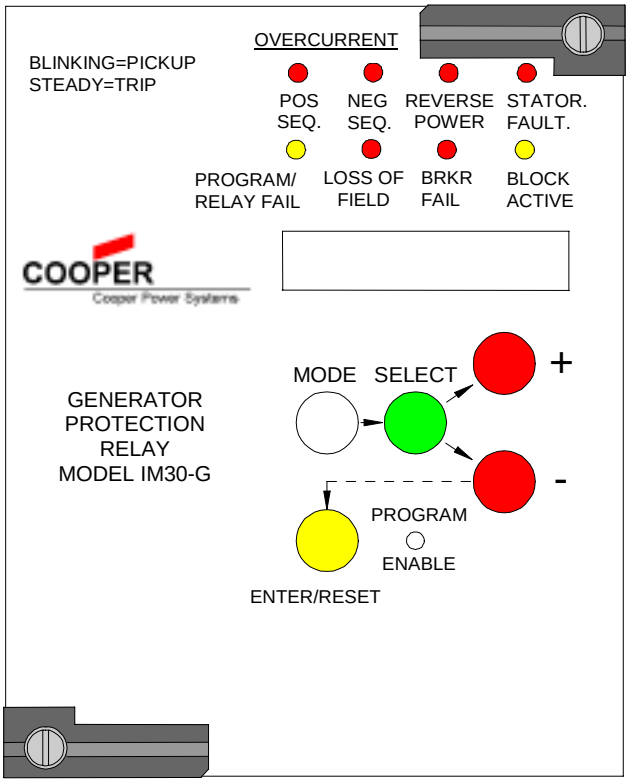
MULTIFUNCTION MICROPROCESSOR GENERATOR PROTECTION RELAY

TYPE

IM30-G

OPERATIONS MANUAL



 The Operations Manual is designed to familiarize the reader with how to install, program, and set up the relay for operation. For programming the relay via computer software, consult the appropriate manual. Contact your local Cooper Power Systems representative for ordering information.

CONTENTS

1. INTRODUCTION

The IM30-G is ideally suited for the protection of small generators, or as the core of a protection package for medium or large generators. The IM30-G provides all of the basic protective functions required for generator protection. Two digital inputs are provided to provide selective blocking of various functions. Five output relays are provided, of which four are programmable. All settings, measurements, and programming of the relay are possible through its front panel controls, or by means of a computer connected to the relay's RS485 communications port. The functions provided by the IM30-G are:

- Reverse Power (32).
- Loss of Field (40).
- Negative sequence overcurrent (46).
- Time and instantaneous phase overcurrent (50/51)
- Stator ground fault (50/51G)
- Breaker Failure

2. HANDLING

As with any piece of electronic equipment, care should be taken when handling the relay, particularly in regards to electrostatic discharge, as the damage may not be immediately obvious. All Edison relays are immune to electrostatic discharge when left in their protective case. However, when the relay is removed from its case, the following practices should be observed.

- Touch the case to ensure that your body and the relay are at the same potential.
- Whenever possible, handle the exposed relay by the front panel, the rear connector, or by the edges of the printed circuit boards. Avoid touching the individual electronic components or the embedded traces on the circuit boards.
- If you must hand the exposed (i.e., drawn-out) relay to another person, make sure both of you are at the same electrical potential.
- When setting the drawn-out relay down, make sure the surface is either anti-static or is at the same electrical potential as your body.
- Relays should always be stored in their protective cases. If storage of a drawn-out relay outside of its protective case is required, then the exposed relay should be placed in a suitable anti-static plastic or foam container.

3. INSTALLATION

Edison relays are shipped either in single or double width cabinets, or in standard 19" 3U rack mount enclosures that are capable of housing up to four Edison relays. Outline dimensions for the single relay housing is shown in Figure 3.1. For dimensions of other cabinets, see catalog section 150-05.

The double case mounting is similar to the single case, but requires a 113mm L x 142mm H panel opening. The 19" rack mount case is a standard 3U high 19" cabinet.

To remove the relay from its case, refer to Figure 3.2. The relay may be removed from its protective case by turning with a flat bladed screwdriver the locking screws ① and ② on the front panel latches ③ so that the slot on the screw is parallel to the ground. The latches may then be pulled from the inside edge to release the relay. Carefully pull on the latches to remove the relay from the housing.

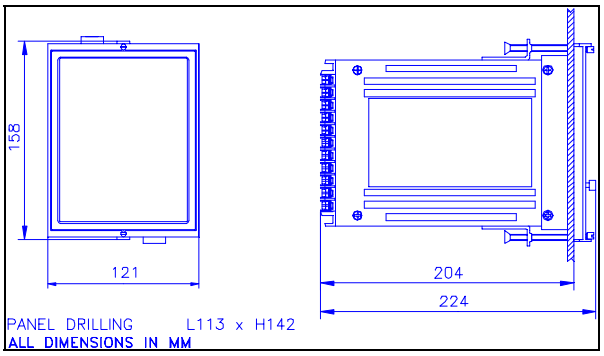


Figure 3.1: Single Module Enclosure Mounting

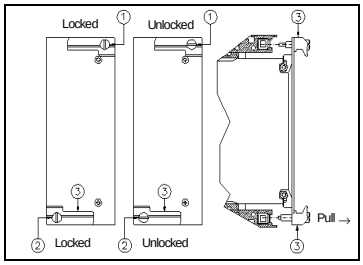


Figure 3.2: Latch Mechanism for Removal of Relay from Case

To re-install the relay into its case, align the printed circuit boards with the guides in the relay case and slide the relay in most of the way. For single and double cases, make sure the locking arm on the back of each of the latches ③ lines up with the locking pins in the case. Then push the latches in, seating the relay. Turn the screws on the latches until the slot is perpendicular to the ground.

4. ELECTRICAL CONNECTIONS

Phase currents are supplied to three current transformers. Rated current inputs can be either 1 or 5A, which can be selected with a jumper, as described in Section 5.

A Phase-to-phase voltage is supplied to the potential transformer rated 220V. The relay's phase-to-phase input voltage (Uns) can be adjusted from 100V through 125V.

Make electric connections in conformity with the diagram reported on relay's enclosure. Check that input currents are same as reported on the diagram and on the test certificate.

Auxiliary power is supplied via terminals 12 and 13, with a chassis ground at terminal 44. All Edison relays are available with one of two interchangeable auto-ranging power supplies. Descriptions of the input voltage ranges are given in Table 4.1. The input supply voltage is noted on the relay case. If in the event that the relay is fitted with the incorrect power supply, the power supply boards are easily field replaceable. See Bulletin S150-99-1 for instructions and part numbers.

Table 4.1: Power Supply Input Ranges

POWER SUPPLY	DC VOLTAGE RANGE	AC VOLTAGE RANGE
L	24V (-20%) to 125V (+20%)	24V (-20%) to 110V (+15%) 50/60 Hz
H	90V (-20%) to 250V (+20%)	80V (-20%) to 220V (+15%) 50/60 Hz

All electrical connections, including the RS485 connections, are made on the back of the relay (See Figure 4.1). All of the relay's terminals will accept up to a No. 6 stud size spade connector (or any type of lug up to 0.25" (6.3mm) wide), 12 AWG wire (4 mm²), or FASTON connectors. Electrical connections must be made in accordance with one of the relay's wiring connection diagrams shown in Figures 4 and 5.

