Operations Manual

COOPER Power Systems

Electrical Apparatus

IM3G-V Generator Protection Relay

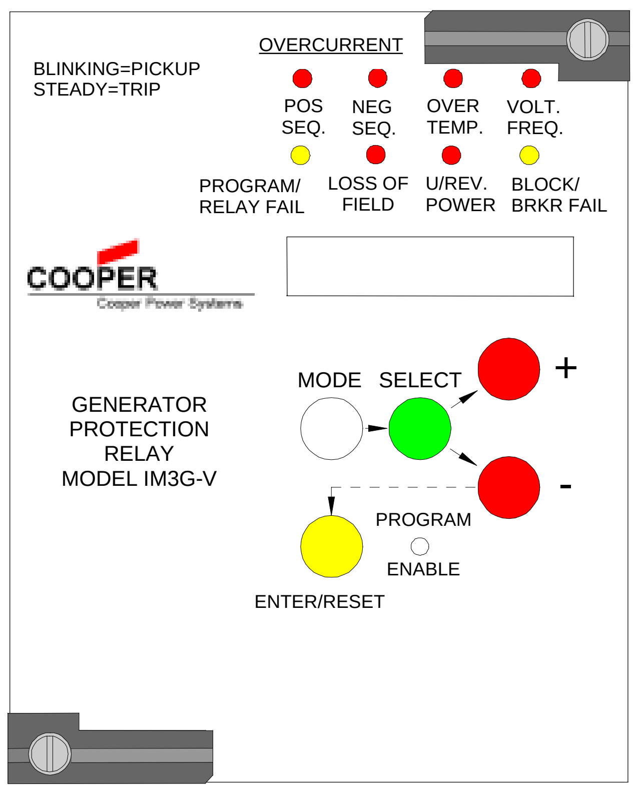
S150-51-1

MULTIFUNCTION MICROPROCESSOR GENERATOR PROTECTION RELAY

TYPE

IM3G-V

OPERATIONS MANUAL



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 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 IM3G-V is ideally suited for the protection of small generators, or as the core of a protection package for medium or large generators. The IM3G-V provides all of the basic protective functions required for generator protection. Three 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 IM3G-V are:

- Undervoltage (27).
- Reverse Power (32).
- Underpower (37).
- Loss of Field (40).
- Negative sequence overcurrent (46).
- Stator Thermal Imaging (49)
- Time and instantaneous phase overcurrent (50/51) with or without Voltage Restraint.
- Overvoltage (59)
- Two Frequency elements (81)

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.

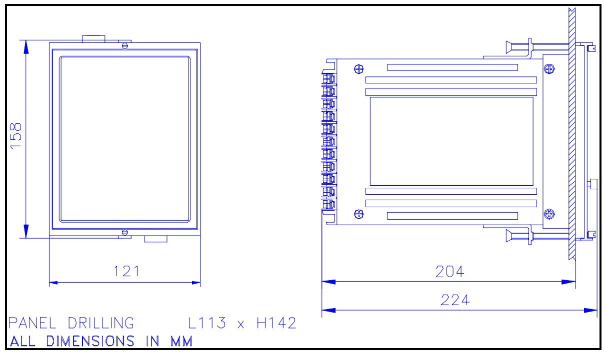


Figure 3.1: Single Module Enclosure Mounting

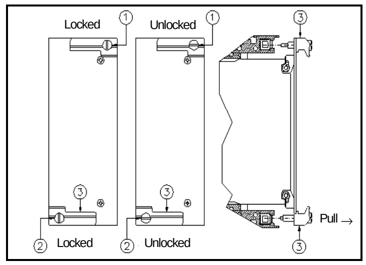


Figure 3.2: Latch Mechanism for Removal of Relay from Case

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.

Phase-to-neutral voltages are supplied to three potential transformers 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 mm^2), or FASTON connectors. Electrical connections must be made in accordance with the relay's wiring connection diagram shown in Figure 4.2.

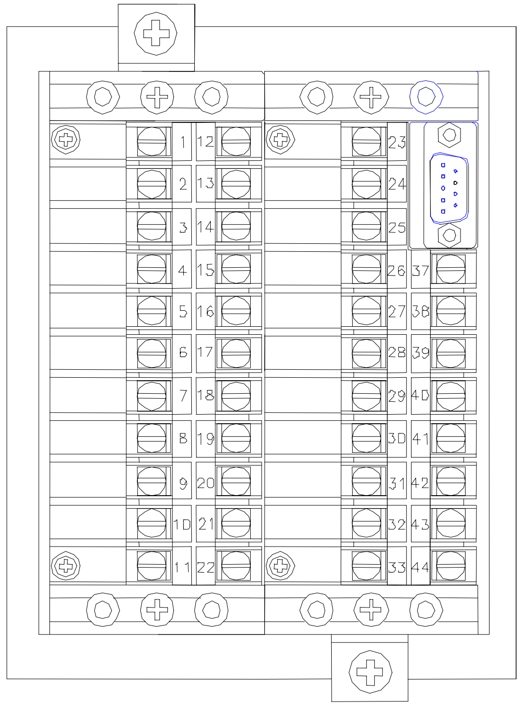


Figure 4.1: Rear View of Terminal Connections

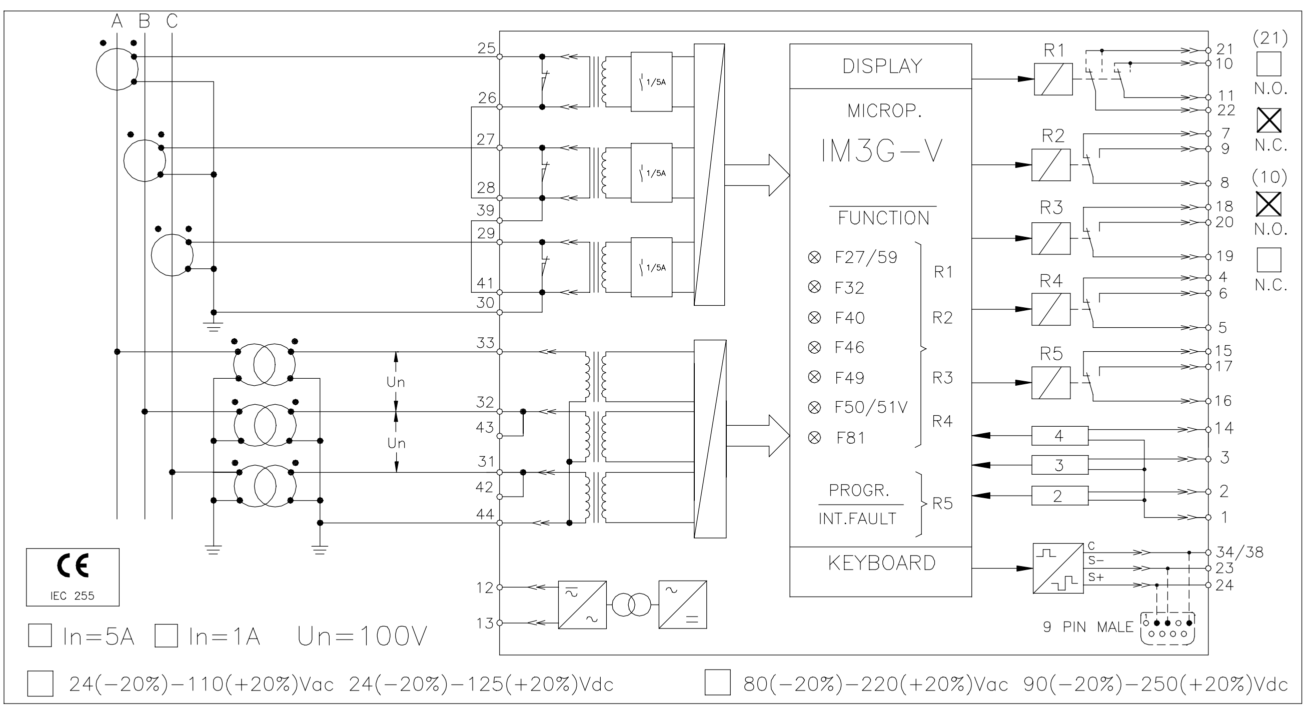


Figure 4.2: Wiring Diagram for the IM3G-V

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).

