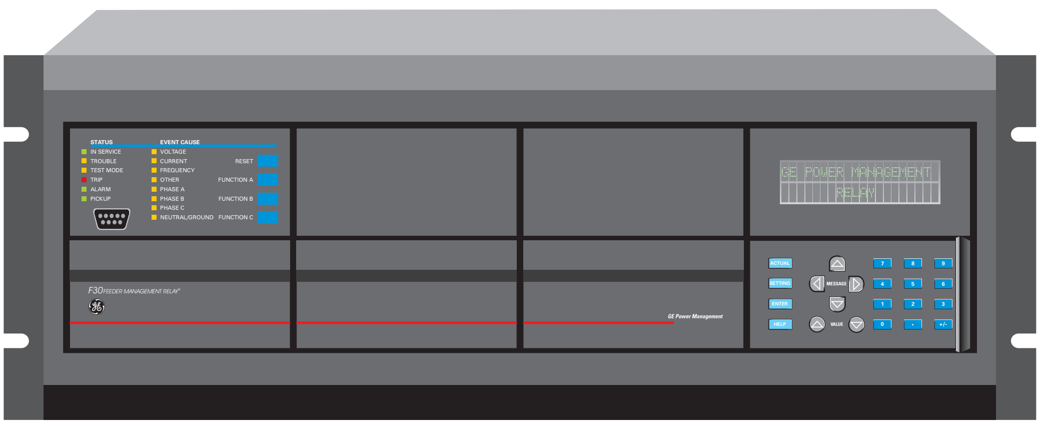
F30 Feeder Management Relay

Instruction Manual

F30 Revision: 1.0X (AGCMC10X.000)

Manual P/N: 1601-0076-A1



832706AH.CDR

F30 FEEDER MANAGEMENT RELAY®

Note: The IRIG-B and circuit supervision for Form-A contacts features are not supported in this release of firmware. A firmware upgrade including these features will be available free of charge when these features are implemented.

Note: All relays must be powered up at least once per year to avoid deterioration of electrolytic capacitors and subsequent relay failure.

MULTILIN

CANADA

215 Anderson Avenue, Markham,
Ontario, L6E 1B3

ISO9001
REGISTERED

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A. MODBUS® RTU PROTOCOL

To help ensure years of trouble free operation, please read through the following chapter for information to help guide you through the initial installation procedures of your new relay.

1.1.1 INSPECTION CHECKLIST

- Open the relay packaging and inspect the relay for physical damage
- View the rear name-plate and verify that the relay is the correct model ordered

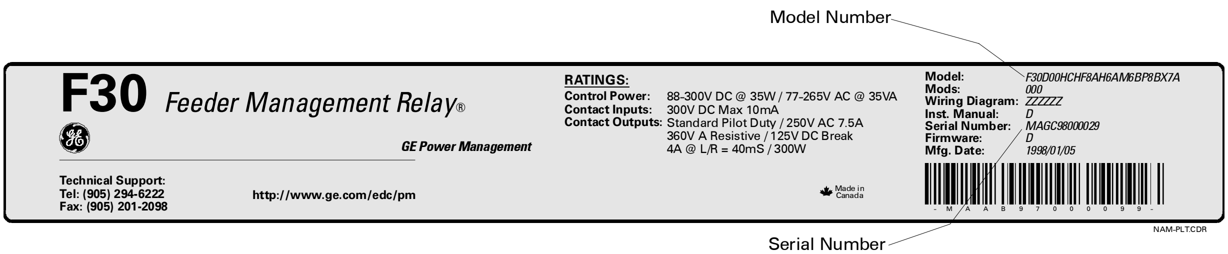


Figure 1–1: REAR NAME PLATE

- Ensure that the following items have been included with the relay:
  - instruction manual
  - software CD
  - mounting screws
  - registration card (attached as the last page of the manual)
- Fill out the registration form and mail it back to GE Power Management (include the serial number located on the rear name-plate)
- For product information, instruction manual updates, and the latest software updates, please visit the GE Power Management Home Page.

Note: If there is any physical damage noticed on the relay, or any of the contents listed are missing, please contact GE Power Management immediately.

GE Power Management contact information:

GE Multilin
215 Anderson Avenue
Markham, Ontario
Canada L6E 1B3

Telephone: (905) 294-6222

Fax: (905) 201-2098

Email: info.pm@edc.ge.com

Home Page: www.ge.com/edc/pm

1.2.1 HARDWARE AND SOFTWARE REQUIREMENTS

The following minimum requirements must be met for the URPC® software to properly operate on a PC.

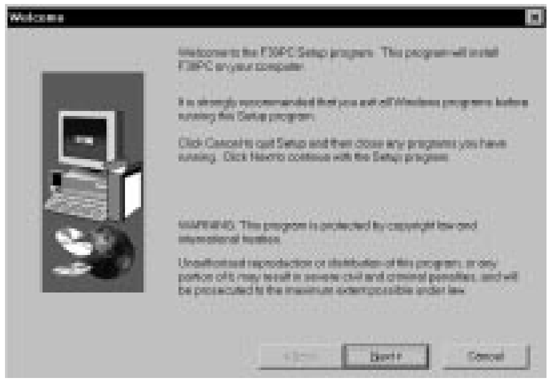
Processor:	Intel® Pentium 200 MMX recommended
Memory:	16 Mb minimum (32 Mb recommended)
Hard Drive:	20 Mb free space required before installation of URPC® software
O/S:	Windows NT 4.X or Windows 95
Hardware:	CD ROM drive
	Unused communications port (i.e. Com 1)

1.2.2 SOFTWARE INSTALLATION

The faceplate keypad or the PC software can be used to communicate with the relay. The PC software is the preferred method to edit settings and view actual values since the PC monitor can display more information in a simple comprehensible format. Refer to the following instructions to install the URPC® software.

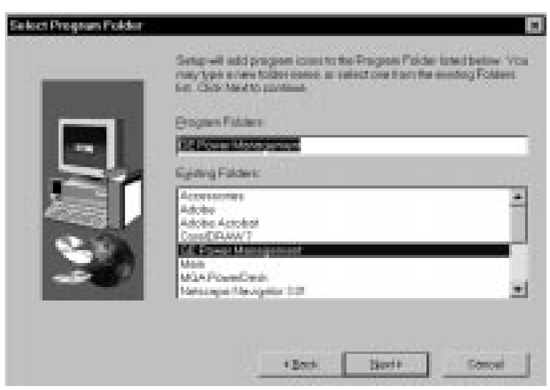
1. Start the **Windows**® program.
2. Insert the URPC® software CD into the CD ROM drive.
3. If the installation program does not start automatically, from the **START** menu, choose **RUN**, type d:\SETUP.EXE and press Enter.

4. Follow the on-screen instructions to install the URPC® software. The following window will appear, click on **NEXT** to continue with the installation.



5. If the software is not to be located in the default directory, type in the complete path including the new directory name indicating where on the hard drive the URPC® software is to be installed.
6. Click **NEXT** to continue with the installation procedure.

7. The default program group which the application will be added to is shown in this screen. If it is desired that the application be added to an already existing program group, choose the group name from the list shown.
8. Click **NEXT** to begin the installation procedure.



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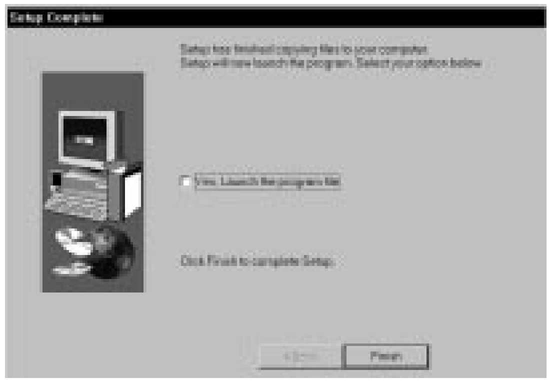
9. To complete the installation procedure, choose the option which restarts the computer and click **FINISH**.



10. After Windows has re-started, double click on the URPC® software icon to activate the application.

Refer to the HUMAN INTERFACES chapter for more information on using the URPC® software.

1.3.1 MOUNTING AND WIRING

Please refer to the HARDWARE chapter for detailed relay mounting and wiring instructions. Review all warnings and safety precautions.

1.3.2 COMMUNICATIONS

The URPC® software can communicate to the relay via the faceplate RS232 port or the rear panel RS485 or Ethernet ports. To communicate with the relay via the front RS232 port, a standard “straight through” serial cable is used. The DB-9 male end is connected to the relay and the DB-9 or DB-25 female end is connected to the PC for COM1 or COM2 respectively as described in the HARDWARE chapter.

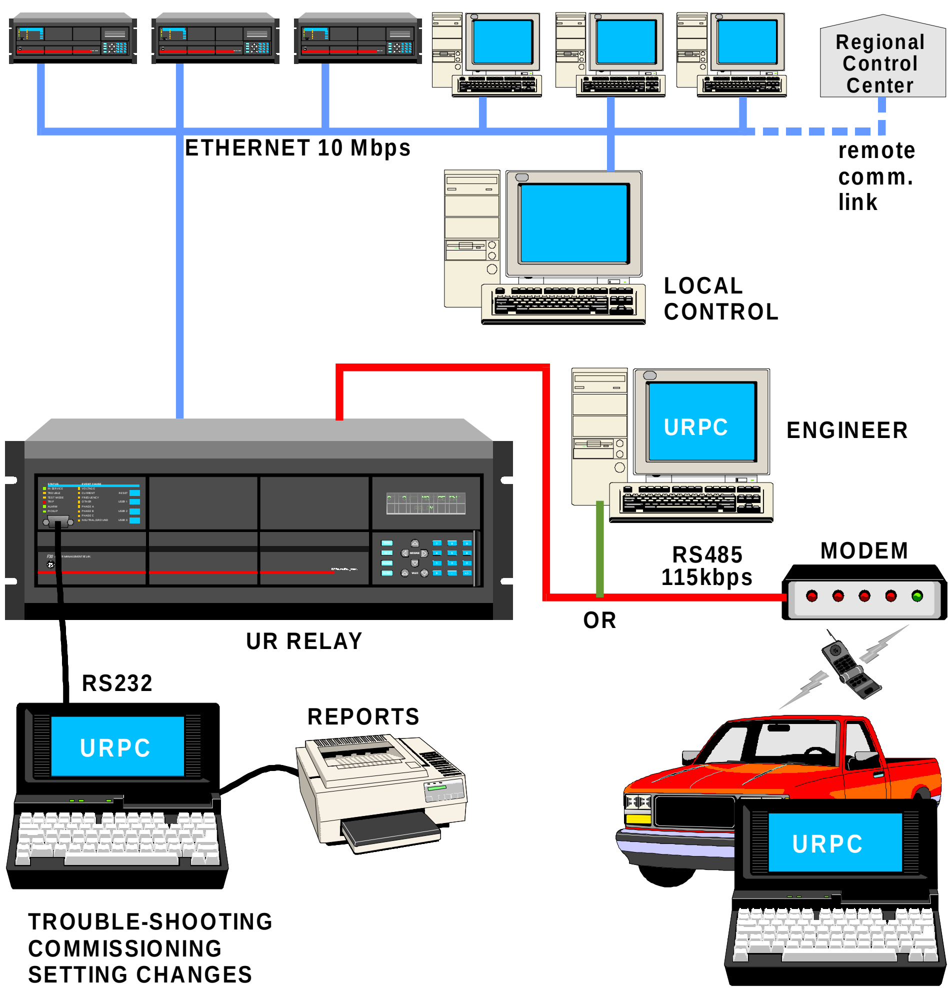


Figure 1–2: RELAY COMMUNICATIONS OPTIONS

To communicate with the relay rear RS485 port from a computer RS232 port, GE Multilin’s RS232/RS485 Converter box is needed. The RS232/RS485 converter box (catalog number F485) is connected to the computer using a “straight through” serial cable. A shielded twisted pair (20, 22 or 24 AWG) cable is used to connect the converter box to the relay rear terminals. The converter box (+ , -, GND) terminals are connected to the (B1, B2, B3) relay terminals for relay COM1 respectively. The line should also be terminated in an RC network (i.e. 120 ohm, 1nF) as described in the HARDWARE chapter.

1.3.3 FACEPLATE KEYPAD

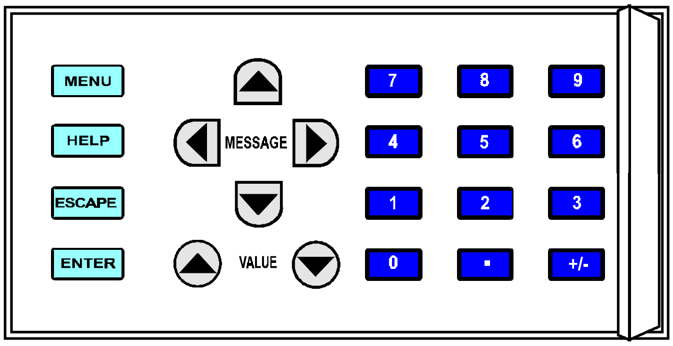


Figure 1–3: KEYPAD

Display messages are organized into pages under the main headings, Actual, Settings, Commands, and Targets. The MENU key is used to navigate through the main heading pages. Each main heading page is further broken down into logical subgroup messages. The MESSAGE keys may be used to navigate through the subgroups.

The VALUE keys are used to scroll through variables in the setting programming mode. They will increment and decrement numerical setting values. Alternatively, these values may be entered with the numeric keypad.

The ENTER key is used to store altered setting values. The HELP key may be pressed at any time for context sensitive help messages.

The . key is used to initiate, and advance to, the next character in text edit mode or to enter a decimal point. The VALUE keys are used to scroll through alphanumeric values in text edit mode.

1.3.4 FACEPLATE DISPLAY

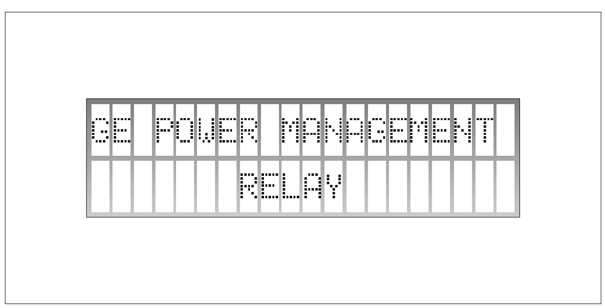


Figure 1–4: DISPLAY

All messages are displayed on a 2 x 20 character vacuum fluorescent display to make them visible under poor lighting conditions. Messages are displayed in plain English and do not require the aid of an instruction manual for deciphering. While the keypad and display are not actively being used, the display will default to defined messages. Any high priority event driven messages will automatically override the default messages and appear on the display.

1.3.5 LED INDICATORS

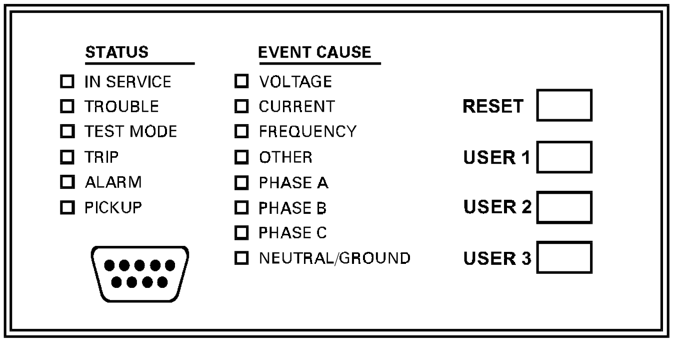


Figure 1–5: LED INDICATOR PANEL

There are several groups of LED indicators. The RESET key is used to reset any latched output, LED indicators, or event messages once the condition has been cleared. The RS232 port is intended for connection to a portable PC.

a) Status Indicators

- **IN SERVICE:** Indicates that control power is applied; all monitored I/O and internal systems are OK; the relay has been programmed.
- **TROUBLE:** Indicates that the relay has detected an internal problem.
- **TEST MODE:** Indicates that the relay is in test mode.
- **TRIP:** Indicates that an output relay selected to be a “Trip” type has operated. This indicator always latches and the Reset command must be initiated when no “Trip” type output relays are operated to reset this indicator.
- **ALARM:** Indicates that an output relay selected to be an “Alarm” type is currently operated. This indicator is never latched.
- **PICKUP:** Indicates that an element is picked up. This indicator is never latched.

b) Event Cause Indicators

Indicate the input type that was involved in a condition detected by an element that is operated or has a latched flag waiting to be reset.

- **VOLTAGE:** Indicates voltage was primarily involved.
- **CURRENT:** Indicates current was primarily involved.
- **FREQUENCY:** Indicates frequency primarily was involved.
- **OTHER:**
- **PHASE A:** Indicates phase A was involved.
- **PHASE B:** Indicates phase B was involved.
- **PHASE C:** Indicates phase C was involved.
- **NEUTRAL/GROUND:** Indicates neutral or ground was involved.

1

1.4.1 MENU NAVIGATION

Press the MENU key to display the desired header display page. The header title will flash momentarily and the header display page will appear on the display. Each press of the MENU key advances through the main heading pages as illustrated.

MENU	⇨	MENU	⇨	MENU	⇨	MENU
ACTUAL		SETTINGS		COMMANDS		TARGETS
⇩		⇩		⇩		⇩
■■ A1 ACTUAL VALUES ■■ STATUS		■■ S1 SETTINGS ■■ PRODUCT SETUP		■ CLEAR RECORDS ■		No Active Targets

1.4.2 MENU HIERARCHY

The setting and actual value messages are setup in a hierarchical format. The header display pages are indicated by the double scroll bar characters (■■), while sub-header pages are indicated by a single scroll bar character (■). The header display pages are at the highest level of the hierarchy and the sub-header display pages fall below this level. The MESSAGE ▲ and MESSAGE ▼ keys are used to move within a group of headers, sub-headers, setting values or actual values. Continually pressing the MESSAGE ▶ key from a header display, displays more specific information for the header category. Conversely, continually pressing the ◀ MESSAGE key from a setting value or actual value display will return to the header display.

Highest Level				**Lowest Level (Setting Value)**
■■ S1 SETTINGS ■■ PRODUCT SETUP	◀▶	■ PASSWORD ■ SECURITY	◀▶	ACCESS LEVEL: Restricted
▼				
■■ S2 SETTINGS ■■ SYSTEM SETUP				

1.4.3 SETTINGS NOT PROGRAMMED

The relay is defaulted to the 'Settings Not Programmed' state before it leaves the factory. This safeguards against the installation of a relay whose settings have not been entered. In addition, a relay in the ‘Not Programmed’ state blocks signaling of any output relay, and turns off the IN SERVICE indicator.

```
RELAY SETTINGS:
Not Programmed
```

Move to message S1 PRODUCT SETUP \ INSTALLATION \ RELAY SETTINGS:. To put the relay in the 'Programmed' state, press the VALUE key once and press ENTER. The faceplate IN SERVICE indicator will now turn on.

