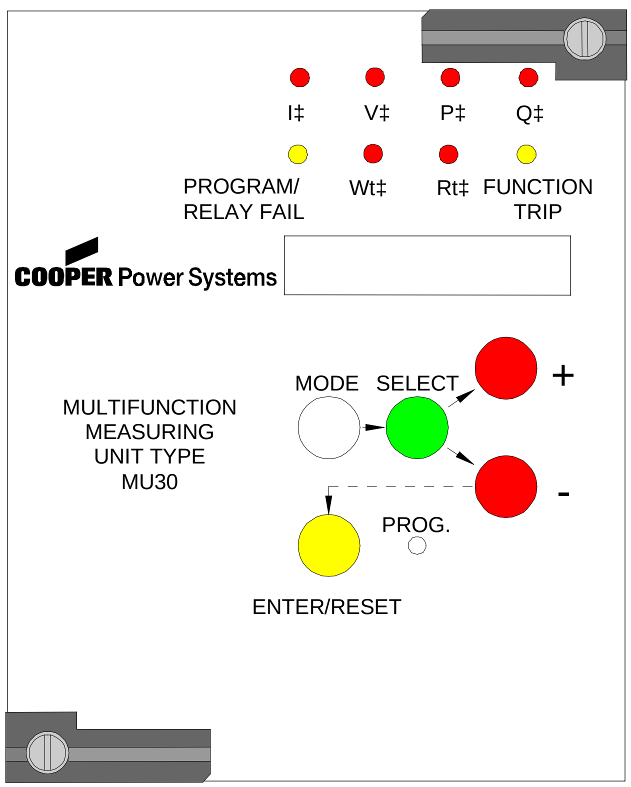
MICROPROCESSOR CONTROLLED MEASUREMENT AND SUPERVISION UNIT TYPE MU30

OPERATIONS MANUAL



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

CONTENTS

1. INTRODUCTION

The MU30 measurement and metering module unit is a member of Cooper Power Systems' Edison Series of microprocessor based protective relays, which provides comprehensive measurement and metering functions from a common measuring point. The MU30 is ideal for obtaining any type of metered value on a bus or feeder. Measured values are displayed on the front panel of the MU30, or may be accessed via MODBUS for use in a SCADA or data logging system. The ability to operate output contacts based on any measured quantity makes the MU30 an extremely flexible device for a variety of applications. These applications include reverse power, reactive or voltage based control, frequency based load shedding, transformer overload (MVA) alarms, and so on. Any of the protective elements may be disabled if not required for a given application. The functions provided by the MU30 are:

- Inputs for three phase currents and three phase to ground voltages.
- Comprehensive voltage, current, real power (W), reactive power (VAR), apparent power (VA), power factor, frequency, kilowatt-hour, and kVAR-hour measurements.
- Demand metering for currents, real power, reactive power, apparent power, kW-Hours, and kVAR-Hours.
- Two under/over instantaneous voltage elements (27/59).
- Two under/over instantaneous frequency elements (81U/810).
- Two under/over instantaneous current elements (37I/50).
- Two under/over instantaneous power elements.
- Two under/over instantaneous active power elements.
- Two under/over instantaneous reactive power elements.
- Two under/over instantaneous apparent power elements.
- Two watt-hour instantaneous threshold elements.
- Two active energy instantaneous threshold elements.
- Two reactive energy instantaneous threshold elements.
- Time synchronization input.
- Single event, triggered, 12 cycle oscillographic captures of all six input channels.

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 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 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.

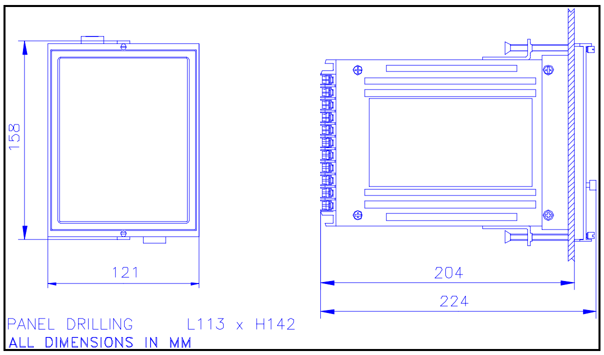


FIGURE 1: SINGLE MODULE ENCLOSURE MOUNTING

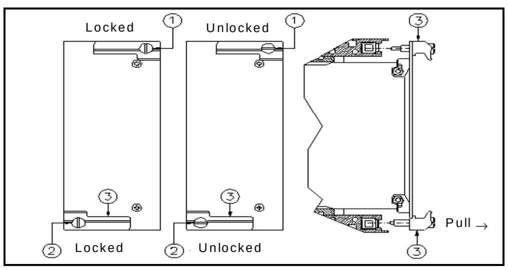


FIGURE 2: LATCH MECHANISM FOR REMOVAL OF RELAY FROM CASE

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

Input quantities are supplied to three current transformers and to three potential transformers measuring phase currents and phase-to-neutral voltages. Rated secondary current inputs can be either 1 or 5A.

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

Auxiliary Power is supplied via terminals 12 and 13, with the 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 1. The input supply voltage is noted on the relay case. 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 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 of the relay's terminals will accept up to a No. 6 stud size spade connector (or any type of lug up to 0.25" (6.3mm) wide), 12 AWG wire (4 mm²), or FASTON connectors. Electrical connections must be made in accordance with the relay's wiring connection diagram shown in Figure 4.

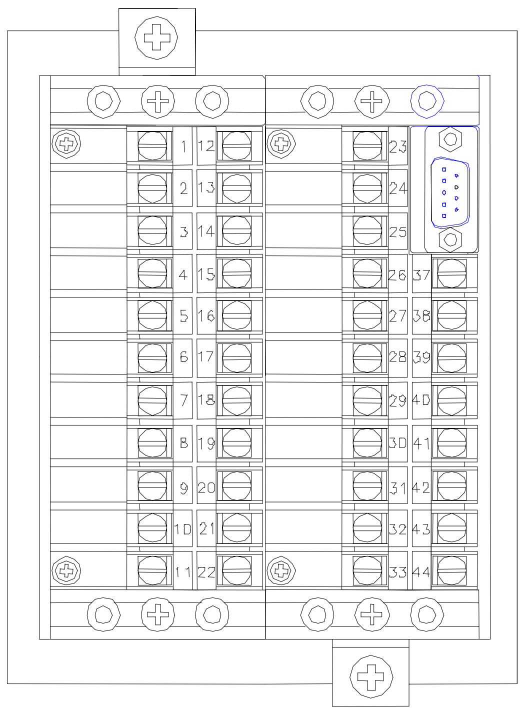


FIGURE 3: REAR VIEW OF TERMINAL CONNECTIONS

In Figure 4 the numbers next to the circles along the functional diagram of the relay indicate the terminal numbers on the back of the relay as shown in Figure 3. The PT inputs must be in Y-N form and in the phase rotation shown.