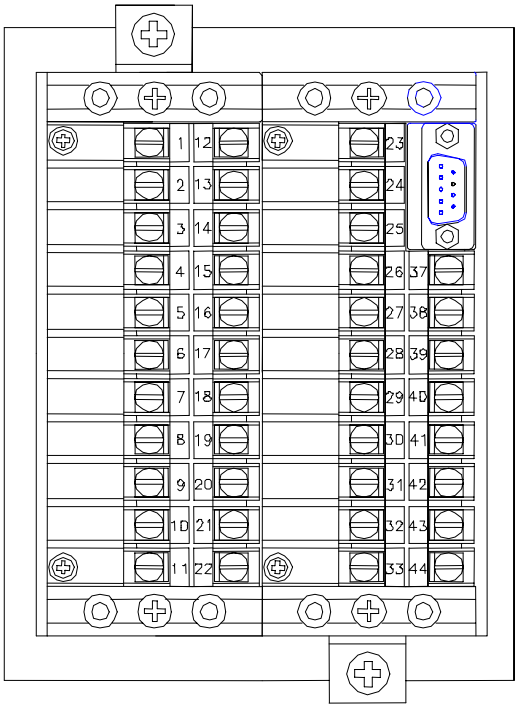


Figure 4.1: Rear View of Terminal Connections

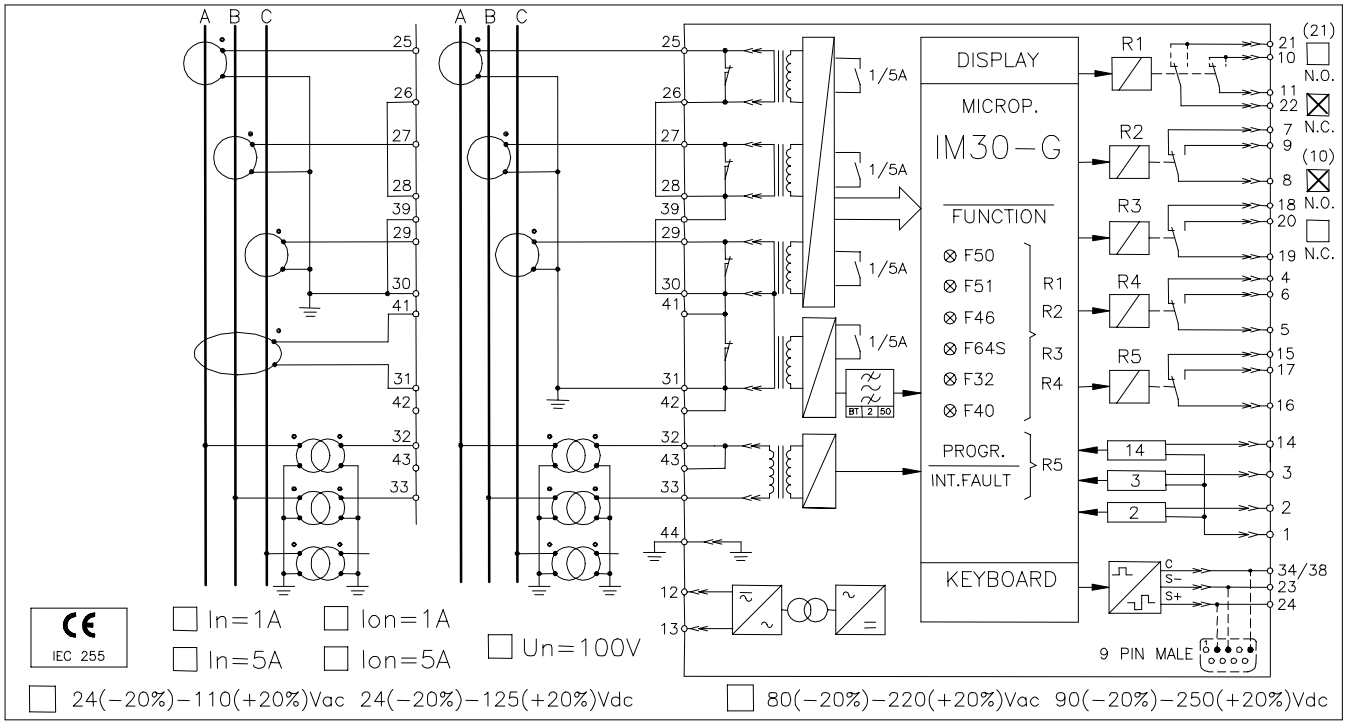


Figure 4.2: IM30-G Wiring Diagram

5. CHANGE THE CT SECONDARY RATED INPUT, 1 OR 5A

The 8th character of the relay's part number, either "1" or "5", indicates the factory set input range as shipped. If the input range needs to be changed, for any of the CT inputs, this may be accomplished via jumpers on the relay's main circuit board.

The two possible selections to specify the rated secondary input currents are 1 or 5 Amperes. The jumper placement determines what the secondary rated current values will be. The 5 Amperes rating is selected by either joining the bottom two pins (vertical) or the two leftmost pins (horizontal). The 1-Ampere rating is selected by either joining the top two pins (vertical) or the two rightmost pins (horizontal).

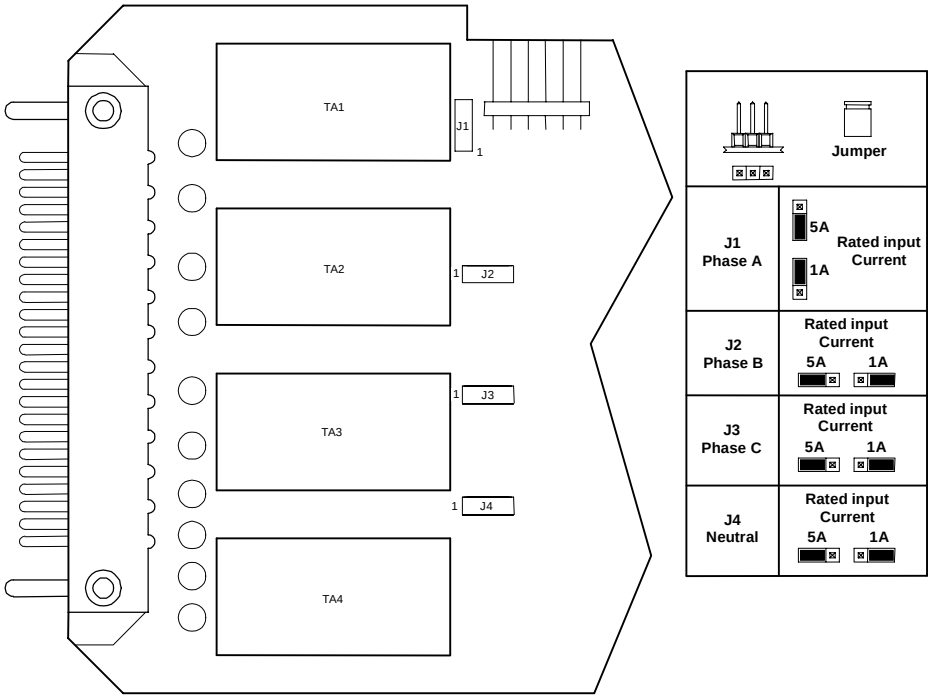


Figure 5.1: Rated Secondary Input Current Selection

NOTE: When changing the rated secondary input currents, be sure that the jumper is changed on all phases and neutral inputs.

6. OUTPUT RELAYS

Five output relays are available (R1, R2, R3, R4, R5) as shown in Figure 4.2.

The output relays R1, R2, R3, R4 are normally de-energized (energized on trip): these output relays are user programmable and any of them can be associated to any of the IM30-G's functions. Relay 1 consists of two isolated SPST terminals, which may be selected as being either normally open or normally closed. The other three output relays, 2-4, have form C (i.e., SPDT) contact arrangements.

Reset of the output relays after pick-up takes place automatically when the tripping cause is cleared. For relays controlled by the time delayed elements of the protection functions (tI>, tI>>, tIr>, …) it is possible to select Automatic reset or Manual Reset by the front reset button (see programming of **tFRes**, section 11.4, Table 4).

The output relay **R5** is normally energized, is not programmable and it is de-energized on:

- Internal fault

- Power supply failure
- During programming of the relay.
-

7. BLOCKING INPUTS

IM30-G has two digital blocking inputs that are used to block operation of the relay's protection elements. Operation of the blocking inputs is as follows:

Blocking input –2 (terminals 1-2):
Assertion of blocking input '-2' blocks operation of the selected phase and ground overcurrent time-delayed elements.

Blocking input –3 (terminals 1-3):
Assertion of blocking input '-3' blocks operation of the selected loss-of-field and reverse power time-delayed elements.

The open circuit voltage across the terminals of these inputs is 15 VDC. The internal resistance is 2.2 k Ω. When the external resistance across these terminals is less than 2.0kΩ, they are considered to be shorted. See Programming the Relay for more information on the function of these inputs.

8. TARGET DESCRIPTION

The front panel of the IM30-G contains eight LEDs that are normally OFF and which act as the targets for the relay elements. See Figure 8.1 for identification of the targets. As soon as the measured value exceeds the trip level defined by the programming variables, the appropriate LED begins to flash. Once the time delay element associated with that element has expired, the relay will have tripped and the LED goes to a constant ON state. Table 8.1summarizes the target functions.

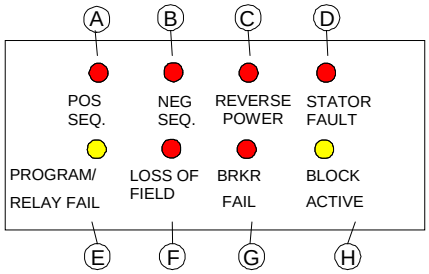


Figure 8.1: IM30-G Front Panel Targets

Table 8.1: Target Description

TARGET ID	COLOR	LEGEND	DESCRIPTION
A	Red	Positive Sequence (POS SEQ.)	Flashing when measured current exceeds the set pickup level [I>, I>>]. Illuminated on trip after expiration of the set time delay [tI>, tI>>].
B	Red	Negative Sequence (NEG SEQ.)	Same as above, related to [1Is, 2Is].
C	Red	REVERSE POWER	Same as above, related to [Ir>] and [tIr>].
D	Red	STATOR FAULT	Same as above, related to [O>] and [tO>].
E	Yellow	PROGRAM/	Flashing when the relay is in programming mode. Constantly

TARGET ID	COLOR	LEGEND	DESCRIPTION
		RELAY FAIL	illuminated in case of an Internal Relay Failure.
F	Red	LOSS OF FIELD	Flashing during the trip time delay of the function [Z<]. Illuminated on trip after expiration of the trip time delay [tz].
G	Red	BRKR FAIL	Illuminated when the breaker failure function is activated.
H	Yellow	BLOCK/ ACTIVE	Flashing when a blocking signal is present at the relevant input terminals. Illuminated when one or more of relay's functions is disabled.

