	ON	ON	OFF	OFF	ON	ON
S5-3	OFF	OFF	OFF	OFF	ON	ON	ON	ON	OFF	OFF	OFF	OFF	ON	ON	ON	ON
S5-4	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	ON	ON	ON	ON	ON	ON	ON	ON
I>>	1	2	3	4	5	6	7	8	9	10	12	14	16	18	20	E

t>> selection, switch S5/5-8

S5-5	OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF	ON
S5-6	OFF	OFF	ON	ON	OFF	OFF	ON	ON	OFF	OFF	ON	ON	OFF	OFF	ON	ON
S5-7	OFF	OFF	OFF	OFF	ON	ON	ON	ON	OFF	OFF	OFF	OFF	ON	ON	ON	ON
S5-8	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	ON	ON	ON	ON	ON	ON	ON	ON
t>>	0.04	0.07	0.1	0.15	0.2	0.25	0.3	0.4	0.6	0.8	1	1.4	1.8	2.2	2.6	3

6.2.6 Operation time / start current selection for low-set overcurrent

Io> > selection, switch S6/1-4

S6-1	OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF	ON
S6-2	OFF	OFF	ON	ON	OFF	OFF	ON	ON	OFF	OFF	ON	ON	OFF	OFF	ON	ON
S6-3	OFF	OFF	OFF	OFF	ON	ON	ON	ON	OFF	OFF	OFF	OFF	ON	ON	ON	ON
S6-4	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	ON	ON	ON	ON	ON	ON	ON	ON
Io>>	1	2	3	4	5	6	7	8	9	10	12	14	16	18	20	E

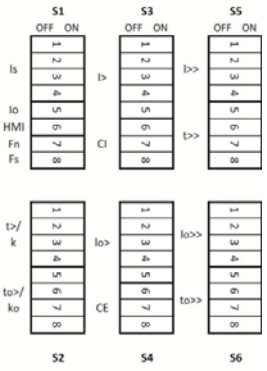
to>> selection, switch S6/5-8

S6-5	OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF	ON
S6-6	OFF	OFF	ON	ON	OFF	OFF	ON	ON	OFF	OFF	ON	ON	OFF	OFF	ON	ON
S6-7	OFF	OFF	OFF	OFF	ON	ON	ON	ON	OFF	OFF	OFF	OFF	ON	ON	ON	ON
S6-8	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	ON	ON	ON	ON	ON	ON	ON	ON
t>>	0.04	0.07	0.1	0.15	0.2	0.25	0.3	0.4	0.6	0.8	1	1.4	1.8	2.2	2.6	3

6.3 Total Switch setting matrix

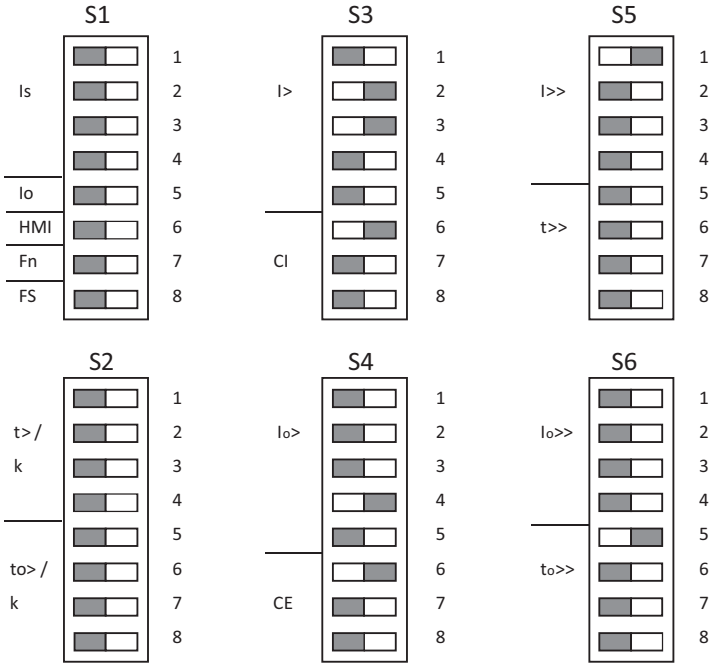
The REJ603 relay on the terminal side contains below indicated setting matrix view, for ease of setting the relay.