The relay is shipped with the CT inputs set for either 1A or 5A nominal inputs. The ninth character of the relay's part number will either be "1" or "5" indicating the factory set input secondary current rating. If the CT input rating needs to be changed, for any of the CT inputs, this may be accomplished via jumpers on the relay's main circuit board (See Section 7).

5. CONNECTION DIAGRAM

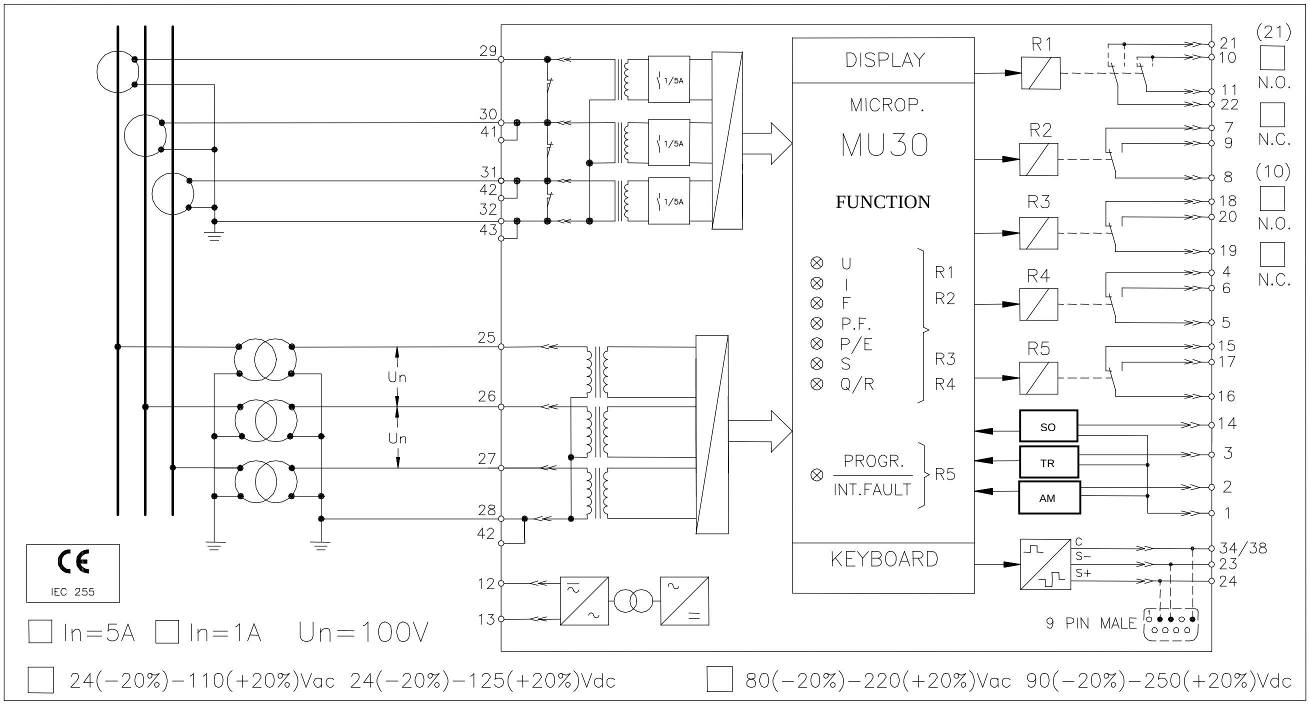


FIGURE 4: Wiring Diagram for the MU30

6. WIRING THE SERIAL COMMUNICATION BUS

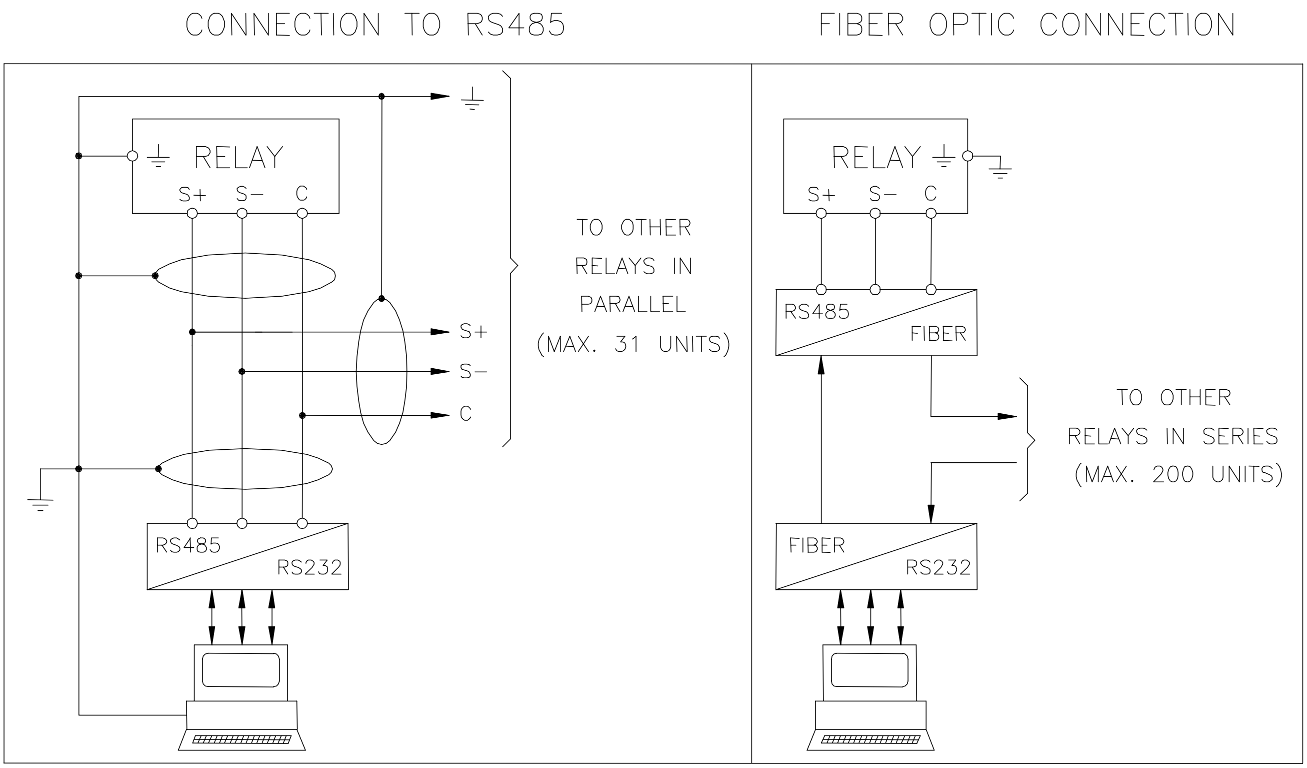


FIGURE 5: Wiring the Serial Communication Bus

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

Input quantities are supplied to three current transformers and three potential transformers respectively measuring phase currents and phase-to-neutral voltages.