The Settings for the relay can be setup manually (refer to HUMAN INTERFACES chapter, RELAY SETTINGS NOT PROGRAMMED section) or remotely by editing a URPC® software Settings file which can be downloaded (refer to HUMAN INTERFACES chapter).

1.4.4 RELAY PASSWORDS

It is recommended that passwords be setup on the relay for each security level and assigned to specific personnel. There are four password security access levels:

1. **COMMAND**

   The COMMAND access level restricts the user from making any settings changes, but allows the user to perform the following operations:

   - change state of virtual settings
   - clear event record
   - clear setting changes record
   - clear oscillography record

2. **SETTING**

   The SETTING access level allows the user make any changes to any of the setting values.

3. **MASTER**

   The MASTER access level allows the user to perform changes to both COMMAND and SETTING setting values.

4. **FACTORY SERVICE**

   The FACTORY SERVICE access level is restricted to factory service personnel only.

(Refer to the HUMAN INTERFACES chapter for complete instructions on setting up security level passwords.)

1.4.5 COMMISSIONING

(Refer to the COMMISSONING chapter for guidance on commissioning the relay.)

2.1.1 OVERVIEW

The F30 Relay is a microprocessor based relay designed for the protection of primary feeders. Overcurrent and undervoltage protection, fault diagnostics, power metering, and RTU functions are provided. The F30 provides instantaneous and time overcurrent protection for phase, neutral and ground faults. The time overcurrent function provides multiple curve shapes or FlexCurve™ for optimum co-ordination. A sensitive ground fault feature is available.

Diagnostic features include a sequence of events record of 1024 time-tagged events. The internal clock used for time-tagging can be synchronized with an IRIG-B signal. This precise time stamping allows the sequence of events to be determined throughout the system. A snapshot of measured parameters is recorded when an event occurs to reflect the state of the relay at the time of the event. Events can also trigger oscillography data capture which records measured parameters before and after the event for viewing on a PC. These tools will significantly reduce troubleshooting time and simplify report generation in the event of system faults.

A faceplate RS232 port may be used for programming of settings and for monitoring, using a portable computer. A variety of communications modules are available. Two rear RS485 ports are standard to allow independent access by operating and engineering staff. All serial ports use the Modbus® RTU protocol and may be connected to system computers with baud rates up to 115 kbps. Optional communications modules include a 10BaseF Ethernet interface which can be used to provide fast, reliable communications in noisy environments. Another option provides two 10BaseF fiber optic ports for redundancy. The Ethernet port supports MMS/UCA 2.0 protocol.

The relay uses flash memory technology, which allows field upgrading as new features are added. The testing features can be used to verify and test settings of protection or monitoring elements.

The Figure 2–1: SINGLE LINE DIAGRAM, illustrates the relay functionality using ANSI (American National Standards Institute) device numbers.

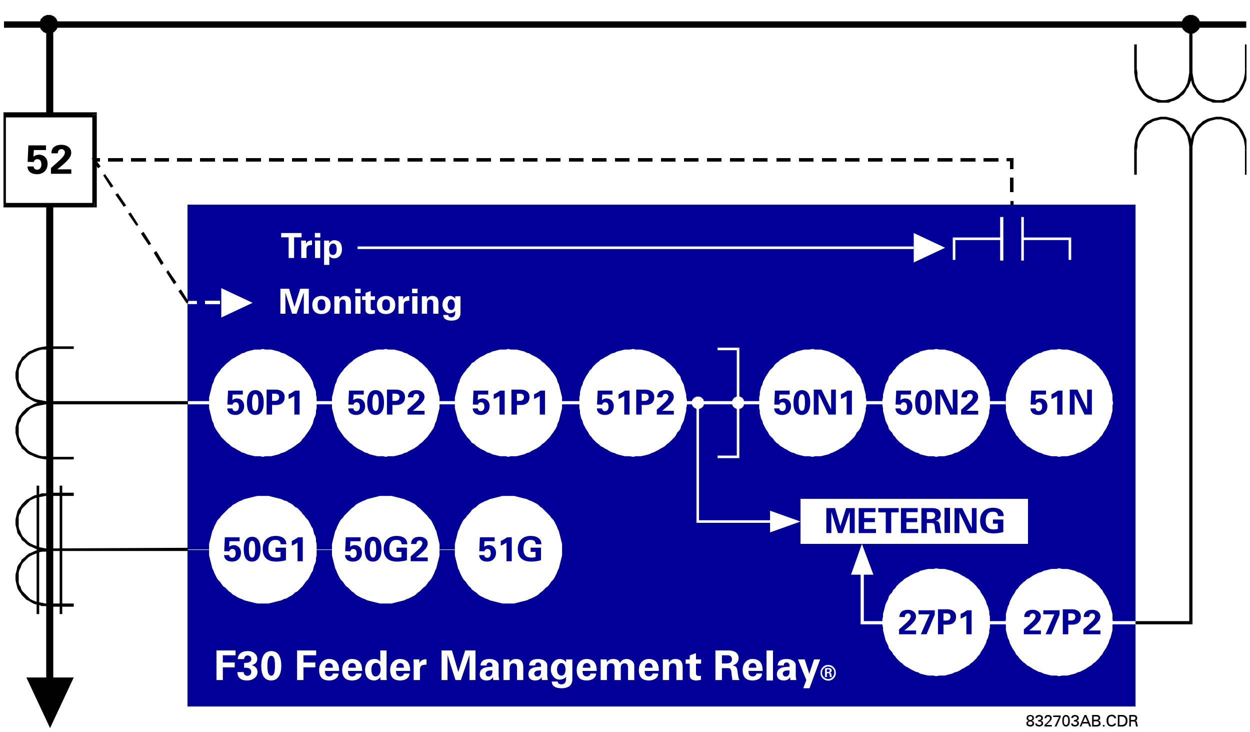


Figure 2–1: SINGLE LINE DIAGRAM

Voltage and current metering is built into the relay as a standard feature. Both of these parameters are available as the RMS magnitude or fundamental frequency magnitude and angle (phasor). Power and power factor measurements are also provided.

2.1.2 ORDERING

2

The relay is available as a 19 inch rackmount horizontal unit, and consists of four UR modules: Power Supply, CPU, CT/VT DSP and Digital Input/Output. Each of these modules can be supplied in a number of configurations which must be specified at the time of ordering. The information required to completely specify the relay is provided in the following table. (Full details of the modules that are available for the relay are contained in the HARDWARE chapter.)

Table 2–1: ORDER CODES

	F30 -	*	00 -	H	C	* -	F ** -	H ** -	M **	
Base Unit	F30	|	|	|	|	|	|	|	|	Base Unit
CPU		A	|	|	|	|	|	|	|	RS485 + RS485
			|	|	|	|	|	|	|	
		C	|	|	|	|	|	|	|	RS485 + 10BaseF
		D	|	|	|	|	|	|	|	RS485 + Redundant 10BaseF
			|	|	|	|	|	|	|	
Software Options			00	|	|	|	|	|	|	No Software options
Mounting				H	|	|	|	|	|	Horizontal
Faceplate					C	|	|	|	|	Faceplate with keypad and display
Power Supply						L	|	|	|	24/48 V(Low); 19-60 VDC, 19-81 VAC
						H	|	|	|	125/250 V (High); 88-300 VDC, 70-265 VAC
							|	|	|	
CT/VT							8A	|	|	Standard 4CT/4VT
							8B	|	|	Standard 3CT and Sensitive ground CT/4VT
								|	|	
Digital I/O[1]								6A	6A	2 Form-A, 2 Form-C, 8 inputs
								6B	6B	2 Form-A, 4 Form-C, 4 inputs
									6C	8 Form-C outputs
									6D	16 inputs
									6E	4 Form-C, 8 inputs
									XX	No module

[1]**Custom I/O configurations available. Consult factory with requirements.**

Accessories

DEMO Sturdy carrying case

SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE

2.2.1 PROTECTION ELEMENTS

Note: [x] indicate 1A secondary CT specifications, other values are for 5A secondary.

PHASE/NEUTRAL/GROUND TOC

Current:	Fundamental or RMS
Pickup Level:	0.25 [0.05] to 100.00 [20.00] A in steps of 0.01
Dropout Level:	97% to 98% of Pickup
Level Accuracy:	± 0.75% of reading or ± 1% of rated (whichever is greater) from 0.1 to 2.0 x CT rating ± 1.5% of reading > 2.0 x CT rating
Curve Shapes:	IEEE Moderately/Very/Extremely Inverse IEC (and B.S.) A/B/C and Short Inverse GE IAC Inverse, Short/Very/ Extremely Inverse I^2t FlexCurve™ (Programmable) Definite Time (0.01s base curve)
Curve Multiplier:	Time Dial = 0.00 to 600.00 in steps of 0.01
Reset Type:	Instantaneous/Timed (per IEE)
Timing Accuracy:	at > 1.03 x Actual Pickup ± 3.5% of operate time or ± 40ms (whichever is greater)

PHASE/NEUTRAL/GROUND IOC

Current:	Fundamental only
Pickup Level:	0.25 [0.05] to 115.00 [23.00] A in steps of 0.01
Dropout Level:	97% to 98% of Pickup
Level Accuracy:	± 0.75% of reading or ± 1% of rated (whichever is greater) from 0.1 to 2.0 x CT rating ± 1.5% of reading > 2.0 x CT rating
Overreach:	< 2 %
Operate Delay:	0.00 to 600.00 in steps of 0.01 s
Reset Delay:	0.00 to 600.00 in steps of 0.01 s
Operate Time	< 20 ms @ 1.5 x Pickup @ 60Hz
Timing Accuracy:	Operate @ 1.5 x Pickup = ± 3% or ± 4 ms (whichever is greater)

SENSITIVE GROUND TOC

Current:	Fundamental or RMS
Pickup Level:	0.025 [0.005] to 10.00 [2.00] A in steps of 0.01
Dropout Level:	97% to 98% of Pickup
Level Accuracy:	± 0.75% of reading or ± 1% of rated (whichever is greater) from 0.01 to 0.2 x CT rating ± 1.5% of reading > 0.2 x CT rating
Curve Shapes:	IEEE Moderately/Very/ Extremely Inverse IEC(andB.S.)A/B/CandShortInverse IAC Inverse, Short/Very/Extremely Inverse I^2t FlexCurve™ (Programmable) Definite Time (0.01s base curve)
Curve Multiplier:	Time Dial = 0.00 to 600.00 in steps of 0.01
Reset Type:	Instantaneous/Timed (per IEEE)
Timing Accuracy:	at > 1.03 x Actual Pickup ± 3.5% of operate time or ± 40 ms (whichever is greater)

SENSITIVE GROUND IOC

Current:	Fundamental only
Pickup Level:	0.025 [0.005] to 11.50 [2.30] A in steps of 0.01
Dropout Level:	97% to 98% of Pickup
Level Accuracy:	± 0.75% of reading or ± 1% of rated (whichever is greater) from 0.01 to 0.2 x CT rating ± 1.5% of reading > 0.2 x CT rating
Overreach:	< 2 %
Operate Delay:	0.00 to 600.00 in steps of 0.01 s
Reset Delay:	0.00 to 600.00 in steps of 0.01 s
Operate Time:	< 20 ms @ 1.5 x Pickup @ 60Hz
Timing Accuracy:	Operate @ 1.5 x Pickup 3% or ± 4 ms (whichever is greater)

UNDERVOLTAGE

Voltage:	Fundamental
Pickup Level:	0.00 - 250.00 V in steps of 0.01
Dropout Level:	102 to 103 % of Pickup
Level Accuracy:	± 0.5% of reading from 10 to 208 V
Curve Shapes:	GE IAV Inverse Definite Time (0.1s base curve)
Curve Multiplier:	Time Dial = 0.00 to 600.00 in steps of 0.01
Timing Accuracy:	at < 0.90 x Pickup ± 3.5% of operate time or ± 40 ms (whichever is greater)

MONITORING

OSCILLOGRAPHY

Records:	1 x 72 Cycles to 15 x 9 Cycles (configurable)
Sampling Rate:	64 samples per power frequency Cycle
Triggers:	any element pickup or operate digital input change of state digital output change of state FlexLogic™ equation
Data:	AC input channels digital input state element state digital output state

EVENT RECORDER

Capacity:	1024 events
Time-tag:	To 1 millisecond
Triggers:	any element pickup or operate digital input change of state digital output change of state setting changes self test events

METERING

RMS CURRENT - Phase, Neutral and Ground

Accuracy:	± 0.25% of reading or ±0.1% of rated (whichever is greater) from 0.1 to 2.0 x CT rating ± 1.0% of reading @ > 2.0 x CT rating

RMS VOLTAGE

Accuracy:	± 0.25% of reading from 10 to 208V

APPARENT POWER VA

Accuracy:±1.0% of reading

REAL POWER WATT

Accuracy:	±1.0% of reading @ PF between ±0.8 and 1.0

REACTIVE POWER var

Accuracy:	±1.0% of reading @ PF between ±0.2 and 0.0

Power Factor

Accuracy:	±0.02

INPUTS

AC CURRENT

CT Rated Primary:	1 to 50 000 A
CT Rated Secondary:	1 A or 5 A by connection
Frequency Range:	20 to 65 Hz.
Relay Burden:	< 0.2 VA @ rated secondary
Conversion Range:	0.01 to 46 x CT rating RMS symmetrical
Current Withstand:	20 msec. @ 250 times rated 1 sec. @ 100 times rated Cont. @ 3 times rated

AC SENSITIVE GROUND CURRENT

CT Rated Primary:	1 to 50 000 A
CT Rated Secondary:	1 A or 5 A by connection
Frequency Range:	20 to 65 Hz.
Relay Burden:	< 0.2 VA @ rated secondary
Conversion Range:	0.001 to 4.6 x CT rating RMS symmetrical
Current Withstand:	20 msec. @ 250 times rated 1 sec. @ 100 times rated Cont. @ 3 times rated

AC VOLTAGE

VT Rated Secondary:	50.0 to 240.0 V
VT Ratio:	0.1 - 24000.0
Frequency Range:	20 to 65 Hz.
Relay Burden:	< 0.25 VA @ 120 V
Conversion Range:	1 to 275 V
Voltage Withstand:	Cont. @ 260 V to neutral 1 Min./Hr @ 420 V to neutral

CONTACT INPUTS

Dry Contacts:	1000 Ω Maximum
Wet Contacts:	300 VDC Maximum
Selectable Thresholds:	16 V, 30 V, 80 V, 140 V
Recognition Time:	< 4 ms.

2.2.2 POWER SUPPLY

LOW RANGE

Nominal DC Voltage: 24 - 48

Min./Max. DC Voltage: 19 / 60

HIGH RANGE

Nominal DC Voltage: 125 - 250

Min./Max. DC Voltage: 88 / 300

Nominal AC Voltage: 100 - 240 @ 48-62 Hz

Min./Max. AC Voltage: 88 / 288 @ 48-62 Hz

ALL RANGES

Volt Withstand: 2 x Highest Nominal Voltage for 10ms

Voltage Loss Hold-Up: 100 ms

Power Consumption: Typical = 35 VA

2.2.3 OUTPUTS

FORM-A RELAY

Make and Carry for 1.0 sec: 30 A @ 300 VDC (ANSI)

Carry Continuous: 6 A @ 300 VDC.

Break @ L/R of 40 ms: 0.5 ADC Max.

Operate Time: < 4 ms.

Contact Material: Silver alloy

FORM-C AND CRITICAL FAILURE RELAY

Make and Carry for 0.2 sec: 30 A @ 300 VDC (ANSI)

Carry Continuous: 6 A @ 300 VDC.

Break @ L/R of 40 ms: 0.1 ADC Max.

Operate Time: < 8 ms.

Contact Material: Silver alloy

CONTROL POWER EXTERNAL OUTPUT (for Dry Contact Input)

Capacity: 100 mA DC @ 48 VDC

Isolation: ± 300 Vpk

COMMUNICATIONS

RS232: Front Port (19.2 kbps, Modbus® RTU)

RS485: 1 or 2 Rear Ports (up to 115 kbps, Modbus® RTU) Isolated together @ 36Vpk

Ethernet port: 10BaseF or dual-redundant 10BaseF; MMS/UCA 2.0 (10BaseF: 820 nm, multi-mode, fiber optic with ST connector)

2.2.4 ENVIRONMENTAL

Operating Temperature Range: -40° C to +60° C

Ambient Storage Temperature: -40° C to +80° C

Humidity (noncondensing): up to 95%

2.2.5 TYPE TESTS

Electrical Fast Transient: ANSI/IEEE C37.90.1
BS EN 61000-4-4

Oscillatory Transient: ANSI/IEEE C37.90.1

Insulation Resistance: IEC 255-5

Dielectric Strength: IEC 255-6, Series C 2240V
ANSI/IEEE C37.90

Electrostatic Discharge: EN 61000-4-2

Surge Immunity: EN 61000-4-5

RFI Susceptibility: ANSI/IEEE C37.90.2
EN 61000-4-3

Note: Type test report available upon request.

2.2.6 PRODUCTION TESTS

Dielectric Strength:

AC:	ANSI/IEEE C37.90 (CT, VT, Control Power & Contact Inputs)
DC:	Contact Outputs

2.2.7 APPROVALS

UL Certification applied for

CSA Certification applied for

ISO9001 Registered

3.1.1 PANEL CUTOUT

The relay is a 4RU, 19 inch rack configuration with a removable faceplate for switchgear mounting. The modular design allows the relay to be easily upgraded or repaired by a qualified service person. The faceplate is hinged, to allow for easy access to the removable modules or removable for mounting on doors with limited rear depth. There is also a removable dust cover that fits over the faceplate and must be removed when attempting to access the keypad or RS232 communications port.

Case dimensions are as shown in Figure 3–1: UR RELAY MOUNTING AND DIMENSIONS DRAWING, along with panel cutout details for panel mounting. When planning the location of your panel cutout, ensure that provision is made for the faceplate to swing open without interference to, or from, adjacent equipment.

