Relion® 605 series

Self-Powered Feeder Protection REJ603
User & Technical Manual

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Conformity

This product complies with the directive of the Council of the European Communities on the approximation of the laws of the Member States relating to electromagnetic compatibility (EMC Council Directive 2004/108/EC) and concerning electrical equipment for use within specified voltage limits (Low-voltage directive 2006/95/EC). This conformity is the result of a test conducted by ABB in accordance with Article 10 of the directive in agreement with the product standards EN 50263 and EN 60255-26 for the EMC directive, and with the product standards EN 60255-6 and EN 60255-27 for the low voltage directive. The IED is designed in accordance with the international standards of the IEC 60255 series.are hereby required to ensure that all measures are taken to exclude or mitigate such risks.

Table of contents

Section 1 Introduction

1.1 This manual

This manual contains application and functionality descriptions and connection diagrams, input and output signals, setting parameters and technical data. The manual can be used as a technical reference during the engineering phase, installation and commissioning phase, and during normal service. The manual can also be used when calculating settings. Instructions on how to operate the IED during normal service once it has been commissioned and it can be used to find out how to handle disturbances or how to view calculated and measured network data in order to determine the cause of a fault

1.2 Intended Audience

This manual addresses system engineers, installation and commissioning personnel, who use technical data during engineering, installation and commissioning, and in normal service. system engineer must have a thorough knowledge of protection systems, protection equipment, protection functions and the configured functional logics in the IEDs. The installation and commissioning personnel must have a basic knowledge in handling electronic equipment.

This manual addresses Protection and control engineer responsible for planning, pre-engineering and engineering. The protection and control engineer must be experienced in electrical power engineering and have knowledge of related technology, such as communication and protocols.

The manual also addresses the operator, who operates the IED on a daily basis. The operator must be trained in and have a basic knowledge of how to operate protection equipment. The manual contains terms and expressions commonly used to describe this kind of equipment.

1.3 Document Revision History

Document version	Release date	Document history
A	18.02.2008	Document released
B	22.12.2010	

1.4 Document Symbol and Conventions

1.4.1 Safety information

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

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.

1.4.2 Functions,codes & Symbols

Protection	IEC code	ANSI code
Three-phase non-directional overcurrent, low-set stage	3I>	51
Three-phase non-directional overcurrent, high-set stage	3I>>	50 / 51
Non-directional earth-fault, low-set stage	Io>	51N
Non-directional earth-fault, high-set stage	Io>>	50N/51N
Three phase transformer inrush detector	3I2f>	68

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 industies. The relay is a self-powered Numerical relay, which does not requires 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).

REJ603 relay is available with a touch sensitive dual powered HMI for data display and menu navigation.

2.2 Product version history

Product version	Release date	Product history
1.0	18.03.2008	Product released
1.0 SP1	01.10.2010	
1.0 HMI	29.10.2010	

2.3 Protection functionality

Protection	IEC	ANSI
Three phase overcurrent protection, low-set stage	3I>	51
Three phase overcurrent protection, high-set stage	3I>>	50 / 51
Earth-fault protection, low-set stage	I_0>	51N
Earth-fault protection, high-set stage	I_0>>	50N / 51N
Three 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 start current of the low-set stage I>, the overcurrent unit starts. when the set operate time at definite 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 starts when the set start current is exceeded. When the set operate time elapses, the overcurrent unit operates.

When the earth-fault current exceeds the set start current of the low-set stage Io>, the earthfault unit starts. When the set operate time at definite 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 starts when the set start current is exceeded. When the set operate time elapses, the earth-fault unit operates.

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.

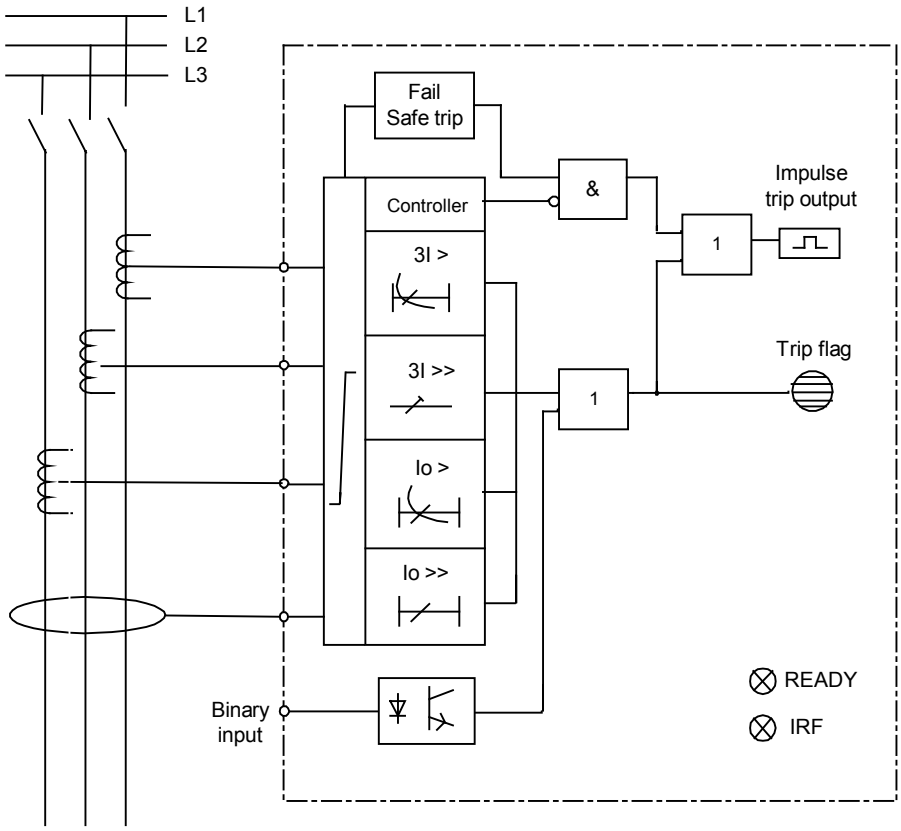

Fig. 1 – Block diagram of self-powered feeder protection relay REJ603

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. The mechanical flag of the relay , turns red when the relay operates. This flag can only be reset manually when the relay is energized and the 'Trip' flag turns green after reset. The relay includes one external binary input, which is controlled by an external control voltage. This input can be utilized to give an output trip command.

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 hardware.

There are three possible ways to give an output trip command as shown in figure2.

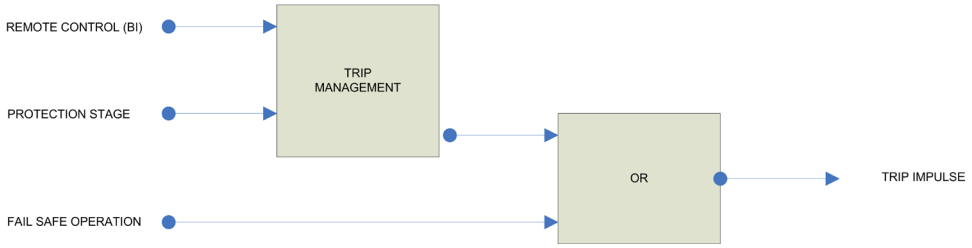

Fig. 2 – Output trip arrangement for REJ603

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.

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		
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

Width	96 mm
Height	160 mm
Depth	149 mm
Weight	~ 0.8 kg

3.2 Energizing Inputs

Rated Frequency		50/60 Hz ± 5 Hz
Phase inputs	Nominal primary current	
	CT type	Rated CT current range I_s
	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 I_{smax} 25 kA primary current 20 kA primary current
	Dynamic current withstand: • Half-wave value	 62.5 kA primary current
Earth input	Rated current, I_n	1 A
	Thermal withstand capability • Continuously • For 1 s • For 3 s	 4 A 100 A
	Dynamic current withstand: • Half-wave value	 250 A
	Input impedance	< 100 mΩ

3.3 Binary inputs

Rated voltage	24 - 240 V AC/DC
Operating range	-15%…+10% for AC , -30% … +20% for DC
Current drain	2...15 mA
Power consumption	< 0.8 W

3.4 Impulse voltage trip output

Rated output voltage	12 V
Pulse time	30 ms
Energy	50 mJ

3.5 Setting range and accuracy

Setting range of nominal current I_s

REJ603-CT2	16	18	20	22	24	26	28	30	32	34	36	40	44	48	52	56
REJ603-CT3	32	36	40	44	48	52	56	60	64	68	72	80	88	96	104	112
REJ603-CT4	64	72	80	88	96	104	112	120	128	136	144	160	176	192	208	224
REJ603-CT5	128	144	160	176	192	208	224	240	256	272	288	320	352	384	416	448

Low-set phase over-current protection stage I>	
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
Setting resolution/steps	I_s x 0.9...2.5 (31 steps), exit
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...85ºC
Setting range of definite time delay 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
Accuracy of operate time	±1% or 10 ms, whichever is greater
Setting of inverse time characteristics	**IEC 60255-3:** Normal Inverse, Very Inverse, Extremely Inverse, Long time Inverse **Special Curves:** RI Inverse Time, HR-Fuse, FR-Fuse
Setting range of time multiplier 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
Accuracy of operate time IEC characteristics RI characteristics HR, FR curve characteristics	 class E(5) ±35 ms, whichever is greater As per NI (IEC) curve ±20% of set value or ±35 ms, whichever is greater

High-set phase overcurrent protection stage I>>	
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, exit
Accuracy of pick-up current	±5% of set value in the temperature range 0...70ºC ±7.5% of set value in the temperature range -40...85ºC

Setting range of definite time delay 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, 08, 1.0, 1.4, 1.8, 2.2, 2.6, 3.0
Accuracy of Operate time	±1% or 10 ms, whichever is greater

Low-set earth-fault protection stage I_0>	
Nominal value of earth curent • 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), exit
Accuracy of pick-up current Internal measurement External measurement	 ±3% of I_s in the temperature range 0...70ºC ±7.5% of I_s in the temperature range -40...85ºC ±5% of I_n in the temperature range 0...70ºC ±20% of I_n in the temperature range -40...85ºC
Setting range of definite time delay t_0>	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
Accuracy of operate time	±1% or 10 ms, whichever is greater
Setting of inverse time characteristics	**IEC 60255-3:** Normal Inverse, Very Inverse Extremely Inverse, Long time Inverse **Special Curves:** RI Inverse Time, HR-Fuse, FR-Fuse
Setting range of time multiplier k_0	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
Accuracy of operate time IEC characteristics RI characteristics HR, FR curve characteristics	 class E(5) ±35 ms, whichever is greater As per NI (IEC) curve ±20% of set value or ±35 ms, whichever is greater

High-set earth-fault protection stage I_0>>	
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, exit
Accuracy of pick-up current Internal measurement External measurement	 ±3% of set value in the temperature range 0...70ºC ±7.5% of set value in the temperature range -40...85ºC ±5% of set value in the temperature range 0...70ºC ±15% of set value in the temperature range -40...85ºC
Setting range of definite time delay t_0>>	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
Accuracy of operate time	±1% or 10 ms which ever is greater

3.6 Degree of protection by enclosure

Front portion with cover	IP 54
Side with connection terminals	IP 20

3.7 Environmental conditions and test

Environmental conditions	
Service temperature range	-25...+85ºC (without HMI) -25...+70ºC (with HMI)
Relative humidity	< 93%
Atmospheric pressure	86...106 kPa
Altitude	up to 2000 m
Transport and storage temperature range	-40...+85ºC

Environmental tests	
Dry heat test	According to IEC 60068-2-2 Test values: • 16 h at +70ºC • 96 h at +85ºC
Dry cold test	According to IEC 60068-2-1 Test values: • 16 h at -25ºC • 96 h at -40ºC
Damp heat test, cyclic	According to IEC 60068-2-30 Test values: • 2 cycles at +25...55ºC humidity 95...97%
Damp heat test, steady state	According to IEC 60068-2-78 Test values: • 96 h at +40ºC humidity 94%
Storage test	According to IEC 60068-2-8 Test values: • 96 h at +85ºC • 96 h at -40ºC

Electromagnetic compatibility tests	
The EMC immunity test level meets the requirements listed below:	
1 MHz burst disturbance test • Common mode • Differential mode	According to IEC 61000-4-12 and IEC 60255-22-1 2.0KV, 1MHz, 400 pulses/sec 1.0KV, 1MHz, 400 pulses/sec
Electrostatic discharge test • Contact discharge • Air discharge	According to IEC 60255-22-2, class III, 6kV, 150 pF/330 Ω 8kV, 150 pF/330 Ω
Radiated, electro-magnetic field immunity test	According to IEC 60255-22-3, level III, Test values: 10 V/m, f = 80…1000 MHz

Section 4 Protection characteristics

4.1 Time / Current characteristics

REJ603 relay has two-stage low-set and high-set non-directional overcurrent and earth-fault protection stages. 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 I0> 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:

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

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 ß as indicated below:

Slope of the time/current curve set	α	ß
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:

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

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:

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

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

$$t = 10\frac{(\log(I / Iset) * (-7.16) + 3.0)}{} * (\alpha / 0.1) \text{ for } I/Iset = 1\text{-}2$$

$$t = 10\frac{(\log(I / Iset) * (-5.4) + 2.47)}{} * (\alpha / 0.1) \text{ for } I/Iset = 2\text{-}2.66$$

