Multifunction Overcurrent Relays

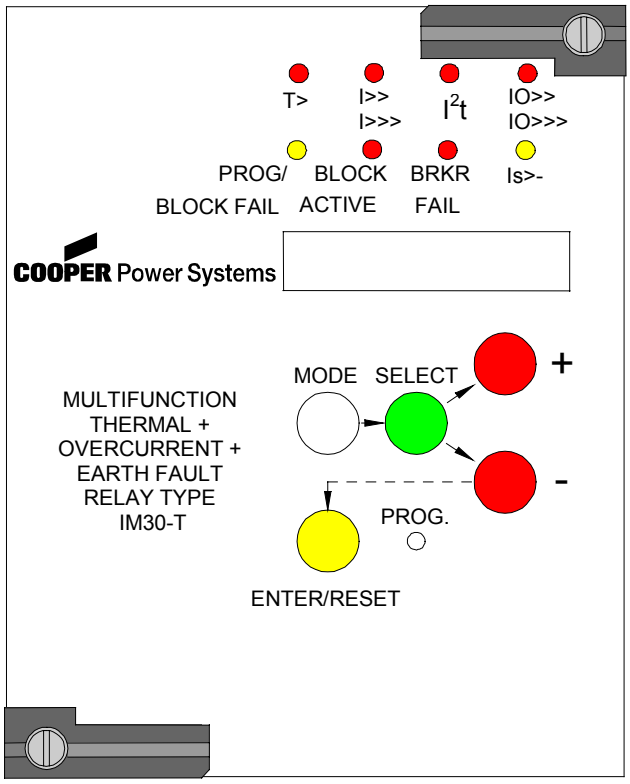
COOPER Power Systems

Electrical Apparatus

IM30T Transformer Backup Relay

S150-11-1

MICROPROCESSOR 3-Phase OVERCURRENT and Ground Overcurrent and Thermal PROTECTION RELAY TYPE IM30-T OPERATIONS MANUAL



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Safety for Life

Cooper Power Systems products meet of exceed all applicable industry standards relating to product safety. We actively promote safe practices in the use and maintenance of our products through service literature, instructional training programs and the continuous efforts of all Cooper Power Systems' employees involved in product design, manufacture, marketing and service.

We strongly urge that you always follow all locally approved safety procedures and safety instructions when working around high voltage lines and equipment and support our "Safety for Life" mission.

SAFETY INFORMATION

Following is important safety information. For safe installation and operation of this equipment be sure to read and understand all cautions and warnings.

Hazard Statement Definitions

This manual contains two types of hazard statements:

WARNING: Refers to hazards or unsafe practices which can result in death, severe personal injury and equipment damage.

CAUTION: Refers to hazards or unsafe practices that can result in damage to equipment or in personal injury.

Safety Instructions

The following general caution and warning statements apply to this equipment. Additional statements, relating to specific tasks and procedures, are located throughout the manual.

WARNING: Before installing, operating, maintaining, or testing this equipment, carefully read and understand the contents of this manual. Improper operation handling or maintenance can result in death severe personal injury, and equipment damage.

WARNING: This equipment is not intended to protect human life. Follow all locally approved procedures in safety practices when installing or operating this equipment. Failure to comply can result in death, severe personal injury and equipment damage.

WARNING: Hazardous voltage. Contact with high voltage will cause death or severe personal injury. Follow all locally approved safety procedures working around high voltage lines and equipment.

CAUTION:	Equipment mis-operation. Do not connect this relay to an energized circuit breaker until all control settings have been properly programmed and verified. Refer to the programming information for this control. Failure to comply can result in relay and breaker mis-operation, equipment damage, and personal injury.

CAUTION:	Hazardous voltage. This device is not a substitute for visible disconnect. Follow all locally approved safety practices. Failure to follow proper safety practices can result in contact with high-voltage, which will cause death or severe personal injury.

WARNING:	A relay must be properly selected for the intended application. It must be installed in service by competent personnel who have been trained and understand proper safety procedures. These instructions are written for such personnel and are not a substitute for adequate training and experience in safety procedures. Failure to properly select, install or maintain the relay can result in death, severe personal injury, and equipment damage.

CAUTION:	Equipment damage. Always wear grounding wrist strap to control static electricity before handling circuit boards. Failure to use this strap may result in circuit board damage. The relay must be completely de-energized prior to removing, configuring and/or replacing any internal circuit boards.

This Operations Manual is designed to familiarize the reader with how to install, program, and set up the IM30-T 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

INTRODUCTION

The IM30T relay provides all of the basic functions including three-phase thermal, three phase and ground overcurrent elements, and negative sequence currents suitable for the protection of transformers and feeders. True RMS values of the currents through the 5th harmonic are used, while the ground current and voltage inputs include 3rd harmonic filtering. 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 is 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 IM30T are:

- Non-directional time and instantaneous phase overcurrent (50/51).
- Time and instantaneous ground overcurrent (50N/51N).
- Breaker Fail (62 BF).
- Fast Bus Trip (zone inter-locking)
- The IM30-T offers three programmable inputs which can serve to block the operation of the phase overcurrent elements, the ground overcurrent elements, and to allow for remote trips.

It is possible to disable any of the overcurrent elements. Separate pickup functions are also provided which may be used to operate output relays.

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 the exposed (i.e., drawn-out) relay must be handed to another person, make sure both persons 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 placed in storage in their protective case. If storage of the 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.

INSTALLATION

Edison relays are shipped either in single or double width cabinets, or in standard 19" 3U rack mount enclosures capable of housing up to four Edison relays. Outline dimensions for the single relay housing is shown in Figure 1. For dimensions of other cabinets, see Catalog Section 150-05. The double case mounting is similar to the single case, but requires a 226mm L x 142mm H panel opening. The 19" rack mount case is a standard 3U high 19" wide cabinet. To remove the relay from its case, refer to Figure 2. The relay may be removed from its protective case by turning with a flat bladed screwdriver the locking screws 2 and 3 on the front panel latches 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.

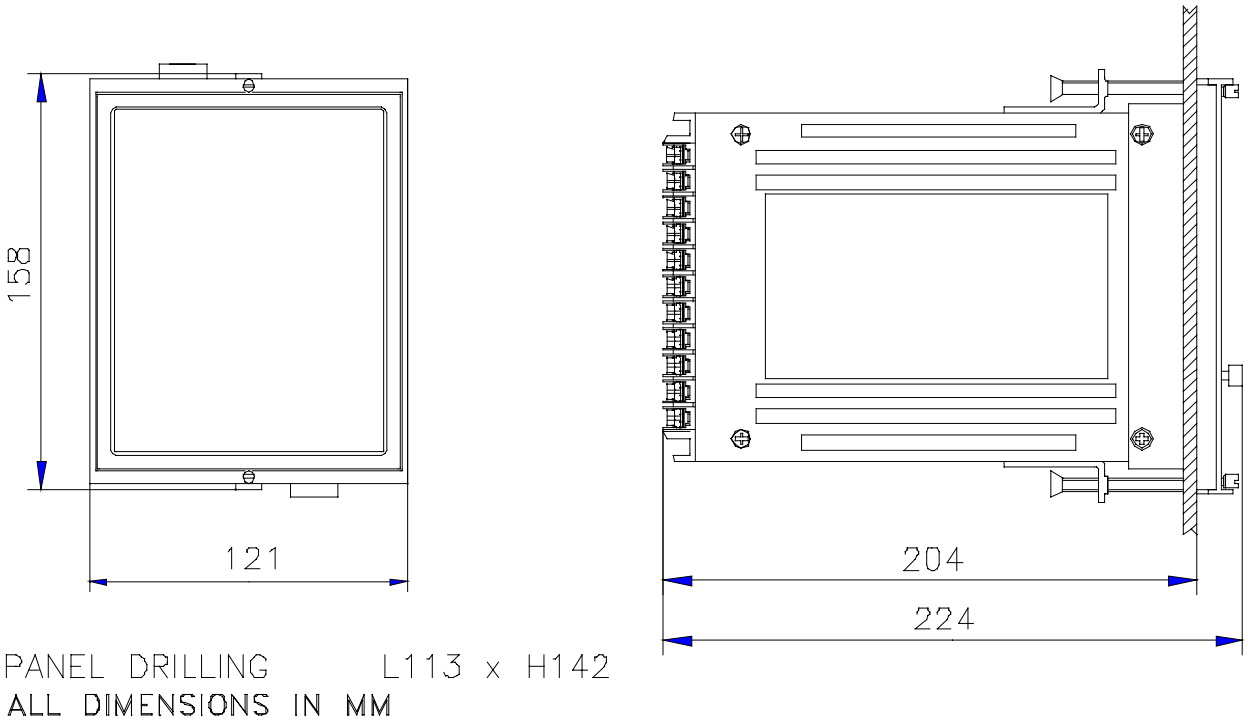


Figure 1 : SINGLE MODULE ENCLOSURE MOUNTING

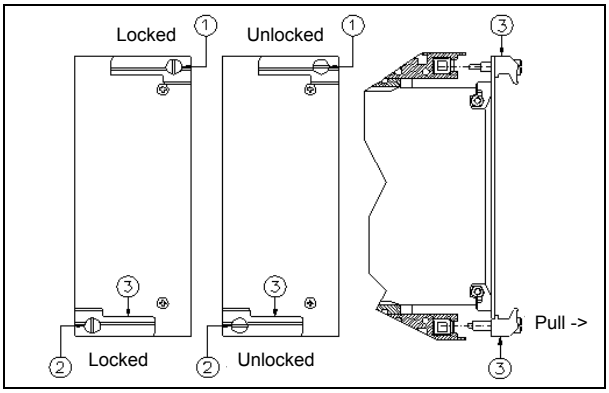


Figure 2: LATCH MECHANISM FOR REMOVAL OF RELAY FROM CASE

To re-install the relay in 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 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.