DIP i		OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF	ON
DIP ii		OFF	OFF	ON	ON	OFF	OFF	ON	ON	OFF	OFF	ON	ON	OFF	OFF	ON	ON
DIP iii		OFF	OFF	OFF	OFF	ON	ON	ON	ON	OFF	OFF	OFF	OFF	ON	ON	ON	ON
DIP iv		OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	ON	ON	ON	ON	ON	ON	ON	ON
DIP v*		OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF
DIP v**		ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON
CT1	Is S1/1-4	8	9	10	11	12	13	14	15	16	17	18	20	22	24	26	28
CT2		16	18	20	22	24	26	28	30	32	34	36	40	44	48	52	56
CT3		32	36	40	44	48	52	56	60	64	68	72	80	88	96	104	112
CT4		64	72	80	88	96	104	112	120	128	136	144	160	176	192	208	224
CT5		128	144	160	176	192	208	224	240	256	272	288	320	352	384	416	448
Io	S1/5	OFF = Earthfault measurement by internal calculation								ON = Earthfault measurement by external input							
HMI	S1/6	OFF = Setting by DIP switches								ON = Setting by DIP switches (coarse) + HMI (fine)							
Fn	S1/7	OFF = 50 Hz								OFF = 60 Hz							
Fs	S1/8	OFF = Failsafe Disable								ON = Failsafe Enable							
t>/k	S2/1-4	0.05	0.07	0.1	0.15	0.2	0.25	0.3	0.4	0.6	0.8	1	1.4	1.8	2.2	2.6	3
to>/ko	S2/5-8	0.05	0.07	0.1	0.15	0.2	0.25	0.3	0.4	0.6	0.8	1	1.4	1.8	2.2	2.6	3
I>*	S3/1-5	0.9	0.95	1	1.05	1.1	1.15	1.2	1.25	1.3	1.35	1.4	1.45	1.5	1.55	1.6	1.65
I>**	S3/1-5	1.7	1.75	1.8	1.85	1.9	1.95	2.0	2.05	2.1	2.15	2.2	2.25	2.3	2.4	2.5	E
CI	S3/6-8	DMT	NI	EI	VI	LI	RI	HR	FR	NA	NA	NA	NA	NA	NA	NA	NA
Io>*	S4/1-5	0.1	0.125	0.15	0.175	0.2	0.225	0.25	0.275	0.3	0.325	0.35	0.375	0.4	0.425	0.45	0.475
Io>**	S4/1-5	0.5	0.525	0.575	0.6	0.625	0.65	0.675	0.7	0.725	0.75	0.8	0.85	0.9	0.95	1	E
CE	S4/6-8	DMT	NI	EI	VI	LI	RI	HR	FR	NA	NA	NA	NA	NA	NA	NA	NA
I>>	S5/1-4	1	2	3	4	5	6	7	8	9	10	12	14	16	18	20	E
t>>	S5/5-8	0.04	0.07	0.1	0.15	0.2	0.25	0.3	0.4	0.6	0.8	1	1.4	1.8	2.2	2.6	3
Io>>	S6/1-4	1	2	3	4	5	6	7	8	9	10	12	14	16	18	20	E
to>>	S6/5-8	0.04	0.07	0.1	0.15	0.2	0.25	0.3	0.4	0.6	0.8	1	1.4	1.8	2.2	2.6	3



6.4 Switch setting matrix example

Selection of Is based on CT, Is=32 for CT3
Earth measurement: Internal
I > = 120% or 1.2
CI = Normal inverse
t> / k = 0.05
Io> = 30% or 0.3
CE = Normal inverse
t> / k = 0.05
I>> = 200% or 2.0
t>> = 0.04
Io>> = 100% or 1.0
to>> = 0.07
HMI : Setting through DIP switch
System frequency = 50 Hz
Fail safe = Disable



Section 7 Installation and commissioning

7.1 Unpacking and inspecting the device

REJ603 products, although of robust construction, require careful handling prior to installation on site. The delivered products should always be examined to ensure that no damage has been sustained during transit.

Remove transport packing carefully without force. Appropriate tools needs to be used.

Check the relay for transport damages. If the product has been damaged, a claim should be made to the transport contractor and the local representative of ABB should be promptly notified. Compare the type designation of the product with the ordering information to verify that you have received the right product.

Electrostatic discharge (ESD)

The products contain components that are sensitive to electrostatic discharge. The electronic circuits are well protected by the relay case and therefore the rear panel may not be removed.

7.2 Storage

On receipt, the apparatus must be carefully unpacked and checked as described under section 7.1. Should installation not be carried out immediately, the apparatus must be repacked using the original packing material. Should the original packing material no longer be available, store the apparatus in a dry, dust-free, covered area which is non-corrosive and has a temperature of between – 40 °C and + 70 °C.