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

4.1.4 Normal inverse-time characteristics curve

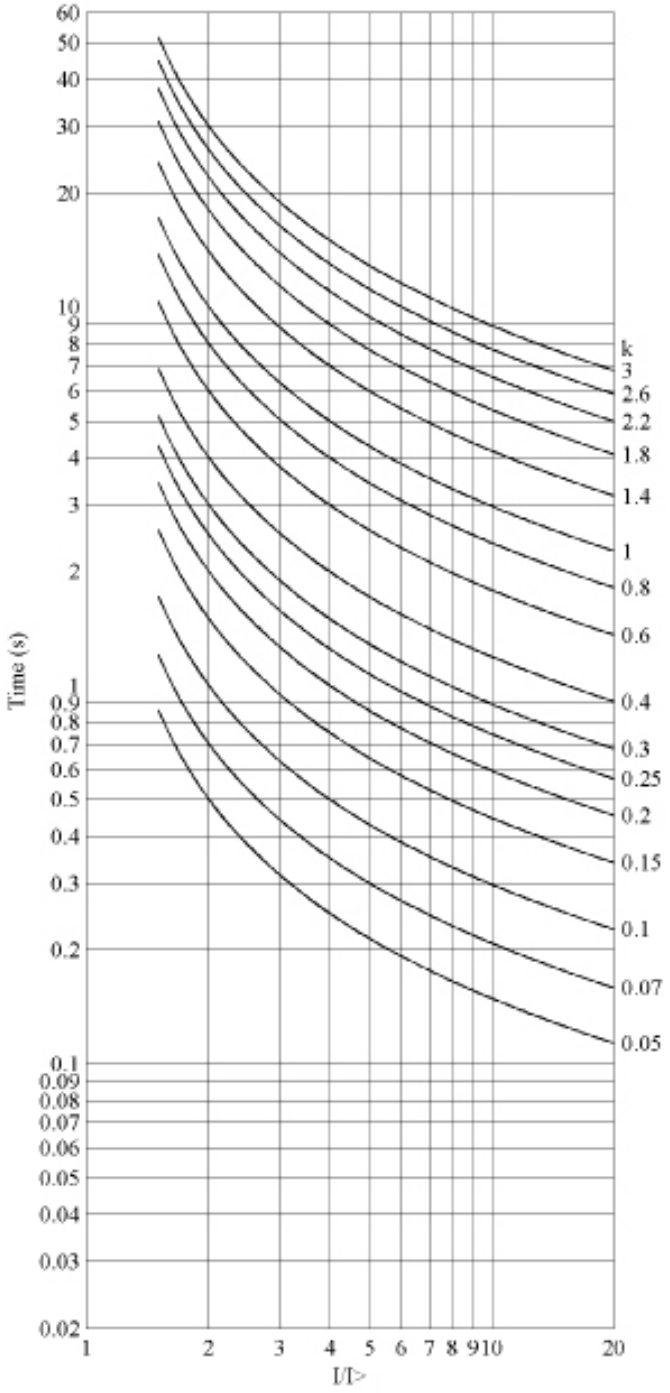

Fig. 3 – Normal inverse-time characteristics of relay REJ603

4.1.5 Extremely inverse-time characteristics

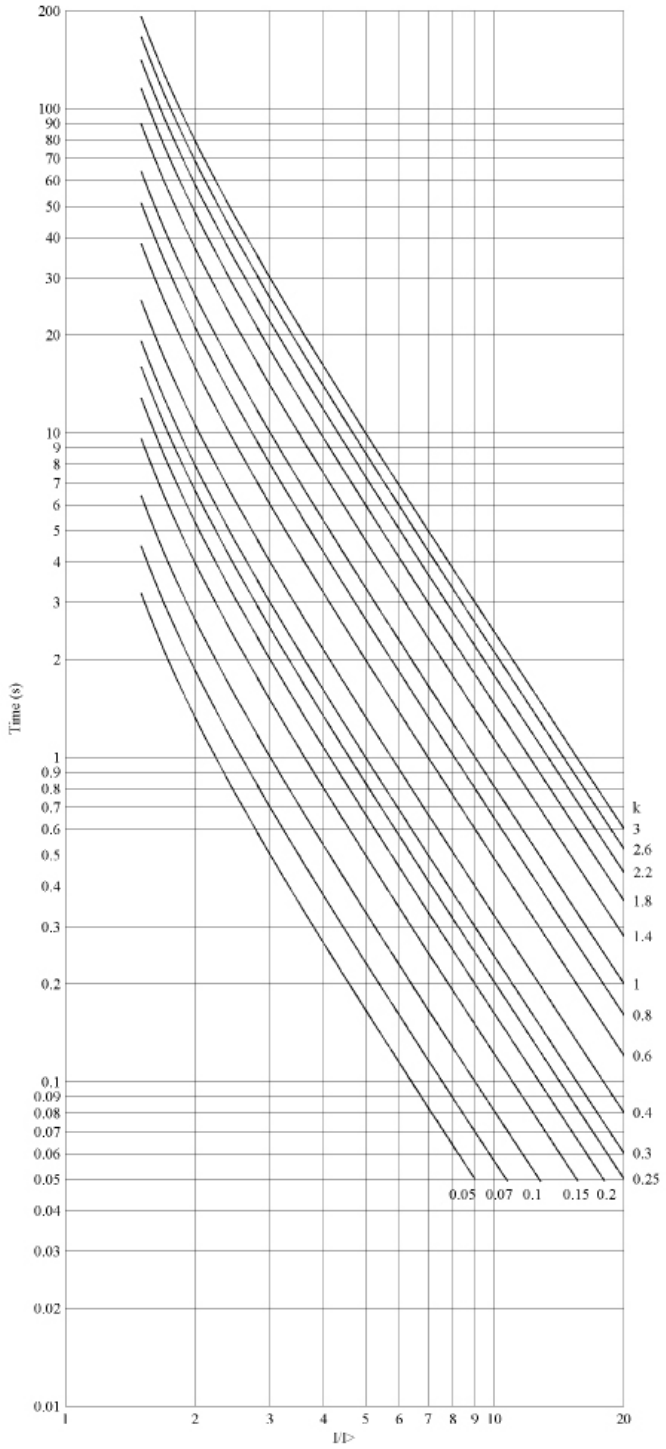

Fig. 4 – Extremely inverse-time characteristics of relay REJ603

4.1.6 Very inverse-time characteristics curve

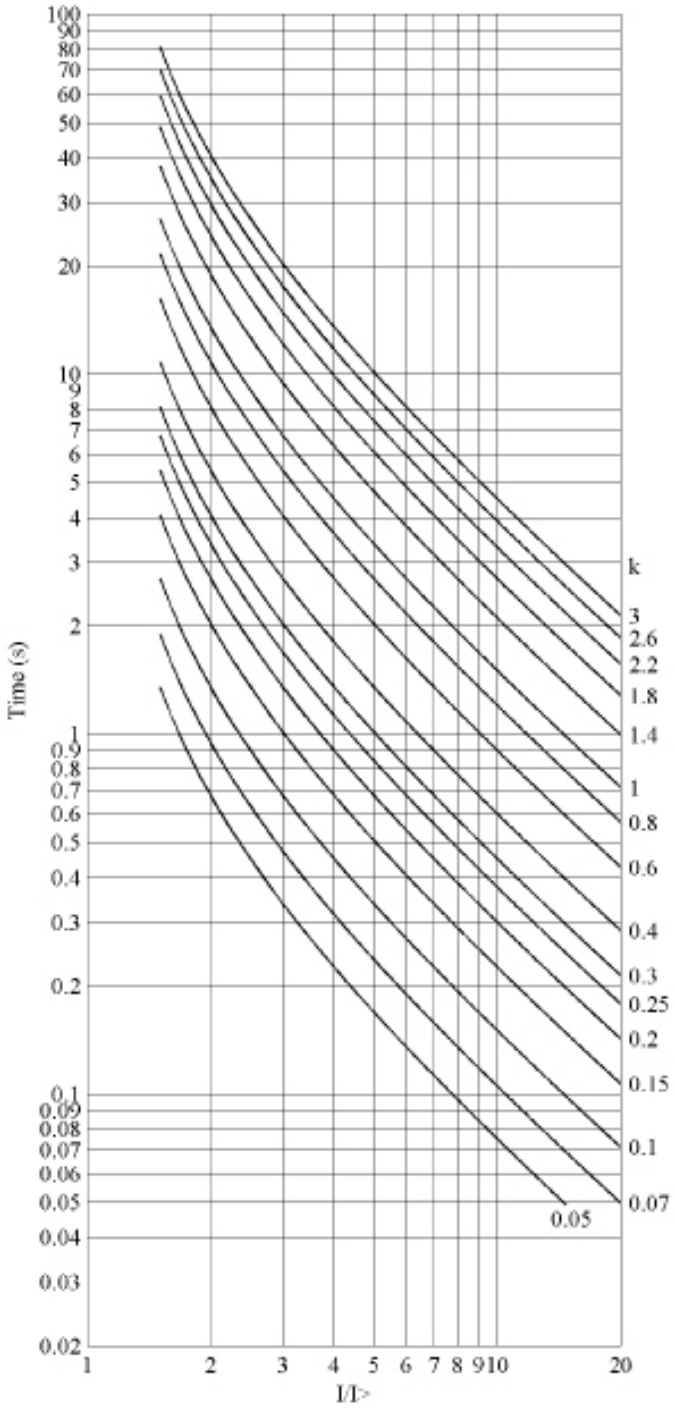

Fig. 5 – Very inverse-time characteristics of relay REJ603

4.1.7 Long-time inverse-time characteristics curve

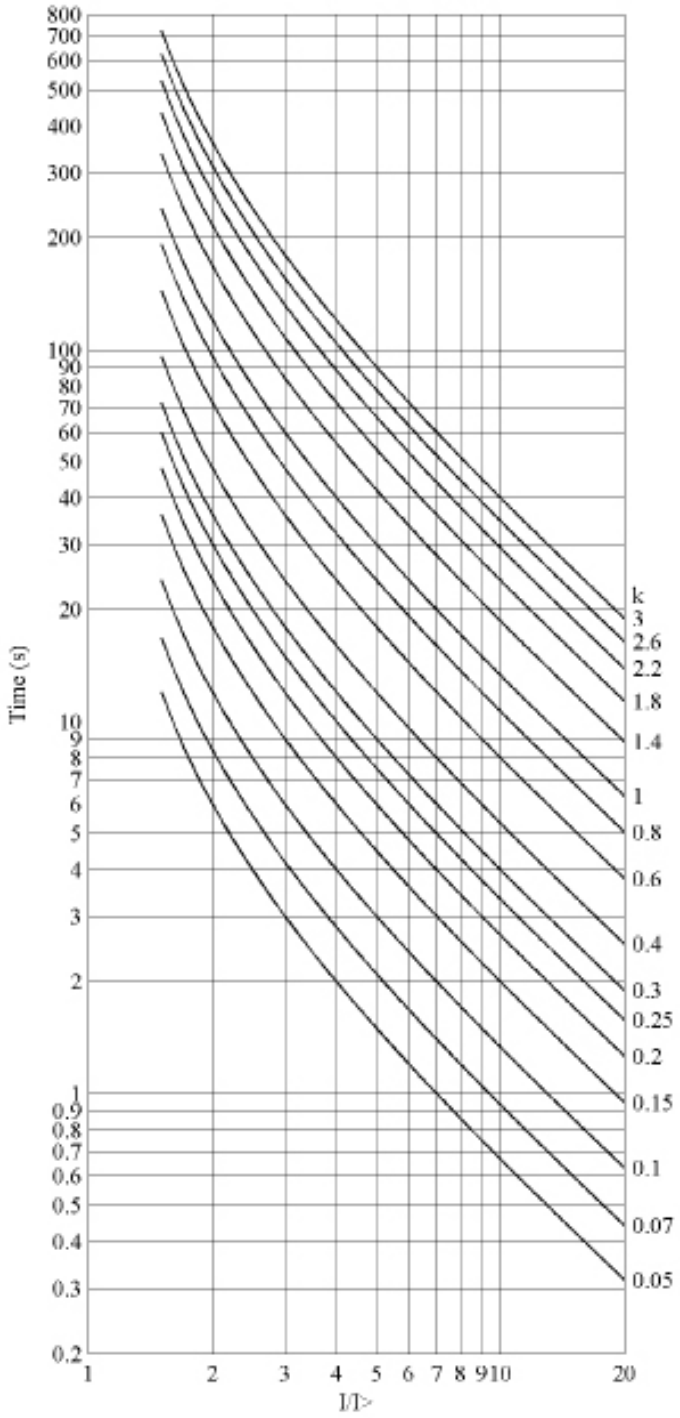

Fig. 6 – Long-time inverse-time characteristics of relay REJ603

4.1.8 RI type inverse-time characteristics curve

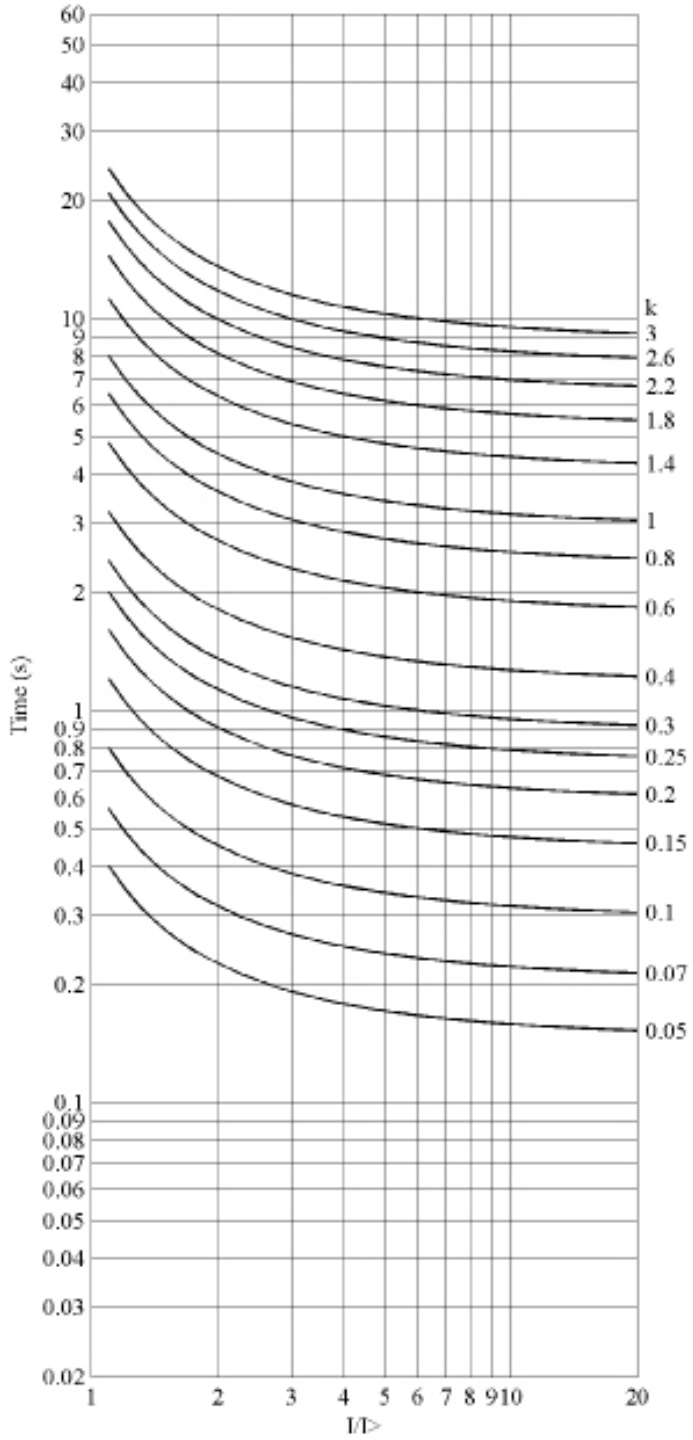

Fig. 7 – RI type inverse-time characteristics of relay REJ603

4.1.9 HR Fuse characteristics curve

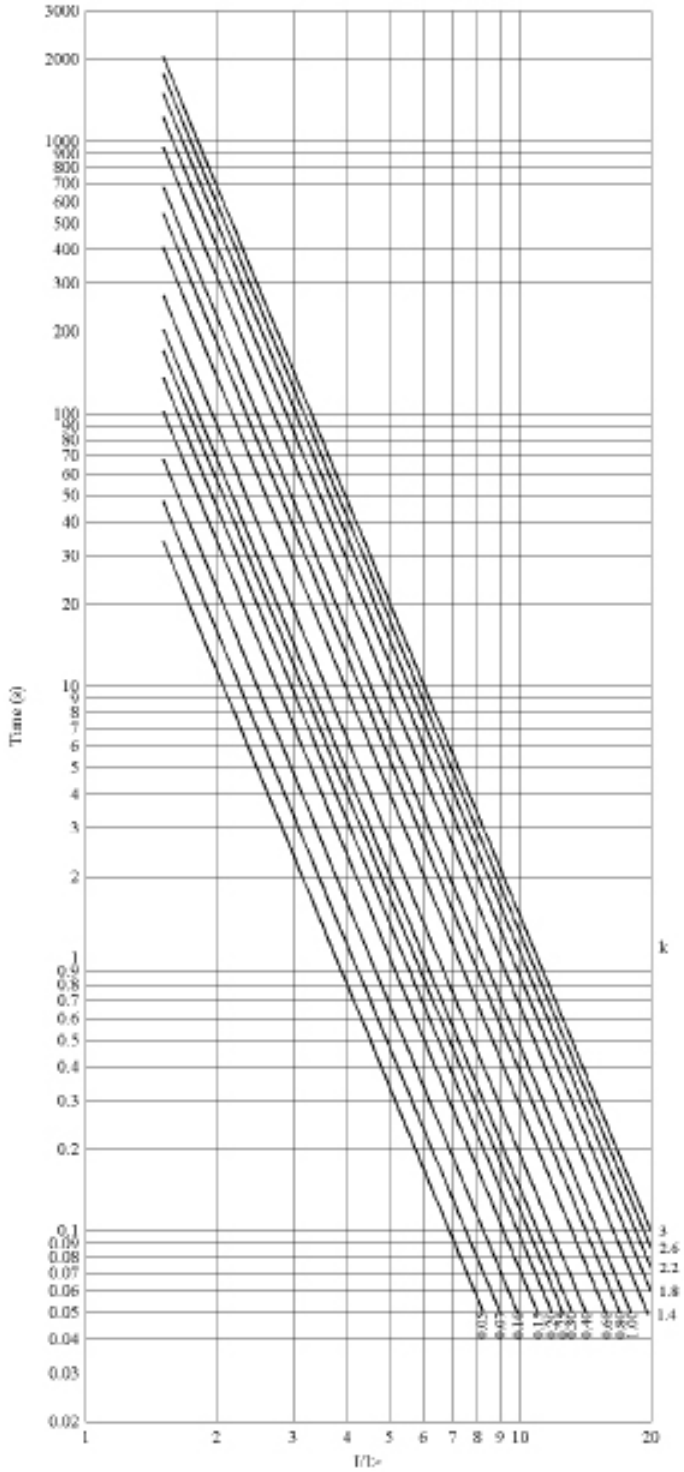

Fig. 8 – HR Fuse characteristics of relay REJ603

4.1.10 FR Fuse characteristics curve

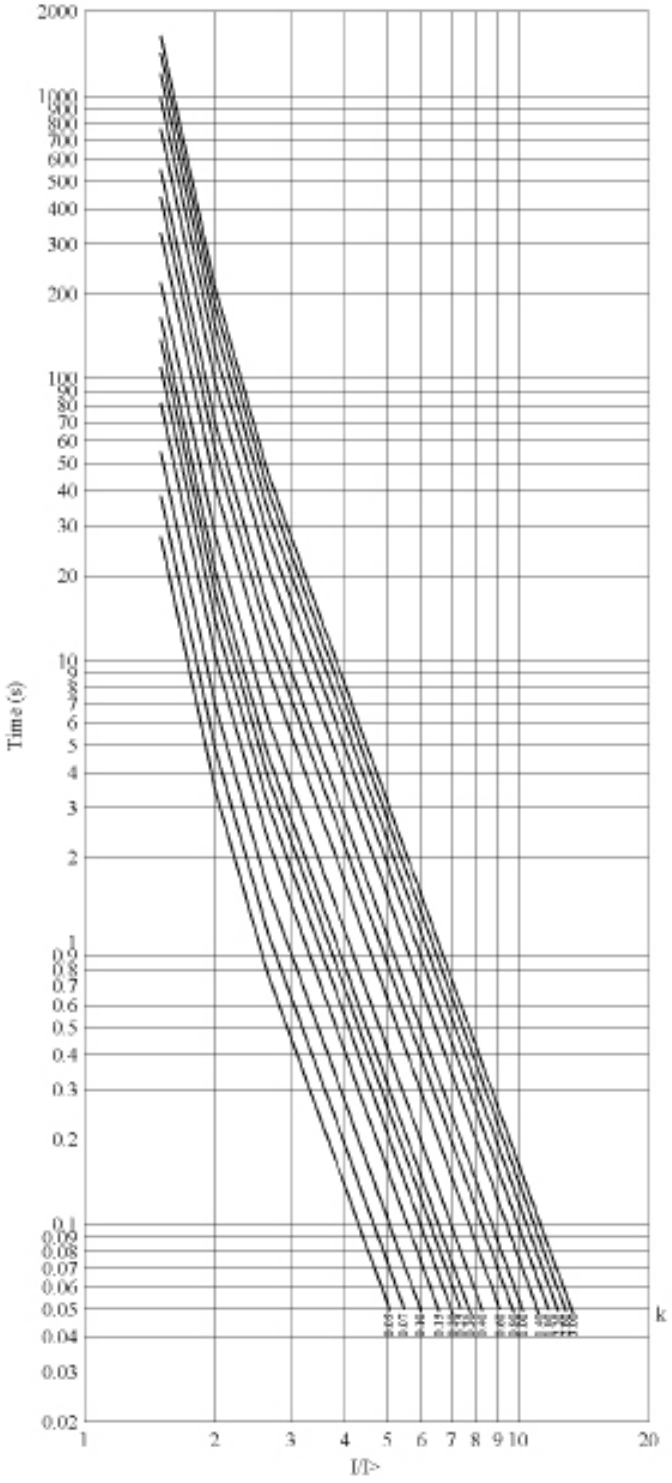

Fig. 9 – FR Fuse characteristics of relay REJ603

Section 5 HMI

5.1 Features

HMI603 is a product which will deliver a human machine interface module (HMI) for the REJ603 product releases. It is a cost optimized and intelligent solution, that can be connected to the REJ603 relay and serve as a HMI.

HMI603 will enhance the functionality of REJ603 by providing the support of ammeter function, fine settings, event log & data log with time stamp as key features along with other functionalities. The primary function of the product is to provide an interactive user interface to the relay, by displaying the various parameters of the relay including the line current measurements, protection settings, Event logs, etc

This HMI can be bought separately or together with basic REJ603 relay. Basic version of REJ603 was designed to power, communicate and accommodate HMI. HMI has limited support to the previous released versions of REJ603 and completely functional usability with the forward versions of REJ603

- HMI serves the purpose of
  - o Finer settings,
  - o Event data storage
  - o Trip data logs
  - o Ammeter Function
- HMI is dual powered. The REJ603 provides the power to the HMI603 as well as a battery (enclosed inside REJ603 enclosure) to supply power to the HMI603 only in case the Relay is OFF.
- HMI uses Graphic LCD and Touch sensitive keypad for data display and menu navigation
- HMI comes with a backlight for better data readability in dark environments.
- HMI has an on-chip RTC module (with battery back-up) for time stamping.
- HMI provides ammeter function in terms of both nominal currents and primary currents depending on the CT selection.
- HMI records of last 5 events information with time stamp.
- HMI also records last 5 Trip data currents with time stamp with data logs of currents 20ms and 40ms before trip.
- HMI stores information of the last Relay Settings change with time stamp.
- HMI supports user settable inrush parameter settings.
- HMI gives IRF message for both base relay & HMI
- HMI has watchdog supervisory circuit to monitor controller health and to ensure proper power supply to controller

5.1.1 HMI Access Control

The REJ603_HMI with touch panel and LCD, used to view the settings and event and data records, are to be protected in terms of its accessibility by the user. Two different modes for viewing and editing are implemented with different way of using key

Read or edit mode are defined for the HMI operation during menu navigation. All menu options and settings are always visible. The user session is a Read only session. The user can enter a menu navigation by pressing ENTER/OK key in the default screen. The user can navigate to all menu screens to view the various menu items and settings. This means that the settings cannot be edited or changed in this mode. The edit mode access enables changing of relay settings and HMI parameters. An extended press of ENTER key needs to be entered in editable screen to edit the parameter.

Following parameters are editable

- Relay fine settings
- CT type settings
- Time settings
- Erase the stored data from Records
- Erase the stored fine settings
- Edit inrush settings
- Ammeter Units

On extended press of ENTER key, the read mode automatically gets changed to edit mode. Once in the edit mode, parameters can be changed. Once required parameter value is selected by the UP/DOWN keys, the Enter key sets the value and saves the value in NvRAM of HMI. In special parameters changes, i.e. CT type change through menu navigation, the acknowledgement is also given as a separate screen. On saving the parameter, the Edit mode is changed back to the read mode. If there is no activity on keyboard for 1 minute in the Edit Mode, the Edit mode is forcefully closed and read mode will be resumed without affecting the previous settings or parameters (i.e. no revised settings will be applicable).