The relay must be mounted such that the faceplate sits semi flush with the panel or switchgear door, allowing the operator access to the keypad or RS232 communications port. The relay is secured to the panel with the use of four screws supplied with the relay.

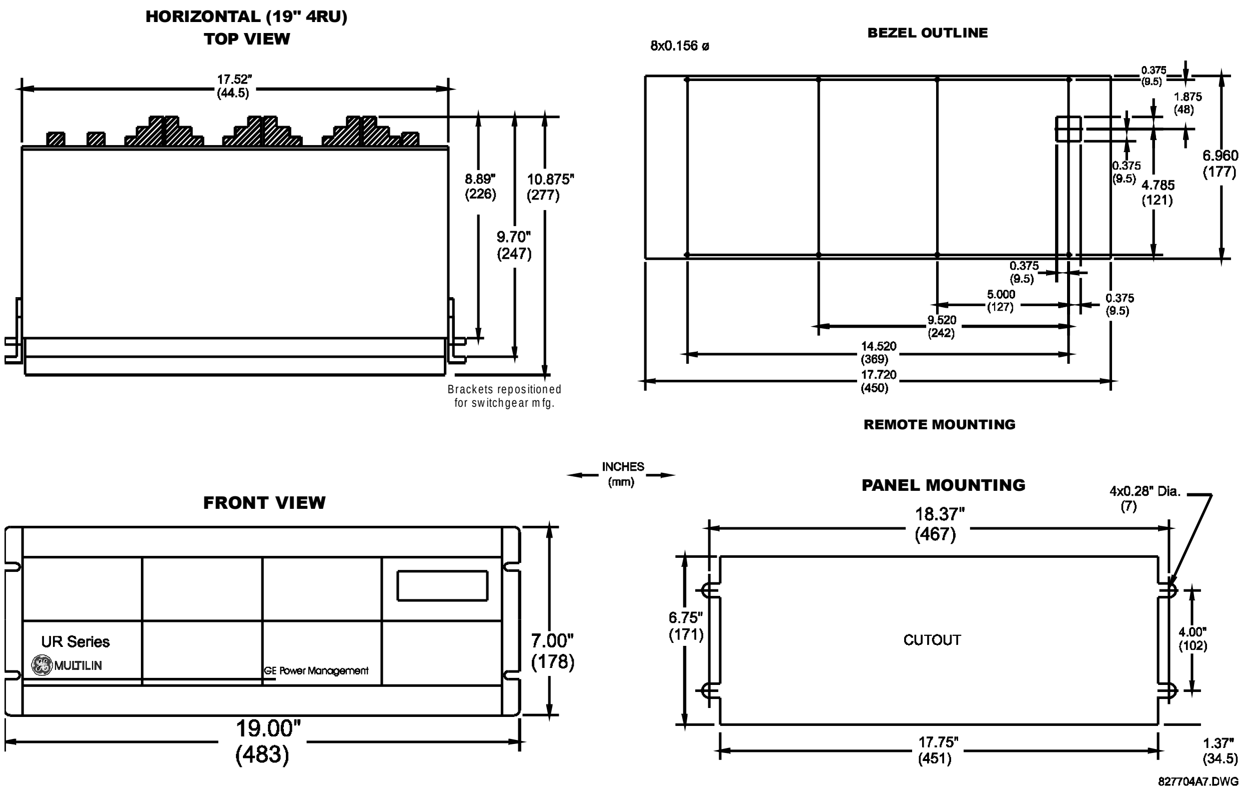


Figure 3–1: UR RELAY MOUNTING AND DIMENSIONS DRAWING

3.1.2 MODULE WITHDRAWAL / INSERTION

WARNING: Module withdrawal and insertion may only be performed when control power has been removed from the unit. Inserting an incorrect module type into a slot may result in personal injury, damage to the unit or connected equipment, or undesired operation!

The relay, being modular in design, allows for the withdrawal and insertion of modules. Modules must only be replaced with like modules in their original factory configured slots.

The faceplate can be opened to the left, once the sliding latch on the right side has been pushed up, as shown in the drawing below. This allows for easy accessibility of the modules for withdrawal.

Figure 3–2: UR MODULE WITHDRAWAL/INSERTION

WITHDRAWAL: The ejector/inserter clips located at the top and at the bottom of each module, must be pulled simultaneously in order to release the module for removal. Before performing this action, **control power must be removed from the relay**. The original location of the module should be recorded to help ensure that the same or replacement module is inserted into the correct slot. Modules with current input, provide automatic shorting of external CT circuits.

INSERTION: Take care to ensure that the **correct** module type is inserted into the **correct** slot position. The ejector/inserter clips located at the top and at the bottom of each module, must be in the disengaged position as the module is smoothly inserted into the slot. Once the clips have cleared the raised edge of the chassis, engage the clips simultaneously. When the clips have locked into position, the module will be fully inserted.

3.1.3 REAR TERMINAL LAYOUT

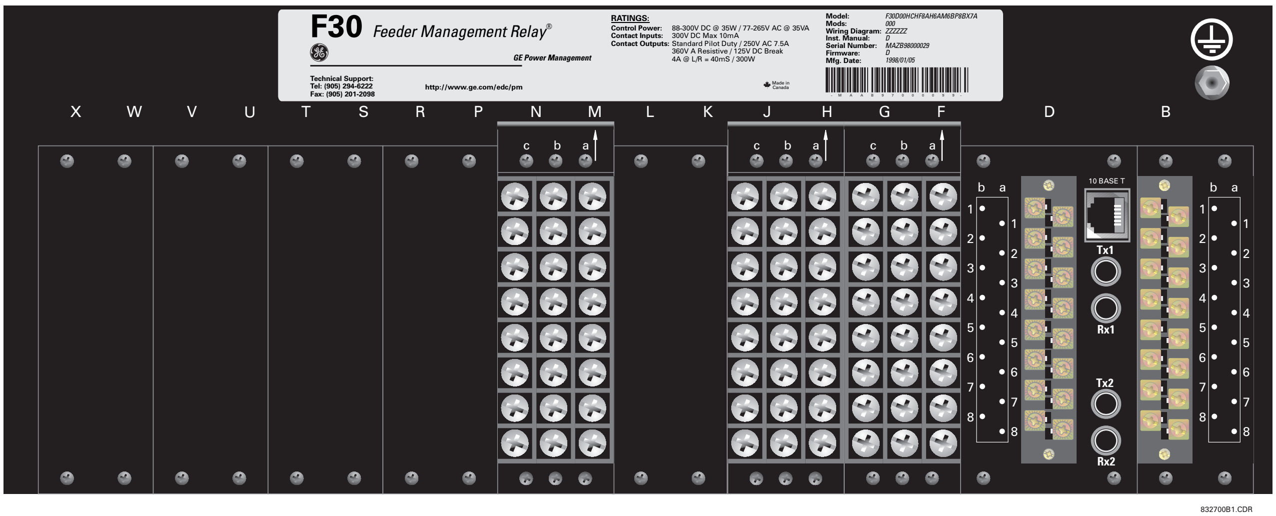


Figure 3–3: REAR TERMINAL VIEW

3.1.4 REAR TERMINAL ASSIGNMENTS

The relay follows a convention with respect to terminal number assignments. They are three characters long assigned by module slot position, row number, and column letter.

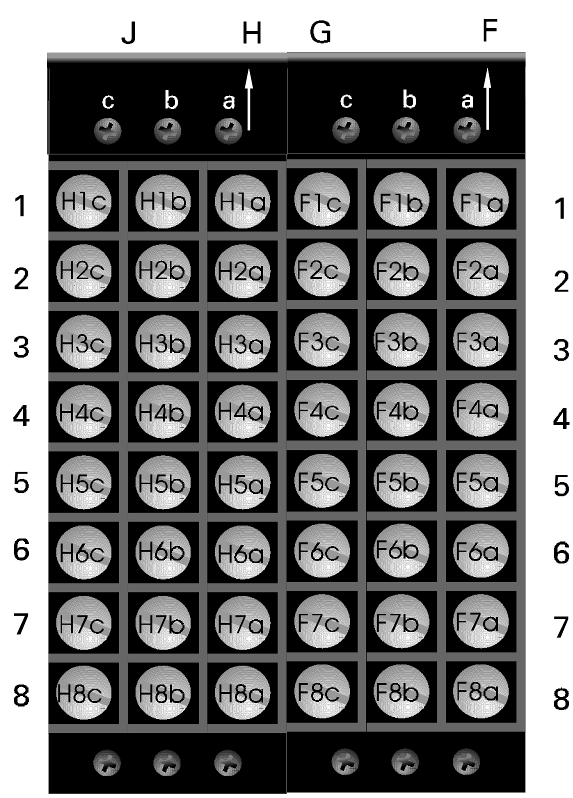


Figure 3–4: EXAMPLE OF DIGITAL I/O OR DSP MODULE IN F & H SLOTS

3.2.1 TYPICAL WIRING DIAGRAM

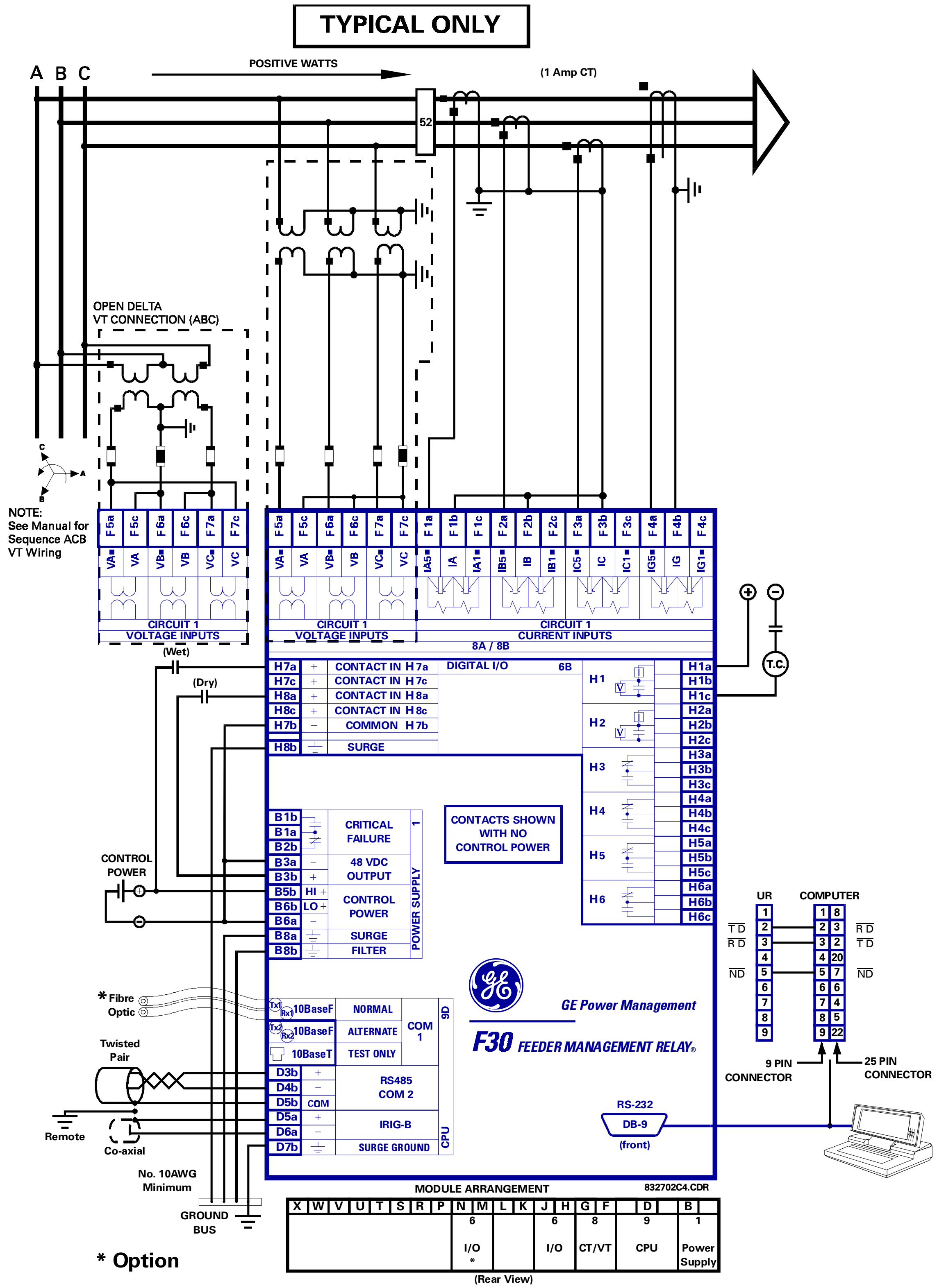


Figure 3–5: TYPICAL WIRING DIAGRAM

3.2.2 CONTROL POWER

CAUTION: Control power supplied to the relay must be connected to the matching power supply range of the relay. If the voltage is applied to the wrong terminals, damage may occur.

The power supply module of the relay is designed for two voltage ranges. Each range has a dedicated input for proper operation. The ranges are as shown below (see the specifications for detailed ranges):

Table 3–1: CONTROL POWER VOLTAGE RANGE

RANGE	Nominal Voltage
LO	24/48 V
HI	125/250 V

This module provides power to the relay and supplies power for dry contact input connections.

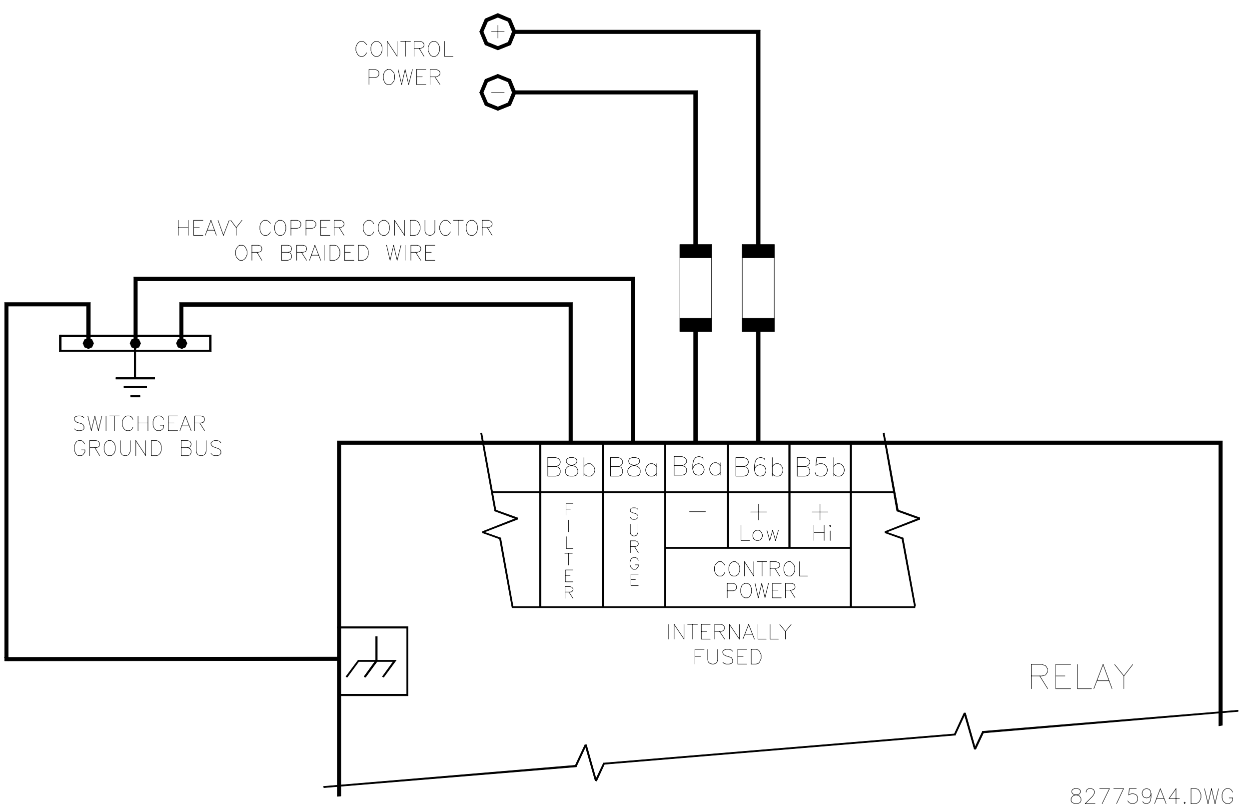


Figure 3–6: CONTROL POWER CONNECTION

The power supply module provides 48 VDC power for dry contact input connections and a critical failure relay. (See Figure 3–5: TYPICAL WIRING DIAGRAM). The critical failure relay is a Form-C that will be energized once control power is applied and the relay has successfully booted up with no critical self-test failures. If any of the on-going self-test features detect a critical failure or control power is lost, the relay will de-energize.

3.2.3 AC CURRENT TRANSFORMER INPUTS

CAUTION: Verify that the connection made to the relay nominal current of 1 A or 5 A matches the secondary rating of the connected CTs. Unmatched CTs may result in equipment damage or inadequate protection.

VT connections for both WYE-VTs for ABC and ACB phase rotations are identical, as shown in Figure 3–5: TYPICAL WIRING DIAGRAM, VT connections for open-delta VTs for use on ABC rotation systems are also shown on Figure 3–5: TYPICAL WIRING DIAGRAM, and for ACB rotation below in Figure 3–8: OPEN DELTA VT CONNECTION - ACB ROTATION.

The CT/VT module may be ordered with a standard ground current input that is the same as the phase current inputs (type 8A) or with a sensitive ground input (type 8B) which is 10 times more sensitive (see the specifications for more details). Each AC current input has an isolating transformer and an automatic shorting mechanism that shorts the input when the module is withdrawn from the chassis. There are no internal ground connections on the current inputs. Current transformers with 1 to 50000 A primaries and 1A or 5A secondaries may be used.

CT connections for both ABC and ACB phase rotations are identical, as shown in Figure 3–5: TYPICAL WIRING DIAGRAM.

The exact placement of a zero sequence CT, so that ground fault current will be detected, is shown below. Twisted pair cabling on the zero sequence CT is recommended.