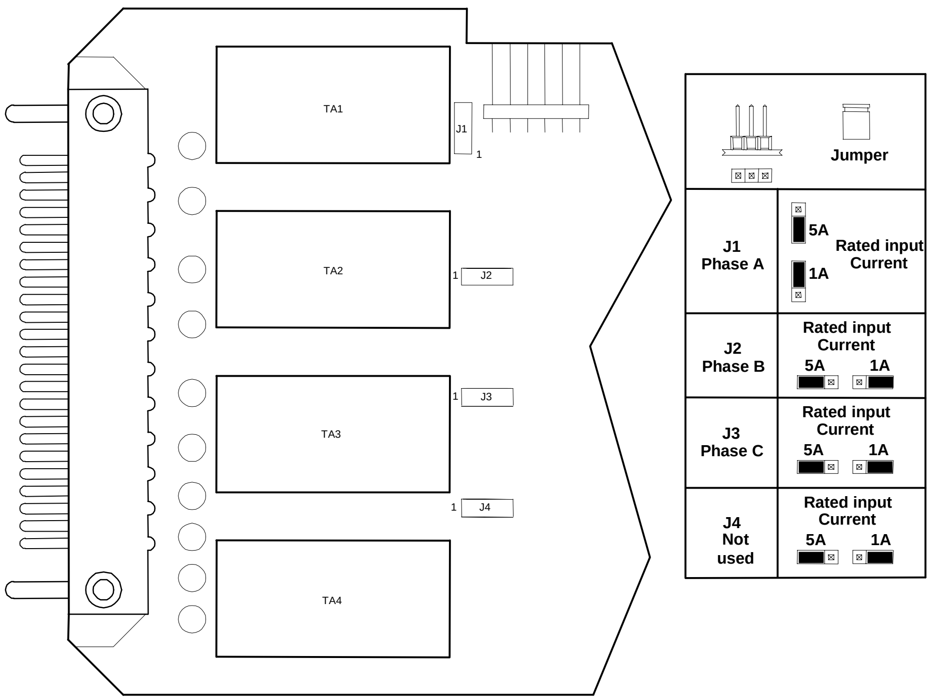


Figure 5.1: Rated Secondary Input Current Selection

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 IM3GV'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> t1u, …) 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

IM3G-V has three digital blocking inputs D2, D3, and D4. The PROGRAM F➔Relay mode provides access to setting four variables that determine which protective elements are affected by the three blocking inputs. Descriptions of these variable names, and their effects are found in Table 7.1

Table 7.1: Blocking Input Setting Variables

2=	I>>	Assertion of input D2 (terminals 1-2) blocks operation of the time delayed elements for the selected phase overcurrent elements (I> and/or I>>).
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 D3 (terminals 1-3) blocks operation of the time delayed elements associated with the selected function(s) (Z<) or (Ir>) or (Z<+Ir>). Blocking of the selected functions will last as long as the blocking input is active.
4=	1--2**--**	Assertion of input D4 (terminals 1-14) blocks operation of one or more of the functions 1U, 2U, 1f, and 2f in any possible combination. Blocking of the selected functions will last as long as the blocking input is active.

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 IM3G-V 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 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.

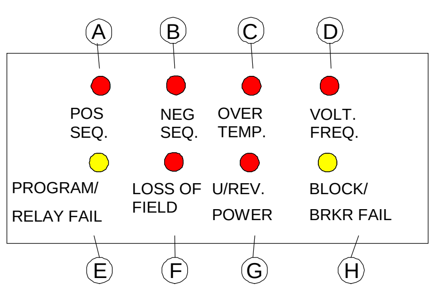


Figure 8.1: IM3G-V Front Panel Targets

Table 8.1: Target Description

TARGET ID	COLOR	LEGEND	DESCRIPTION
A	Red	Positive Sequence (POS SEQ.)	Flashing when measured current exceeds the set trip 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	Over Temperature (OVER TEMP.)	Flashing when the thermal image's temperature exceeds the prealarm temperature [Ta]. Illuminated when the temperature exceeds the trip level.
D	Red	Voltage and Frequency (VOLT. FREQ.)	Flashing during the trip time delay of any over/under voltage element [1U, 2U] or any ovr/under frequency element [1f, 2f]. Illuminated on trip at the end of the corresponding time delay.
E	Yellow	PROGRAM/ RELAY FAIL	Flashing when the relay is in programming mode. Constantly illuminated in case of an Internal Relay Failure.
F	Red	Loss of Field	Flashing during the trip time delay of the function [Zc<]. Illuminated on trip after expiration of the trip time delay [tz>].
G	Red	U/REV. Power	Flashing during the trip time delay of the functions [W< or Ir>]. Illuminated at the end of the time delay of either [W< or Ir>].
H	Yellow	BLOCK/ BRKR FAIL	Flashing when a blocking signal is present at the relevant input terminals. Illuminated when the Breaker Failure function operates.

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.