Phase current input can be 1 or 5A (movable jumpers on relay's card). Rated voltage input can be programmed from 100 to 125V (phase to phase) 50 or 60Hz.

Make electric connections in conformity with the diagram reported on the relay's enclosure. Check that the input currents are the same as those reported on the diagram and on the test certificate. The auxiliary power is supplied by a built-in interchangeable module that is fully isolated and self-protected.

Input rated current is set to 1A or 5A by the three dip-switches provided on the relay's card (A-B-C), as shown in Figure 6.

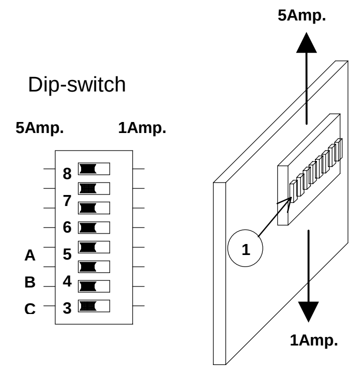


Figure 6: Setting 1A or 5A CT inputs.

8. OUTPUT RELAYS

Five output relays are available (R1, R2, R3, R4, R5).

a) - The output relays **R1, R2, R3, R4** are normally de-energized (energized on trip).

Reset of the output relays can be programmed as AUTOMATIC or MANUAL. In AUTOMATIC mode, reset takes place as soon as the tripping cause disappears. In MANUAL mode, a reset common has to be issued to the relay by the ENTER/RESET push button or via the serial communications interface.

The R3 output relay can be configured to toggle its status with a frequency that is proportional to the currently measured active power. A 1Hz square wave corresponds to the nominal active power. If R3 is employed for this particular function, it can not be associated to any other element.

b) - The output relay R5 is normally energized, is not programmable and it is de-energized during:

- internal fault
- power supply failure
- programming of the relay.

9. TARGET DESCRIPTION

The front panel of the MU30 consists of eight LEDs that are normally OFF and which act as the targets for the relay elements. See Figure 7 for identification of the targets. The top row of four targets, A, B, C, D correspond respectively to the current, voltage or frequency, active power and reactive power under, over or under/over property for each element. These targets illuminate on trip of one of their elements. The targets F and G correspond respectively to the active energy and reactive energy elements that will illuminate for a trip of the elements based upon integration over a definite time above the trip level set by the user. Target E flashes during relay programming or for an internal relay fault. Target H flashes for an overflow of any of the measured quantities. Table 2 summarizes the target functions.

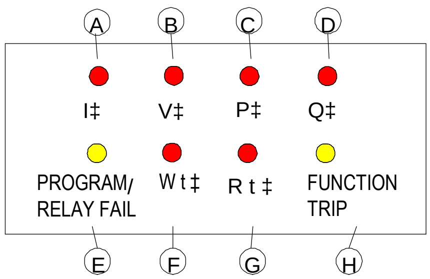


FIGURE 7: FRONT PANEL TARGETS ON THE MU30

TABLE 2: TARGET DESCRIPTION

TARGET ID	COLOR	LEGEND	DESCRIPTION
A	Red	I‡	Illuminated on trip of one of the current elements (under, over or under/over).
B	Red	V‡	Illuminated on trip of one of the voltage or frequency elements (under, over or under/over).
C	Red	P‡	Illuminated on trip of one of the active power elements (under, over or under/over).
D	Red	Q‡	Illuminated on trip of one of the reactive power elements (under, over or under/over).
E	Yellow	PROGRAM/ RELAY FAIL	Flashes during relay programming or internal fault.
F	Red	Wt‡	Illuminated on trip of one of the active energy elements (under, over or under/over).
G	Red	Rt‡	Illuminated on trip of one of the reactive energy elements (under, over or under/over).
H	Yellow	FUNCTION TRIP	Flashes on overflow of any of the measured quantities.

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 or via the serial communication interface.

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.

10. 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 8 and 9 give an overview of the keyboard operation.