ELECTRICAL CONNECTIONS

Power is supplied via terminals 12 and 13, with chassis ground at terminal 44. A case ground is provided by a stud on the side of the relay cabinet. All Edison relays are available with one of two auto-ranging power supplies. Descriptions of the input voltage ranges are given in Table 1. The input supply voltage is noted on the relay case. In the event 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 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 3. All the terminals will accept up to a No. 6 stud size spade connector (or any type of lug up to 0.25" (6.3mm) wide) or 12 AWG wire (4 mm²). Electrical connections must be made in accordance with the relay's wiring diagram found in Figure 4.
In Figure 4, the numbers next to the circles along the functional diagram of the relay indicate the terminal number on the back of the relay as shown in Figure 3. Figure 4 indicates the proper connection for overcurrent protection with different combinations of current transformers, e.g., three phase and one ground CT (3P+1G), or three phase CTs connected residually (3P), or two phase and one ground CT (2P+1G).

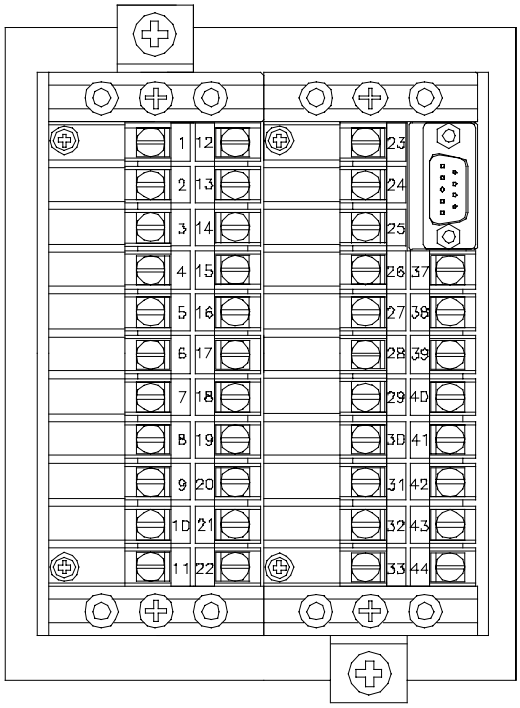
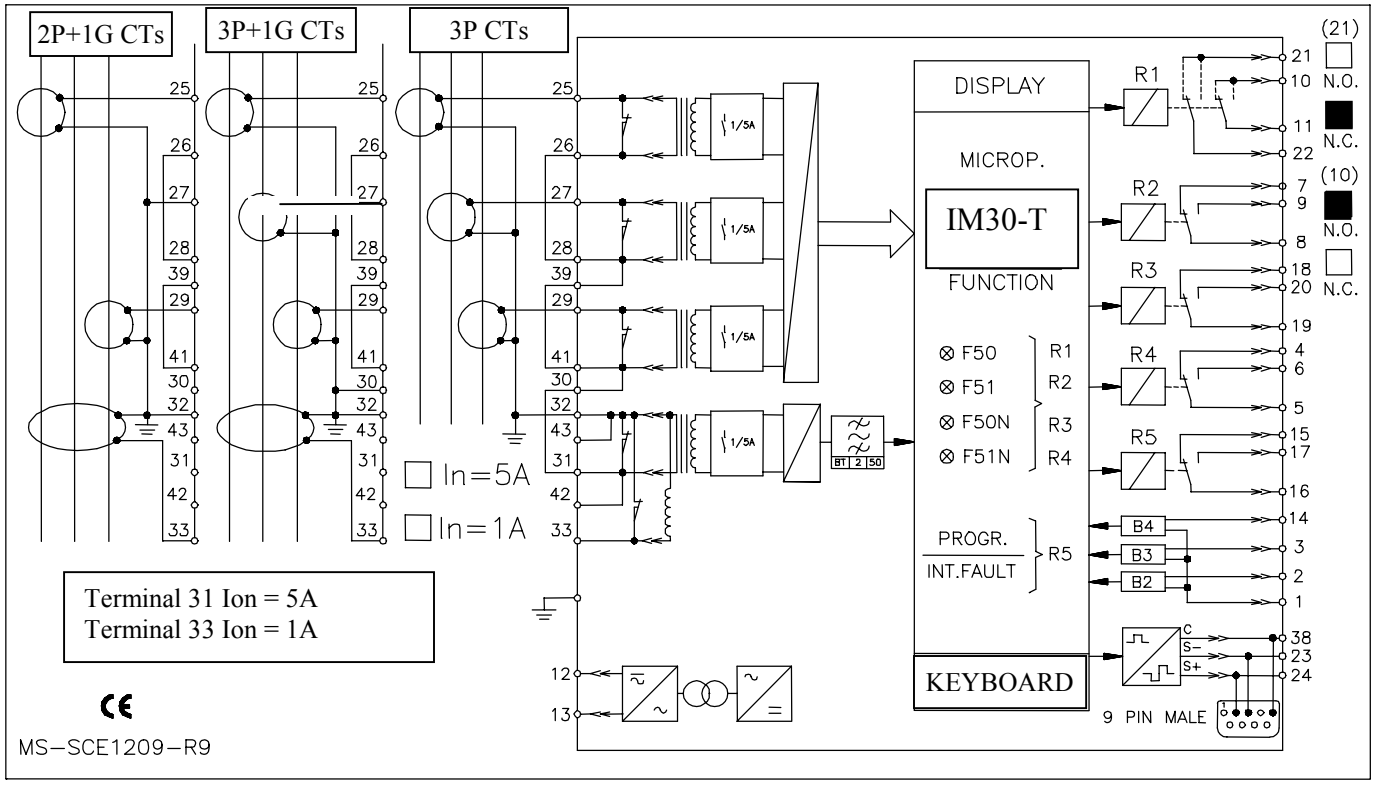


Figure 3: VIEW OF REAR TERMINAL CONNECTIONS

Figure 4: Wiring Diagram of the IM30-T Relay



Output Relays

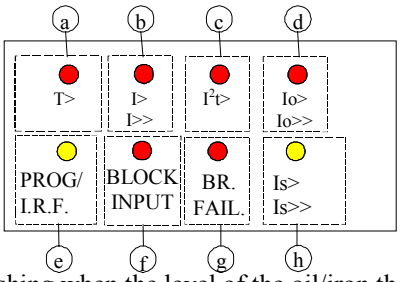
Output relays 1 through 4 are user programmable to operate in conjunction with the tripping of any protective element or elements. Relay 1 consists of two isolated SPST terminals which may be selected as being either normally open or normally closed. The other three output relays, 2-4, all have form C (i.e., SPDT) contact arrangements.
Output relay 5 is normally energized (shown de-energized) and operates only upon power supply failure or on an internal relay fault.

DIGITAL INPUTS

Any function can be permanently deactivated by setting its value to **Dis.** Some functions can be temporarily disabled via the digital inputs B2 and B3. The operation of the blocking inputs can be programmed to block (when activated) any of the relay functions by programming the variables B2 and B3
When any blocking input is activated the led f goes flashing. The IM30-T has two inputs which perform blocking functions. The IM30-T has a third input which allows for remote trips. The inputs are active when the relevant terminals are shorted. The open circuit voltage across the terminals of these inputs is 15 VDC. The internal resistance is 2.2 kΩ. 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

TARGET DESCRIPTION

The front panel of the IM30-T contains eight LEDs (normally off) which act as the targets for the relay elements. See Figure below for identification of the targets.
The status of the targets is maintained when auxiliary power is restored.



a)	Red LED	**T>**	❑ Flashing when the level of the oil/iron thermal element reaches the set alarm temperature [Ta] ❑ Illuminated when the oil/iron's temperature reaches 125% or the winding's temperature reaches 200%
b)	Red LED	**I>** **I>>**	❑ Flashing when the measured current reaches the set current level [I>] or [I>>] ❑ Illuminated on trip after expiry of the set trip time delay [tI>] or [tI>>]
c)	Red LED	**I^2t>**	❑ Flashing when the measured current exceeds 2*[It] ❑ Illuminated when I^2*t>[2It]*[t2]
d)	Red LED	**I0>** **I0>>**	❑ Flashing when the measured current reaches the set current level [Io>] or [Io>>] ❑ Illuminated on trip after expiry of the set trip time delay [tIo>] or [tIo>>]
e)	Yellow LED	**PROG** **I.R.F.**	❑ Flashing during the programming of the parameters or in case of Internal Relay Failure.
f)	Red LED	**BLOCK** **ACTIVE**	❑ Flashing when a blocking signal is present at the relevant input terminals ❑ Illuminated when a Remote Trip has been operated by the RT input (terminals 1-14)

g) Red LED — **BRKR FAIL**
- ❑ Illuminated on trip of the Breaker Failure function

h) Yellow LED — **Is> Is>>**
- ❑ Flashing when the measured current reaches the set current level [1Is] or [2Is]
- ❑ Illuminated on trip after expiry of the set trip time delay [t1Is>] or [t2Is]>>]

The reset of the leds takes place as follows:
-From flashing to off, automatically when the lit-on cause disappears.
-From ON to OFF, by "ENTER/RESET" push button or via serial communication only if the tripping cause has disappeared. In case of auxiliary power supply failure the status of the leds is recorded to non-volatile memory. The status of the targets is maintained when auxiliary power is restored.