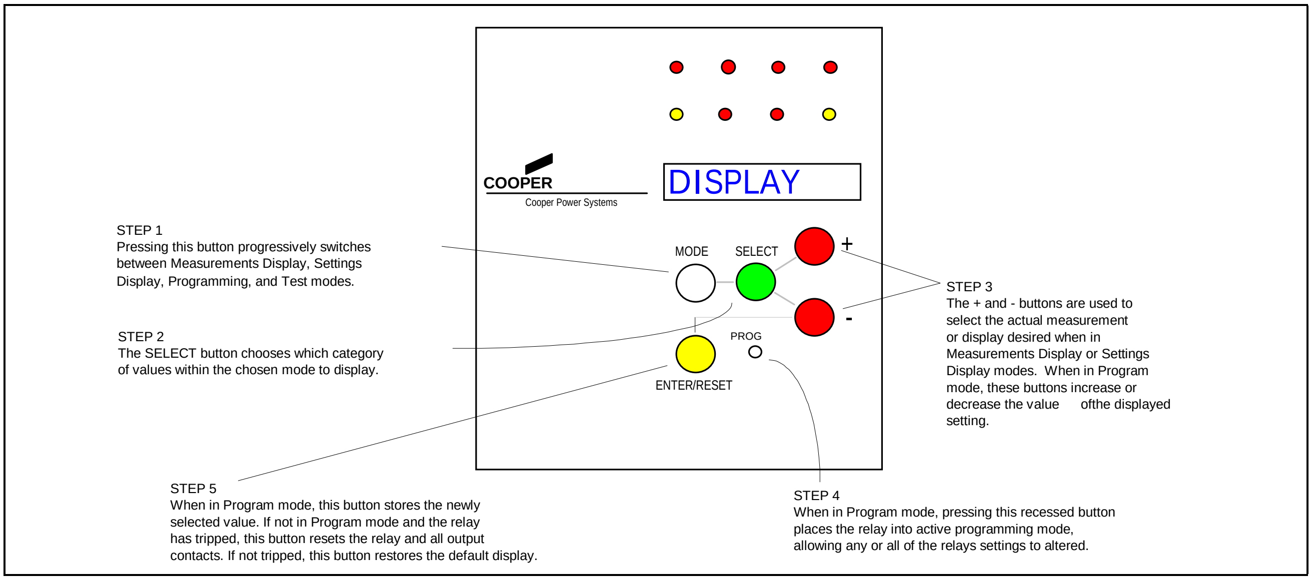


Figure 9.1: Keyboard Operation Overview

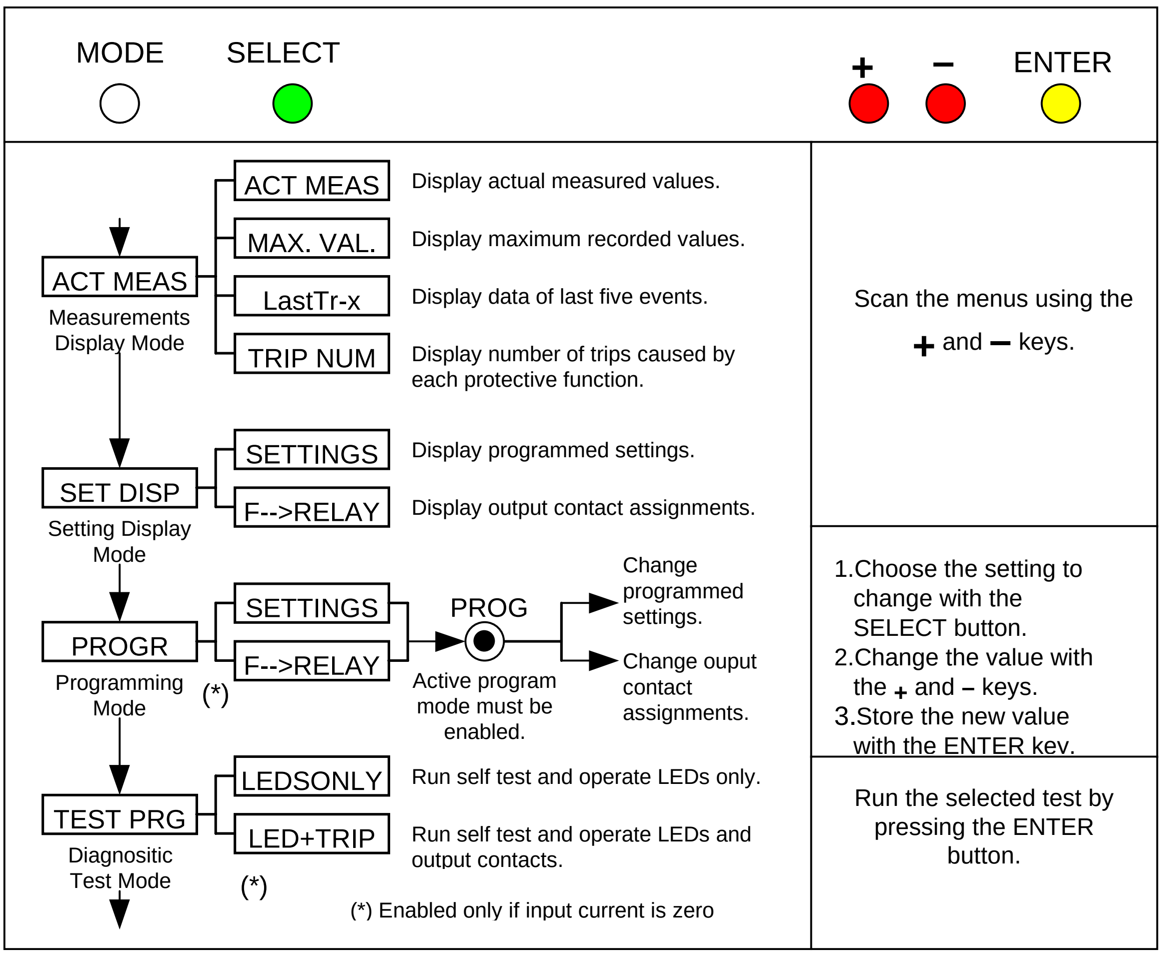


Figure 9.2: Keyboard Menu Structure

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:

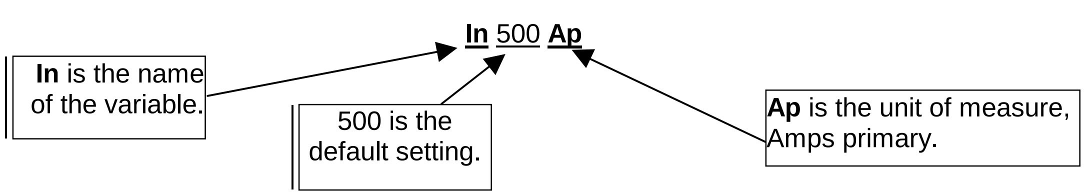


Table 10.1: Program Setting Variables

DISPLAY	DESCRIPTION	SETTING RANGE
NodAd	10.2.1.1 Modbus device address	1-254
Fn 60 **Hz**	10.2.1.2 System frequency	50 or 60 Hz
In 500**Ap**	Rated primary current of the phase CTs.	1 to 9999 in 1A steps
Uns 100**V**	Rated secondary voltage of the VTs (Phase-to-phase).	100V to 125V in 1V steps
Ib 0.5**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 (time overcurrent) phase overcurrent element.	D Definite time delay SI US Standard Inverse
U/I > ON	Voltage restraint select for low-set phase overcurrent element	ON-OFF
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
U/I >> ON	Voltage restraint select for high-set phase overcurrent element	ON-OFF
I>> 3**Ib**	Pickup level of the high-set phase overcurrent element in per unit of Ib.	Disable, or 1 to 9.9 in 0.1Ib steps
tI>>0.05**s**	Time delay of the high-set phase overcurrent element.	0.05 to 3.0 seconds 0.05 to 0.99 in 0.01 second steps 1.0 to 3.0 in 0.1 second steps
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
tcs 10**s**	Cooling time for the negative sequence current.	10 to 1800 s in 1s steps
2Is .03**Ib**	Negative sequence current alarm level	Dis, or 0.03 to 0.5 in 0.01Ib steps.
t2Is 1**s**	Independent trip time delay of alarm element	1 to100 s in 1s steps
Ir> .02**Ib**	Reverse power trip level.	Dis, or 0.02 to 0.2 in 0.01Ib steps
tIr 0.1**s**	Independent trip time delay of the reverse power element	0.1 to 60 seconds 0.1 to 9.9 in 0.01 second steps 10.0 to 60 in 0.1 second 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 for undervoltage V<0.3Vn and under-**	5 to 50% in 1%Zb steps

DISPLAY	DESCRIPTION	SETTING RANGE
	current I<0.2Ib.	
tz 0.2**s**	Time delay of underimpedance element	.2 to 60 s in 0.1 s steps
ti .0**s**	Integration time of underimpedance 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
Un +/- **1u**	Operation mode of first voltage element + = overvoltage - = undervoltage +/- = over/under voltage Dis = Disabled	+ - +/- Dis
1u 15%**Un**	Pickup level of first voltage element	1 to 50% in 1% steps
t1u 1.0**s**	Time delay of first voltage element	0.1 to 60s in 0.1s steps
Un + **2u**	Operation mode of second voltage element + = overvoltage - = undervoltage +/- = over/under voltage Dis = Disabled	+ - +/- Dis
2u 10%**Un**	Pickup level of second voltage element	1 to 50% in 1% steps
t2u 3.0**s**	Time delay of second voltage element	0.1 to 60s in 0.1s steps
Fn +/- 1f	Operation mode of first frequency element + = overfrequency - = underfrequency +/- = over/under frequency Dis = Disabled	+ - +/- Dis
1f 0.5**Hz**	Pickup level of first frequency element	0.05 to 9.99 Hz in 0.01Hz steps
t1f 3**s**	Time delay of first frequency element	0.1 to 60s in 0.1s steps
Fn + 2f	Operation mode of second frequency element + = overfrequency - = underfrequency +/- = over/under frequency Dis = Disabled	+ - +/- Dis
2f 1**Hz**	Pickup level of second frequency element	0.05 to 9.99 Hz in 0.01Hz steps
t2f 0.5**s**	Time delay of second frequency element	0.1 to 60s in 0.1s steps
Tc 60**m**	Thermal time constant of the generator	1 to 400m in 1m steps
Ta/n 100%	Prealarm level of thermal image	50 to 110% in 0.01Tn steps
W< 0**.05Wb**	Pick up level of active underpower element	0.05 to 1.0 Wb in 0.05Wb steps
tW< 0.1**s**	Trip time delay of underpower element	0.1 to 60 in 0.1second steps
tBF 0.05**s**	Maximum reset time delay of the	0.05 to 0.5 in 0.01second steps