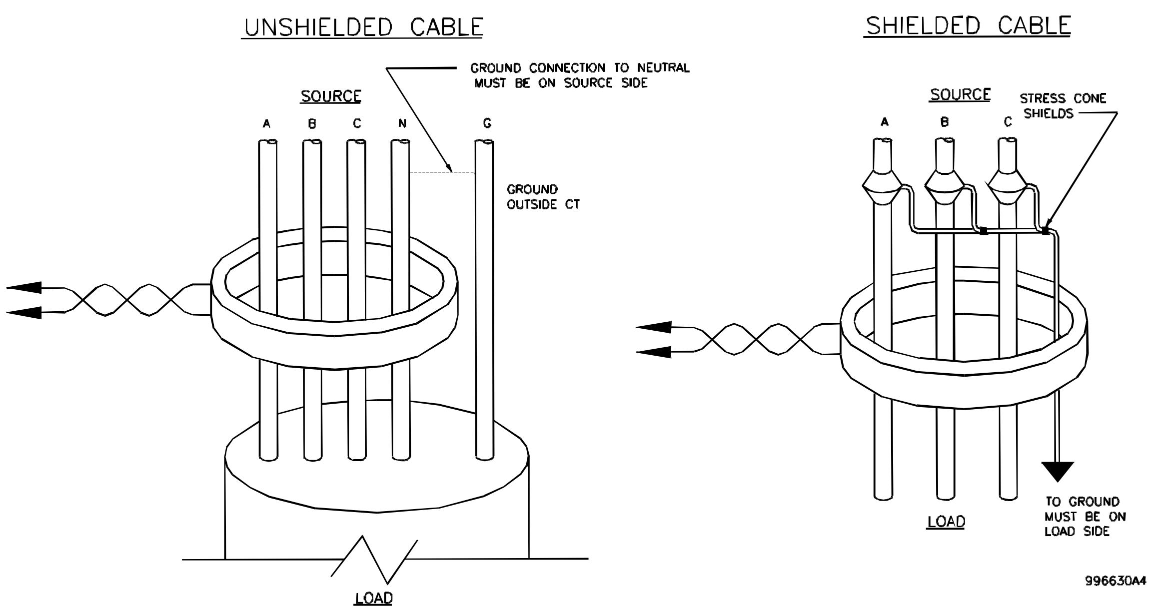


Figure 3–7: ZERO SEQUENCE CORE BALANCE CT INSTALLATION

3.2.4 AC VOLTAGE TRANSFORMER INPUTS

VT connections for both WYE-VTs for ABC and ACB phase rotations are identical, as shown in Figure 3–5: TYPICAL WIRING DIAGRAM, VT connections for open-delta VTs for use on ABC rotation systems are also shown on Figure 3–5: TYPICAL WIRING DIAGRAM, and for ACB rotation below in Figure 3–8: OPEN DELTA VT CONNECTION - ACB ROTATION.

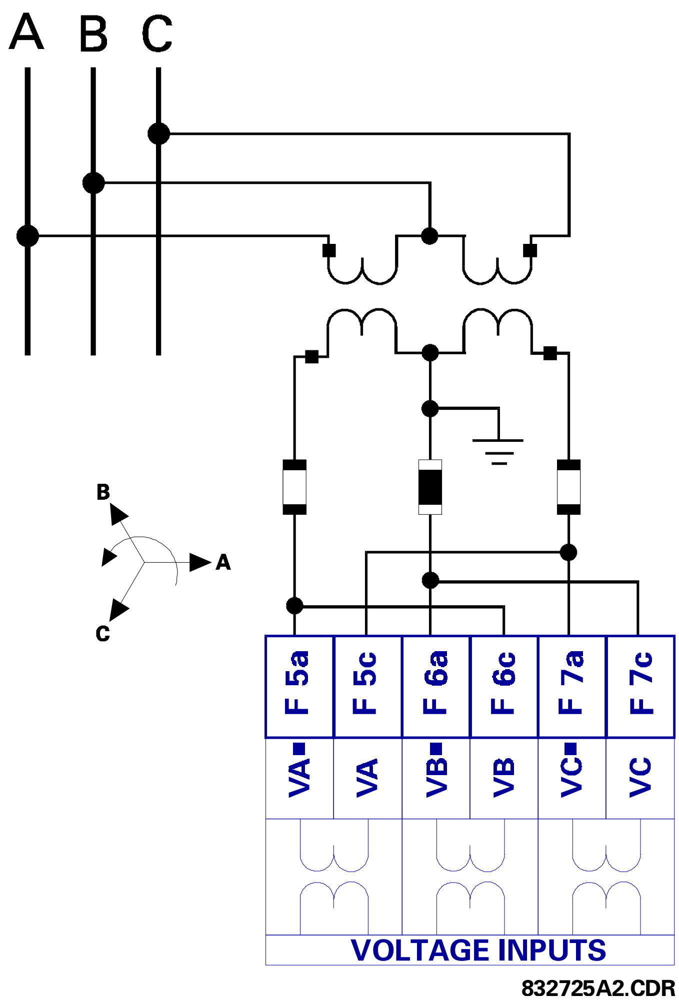


Figure 3–8: OPEN DELTA VT CONNECTION - ACB ROTATION

3.2.5 CONTACT INPUTS/OUTPUTS

Digital I/O modules have a total of 24 terminal connections. They are arranged as 3 terminals per row, with a total of 8 rows. A given row of three terminals may be used for the outputs of one relay. For example, for Form-C relay outputs, the terminals connect to the normally open (NO), normally closed (NC), and common contacts of the relay. For a Form-A or SCR output, two of the terminals are used for the NO output and the third is used for current detection for supervision features. The configuration of the terminals for contact inputs is different. When a digital I/O module is ordered with contact inputs, they are arranged in groups of four and use two rows of three terminals. Ideally, each input would be totally isolated from any other input. This would however require that every input have two dedicated terminals and limit the available number of contacts based on the available number of terminals. So, although each input is individually optically isolated, each group of four inputs uses a single common as a reasonable compromise. This allows each group of four outputs to be supplied by wet contacts from different voltage sources (if required) or a mix of wet and dry contacts.

The tables below illustrate the module types (6A, 6B, 6C, 6D, 6E) and contact names that may be ordered for the relay. Since an entire row is used for a single contact output, the name is assigned using the module slot position and row number. However, since there are two contact inputs per row, the names are assigned by module slot position, row number, and column position.

Table 3–2: I/O MODULE ASSIGNMENTS

~6A I/O MODULE	
Terminal Assignment	**Output or Input**
~1	Form-A
~2	Form-A
~3	Form-C
~4	Form-C
~5a, ~5c	2 Inputs
~6a, ~6c	2 Inputs
~7a, ~7c	2 Inputs
~8a, ~8c	2 Inputs

~6B I/O MODULE	
Terminal Assignment	**Output or Input**
~1	Form-A
~2	Form-A
~3	Form-C
~4	Form-C
~5	Form-C
~6	Form-C
~7a, ~7c	2 Inputs
~8a, ~8c	2 Inputs

~6C I/O MODULE	
Terminal Assignment	**Output or Input**
~1	Form-C
~2	Form-C
~3	Form-C
~4	Form-C
~5	Form-C
~6	Form-C
~7	Form-C
~8	Form-C

~6D I/O MODULE	
Terminal Assignment	**Output or Inputs**
~1a, ~1c	2 Inputs
~2a, ~2c	2 Inputs
~3a, ~3c	2 Inputs
~4a, ~4c	2 Inputs
~5a, ~5c	2 Inputs
~6a, ~6c	2 Inputs
~7a, ~7c	2 Inputs
~8a, ~8c	2 Inputs

~6E I/O MODULE	
Terminal Assignment	**Outputs or Inputs**
~1	Form-C
~2	Form-C
~3	Form-C
~4	Form-C
~5a, ~5c	2 Inputs
~6a, ~6c	2 Inputs
~7a, ~7c	2 Inputs
~8a, ~8c	2 Inputs

NOTE: substitute the slot position where a tilde "~" appears

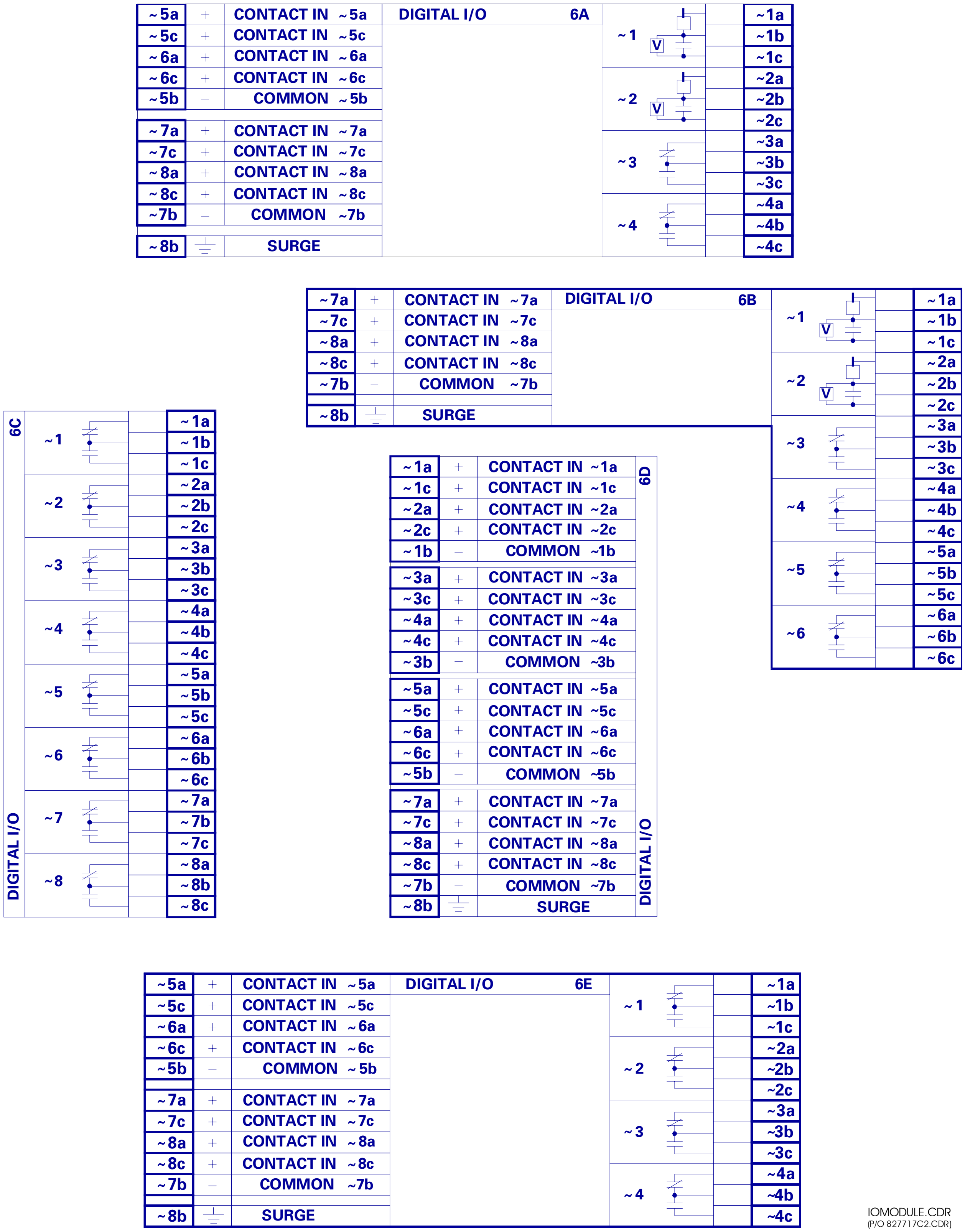


Figure 3–9: TYPICAL DIGITAL I/O WIRING MODULES

CAUTION: CORRECT POLARITY MUST BE OBSERVED FOR ALL CONTACT INPUT CONNECTIONS OR EQUIPMENT DAMAGE MAY RESULT.

A dry contact has one side connected to terminal B3b. This is the +ve 48 VDC voltage rail supplied by the power supply module. The other side of the dry contact is connected to the required contact input terminal. Each contact input group has its own common (-ve) terminal which must be connected to the DC negative terminal (B3a) of the power supply module. When a dry contact closes, a current of 1 to 3 mA will flow through the associated circuit.

A wet contact has one side connected to the positive terminal of an external DC power supply. The other side of this contact is connected to the required contact input terminal. In addition, the negative side of the external source must be connected to the relay common (-ve) terminal of each contact input group. The maximum external source voltage for this arrangement is 300 VDC.

The voltage threshold at which each group of four contact inputs will detect a closed contact input is programmable as 16 VDC for 24 Volt sources, 30 VDC for 48 Volt sources, 80 VDC for 110-125 Volt sources, and 140 VDC for 250 Volt sources.

Contact outputs may be ordered as Form-C or Form-A. The Form A contacts may be connected for external circuit supervision. These contacts are provided with voltage and current monitoring circuits used to detect the loss of DC voltage in the circuit, and the occurrence of DC current flowing through the contacts when the Form-A contact closes. If enabled, the current monitoring can be used as a seal-in signal to ensure that the Form-A contact does not attempt to break the energized inductive coil circuit and weld the contacts.

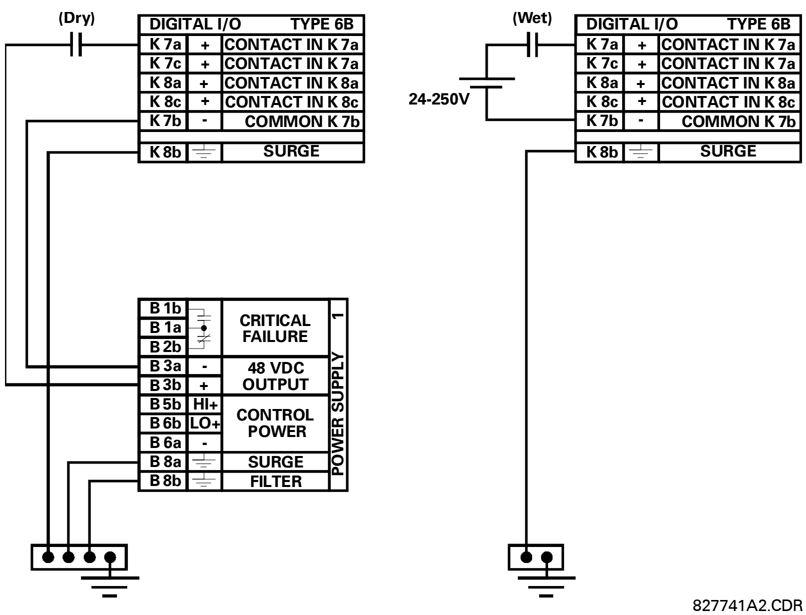


Figure 3–10: DRY AND WET CONTACT INPUT CONNECTIONS

3.2.6 RS232 FACEPLATE PROGRAM PORT

A 9 pin RS232C serial port is located on the relay's faceplate for programming with a personal computer. All that is required to use this interface, is a personal computer running the local PC software provided with the relay. Cabling for the RS232 port is shown here for both 9 pin and 25 pin connectors.

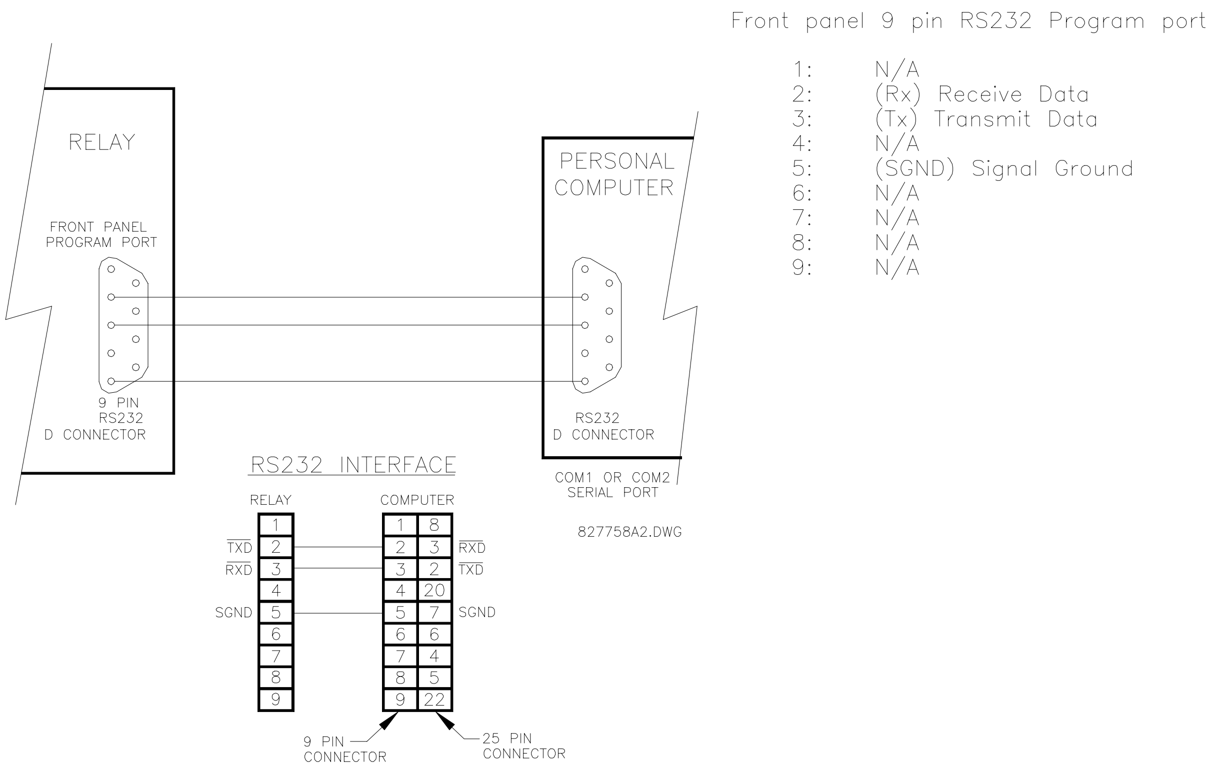


Figure 3–11: RS232 FACEPLATE PROGRAM PORT CONNECTION

3.2.7 RELAY COMMUNICATION PORTS

In addition to the RS232 port on the faceplate, the relay provides the user with two additional communication port(s) depending on the CPU module installed.