PROGRAM SETTING VARIABLES AND RANGES

TABLE 2 : PROGRAM SETTING Variables

Display	Description	Setting Range
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
On 500**Ap**	Rated primary current of the CTs or the window CT used for supplying the zero sequence input current	1 to 9999 in 1A steps
It 0.5**In**	Rated current of the thermal element as p.u. of the rated current of phase CTs	0.50-2.00 in (0.01*In) steps
tw 3**min**	Thermal time-constant of winding	1-60 minutes in 1 minute steps
lbw 1.05**t**	Continuous permissible winding overload	1.05-1.5, in steps of 0.01*It
tf 10 **min**	Thermal time constant of the oil/iron	10-400 minutes in 1 minute steps
t2 0.1 **s**	Trip time delay of the I^2t element when I=2*[It]	0.1-10-Dis in 0.1 s steps
Ta/n 50**%**	Thermal prealarm temperature as % of full load (I=It) steady state temperature Tn	50-120% in steps of 1%
I>0.5**In**	Trip level of the low-set overcurrent element in per unit of the phase CT's rated current	0.50 – 9.99 – Dis, in 0.01 In steps
tI> 0.05**s**	Time delay of the low set phase overcurrent element.	0.05 – 30 s in steps of 0.01 s
I>> 0.5**In**	Trip level of the high-set overcurrent element in per unit of the phase CT's rated current	0.5 - 20.0 -Dis, in 0.1 In steps
tI>> 0.1**s**	Time delay in seconds of the high-set overcurrent element.	0.05 to 3 seconds in 0.01 second steps
O> 0.02**On**	Tap (trip level) of the low set ground overcurrent element in per unit of the zero sequence sensing CT's rated current	Dis, or 0.02 to 0.4 per unit of On in 0.01 per unit steps
tO> 0.05**s**	Time delay of the low set ground overcurrent element.	0.05 - 30.00 in 0.01 steps
O>> 0.04**On**	Tap (trip level) of the instantaneous ground element in per unit of the zero sequence sensing CT's rated current	Dis, or 0.04 to 2.0 in 0.01 per unit steps
tO>>0.05**s**	Time delay in seconds of the instantaneous ground overcurrent element.	0.05 to 3 seconds in 0.01 second steps
1Is 0.2**It**	Trip level of low-set negative sequence overcurrent element as p.u. of **It**	Dis, 0.02-0.8, in steps of 0.1 **It**.
t1Is 1**s**	Inverse time delay of element **1Is** when Is=It (see curves)t	1-8, in steps of 1 **s**.
2Is 0.2**It**	Trip level of high-set negative sequence overcurrent element as p.u. of **It**	Dis, 0.02-2.0, in steps of 0.1 **It**.
t2Is 0.05**s**	Trip time delay of high set negative sequence overcurrent element	0.05-3, in steps of 0.01 s
tBO .0.05**s**	Max. reset time delay of the instantaneous element after tripping of the delayed element.	0.05 to 0.25 seconds in 0.01 second steps
NodAd 1	Identification number of relay when connected on a serial communication bus.	1 to 250 in steps of 1

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 settings are in regular typeface.

TABLE 3 - Output Relay Programming Display Definitions

Display	Description
I> --3-	Pick-up (or start-time) element associated with the low set (time) phase over current element.
tI> 1---	Time delayed element associated with the low set phase overcurrent element.
I>> --3-	Start-time element associated with the high set phase over current element.
tI>> 1---	Time delayed element associated with the high set phase overcurrent element.
O> ---4	Start-time element associated with the low set ground over current element.
tO> -2--	Time delayed element associated with the low set ground overcurrent element.
O>> ---4	Start-time element associated with the high set ground over current element.
tO>> -2--	Time delayed element associated with the high set ground overcurrent element.
T> 1---	Thermal overload element
Ta -2--	Thermal pre-alarm element.
I^2t 1---	Energy inrush element
t1Is 1---	Inverse time low-set negative sequence overcurrent element
t2Is -2--	Definite time high-set negative sequence overcurrent element
RT 1---	Remote Trip input operates Relay 1
tFRes: A	Reset mode for time delay elements tI>, tI>>, tO>, tO>>, T>, I^2t, t1Is, t2Is. If "A" then reset takes place automatically when the current drops below the pick-up value. When set to "M", reset is only possible via the front panel ENTER/RESET key.

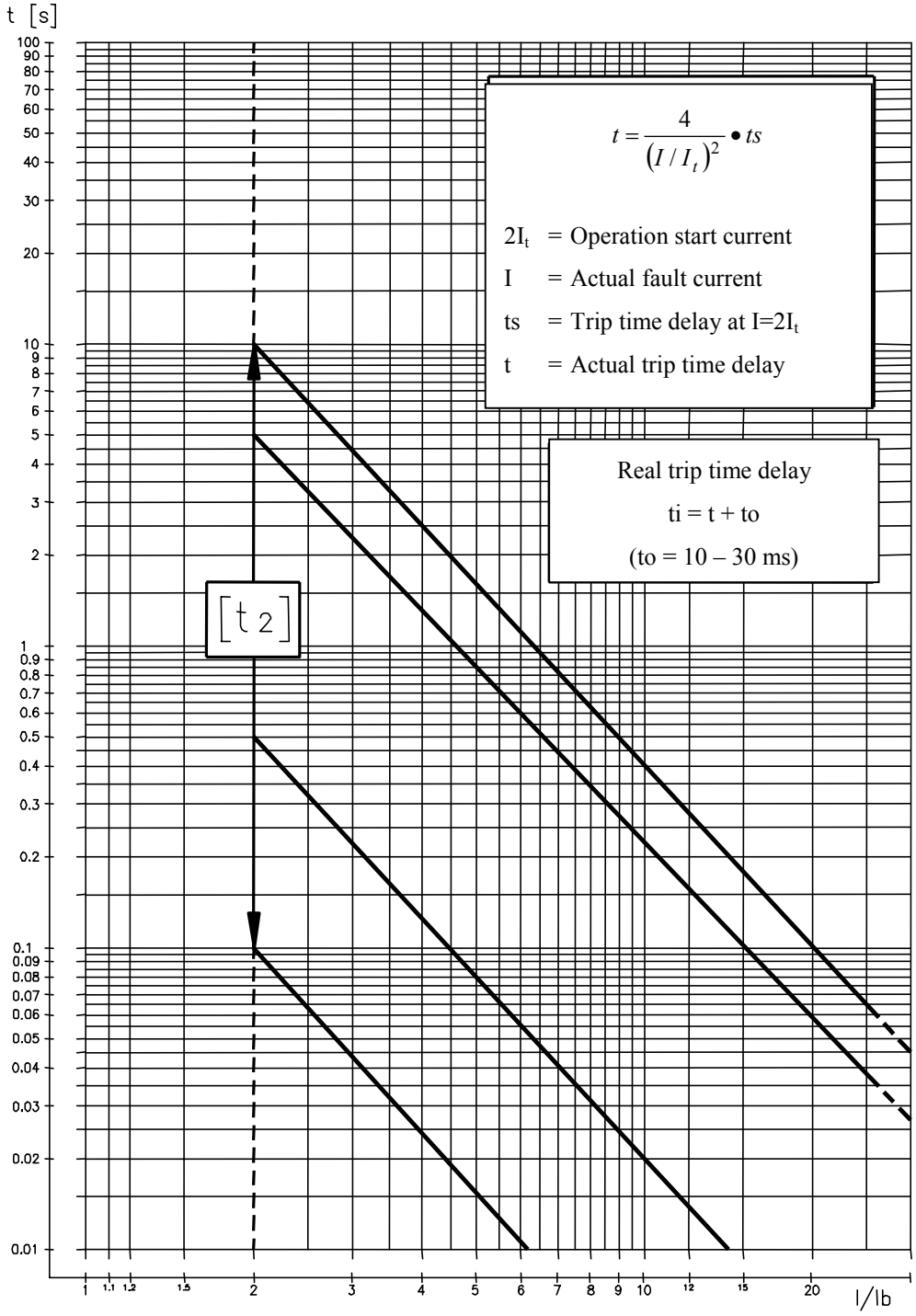
PROGRAMMABLE BLOCKING VARIABLES

In addition to the output relay programming, the **PROGRAM F➔Relay** mode also provides access to four variables which determine which protective elements are affected by the various blocking inputs. Descriptions of these variables are found in Table 4.

TABLE 4: Programming Variables Affecting Blocking Input Behavior

Display	Description
Bf I>> I>	Operation of the phase element blocking input, Bf. Set the display to show which time delayed phase overcurrent elements are to be blocked (if any) when this input is active. I>> corresponds to instantaneous, and I> corresponds to time overcurrent (low set). Terminals 1 and 2
Bo O>>O>	Operation of the ground overcurrent element blocking input, Bo. Set the display to show which time delayed ground overcurrent elements are to be blocked (if any) when this input is active. O>> corresponds to instantaneous, and O> corresponds to time overcurrent (low set). Terminals 1 and 3
tBf 2tBF	The blocking of the phase fault elements can be programmed so that it lasts as long as the blocking input signal is present (tBf=Dis) 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 equal to 2tBF
tBo 2tBF	As above, except for the ground overcurrent blocking input Bo.