DISPLAY	DESCRIPTION	SETTING RANGE
	instantaneous elements after tripping of the time delayed elements and time delay for activation of the output relay associated with the breaker failure function	

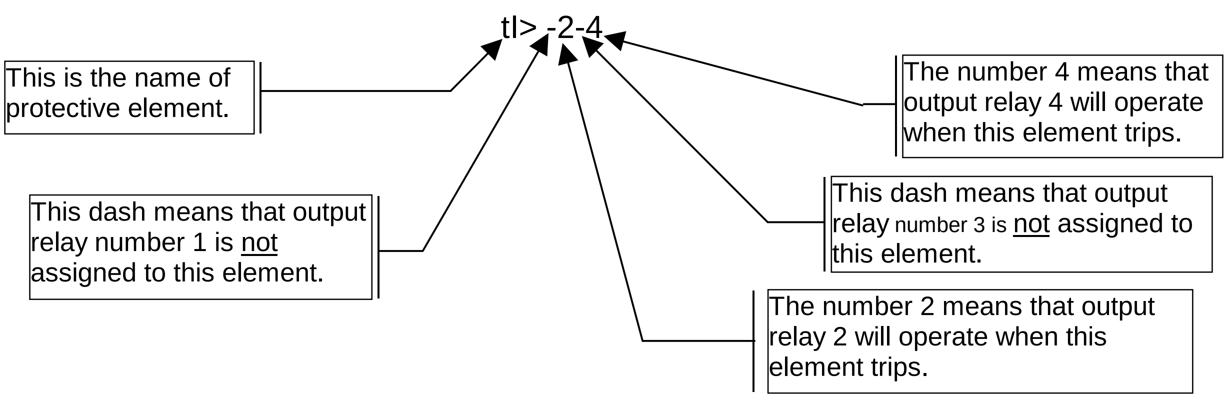
10.3 CHANGING OUTPUT RELAY ASSIGNMENTS

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> ----	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.

DISPLAY	DESCRIPTION
I>> ----	Pick-up element associated with the high-set phase overcurrent element.
tI>> 1---	Time delayed element associated with the high-set phase overcurrent element.
1Is -2--	First negative sequence unbalance time-delayed element.
2Is ---4	Second negative sequence unbalance time-delayed element.
Ir> --23-	Reverse power time-delayed element
Z< -2--	Loss-of-field time-delayed element.
tW< ---4	Underpower time-delayed element.
1U ---4	First undervoltage time-delayed element.
2U -23-	Second undervoltage time-delayed element.
1f ---4	First frequency time-delayed element.
2f ---4	Second frequency time-delayed element.
T> -2--	Over-temperature element.
Ta/n ---4	Thermal pre-alarm element.
tBF ----	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= I>>	Assertion of input D2 (terminals 1-2) blocks operation of the selected phase overcurrent elements (I> and/or I>>).
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 D3 (terminals 1-3) blocks operation of the selected function(s) (Z<) or (Ir>) or (Z<+Ir>)
4= 1--2**--**	Assertion of input D4 (terminals 1-14) blocks operation of one or more of the functions 1U, 2U, 1f, and 2f in any possible combination.

10.5 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 “-”.

10.5.1 ACT.MEAS

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

Table 10.3: Actual Measurements Display

DISPLAY	DESCRIPTION
Txxxx**%Tn**	Actual thermal status of % of the steady full load status Tn: (0-999)%.
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.
EAxxx**%En**	R.M.S. value of Phase A voltage in % of the rated voltage: (0-999)%.
EBxxx**%En**	Same as above, Phase B.
ECxxx**%En**	Same as above, Phase C.
φaxxxxx°	Phase angle displacement of IA leading EA: (0-360º counter clockwise).
φbxxxxx°	Phase angle displacement of IB leading EB: (0-360º counter clockwise).
φcxxxxx°	Phase angle displacement of IC leading EC: (0-360º counter clockwise).
W+xxx**%Wb**	Three phase active power as a % of the generator’s rated power: (0-999)%, (Wb = 1.732xUnxIb.
Fxxxxx**Hz**	System frequency: (40.00 – 70.00).
I2xx0**%Ib**	R.M.S. Negative sequence current as a percentage of the generator’s rated current Ib.

10.5.2 MAX VAL

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

Table 10.4: Maximum Values Display

DISPLAY	DESCRIPTION
Txxxx**%In**	Thermal image status as a % of the full load rated temperature.
IAxx.x**In**	Phase A current displayed as per unit of the CT’s primary rated current.
IBxx.x**In**	Same as above for Phase B.
ICxx.x**In**	Same as above for Phase C.
I_2xxxx%**Ib**	Negative sequence current as % of generator’s rated current
Irxxxx%**Ib**	Reverse current. (Ir=[(I·cosφ)/Ib]•100)
Wxxxx%Wb	Active power as % of generator’s rated power

10.5.3 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<**
Txxxx%**Tn**	Temperature of thermal image.
Iaxx.0**In**	Phase A current.
Ibxx.0**In**	Phase B current.
Icxx.0**In**	Phase C current.
Eaxxx%**En**	Phase A voltage.
Ebxxx%**En**	Phase B voltage.
Ecxxx%**En**	Phase C voltage.
φaxxxx0°	Phase displacement of current phase A.
φbxxxx0°	Phase displacement of current phase B.
φcxxxx0°	Phase displacement of current phase C.
fxxxxx**Hz**	Frequency
I_2x.00**In**	Negative Sequence component of current.

10.5.4 TRIP NUM

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

Table 10.6: Trip Number Display

DISPLAY	DESCRIPTION
T>xxxxxx	Thermal overload
I>xxxxx0	Time delayed element of first overcurrent level [tI>]
I>>xxxx0	Time delayed element of second overcurrent level [tI>>]
1Is>xxxx0	Time delayed element of first negative sequence overcurrent level
2Isxxx0	Time delayed element of second negative sequence overcurrent level
Ir>xxxxx	Time delayed element of reverse current
1Uxxxxx	Time delayed element 1U
2Uxxxxx	Time delayed element 2U
1fxxxxx	Time delayed element 1f
2fxxxxx	Time delayed element 2f
Z<xxxxx	Time delayed element loss of field
W<xxxxx	Time delayed element under power

11. PROTECTION ELEMENTS

Most of the IM3G-V 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:

IM3G-V measures the phase angle difference between the phase 'C' voltage and phase A, B, and C currents. The measurement for phases 'A' and 'B' is then multiplied by ±120° to come up with phase 'A' and 'B' displacements.

$\varphi_A = \varphi_{A\text{-}C} - 120°$

$\varphi_B = \varphi_{B\text{-}C} + 120°$

$\varphi_C = \varphi_{C\text{-}C}$

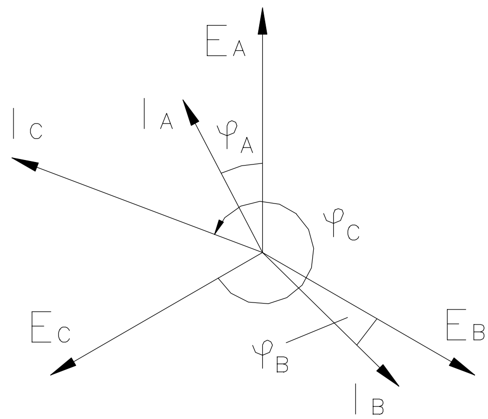


Figure 11.1: IM3G-V Phase Angle Measurement

11.2 VOLTAGE ELEMENTS (27/59):

Two, three-phase voltage elements are provided. Each element can be set as either under, over, or over/under.