7.3 Checking environmental condition and mounting space

The mechanical and electrical environmental conditions at the installation site must be within the limits described in the technical data.

- Avoid installation in dusty, damp places.

  Avoid places susceptible to rapid temperature variations, powerful vibrations and shocks, surge voltages of high amplitude and fast rise time, strong induced magnetic fields or similar extreme conditions.
- Check that sufficient space is available.

  To allow access for maintenance and future modifications a sufficient space is needed in front and at side of the relays.

- Suitably qualified personnel with adequate knowledge of the apparatus must carry out all the installation operations.
- The relay should be disconnected before carrying out any work on relay.

7.4 Mounting the relay

The relay has provision of wall mounting.

The space requirement of mounting:

Dimensions (H x W x D):	160x96x150 mm
Weight:	800g without HMI
	900g with HMI

By using the six nos. 4mm^2 drill holes, the relay is directly mounted on to the mounting plate. Detailed mounting drawing with all measurement is furnished in section 7.6.

7.5 Relay wiring

The connection wiring to the relay should be made by using single strand wire or stranded wire with the use of insulated crimp terminal to maintain the insulation requirements. The wire with below indicated cross-section should be used for wiring:

- 0.2 – 2.5 sq. mm single-core
- 0.2 – 2.5 sq. mm finely stranded

7.6 Relay mounting dimensions

The relay is projection mounted. The relay provides IP54 on front side. The overall dimensions of the relay are as follows:

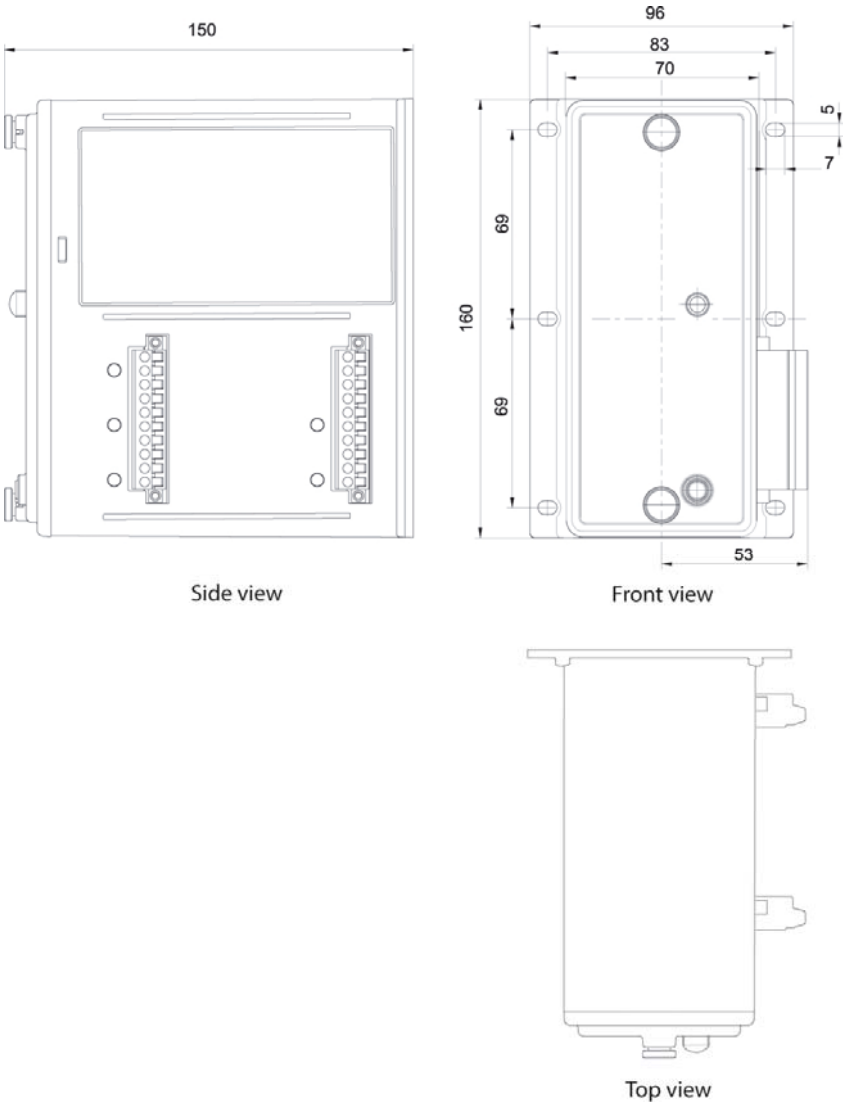


Figure12: Relay mounting dimention

7.7 Relay connection diagram

The relay is projection mounted. The relay provides IP54 on the front side. The overall dimensions of the relay are as follows:

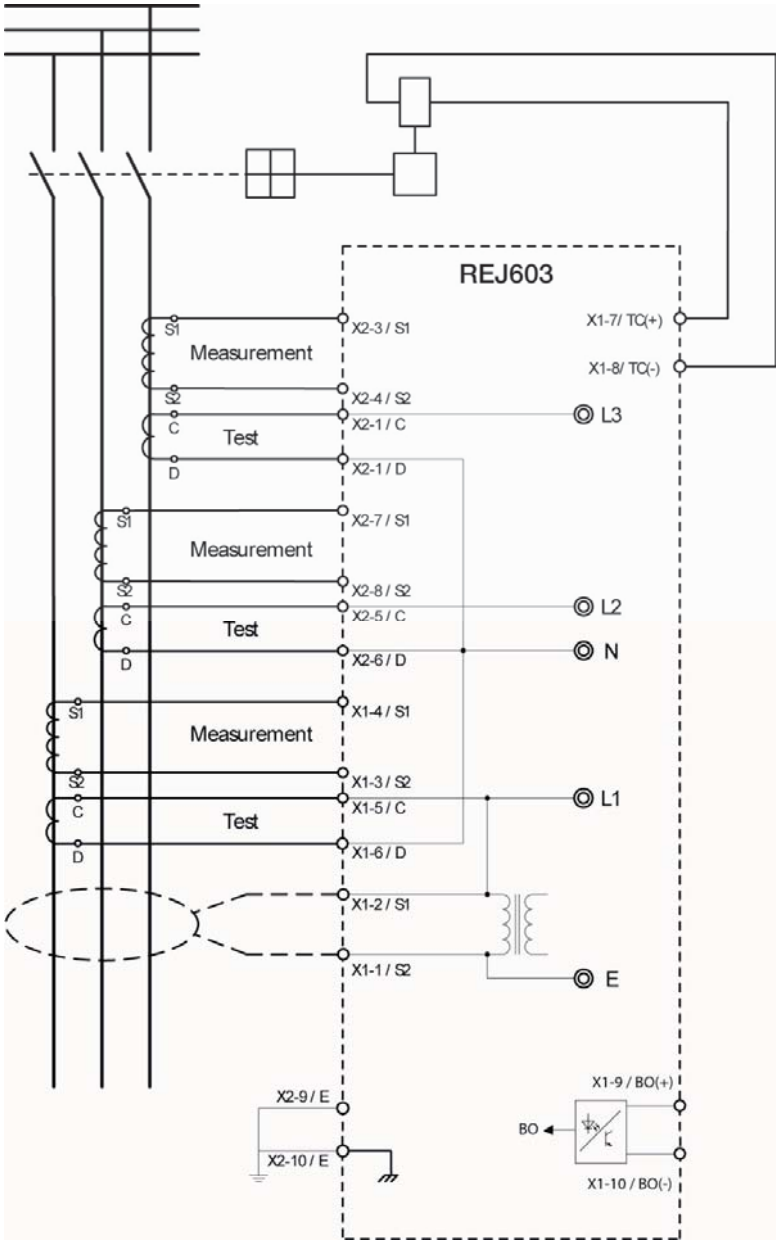


Figure 13: Relay terminal diagram

7.8 Relay connection

The relay is available with three analog phase measuring inputs. The special CTs are designed for REJ603 relay, the current measuring inputs of the relay are specially adjusted to these CTs. The details of these CTs are available in technical data section 3. The relay can be powered from these three analog phase measuring inputs as indicated below:

- CT input phase L1 (S1, S2), Terminal no. X1-4, X1-3
- CT input phase L2 (S1, S2), Terminal no. X2-7, X2-8
- CT input phase L3 (S1, S2), Terminal no. X2-3, X2-4

The earth current is calculated from the three currents.

Alternatively additional earth current measuring input is available in relay for connection of core balance current transformer (CBCT) if needed which can be connected to below indicated input:

- CT input earth L1 (S1, S2), Terminal no. X1-2, X1-1

The special CTs for REJ603 have a test windings to simulate primary current, test socket are provided on the relay through which current can be injected in the test winding of CT's which facilitates the testing of complete protection scheme including CT, relay and trip coil.

- Test socket - L1, L2, L3, N for phase circuit testing
- Test socket – E, N for earth circuit testing

Signal output is provided to communicate the trip status to external system

- Signal output BO(+), BO(-), Terminal no. X1-9, X1-10

Low energy impulse type trip output is available to trip circuit breaker.