Table 3–3: COMMUNICATION PORT OPTIONS

CPU Type	COM 1	COM 2
9A	RS485	RS485
9D	redundant 10BASE-F (10BASE-T debug)	RS485

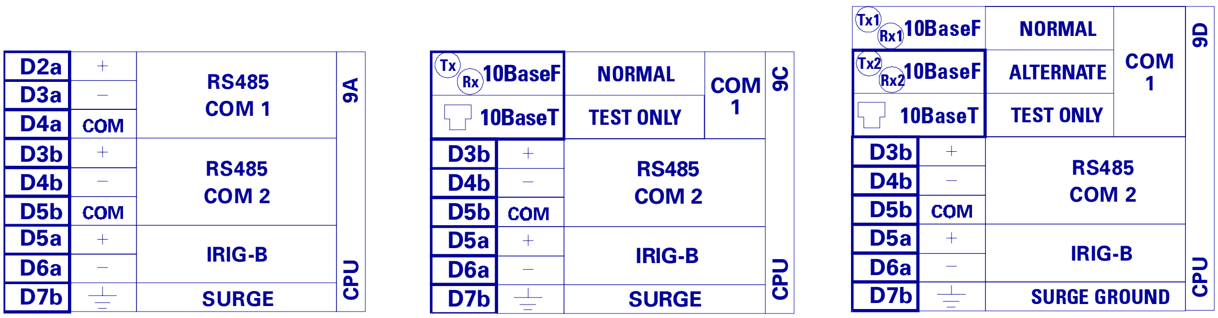


Figure 3–12: TYPICAL COMMUNICATION MODULE WIRING

RS485 data transmission and reception are accomplished over a single twisted pair with transmit and receive data alternating over the same two wires. Through the use of these port(s), continuous monitoring and control from a remote computer, SCADA system or PLC is possible.

To minimize errors from noise, the use of shielded twisted pair wire is recommended. Correct polarity must also be observed. For instance, the relays must be connected with all RS485 "+" terminals connected together, and all RS485 "-" terminals connected together. The COM terminal should be connected to the common wire inside the shield. To avoid loop currents, the shield should be grounded at one point only. Each relay should also be daisy chained to the next one in the link. A maximum of 32 relays can be connected in this manner without exceeding driver capability. For larger systems, additional serial channels must be added. It is also possible to use commercially available repeaters to increase the number of relays on a single channel to more than 32. Star or stub connections should be avoided entirely.

Lightning strikes and ground surge currents can cause large momentary voltage differences between remote ends of the communication link. For this reason, surge protection devices are internally provided at both communication ports. An isolated power supply with an opto-coupled data interface also acts to reduce noise coupling. To ensure maximum reliability, all equipment should have similar transient protection devices installed.

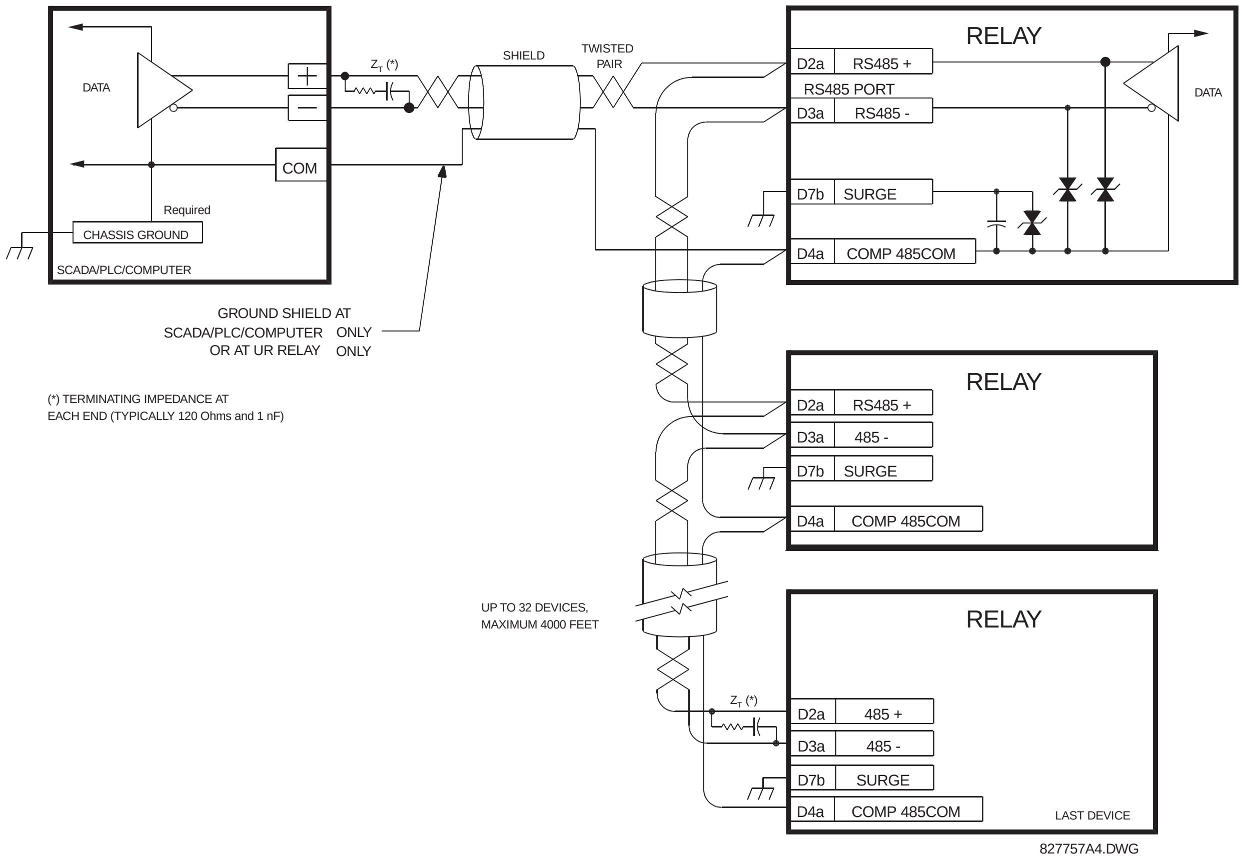


Figure 3–13: RS485 SERIAL CONNECTION

3.2.8 10BASE-F FIBER OPTIC PORT

CAUTION: ENSURE THE DUST COVERS ARE INSTALLED WHEN THE FIBER IS NOT IN USE. DIRTY OR SCRATCHED CONNECTORS CAN LEAD TO HIGH LOSSES ON A FIBER LINK.

CAUTION: OBSERVING THE TRANSMITTER OUTPUT MAY CAUSE INJURY TO THE EYE.

The fiber optic communication ports allow for fast and efficient communications between relays at 10 Mbps. Optical fiber may be connected to the relay supporting a wavelength of 820 nanometers in multimode. Optical fiber is only available for CPU type 9D. The 9D CPU has a 10BASE-F transmitter and receiver for optical fiber communications and a second pair of identical optical fiber transmitter and receiver for redundancy.

The optical fiber sizes supported include 50/125 µm, 62.5/125 µm and 100/140 µm. The fiber optic port is designed such that the response times will not vary for any core that is 100 µm and less in diameter. For optical power budgeting, splices are required every 1 km for the transmitter/receiver pair and the ST type connector contributes for a connector loss of 0.2 dB. When splicing optical fibers, the diameter and numerical aperture of each fiber must be the same. In order to engage or disengage the ST type connector, only a quarter turn of the coupling is required.

3.2.9 IRIG-B

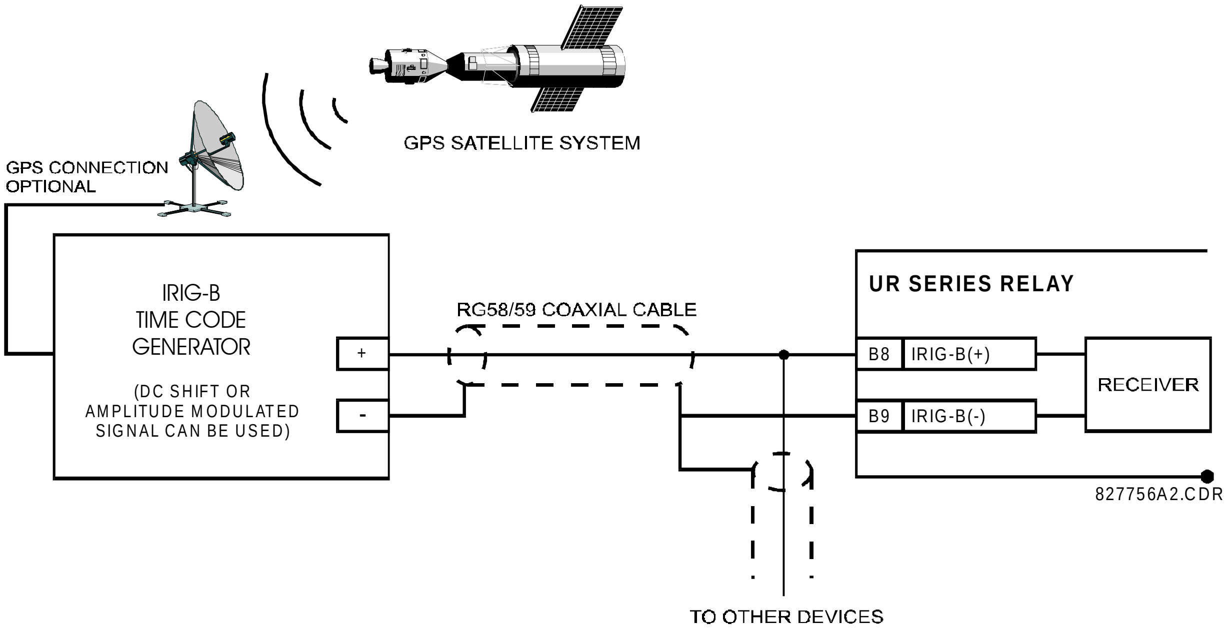


Figure 3–14: IRIG-B CONNECTION

IRIG-B is a standard time code format that allows stamping of events to be synchronized among connected devices within 1 millisecond. The IRIG time code formats are serial, width-modulated codes which can be either DC level shifted or amplitude modulated (AM). Third party equipment is available for generating the IRIG-B signal; this equipment may use a GPS satellite system to obtain the time reference so that devices at different geographic locations can also be synchronized.

4.1.1 GRAPHICAL USER INTERFACE

The URPC® software provides a graphical user interface (GUI) as one of two human interfaces to a UR relay device. The alternate human interface is implemented via the device's faceplate keypad and display (see FACEPLATE INTERFACE section).

The URPC® software program provides users with a single facility to configure, monitor, maintain and trouble-shoot the operation of relay protection devices, connected over local or wide area communication networks.

The URPC® software interface can be used while disconnected (i.e. off-line) or connected (i.e. on-line) to a UR device. In off-line mode, you can prepare a file of the device's parameter settings for eventual downloading to the device. In on-line mode, you can communicate with the device in real-time.

The URPC® software, provided with every UR device, can be run from any computer supporting Microsoft® Windows 95® or Windows NT®.

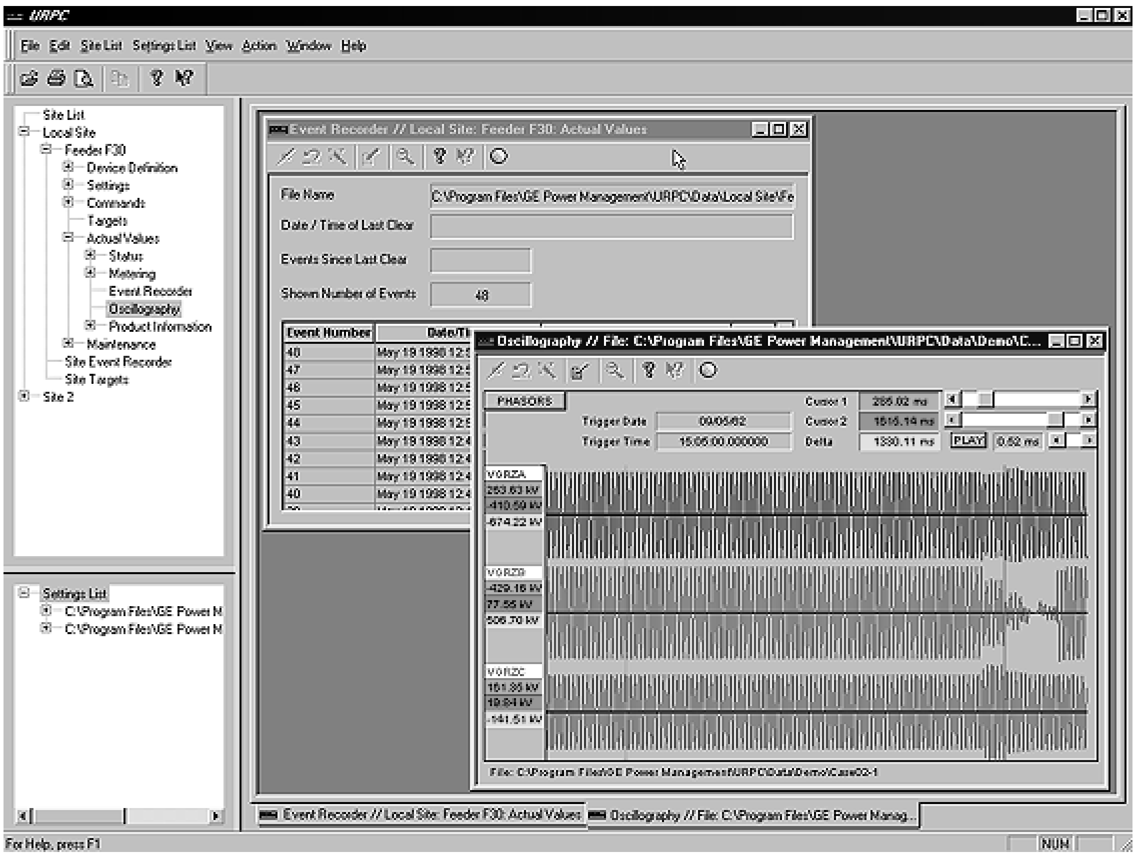


Figure 4–1: URPC® SOFTWARE SAMPLE SCREEN

4.1.2 URPC® SOFTWARE OVERVIEW

The URPC® software provides the interface through which you can:

- Configure a simple site of multiple relay devices sharing common communication networks
- Use, concurrently, various communications protocols over RS232, RS485, and optical fibre
- Send commands to communicating devices
- Configure relay protection algorithms, via tables or graphics
- Specify/Modify all device settings
- Save/Print all or selected device settings
- Load entire or selected portions of settings files to any selected device
- Monitor relay status
- Monitor, simultaneously, actual values from multiple sites and devices
- Monitor targets from individual devices and/or sites
- Read individual device and/or site event records
- Perform waveform capture (oscillography)
- Show/Print device oscillography waveforms graphically
- Upgrade the firmware in the device
- Get help on any topic
- Perform trouble-shooting and maintenance tasks

The following sub-sections present brief descriptions of the major user features of the URPC® software.

a) Using Settings Files

The URPC® software interface supports three ways of handling changes to a relay's settings:

- You can initially use the URPC® software interface in off-line mode to create or edit relay settings files for later writing to communicating relays.
- You can use the interface while connected to a communicating relay to directly modify the relay's settings via relay data view windows, and then forward the settings to the relay's settings file.
- You can create/edit settings files and then write them to the relay while the interface is connected to the relay.

Settings files are organized on the basis of file names assigned by the user. A settings file contains data pertaining to:

- Device Definition
- Product Setup
- System Setup
- FlexLogic
- Elements
- Inputs/Outputs

Factory default values are initially supplied and can be restored after any changes.

b) Engaging a Communicating Device

You can use the URPC® software interface in connected mode to directly communicate with a relay device.

Communicating relay devices are organized and grouped into sites, where each device within a site shares the same communications resources. Sites may contain any number of devices selected from the UR product series.

c) Editing FlexLogic™ Equations

You can edit FlexLogic equations in order to customize the relay, from a list of elementary parameters and be able to view the corresponding logic diagrams.

d) Viewing Actual Values

You can view real-time device data such as input/output statuses and measured parameters.

e) Viewing Triggered Events

While the interface is in on-line or off-line mode, you can view and analyze data generated by triggered power disturbance events, via:

- **Event Recorder facility**

The event recorder captures contextual data associated with the last 1024 events, listed in chronological order from most recent to oldest.

- **Oscillography facility**

The oscillography waveform traces are used to give a visual display of power systems data and relay operation data captured during specific triggered events.

f) Shell Support

- **Execute**

Any file which is double clicked or opened will launch the application or provide focus to the already opened application. If the window is minimized when this occurs, it will be maximized. Under all these conditions, the selected file is added to the Settings List window.

- **File Drag and Drop**

The Windows shell provides a mechanism to support drag and drop of files between its Explorer/file manager programs and other applications.

Only the Site List and Settings List windows are file drop targets. Attempting to drop a file to any other window, results in the cursor icon changing to reflect an invalid operation. The Settings List window is the only drag source for a file drop operation.

All files which are dropped into the Settings List window are added to the tree which is automatically sorted alphabetically with respect to settings file names. File names from the Settings List which are dragged to other applications are tagged as a copy operation. For example, such a file dropped into the Windows Explorer will result in a file copy operation.

Files which are dropped in the Site List window will automatically be sent to the target device or the parent device item if one of its child items is the target.

- **Site List Drag Sources**

The user is provided with the ability to select a device name tree item or a Device View item which contains settings as the source of a drag operation in the Site List window. The target for this operation is a settings file contained in the Settings List. Either the file name tree item or one of its child items can be selected as the drop target.

If a device view was the source, only the settings parameters which it contains and which are included in the target settings file are copied from the device to the file. There is no need to select a corresponding Settings List view as it is inferred from the drop source. It is not possible for the user to select Device Views which do not contain settings or branches of the tree which contain settings as a drop source.

If a device name was selected as the drop source, all the settings contained in the target settings file are copied from the device to the file.

- **Settings List Drag Sources**

As with the Site List window, the Settings List window implements drag sources to support the transfer of settings from a file to a device. Both the transfer of an entire settings file contents and those settings contained within a selected view are supported. As with the Site List drag sources, there is no need to select a corresponding Device View target as it is inferred from the selected view. It is sufficient to select either the device name tree item or any of its children.

- **Limitations**

It should be noted that all device settings may not be transferred during a particular drag and drop operation using these techniques. Settings files are ASCII files which may be edited by an informed user to remove specific settings which should not be considered during a transfer. If all the values related to a specific dragged view are removed, the drag and drop operation may appear to complete immediately.

Note also that the program does not generate template settings files which contain any device communications parameters, which if changed, would prevent the completion of the transfer of a settings file to a device, or any time of day settings. Also, there are settings views which contain read-only settings (e.g. Password view) which can only be changed when factory service mode is entered from the faceplate of the device.