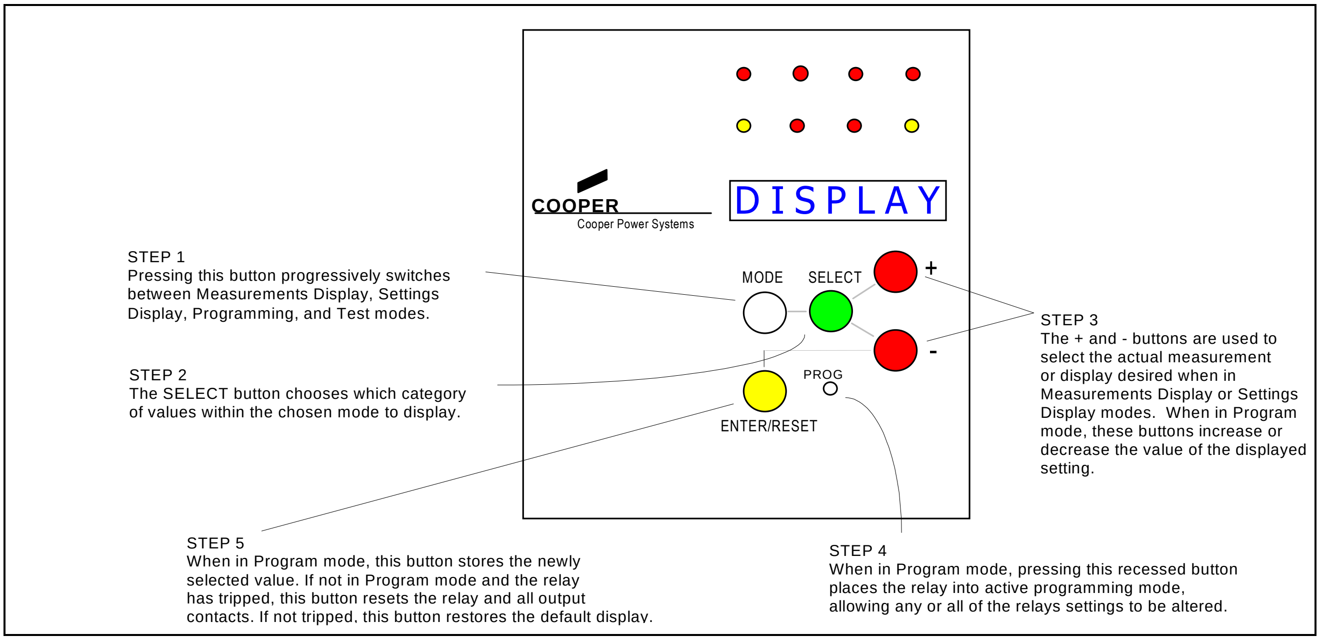


FIGURE 8: Keyboard Operation Overview

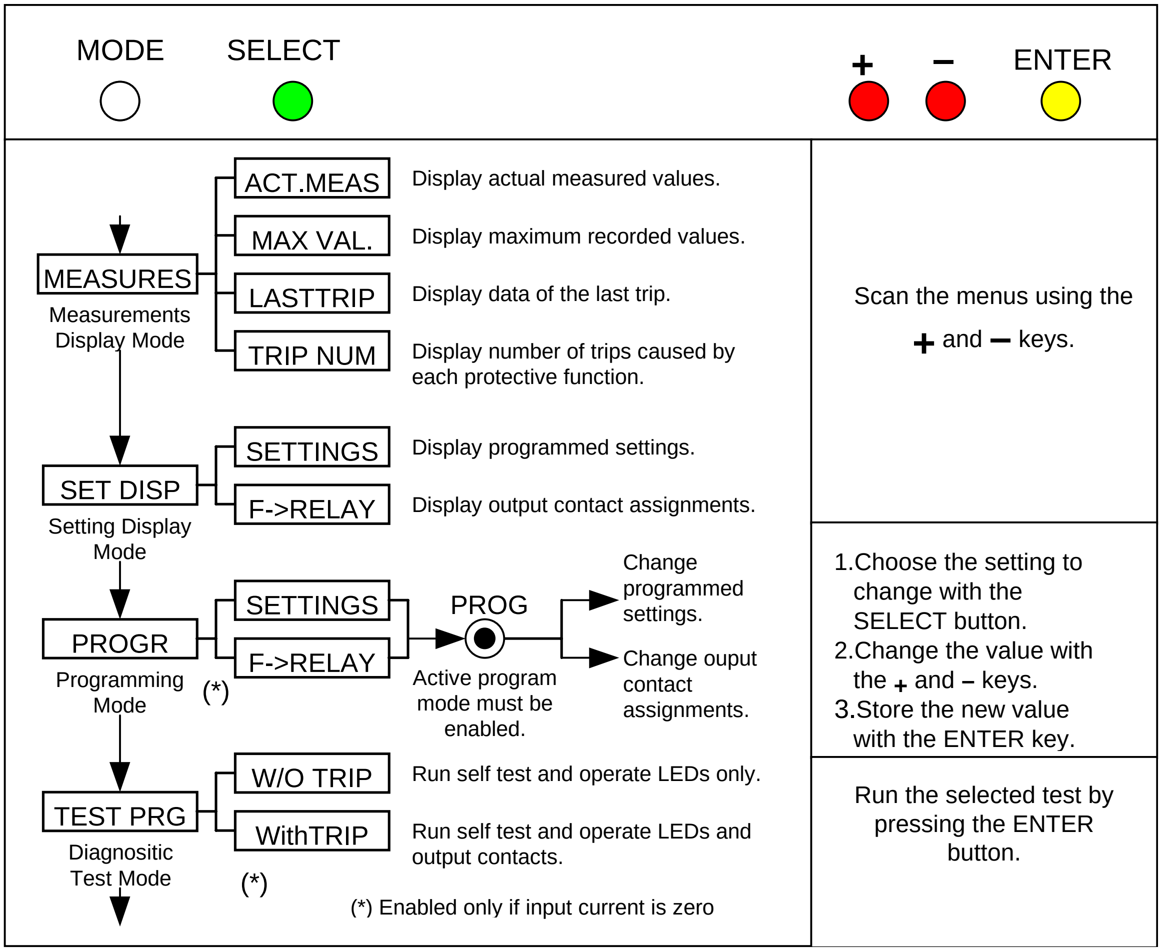


FIGURE 9: KEYBOARD MENU STRUCTURE

11. 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 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, then 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** button. The **PROGRAM** LED will now be flashing, indicating that the **PROGRAM** mode has been successfully entered.

11.1 CHANGING A SETTING

Once you have entered the active PROGRAM SETTINGS mode, relay settings may be changed. For instructions on changing the output relay assignments, see the section titled: Changing Output Relay Assignments (11.3).

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 change rate may be sped up by pressing the SELECT button at the same time the + or – button is pressed.
3. When the desired value in displayed, press the ENTER/RESET button to store the new setting for each 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.

11.2 DESCRIPTION OF RELAY SETTING VARIABLES

Table 3 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. Examples of these are variables that define under, over, or under/over function operations.

The Relay Setting Display menu does not display the current date and time.

The default value is shown in regular typeface.

For example:

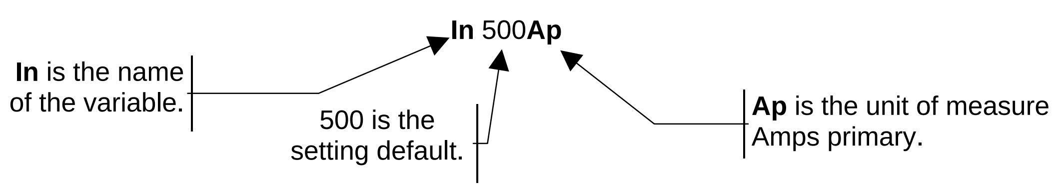


TABLE 3: PROGRAM SETTING VARIABLES

DISPLAY	DESCRIPTION	SETTING RANGE
xxxxxxx	Current Date	DDMMMYY
xx:xx:xx	Current Time	HH:MM:SS
TsynDis**m**	Synchronized Time Signal: The expected time interval between synchronization pulses is received from the SO input (terminals 1 and 14). Setting it to IRIG-B sets the relay up to receive IRIG-B time signals. "Dis" disables the time synch.	5, 10, 15, 30, or 60 minutes or IRIG-B or Dis
Fn 60 **Hz**	System frequency	50 or 60 Hz
In 500**Ap**	Rated primary current of the phase CTs.	1 to 9999 in 1A steps
UnP 10**kV**	Rated primary phase-phase voltage of the systems PT's.	10 to 655 in 1kV steps
UnS 100**V**	Rated secondary phase-phase voltage of the systems PT's.	100 to 125 in 1V steps
Tint 15**m**	Energy integration time.	5 to 15 in 1 minute steps
WOUT OFF	Enable pulse output for external energy counters.	OFF – ON
Un Dis**1u**	First voltage element operation mode: + = overvoltage - = undervoltage -/+ = under/overvoltage Dis. = Function is disabled.	+, -, -/+, Dis.
1u 90%**Un**	This is the % difference from Un for the first voltage control element.	5 to 90 in 1% Un steps.
Un Dis**2u**	Second voltage element operation mode: + = overvoltage - = undervoltage -/+ = under/overvoltage Dis. = Function is disabled.	+, -, -/+, Dis.
2u 90%**Un**	This is the % difference from Un for the second voltage control element.	5 to 90 in 1% Un steps.
Fn Dis**1f**	First frequency element operation mode: + = overfrequency - = underfrequency -/+ = under/overfrequency Dis. = Function is disabled.	+, -, -/+, Dis.
1f9.99**Hz**	This is the Hertz difference from Fn for the first frequency control element.	0.05 to 9.99 in 0.01 Hz steps.
Fn Dis**2f**	Second frequency element operation mode: + = overfrequency - = underfrequency -/+ = under/overfrequency	+, -, -/+, Dis.