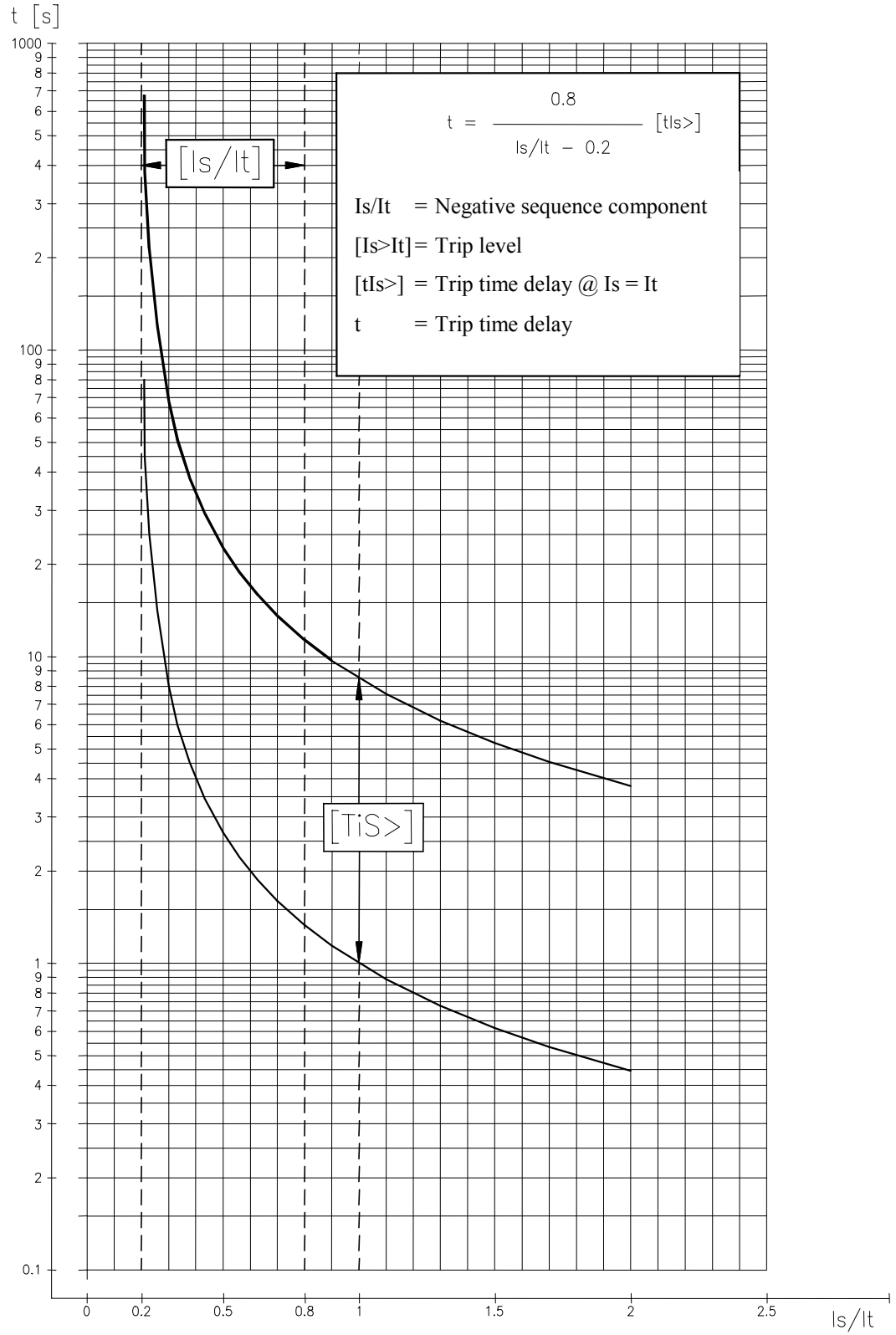
I^2T = CONSTANT ELEMENT



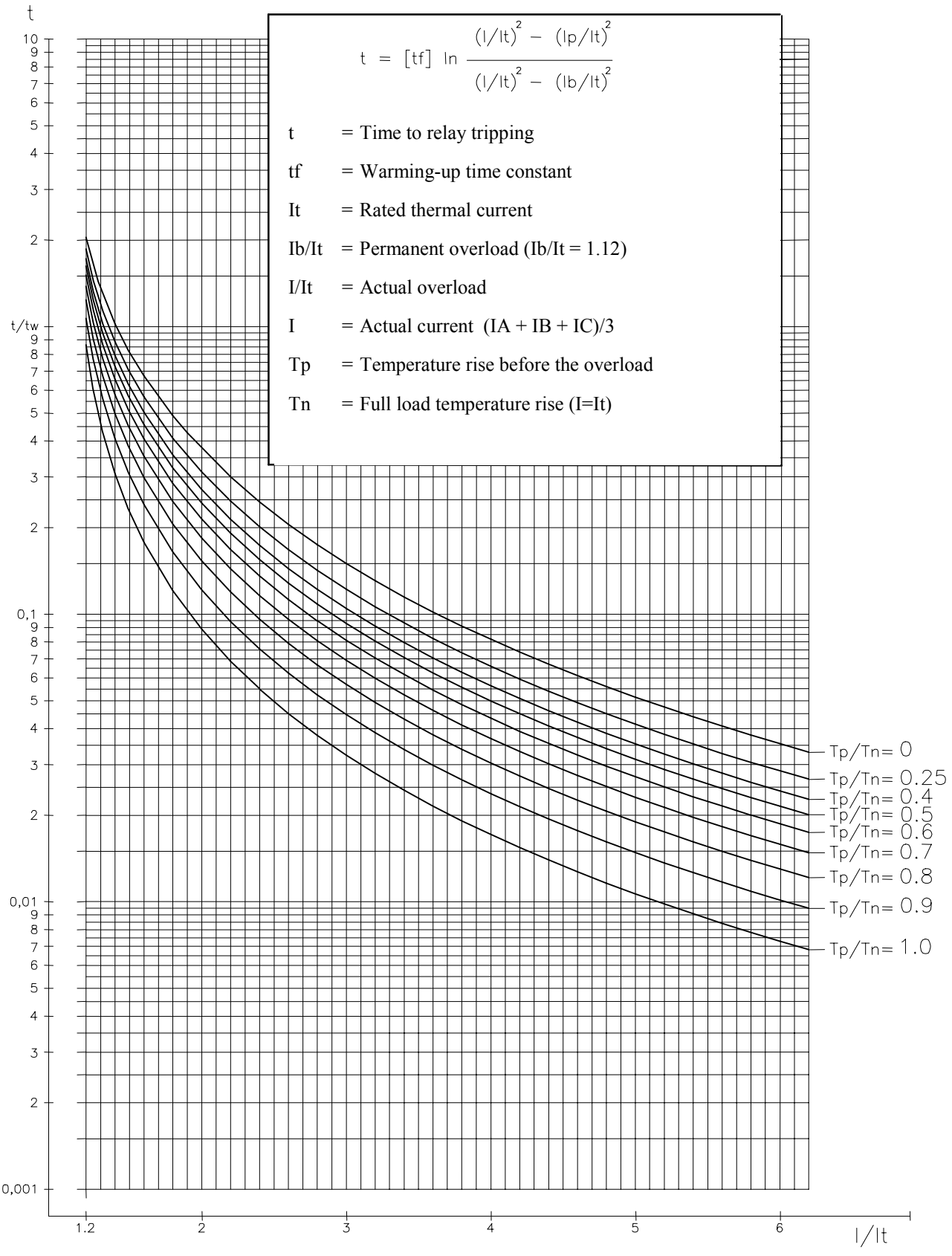
It = (0.5 – 2)In step 0.01In

t = (0.1 – 10)sec. @ I = 2It step 0.1sec.

INVERSE TIME UNBALANCE PROTECTION



OIL/IRON THERMAL IMAGE CURVES



$$t = [tf] \ln \frac{(I/It)^2 - (Ip/It)^2}{(I/It)^2 - (Ib/It)^2}$$

t = Time to relay tripping

tf = Warming-up time constant

It = Rated thermal current

Ib/It = Permanent overload (Ib/It = 1.12)