5.1.2 HMI Boot Up Sequence

HMI can be powered up through base relay and battery. If powered through base relay, it communicates to identify base relay software version and accordingly it behaves. With every software version, the HMI supports specific features.

The HMI checks its power source on boot up. The HMI does not communicate to the base relay when powered up through Battery. The boot sequence is completed without any communication fault. Ammeter display shows no current values. HMI shows last saved settings of the relay. Changes in finer settings are saved in HMI, and on next power up from base relay, they are transmitted to the Base relay if there is no change in the DIP settings. If the HMI finds that the DIP settings are changed the fine settings are void and an alert is given.

A check is done at periodic intervals in HMI when powered from battery for availability of base power and resume the communication with base relay. In case the HMI receives no response to its requests in a definite time, the communication failusre is declared. The HMI attempts to connect to the base relay even after the communication failure.

5.2 Events and Trip data logs

After intimation of trip event from base relay, the HMI enables the battery power circuit. In case of power off from base relay; the battery will ensure faithful data storage if data transferred to HMI. If communication fails after trip event, no data will be stored. In case of low battery or no battery data storage are not guaranteed. After faithful storage of all data received from base relay in to NvRAM of HMI, the HMI will disable the battery power circuit.

The events occur in the Base relay. The events communicated to the HMI are to be recorded. When the HMI receives a correct event data, it adds a time stamp to the event before storage. All events are time stamped with details of date of occurrence and time of occurrence up to seconds. No time stamping is done for Data logs. Thus the Communication link becomes critical. No data is recorded if the base – HMI communication link fail.

5.2.1 Trip Records

The HMI stores trip information with the following details.

- o Trip Stage: I>,I>>,Io>,Io>>
- o CT & Earth type information during the trip with Is Settings.
- o Line & Earth current at the instant of trip
- o Line & Earth current at 20ms and 40 ms before trip
- o Time and date stamping

Any new entry of fault record will push existing records down and deleting the last entry.

5.2.2 Event Records

The following events are stored with the HMI in 5 separate memory location with its time stamp.

- Protection Block (Inrush)
- Binary Input Event

The Protection Start event is not part of the event record database but stored as a separate event for user information with its time stamp.

Similarly the DIP change is recorded as an event and stored separately along with its timestamp.

The last IRF recorded is also stored with a time stamp.

5.3 HMI Fine Settings

The base relay is provided with limited settings through DIP switches. HMI should be able to provide the fine settings to the coarse settings done by DIP switches.

Finer setting will be applicable in rolling fashion only between two consecutive DIP settings. The setting can be changed in edit mode by pressing either up or down arrow on touch pad navigation menu. While editing the finer settings, corresponding base DIP setting will appear on menu. In case of offline finer settings through HMI, the last image of DIP setting will appear on menu.

In case of HMI failure or communication failure between HMI and Base relay or at the start of base relay (power on condition) the base relay will assume DIP settings as correct settings for protection. Once base relay is powered, HMI is healthy and communication is ok between HMI and base relay, the finer settings will be applicable after around 150msec over and above the DIP settings. If in run time or in power off condition of base relay if DIP settings are changed, the base relay will assume only DIP settings as correct settings for protection function and corresponding finer settings from HMI will be made zero

If in run time DIP settings are changed, there will be an intimation on HMI screen (if communication link is healthy between HMI and base relay and HMI is also healthy) such as “fine settings are void” or “change fine settings” etc. The message will continue on screen until and unless acknowledgement is received in terms of “enter” key press.

5.4 HMI Backword Compatibility

The HMI designed should be compatible with the older versions of the relay.

Base Relay Release	HMI Features Supported
UP to Ver 10	Ammeter in terms of “Is” only will be supported
Ver 11	Compatible with all HMI features as covered in this manual

On HMI in case of Base relay with sw version upto Ver 10,on display in version info ver 00 will be displayed to indicate that it is old version base relay.

5.5 HMI Backlight functionality

LCD screen of the HMI is provided with the backlight. Back light will turn ON at every wake up when powered through battery. Back light will be ON up to 1 minute after last key touch on HMI. During run time if backlight is OFF then on any key press on HMI area, back light shall be ON for 1 minute after last key press. HMI shall continue functioning for 5 minutes after last key press (backlight will be off after 1 minute from last key press) and then will turn OFF.

5.6 Date and Time (RTC)

Time stamping is required for the data records therefore the HMI has a feature of Real Time clock which is supported by the battery even if HMI is OFF. The RTC (Real Time Clock) is set to the local time (manually) during setup. The time and date settings can be changed after setup during normal run of

HMI from menu navigation. The user can also view the current HMI time and Date from the menu navigation.

The RTC will have following information:

Time information:

- Hours (24 Hr Format only) [00...23]
- Minutes [00...59]
- Seconds [00...59]

Date information (with automatic correction on leap year)

- Day [01...31]
- Month [01...12]
- Year [2010...2099]

On receiving the Trip and Event record from the base relay, the HMI will save the Records with the “Instantaneous” time (the time at which HMI receives the data and is found correct). Only events and trip times are recorded. If the RTC is not configured, the records will be saved with 00/00/0000 date and 00:00:00 time stamps.

5.7 HMI IRF

The HMI has self-supervision ability. It also displays the IRF codes of the base relay if the base relay is in energized condition.

HMI can display IRF codes from base relay only if HMI is powered through base relay. HMI however can display its own IRF codes when powered through both battery and base relay.

IRFs considered for base relay are:

Relay EEPROM Failure

Relay Trip capacitor Voltage Failure

IRF’s considered for HMI:

HMI NvRAM Failure

No HMI failure indications (LED) on base relay. All protection functions shall be blocked on base relay IRFs. Protection blocking shall be self reset type on recovery of healthy condition from IRF condition. IRF indication (LED) on base relay shall be of self reset type on recovery of healthy condition from IRF condition.

5.8 Inrush Functionality

Inrush settings for the relay can be done through HMI. After HMI startup & startup of base relay & after communication between the two is established, the inrush settings shall be uploaded to relay. The relay starts with a default inrush parameter set. Once successful communication is established with the relay, the HMI attempts to communicate the Inrush parameters set by the user.

5.9 Low Battery Indication

HMI can indicate the strength and absence of battery. If the battery becomes weak, there is a Low Battery Alert on screen. The user can clear the intimation by pressing the ENTER key. There would not be any alert message on battery health after this, but there will be an icon on the HMI Screen in top middle area, to indicate that the battery is running low.

The low battery indication icon will continue till battery supply is available before complete drain. On complete consumption of battery power, the battery will show NO BATTERY Alert and the icon will also change to No Battery Icon. The user can change the battery by removing the HMI and replacing the battery in the battery compartment with the fresh one available through product vendor.

The user is recommended to change the battery as soon as the low battery indication is given. The storage of event data and data logs are not guaranteed once the battery is below the threshold (after low battery indication is active). However, this threshold is below the “low battery” voltage level. This may give some time to user for reading important data.

In NO Battery conditions, the trip data cannot be guaranteed to be stored.

5.10 Wake Up through push button

The HMI is mounted on the base relay which has a protection of a transparent cover. A push button is provided so that user can access through the HMI without opening the transparent cover. User can use this push button to wake up the HMI to view the default screen. If at all there is some alert, then the HMI shows the alert up on its wakeup. The user can also directly navigate to the last recorded trip fault data by the press of the same push button. Once the navigation is complete, the user can switch off the HMI by pressing the power button for more than 3 seconds.

5.11 HMI Enable or Disable function

HMI functionalities can be disabled by a single DIP switch on the base relay. Whenever the DIP switch for HMI Disable/ Enable is OFF, the default settings stored in the base relay are applicable for the protection function. The fine settings and the functionalities of the HMI comes into existence only when the switch ON.

5.12 Ammeter functionality

HMI displays the online current measurements as default screen. HMI displays the online measured current values. User has the option of displaying the current in terms of ‘Is’ or absolute primary

Amperes. User has to select the CT installed from the HMI menu navigation. Three phase current values and earth current values (external or internal) are displayed.

5.13 HMI Alerts

HMI when started should show some alerts and wait for the user acknowledge. HMI upon its wakeup shows the following alerts, if any, with priority defined.

ALERT	CONDITION
HMI NvRAM IRF	HMI NvRAM is not readable or writeable in 5 consecutive read/write attempts
Base relay IRF	Base relay reports a IRF condition,reports only if the communication is OK
Low/No Battery	The low battery condition and battery absence is sensed by the ADC pin.
CT not selected	If the user deletes the settings of HMI or if there is no CT information in a fresh relay
Time not set	No battery to maintain RTC or first time setting of the RTC
Trip	Previous or current unread trip message
Non Trip Events	All other intimations of events other than trip
DIP switch change (Fine settings void)	User changes DIP switch settings online/offline
Communication Error	No communication with the base relay for 5 attempts.
HMI Disabled	DIP for HMI Enabled/Disabled switched is in OFF position.

5.14 Battery

The battery is mounted within a compartment provided in the base relay itself and should be connected to interconnect provided on the base relay, as shown in the images supported in Section 9.7.

The battery used is made of Lithium-Manganese Dioxide type (LiMnO2) composition with model type CR17450.

The battery should support healthy operation for a time period of 82Hr, when the HMI module is operated only with the Battery supply, in absence of the CT power, at room temperature.

When the battery is discharged completely, the user should contact the ABB service department, to get a new battery, as this is an industrial grade battery and will not be available as off-the-shelf

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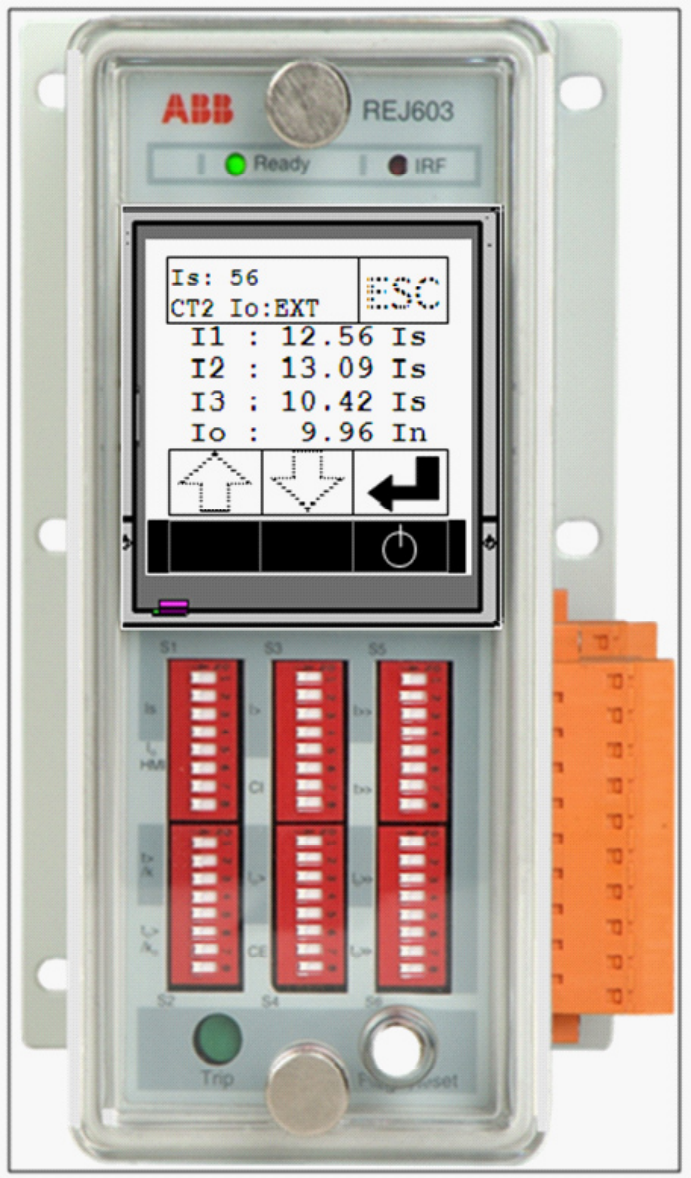
Section 6 HMI Menu Navigation

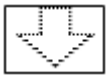
6.1 HMI Touch Panel and LCD display

HMI is provided with a touch Pad and LCD screen for navigation and viewing respectively. The touch pad has 5 keys for wake up and menu navigation. There is a single dedicated key, used to wake up the HMI. LCD screen has dedicated area to display the current values and the alerts etc. It also displays the 'Is' and CT information on the upper left side of the screen. The LCD Module is a 128X64 bits graphics LCD customized for REJ603. The complete module for LHMI is independently powered by the Relay and auxiliary battery in a special compartment



6.2 Navigation

The navigation keypads are as touch pads on the surface of the LCD Module. There are 9 regular sized touch pads plus 3 smaller touch pads on the surface of LCD Module. The Touch pads are pressure sensitive and respond to a faint touch on surface. The buttons are made as graphics on the GLCD which denote active areas of touch. Pressing on touchpad other than the defined areas below will not have any action.

Key Picture	Key Name	Function
	UP	Used for incrementing of parameter value while editing, or provides up level selection of menu item.
	UP disabled	This Icon indicates the UP key is in disabled state and it has no user action defined for present state of display.
	DOWN	Used for decrementing of parameter value while editing, or provides down level selection of menu item.
	DOWN disabled	This Icon indicates the DOWN key is in disabled state and it has no user action defined for present state of display.
	ENTER / Edit	Used for saving of edited parameter value or entering a sub-menu level By continuously pressing Enter key for 2 Seconds will enable user to Edit settings.
	Escape/Cancel	Used for discarding changed parameter value in edit mode, or for going back to main menu from any level of menu navigation. Extended press on the ESC button results in cancelling the menu navigation and coming to home (default) screen.
	Escape disabled	This Icon indicates the ESC key is in disabled state and it has no user action defined for present state of display.
	POWER	Power ON-Power OFF button. The button also navigates to the recent fault records through single press.

Pressing anywhere on the HMI surface will turn on the backlight. The backlight will turn off itself if there is no touch activity for 1 minute.

6.3 Menu Navigation

6.3.1 Default Screens

The HMI default screens are dependent on the mode of operation of the HMI. When the HMI is switched ON with the help of Battery, the relay is not powered on, and then the default screen is the date and time.

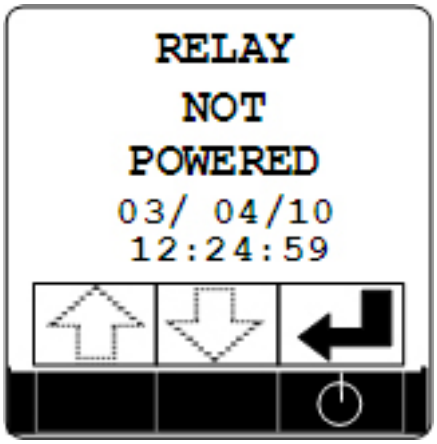


Figure : Default Screen , HMI on Battery

If the relay is sufficiently powered up, it powers the HMI automatically, during this mode if the HMI can successfully communicate to the relay; the default screen is the Ammeter. Depending on the user information, the ammeter can be in Amperes or in absolute Is.

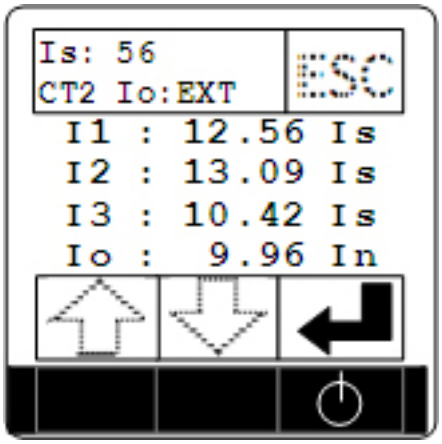
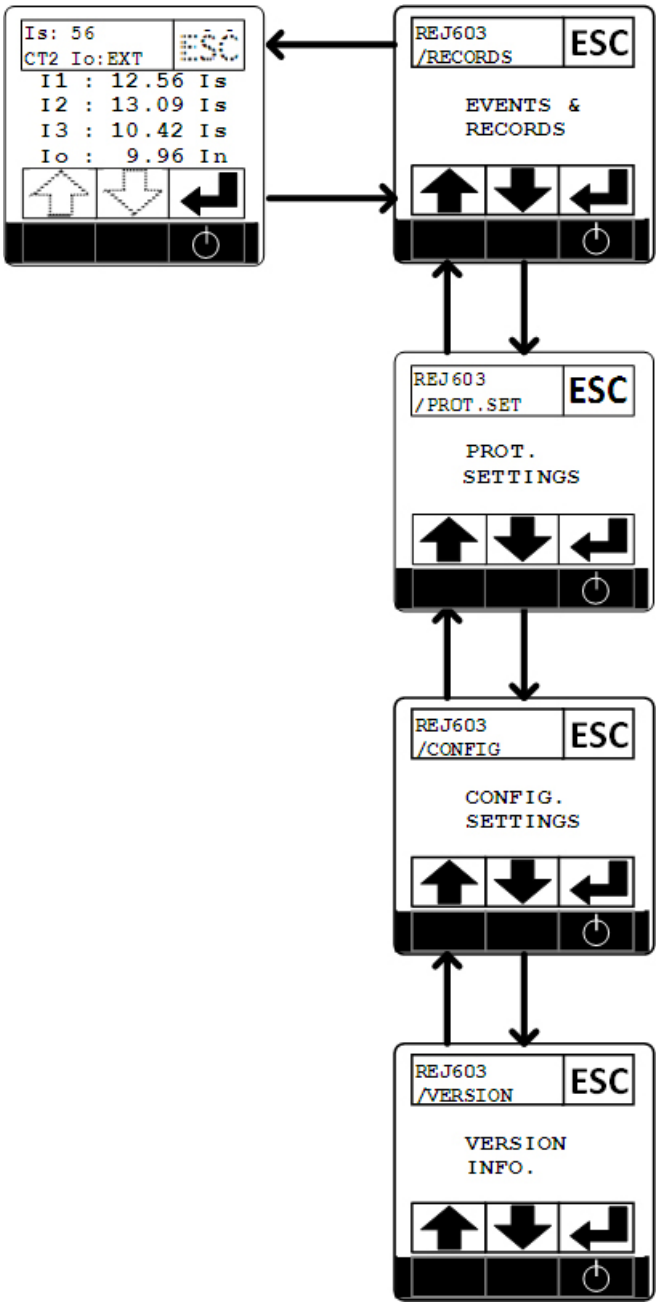


Figure : Default screen , Ammeter in Is

6.3.2 Main Menu Navigation

The main menu navigation is entered through the default screens by pressing the enter  key.

The below screens show the levels in the main menu navigation.



6.3.3 MENU : Events & Records

The event and records menu holds the database information of all stored Trip and Events along with the IRF and DIP changes records.