Reset of the LEDs takes place as follows:

- From flashing to OFF, automatically when the tripping cause disappears.
- From ON to OFF, by "ENTER/RESET" push button only if the associated tripping element is not picked up.

In the case of an auxiliary power supply failure the status of the targets is recorded to non-volatile memory. The status of the targets is maintained when auxiliary power is restored.

9. KEYBOARD OPERATION

All measurements, programmed settings, and recorded data may be accessed through the front panel. The five buttons are color-coded and their sequence of operation is indicated on the front panel by means of arrows directing the user to the next appropriate button to press. Figure 9.1 and Figure 9.2 give an overview of the keyboard operation.

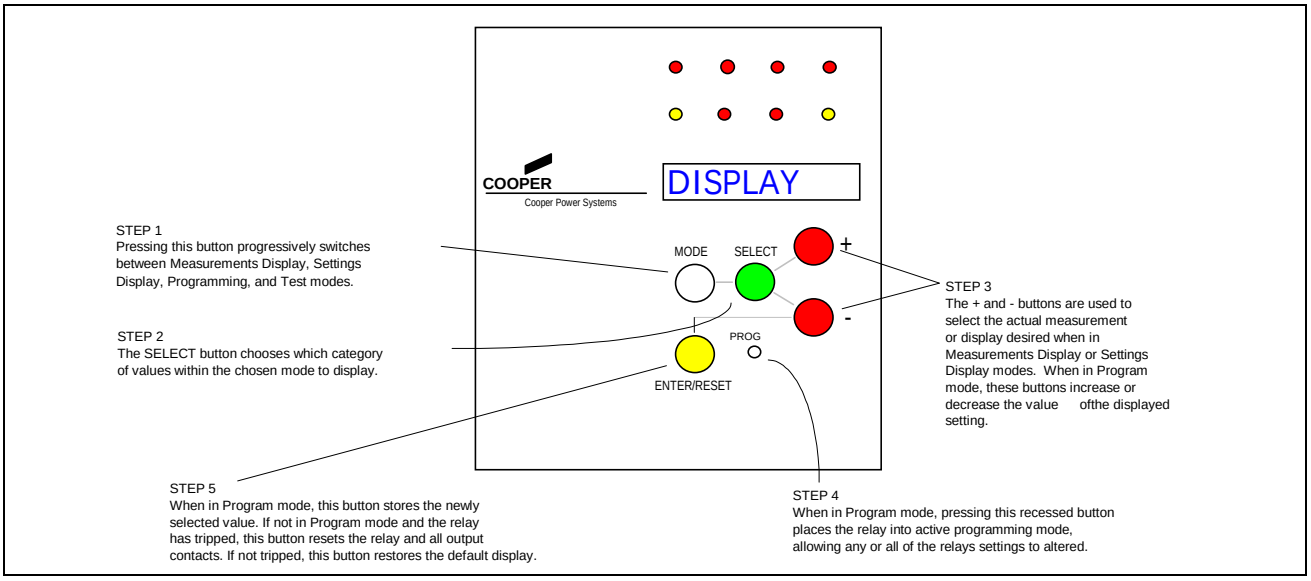


Figure 9.1: Keyboard Operation Overview

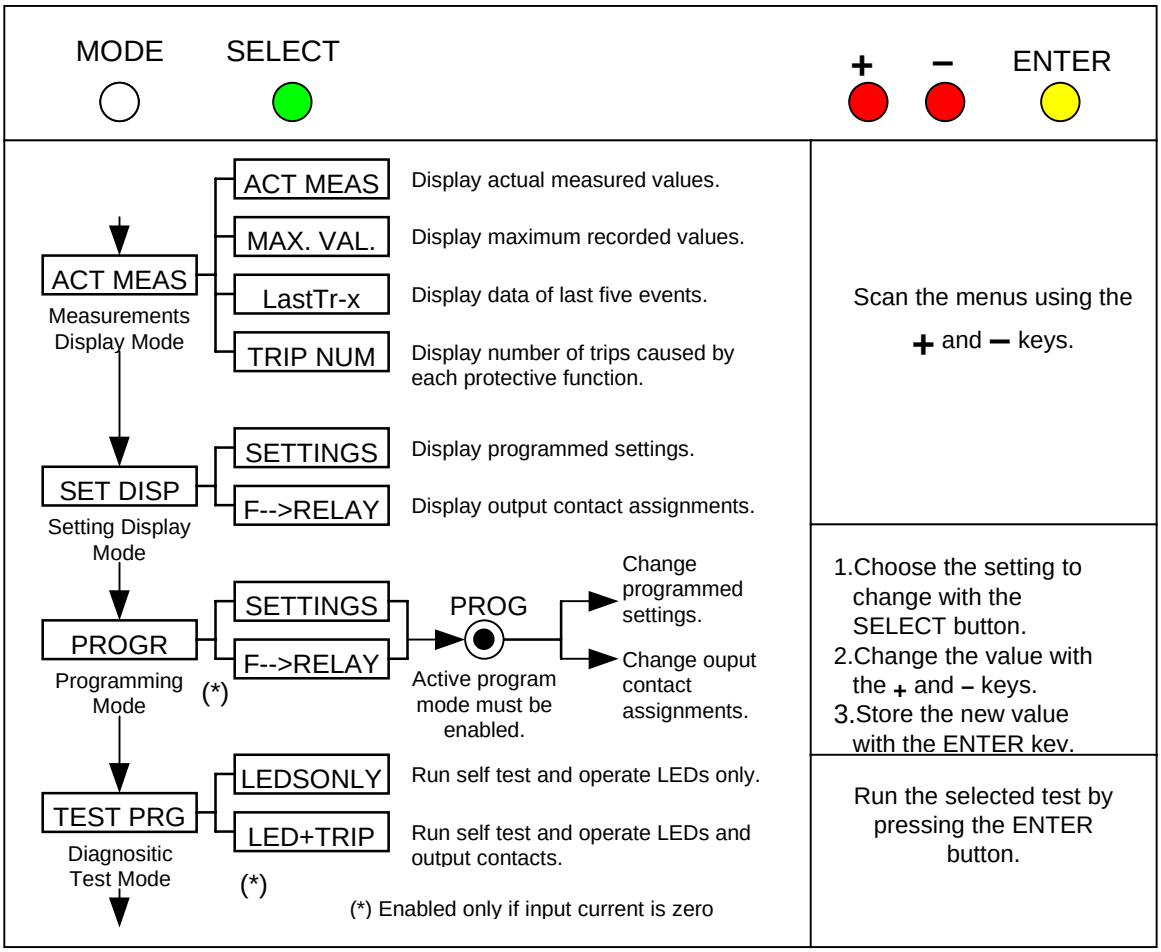


Figure 9.2: Keyboard Menu Structure

10. PROGRAMMING THE RELAY

Two programming modes are available. The first is the SETTINGS mode, where all of the input parameters (e.g., CT ratio, rated frequency) and settings (e.g., time dials, taps) are set. The second is the F➔Relay mode where the various output relays are assigned to the various protective elements. To enter the **PROGRAM** mode, follow these steps:

1. Make sure the input currents are all zero. As a security measure, the relay will not go into program mode when input quantities are not equal to zero. This prevents the settings from being altered while the relay is actively protecting the system. If it is necessary to make setting changes while the relay is in service, the use of the optional EdisonCom software is required.
2. Press the **MODE** button, to get into the **PROGRAM** mode.
3. Press the **SELECT** button to obtain either the **SETTINGS** or **F➔Relay** display.
4. Using a thin tool (e.g., a small screwdriver) press the recessed **PROG ENABLE** button. The **PROGRAM** LED will now be flashing, indicating that the **PROGRAM** mode has been successfully entered.

10.1 CHANGING A SETTING

Once you have entered into the active PROGRAM SETTINGS mode, relay settings may be changed. For instruction on changing the output relay assignments see the section titled Changing Output Relay Assignments. Change the settings as follows:

1. Press the SELECT button to scroll through the various input parameters available for programming.
2. When the desired parameter to be changed is displayed, press the + and – buttons to change the displayed value. For numerical values where the range of settings is large, the display may be sped up by pressing the SELECT button at the same time the + or – button is pressed.
3. When the desired value is displayed, press the ENTER/RESET button to store the new setting for that parameter.
4. Repeat steps 1 - 3 for each setting.