DISPLAY	DESCRIPTION	SETTING RANGE
	Dis. = Function is disabled.	
2f9.99**Hz**	This is the Hertz difference from Fn for the second frequency control element.	0.05 to 9.99 in 0.01 Hz steps.
InDis**1i**	First current element operation mode: + = overcurrent - = undercurrent -/+ = under/overcurrent Dis. = Function is disabled.	+, -, -/+, Dis.
1i 95%**In**	This is the % difference from In for the first current control element.	5 to 95 in 1% In steps.
In Dis**2i**	Second current element operation mode: + = overcurrent - = undercurrent -/+ = under/overcurrent Dis. = Function is disabled.	+, -, -/+, Dis.
2i 95%**In**	This is the % difference from In for the second current control element.	5 to 95 in 1% In steps.
Pn Dis**1p**	First active power element operation mode: + = overpower - = underpower -/+ = under/overpower Dis. = Function is disabled.	+, -, -/+, Dis.
1p 95%**Pn**	This is the % difference from Pn for the first active power control element.	5 to 95 in 1% Pn steps.
Pn Dis**2p**	Second active power element operation mode: + = overpower - = underpower -/+ = under/overpower Dis. = Function is disabled.	+, -, -/+, Dis.
2p 95%**Pn**	This is the % difference from Pn for the second active power control element.	5 to 95 in 1% Pn steps.
Qn Dis**1q**	First reactive power element operation mode: + = overpower - = underpower -/+ = under/overpower Dis. = Function is disabled.	+, -, -/+, Dis.
1q 95%**Qn**	This is the % difference from Qn for the first reactive power control element.	5 to 95 in 1% Qn steps.
Qn Dis**2q**	Second reactive power element operation mode: + = overpower - = underpower -/+ = under/overpower Dis. = Function is disabled.	+, -, -/+, Dis.

DISPLAY	DESCRIPTION	SETTING RANGE
2q 95%**Qn**	This is the % difference from Qn for the second reactive power control element.	5 to 95 in 1% Qn steps.
Sn Dis**1s**	First apparent power element operation mode: + = overpower - = underpower -/+ = under/overpower Dis. = Function is disabled.	+, -, -/+, Dis.
1s 95%**Sn**	This is the % difference from Sn for the first apparent power control element.	5 to 95 in 1% Sn steps.
Sn Dis**2s**	Second apparent power element operation mode: + = overpower - = underpower -/+ = under/overpower Dis. = Function is disabled.	+, -, -/+, Dis.
2s 95%**Sn**	This is the % difference from Sn for the second apparent power control element.	5 to 95 in 1% Sn steps.
1w Dis**Wtn**	This is the trip level of the first active energy element.	5 to 95 in 1% Wtn steps or Dis..
2w Dis**Wtn**	This is the trip level of the second active energy element.	5 to 95 in 1% Wtn steps or Dis..
1r Dis**Qtn**	This is the trip level of the first reactive energy element.	5 to 95 in 1% Qtn steps or Dis..
2r Dis**Qtn**	This is the trip level of the second reactive energy element.	5 to 95 in 1% Qtn steps or Dis..
NodAd 1	Identification number of relay when connected on a serial communication bus.	1 to 250 in steps of 1

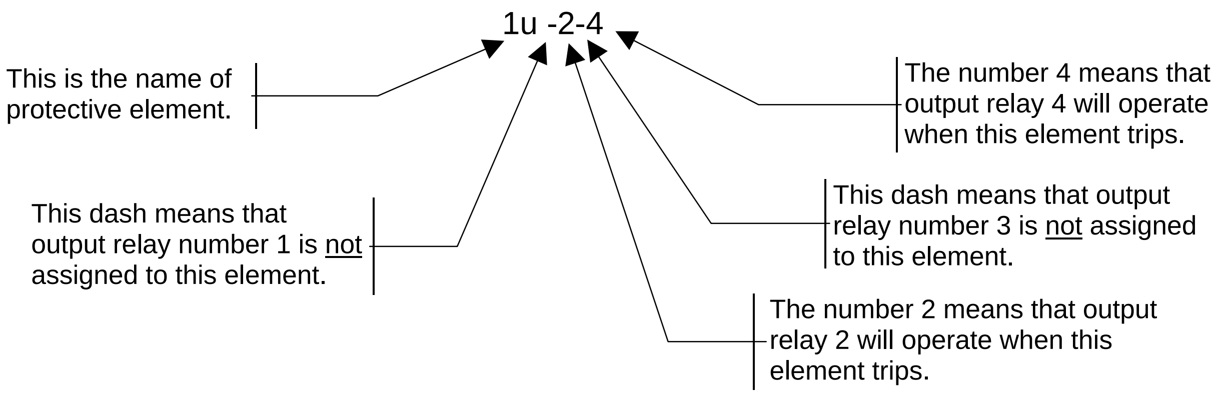
11.3 CHANGING OUTPUT RELAY ASSIGNMENTS

Output relays 1 through 4 may be assigned to any protective element, or any combination of 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:



11.4 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 4 - OUTPUT RELAY PROGRAMMING DISPLAY DEFINITIONS

DISPLAY	DESCRIPTION
1u ----	1st voltage element operates relays R1, R2, R3, R4
2u ----	2nd voltage element operates relays R1, R2, R3, R4
1f ----	1st frequency element operates relays R1, R2, R3, R4
2f ----	2nd frequency element operates relays R1, R2, R3, R4
1i ----	1st current element operates relays R1, R2, R3, R4
2I ----	2nd current element operates relays R1, R2, R3, R4
1p ----	1st active power element operates relays R1, R2, R3, R4
2p ----	2nd active power element operates relays R1, R2, R3, R4
1q ----	1st reactive power element operates relays R1, R2, R3, R4
2q ----	2nd reactive power element operates relays R1, R2, R3, R4
1s ----	1st apparent power element operates relays R1, R2, R3, R4
2s ----	2nd apparent power element operates relays R1, R2, R3, R4
1w ----	1st active energy element operates relays R1, R2, R3, R4
2w ----	2nd active energy element operates relays R1, R2, R3, R4
1r ----	1st reactive energy element operates relays R1, R2, R3, R4
2r ----	2nd reactive energy element operates relays R1, R2, R3, R4
tFRes: M	Reset mode of output relays (M = manual, A = automatic)

11.5 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 "-".