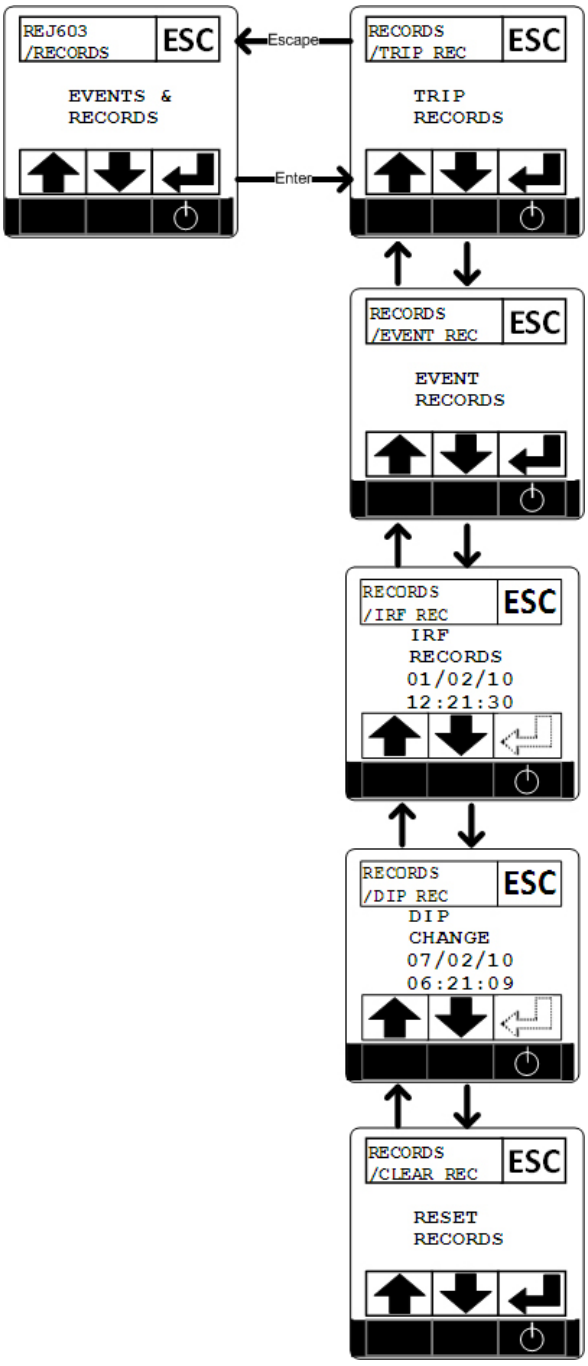


Figure : Events & Records

6.3.4 MENU : Trip Records

The last 5 Trips are stored in the trip records.