It is also possible for a user to change the device order code associated with a settings file header. This could impact the interpretation of certain MODBUS addresses, especially in the area of contact inputs and outputs, which are order code dependent. If such a modified file contents is viewed from the Settings List, it is likely that the view may contain blank fields for settings which cannot be resolved to valid values based on the order code setting. For these reasons, the user is prevented from writing a settings file to a device with a different order code.

To ease compatibility issues arising from order code dependencies, all settings file templates are generated for a device assuming it is fully populated. The relay is designed to read and write settings which are associated with unpopulated hardware options.

4.1.3 URPC® SOFTWARE MAIN WINDOW

The URPC® software main window supports the following primary display components:

a. Main window menu bar

b. Main window tool bar

c. Site List window with pop-up menu

d. Settings List window with pop-up menu

e. Workspace area with data view tabs

f. Device data view windows, each with common tool bar

g. File data view windows, each with common tool bar

h. Status bar

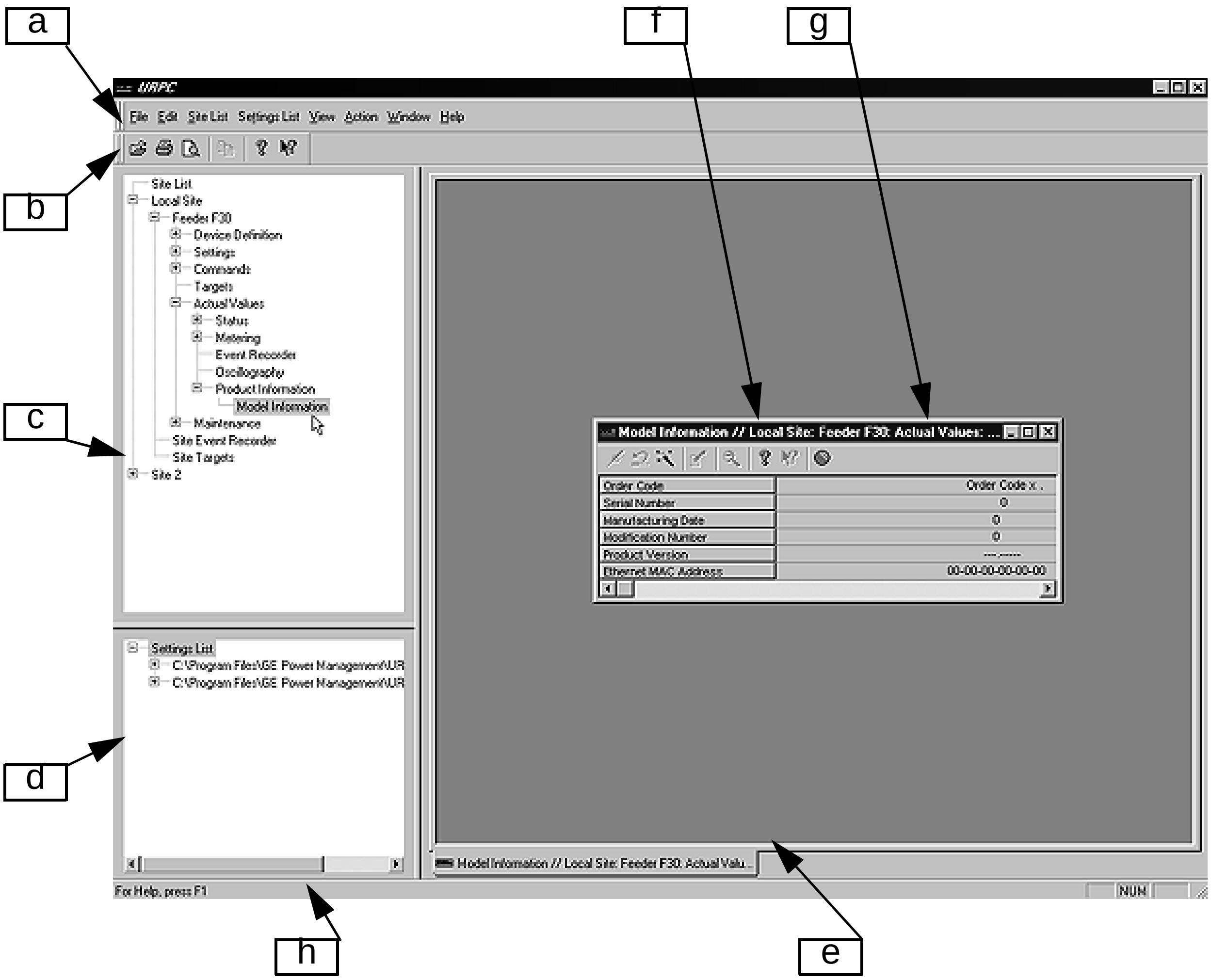


Figure 4–2: URPC® SOFTWARE MAIN WINDOW

The display components can be re-organized for convenience, by using appropriate commands in the:

- View Menu (see section on MAIN WINDOW MENU BAR)
- Pop-up Menus (see section on POP-UP MENUS)
- Window Menu (see section on MAIN WINDOW MENU BAR)

Figure 4–3: MAIN WINDOW MENU BAR

The above figure shows the complete menu bar. The Edit, Action, and Window menus only appear while a device or file data view is open.

a) File Menu

Provides options for working with various event recorder or oscillography files.

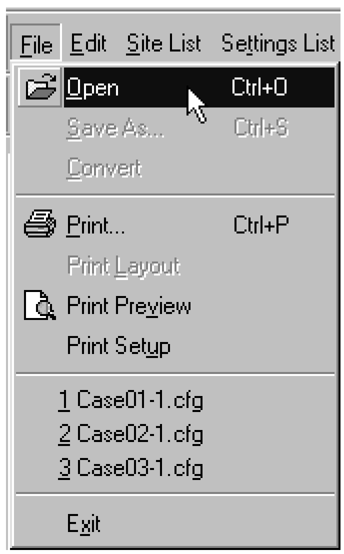


Figure 4–4: FILE MENU

Open: Displays a dialog box for opening a selected device event recorder file (*.EVT) or oscillography COMTRADE file (*.CFG).

Save As: Displays a dialog box for saving the active data view file (oscillography or event recorder).

Convert: Converts the active oscillography view COMTRADE file from binary to ASCII format.

Print: Provides a graphical plot of the active view window.

Print Layout: Displays a dialog box for selecting plotting parameters for graphical output. This command is only available when an Oscillography or Phasor view is opened.

Print Preview: Provides a print preview of the active view.

Print Setup: Displays a dialog box for selecting a printer and its properties.

Recent Files: Displays a list of up to four of the most recently opened view files. You can select any file to re-open it.

Exit: Closes all open views and shuts down the current session of the URPC® software program. The user is prompted to save any unsaved data before the program can shut down.

b) Edit Menu

Provides the copy action for working within a data file.

Figure 4–5: EDIT MENU

Copy: Copies the current selection within the active data view to the clipboard memory buffer.

Copy Special: Copies the selection in a bitmap format.

4

c) Site List Menu

Provides options for working with various sites.

Figure 4–6: SITE LIST MENU

Edit Site List: Launches the Site List configuration view to allow changing of various options and settings for any site or device.

Read Device Settings: Reads all the settings associated with a selected Settings item in the Site List and saves them to the destination settings file selected in the Select Target File dialog box. The dialog box only appears when a specific Settings item is selected.

Print Device Information: Displays a dialog box for selecting any of Settings, Targets, and Actual Values from a selected communicating device, for printing in an ASCII format to the currently selected printer.

Print Preview Device Information: Displays a dialog box for selecting any of Settings, Targets, and Actual Values from a selected communicating device, for print preview.

d) Settings List Menu

Provides options for working with various settings files (*.URS).

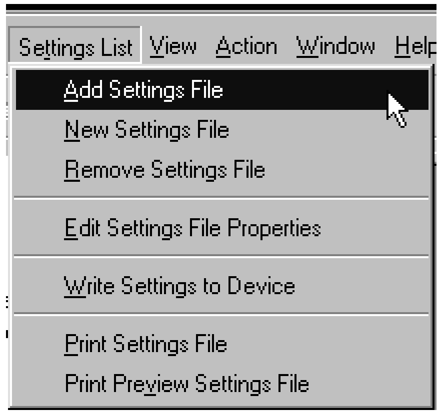


Figure 4–7: SETTINGS LIST MENU

Add Settings File: Displays a dialog box for selecting an existing settings file which is added to the Settings List.

New Settings File: Launches the Create New Settings File dialog box for entering parameter data. Creates the new settings file and adds it to the Settings List.

Remove Settings File: Removes the selected settings file from the Settings List. The file is not removed from disk storage.

Edit Settings File Properties: Displays a dialog box for modifying any device definition parameter of a selected Settings File (any item in the device file's tree may be selected).

Write Settings to Device: Displays a dialog box for selecting a device and for sending to it, the contents of a selected settings file.

Print Settings File: Displays a dialog box for selecting a printer and for printing pages of an ASCII listing of the contents of a selected settings file.

Print Preview Settings File: Displays a window showing an ASCII listing of the contents of a selected settings file. This window includes page view and zoom controls, and the print command. The left mouse button zoom cursor is available in this window.

e) View Menu

Provides options for working within the URPC® software program.

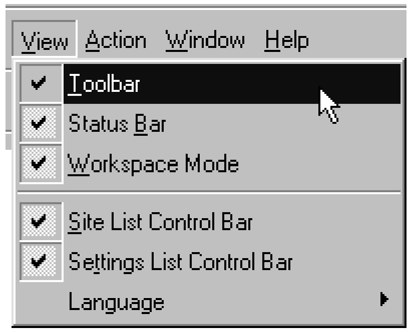


Figure 4–8: VIEW MENU

Toolbar: Hides/Shows the main window tool bar.

Status Bar: Hides/Shows the status bar (at the bottom edge).

Workspace Mode: Enables/Disables workspace view tabs.

Site List Control Bar: Hides/Shows the Site List window.

Settings List Control Bar: Hides/Shows the Settings List window.

Language: Selects the program language (currently - English).

f) Action Menu

Provides options for working with various data views. The menu items are enabled/diasbled according to the specific data view. All of these menu items are also available on each data view window's tool bar.

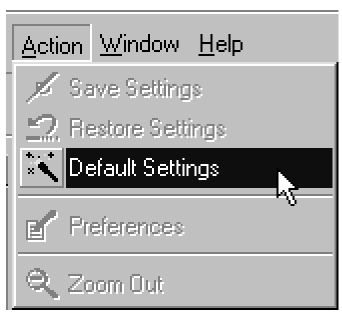


Figure 4–9: ACTION MENU

Save Settings: Saves the contents of the active data view to a selected device or file.

Restore Settings: Restores the contents of the active data view to their last saved version.

Default Settings: Resets the contents of the active data view to the factory default values for the associated device or file.

Preferences: Launches a preferences dialog box for those data views that support it.

Zoom Out: Restores the previous zoom setting for a data view which supports zooming with the left mouse button.

g) Window Menu

Provides options on how data view windows are viewed and organized.

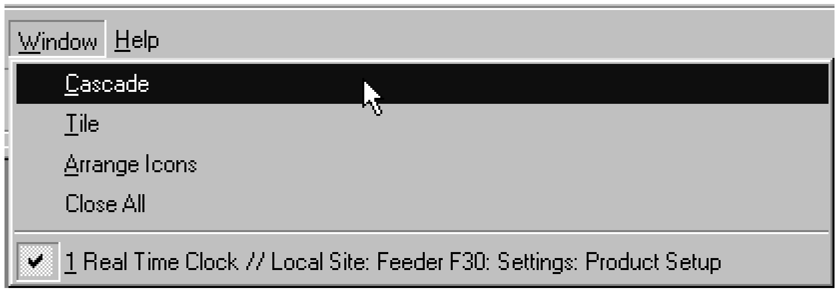


Figure 4–10: WINDOW MENU

Cascade: Arranges all open data view windows, overlapping one in front of the other.

Tile: Arranges all open data view windows, side by side, for simultaneous viewing on the screen.

Arrange Icons: Arranges the icons of all minimized data view windows onto rows at the bottom of the workspace area.

Close All: Closes all open data view windows.

The bottom section of this menu provides a list of the open data view windows. A checkmark signifies the active window. Clicking another window entry makes that window the active window. Clicking any minimized window entry will un-minimize it.

h) Help Menu

Provides help on a variety of topics.

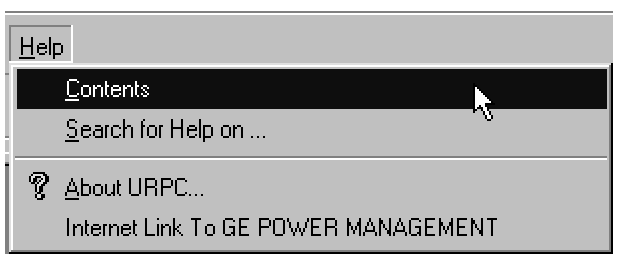


Figure 4–11: HELP MENU

Contents: Displays a window that provides hyperlink access from a table of contents to topics within a reference manual.

Search for Help on... : Displays a search engine dialog box for finding indexed topics within a reference manual.

About URPC... : Displays the current version data for the installed URPC® software.

Internet Link To GE POWER MANAGEMENT: Will automatically open the installed current web browser (i.e. Netscape or Internet Explorer) and open the GE Power Management home page. Internet access is required for this function.

4.1.5 POP-UP MENUS

Each of the Site LIst and Settings List windows supports a pop-up menu via the right mouse button for any cursor location within the respective window.

The Site List pop-up menu includes a duplicate of the Site List Menu of the main window menu bar.

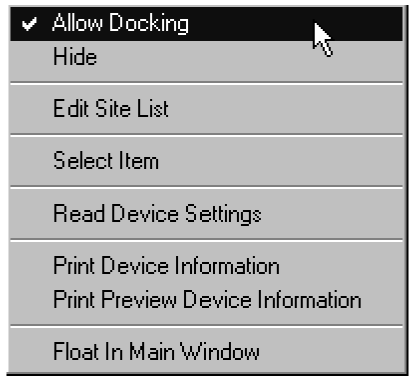


Figure 4–12: SITE LIST POP-UP MENU

The Settings List pop-up menu includes a duplicate of the Settings List Menu of the main window menu bar.

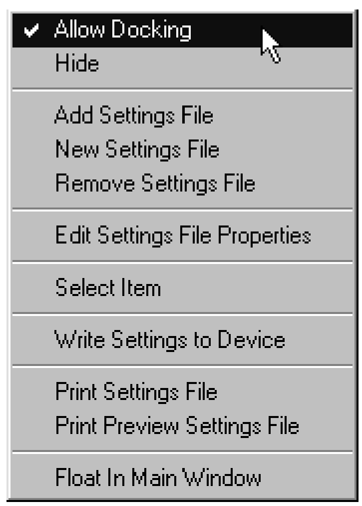


Figure 4–13: SETTINGS LIST POP-UP MENU

Both pop-up menus also include the following menu items:

Allow Docking: Toggles allowing/disabling the docking of the corresponding Site/Settings List window. Disabling the docking allows the relevant window to be moved and sized anywhere in the main window. Allowing docking and then moving the window towards the left or right side of the main window, causes the window to snap into a docked position.

Hide: Hides the corresponding Site/Settings List window. You can use the main window View menu to re-display the List window.

Select Item: Launches the data view window of a selected bottom level tree menu item.

Float in Main Window: Floats the corresponding Site/Settings List window elsewhere in the main window. Disables the Allow Docking command.

4.1.6 MAIN WINDOW TOOL BAR

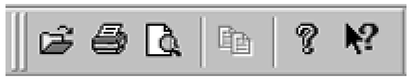
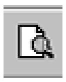


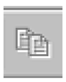
Figure 4–14: MAIN WINDOW TOOL BAR

Open File: Selects a device event recorder file (*.EVT) or oscillography COMTRADE file (*.CFG).

Print: Allows printing of settings or graphed objects.



Print Preview: Displays an on-screen preview of what will be printed.



Clipboard Copy: Copies your current selection to the clipboard memory buffer.

About: Displays the current version data for the installed URPC® software.

Help: Provides help on the object or text that is selected.

4.1.7 DATA VIEW TOOL BAR

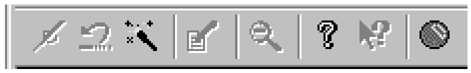
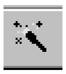


Figure 4–15: DATA VIEW TOOL BAR

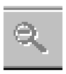
Save Settings: Saves the contents of the active data view to a selected device or file.

Restore Settings: Restores the contents of the active data view to their last saved version.



Default Settings: Resets the contents of the active data view to the factory default values for the associated device or file.

Preferences: Launches a preferences dialog box for those data views that support it.



Zoom Out: Restores the previous zoom setting for a data view which supports zooming with the left mouse button.

About: Displays the current version data for the installed URPC® software.

Help: Provides help on the object or text that is selected.

Status: Provides communications status. If the URPC® software is able to communicate with the device, the open data view window will display a flashing Green LED symbol. If the URPC® software is unable to establish communications, the LED symbol will be flashing in Red.

4.1.8 PRE-PROCESSING A SETTINGS FILE

The URPC® software interface can be used to pre-process a settings file before sending it to a relay device. This can be done with the URPC® software interface either in off-line or on-line mode. Pre-processing a settings file refers to settings files that are or will be listed in the Settings List.

a) NEW Settings File

1. Run the URPC® software by double-clicking the icon installed during the installation process.
2. Click the **New Settings File** item in the **Settings List** menu to display the Create New Settings File dialog. Enter a file name, and select a file location using the 'Select location of settings file' dialog which is accessed via the button at end of File Name field. Enter the device order number, version number, and a descriptive phrase.