When finished, press the MODE button to leave the programming mode and return the relay to normal operation.

10.2 DESCRIPTION OF RELAY SETTING VARIABLES

Table 10.1 describes each variable in the PROGRAM SETTINGS mode. The following conventions are used:

The name of the variable and any unit of measure displayed (Volts, Hz, etc.) is in bold face type. Some variables do not have a unit of measure displayed. Examples of these are variables that define curve shapes.

The default value is shown in regular typeface.

For example:

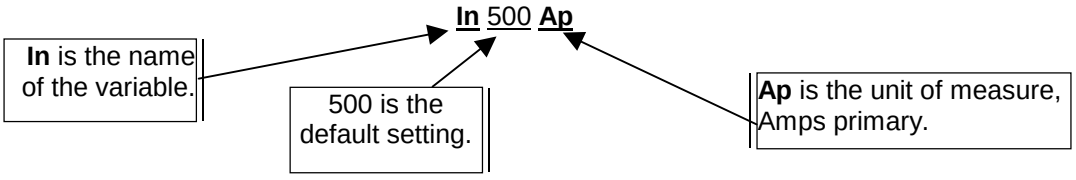


Table 10.1: Program Setting Variables

DISPLAY	DESCRIPTION	SETTING RANGE
NodAd 1	Modbus device address	1-250
Fn 50 **Hz**	System frequency	50 or 60 Hz
In 500**Ap**	Rated primary current of the phase CTs.	1 to 9999 in 1A steps
0n 500**Ap**	Rated primary current of the CT(s) supplying the zero sequence current	1 to 9999 in 1A steps
Uns 100**V**	Rated secondary voltage of the VTs (Phase-to-phase).	100V to 125V in 1V steps

DISPLAY	DESCRIPTION	SETTING RANGE
Ib .5**In**	Generator's rated current as pu of CTs rated current	(0.5-1.1)In in 0.1In steps
F(I>) D	Operating characteristic of the low-set phase time overcurrent element.	D Definite time delay SI US Standard Inverse
I> 1.0**Ib**	Tap (or pickup level) of the low-set phase overcurrent element in per unit of Ib.	Disable, or 1 to 2.5 in 0.01Ib steps
tI> 0.05**s**	*Definite time mode*: Trip time delay of the low-set phase overcurrent element *Inverse time mode*: Time delay at 5 times pickup	0.05 to 30.0 seconds 0.05 to 9.9 in 0.01 second steps 10.0 to 30.0 in 0.1 second steps
I>> 1**Ib**	Pickup level of the high-set phase overcurrent element in per unit of Ib.	Disable, or 1 to 12 Ib 1 to 9.9 in 0.1 Ib steps 10 to 12 in 1.0 Ib steps
tI>>0.05**s**	Time delay in seconds of the high-set phase overcurrent element.	0.05 to 3 seconds 0.05 to 0.99 in 0.01 second steps 1.0 to 3.0 in 0.1 second steps
0>.02**On**	Pickup level of earth fault element in per unit of the rated ground CT current, 0n.	Disable, or 0.02 to 0.4 in 0.01 0n steps
t0> .05**s**	Time delay of low-set earth fault element	0.05 to 30.0 seconds 0.05 to 9.99 in 0.01 second steps 10.0 to 30.0 in 0.1 second steps
1Is .05**Ib**	Maximum continuous negative sequence current rating of generator in per unit of Ib	Disable, or 0.05 to 0.5 in 0.01Ib steps
Ks 5**s**	Time delay of the I^2t time current curve	5 to 80 s in 1s steps
tc 10**s**	Cooling time for the negative sequence current to reduce to the generator's maximum continuous rating, 1Is.	10 to 1800 s in 1s steps
2Is .03**Ib**	Negative sequence current alarm level in per unit of the generator rated output, Ib.	Dis, or 0.03 to 1 in 0.01Ib steps.
t2Is 1**s**	Independent trip time delay of alarm element	1 to100 s in 1s steps
Ir> .02**In**	Reverse power trip level in per unit of the rated phase CT current, In.	Dis, or 0.02 to 0.2 in 0.01In steps
tIr 0.1**s**	Independent trip time delay of the reverse power element	0.1 to 60 seconds 0.1 to 9.99 in 0.01 second steps 10.0 to 60.0 in 0.1 second steps
αz270 **C**	Impedance characteristic angle (Max sensitivity direction)	0 to 330 in 30° steps
K1 300%**Zb**	Diameter of the mho circle characteristic for the under-impedance loss of field element	Dis, or 50 to 300% in 1%Zb steps
K2 50%**Zb**	Offset of the under-impedance mho circle (% of Zb=Vn/(•3 Ib) **Under-impedance trip is inhibited on undervoltage V<0.3Vn and under-current I<0.2Ib.**	5 to 50% in 1%Zb steps

DISPLAY	DESCRIPTION	SETTING RANGE
tz .2**s**	Time delay of the loss-of-field element	.2 to 60 s in 0.1 s steps
ti .0**s**	Integration time of the under-impedance element. To avoid non-operation in case of impedance swings the reset of the trip time delay (tZ) only takes place if the measured impedance remains outside the tripping zone for at least ti. **(ti) must always be shorter than (tz)**	0 to 10s in 0.1s steps
tBF .05**s**	Maximum reset time delay of the instantaneous elements after tripping of the time delayed elements and time delay for activation of the output relay associated with the breaker failure function	0.05 to 0.5 in 0.01second steps

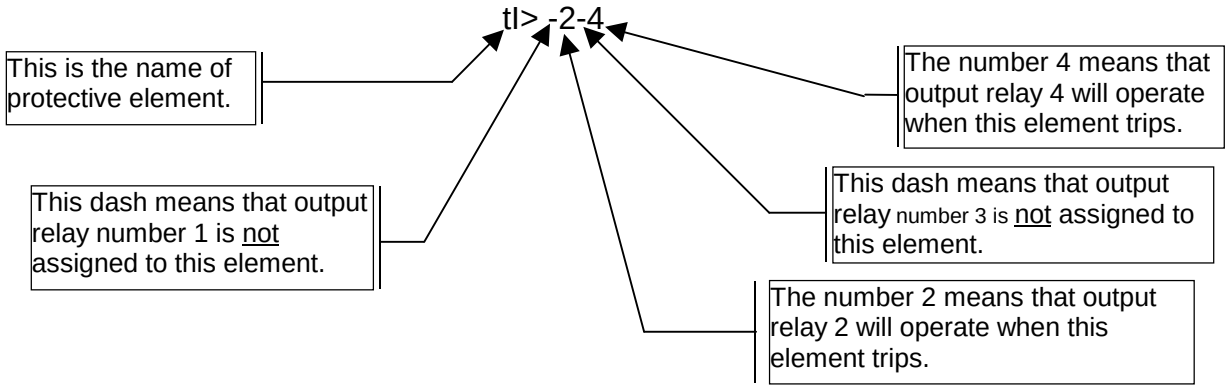
10.3 CHANGING OUTPUT RELAY ASSIGNMENTS

Output relays 1 through 4 may be assigned to any protective element, or any combination of elements. The only exception is that the relay cannot be assigned to both pick-up (start-time) elements, and time dependent protective elements.

1. First, enter the F➔Relay program mode.
2. Press the SELECT button to display the protective element for which the relay's assignments are to be made or changed.
3. Press the + key to select the output relay. Each press of the + key selects the next output relay. Once selected, the relay position blinks.
4. Press the - key to toggle whether the element is assigned to the output relay or not. If assigned, the output relay number appears. If not, only a hyphen (-) will be displayed.
5. Press the ENTER/RESET button to store the changes.
6. Repeat steps 1 through 5 for each protective element.

When finished, press the MODE button to leave programming mode and return the relay to normal operation.

For example:



10.4 DESCRIPTION OF OUTPUT RELAY VARIABLES

This section describes each variable in the PROGRAM, F➔Relay mode. The following conventions are used:

- The name of the variable is in bold face type.

- The default output relay settings are shown in regular typeface.