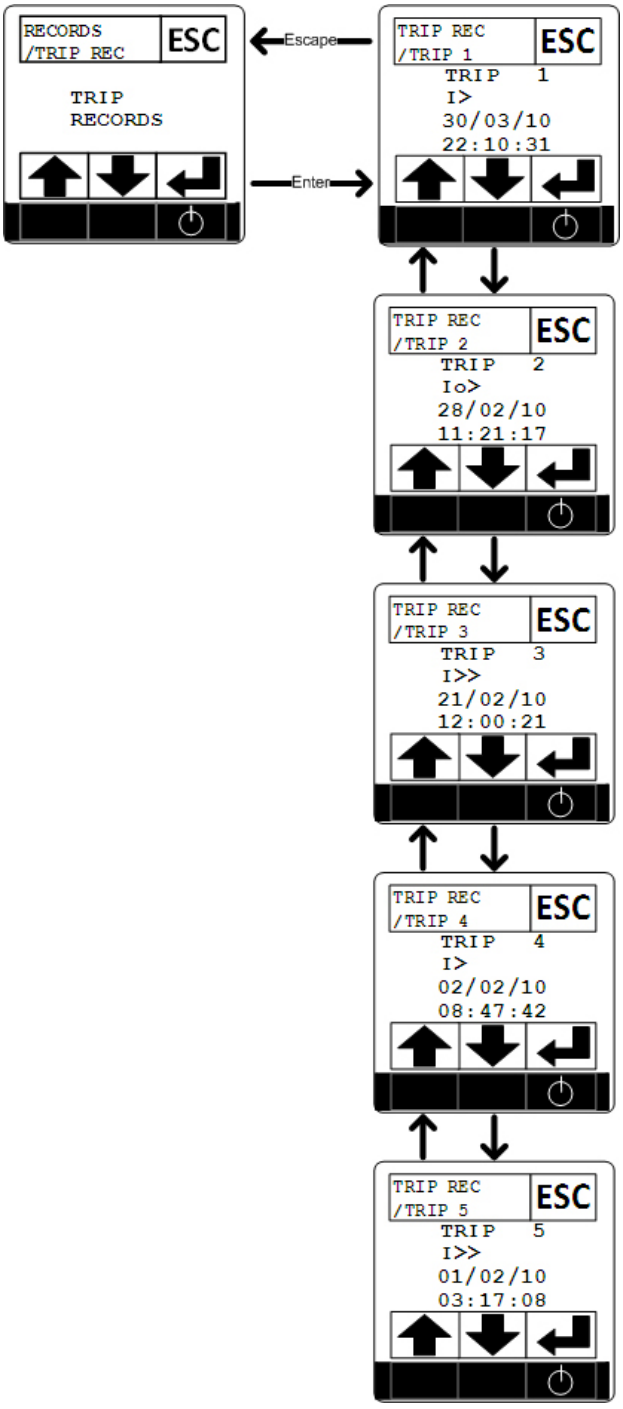


Figure : Trip Records

6.3.5 MENU : Trip Elements

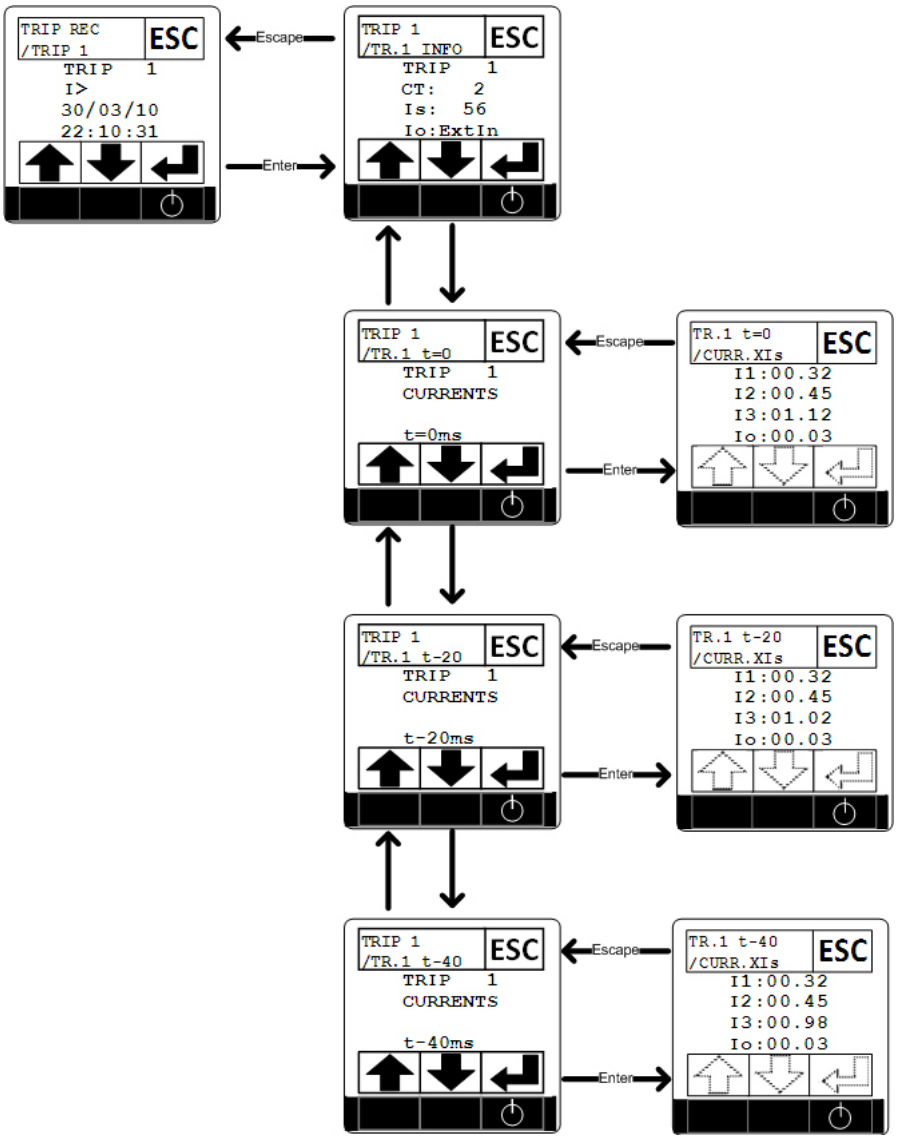


Figure : Submenu for trip elements

6.3.6 MENU : Event

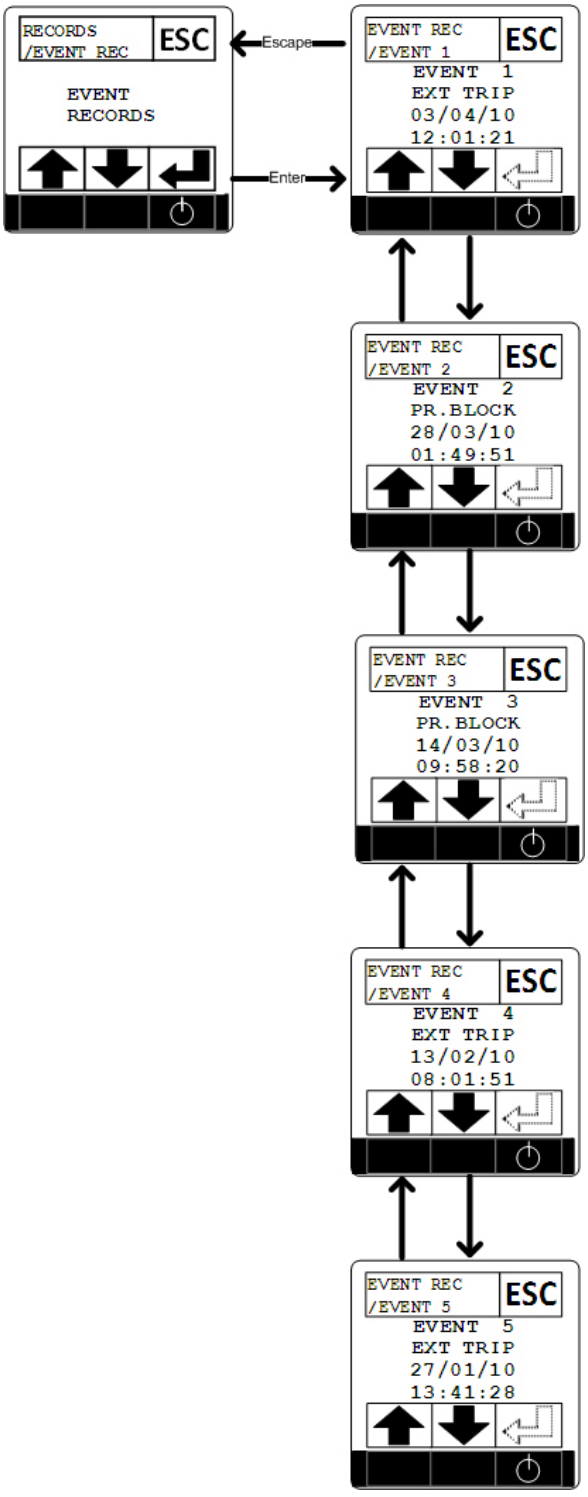


Figure : Events Database

6.3.7 MENU : Protection Settings

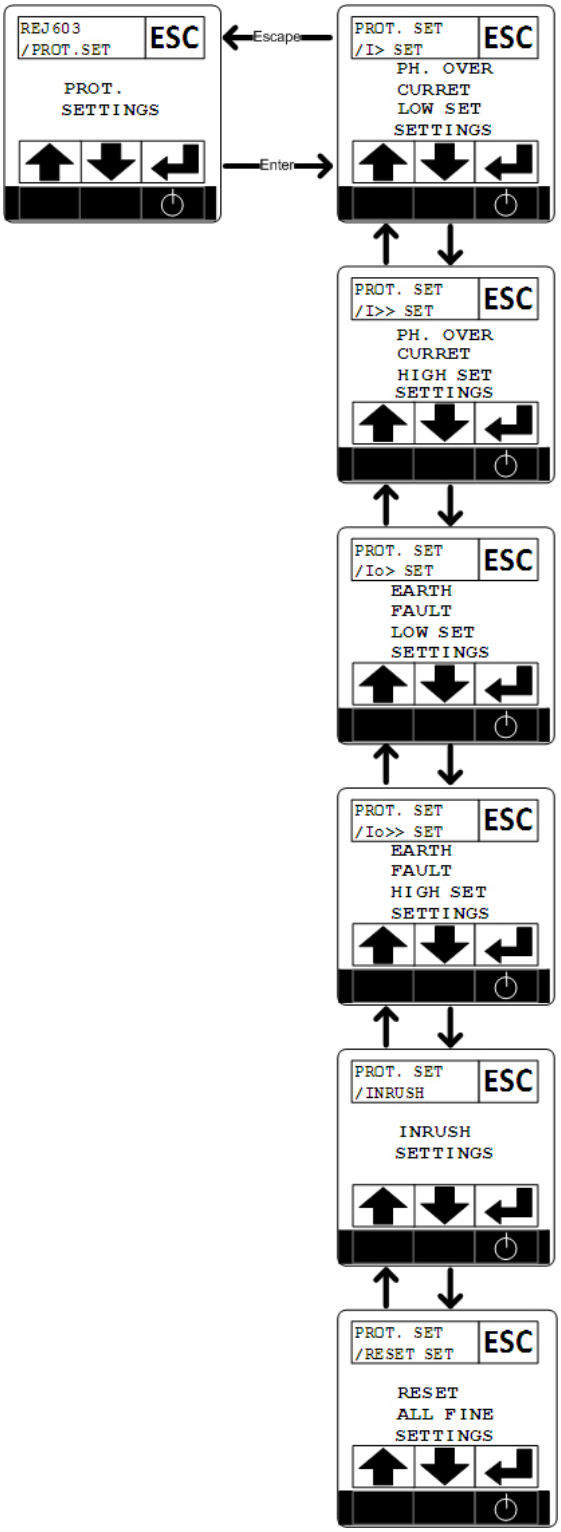


Figure : Protection Settings

6.3.8 MENU : Phase Low Set Settings

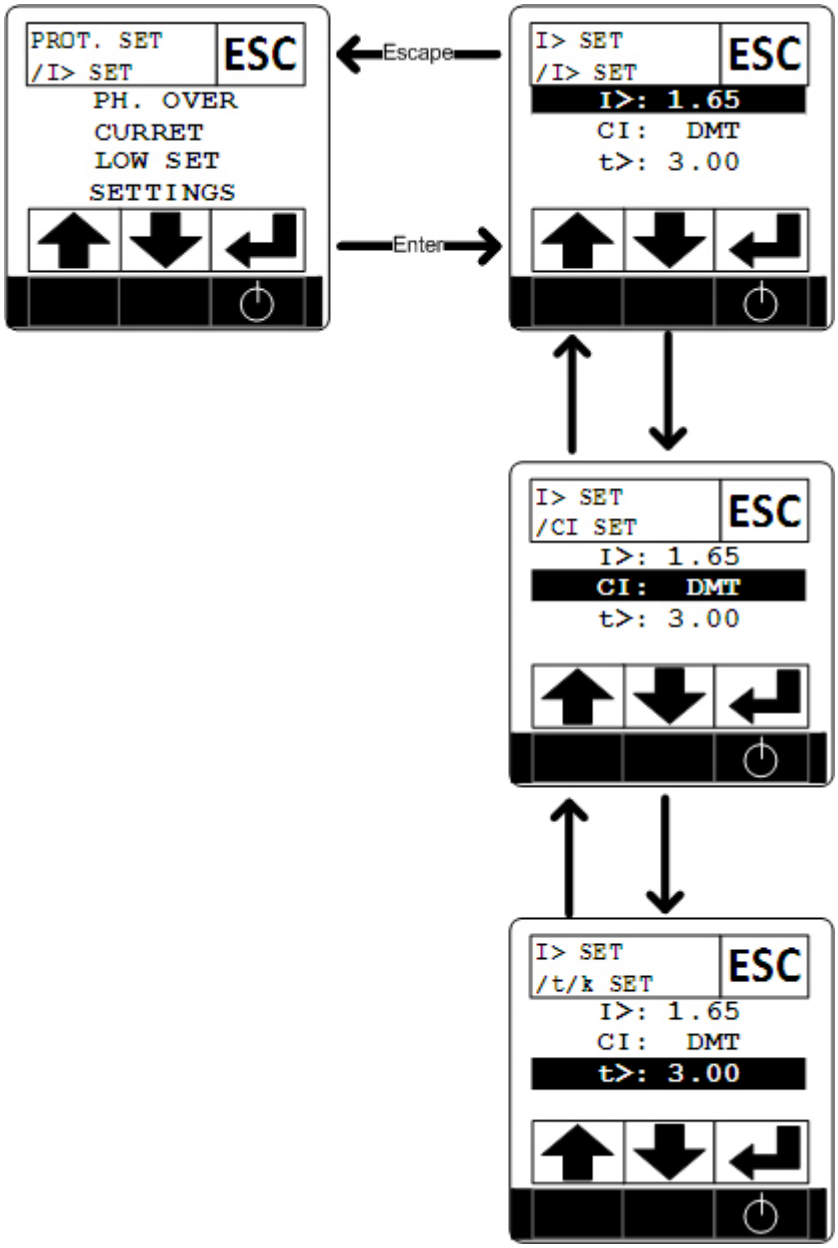


Figure : Phase Lowset Settings

6.3.9 MENU : Phase High Set Settings

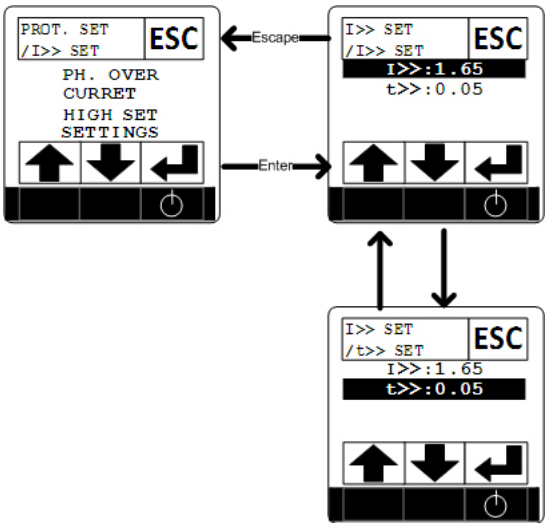


Figure : Phase Highset menu

6.3.10 MENU : EarthFault Low Set Settings

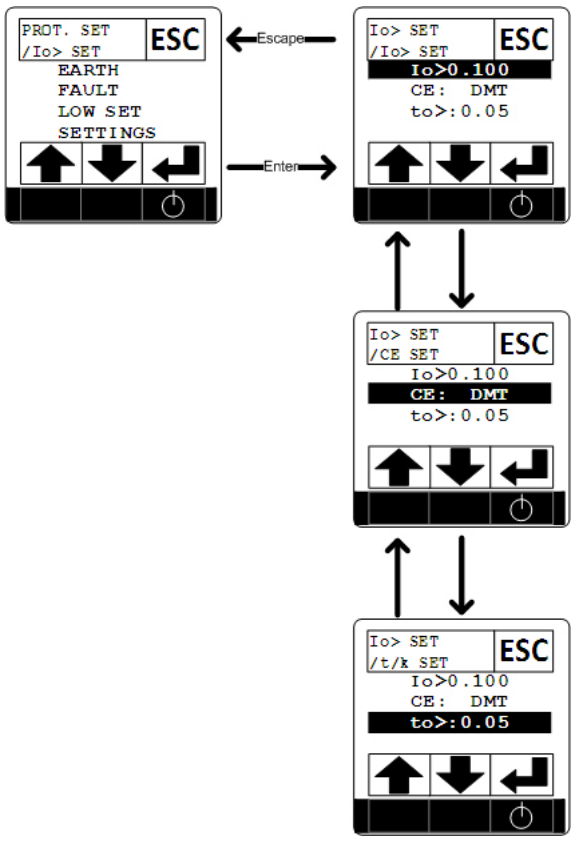


Figure : Earth lowset menu

6.3.11 MENU : Earth High Set Settings

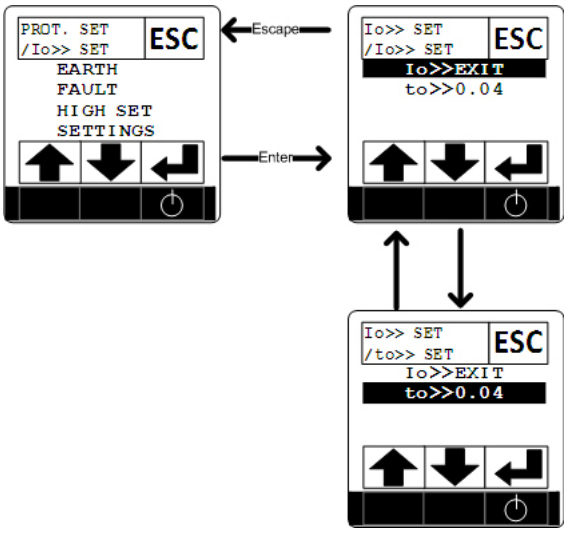


Figure : Earth Highset menu

6.3.12 MENU : INRUSH Settings

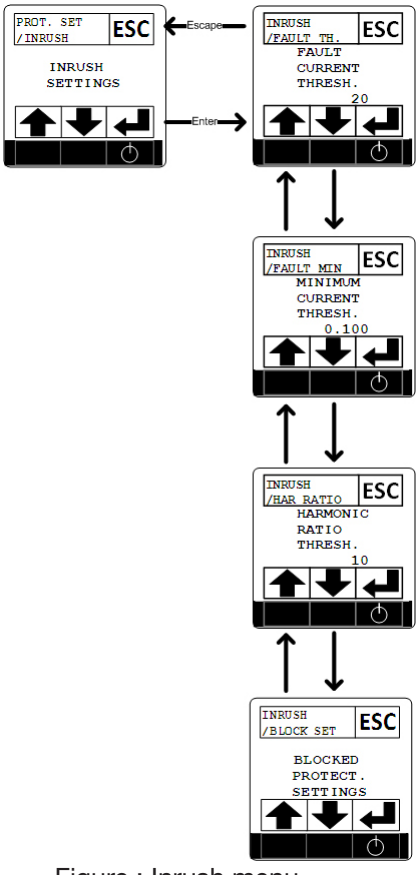


Figure : Inrush menu

6.3.13 MENU : Protection Blocking

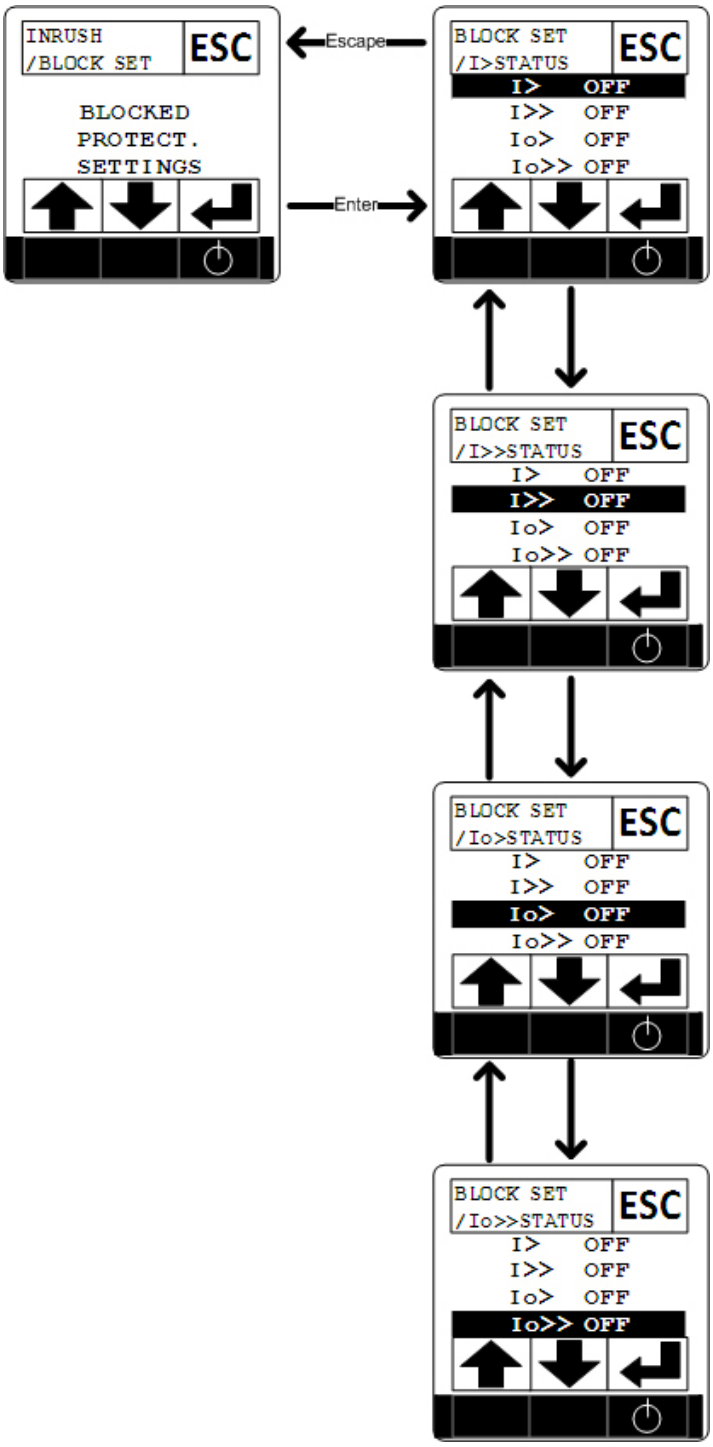


Figure : Protection blocking menu

6.3.14 MENU : Configuration & Time

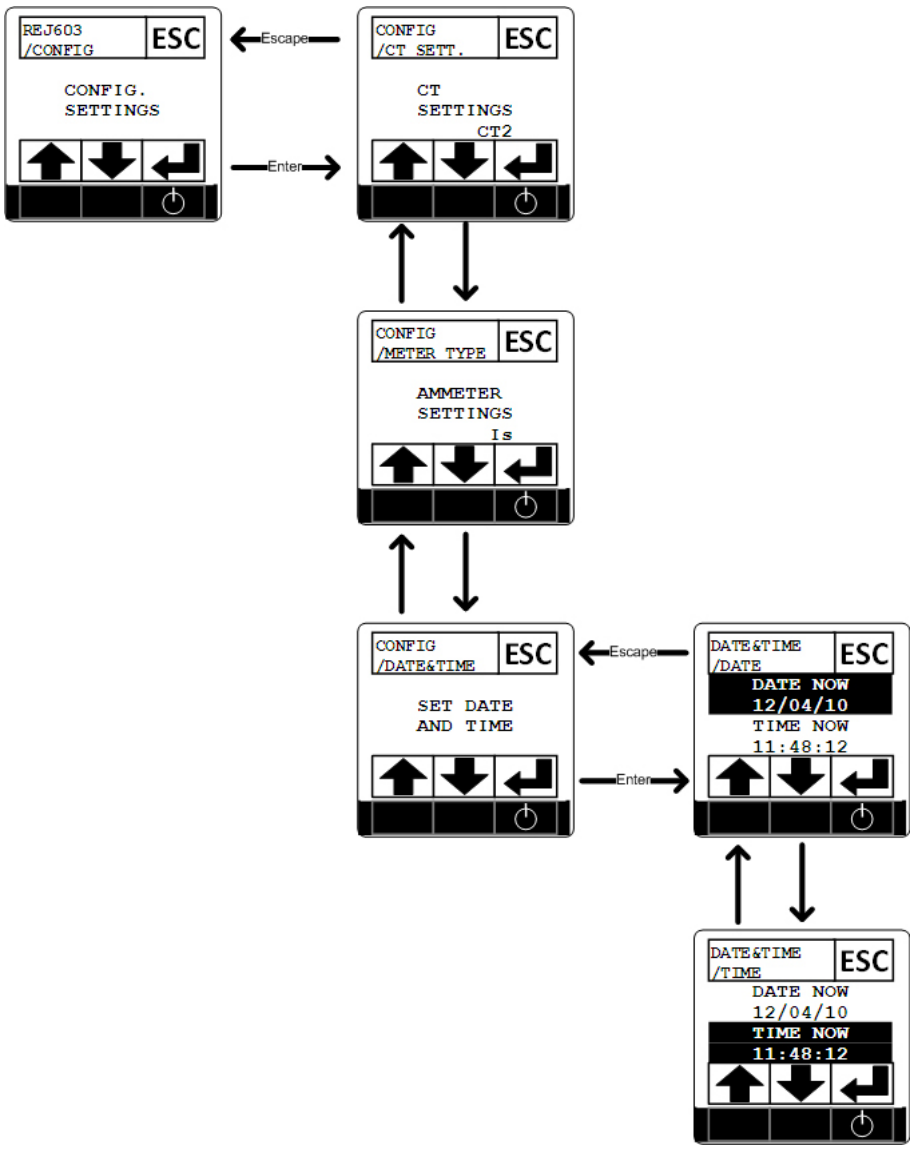


Figure : Configuration & Time menu

6.3.14 MENU : Version

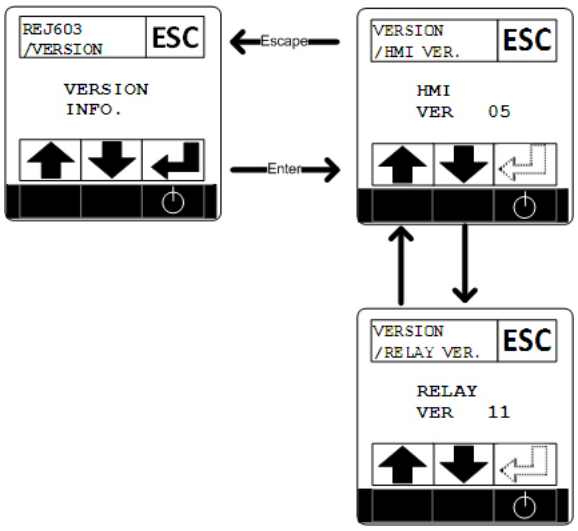


Figure : Version menu

6.4 Reset Record

The records can be erased by the following method in the menu navigation.

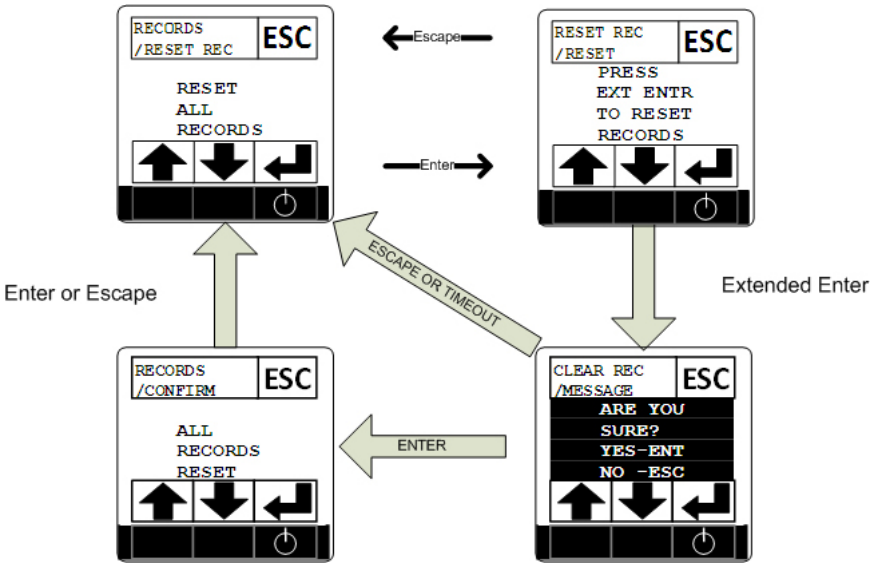


Figure : Reset records

6.5 Protection Parameters Edit

6.5.1 Edit Mode

The Edit mode is the special mode in the HMI operation. Only some screens can have edit features. In the edit mode, the distinctive feature is the Reverse Video of the text.

ACTIVITATE EDIT MODE

The Edit mode can be accessed by pressing the Enter and Escape Keys**.**

EXIT EDIT MODE

The Edit mode can be exit by either pressing Escape key, which does not save any changes in the parameter or by pressing Enter key, which saves any changes in the parameter. The edit mode is automatically deactivated when there is no activity on the keypad for 5 min.

6.5.2 Parameter : Phase Low Set

The phase lowset protection settings include I>, CI (Curve Type) and t>/k> depending on the Curve type. The curve type can be selected on the relay DIP. The available curve types are DMT, EI,NI, VI, LI, HR and FR. This parameter is “View Only” in the HMI.

6.5.2.1 I> EDIT

The HMI has I> fine settings above the DIP settings for limited I> DIP settings. The following figure shows the flow of changing the fine settings for I>. If the protection is blocked for I>, the HMI display shows EXIT

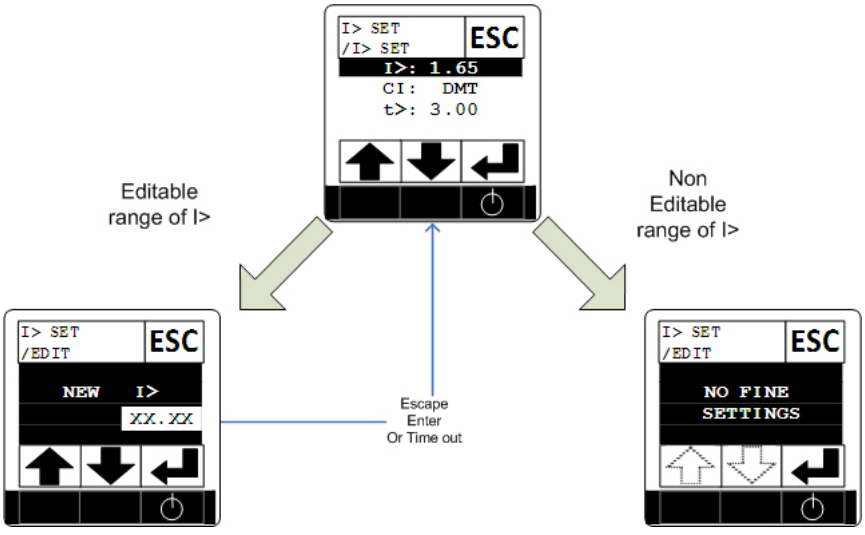


Figure : I > Edit Flow

The following table shows the DIP settings which have fine settings.

Table : I > Fine Settings

Parameter Value	Fine Settings
0.50 – 2.25	No Fine Settings
2.30	2.35
2.40	2.45

6.5.2.2 K>/T> EDIT

The k/t parameters are also set through the DIP switches on the Relay. The fine settings for the k/t are done through the HMI by the user in the following flow.

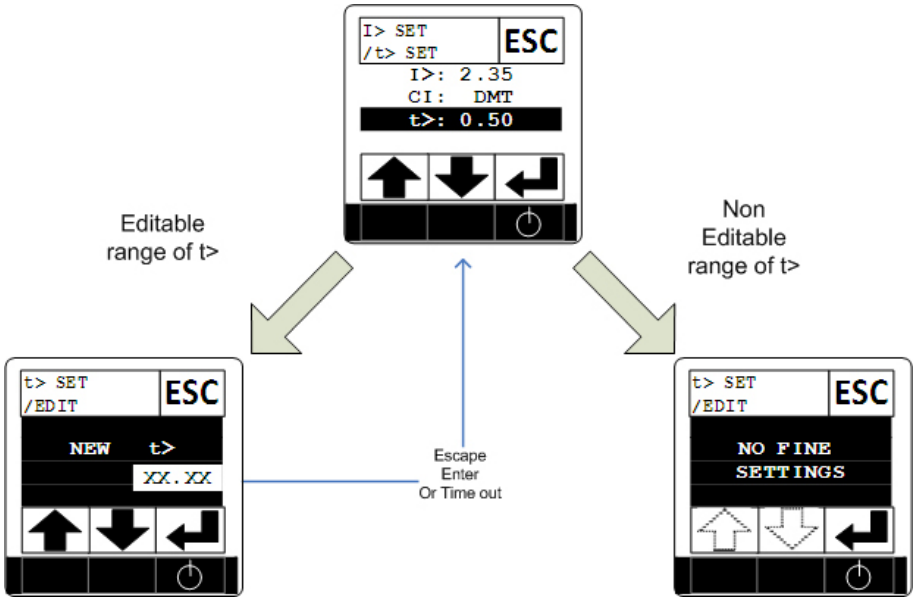


Figure : t > Edit

Table : t/K fine settings

Parameter Value	Fine Settings
0.05	0.06
0.07	0.08,0.09
0.10	[0.11 - 0.14], step size of 0.01
0.15	[0.16 - 0.19], step size of 0.01
0.20	[0.21 - 0.24], step size of 0.01
0.25	[0.26 - 0.29], step size of 0.01
0.30	[0.31 – 0.39], step size of 0.01
0.40	[0.41 – 0.59], step size of 0.01
0.60	[0.61 – 0.79], step size of 0.01
0.80	[0.81 – 0.99], step size of 0.01
1.00	[1.01 – 1.39], step size of 0.01
1.40	[1.41 – 1.79], step size of 0.01
1.80	[1.81 – 2.19], step size of 0.01
2.20	[2.21 – 2.59], step size of 0.01
2.60	[2.61 – 2.99], step size of 0.01
3.00	No Fine Settings

6.5.3 Parameter : Phase High Set

The Phase Highset has got two parameters for user, I>> and t>>, which can be set via DIP settings. Again some of them have fine settings.

6.5.3.1 I >> EDIT

The Phase High set current can be changed with additional fine settings in the following way. If the protection is blocked by the DIP, the HMI shows EXIT.

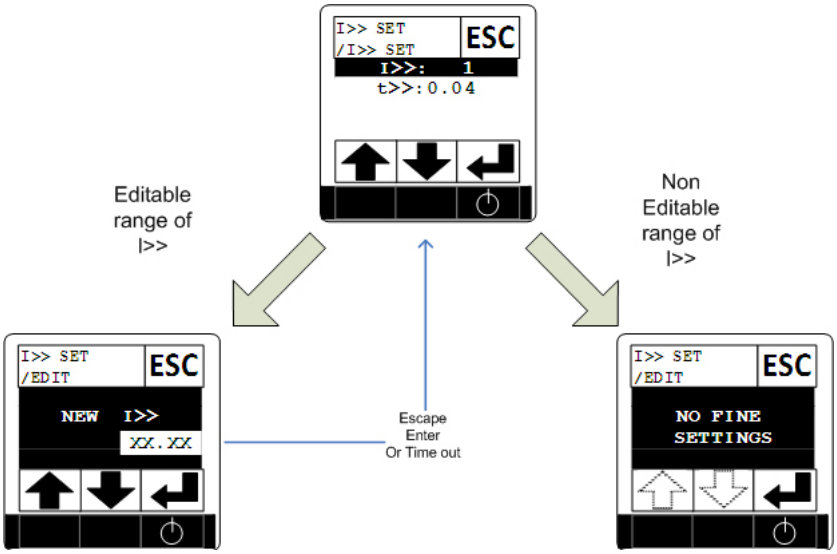


Figure : I >> Edit

Table : I>> fine settings

Parameter Value	Fine Settings
[1 – 9]	No Fine Settings
10	11
12	13
14	15
16	17
18	19
20	No Fine Settings

6.5.3.2 t >> EDIT

The highset time for the Phase trip can also be fine tuned in the following manner.