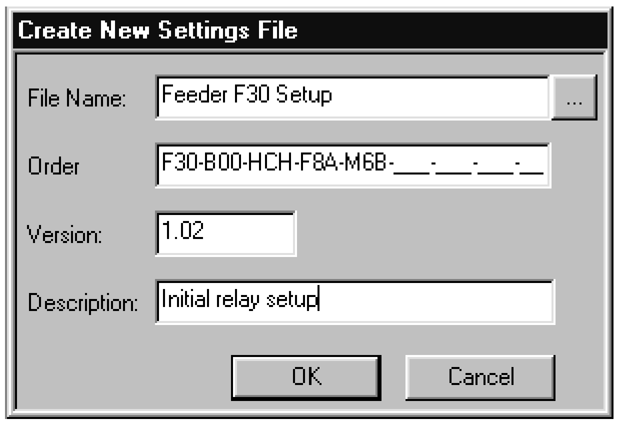


Figure 4–16: Create New Settings File Dialog

3. Click OK in the Create New Settings File dialog to display the settings file name (*.urs) in the Settings List. Expand the new settings file tree menu in the Settings List window. The Device Definition will reflect entries of the previous step.
4. Double click on any bottom level menu tree item to display the corresponding device data view window in the Workspace area. All settings values in the new settings file are the default factory settings of the device. Modify the default values according to your requirements (see the section on Example Setting Entry). **Save Settings** either via the data view's tool bar or the main window's **Action** menu, and close the data view window to add the new settings to the settings file.
5. Optionally, you can print preview and print the new settings file in ASCII format by using the **Print Preview Settings File** and the **Print Settings File** commands in the **Settings List** menu.

b) EXISTING Settings File

An existing settings file can be listed on the Settings List since it was previously created/modified, or be removed from the Settings List via the **Remove Settings File** command in the **Settings List** menu. When removed, the file still exists on disk storage. You can return the removed settings file to the Settings List by using the **Add Settings File** command in the **Settings List** menu, or by dragging and dropping.

You can edit the Device Definition of a selected settings file by using the **Edit Settings File Properties** command in the **Settings List** menu, and by editing the Edit Settings File Properties dialog.

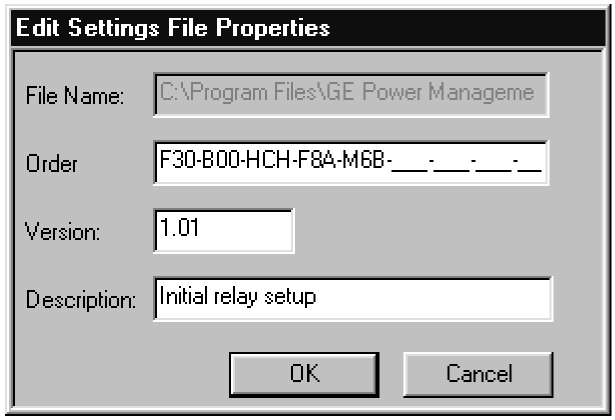


Figure 4–17: Edit Settings File Properties Dialog

You can edit settings values by double clicking on any bottom level menu tree item to display the corresponding device data view window in the Workspace area. Edit the existing values according to your requirements. **Save Settings** either via the data view's tool bar or the main window's **Action** menu, and close the data view window to add the new settings to the settings file.

Optionally, you can print preview and print the modified settings file in ASCII format by using the **Print Preview Settings File** and the **Print Settings File** commands in the Settings List menu.

c) Example Setting Entry

The following example illustrates entering settings for S2 SYSTEM SETUP / POWER SYSTEM using the URPC® software interface.

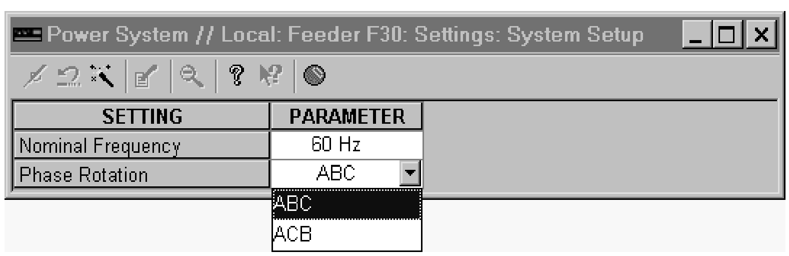


Figure 4–18: ENTERING A SETTING

1. From the device's **Settings > System Setup** menu, select **Power System**.
2. Click a parameter field and then click the down arrow for choices. Click the selection.
3. If in connect mode, click on the **Write Settings to Device** button when done. This will immediately send the changed settings to the device.
4. If in edit mode, click on the **Save Settings** button, to save the changes to the settings file.
5. Click on **Restore Settings** to retain the previous value.
6. Click on **Default Settings** to restore the settings back to factory defaults.
7. Click on **Help** to display help related to settings seen in this window.

d) Exporting Settings to a Device

You can export the complete contents of a selected settings file in the Settings List to a selected communicating device, by using the **Write Settings to Device** command in the **Settings List** menu. A dialog box will be displayed in the Workspace area for selecting an existing device.

4.1.9 SETTING UP A COMMUNICATING DEVICE

Connect the computer to the relay via one of the rear RS485 ports or via the front RS232 port. Following are the steps to begin communicating with the relay using the URPC® software:

1. Run the URPC® software by double-clicking the icon installed during the installation process.
2. Establish a communications link with the device by selecting **Edit Site List** from the **Site List** menu, and by entering/updating the device definition.

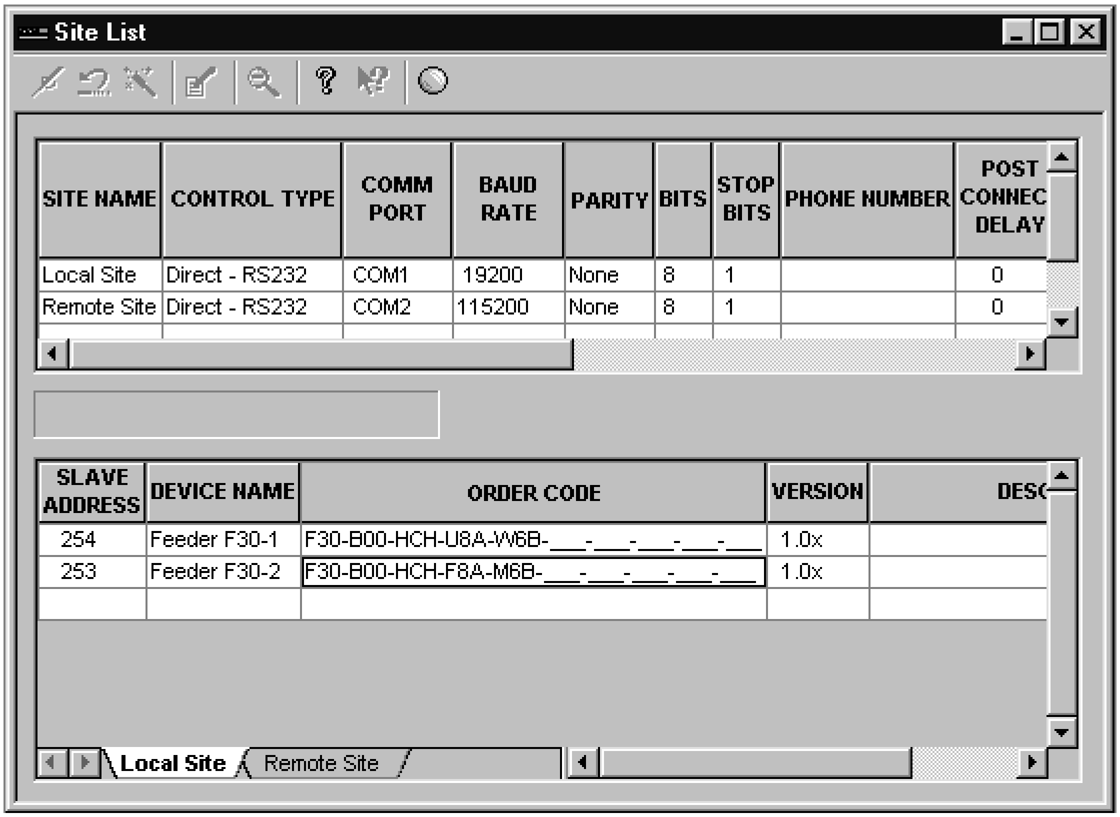


Figure 4–19: EDIT SITE LIST VIEW

3. Check the relay's Communications settings via the Faceplate Interface, and note the following:

Communications Port: Ensure that the COMM PORT entry is the COM port on your computer which is connected to the relay (i.e. COM1 or COM2). On most PCs, COM1 is used by the mouse device and so COM2 is usually available for communications.

Control Type: Set to match the type of RS232/RS485 converter control type. If you are connected to the relay faceplate RS232 port, select "No Control Type". If you are connected to a MULTILIN RS232/RS485 converter, select "MULTILIN 232/485 Converter". If you are connected to a modem, select "Modem". If you are connected to a third party's converter box, use the manufacturer's specifications to select the appropriate control type from the available list.

The following settings should have the same parameter value as that of the corresponding faceplate interface S1 SETTINGS / PRODUCT SETUP / COMMUNICATIONS / parameter:

- **Slave Address**
- **RS232 Baud Rate**
- **RS232 Parity**

- **RS485 COM1 Baud Rate**
- **RS485 COM1 Parity**
- **RS485 COM2 Baud Rate**
- **RS485 COM2 Parity**
- **Ethernet IP Address**
- **Gateway IP Address**

4. Enter the Communications parameters on the Edit Site List view

4.2.1 FLEXLOGIC™ GRAPHIC VIEW

FlexLogic™ allows you to customize the relay through a series of equations which consist of operators and operands. The operands are the states of inputs, elements, and outputs. The operators are logic gates, timers and latches. A system of sequential operations allows any combination of specified operands to be assigned as inputs to specified operators to create an output. The final output of an equation is a numbered register called a “VIRTUAL OUTPUT”. Virtual outputs can be used as an input operand in any equation, including the equation which generates the output, as a seal-in or other type of feedback.

FlexLogic™ settings can be entered via the Faceplate Interface (see section on FLEXLOGIC™) or via the URPC® software interface (as follows).

The FlexLogic Graphic view provides a graphic representation of the FlexLogic™ settings selected in the **Settings > FlexLogic > Equation Editor** view. The **FlexLogic Graphic** view is launched by clicking the **View** button in the **Equation Editor** view.

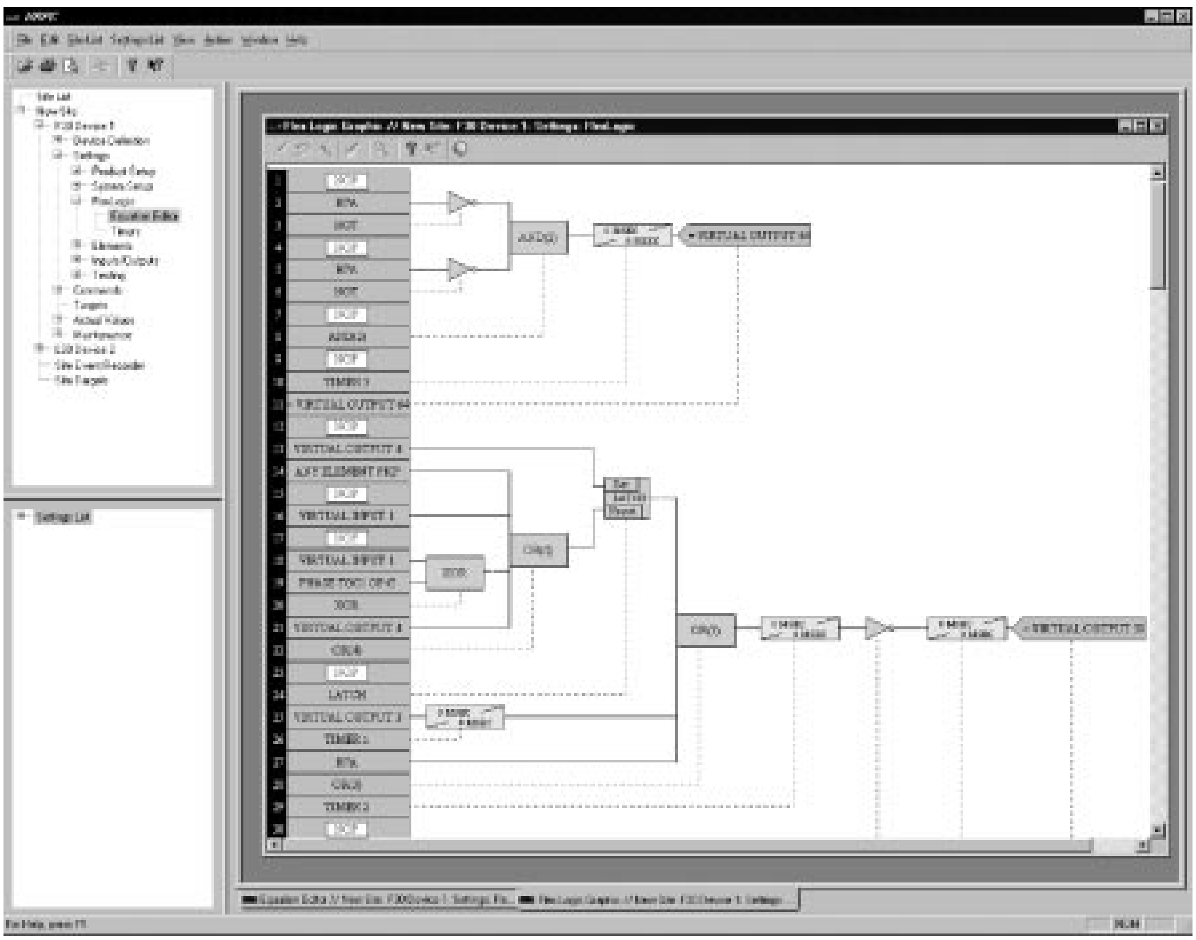


Figure 4–20: SAMPLE FLEXLOGIC GRAPHIC VIEW

4.3.1 EVENT RECORDER

The Event Recorder view provides a chronological display of UR event records.

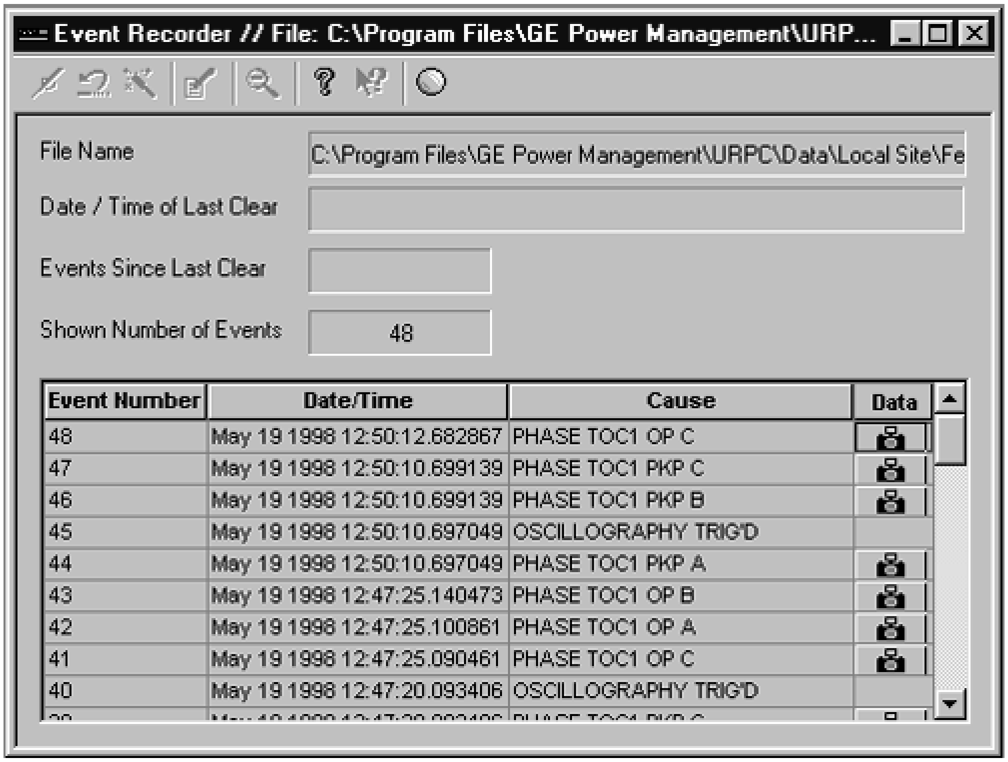


Figure 4–21: Event Recorder View

The Event Recorder view can be launched from the **File > Open** menu for files that have been saved, or via the **Actual Values > Event Recorder** item to retrieve files from the relay. If launched from the Site List, the Events Since Last Clear and the Date/Time Of Last Clear header fields are set according to information read from the device. If launched from the File Open menu, these fields remain blank. In either case, the path of the event file which is displayed and the total number of displayed events are shown.

All events will have the event identifier number, date/time stamp, and cause information associated with the event trigger. The three basic elements of all events are displayed in the first three columns of the Event Recorder view. The fourth column contains a list of push-buttons which allow a more detailed view of the data to be launched for Snapshot, Setting Change, and Oscillography events.

A snapshot record is always recorded for trips and self-test errors. It can also be enabled for element pickup/ dropout as well as contact input, virtual input, alarm output, other output and/or virtual output state changes. The last 256 events of these types may have a snapshot record.

4

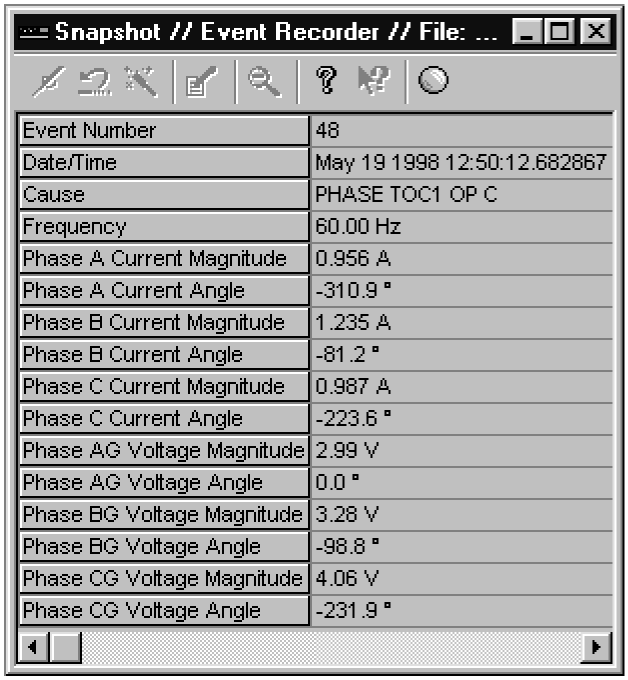


Figure 4–22: Sample Snapshot Record

This record contains frequency, current and voltage information at the time of the event. Voltage quantities will be phase to ground for Wye connection and phase to phase for Delta connections.