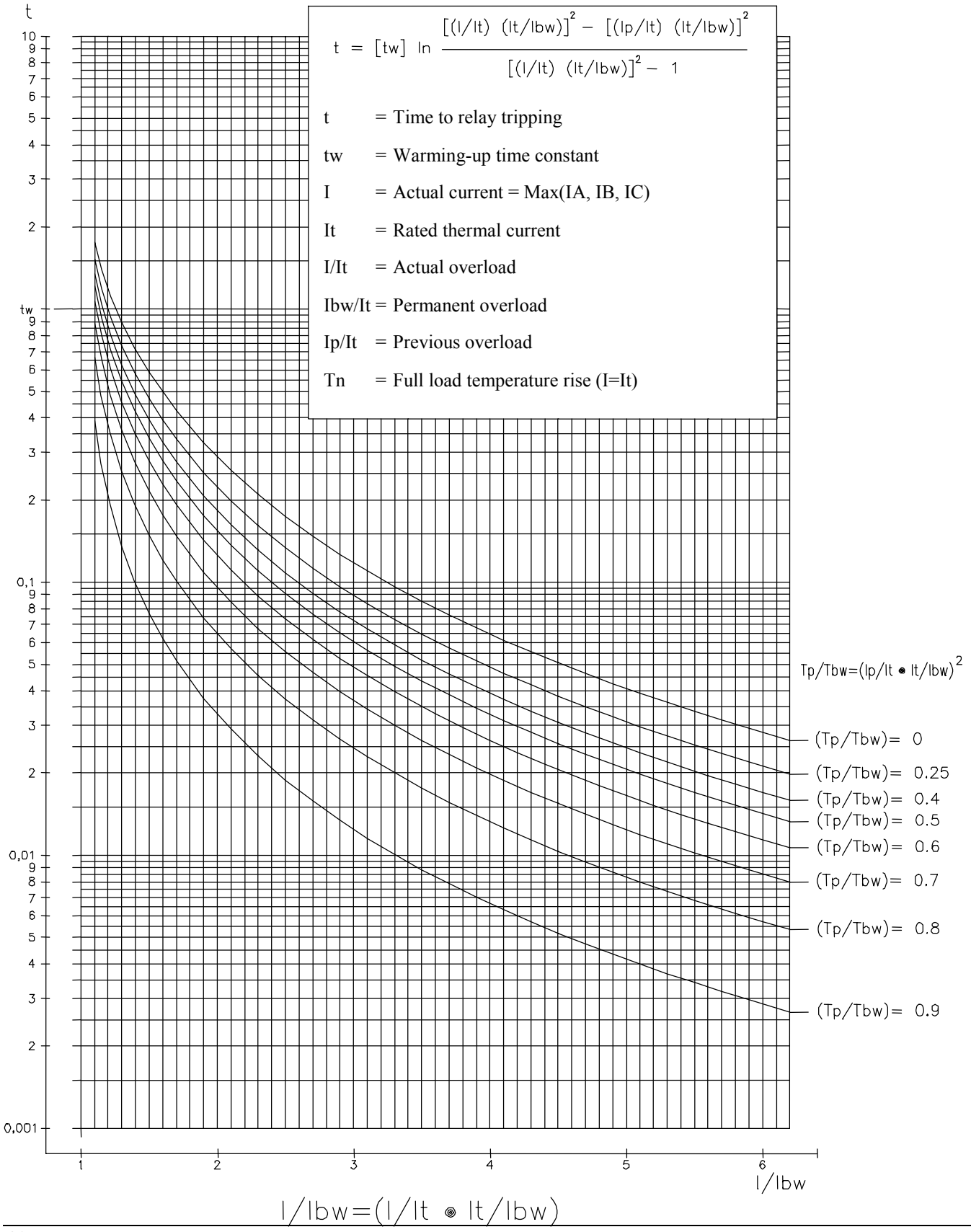
I/It = Actual overload

I = Actual current (IA + IB + IC)/3

Tp = Temperature rise before the overload

Tn = Full load temperature rise (I=It)

WINDINGS' THERMAL IMAGE CURVES



BREAKER FAILURE LOGIC

The IM30-T may be set to back up a downstream breaker through implementation of its breaker failure logic. This logic is implemented via use of the Program Setting variable tBF (See Table 2), and the Blocking Input Variables tB2 and tB3 (see Table 4).

The breaker open timer, tBF, is set to a time delay sufficient to allow opening of the circuit breaker after a trip signal is issued by the downstream relay. The downstream relay must be set to block the operation of the IM30-T's phase and/or ground elements via the external blocking contacts B2 and B3 (see Table 4).

When inputs B2 and B3 are shorted, the operation of the output contacts associated with the IM30-T's phase and ground elements are blocked. If the Breaker Failure time delay settings tB2 (phase) or tB3 (ground) are set to "Dis" for "Disable", the blocking action is permanent and will last as long as the blocking signal is present. This effectively disables the Breaker Failure logic.

If tB2 and/or tB3 are set to "2tBF", then the blocking action will last only for twice as long as the time delay set by the variable tBF. If a blocked trip element remains picked up after a time delay equal to twice tBF, the blocking action is ignored, allowing the IM30-T to trip the appropriate output contact(s) and illuminating the BKR FAIL" LED.

BUS FAULT PROTECTION

The IM30-T relay contains programmable blocking inputs which may be used to implement a very efficient bus fault and feeder backup mechanism without the need for a separate high impedance bus differential relaying system. Bus trip times of 2.5 to 3.0 cycles are typical. This feature is also shared with the other overcurrent relays in the Edison Line, including the IM30BE, IM30DE, IM30DRE, and DM30E relays. The features used on these relays to implement this protection are:

- Programmable phase and ground blocking inputs, B2, and B3
- Phase and ground fault pick-up protective elements, I>, I>>, I_0>, and I_0>>
- Blocking request timers, tB2, and tB3
- Breaker Fail timer, tBF

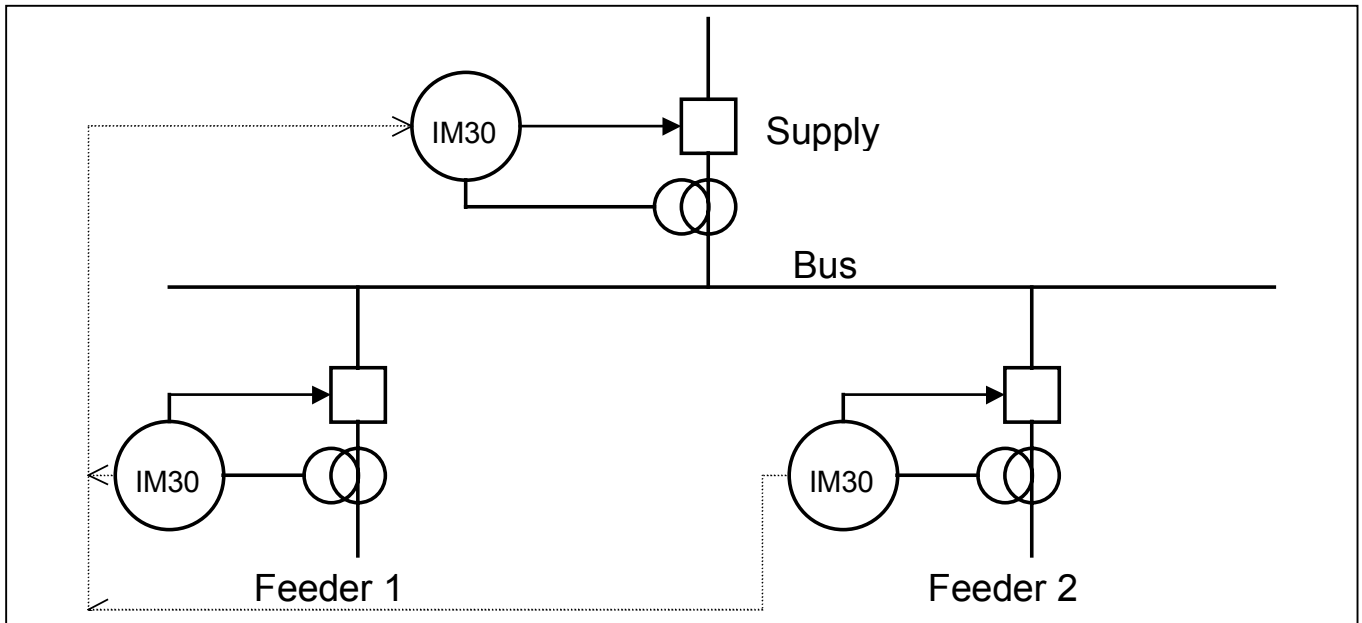


FIGURE 17: Typical Implementation of the IM30-T's Fast Bus Trip Logic

Figure 17 indicates typical application. It is assumed that all relays are set for both phase and ground overcurrent protection. In addition, it is assumed that both low and high set protective elements for both phase and ground elements are used. This document should be considered a guide as to the general methodology required to implement the described functions. It is incumbent upon the user to modify the described procedure as required for any given protective application.

The Supply line and both feeders are protected by any combination of IM30-T, IM30BE, IM30DE, IM30DRE or DM30E relays. The Feeder relays are

set so that the phase pick-up elements, I> and I>> are programmed to operate output contact R3. The ground pick-up elements, I_0>, and I_0>> are all assigned to operate contact R4. These contacts will close immediately when the operating quantity exceeds the pick-up value. These are sometimes referred to as start-time elements.
The output of the Feeder's phase pick-up contact, R3, is then connected to the phase blocking input, B2 (terminals 1 and 2) on the Supply relay. The phase blocking input variable B2 should be programmed to display "B2 I>> I>". This ensures that the Supply relay's low and high set phase elements will be prevented from operating as long as the phase block input is active. The ground overcurrent pick-up element contact R4 is similarly wired to the ground blocking input on terminals 1 and 3 of the Supply relay. The ground blocking input on the Supply relay is programmed to display "B3 O>> O>".
The blocking inputs on the Supply relay may be programmed to honor the blocking request for as long as the blocking input is active, or to ignore the blocking request after a certain period of time equal to twice the programming variable tBF (breaker fail timer). The blocking inputs should be set to honor the blocking request for only a fixed time period by setting the tB2 and tB3 variables to "2tBF". The variable tBF on each of the feeder relays should be set to a time delay equal to their breaker's expected operating time after receiving a trip signal.
The Supply relay should be set for very tight coordination with the Feeder relays to ensure rapid bus fault clearing.
With these connections and settings, the following will occur:

1. If a fault occurs on one of the feeders, the feeder relay will pick-up. The pick-up contact will block the operation of the upstream Supply relay, allowing the Feeder relay to clear the fault.
2. If a bus fault occurs, neither of the Feeder relays will pick-up, therefore the Supply relay will not be blocked and the Supply relay will trip, implementing bus fault protection.
3. If the Feeder relay experiences a breaker fail condition – meaning the breaker has not cleared the fault after the time delay tBF, then the pick-up element of the Feeder relay automatically drops out, removing the blocking signal from the Supply relay, allowing it to trip. This implements a breaker fail back-up function.