The voltage elements are set in per unit of the nominal phase-phase voltage input setting, UnS. When any of the phase voltages exceed the setpoint, the element operates and starts its timer.

Voltage setpoint = $xu \times \frac{UnS}{\sqrt{3} \times 100}$ Where: x = 1 for the 1st voltage element

x = 2 for the 2nd voltage element

ELEMENT	DESCRIPTION	SETTING RANGE
Un +/- **1u**	Operation mode of first voltage element + = overvoltage - = undervoltage +/- = over/under voltage Dis = Disabled	+ - +/- Dis
1u 15%**Un**	Pickup level of first voltage element	1 to 50% in 1% steps
t1u 1.0**s**	Time delay of first voltage element	0.1 to 60s in 0.1s steps
Un + **2u**	Operation mode of second voltage element + = overvoltage - = undervoltage +/- = over/under voltage Dis = Disabled	+ - +/- Dis
2u 10%**Un**	Pickup level of second voltage element	1 to 50% in 1% steps

ELEMENT	DESCRIPTION	SETTING RANGE
t2u 3.0**s**	Time delay of second voltage element	0.1 to 60s in 0.1s steps

11.3 REVERSE POWER (32):

IM3G-V 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 generator's output rating. tIr is the timer associated with the reverse power element.

ELEMENT	DESCRIPTION	SETTING RANGE
Ir> .02**Ib**	Reverse power trip level.	Dis, or 0.02 to 0.2 in 0.01Ib 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)

11.4 UNDERPOWER (37):

Three-phase active power is measured in the forward direction. If the measured value drops below the setpoint, W<, the element will pickup and start the timer tW<.

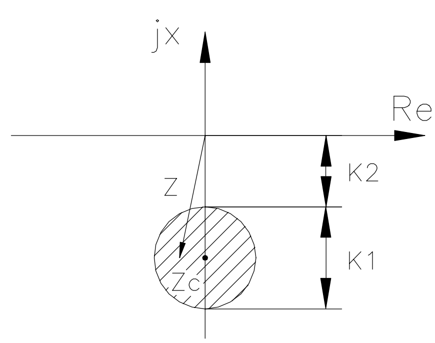
ELEMENT	DESCRIPTION	SETTING RANGE
W< 0.**05Wb**	Pick up level of active underpower element	0.05 to 1.0 Wb in 0.05Wb steps
tW< 0.1**s**	Trip time delay of underpower element	0.1 to 60 in 0.1second steps

11.5 LOSS-OF-FIELD (40):

IM3G-V calculates the capacitive impedance for each phase. If the calculated impedance falls within the trip zone for all three phases, the underimpedance element, Zc, picksup and starts the tz timer. Reset of timer tz takes place if the calculated impedance, Zc 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 per phase impedance: $$Zc_x = \frac{E_x}{I_x \cos(\varphi_x - 90°)}$$; where x = A, B, or C

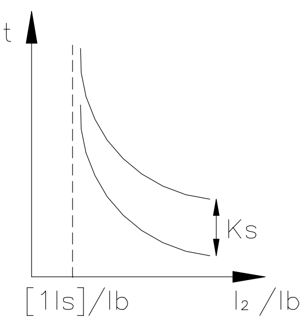
ELEMENT	DESCRIPTION	SETTING RANGE
K1 300%**Zb**	Diameter of the mho circle characteristic for the under-impedance loss of field element	Dis, or 50 to 300% in 1%Zb steps
K2 50%**Zb**	Offset of the under-impedance mho circle	5 to 50% in 1%Zb steps

ELEMENT	DESCRIPTION	SETTING RANGE
tz 0.2**s**	Time delay of underimpedance element	.2 to 60 s in 0.1 s steps
ti .0**s**	Integration time of underimpedance element.	0 to 10s in 0.1s steps

11.6 NEGATIVE SEQUENCE (46):

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

11.6.1 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, tcs. 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: $$tc = \frac{tcs}{Ks}\left(\frac{I_2}{I_b}\right)^2 .t \quad (2)$$

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
tcs 10**s**	Cooling time for the negative sequence current.	10 to 1800 s in 1s steps

11.6.2 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 0.5 in 0.01Ib steps.
t2Is 1**s**	Independent trip time delay of alarm element	1 to100 s in 1s steps

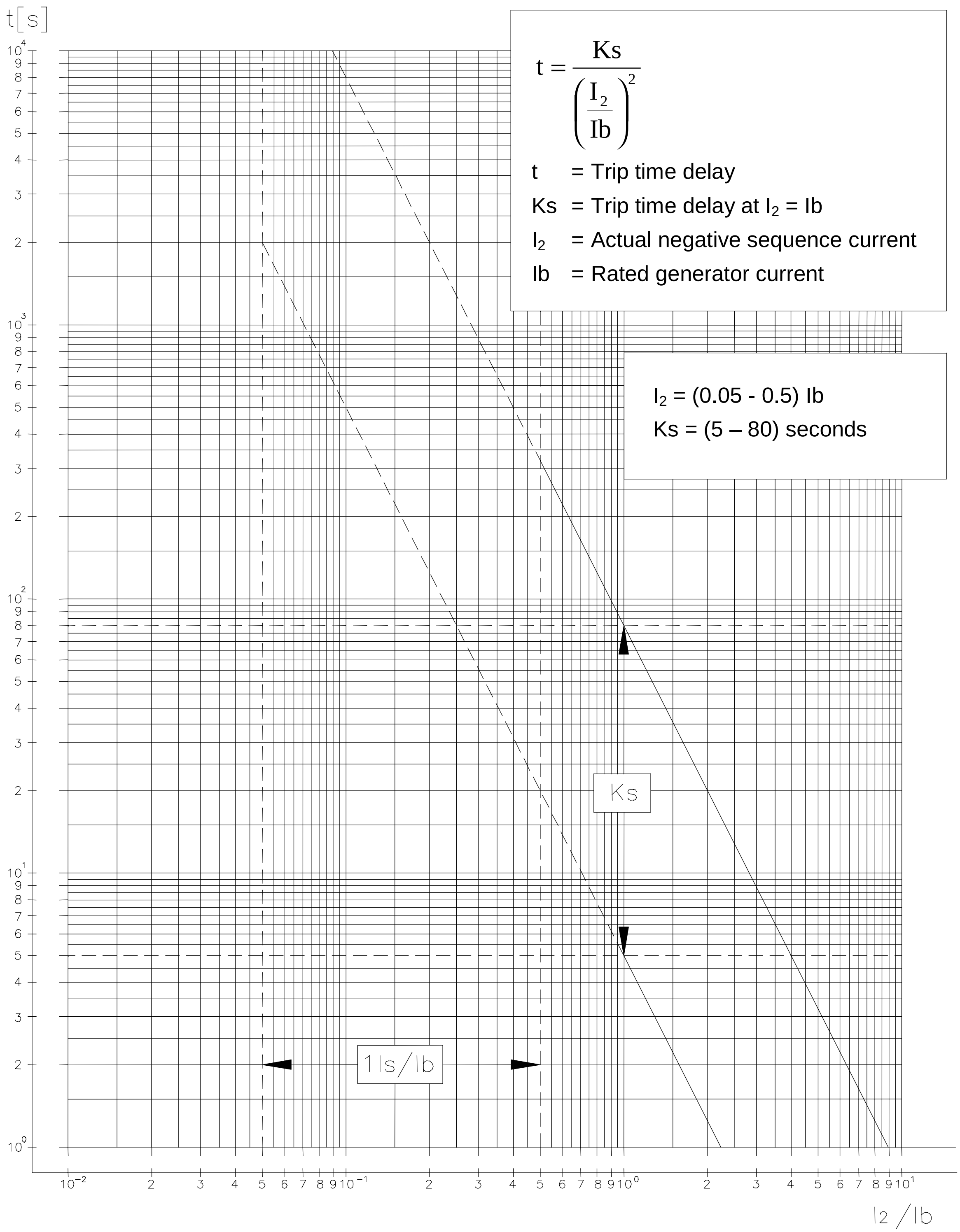


Figure 11.2: IM3G-V I_2^2t Element

11.7 THERMAL OVERLOAD PROTECTION (49):

IM3G-V computes a thermal image of the machine based on the ratio of the phase currents to the machine's rated current.