Table 10.2: Output Relay Programming Display Definitions

DISPLAY	DESCRIPTION
I> **--3-**	Pick-up (or start-time) element associated with the low-set phase overcurrent element.
tI> **1---**	Time delayed element associated with the low-set phase overcurrent element.
I>> **--3-**	Pick-up element associated with the high-set phase overcurrent element.
tI>> **1---**	Time delayed element associated with the high-set phase overcurrent element.
0> **--3-**	Instantaneous element associated with the low-set earth fault element.
t0> **1---**	Time delayed element assoaciated with the low-set earth fault element.
1Is **1---**	First negative sequence unbalance time-delayed element.
2Is **-2--**	Second negative sequence unbalance time-delayed element.
Ir> **1---**	Reverse power time-delayed element
Z< **1---**	Loss-of-field time-delayed element.
tBF **---4**	Breaker failure element.
TFRes: A	Reset after tripping of the relays associated with the time delayed elements (A) Automatically when current drops below trip level. (M) Manually by the operation of the "ENTER/RESET" key.
2= - - Ih - -	Blocking input (2) will block the time-delayed phase and ground overcurrent elements (Ih = tI>>;Il = tI>; I0 = t0>).
t2= OFF	Blocking input (2) can be programmed so that blocking of the elements lasts as long as the blocking input signal is present (t2=OFF) or so that, even with the blocking input still present, it only lasts for the set trip time delay of the function plus an additional time 2xtBF (t2=2xtBF)
3= **--**Ir	Assertion of input 3, blocks operation of the time delayed function (Z<) or (Ir>) or (Z<+Ir>)

10.5 PROGRAMMABLE BLOCKING VARIABLES

In addition to the output relay programming, the PROGRAM F➔Relay mode also provides access to setting four variables which determine which protective elements are affected by the various blocking inputs. Descriptions of these variable names, and their effects are found in Table 10.2

10.6 READING OF MEASUREMENTS AND RECORDED PARAMETERS

Enter the MODE "MEASURE", SELECT the menus "ACT.MEAS"-"MAX VAL"-"LASTTRIP"-
-"TRIP NUM", scroll available information by key "+" or "-".

10.6.1 ACT.MEAS

Actual values as measured during the normal operation. The values displayed are continuously refreshed.

Table 10.3: Actual Measurements Display

DISPLAY	DESCRIPTION
IAxxxxx**A**	R.M.S. value of the Phase A current display in primary Amps. : (0-99999).
IBxxxxx**A**	Same as above, Phase B.
ICxxxxx**A**	Same as above, Phase C.
I0xxxxx**A**	R.M.S. value of the ground current display in primary Amps. : (0-99999).
Usxxxxx**%**	R.M.S. value of voltage in % of the rated secondary voltage: (0-999)%.
I2xxx**%Ib**	R.M.S. Negative sequence current as a percentage of the generator's rated current Ib.
φxxxxx**°**	Phase displacement of I leading E: (0-360º counter clockwise).

10.6.2 MAX VAL

Highest values recorded starting from 100ms after closing of main Circuit Breaker.

Table 10.4: Maximum Values Display

DISPLAY	DESCRIPTION
IAxxxx**In**	Max. value of phase A current after the first 100 ms in per unit of the CT's rated current.
IBxxxx**In**	Same as above for Phase B.
ICxxxx**In**	Same as above for Phase C.
I_0xxxx**On**	Same as above for zero sequence current.
I_2xxxx%**Ib**	Max. value of negative sequence current after the first 100 ms in per unit of the generator's rated output.
Usxxxx%	Max. value of the input voltage after the first 100 ms in percent of the rated secondary voltage, UnS.
SAxxxx**In**	Max. phase A current during the first 100 ms.
SBxxxx**In**	Max. phase B current during the first 100 ms.
SCxxxx**In**	Max. phase C current during the first 100 ms.
S0xxxx**On**	Max. zero sequence current during the first 100 ms.
SUxxxx**%**	Max. input voltage during the first 100 ms.

10.6.3 EVENT RECORDING (LASTTRIP)

RECORDING OF THE LAST EVENT: Display of the function that caused the tripping of the relay plus values of the parameters at the moment of tripping. The memory buffer is refreshed at each new relay tripping. The last event is stored into the "first in, first out" (FIFO) memory.

Table 10.5: Last Trip Display

DISPLAY	DESCRIPTION
F:xxxxxx	Display of the function which caused the last tripping: **I>**; **I>>**; **Io>**; **1Is**; **2Is, Ir>, Z<**
IAxxxx**In**	Phase A current.
IBxxxx**In**	Phase B current.
ICxxxx**In**	Phase C current.
I0xxxx**On**	Zero sequence current.
I2xxx%**Ib**	Negative sequence current.
UsXXXX%	Input voltage

10.6.4 TRIP NUM

Counters of the number of operations for each of the relay functions.

Table 10.6: Trip Number Display

DISPLAY	DESCRIPTION
I>xxxx	Time delayed element of the low-set overcurrent level [tI>]
I>>xxxx	Time delayed element of the high-set overcurrent level [tI>>]
I0>xxxx	Time delayed element of ground fault element [tI0>]
1Isxxxx	Time delayed element of the first negative sequence overcurrent level
2Isxxxx	Time delayed element of the second negative sequence overcurrent level
Ir>xxxxx	Time delayed element of reverse power
Z<xxxxx	Time delayed element of loss of field element

11. PROTECTION ELEMENTS

Most of the IM30-G's settings are based on the nominal voltage and current inputs and the generator's rated output. This makes it convenient to relate the setting to the actual machine rating.

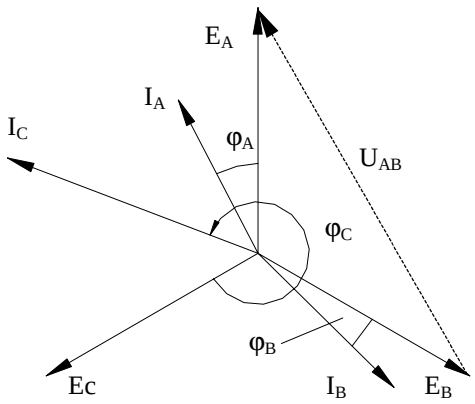
11.1 PHASE ANGLE MEASUREMENTS:

IM30-G measures the phase angle between the phase-to-phase voltage 'A-B' and phase A, B, and C currents. The phase angle displacement is then calculated as follows:

$\varphi_A = \varphi(U_{A\text{-}B,} I_A) + 30°$

$\varphi_B = \varphi(U_{A\text{-}B,} I_B) + 150°$

$\varphi_C = \varphi(U_{A\text{-}B,} I_C) - 90°$



11.2 REVERSE POWER (32):

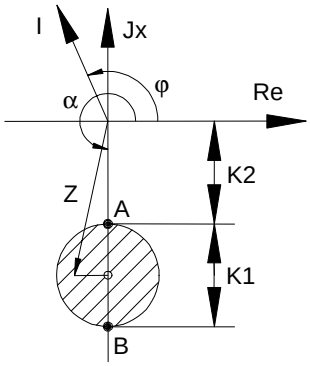
IM30-G measures the 'C' phase current and calculates its active component, Ic Cos (φ_C - 180°). The calculated quantity is then compared against the setpoint, Ir. The setting range for Ir is 2-20% of the current transformer's rated current, In. tIr is the timer associated with the reverse power element.

ELEMENT	DESCRIPTION	SETTING RANGE
Ir> .02**In**	Reverse power trip level.	Dis, or 0.02 to 0.2 in 0.01In steps
tIr> 0.1**s**	Independent trip time delay of the reverse power element	0.1 – 60 seconds (0.1 to 9.9 in 0.01s steps, 10.0 to 60 in 0.1s steps)

11.3 LOSS-OF-FIELD (40):

IM30-G calculates the capacitive impedance for phase 'A'. If the calculated impedance falls within the trip zone, the underimpedance element, Z<, picksup and starts the tz timer. Reset of timer tz takes place if the calculated impedance, Z stays outside the trip zone for a minimum of ti timer setting. Set ti less than tz to insure proper reset of the tz timer.

The loss-of-field element is supervised by an undervoltage and an undercurrent element. Its operation is inhibited if the voltage falls below 30% of nominal or if the measured current drops blow 20% of the generator's rated output.



K1 and K2 settings define the diameter and offset of the mho circle for the trip zone respectively. Both settings are in per unit of the generator's rated impedance, Zb.

Generator's rated impedance: $$Zb = \frac{UnS}{I_b\sqrt{3}}$$

Calculated impedance: $$Z\alpha = \frac{E}{I\cos(\varphi - \alpha^\circ)}$$

E: Phase A voltage

I: Phase A current

φ: Displacement angle

α: Impedance angle; Set at 270° for highest sensitivity during a complete loss-of-field condition

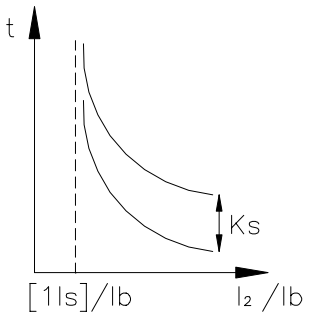
ELEMENT	DESCRIPTION	SETTING RANGE
αz270 **C**	Impedance characteristic angle (Max sensitivity direction)	0 to 330 in 30° steps
K1 300%**Zb**	Diameter of the mho circle characteristic for the under-impedance loss of field element	Dis, or 50 to 300% in 1%Zb steps
K2 50%**Zb**	Offset of the under-impedance mho circle	5 to 50% in 1%Zb steps
tz 0.2**s**	Time delay of the loss-of-field element	.2 to 60 s in 0.1 s steps
ti .0**s**	Time required for the loss-of-field element to remain unasserted before timer tz resets. Timer ti has to be set less than tz.	0 to 10s in 0.1s steps

11.4 NEGATIVE SEQUENCE (46):

Two independent negative sequence elements are provided. One I_2^2t element and one definite-time element.