   Note that the blocking input blocks the pick-up of the time delayed functions on the Supply relay. Therefore the time delay for the Supply can be set for very fast operation, assuming a bus fault, allowing only enough time delay (10ms[1]) for the pick-up element of the Feeder relay to block the operation of the Supply relay in case of a feeder fault.
4. If the breaker fail function does not operate in the Feeder relay, or if the blocking circuit connection is shorted, then after twice the breaker operating time tBF, as set in the Supply relay, the blocking request will be ignored, allowing the Supply relay to trip. This provides an additional level of back-up.

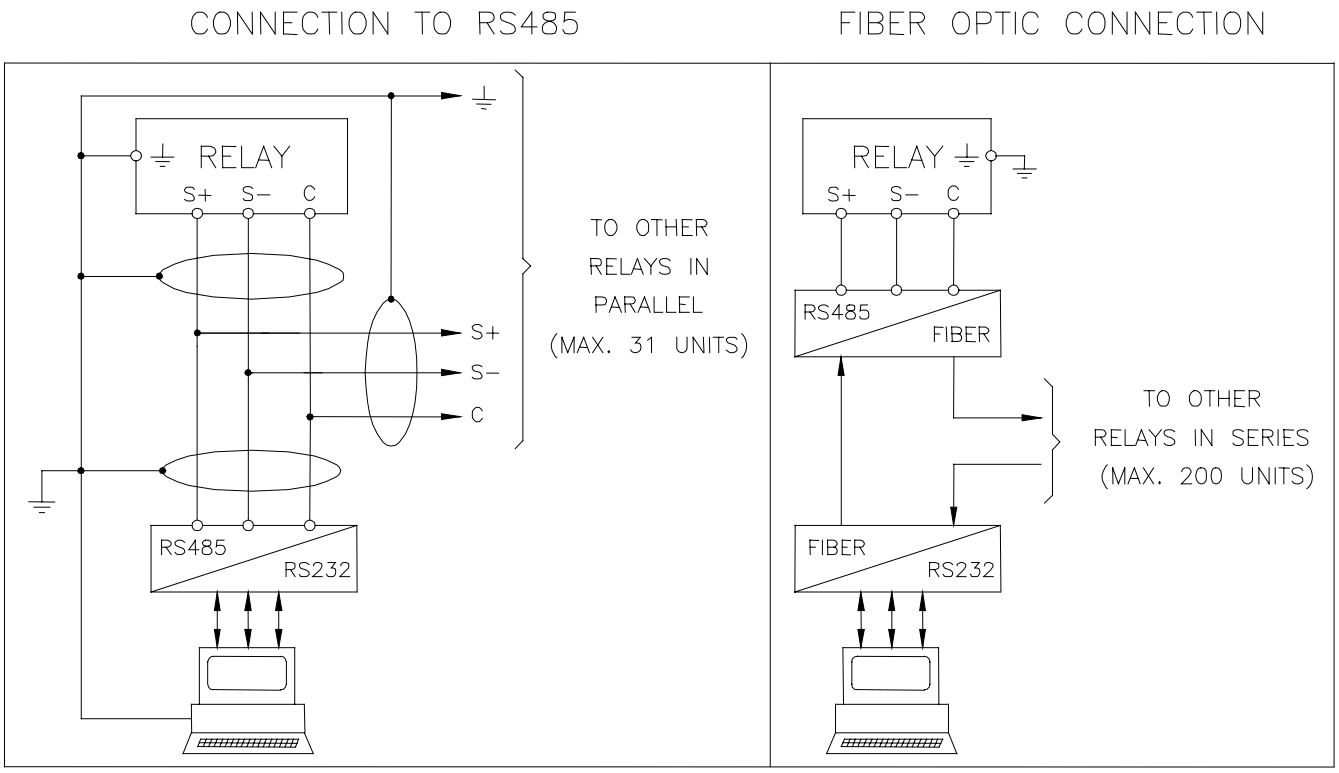
In a similar fashion, the Supply relay may be interconnected with an upstream breaker, effectively implementing fault discrimination and back-up functions for itself.

SERIAL COMMUNICATION (OPTIONAL: SEE RELEVANT INSTRUCTION MANUAL)

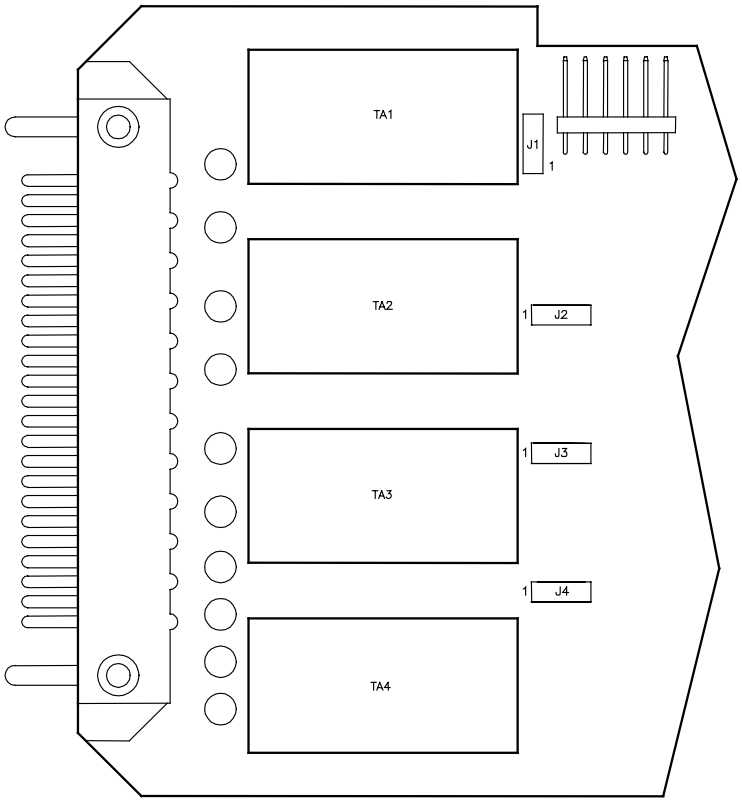
The relays fitted with the serial communication option can be connected via a cable bus or (with proper adapters) a fiber optic bus for interfacing with a Personal Computer (type IBM or compatible).
All the operations which can be performed locally (for example reading of measured data and changing of relay's settings) are also possible via the serial communication interface.
Furthermore the serial port allows the user to read the event recording data and time to a higher precision value.
The unit has a RS232 / RS485 interface and can be connected either directly to a P.C. via a dedicated cable or to a RS485 serial bus, thus having many relays to exchange data with a single master P.C. using the same physical serial line. A RS485/232 converter is available on request.
The communication protocol is MODBUS RTU.
Each relay is identified by its programmable address code (NodeAd) and can be called from the P.C.
A free dedicated communication software EdisonComLite for Windows 95/98 (or later) is available from http://www.cooperpower.com.
Please refer to the EdisonComLite instruction manual for more information.

[1] The output contact of the feeder relay will close in 7-10 msec after it picks up. This is the inherent time delay of the output contact.

WIRING THE SERIAL COMMUNICATION BUS



CHANGE PHASE CURRENT RATED INPUT 1 OR 5A



Connector	Jumper
J1 Phase A	5A / 1A — Rated Input Current
J2 Phase B	Rated Input Current — 5A / 1A
J3 Phase C	Rated Input Current — 5A / 1A
J4 Neutral	Rated Input Current — 5A / 1A

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. Figures 18 and 19 give an overview of the keyboard operation.