Time to warm-up from pre overload temperature, Tp to trip temperature (110% Tn):

$$t = [Tc]\ln\frac{\left(\frac{Tx}{Tn}\right)-\left(\frac{Tp}{Tn}\right)}{\left(\frac{Tx}{Tn}\right)-\left(\frac{Tb}{Tn}\right)} = [Tc]\ln\frac{\left(\frac{I}{[Ib]}\right)^2-\left(\frac{Ip}{[Ib]}\right)^2}{\left(\frac{I}{[Ib]}\right)^2-\left(\frac{Ic}{[Ib]}\right)^2}$$

where:

	Tc:	is the warming up time constant.
	Ic:	Maximum continuous overload; Ic = 1.05 Ib
	Tn:	Rated full load temperature rise
	Ta:	Overtemperature prealarm level
	Ip:	Current corresponding to machine's temperature prior to overload, Tp.
	[Ib]:	Generator's rated full load setpoint

ELEMENT	DESCRIPTION	SETTING RANGE
Tc 60**m**	Thermal time constant of the generator	1 to 400m in 1m steps
Ta/n 100%	Prealarm level of thermal image	50 to 110% in 0.01Tn steps

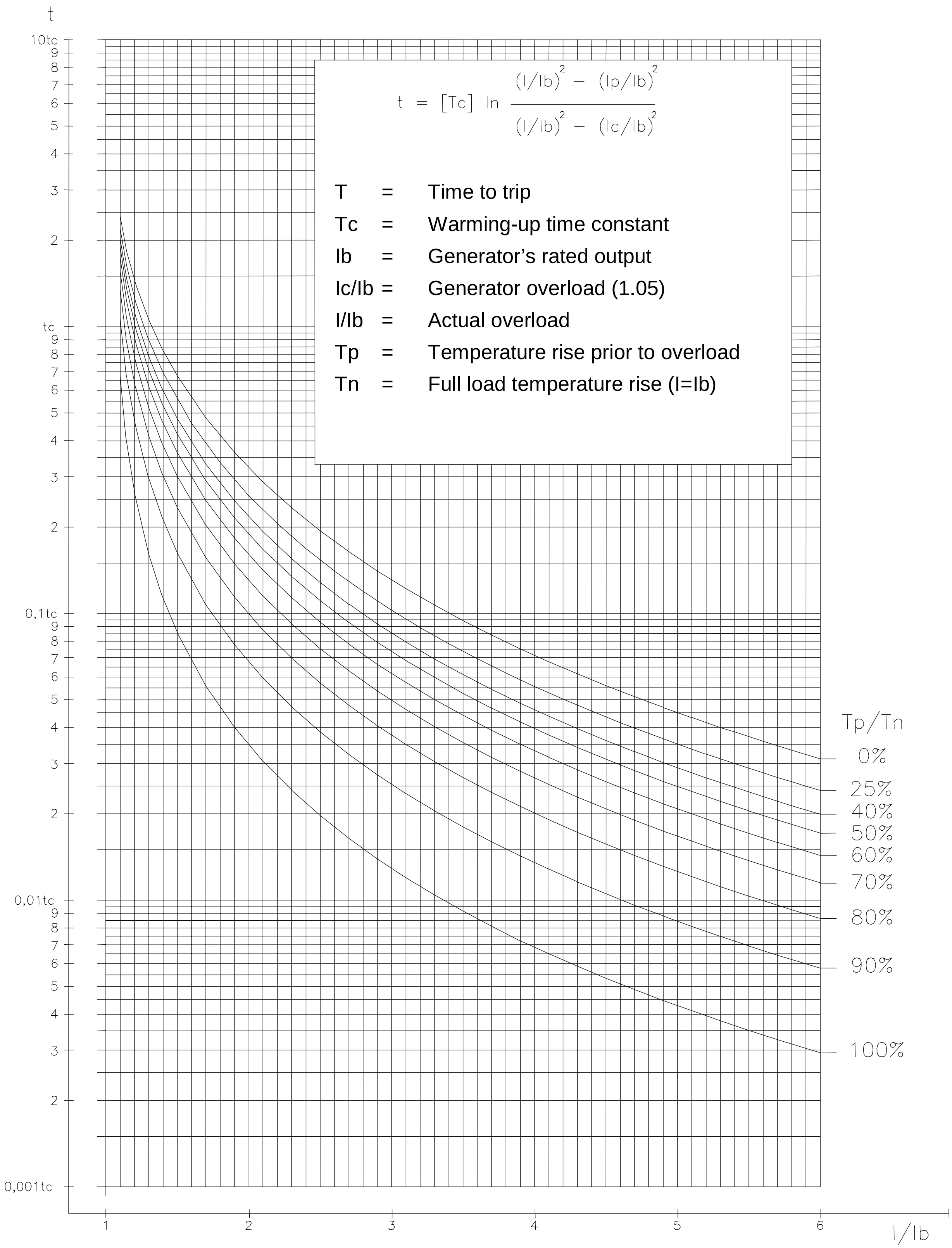


Figure 11.3: IM3G-V Thermal Overload Element

11.8 OVERCURRENT PROTECTION (50/51-V):

Two overcurrent elements are provided in the IM3G-V. The overcurrent elements can be setup with or without voltage restrain.

11.8.1 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
U/I > ON	Voltage restraint select for the low-set phase overcurrent element	ON-OFF
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