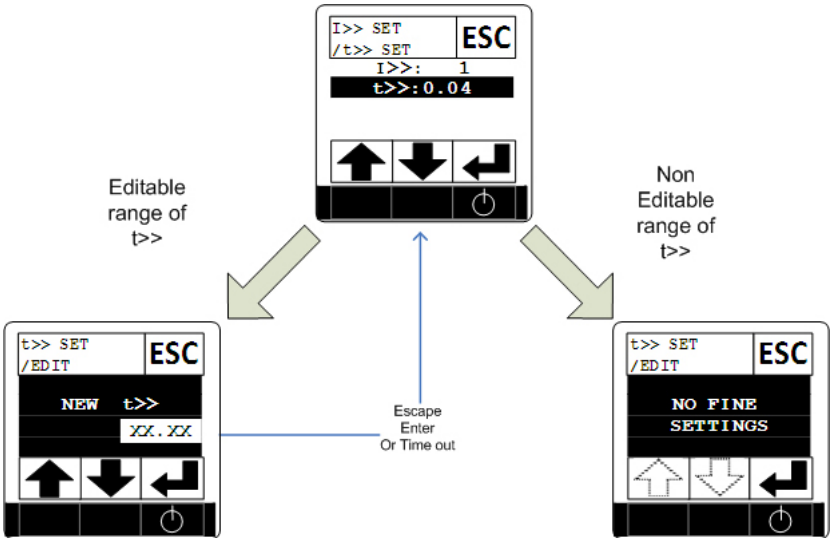


Figure : I > Edit Flow

Table : t>> fine settings

Parameter Value	Fine Settings
0.04	0.05,0.06
0.07	0.08,0.09
0.10	[0.11 - 0.14], step size of 0.01
0.15	[0.16 - 0.19], step size of 0.01
0.20	[0.21 - 0.24], step size of 0.01
0.25	[0.26 - 0.29], step size of 0.01
0.30	[0.31 – 0.39], step size of 0.01
0.40	[0.41 – 0.59], step size of 0.01
0.60	[0.61 – 0.79], step size of 0.01
0.80	[0.81 – 0.99], step size of 0.01
1.00	[1.01 – 1.39], step size of 0.01
1.40	[1.41 – 1.79], step size of 0.01
1.80	[1.81 – 2.19], step size of 0.01
2.20	[2.21 – 2.59], step size of 0.01
2.60	[2.61 – 2.99], step size of 0.01
3.00	No Fine Settings

6.5.4 Parameter : Earth Low Set

The Earth lowset follows similar to the Phase lowset. The CE or curve for the earth low set can be set only through the DIP switches on the relay.

6.5.4.1 I o > EDIT

The I0> can be fine adjusted using the following method. If the protection is blocked for the I0>, the HMI Display shows EXIT

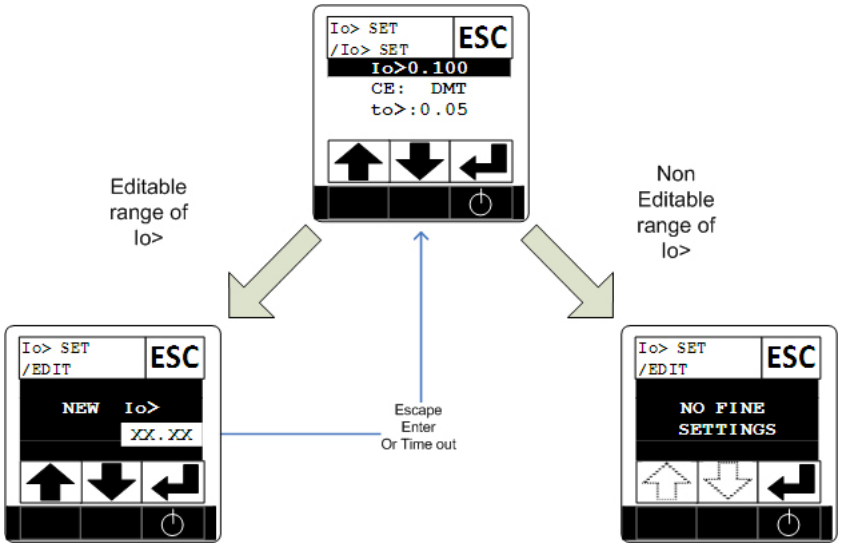


Figure : Io > Edit

Table : Io> fine settings

Parameter Value	Fine Settings
[0.100 – 0.500]	No Fine Settings
0.525	0.550
[0.575 – 0.725]	No Fine Settings
0.750	0.775
0.800	0.825
0.850	0.875
0.900	0.925
0.950	0.975
1.000	No Fine Settings

6.5.4.2 Ko/T o > EDIT

The fine settings for k0>/t0> parameters are set as below.

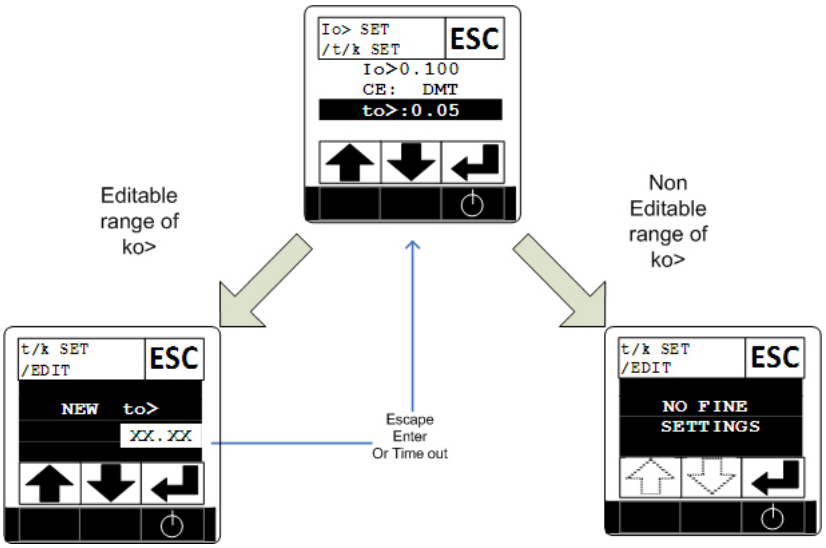


Figure : Ko > Edit Flow

Table :Ko/To fine settings

Parameter Value	Fine Settings
0.05	0.06
0.07	0.08,0.09
0.10	[0.11 - 0.14], step size of 0.01
0.15	[0.16 - 0.19], step size of 0.01
0.20	[0.21 - 0.24], step size of 0.01
0.25	[0.26 - 0.29], step size of 0.01
0.30	[0.31 – 0.39], step size of 0.01
0.40	[0.41 – 0.59], step size of 0.01
0.60	[0.61 – 0.79], step size of 0.01
0.80	[0.81 – 0.99], step size of 0.01
1.00	[1.01 – 1.39], step size of 0.01
1.40	[1.41 – 1.79], step size of 0.01
1.80	[1.81 – 2.19], step size of 0.01
2.20	[2.21 – 2.59], step size of 0.01
2.60	[2.61 – 2.99], step size of 0.01
3.00	No Fine Settings

6.5.5 Parameter : Earth High Set

The earth highset parameters are similar to the phase highset.

6.5.5.1 I o >> EDIT

The earth highset phase currents has the fine settings as follows.

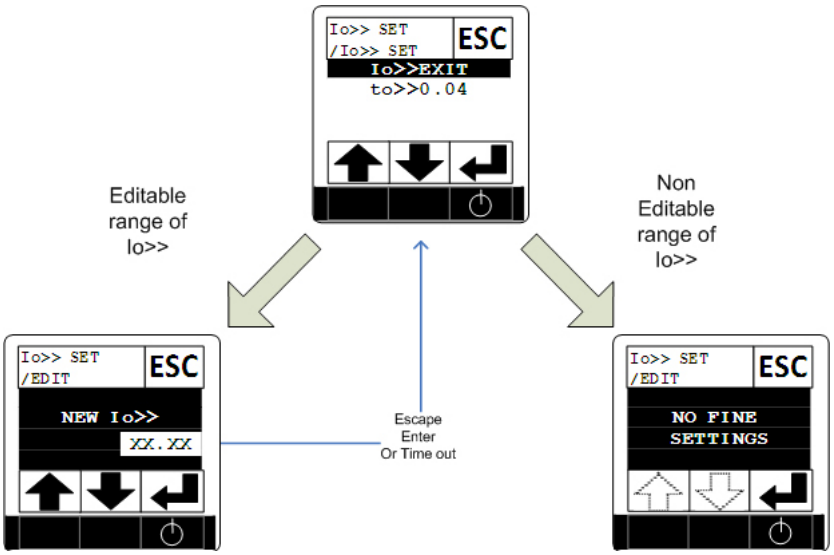


Figure :Io >> Edit Flow

Table : Io>> fine settings

Parameter Value	Fine Settings
[1 – 9]	No Fine Settings
10	11
12	13
14	15
16	17
18	19
20	No Fine Settings

6.5.5.2 T o >> EDIT

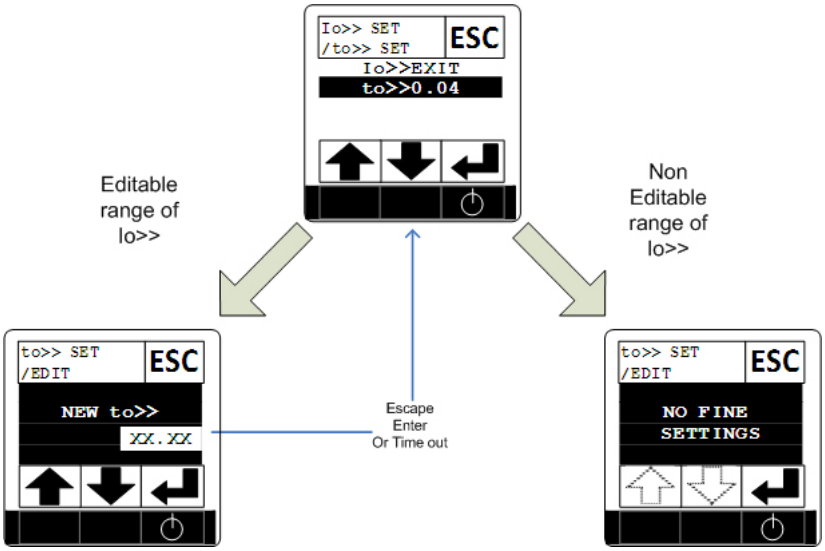


Figure : To >> Edit Flow

Table : To>> fine settings

Parameter Value	Fine Settings
0.04	0.05,0.06
0.07	0.08,0.09
0.10	[0.11 - 0.14], step size of 0.01
0.15	[0.16 - 0.19], step size of 0.01
0.20	[0.21 - 0.24], step size of 0.01
0.25	[0.26 - 0.29], step size of 0.01
0.30	[0.31 – 0.39], step size of 0.01
0.40	[0.41 – 0.59], step size of 0.01
0.60	[0.61 – 0.79], step size of 0.01
0.80	[0.81 – 0.99], step size of 0.01
1.00	[1.01 – 1.39], step size of 0.01
1.40	[1.41 – 1.79], step size of 0.01
1.80	[1.81 – 2.19], step size of 0.01
2.20	[2.21 – 2.59], step size of 0.01
2.60	[2.61 – 2.99], step size of 0.01
3.00	No Fine Settings

6.5.6 Parameter : INRUSH

All inrush parameters are set through the HMI only. The default settings for the inrush

6.5.6.1 INRUSH Fault Threshold EDIT

The Fault Current Threshold is set to 20, default. User can change the settings as follows.

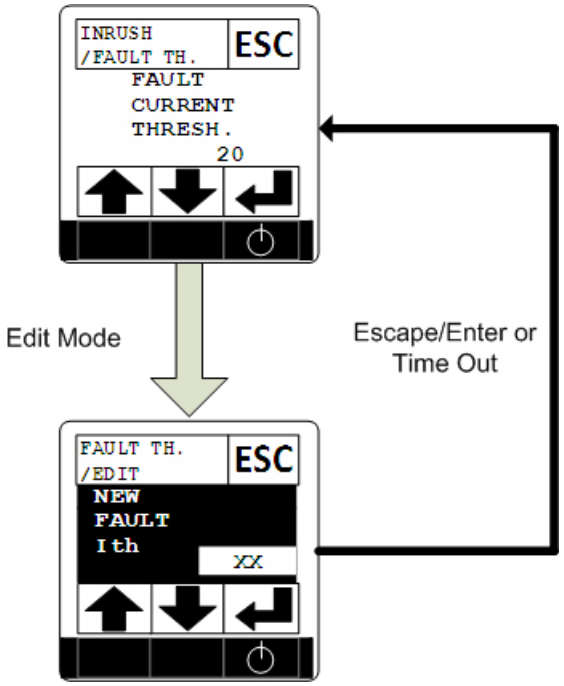


Figure : Inrush fault threshold edit

Table : Threshold current setting

Parameter Value	Fine Settings
20	[01 - 19], step size of 1

6.5.6.2 INRUSH Minimum Threshold EDIT

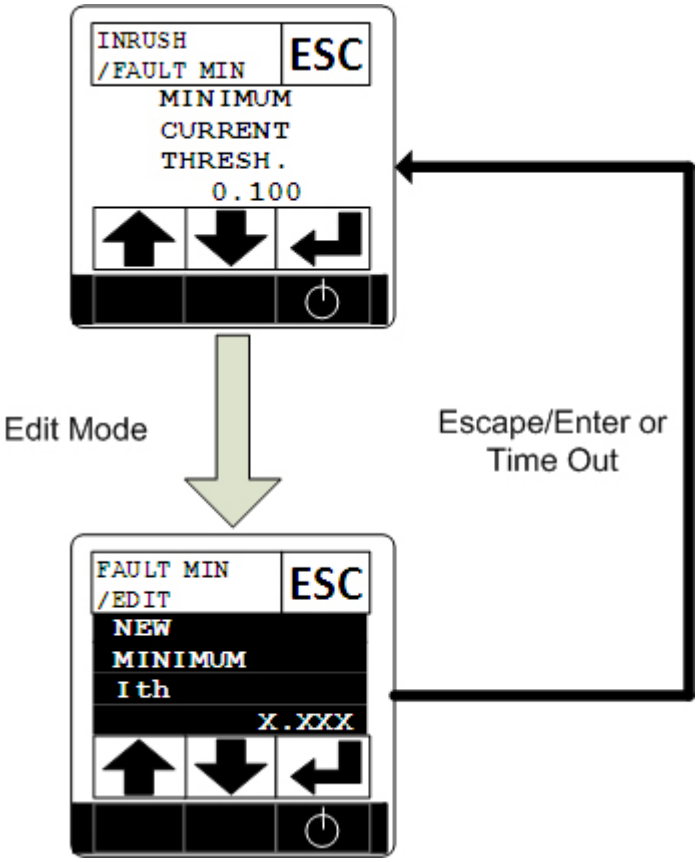


Figure : Inrush minimum threshold edit

Table : Minimum Inrush threshold setting

Parameter Value	Fine Settings
0.100	[0.100 – 2.500], step size of 0.100

6.5.6.3 INRUSH Harmonic Ratio EDIT

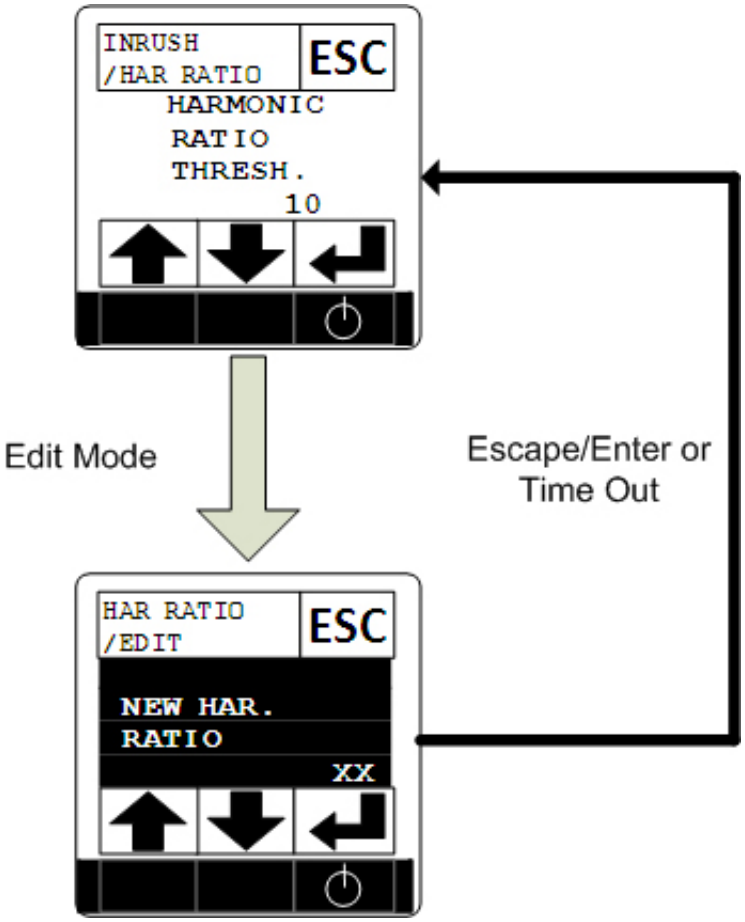


Figure : Inrush Harmonic ratio threshold edit

Table : Harmonic Ratio setting

Parameter Value	Fine Settings
10	[05 - 50], step size of 5

6.5.6.4 INRUSH Protection Blocking EDIT

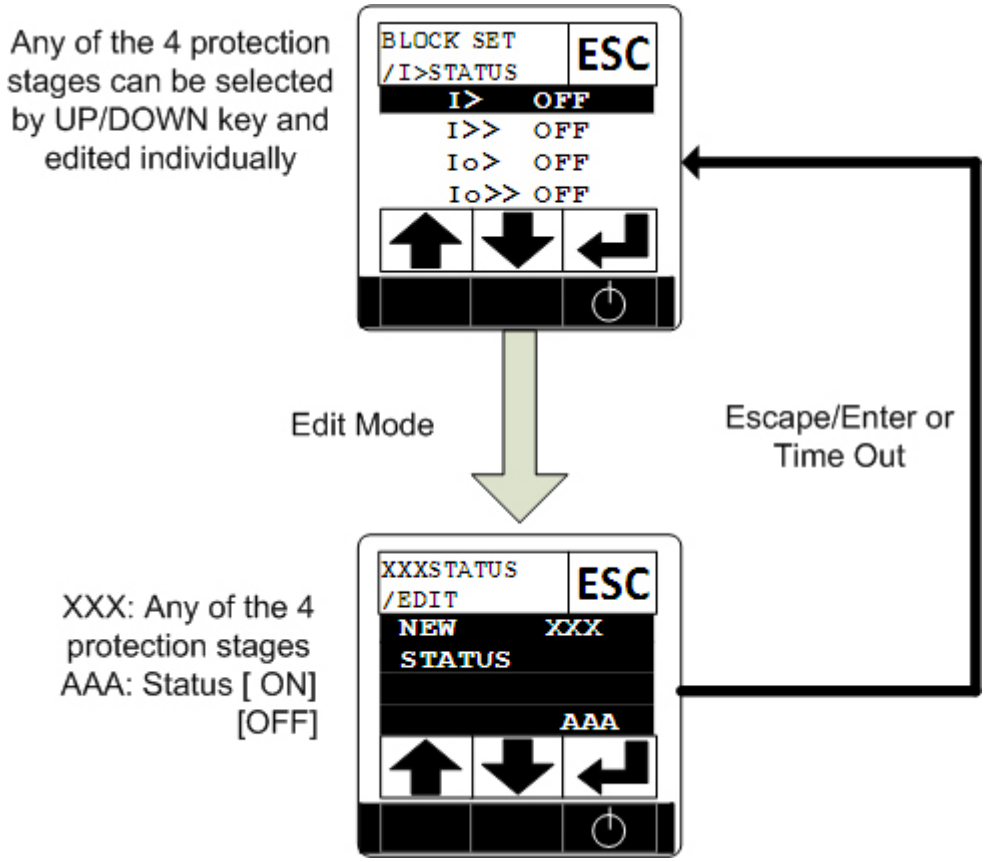


Figure : Protection block by inrush

6.6 Reset Fine Settings

The separate menu is available to remove all fine settings for protection parameters mentioned in earlier sections. The defaults are restored for the Inrush parameters.