Pushing the ENTER button while the ACT.MEAS menu is active makes the relay enter the AUTOMATIC DISPLAY SCROLLING mode. While running in this mode, the unit cyclically displays all the available measurements for 5 seconds each. If the ENTER button is pressed again, the relay switches back to the normal display mode (the UP and DOWN buttons have to be pressed to scroll the menu).

11.5.1 ACT.MEAS

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

Table 5 – Actual Measurements Display

DISPLAY	DESCRIPTION
xxxxxxx	Current date in the DDMMMYY format.
xx:xx:xx	Current time in the HH:MM:SS format.
F--.--Hz	Input Frequency
Ia----0**A**	True R.M.S. values of the phase A current displayed as primary Amps.
Ib----0**A**	As above, phase B
Ic----0**A**	As above, phase C
I-----0**A**	Average phase current ((IA+IB+IC)/3)
Ea----0**V** **EA**xx.x**KV** **EA** xxx**KV**	True R.M.S. values of the phase A voltage (phase to neutral) displayed as primary volts (or kV).
Eb----0**V** **EB**xx.x**KV** **EB** xxx**KV**	As above, phase B
Ec----0**V** **EC**xx.x**KV** **EC** xxx**KV**	As above, phase C
E-----0**V** **E** x.xx**KV** **E** xxx**KV**	Average phase to neutral voltage ((EA+EB+EC)/3), displayed as primary volts (or kV)
UAB---0**V** **UAB**xx.x**K** **UAB** xxx**K**	True R.M.S. value of the A to B voltage displayed as primary volts (or kV)
UBC---0**V** **UBC**xx.x**K** **UBC** xxx**K**	True R.M.S. value of the B to C voltage displayed as primary volts (or kV)
UCA---0**V** **UCA**xx.x**K** **UCA** xxx**K**	True R.M.S. value of the C to A voltage displayed as primary volts (or kV)
U-----0**V** **U** x.xxx**k** **U** xxxx**K**	Average phase to phase voltage displayed as primary volts (or kV).
coφA+.++	Phase A power factor
coφB+.++	As above, phase B
coφC+.++	As above, phase C
coφ-+.++	Average power factor ((cosφA + cosφB + cosφC)/3)
Sa----0**K** **SA**xxx.x**M** **SA**xxxxx**M** **SA**xxx.x**G**	Apparent power of phase A, displayed as primary kVA (or MVA or GVA)

DISPLAY	DESCRIPTION
SB----0**K** **SB**xxx.x**M** **SB**xxxxx**M** **SB**xxx.x**G**	As above, phase B
SC----0**K** **SC**xxx.x**M** **SC**xxxxx**M** **SC**xxx.x**G**	As above, phase C
S-----0**K** **S** xxx.x**M** **S** xxxxx**M** **S** xxx.x**G**	Total apparent power (SA + SB + SC), displayed as primary kVA (or MVA or GVA)
PA----0**K** **PA** xx.x**M** **PA** xxxx**M** **PA** xx.x**G**	Active power of phase A, displayed as primary kW (or MW or GW)
PB----0**K** **PB** xx.x**M** **PB** xxxx**M** **PB** xx.x**G**	As above, phase B
PC----0**K** **PC** xx.x**M** **PC** xxxx**M** **PC** xx.x**G**	As above, phase C
P-----0**K** **P** xxx.x**M** **P** xxxxx**M** **P** xxx.x**G**	Total active power (PA + PB + PC) displayed as primary kW (or MW or GW)
QA----0**K** **QA** xx.x**M** **QA** xxxx**M** **QA** xx.x**G**	Reactive power of phase A, displayed as primary kVAR (or MVAR or GVAR)
QB----0**K** **QB** xx.x**M** **QB** xxxx**M** **QB** xx.x**G**	As above, phase B
QC----0**K** **QC** xx.x**M** **QC** xxxx**M** **QC** xx.x**G**	As above, phase C

DISPLAY	DESCRIPTION
Q-----0**K** **Q** xxx.x**M** **Q** xxxxx**M** **Q** xxx.x**G**	Total reactive power (SA + SB + SC) displayed as primary kVAR (or MVAR or GVAR)
Wh---0**Kh** **Wh** x.x**Mh** **Wh** xxx**Mh** **Wh** x.x**Gh** **Wh** xxx**Gh**	Total active energy, displayed as kWh (or MWh or GWh)
Rh---0**Kh** **Rh** x.x**Mh** **Rh** xxx**Mh** **Rh** x.x**Gh** **Rh** xxx**Gh**	Total reactive energy, displayed as KVARh (or MVARh or GVARh)
Wt---0**Kh** **Wt** x.x**Mh** **Wt** xxx**Mh** **Wt** x.x**Gh** **Wt** xxx**Gh**	Active energy (integrated over a definite time T_{int}), displayed as kWh (or MWh or GWh)
Rt---0Kh **Rt** x.x**Mh** **Rt** xxx**Mh** **Rt** x.x**Gh** **Rt** xxx**Gh**	Reactive energy (integrated over a definite time T_{int}), displayed as kVARh (or MVARh or GVARh)

11.5.2 MAX VAL

These are the time stamped maximum demand values. The values can be reset via the AM digital input or via the serial communication interface.

TABLE 6: MAXIMUM VALUES DISPLAY

DISPLAY	DESCRIPTION
xxxxxxx	Date of the last MAX VAL reset (in the DDMMMYY format)
xx:xx:xx	Time of the last MAX VAL reset (in the HH:MM:SS format)
Ia----0**A**	Maximum phase A current, displayed as primary A
00:00:00	Time between the last MAX VAL reset and the recording of the IA maximum demand value.
Ib----0**A**	Maximum phase A current, displayed as primary A
00:00:00	Time between the last MAX VAL reset and the recording of the IB maximum demand value.

DISPLAY	DESCRIPTION
Ic----0**A**	Maximum phase C current, displayed as primary A
00:00:00	Time between the last MAX VAL reset and the recording of the IC maximum demand value.
S-----0**K** **S** xxx.x**M** **S** xxxxx**M** **S** xxx.x**G**	Maximum total apparent power, displayed as primary KVA (or MVA or GVA)
00:00:00	Time between the last MAX VAL reset and the recording of the S maximum demand value.
P-----0**K** **P** xxx.x**M** **P** xxxxx**M** **P** xxx.x**G**	Maximum total active power, displayed as primary kW (or MW or GW)
00:00:00	Time between the last MAX VAL reset and the recording of the P maximum demand value.
Q-----0**K** **Q** xxx.x**M** **Q** xxxxx**M** **Q** xxx.x**G**	Maximum total reactive power, displayed as primary KVAR (or MVAR or GVAR)
00:00:00	Time between the last MAX VAL reset and the recording of the Q maximum demand value.
Wt---0**Kh** **Wt** x.x**Mh** **Wt** xxx**Mh** **Wt** x.x**Gh** **Wt** xxx**Gh**	Maximum value of active energy integrated over a definite time, displayed as primary kWh (or MWh or GWh)
00:00:00	Time between the last MAX VAL reset and the recording of the Wt maximum demand value.
Rt---0**Kh** **Rt** x.x**Mh** **Rt** xxx**M**h **Rt** x.x**Gh** **Rt** xxx**Gh**	Maximum value of reactive energy integrated over a definite time, displayed as primary kVARh (or MVARh or GVARh)
00:00:00	Time between the last MAX VAL reset and the recording of the Rt maximum demand value.