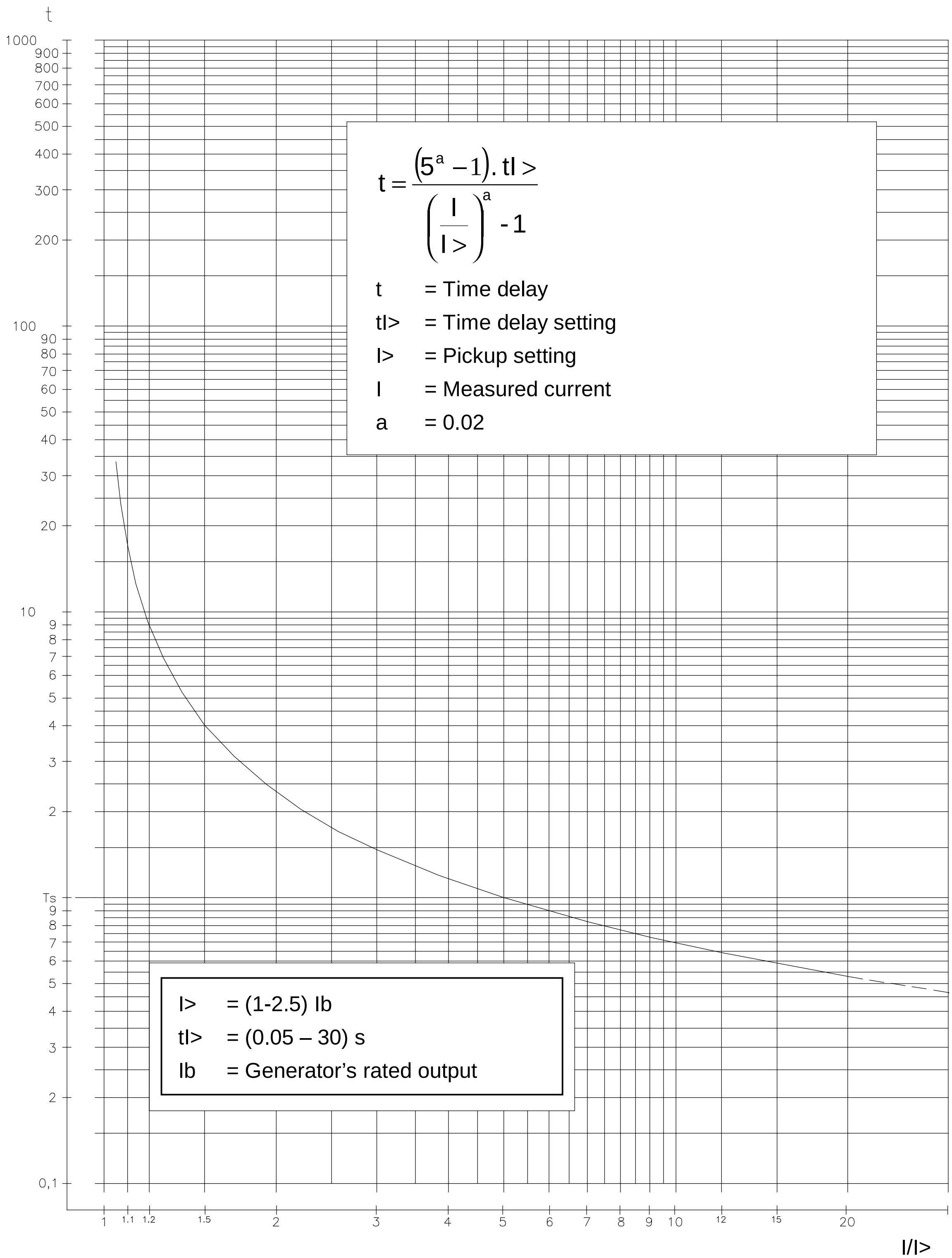


Figure 11.4: IM3G-V Standard Inverse Time Overcurrent Curve-51

11.8.2 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
U/I >> ON	Voltage restraint select for the high-set phase overcurrent element	ON-OFF
I>> 3**Ib**	Pickup level of the high-set-phase overcurrent element in per unit of Ib.	Disable, or 1 to 9.9 in 0.1Ib steps
tI>>0.05**s**	Time delay of the high-set phase overcurrent element.	0.05 to 3 s in 0.01 second steps

11.8.3 Voltage Restrained Overcurrent Protection:

Both the low-set and the high-set overcurrent elements can be setup with voltage restraint operation by setting the U/I> and U/I>> settings to 'ON' respectively.

When voltage restraint is active, the actual overcurrent element pickup will vary proportionally to the ratio of the measured voltage and the nominal voltage setting, UnS.

$$I> = [I>] \times \frac{E\sqrt{3}}{UnS} \qquad I>> = [I>>] \times \frac{E\sqrt{3}}{UnS}$$

I> = Actual low-set overcurrent pickup

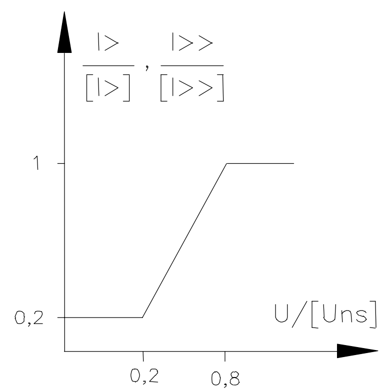
[I>] = Low-set overcurrent pickup setting

I>> = Actual high-set overcurrent pickup

[I>>] = High-set overcurrent pickup setting

E = Lowest measured phase-to-ground voltage among the three phases

UnS = Rated secondary voltage setting



11.9 FREQUENCY ELEMENTS (81):

Two frequency elements are provided in the IM3G-V. Each frequency element is equipped with a timer and can be setup for under, over, or over/under frequency operation.

ELEMENT	DESCRIPTION	SETTING RANGE
Fn +/- 1f	Operation mode of the first frequency element + = overfrequency - = underfrequency +/- = over/under frequency Dis = Disabled	+ - +/- Dis
1f 0.5**Hz**	Pickup level of the first frequency element	0.05 to 9.99 Hz in 0.01Hz steps

ELEMENT	DESCRIPTION	SETTING RANGE
t1f 3**s**	Time delay of the first frequency element	0.1 to 60s in 0.1s steps
Fn **+ 2f**	Operation mode of the second frequency element + = overfrequency - = underfrequency +/- = over/under frequency Dis = Disabled	+ - +/- Dis
2f 1**Hz**	Pickup level of the second frequency element	0.05 to 9.99 Hz in 0.01Hz steps
t2f 0.5**s**	Time delay of the second frequency element	0.1 to 60s in 0.1s 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.

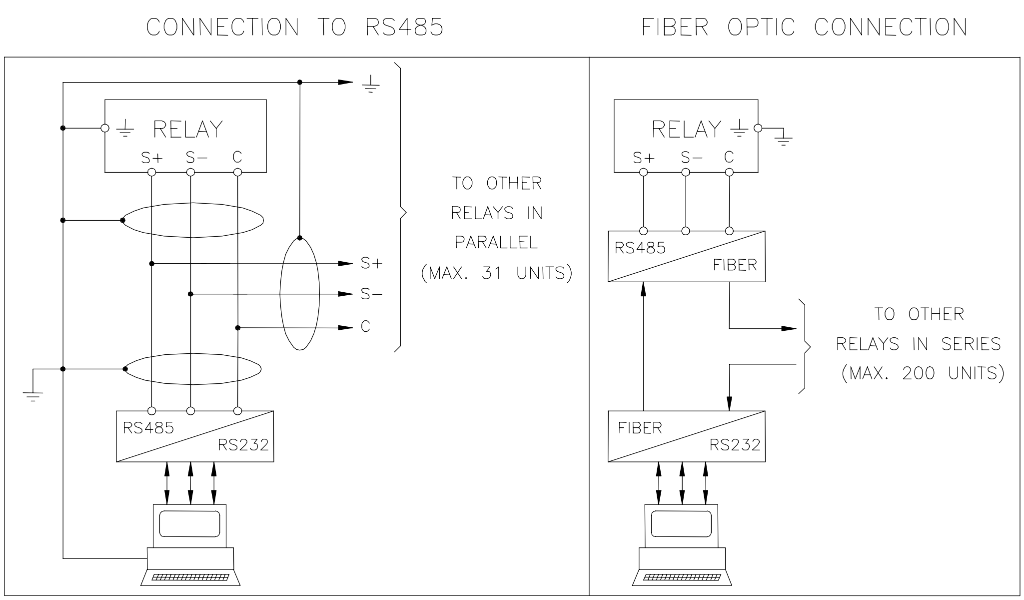


Figure 12.1: Serial Communication Wiring

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 $\leq$ 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.