11.4.1 I_2^2t element:

The I_2^2t element starts accumulating when the measured negative sequence current exceeds the continuous negative sequence rating setpoint, 1Is. Time-to-trip for the I_2^2t element is calculated per equation (1).



Once the measured negative sequence current drops below the continuous setpoint, 1Is, the time-to-trip timer starts to decrement. The rate of decrease is dependent on the Cooling Time setpoint, tc. The Cooling Time setting defines the time required for the I_2^2t timer to reset to zero from its trip point. Cooling time is defined by equation (2).

The following settings are associated with the I_2^2t element:

1Is: Generator's continuous I_2 rating.

Ks: Permissible generator I_2^2t.

Time-to-trip: $$t = \frac{Ks}{\left(\frac{I_2}{I_b}\right)^2} \quad (1)$$

Cooling time: $$t = \frac{tc}{Ks}\left(\frac{I_2}{I_b}\right)^2 \quad (2)$$

ELEMENT	DESCRIPTION	SETTING RANGE
1Is 0.05**Ib**	Maximum continuous negative sequence current rating of generator in per unit of Ib	Disable, or 0.05 to 0.5 in 0.01Ib steps
Ks 5**s**	Time delay of the I^2t time current curve	5 to 80 s in 1s steps
tc 10**s**	Cooling time for the negative sequence current.	10 to 1800 s in 1s steps

11.4.2 Definite-time Element:

One definite-time negative sequence overcurrent element with its independent timer is provided.

ELEMENT	DESCRIPTION	SETTING RANGE
2Is .03**Ib**	Negative sequence current alarm level	Dis, or 0.03 to 1.0 in 0.01Ib steps.
t2Is 1**s**	Independent trip time delay of alarm element	1 to100 s in 1s steps

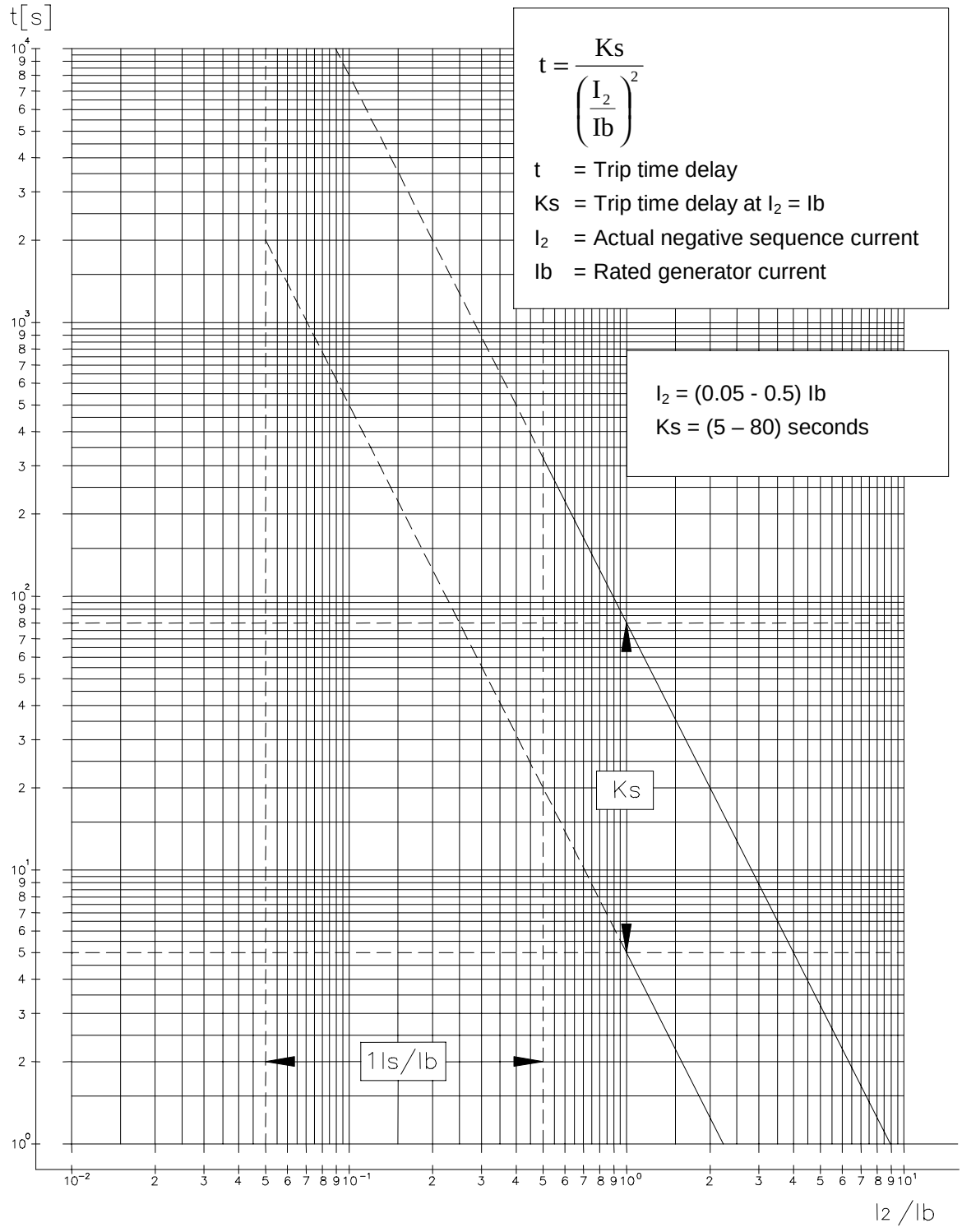


Figure 11.1: IM30-G I_2^2t Element

11.5 PHASE OVERCURRENT PROTECTION (50/51):

Two overcurrent elements are provided in the IM30-G.

11.5.1 Low-set Overcurrent Element:

The low-set overcurrent element, F(I>), can be setup with either a definite-time or inverse characteristic. The tI> setting determines the time delay for the low-set overcurrent element. For the inverse characteristic, tI> setting specifies the point on the curve at five times the pickup.

Trip time delay for the inverse characteristic (**F(I>) = SI**):

$$t = \frac{0.033 \times tI>}{\left(\frac{I}{I>}\right)^{0.02} - 1}$$

Where I> = Pickup setting for the low-set overcurrent element

tI> = Time delay setting for the low-set overcurrent element

ELEMENT	DESCRIPTION	SETTING RANGE
F(I>) D	Operating characteristic of the low-set (time overcurrent) phase overcurrent element.	D Definite time delay SI US Standard Inverse
I> 1.0**Ib**	Tap (or pickup level) of the low-set phase overcurrent element in per unit of Ib.	Disable, or 1 to 2.5 in 0.01Ib steps
tI> 0.05**s**	*Definite time mode*: Trip time delay of the low-set phase overcurrent element *Inverse time mode*: Time delay at 5 times pickup	0.05 to 30.0 seconds 0.05 to 9.9 in 0.01 second steps 10.0 to 30 in 0.1 second steps