11.5.3 LASTTRIP

This is the display of the function that caused the tripping of the relay plus values of the parameters at the moment of tripping.

TABLE 7: Last Trip Display

DISPLAY	DESCRIPTION
Cau: ----	Function which produced the last event being displayed: 1f, 2f, 1u, 2u, 1I, 2I, 1p, 2p, 1q, 2q, 1s, 2s, 1w, 2w, 1r, 2r
F--.--Hz	Frequency
IA----0**A**	Phase A current, display as primary A
IB----0**A**	As above, phase B
IC----0**A**	As above phase C
EA----0**V** **EA**xx.x**KV** **EA** xxx**KV**	Phase A voltage, displayed as primary V (or kV)
EB----0**V** **EB**xx.x**KV** **EB** xxx**KV**	As above, phase B
EC----0**V** **EC**xx.x**KV** **EC** xxx**KV**	As above, phase C
coφA-.00	Phase A power factor
coφB-.00	Phase B power factor
coφC-.00	Phase C power factor

11.5.4 TRIP NUM

This feature is the tallying of operations for each of the relay functions.

TABLE 8: Trip Number Display

DISPLAY	DESCRIPTION
1u-----0	1st voltage element
2u-----0	2nd voltage element
1f-----0	1st frequency element
2f-----0	2nd frequency element
1i-----0	1st current element
2i-----0	2nd current element
1p-----0	1st active power element
2p-----0	2nd active power element
1q-----0	1st reactive power element
2q-----0	2nd reactive power element
1s-----0	1st apparent power element
2s-----0	2nd apparent power element
1w-----0	1st active energy element
2w-----0	2nd active energy element
1r-----0	1st reactive energy element
2r-----0	2nd reactive energy element

12. SERIAL COMMUNICATION

The relay which is 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 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. Furthermore, the serial port allows the user to read the oscillographic recording data. 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.

13. DIGITAL AND TIME SYNCHRONIZATION INPUTS

13.1 DIGITAL INPUTS

The relay is fitted with three digital inputs that are activated when the relevant terminals are shorted by a cold contact:

- AM (terminals 1-2): MAX VAL reset. When this input is activated all the recorded maximum values are instantaneously reset.

- TR (terminals 1-3): Trigger input for oscillographic recording. When this input is activated the built-in oscillographic recorder is triggered.

- SO (terminals 1-14): Synchronize. When this input is activated, the unit's clock-calendar is synchronized. See the Tsyn setting on page 13.

13.2 CLOCK AND CALENDAR

The unit features a built in clock calendar with Years, Months, Days, Hours, Minutes, Seconds, Tenths of a second and Hundredths of a second.

13.2.1 Clock synchronization.

The clock can be synchronised via the SO digital input (terminals 1 – 14) or the serial communication interface.
By programming the variable (T_{syn} = 5', 10', 15', 30', 60', IRIG-B, Dis) Synchronization can be achieved in several different manners:

a)	T_{syn} = Dis:	The current date can only be modified manually either via the front panel keyboard (SETTING MENU) or via the serial communication interface (programming mode).
b)	T_{syn} = IRIG-B:	The date is automatically updated by the IRIG-B input signal.
c)	T_{syn} = 5', 10', 15', 30', 60':	The date is updated via the serial interface as follows :

The unit expects to receive a sync signal at the beginning of every hour and once every T_{syn} minutes. When a sync signal is received, the clock is automatically set to the nearest expected synchronization time.
For example: if T_{syn} is 10min and a sync signal is received at 20:03:10 January the 10th, 98, then the clock is set to 20:00:00 January the 10th, 1998. On the other hand, if the same sync signal were received at 20:06:34, the clock would be set to 20:10:00, January the 10th 98.
Note that if a sync signal is received exactly in the middle of a T_{syn} period, the clock is set to the previous expected synchronization time.

13.2.2 Date and time setting

When the PROG/SETTINGS menu is entered, the current date is displayed with one of the groups of digits (YY, MMM or DD) blinking. The DOWN key operates as a cursor.

It moves through the groups of digits in the sequence.

YY => MMM => DD => YY =>.

The UP key allows the user to modify the currently blinking group of digits. If the ENTER button is pressed the currently displayed date is captured. Pressing the SELECT button leaves the current date unchanged and scrolls the SETTINGS menu. Present time can now be modified using the same procedure described above.

If synchronization is enabled and the date (or time) is modified, then the clock is stopped until a sync signal is received (via digital input or the serial port). This allows the user to manually set many units and have them start their clocks in a synchronized fashion.

If synchronization is disabled the clock continues to run.

Note that the setting of a new time always clears 10ths and 100ths of a second.

13.2.3 Time resolution

The clock has a 10ms resolution. This means that any event can be time-stamped with a 10ms resolution, although the information concerning 10ths and 100ths of a second can be accessed only via the serial communication interface.

14. 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.

No maintenance is required. Periodically a functional checkout can be made with the test procedures described under Section 15. In case of a malfunctioning relay, please contact Cooper Power Systems mentioning the relay's Model Type and Serial Number. The Serial Number is reported on the label in the relay's enclosure.

WARNING

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

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 for repair.

If the error message displayed is “E2P Err”, send the relay to Cooper Power Systems for repair.

15. RUNNING THE TEST PROGRAMS

15.1 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.

15.2 MODE "TESTPROG" SUBPROGRAM "WITHTRIP"

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

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

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

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

! 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.

16. 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, 1.2x50 µsec wave
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 50/60 Hz magnetic field..1000 A/m
Immunity to impulse magnetic field...1000 A/m 8 x 20 µsec
Immunity to magnetic burst...100 A/m over 100 - 1000kHz range
Resistance to vibration.. 2g from 10 -500 Hz
Rear Connection Terminals .... Up to 12AWG ($4mm^2$) 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)

ACCURACY

Voltage and current measurements are accurate to better than 1.0%. Power and power factor calculations are accurate to within 2%. Energy measurements (kW-Hour, etc) accuracy varies with the length of the energy calculation window and whether the MU30 clock is allowed to free-run, or whether it is tied to a synchronizing signal. Frequency measurement resolution is 0.01 Hz.