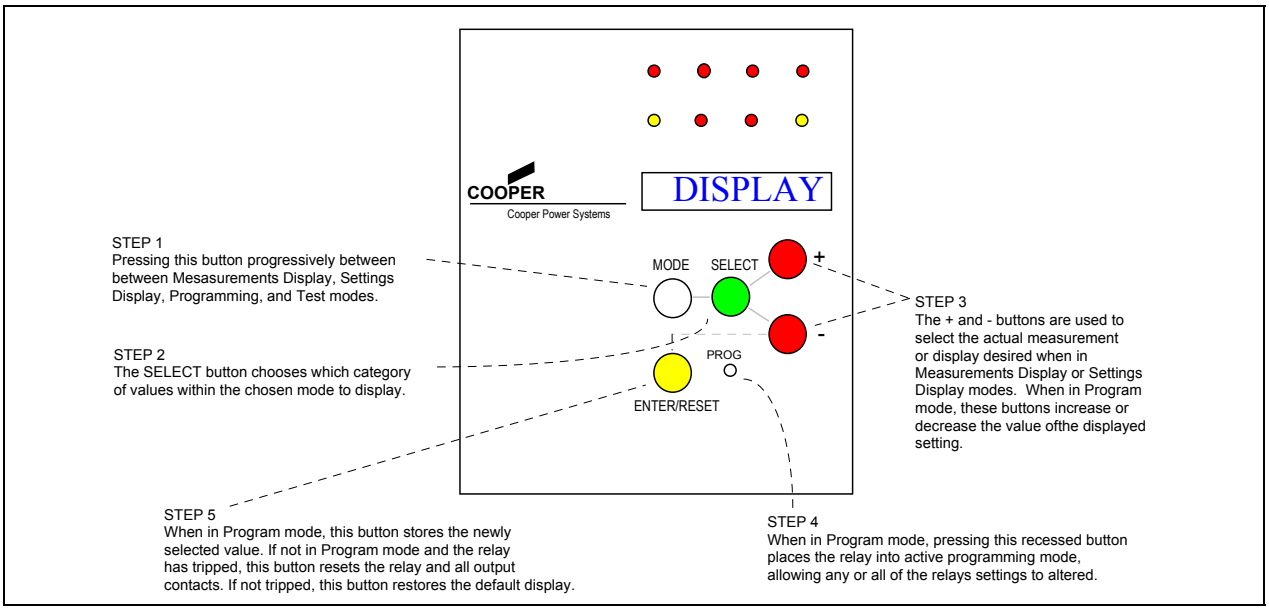


Figure 18: KEYBOARD OPERATION OVERVIEW

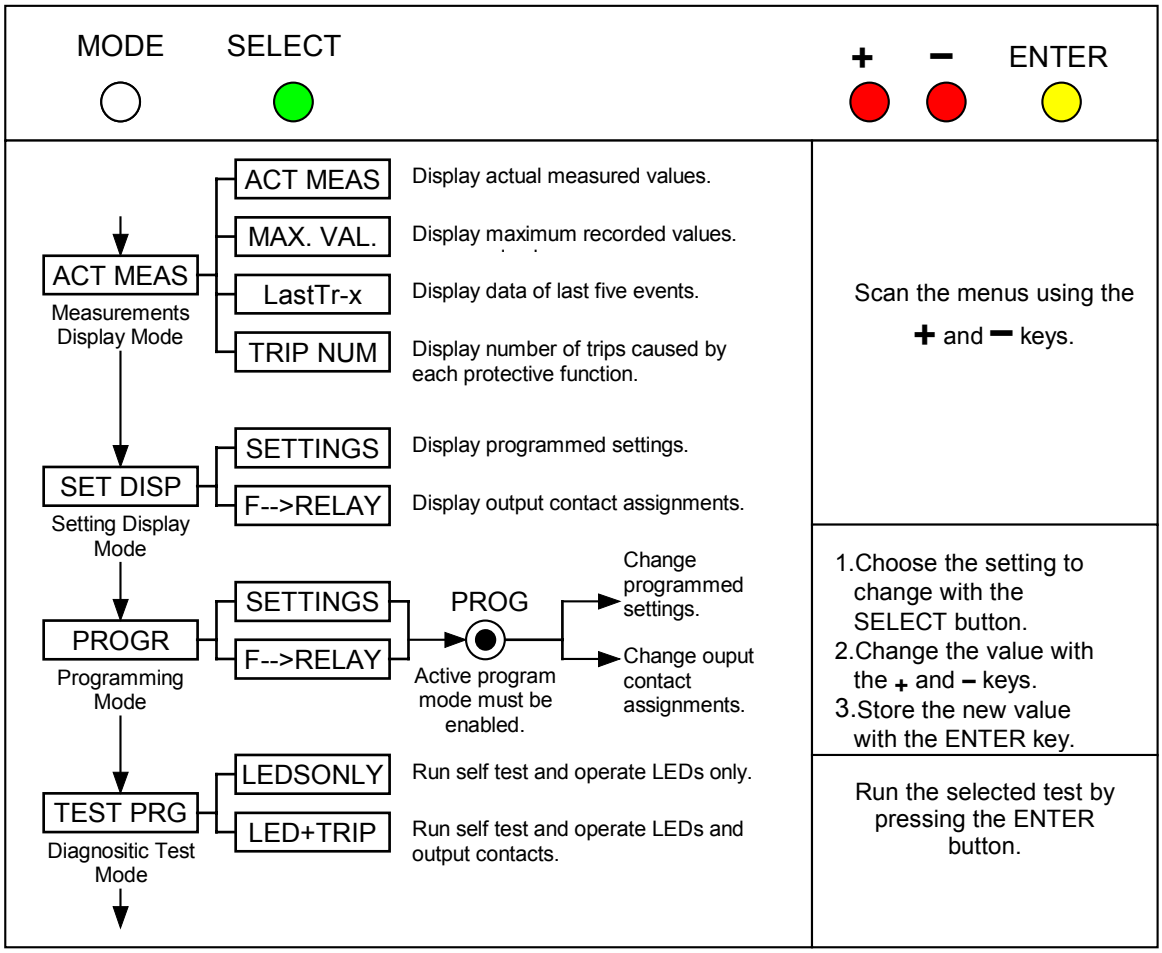


Figure 19: KEYBOARD FUNCTIONAL DIAGRAM

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 program mode, follow these steps:

1. Make sure the input currents are all zero. As a security feature, 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.
2. Press the **MODE** button, to get into **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** button. The **PROGRAM** LED will now be flashing, indicating that **PROGRAM** mode has been successfully entered.

CHANGING A SETTING

Once in active **PROGRAM SETTINGS** mode, you may now change the relay settings. 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 speeded up by pressing the **SELECT** button at the same time the + or — is pressed.
3. When the desired value in 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 programming mode and return the relay to normal operation.

DESCRIPTION OF RELAY SETTING VARIABLES

This section 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 measures displayed. An example of these are variables that define curve shapes.

The default value is shown in regular typeface.

For example:

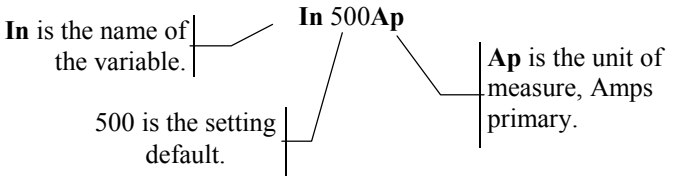


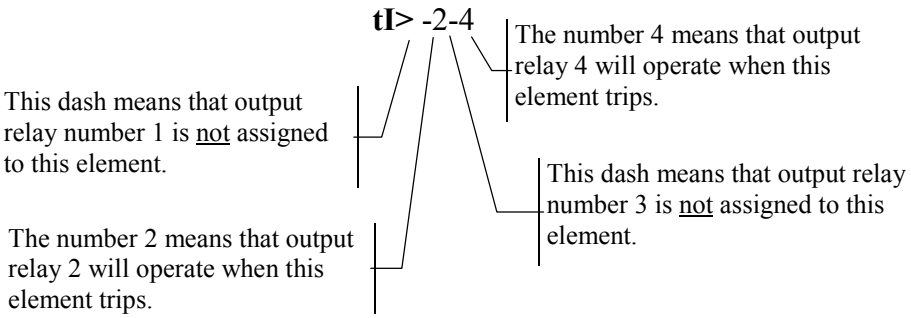
Table 2 details all of the relay setting variables. Please note that Dis indicates that this particular function can be disabled by entering Dis as the setting value.

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 relays 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 whose changes you desire to change.

For example:



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 settings are in regular typeface.

RUNNING THE TEST PROGRAMS

If desired, the start up diagnostic routines may be run at any time by accessing the **TEST PRG** mode. Two tests may be run, both of which are identical except for the effect on the output relays.

1. Press the Mode button until **TEST PRG** is displayed.
2. Select the test to run by pressing the **SELECT** button once to show **W/O TRIP**, or twice to display **WithTRIP**.
   A. If the **W/O TRIP** test is selected, pressing the **ENTER/RESET** button will run the test. All the LEDs should illuminate during the duration of the test. If any error is found, an error code will be displayed and the **RELAY FAIL** light will remain illuminated. The test lasts approximately five seconds. No output relays will be operated or will change status.
   B. If the **WithTRIP** test is selected, pressing the **ENTER/RESET** button will then display **TestRun?.** To run the test the **ENTER/RESET** button must be pressed again. At this point the test will run and all of the output relays will also be operated. The test lasts approximately five seconds.

⚠ CAUTION

Running the **WithTRIP** 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 recommended that this test be run only when all dangerous output connections are removed.

REAL TIME MEASUREMENTS

The normal display of the IM30-T provides automatic scrolling of the three phase currents, the ground current, and the date and time. Display of any one of these quantities may be selected via the front panel. To display the real-time measured values of the relayed quantities, enter the ACT MEAS mode of operation as follows:

1. Press the **MODE** button, to get into **MEASURES** mode.
2. Press the **SELECT** button to select the ACT MEAS mode.
3. Press the + or – buttons to scroll through the available measurements. The data available is summarized in Table 7.

Table 7: AVAILABLE METERED VALUES IN "ACT MEAS" MODE

DISPLAY	MEASURED QUANTITY
I/In	Highest phase current as a percent of the rated line CT primary current
Ia	Phase A RMS current in Amps
Ib	Phase B RMS current in Amps
Ic	Phase C RMS current in Amps
Io	Zero sequence (ground) current in Amps
Tw	Actual windings temperature rise displayed as % of full load (I=[It]) steady state temperature Tn
Tf	Actual oil/iron temperature rise displayed as % of full load (I=[It]) steady state temperature Tn
Id/t	Positive sequence component of phase currents displayed as % of full load current [It]
Is/t	Negative sequence component of phase currents displayed as % of full load current [It]

MAXIMUM VAL

The relay stores the highest value recorded starting 1 s after breaker closing plus inrush values recorded within the first 1 s from breaker closing. Note that these highest values are updated any time the breaker closes.:

1. Press the **MODE** button, to get into **MEASURES** mode.
2. Press the **SELECT** button again to select the **INRUSH** mode. This sets the user up to view the highest values since the breaker closed.
3. Press the + or – buttons to scroll through the event record. The data available is summarized in Table 8.