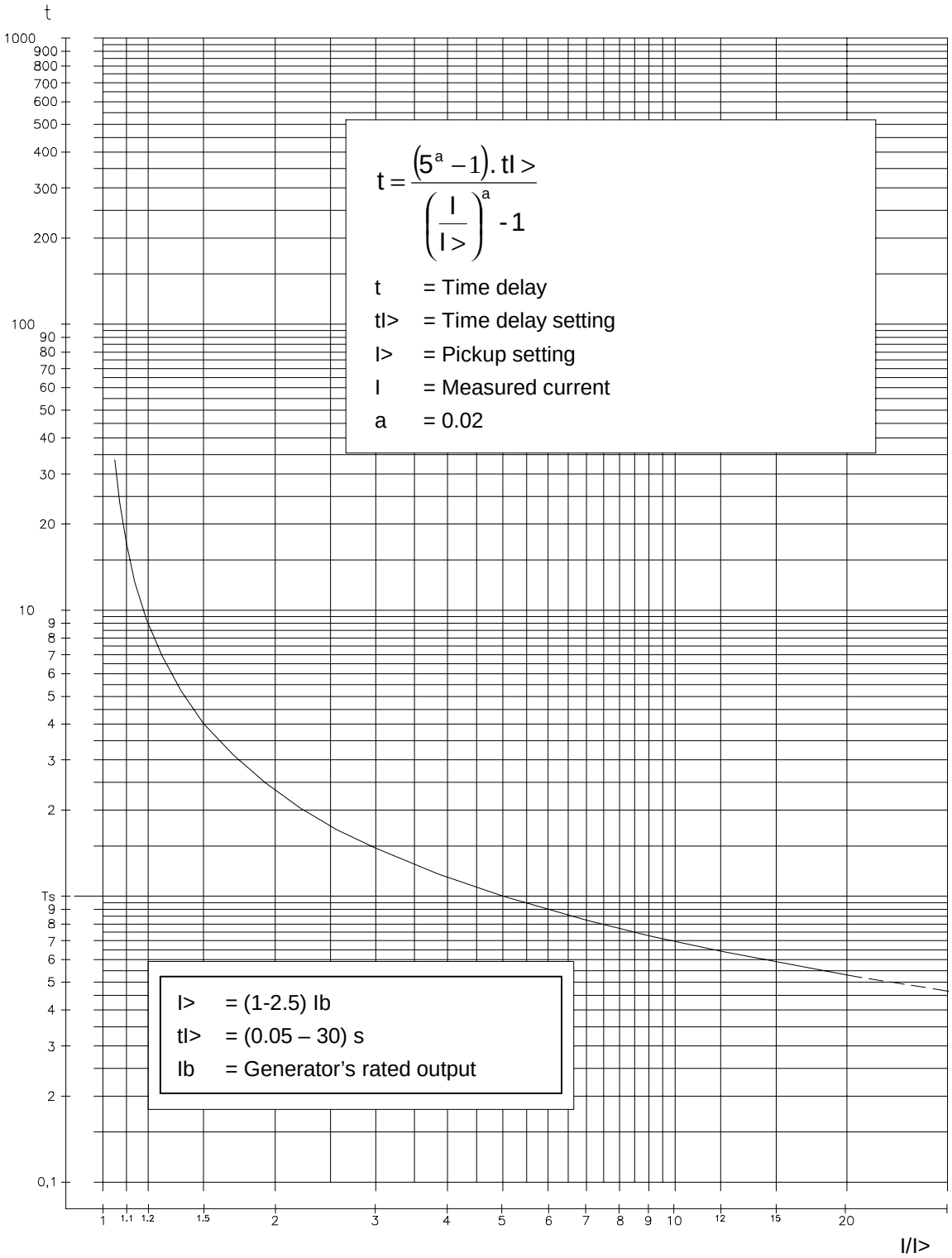


Figure 11.2: IM30-G Standard Inverse Time Overcurrent Curve-51

11.5.2 High-set Overcurrent Element:

The high-set overcurrent element, I>>, is a definite-time element with an independent timer (tI>>). This element can be used for instantaneous overcurrent protection, overload protection, or overload alarm.

ELEMENT	DESCRIPTION	SETTING RANGE
I>> 1**Ib**	Pickup level of the high-set-phase overcurrent element in per unit of Ib.	Disable, or 1 to 12 1 to 9.9 in 0.1Ib steps 10 to 12 in 1.0Ib steps
tI>>0.05**s**	Time delay of the high-set phase overcurrent element.	0.05 to 3 seconds 0.05 to 0.99 in 0.01 second steps 1.0 to 3.0 in 0.1 second steps

11.6 STATOR GROUND FAULT PROTECTION (50/51G)

An instantaneous and a definite time overcurrent element provide ground fault protection for the stator winding.

DISPLAY	DESCRIPTION	SETTING RANGE
On 500**Ap**	Rated primary current of the CT(s) supplying the zero sequence current	1 to 9999 in 1A steps
O>.02**On**	Pickup level of earth fault element in per unit of the rated ground CT current, 0n.	Disable, or 0.02 to 0.4 in 0.01 On steps
tO> .05**s**	Time delay of low-set earth fault element	0.05 to 30.0 seconds 0.05 to 9.99 in 0.01 second steps 10.0 to 30.0 in 0.1 second steps

12. SERIAL COMMUNICATION

All the operations that can be performed locally (for example reading of measured data and changing of relay's settings) are also possible via the serial communication interface. The unit has a RS485 interface that can be connected either directly to a P.C. via a dedicated cable or to a RS485 serial bus. Therefore, many relays can exchange data with a single master P.C. using the same physical serial line. An optional RS485/232 converter is available.

The communication protocol is MODBUS RTU, but only functions 3, 4 and 16 are implemented. Each relay is identified by its programmable address code (NodAd) and can be called from the P.C. Dedicated communication software EdisonCom for Windows 3.11 and Windows 95 is available. Please refer to the EdisonCom instruction manual for more information. A separate Modbus communication reference manual is available. Request reference bulletin R150-05-3.

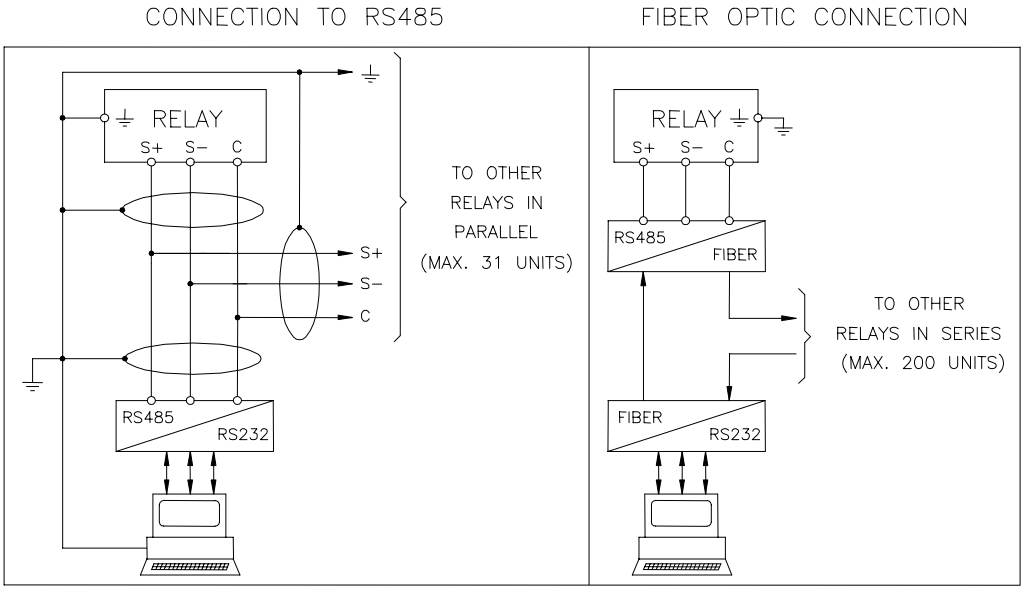


Figure 12.1: Serial Communication Wiring

13. TEST

Besides the normal "WATCHDOG" and "POWERFAIL" functions, a comprehensive program of self-test and self-diagnostic provides:

Diagnostic and functional test: This checks the program routines and the memory's content. This runs every time the auxiliary power is switched-on. The display shows the type of relay and its version Number.

Dynamic functional test: This runs during the normal operation of the relay every 15-min. The relay is disabled for less than 10 ms. If an internal fault is detected, the display shows a fault message, the LED "**PROG/IRF**" illuminates and the relay R5 is de-energized.

Complete test: This may be activated by the keyboard or via the communication bus either with or without tripping of the output relays. The output relay assigned to reclosing is not energized during this test.

14. RUNNING THE TEST PROGRAMS

14.1 MODE "TESTPROG" SUBPROGRAM "W/O TRIP"

Operation of the yellow key activates a complete test of the electronics and the process routines.

All the LEDs are lit and the display shows (TEST RUN).

If the test routine is successfully completed, the display switches-over to the default reading (xx:xx:xx).

If an internal fault is detected, the display shows the fault identification code and the relay R5 is de-energized. This test can be carried-out even during the operation of the relay without affecting the relay tripping in the event that a fault occurs during the test itself.

14.2 MODE "TESTPROG" SUBPROGRAM "WITHTRIP"

Access to this program is enabled only if the current detected is zero (breaker open).

After pressing the yellow key, the display shows "TEST RUN?". A second operation of the yellow key starts a complete test, which includes the activation of all of the output relays.

The display shows (TEST RUN) with the same procedure as for the test with W/O TRIP.

Every 15 minutes during the normal operation, the relay automatically initiates an auto test procedure (duration ≤ 10ms). If an internal fault is detected during the auto test, the relay R5 is de-energized, and he relevant LED is activated with the applicable fault code displayed.

I

⚠ CAUTION

Running the **LED+TRIP** test will operate all of the output relays. Care must be taken to ensure that no unexpected or harmful equipment operations will occur as a result of running this test. It is generally recommended that this test be run only when all dangerous output connections are removed.