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

Operating Temperature Range .... -20 to +60°C at 95% humidity
Storage Temperature .... -30 to +80°C
Rated input Current .... In=1 or 5A, On=1 or 5A
Rated Input Voltage 125V
Current Overload .... 200A for 1 sec; 10A continuous
Voltage Circuits Overload .... 2.0 pu rated voltage, Continuous
Burden on current inputs .... Phase: 0.01 VA at In=1A; 0.2VA at In=5A
Burden on Voltage Inputs .... 0.08 VA at rated voltage
Dielectric test Voltage .... 2000V, 50/60Hz, 1 minute
Impulse Test Voltage .... 5 kV common mode, 1 kV differential mode, 1.2 x 50 μsec.
Immunity to high frequency burst .... 1 kV common mode, 0.5 kV differential mode at 100 kHz,
.... 2.5 kV common mode, 1 kV differential mode at 1 MHz
Immunity to electrostatic discharge .... 15 kV
Immunity to sinusoidal wave burst .... 100V over 10 - 1000kHz range
Immunity to radiated electromagnetic field .... 10V/m over 20 - 1000MHz range
Immunity to high energy burst .... 4 kV common mode, 2V differential mode
Immunity to pulse magnetic field .... 1000 A/m, 8 x 20 seconds
Immunity to magnetic burst .... 100 A/m over 100 - 1000kHz range
Resistance to vibration .... 1g from 10 -500 Hz
Rear Connection Terminals .... Up to 12AWG (4mm²) stranded wire
.... Lugs up to 0.25 inch (6.5mm) wide
Output Contacts .... rated current 5 A
.... rated voltage 380 V
.... nominal switching power with AC resistive load 1100W(380V max.)
.... breaking capacity at 110 VDC: 0.3A with L/R=40ms for 100,000 operations
.... make and carry capacity for 0.5 sec = 30 A (peak)
.... mechanical life over 2,000,000 (2×10^6) operations
PC Board Connectors .... Gold plated, 10A continuous, 200A 1 sec.
Power Supply Input Voltage Range: .... Two Available at 24 - 110 V AC-DC ± 20%
.... or 90 – 220 V AC-DC; ± Ave 20%
Average Power Supply consumption .... 8.5 VA
Weight (in single relay case) 2.3kg (5.0lbs)

16. IM3G-V SETTING SHEET

IM3G-V SETTING SHEET PAGE 1 OF 4

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	1	
UnS	100	V	Rated secondary voltage of the VTs (Phase-to-phase).	100V to 125V	1	
Ib	0.5	pu In	Generator's rated current as pu of CTs rated current	0.5-1.1	0.1	
F(I>)	D		Operating characteristic of the low-set phase overcurrent element: D: Definite-time SI: Standard inverse	D, SI	--	
U/I	ON		Voltage restraint select for low-set phase overcurrent element	ON-OFF		
I>	1.0	pu Ib	Tap (or pickup level) of the low-set phase overcurrent element in per unit of Ib.	Dis., or 1 to 2.5	.01	
tI>	0.05	s	*Definite time mode*: Trip time delay of the low-set phase overcurrent *Inverse time mode*: Time delay at 5X pickup	0.05 to 9.9 10.0 to 30.0	0.01 0.1	
U/I>>	ON		Voltage restraint select for high-set phase overcurrent element	ON-OFF		
I>>	3	pu Ib	Pickup level of the high-set phase overcurrent element in per unit of Ib.	Dis, or 1 to 9.9	0.1	
tI>>	0.05	s	Time delay in seconds of the high-set phase overcurrent element.	0.05 to 0.99 1.0 to 3.0	0.01 0.1	
1Is	0.05	pu Ib	Maximum continuous negative sequence current rating of generator in per unit of Ib	Dis., or 0.05 to 0.5	0.01	
Ks	5	s	Time delay of the I^2t time current curve	5 to 80	1	
tcs	10	s	Cooling time for the negative sequence current.	10 to 1800	1	
2Is	.03	pu Ib	Negative sequence current alarm level	Dis, or 0.03 to 0.5	0.01	
t2Is	1	s	Independent trip time delay of alarm element	1 to100s	1s	
Ir>	.02	pu Ib	Reverse power trip level.	Dis, or 0.02 to 0.2	0.01	

Variable	Factory default	Units	Description	Range	Step	Setting
tIr>	0.1	s	Independent trip time delay of the reverse power element	0.1 to 9.9 10.0 to 60	.01 0.1	
K1	300	%Zb	Diameter of the mho circle characteristic for the under-impedance loss of field element	Dis, or 50 to 300	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	1%	
tz	0.2	s	Time delay of under-impedance element	.2 to 60	0.1	
ti	0	s	Integration time of under-impedance element. **(ti) must always be shorter than (tz)**	0 to 10	0.1	
Un (1U)	+/-		Operation mode of first voltage element + = overvoltage - = undervoltage +/- = over/under voltage Dis = Disabled	+ - +/- Dis		
1u	15	%Un	Pickup level of first voltage element	1 to 50%	1%	
t1u	1	s	Time delay of first voltage element	0.1 to 60	0.1	
Un (2U)	+		Operation mode of second voltage element + = overvoltage - = undervoltage +/- = over/under voltage Dis = Disabled	+ - +/- Dis		
2u	10	%Un	Pickup level of second voltage element	1 to 50%	1%	
t2u	3	s	Time delay of second voltage element	0.1 to 60	0.1	
Fn (1f)	+/-		Operation mode of first frequency element + = overfrequency - = underfrequency +/- = over/under frequency Dis = Disabled	+ - +/- Dis		
1f	0.5	Hz	Pickup level of first frequency element	0.05 to 9.99	0.01	
t1f	3	s	Time delay of first frequency element	0.1 to 60	0.1	

Variable	Factory default	Units	Description	Range	Step	Setting
Fn (2f)	+		Operation mode of second frequency element + = overfrequency - = underfrequency +/- = over/under frequency Dis = Disabled			
2f	1	Hz	Pickup level of second frequency element	0.05 to 9.99	.01	
t2f	0.5	s	Time delay of second frequency element	0.1 to 60	.1	
Tc	60	m	Thermal time constant of the generator	1 to 400	1	
Ta/n	100	%	Prealarm level of thermal image	50 to 110%	.01	
W<	0.05	pu Wb	Pick up level of active underpower element	0.05 to 1.0	.05	
tW< 0.1**s**			trip time delay of underpower element	0.1 to 60	0.1	
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	0.05 to 0.5	0.01	

OUTPUT RELAY PROGRAMMING ASSIGNMENTS (ACCESSIBLE VIA THE F→Relay PROGRAM MODE.)

Variable	Factory default	Units	Description	Range	Setting
I>	- - - -	Outputs	Low-set overcurrent pickup element.	1 2 3 4	
tI>	1 - - -	Outputs	Low-set overcurrent time delayed element	1 2 3 4	
I>>	- - - -	Outputs	High-set overcurrent pickup element.	1 2 3 4	
tI>>	1 - - -	Outputs	High-set overcurrent time delayed element	1 2 3 4	
1IS	- 2 - -	Outputs	Negative Sequence I_2^2t time delayed element	1 2 3 4	
2IS	- - 4 -	Outputs	Negative Sequence definite time element	1 2 3 4	
tIr>	- 2 3 -	Outputs	Reverse power time delayed element	1 2 3 4	
Z<	- 2 - -	Outputs	Loss-of-field time delayed element	1 2 3 4	
tW<	- - - 4	Outputs	Underpower time delayed element	1 2 3 4	
1U	- - - 4	Outputs	1st time delayed voltage element.	1 2 3 4	

OUTPUT RELAY PROGRAMMING ASSIGNMENTS (ACCESSIBLE VIA THE F→Relay PROGRAM MODE.)					
Variable	**Factory default**	**Units**	**Description**	**Range**	**Setting**
2U	- 2 3 -	Outputs	2nd time delayed voltage element.	1 2 3 4	
1f	- - - 4	Outputs	1st time delayed frequency element	1 2 3 4	
2f	- - - 4	Outputs	2nd time delayed frequency element	1 2 3 4	
T>	- 2 - -	Outputs	Overtemperature element	1 2 3 4	
Ta/n	- - - 4	Outputs	Thermal alarm element	1 2 3 4	
tBF	- - - -	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=	I>>	---	Assertion of input D2 (terminals 1-2) blocks operation of the selected phase overcurrent elements (I> and/or I>>).	I>, I>>	
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>	
4=	1 - -2 - -	---	Assertion of input D4 (terminals 1-14) blocks operation of one or more of the functions 1U, 2U, 1f, and 2f in any possible combination.	1 u f 2 u f	

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