- Trip Input TC(+), TC(-), Terminal no.X1-7, X1-8

Earthing should be connected to earth terminal

- Earth Input, Terminal no. X2-9, X2-10

On the front of the relay, LED indications for Unit ready and relay internal fault are available.

Phase and earth over current fault indication are provided through manually re-settable mechanical Flag which ensures availability of relay operation indication even in absence of the primary CT current.

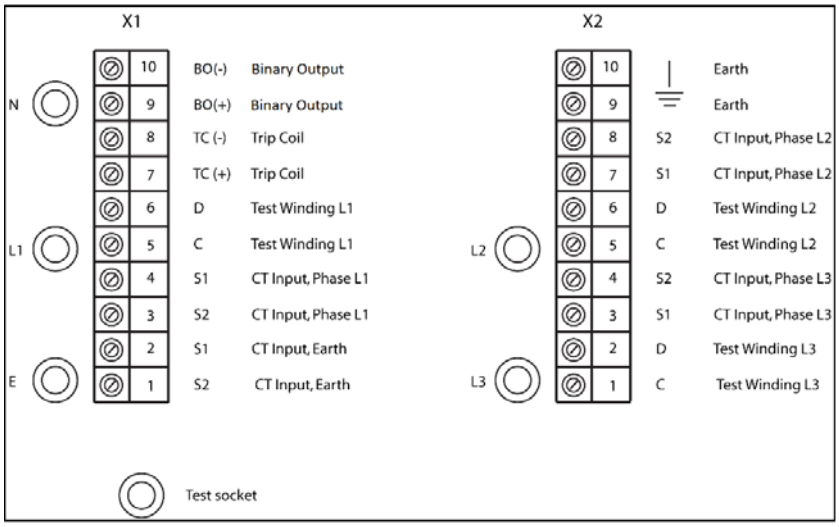


Figure 14: Terminal arrangement diagram

Important points to be taken in to consideration during wiring and operation:

- No winding terminal of the measuring winding of CT to be earthed. Earthing is done internally and brought out at earth terminal.
- The secondary side of test winding always to be kept open (except when relays are tested)
- Polarity of tripping coil wiring TC(+) and TC(-) needs to be properly checked to have correct tripping operation.

1.9 Relay commissioning

During the first time commissioning the relay, it is necessary for user to become familiar with the method by which the settings are applied. All the settings of relay can be changed by using DIP switches refer section 6.

The customer shall be responsible for determining the application-specific settings applied to the relay and for testing of any scheme logic applied by external wiring.

Minimum equipment required:

- Current injection test set.
- Multimeter with suitable AC current range
- Multimeter with recording of maximum value of DC voltage (for DC amplitude of pulse tripping measuring)
- Continuity tester

Pre-commissioning checks:

Below indicated pre-commissioning checks are generally done before commissioning

- Visual inspection
- Wiring checking
- Insulation resistance checking

Testing of the relay:

After installation and before putting into operation complete in and out (from CT to trip coil function) can be checked with use of test winding which gives the possibility of injecting the simulated primary current.

For testing, secondary testing system with 1A rated output current is required. The test current is fed through sockets L1, L2, L3 and N available beside the connection terminal on the relay. The test winding is rated such that the fed current of 1A balances a primary current of 50A (CT type CT2- 16A-56A). Applying the 1A rated current and connecting trip coil at output with setting of relay kept to minimal values, a complete check of protection system is possible with the tripping circuit. Connection diagram for testing of relay with test winding is given in figure 13.

By injecting 1A rated current in test winding, gives the possibility of simulated primary current injection. The value of simulated primary current depends on Primary CT used, details given below:

Table 22: Value of current applied to test winding and simulated primary current

CT Type	Current applied to Test winding	Simulated Primary Current
CT1: 8A-28A	1A	25A
CT2: 16A-56A	1A	50A
CT3: 32A-112A	1A	100A
CT4: 64A-224A	1A	200A
CT5: 128A-448A	1A	400A

This functionality is quite helpful during commissioning and periodic health check of relay.

7.10 Relay ordering information

The relay type and serial number label identifies the protection relay. The serial number and order number label is placed on top of relay.

The order number consists of a string of codes generated from the relays hardware and software modules.

For REJ603 with HMI	:	REJ603BB401NN31E
For REJ603 without HMI	:	REJ603BB401NN3XE
For Add-on HMI kit	:	REJ603BNNNNNNBZA

Specific ring phase CT's needs to be used along with the relays. The ordering details for the same can be available from CT data sheet no. 1YMA583791R0001-4.

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