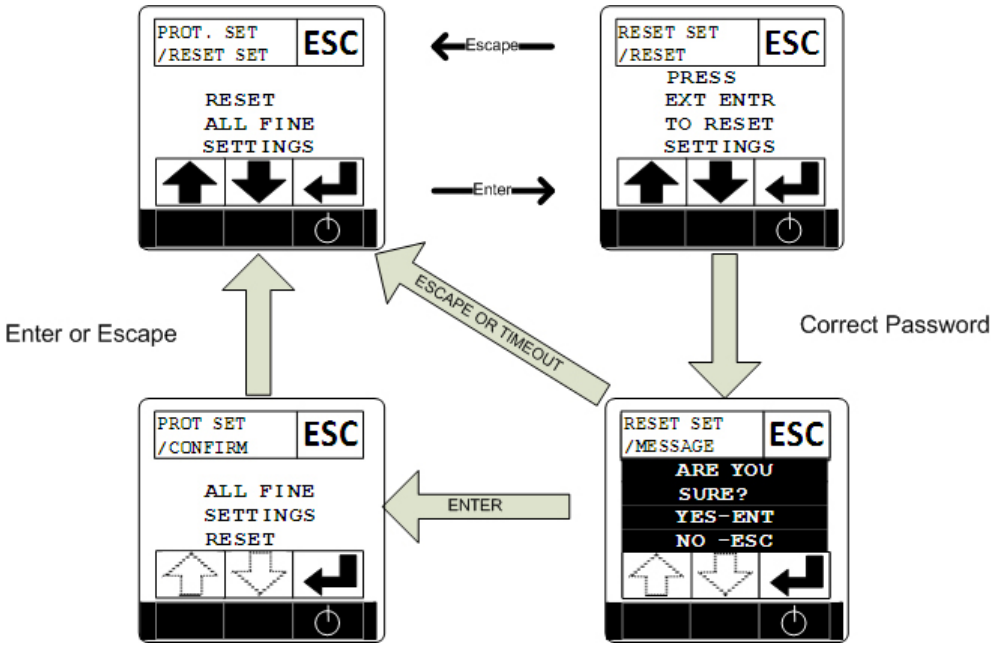


Figure : Reset Fine settings operation

6.7 Other Parameters

The other parameters that can be edited by the user are mainly not affecting the protection settings of the relay.

6.7.1 CT Settings

The user can change the CT Type according to the CT installed at the site. The user can deliberately select UNKNOWN CT TYPE or CT? in the menu navigation if the CT Type is not known. Again, the Ammeter calculations require CT information to calculate Currents in Amperes. Thus if the CT Type is “UNKNOWN” or “CT?” the currents are shown in Is only.

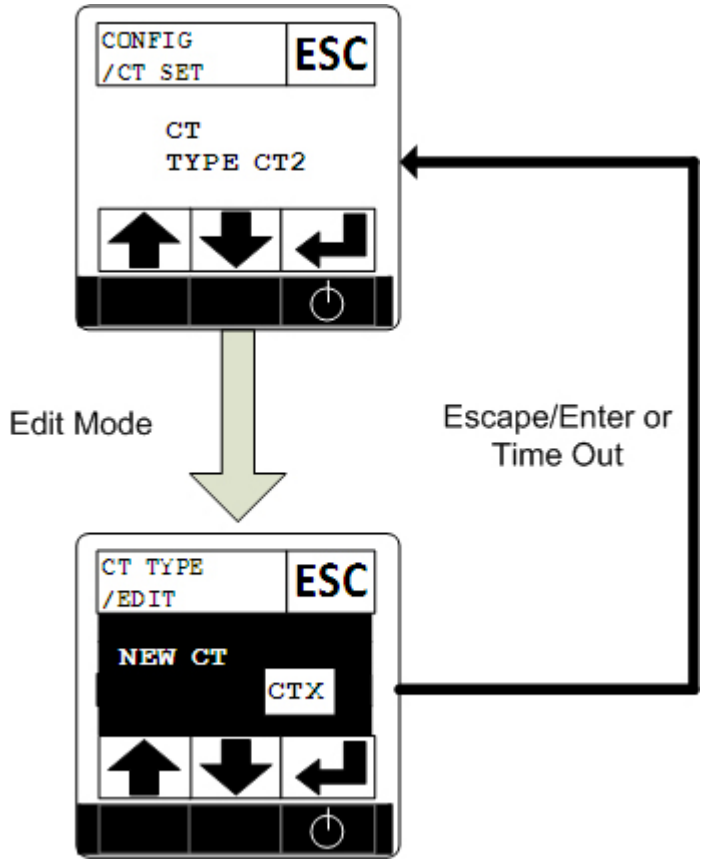


Figure : Change CT Type

6.7.2 Ammeter Settings

The user can set the ammeter view to Is or Ampere. The ammeter can show currents in Ampere if the CT Type is in valid range.

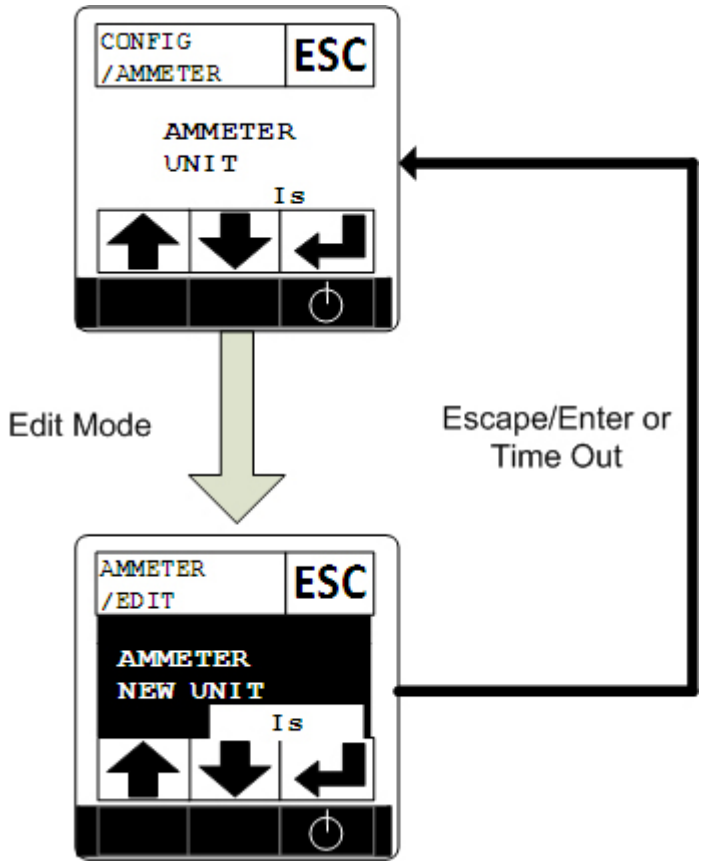


Figure : Ammeter Type Edit

6.8 Date and Time Settings (RTC)

6.8.1 Date Settings

The user can set the date at the Date & Time menu.

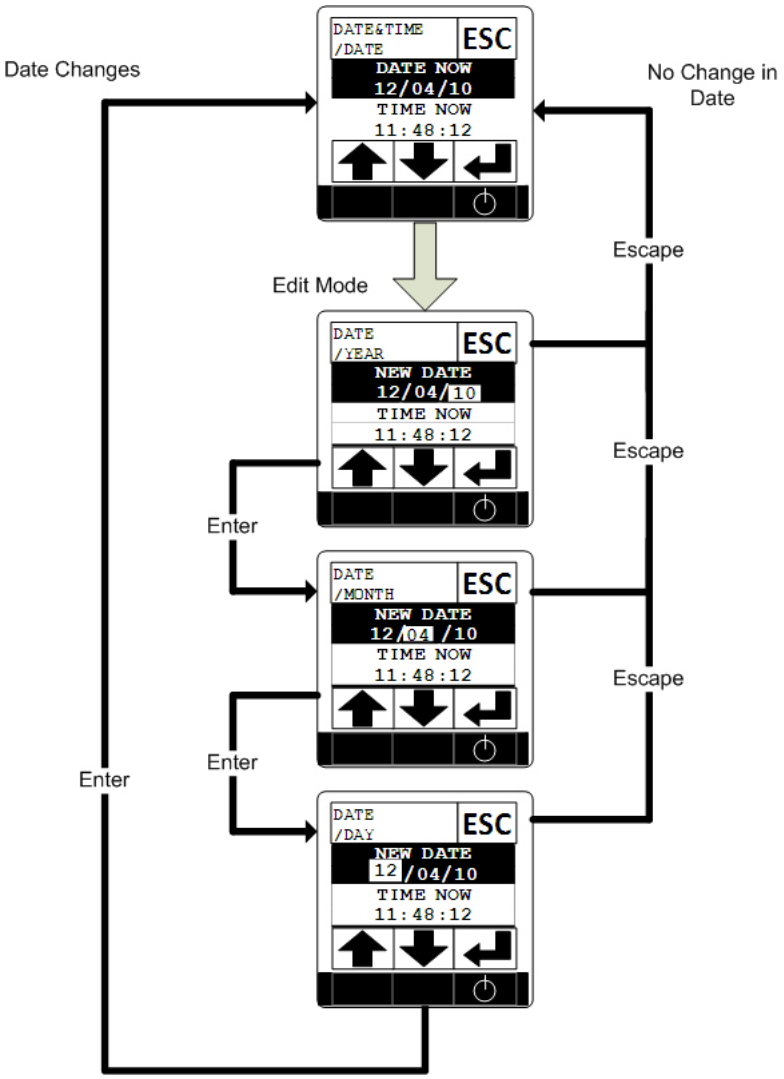


Figure : Date Edit

6.8.2 Time Settings

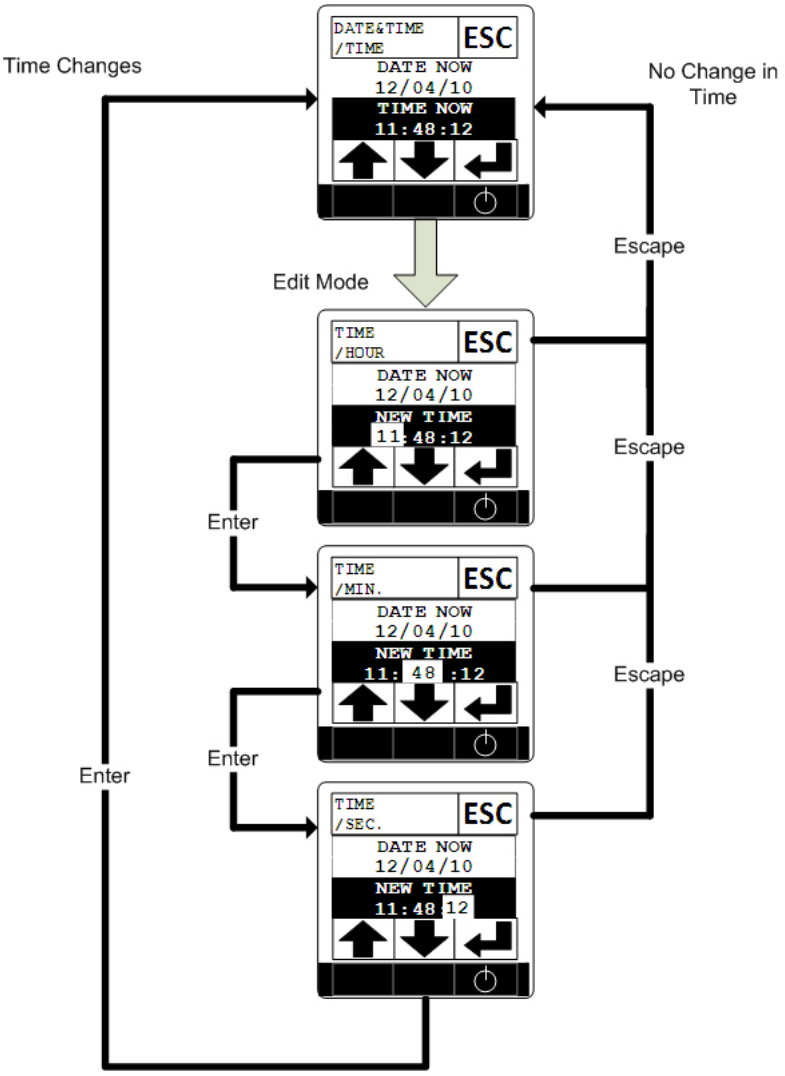


Figure : Time Edit

Section 7 Application Example

7.1 Purpose

This application guide presents generally accepted methods of calculation of over current and earth fault relay settings and it's 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.

7.2 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.

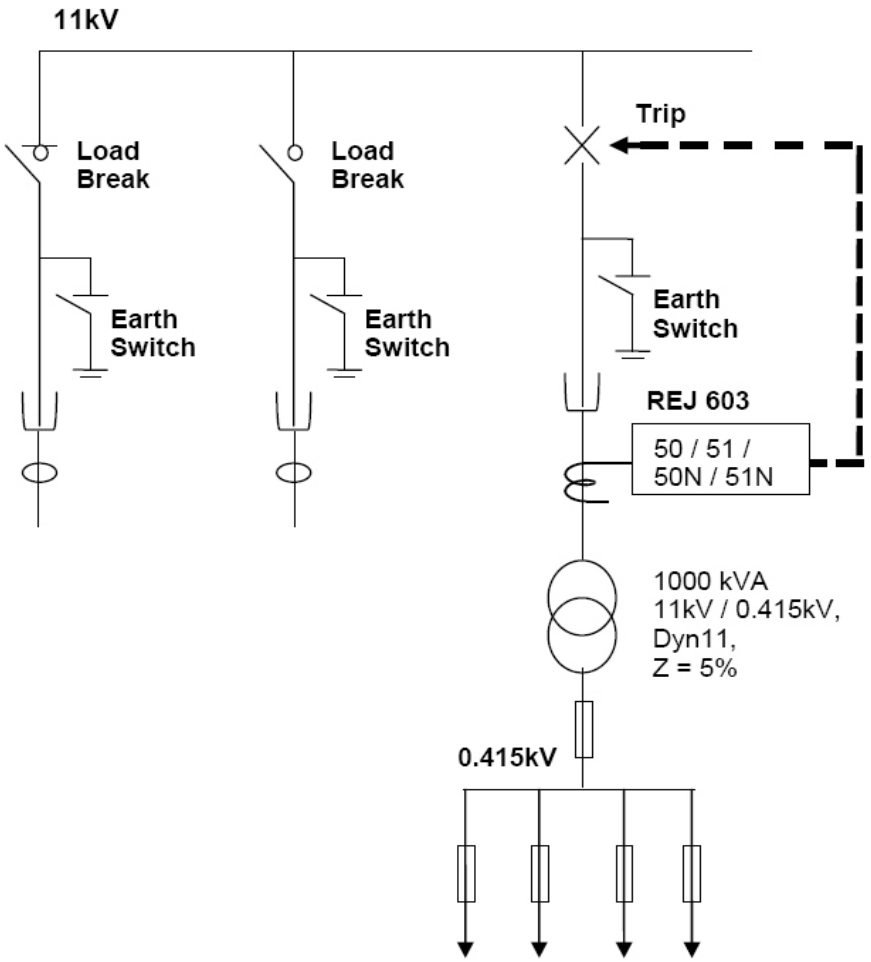


Fig. 10 – Basic circuit diagram of CCV type Ring Main Unit

7.3 Setting calculation

7.3.1 Selection of CT

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

$$I_N = \frac{S_N}{\sqrt{3} \times U_N}$$

where

I_N = Rated full load current of the power transformer
S_N = Rated power of the power transformer
U_N = Rated phase – phase voltage of the power transformer

Therefore,

$$I_N = \frac{S_N}{\sqrt{3} \cdot U_N} = \frac{1000\ kVA}{\sqrt{3} \times 11\ kV} = 52.49\ Amp.$$

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

CT Type	Range	Current Ratio	$I_p$min for relay Oprtn.	O/C range	E/F measurement range	
					Internal	External
REJ603 - CT 3	32A – 112A	28.8 / 0.075	28.8 A	28.8A – 2240A	3.2A – 2240A	0.1 * In – 20 * In

Setting Range for Is:

Is – 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.

7.3.2 Fault level calculation

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

$$= 20000\ kVA = 20\ MVA$$

.

The 415kV system is solidly grounded

$$\text{Thus 3 phase fault current on 0.415kV bus is} = \frac{20}{\sqrt{3} \times 0.415} = 27.83\ kA$$

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

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.

0.415 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.

7.3.3 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.

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

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.

7.3.4 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.

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

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

$$\text{With I> set at 1.0xIs, the PSM} = \frac{\text{Fault current}}{\text{Primary Operating current}} = \frac{1049}{1 \times 80} = 13.11$$

Thus I / I> = 13.12

Consider Normal Inverse Characteristic :

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

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

Operating time at k = 1.0

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

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.

7.3.5 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 A.

7.3.6 Calculation of setting of high-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.

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

Thus I / I> = 5.0

Consider Normal Inverse Characteristic:

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

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

Operating time at k = 1.0

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

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.

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

Thus I / I> = 5.0

Consider Normal Inverse Characteristic:

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

Slope of the time/current curve set	**à**	**ß**
Normal inverse	0.02	0.14

Operating time at k = 1.0

$$t(s) = \frac{1.0 \times 0.14}{(5.0)^{0.02} - 1} = 4.28 \text{ Sec.}$$

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 8 Relay setting

8.1 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.

8.2 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.

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

8.2.1 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

In addition to DIP switches the fine setting can be done through the add-on HMI module if available. Setting switch S1/ 6 can use this feature.