Table 8: HIGHEST VALUES RECORDED SINCE BREAKER CLOSE

DISPLAY	MEASURED QUANTITY (AMPS RMS[2])
Ia	Maximum phase A RMS current after first sec from energization.
Ib	Maximum phase B RMS current after first sec from energization.
Ic	Maximum phase C RMS current after first sec from energization.
Io	Maximum zero sequence (ground) current after first sec from energization.
Tw	Maximum value recorded of winding temperature rise as % of full load (I=[It]) steady state temperature Tn
Tf	Maximum value recorded of oil/iron temperature rise as % of full load (I=[It]) steady state temperature Tn
Is/t	Maximum value of negative sequence component of phase currents displayed as % of full load current [It]

[2] Unless noted.

DISPLAY	MEASURED QUANTITY (AMPS RMS^2)
Sa	Maximum phase A RMS current during first sec from energization.
Sb	Maximum phase B RMS current during first sec from energization.
Sc	Maximum phase C RMS current during first sec from energization.
So	Maximum zero sequence (ground) current during first sec from energization.
SIs	Maximum value of negative sequence component of phase currents displayed as % of full load current [It] during first sec from energization

LAST TRIP

To display the function which caused the tripping of the relay plus values of the parameters at the instant of tripping. Note the memory buffer is refreshed at each new relay tripping with a total of the last five trip event data being stored:

1. Press the **MODE** button, to get into **MEASURES** mode.
2. Press the **SELECT** button to select the "LAST TRIP" mode.
3. Press the + or – buttons to scroll through the available measurements. The data available is summarized in Table 9.

Table 9 Relay quantities at instant of tripping

DISPLAY	HISTORICAL QUANTITY
Cause:xxxx	"xxxx" is the element which caused the last trip operation as follows: I> ph A A phase low set overcurrent I>>ph A A phase high set overcurrent *Same as above but with "B" or "C" in place of "A" for B or C phase overcurrents.* O> Low set ground overcurrent O>> High set ground overcurrent I^2t Instantaneous overcurrent element 1Is negative sequence level 2Is negative sequence level T> Thermal overload element
Ia	Phase A current in Amps at time of trip
Ib	Phase B current in Amps at time of trip
Ic	Phase C current in Amps at time of trip
Io	Zero sequence (ground) current in Amps at time of trip
Tw	Winding temperature as of full load (I=[It]) steady state temperature Tn at time of trip
Tf	Oil/Iron temperature as of full load (I=[It]) steady state temperature Tn at time of trip
Id/t	Positive sequence current at time of trip
Is/t	Negative sequence current at time of trip

TABLE 9 - AVAILABLE LAST EVENT DATA IN "LASTTR-X

CUMULATIVE TRIP COUNTERS

To display how many times the relay has tripped for each of the protective elements, enter the "TRIP NUM" mode of operation as follows:

4. Press the **MODE** button, to get into **MEASURES** mode.
5. Press the **SELECT** button to select the "TRIP NUM" mode.
6. Press the + or – buttons to scroll through the available measurements. The data available is summarized in Table 10.

Table 10: CUMULATIVE TRIP COUNTER DATA IN "TRIP NUM" MODE

DISPLAY	NUMBER OF TRIPS DUE TO...
I>	Time delayed low set phase overcurrent
I>>	Time delayed high set phase overcurrent
O>	Time delayed low set ground overcurrent
O>>	Time delayed high set ground overcurrent
Tw	Thermal winding
Tf	Thermal oil/iron
I^2t	Inrush energy
1Is	Inverse time low-set negative sequence overcurrent
2Is	Time delayed high-set negative sequence overcurrent
RT	Remote Trip

MAINTENANCE

No maintenance is required. Periodically a functional check-out can be made with the test procedures described under MANUAL TEST chapter. In case of malfunctioning please contact Cooper Power Systems or the local Authorised Dealer mentioning the relay's Serial No reported in the label on relays enclosure.

WARNING

In case of Internal Relay Fault detection, proceed as here-below indicated :

- **If the error message displayed is one of the following “DSP Err”, “ALU Err” ,”KBD Err” ,”ADC Err”, switch off power supply and switch-on again. If the message does not disappear send the relay to Cooper Power Systems (or its local dealer) for repair.**

- If the error message displayed is “E2P Err”, try to program any parameter and then run “W/OTRIP”.
- If message disappear please check all the parameters.

If message remains send the relay to Cooper Power Systems or its local dealer for repair.

SPECIFICATIONS

Operating Temperature Range ..... -20 to +60°C at 95% humidity
Storage Temperature ..... -30 to +80°C
Rated Input Voltage 125V
Voltage Circuits Overload ..... 2.0 pu Continuous
Burden on Voltage Inputs ..... 0.2 VA at rated voltage
Rated Input Current ..... 1 A or 5 A each input dip switch selectble
Burden on Phase Current Inputs 0.2 VA, 1.0 pf at 5 A secondary; 0.01 VA, 1.0 pf at 1 A secondary
Current Circuits Overload ..... 200 A for 1 sec, 10 A Continuous
Dielectric test Voltage ..... 2000 V, 50/60 Hz, 1 minute
Impulse Test Voltage ..... 5 kV commo
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 ± Ave.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)

SETTING SHEET FOR IM30T RELAY

VARIABLE	FACTORY DEFAULT	UNITS	DESCRIPTION	VARIABLE	SETTING	UNITS
Fn	50	**Hz**	System frequency	**Fn**		**Hz**
In	500	**Ap**	Rated primary current of the phase CTs	**In**		**Ap**
On	500	**Ap**	Rated primary current of the CTs or the window CT used for supplying the zero sequence input current	**On**		**Ap**
It	0.5	**In**	Rated current of the thermal element as p.u. of the rated current of phase CTs	**It**		**In**
tw	3	**min**	Thermal time-constant of winding	**tw**		**min**
lbw	1.05	**It**	Continuous permissible winding overload	**lbw**		**It**
tf	10	**min**	Thermal time constant of the oil/iron	**tf**		**min**
t2	0.1	**s**	Trip time delay of the I^2t element when I=2*[It]	**t2**		**s**
Ta/n	50	**%**	Thermal prealarm temperature as % of full load (I=It) steady state temperature Tn	**Ta/n**		**%**
I>	0.5	**In**	Trip level of the low-set overcurrent element in per unit of the phase CT's rated current	**I>**		**In**
tI>	0.05	**s**	Time delay of the low set phase overcurrent element.	**tI>**		**s**
I>>	0.5	**In**	Trip level of the high-set overcurrent element in per unit of the phase CT's rated current	**I>>**		**In**
tI>>	0.1	**s**	Time delay in seconds of the high-set overcurrent element.	**tI>>**		**s**
O>	0.02	**On**	Tap (trip level) of the low set ground overcurrent element in per unit of the zero sequence sensing CT's rated current	**O>**		**On**
tO>	0.05	**s**	Time delay of the low set ground overcurrent element.	**tO>**		**s**
O>>	0.04	**On**	Tap (trip level) of the instantaneous ground element in per unit of the zero sequence sensing CT's rated current	**O>>**		**On**
tO>>	0.05	**s**	Time delay in seconds of the instantaneous ground overcurrent element.	**tO>>**		**s**
1Is	0.2	**It**	Trip level of low-set negative sequence overcurrent element as p.u. of **It**	**1Is**		**It**
t1Is	1	**s**	Inverse time delay of element **1Is** when Is=It (see curves)t	**t1Is**		**s**
2Is	0.2	**It**	Trip level of high-set negative sequence overcurrent element as p.u. of **It**	**2Is**		**It**
t2Is	0.05	**s**	Trip time delay of high set negative sequence overcurrent element	**t2Is**		**s**
tBO	.0.05	**s**	Max. reset time delay of the instantaneous element after tripping of the delayed element.	**tBO**		**s**
NodAd	1	None	Modbus Communication Address	**NodAd**		None

Output Relay Programming Assignments (Accessible via the F➔RELAY program mode.)

I>	- - 3 -	Outputs	Pick-up (or start-time) element associated with the low set (time) phase over current element.	I>		Outputs
tI>	1 - - -	Outputs	Time delayed element associated with the low set phase overcurrent element.	tI>		Outputs
I>>	- - 3 -	Outputs	Start-time element associated with the high set phase over current element.	I>>		Outputs
tI>>	1 - - -	Outputs	Time delayed element associated with the high set phase overcurrent element.	tI>>		Outputs
O>	- - - 4	Outputs	Start-time element associated with the low set ground over current element.	O>		Outputs
tO>	- 2 - -	Outputs	Time delayed element associated with the low set ground overcurrent element.	tO>		Outputs
O>>	- - - 4	Outputs	Start-time element associated with the high set ground over current element.	O>>		Outputs
tO>>	- 2 - -	Outputs	Time delayed element associated with the high set ground overcurrent element.	tO>>		Outputs
T>	1 - - -	Outputs	Thermal overload element	T>		Outputs
Ta	- - - -	Outputs	Thermal pre-alarm element.	Ta		Outputs
I^2t	1 - - -	Outputs	Energy inrush element	I^2t		Outputs
t1Is	1 - - -	Outputs	Inverse time low-set negative sequence overcurrent element	t1Is		Outputs
t2Is	- 2 - -	Outputs	Definite time high-set negative sequence overcurrent element	t2Is		Outputs
RT	1 - - -	Outputs	Remote Trip input operates Relay 1	RT		Outputs
tFRes	A	None	Reset mode for time delay elements tI>, tI>>, tO>, tO>>, T>, I^2t, t1Is, t2Is. If "A" then reset takes place automatically when the current drops below the pick-up value. When set to "M", reset is only possible via the front panel ENTER/RESET key.	tFRes		None
Bf	I>> I>	None		Bf		None
Bo	O>> O>	None		Bo		None
tBf	2tBF	None		tBF		None
tBo	2tBF	None		tBo		None

MANUAL REVISION HISTORY
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