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Variable	Factory default	Units	Description	Range	Step	Setting
xxxxxxx	Casual value	**DDMMM YY**	Current Date			
xx:xx:xx	Casual value	**HH:MM: SS**	Current Time			
Tsyn	IRIG	**Minutes**	Synchronized Time Signal: The expected time interval between synchronization pulses. Setting it to IRIG-B sets the relay up to receive IRIG-B time signals. "Dis" disables the time synch.	5, 10, 15, 30 or 60 minutes or IRIG-B or Dis		
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	1.0	
UnP	10	**kV**	Rated primary phase-phase voltage of the system's PTs	10 to 655 kV	10	
UnS	100	**V**	Rated secondary phase-phase voltage of the system's PTs	100 to 125 V	1.0	
Tint	15	**m**	Energy integration time	5 to 15 minutes	1.0	
WOUT	OFF	-----	Enable pulse output for external energy counters	Off – On		
Un	Dis	**1u**	First voltage element operation mode: + = overvoltage - = undervoltage -/+ = under/overvoltage Dis. = Function is disabled.	+, -, -/+, Dis.		
1u	90	**%Un**	This is the % difference from Un for the first voltage control element.	5 to 90% Un	1%	
Un	Dis	**2u**	Second voltage element operation mode: + = overvoltage - = undervoltage -/+ = under/overvoltage Dis. = Function is disabled.	+, -, -/+, Dis.		
2u	90	**%Un**	This is the % difference from Un for the second voltage control element.	5 to 90% Un	1%	

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Variable	Factory default	Units	Description	Range	Step	Setting
Fn	Dis	**1f**	First frequency element operation mode: + = overfrequency - = underfrequency -/+ = under/overfrequency Dis. = Function is disabled.	+, -, -/+, Dis.		
1f	9.99	**Hz**	This is the Hertz difference from Hz for the first frequency control element.	0.05 to 9.99 Hz	0.01	
Fn	Dis	**2f**	Second frequency element operation mode: + = overfrequency - = underfrequency -/+ = under/overfrequency Dis. = Function is disabled.	+, -, -/+, Dis.		
2f	9.99	**Hz**	This is the Hertz difference from Hz for the second frequency control element.	0.05 to 9.99 Hz	0.01	
In	Dis	**1i**	First current element operation mode: + = overcurrent - = undercurrent -/+ = under/overcurrent Dis. = Function is disabled.	+, -, -/+, Dis.		
1i	95	**%In**	This is the % difference from In for the first current control element.	5 to 95% In	1%	
In	Dis	**2i**	Second current element operation mode: + = overcurrent - = undercurrent -/+ = under/overcurrent Dis. = Function is disabled.	+, -, -/+, Dis.		
2i	95	**%In**	This is the % difference from In for the second current control element.	5 to 95% In	1%	
Pn	Dis	**1p**	First power element operation mode: + = overpower - = underpower -/+ = under/overpower Dis. = Function is disabled.	+, -, -/+, Dis.		
1p	95	**%Pn**	This is the % difference from Pn for the first active power control element.	5 to 95% Pn	1%	

M30DRE Setting Sheet Page 3 of 5

Variable	Factory default	Units	Description	Range	Step	Setting
Pn	Dis	**2p**	Second power element operation mode: + = overpower - = underpower -/+ = under/overpower Dis. = Function is disabled.	+, -, -/+, Dis.		
2p	95	**%Pn**	This is the % difference from Pn for the second active power control element.	5 to 95% Pn	1%	
Qn	Dis	**1q**	First reactive power element operation mode: + = overpower - = underpower -/+ = under/overpower Dis. = Function is disabled.	+, -, -/+, Dis.		
1q	95	**%Qn**	This is the % difference from Qn for the first reactive power control element.	5 to 95% Qn	1%	
Qn	Dis	**2q**	Second reactive power element operation mode: + = overpower - = underpower -/+ = under/overpower Dis. = Function is disabled.	+, -, -/+, Dis.		
2q	95	**%Qn**	This is the % difference from Qn for the second reactive power control element.	5 to 95% Qn	1%	
Sn	Dis	**1s**	First apparent power element operation mode: + = overpower - = underpower -/+ = under/overpower Dis. = Function is disabled.	+, -, -/+, Dis.		
1s	95	**%Sn**	This is the % difference from Sn for the first apparent power control element.	5 to 95% Sn	1%	
Sn	Dis	**2s**	Second apparent power element operation mode: + = overpower - = underpower -/+ = under/overpower Dis. = Function is disabled.	+, -, -/+, Dis.		
2s	95	**%Sn**	This is the % difference from Sn for the second reactive power control element.	5 to 95% Sn	1%	

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Variable	Factory default	Units	Description	Range	Step	Setting
1w	Dis	**Wtn**	This is the trip level of the first active energy element.	5 to 95% Wtn, or Dis.	1%	
2w	Dis	**Wtn**	This is the trip level of the second active energy element.	5 to 95% Wtn, or Dis.	1%	
1r	Dis	**Qtn**	This is the trip level of the first reactive energy element.	5 to 95% Qtn, or Dis.	1%	
2r	Dis	**Qtn**	This is the trip level of the second active energy element.	5 to 95% Qtn, or Dis.	1%	
NodAd	1	---	Modbus communication Address.	1 to 250	1	

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OUTPUT RELAY PROGRAMMING ASSIGNMENTS (ACCESSIBLE VIA THE F➔Relay PROGRAM MODE.)					
Variable	**Factory default**	**Units**	**Description**	**Range**	**Setting**
1u	- - - -	Outputs	First voltage element operates output relays	1 2 3 4	
2u	- - - -	Outputs	Second voltage element operates output relays	1 2 3 4	
1f	- - - -	Outputs	First frequency element operates output relays	1 2 3 4	
2f	- - - -	Outputs	Second frequency element operates output relays	1 2 3 4	
1i	- - - -	Outputs	First current element operates output relays	1 2 3 4	
2i	- - - -	Outputs	Second current element operates output relays	1 2 3 4	
1p	- - - -	Outputs	First active power element operates output relays	1 2 3 4	
2p	- - - -	Outputs	Second active power element operates output relays	1 2 3 4	
1q	- - - -	Outputs	First reactive power element operates output relays	1 2 3 4	
2q	- - - -	Outputs	Second reactive power element operates output relays	1 2 3 4	
1s	- - - -	Outputs	First apparent power element operates output relays	1 2 3 4	
2s	- - - -	Outputs	Second apparent power element operates output relays	1 2 3 4	
1w	- - - -	Outputs	First active energy element operates output relays	1 2 3 4	
2w	- - - -	Outputs	Second active energy element operates output relays	1 2 3 4	
1r	- - - -	Outputs	First reactive energy element operates output relays	1 2 3 4	
2w	- - - -	Outputs	Second reactive energy element operates output relays	1 2 3 4	
tFRes	A	---	Reset mode for time delay elements. 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.	A, M	