8.2.2 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

t_0> / 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>/ ko	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

8.2.3 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	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
CP	DMT	NI	EI	VI	LI	RI	HR	FR	NA	NA	NA	NA	NA	NA	NA	NA

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

I_0> selection, switch S4/ 1-4

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	0.125	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> **	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 - 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
CE	DMT	NI	EI	VI	LI	RI	HR	FR	NA	NA	NA	NA	NA	NA	NA	NA

8.2.5 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

8.2.6 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

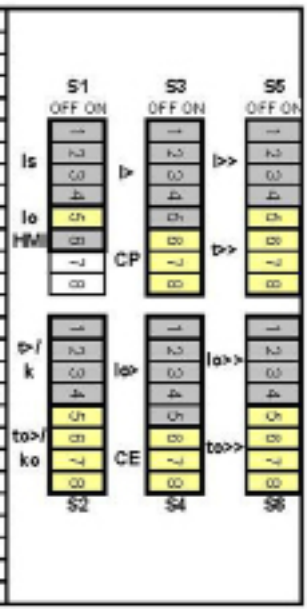
to>> selection, switch S6/ 5-8

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
to>>	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

8.3 Total Switch setting matrix

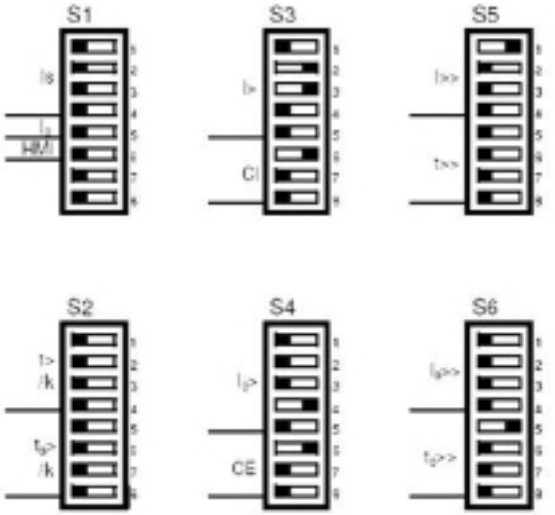
The REJ603 relay on the terminal side contains below indicated setting matrix view, for ease of setting the relay.

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
Is	S1 / 1 - 4																
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
Io	S1 / 5	OFF = Earthfault measurement by internal calculation											ON = Earthfault measurement by external input				
HMI	S1 / 6	OFF = Settings by DIP switches											ON = Settings by DIP switches (coarse) + HMI (fine)				
Spare	S1 / 7 - 8																
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	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



8.4 Switch setting matrix example

Selection of I_s based ON CT, I_s = 32 for CT 3
Earth measurement: Internal
HMI selection: DIP switches
I> = 120% or 1.2
CI = NI – Normal inverse
t>/ k = 0.05
I_o> = 30% or 0.3
CE = NI
t_o>/ k = 0.05
I>> = 200% or 2
t>> = 0.04
I_o >> = 100%, 1
t_o >> = 0.07



Section 9 Installation and commissioning

9.1 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.

9.2 Storage

On receipt, the apparatus must be carefully unpacked and checked as described under chap. 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 + 85 °C.

9.3 Checking environmental conditions 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 relay.
- 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.

9.4 Mounting the relay

The relay is has provision of wall mounting.

The space requirement of mounting:

For relay without HMI

Dimensions (H x W x D) : .....160 x 96 x 149mm

Weight : .....800 gm

For relay with HMI

Dimensions (H x W x D) : .....160 x 96 x 150mm

Weight : .....900 gm

By using the six nos. 4 mm drill holes, the relay is directly mounted on to the mounting plate. Detailed mounting drawing with all measurement is furnished in section 9.6.

9.5 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

9.6 Relay mounting dimensions

The relay is projection mounted. The relay provides IP54 on the front side. The over all dimensions of the REJ603 without HMI module are as follows:

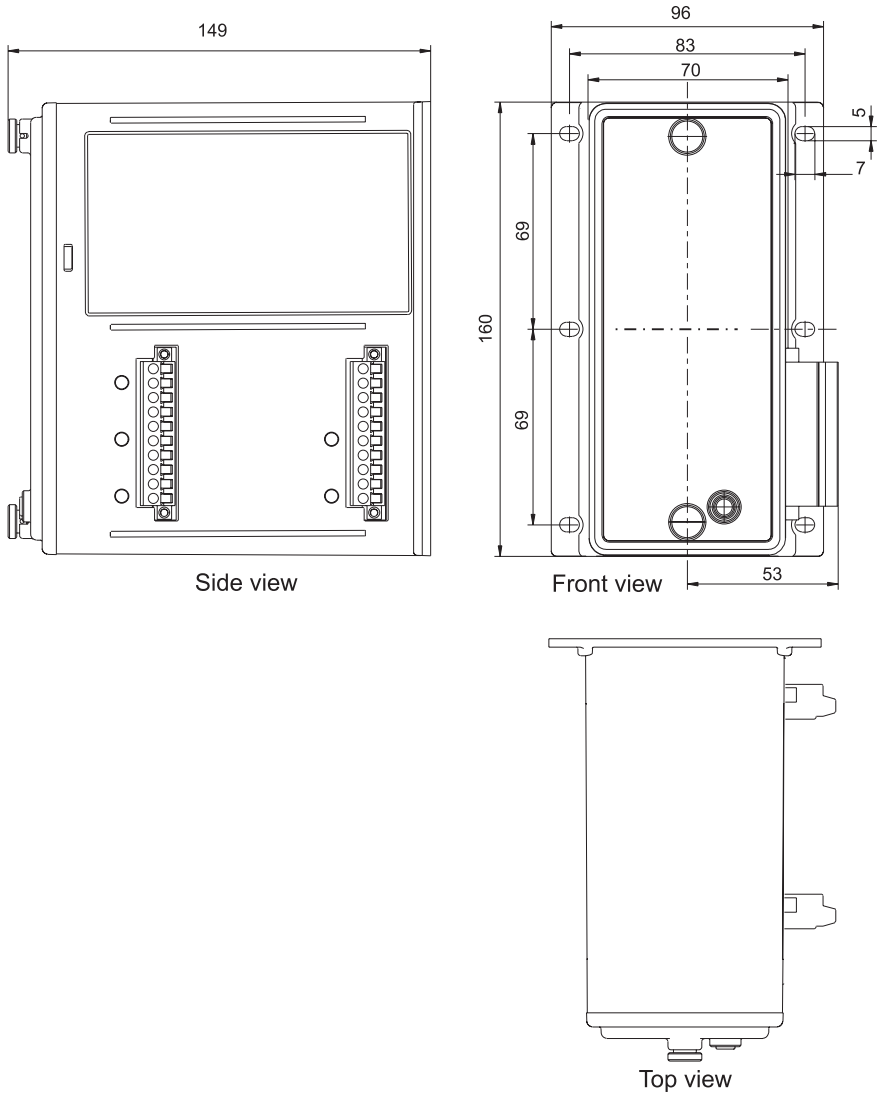


Fig. 11 - Relay mounting and dimentional details REJ603 without HMI

The relay is projection mounted. The relay provides IP54 on the front side. The over all dimensions of the REJ603 with HMI module are as follows:

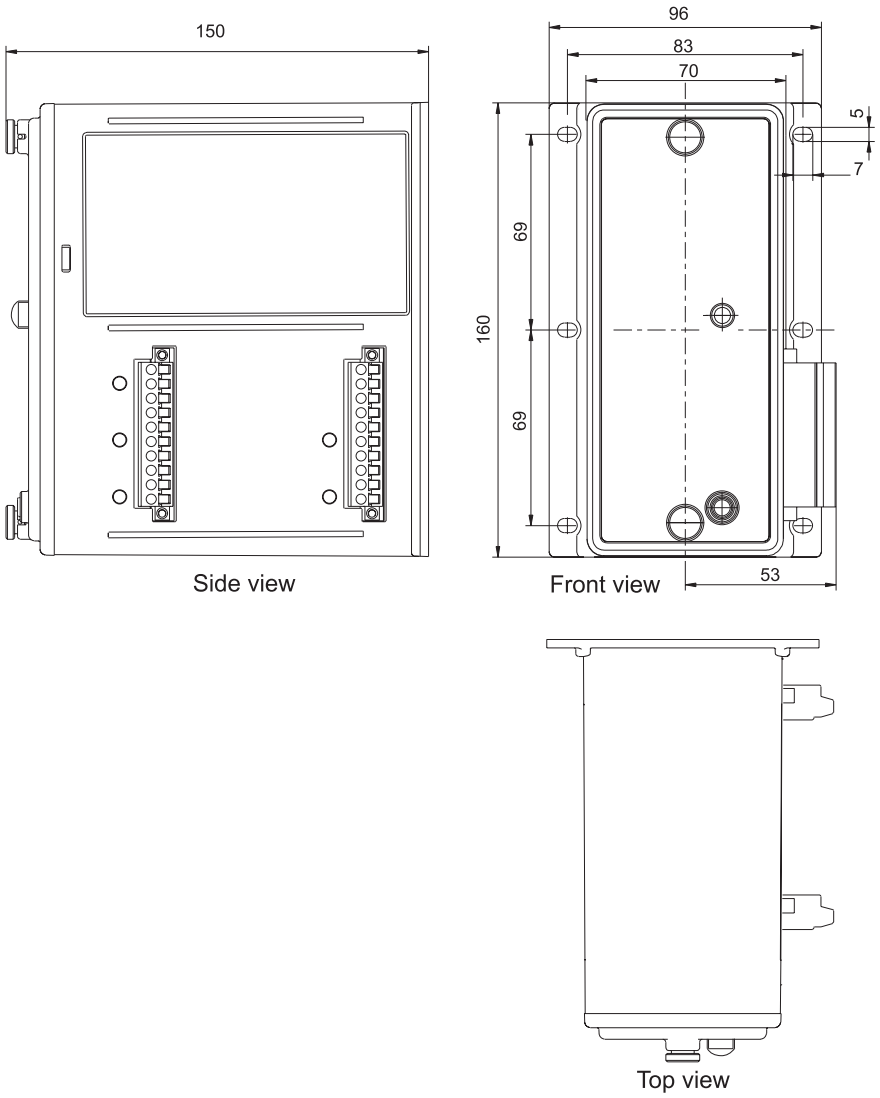
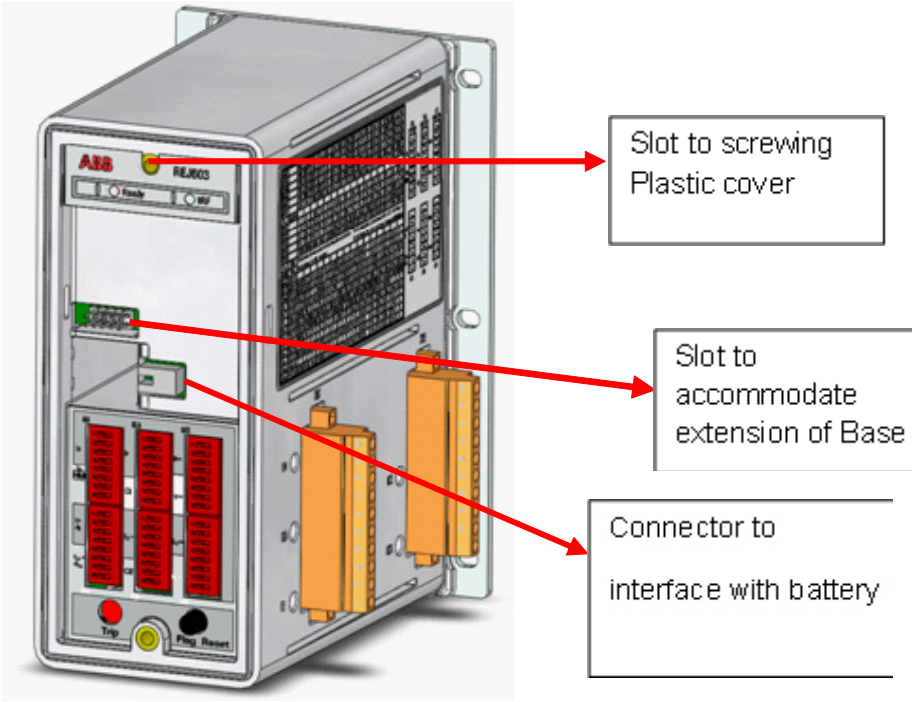
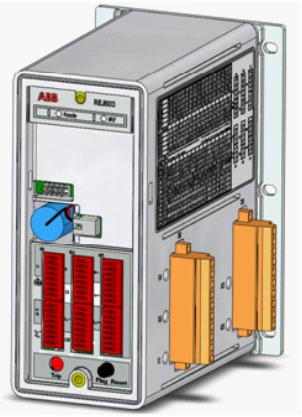
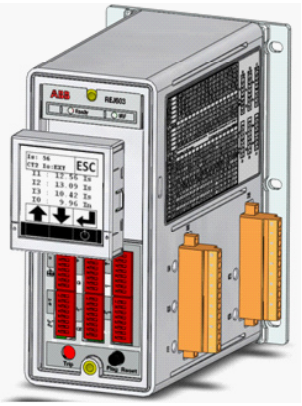


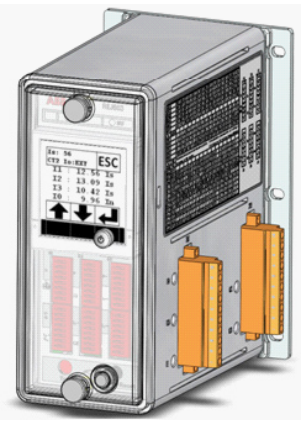
Fig. 12 - Relay mounting and dimentional details REJ603 without HMI

9.7 Installing HMI on Base Relay









9.8 Relay connection diagram

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

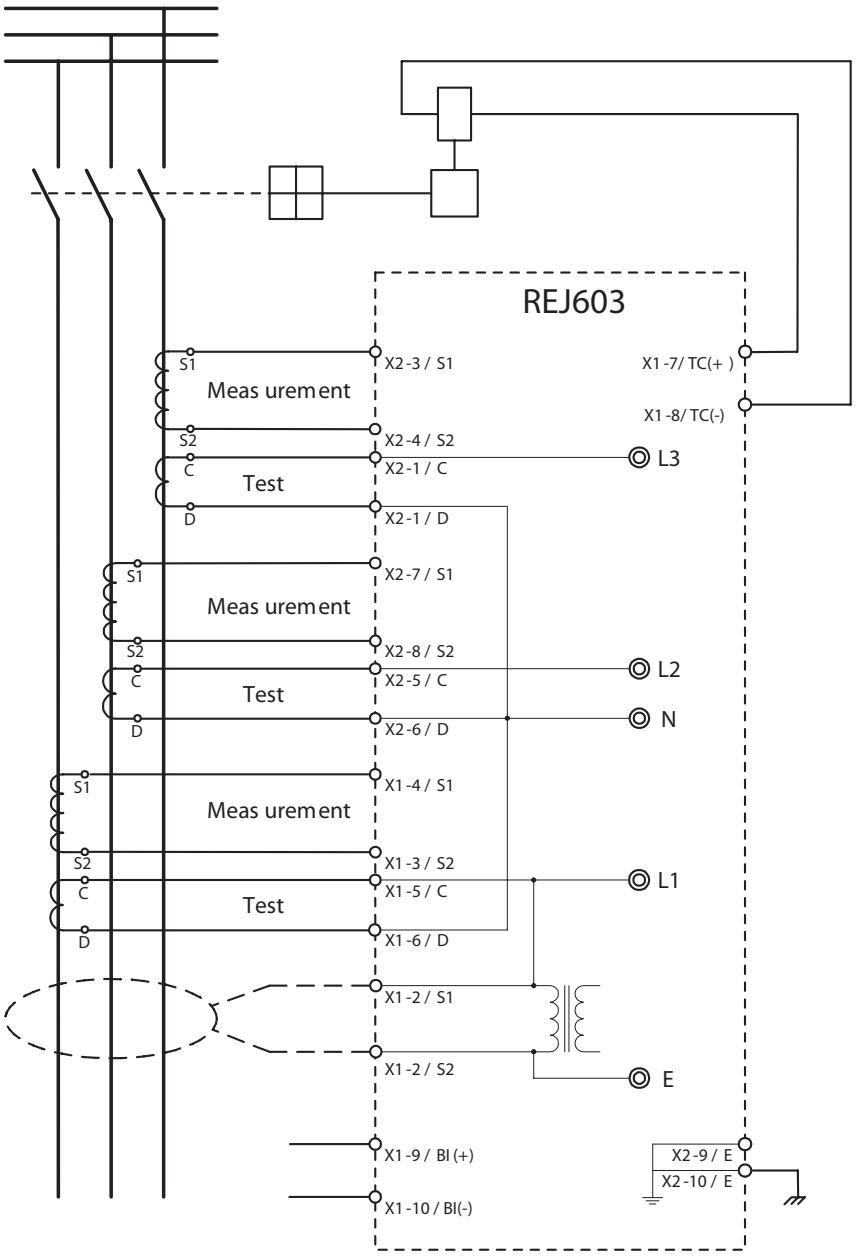


Fig. 13 - Relay connection diagram

9.9 Relay connection

The relay is available with three analogue 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 analogue phase measuring inputs as indicated below:

- CT input phase L1 (S1, S2), Terminal no. X1.3, X1.4
- 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 widning 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 - L1, E. for earth circuit testing

Galvanically isolated binary input is provided with a wide input voltage range 24-240V AC/DC for wiring external trip signal to trip circuit breaker.

- Binary input BI(+), BI(-), 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

Earthling 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 avaibility of relay operation indication even in absence of the primary CT current.

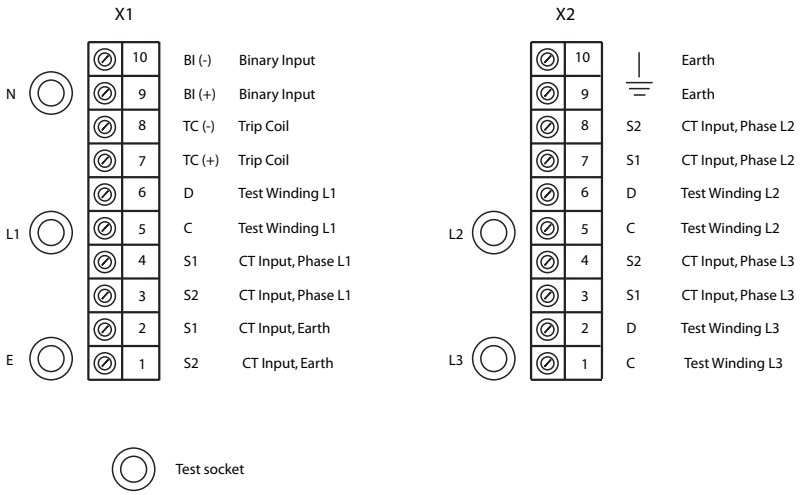


Fig. 14 – Terminal arrangement diagram

Important points to be taken in to consideration during wiring and

operation:

- . No winding terminal of the measuring winding of CT to be earthed. Earthling 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.

9.10 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 5.

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:

CT Type	Current applied to Test winding	Simulated Primacy Current
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.

9.10 Battery Handling and Disposal Steps

Ensure below steps for safe and better battery handling

- Do not charge
- Do not crush, disassemble, expose contents to water, heat above 100 C
- Do not heat above 100ºC or incinerate
- Do not mix fresh batteries and used batteries or other types of battery together
- Do not short circuit
- Do not use if the battery casing was mangled
- Discharged battery should be buried to the ground

9.11 Relay ordering information

The relay is available in single variant. The ordering code of the relay is as below:

For REJ603 with HMI : REJ603BBB10NN31C

For REJ603 without HMI : REJ603BBB10NN3XC

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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