15. SPECIFICATIONS

- Reference standards — IEC 255, IEC1000; IEEE C37; CE Directive
- Dielectric test voltage — IEC 255-5: ..... 2kV, 1 min.
- Impulse test voltage — IEC 255-5 ..... :5kV (c.m.), 2 kV (d.m.) - 1,2/50 s
- HF disturbance test with damped oscillatory wave (1MHz burst test) — IEC255-22-1 class 3 ..... :2.5kV (m.c.), 1kV (d.m.)
- Electrostatic discharge test — IEC1000-4-2 level 4 ..... :15 kV
- Conducted disturbances immunity test — IEC1000-4-6 level 3 ..... :0.15-80MHz, 10V/m
- Radiated electromagnetic field immunity test — IEC1000-4-3 level 3 ..... :80-1000MHz, 10V/m
- Electrical fast transient/burst 2kV, 5kHz, 15/300ms (d.m.) — IEC1000-4-4 level 4 ..... :4kV, 2.5kHz, 15/300ms (c.m.)
- Surge immunity test — IEC1000-4-5 level 4 ..... :4kV(c.m.), 2kV(d.m.)
- Oscillatory waves (Ring waves) — IEC1000-4-12 level 4 ..... :4kV(c.m.), 2kV(d.m.)
- Power frequency magnetic test — IEC1000-4-8 ..... :1000A/m
- Pulse magnetic field — IEC1000-4-9 ..... :1000A/m, 8/20 s
- Damped oscillatory magnetic field — IEC1000-4-10 ..... :1000A/m, 0.1-1MHz
- Immunity test for voltage dips, short interruptions and voltage variations — IEC1000-4-11
- HF inducted voltage — IEC1000-4-1 A.2.6 level 4 ..... :100V, 0.01-1MHz

CE EMC Compatibility:

- Electromagnetic emission EN50081-2
- Radiated electromagnetic disturbance test EN50082-2

- Resistance to vibration and shocks IEC255-21-1, IEC255-21-2

- Accuracy at reference value of ..... 1% In; 0.1% On for protection element pickup
  influencing factors ..... +/- 10ms for timing accuracy
- Rated input current ..... In = 1 or 5A, On = 1 or 5A
- Current overload ..... 200A for 1 sec; 10A continuos
- Burden on current inputs ..... Phase : 0.01VA at In = 1A; 0.2VA at In = 5A
  ..... 0.02VA at On = 1A; 0.4VA at On = 5A
- Rated Voltage ..... Un = 100V (different on request)
- Voltage overload ..... 2 Un continuous
- Burden on voltage input ..... 0.04 VA at Un
- Average power supply consumption ..... 8.5 VA
- Output relays ..... rating 5 A; Vn = 380 V
  ..... A.C. resistive switching = 1100W (380V max)
  ..... make = 30 A (peak) 0.5 sec.
  ..... break = 0.3 A, 110 Vcc,
  ..... L/R = 40 ms (100.000 op.)
- Operating Temperature Range ..... -20°C / +60°C at 95% humidity
- Storage temperature ..... -30°C / +80°C
- PC Board Connectors ..... Gold plated, 10A continuous, 200A 1 sec.
- Weight (in single relay case) 2.3kg (5.0lbs)

16. IM30-G SETTING SHEET

IM30-G SETTING SHEET PAGE 1 OF 3

Variable	Factory default	Units	Description	Range	Step	Setting
NodAd	1	--	Modbus device Address	1-250	1	
Fn	60	Hz	System frequency	50 or 60 Hz		
In	500	Ap	Rated primary current of the phase CTs.	1 to 9999	1A	
On	500	Ap	Rated primary current of the CTs. or of the tore CT supplying the zero sequence current	1 to 9999	1A	
Uns	100	V	Rated secondary voltage of the VTs (Phase-to-phase).	100V to 125V	1V	
Ib	0.5	pu In	Generator's rated current as pu of CTs rated current	(0.5-1.1)In	0.1	
F(I>)	D		Operating characteristic of the low set phase overcurrent element. D Definite SI US Standard Inverse	D, SI		
I>	1.0	pu Ib	Tap (or pickup level) of the low set phase overcurrent element in per unit of Ib.	Disable, or (1 to 2.5)Ib	.01	
tI>	0.5	s	*Definite time mode*: Trip time delay of the low-set phase overcurrent *Inverse time mode*: Time delay at 5X pickup	0.05 – 30.0s	.01s	
I>>	3	pu Ib	Pickup level of the high set phase overcurrent element in per unit of Ib.	Disable, or (1 to 9.9)Ib	0.1	
tI>>	0.05	s	Time delay in seconds of the high set phase overcurrent element.	0.05 to 3s	0.01	
O>	.02	On	Pickup level of earth fault element in per unit On of the rated current of the CTs. for zero sequence detection	Disabled or 0.02 to 0.4	0.01	
tO>	.05	s	Time delay of low set earth fault element	Disabled or 0.05 to 30.0	0.01	
1Is	0.5	pu Ib	Maximum continuous negative sequence current rating of generator in per unit of Ib	Disable, or (0.05 to 0.5)Ib	0.01	
Ks	5	s	Time delay of the I^2t time current curve	5 to 80s	1	

Variable	Factory default	Units	Description	Range	Step	Setting
tc	10	s	Cooling time for the negative sequence current to reduce to the generator's maximum continuous rating, 1Is.	10 to 1800s	1s	
2Is	.03	pu Ib	Negative sequence current alarm level	Dis, or (0.03 to 0.5)Ib.	0.01Ib	
t2Is	1	s	Independent trip time delay of alarm element	1 to100s	1s	
Ir>	.02	pu In	Reverse power trip level.	Dis, or 0.02 to 0.2	0.01In	
tIr>	0.1	s	Independent trip time delay of the reverse power element	0.1 - 60s	.01s	
αz270 **C**	270	C	Impedance characteristic angle (Max sensitivity direction)	0 to 330	30°	
K1	300	%Zb	Diameter of the mho circle characteristic for the under-impedance loss of field element	Dis, or 50 to 300%Zb	1%	
K2	50	%Zb	Offset of the under-impedance mho circle (% of Zb=Vn/(•3 Ib) **Under-impedance trip is inhibited on undervoltage V<0.3Vn and under- current I<0.2Ib.**	5 to 50%Zb	1%	
tz	0.2	s	Time delay of under-impedance element	.2 to 60 s	0.1s	
ti	0	s	Integration time of under-impedance element. **(ti) must always be shorter than (tz)**	0 to 10s	0.1s	
tBF	0.05	s	Maximum reset time delay of the instantaneous elements after tripping of the time delayed elements and time delay for activation of the output relay associated with the breaker failure function	0.05s to 0.5s	0.01s	

OUTPUT RELAY PROGRAMMING ASSIGNMENTS (ACCESSIBLE VIA THE F➔Relay PROGRAM MODE.)					
Variable	**Factory default**	**Units**	**Description**	**Range**	**Setting**
I>	- - 3 -	Outputs	Low-set overcurrent pickup element.	1 2 3 4	
tI>	1 - - -	Outputs	Low-set overcurrent time delayed element	1 2 3 4	
I>>	- - 3 -	Outputs	High-set overcurrent pickup element.	1 2 3 4	
tI>>	1 - - -	Outputs	High-set overcurrent time delayed element	1 2 3 4	
0>	- - 3 -	Outputs	Ground overcurrent pickup element.	1 2 3 4	

OUTPUT RELAY PROGRAMMING ASSIGNMENTS (ACCESSIBLE VIA THE F➔Relay PROGRAM MODE.)					
Variable	**Factory default**	**Units**	**Description**	**Range**	**Setting**
t0>	1 - - -	Outputs	Ground overcurrent time delayed element	1 2 3 4	
1IS	1 - - -	Outputs	Negative Sequence I_2^2t time delayed element	1 2 3 4	
2IS	- 2 - -	Outputs	Negative Sequence definite time element	1 2 3 4	
Ir>	1 - - -	Outputs	Reverse power time delayed element	1 2 3 4	
Z<	1 - - -	Outputs	Loss-of-field time delayed element	1 2 3 4	
tBF	- - - 4	Outputs	Breaker failure element	1 2 3 4	
tFRes:	A	---	Reset after tripping of the relays associated with the time delayed elements (A) Automatically when current drops below trip level. (M) Manually by the operation of the "ENTER/RESET" key.	A, M	
2:	- - Ih - -		Assertion of input 2 (terminals 1-2) blocks operation of the selected phase and ground overcurrent elements (tI>=Il, tI>>=Ih, t0>=I0)	Il, Ih, I0	
t2	OFF		Blocking input (2) can be programmed so that blocking of the elements lasts as long as the blocking input signal is present (t2=OFF) or so that, even with the blocking input still present, it only lasts for the set trip time delay of the function plus an additional time 2xtBF (t2=2xtBF)	OFF, 2tBF	
3:	- - - Ir		Assertion of input D3 (terminals 1-3) blocks operation of the selected function(s) (Z<) or (Ir>) or (Z<+Ir>)	Z<, Ir>	

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