Events can be categorized in relation to their data requirements. Each event category contains at least these three elements: 1) event number, 2) the device time at which the event was logged, and 3) a textual description of the event occurrence. An event which contains only these three elements is called a Simple Event. An event which contains associated detailed information is called a Snapshot Event. Events which log information about a settings change are called Setting Change events. The last kind of event contains a reference to a buffered oscillography data record and is known as an Oscillography Event.

When the Event Recorder view is closed, any Snapshot or Settings Change views which were launched using the bitmap buttons are closed.

4.4.1 INTRODUCTION TO OSCILLOGRAPHY

The oscillography feature of the URPC® software gives a visual display of power systems data and relay operation data captured during specific triggered events. This data can be used for subsequent analysis.

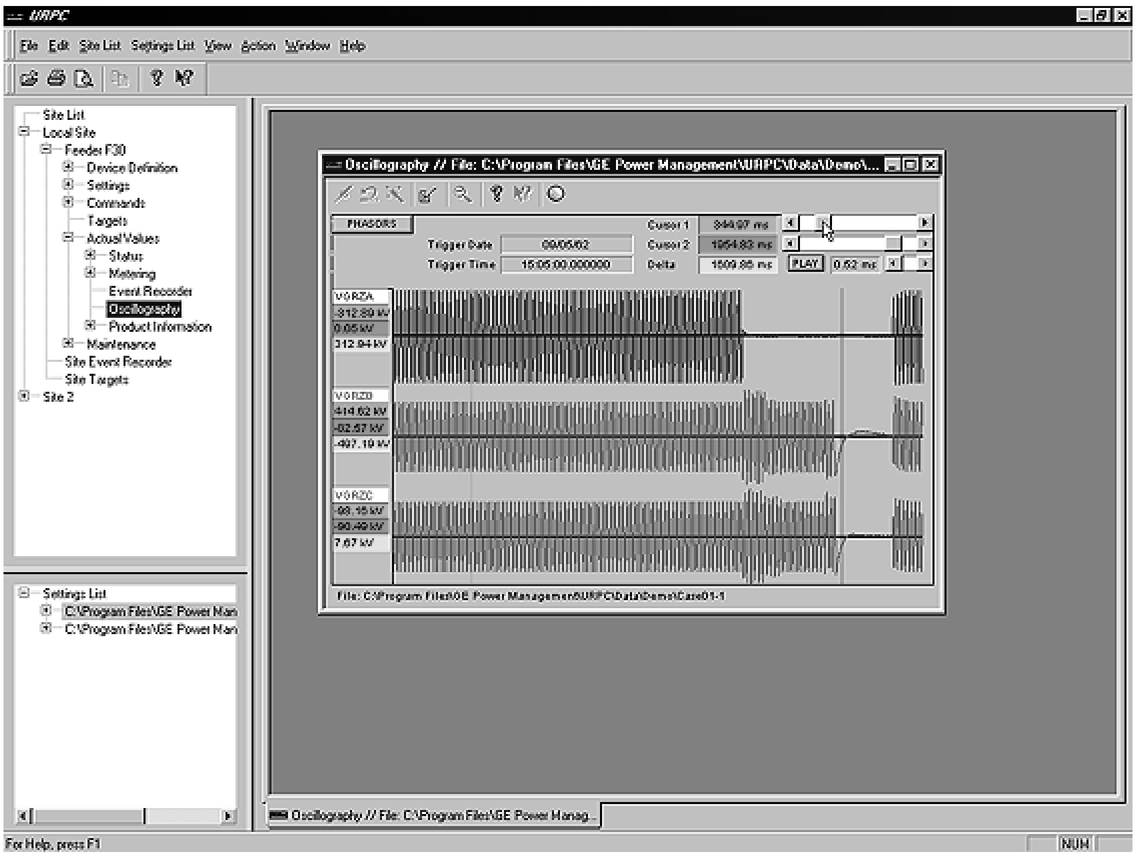


Figure 4–23: Oscillography Data View

The relay has two on-board memory buffers. One buffer is used for storage of event records and the second buffer is used for the storage of oscillography records. By utilizing the URPC® software, the event recorder can be used as an index for quick access of oscillography records. Oscillography records are triggered by a programmable FlexLogic™ operand. The oscillography records captured by the URPC® software consist of current and voltage waveforms, digital input states and settings at the point of trigger. The number of pre-trigger and post-trigger cycles may also be selected.

Some of the main features of the URPC® oscillography function include:

- a sampling rate of 64 samples per cycle
- a selectable number of records ranging from 1 record, 128 cycles long, up to 31 records, 8 cycles long
- 6 analog and 15 digital waveforms
- waveform zooming and printing features

4

4.4.2 OSCILLOGRAPHY FILE VIEW

An oscillography file can be displayed in terms of graphical representations of relevant current and/or voltage waveform traces and associated data.

a) Oscillography View Window

The Oscillography View allows you to plot oscillography records captured by the relay. The view can be launched from the **File > Open** menu for files that have been saved, or via the **Actual Values > Oscillography** item to retrieve files from the relay.

Sample oscillography files (*.cfg) are supplied with the URPC® software. These files are accessed via the **File > Open** menu. These files are located in the **\Program Files \GE Power Management \Urpc \Data ** directory.

The following figure illustrates the view of a sample oscillography file.

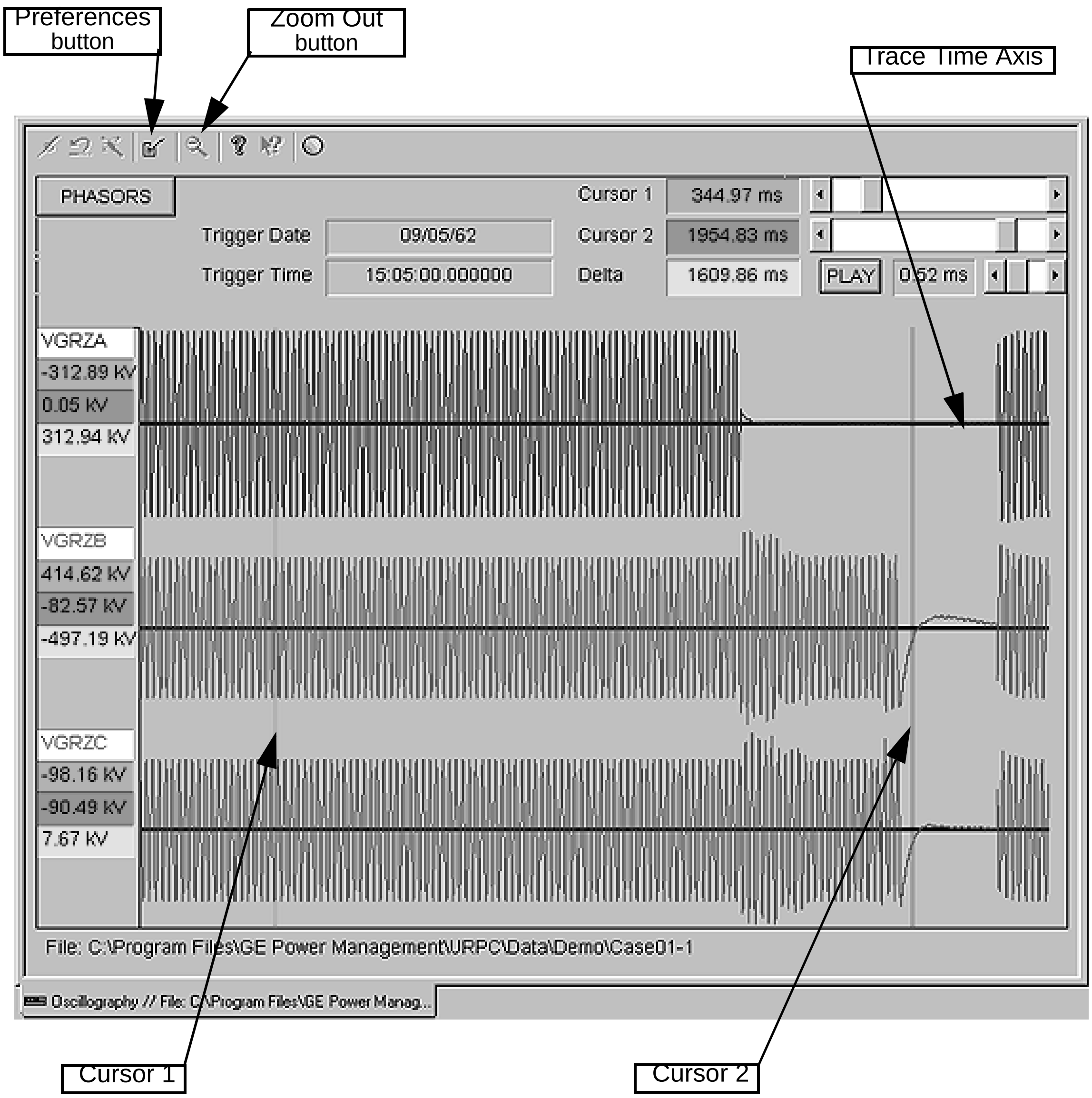


Figure 4–24: SAMPLE OSCILLOGRAPHY FILE VIEW

The oscillography view window supports various display elements, as follows:

1. Common data view tool bar.
2. Horizontal waveform trace time lines, and waveform traces.
3. Vertical red line indicating the trigger position of the data capture.
4. Initial and final vertical time cursor lines (blue & green).
5. At the left end of each time line, there are four information items shown for the displayed waveform traces. The first item (white field) indicates the trace parameter that your are viewing. The second item (blue field) displays the parameter value at the blue cursor (Cursor 1) position. The third item (green field) displays the parameter value at the green cursor (Cursor 2) position. The fourth item (yellow field) indicates the relative parameter value difference between the two cursor amplitude values.
6. Trigger Date and Trigger Time data fields.
7. Cursor 1 and Cursor 2 time position data fields, and the relative Delta time difference between the two cursor time positions.
8. Three scroll bar and two command buttons.

The oscillography view window supports various controls, as folows:

1. **Preferences** button in the tool bar for displaying the **Oscillography / Setup** dialog. This dialog allows you to select the analog and digital channel traces to be plotted. Each trace can have a different colour and line style.
2. **PHASORS** button for displaying color-coded phasor information which is based on the current position of cursor 1.
3. Horizontal scroll bars for moving time line **Cursor 1** (blue vertical line) and time line **Cursor 2** (green vertical line). The scroll bar position reflects the relative position of the cursor in the data set and is particularly useful when the graph is zoomed.
4. Left mouse button click and drag for horizontally moving **Cursor 1** or **Cursor 2**.
5. **PLAY** toggle button for automatic incremental movement of **Cursor 1**. The playback process automatically rewinds and repeats when the end of the oscillography record is reached.
6. Scroll bar, at right of **PLAY** button, for selecting the speed of playback.
7. Left mouse button click and drag for vertically moving any horizontal time line. This allows dragging of traces on top of each other.
8. Any double-clicked non-button text for displaying the **Text Parameters** dialog.
9. Any double-clicked time line or waveform trace for displaying the **Plot Parameters** dialog.
10. Right mouse button click and outline for horizontal **zoom in** of all the parallel time lines. A slider for re-selecting the time line display interval is available during zoom ins. Multiple zoom-ins are possible.
11. **Zoom Out** button in the tool bar for horizontal zoom out of all the parallel time lines. Multiple zoom-outs are possible.

a) Selecting an Oscillography Record

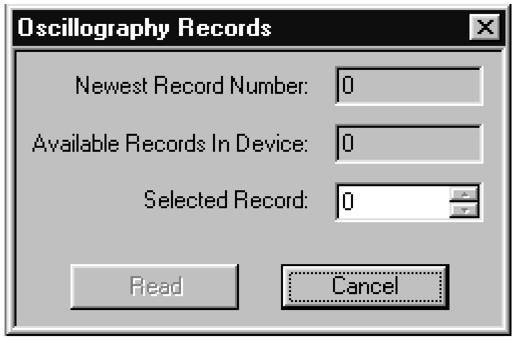


Figure 4–25: OSCILLOGRAPHY RECORDS VIEW

The oscillography selection dialog box is launched from the Site List window when you select the **Actual Values > Oscillography** view. It allows you to select which of the oscillography records buffered in the device is to be read. The number of available buffers is dependent upon the trigger settings and currently can range from 1 for the largest record size to 31 for the smallest.

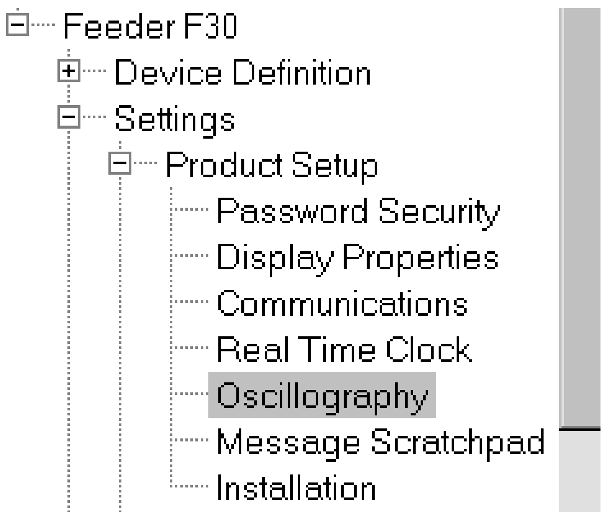
Oscillography record numbers increase monotonically with each trigger event, provided you do not change the trigger settings. The **New Record Number** edit box displays the record number of the most recently triggered event. The **Available Records In Device** edit box displays the current number of stored records in the device. If zero, no records exist in the device or the program was unable to communicate with the device. The **Selected Record** edit box/spin control combination allows you to select which of the records buffered by the device should be read. This number is initialized to the newest available record when the dialog box is first displayed and cannot be set lower than the oldest record number stored by the device.

It should be noted that while this dialog box is displayed, new oscillography triggers may be activated by a device. As the dialog does not poll the device while it is active, it is recommended that the user retrieve the event file to coordinate recovery of oscillography data from the device. The event record contains a timestamp and record number for each trigger condition which is met. If a trigger occurs which invalidates retrieval of the selected record, an error message is displayed during the data transfer and the operation is aborted.

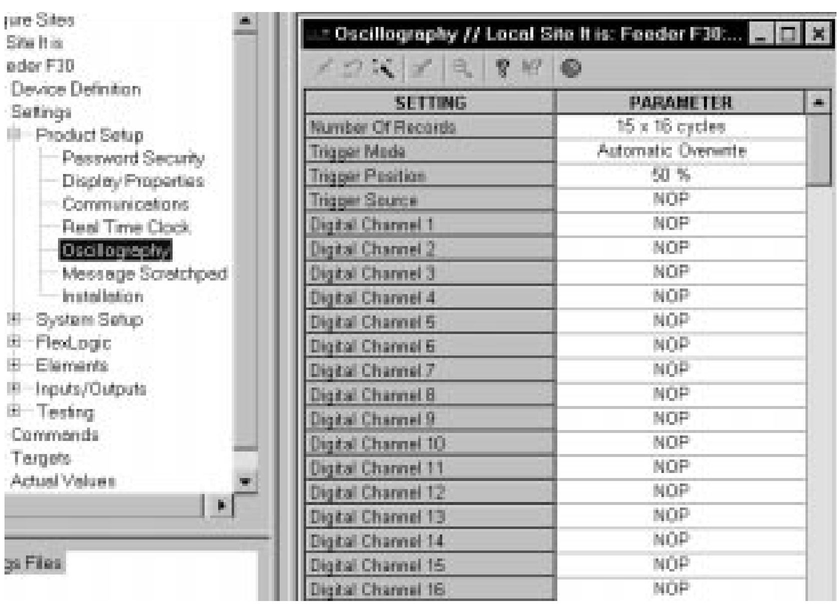
4.4.3 OSCILLOGRAPHY CONFIGURATION

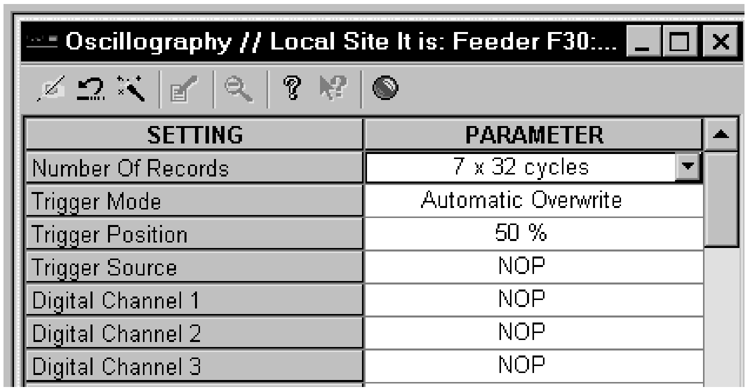
To utilize the oscillography feature, you need to do the following steps to configure the relevant parameters in the URPC® software.

1. Double-click the URPC® software interface icon, and adjust the main window display components for appropriate viewing of the Site List and data views.
2. In the **Site List** window, expand the directory of the desired site.
3. Expand the Device directory; **Settings > Product Setup**.

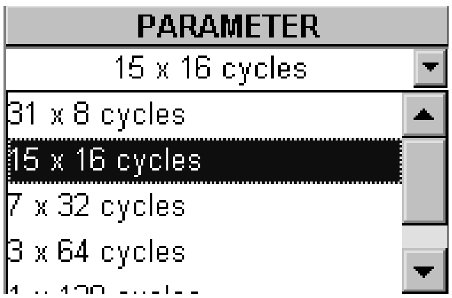


4. Double click on **Oscillography** to open its Setting/Parameter window.



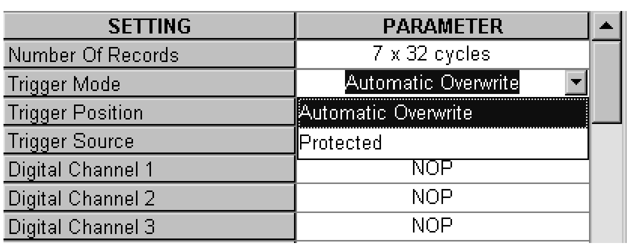


5. In the PARAMETER column, click the **Number Of Records** data field. A scroll button will appear.
6. Click on the scroll button to open a selection window.



The number of records that can be captured is selectable from 31 records, 8 cycles long, to 1 record, 128 cycles long.

7. Select the number of oscillography records required.



8. In the PARAMETER column, click the **Trigger Mode** data field. A scroll button will appear.
9. Click on the scroll button to open a selection window.
10. Select the desired trigger mode.

There are two operational modes available, **Automatic Override** and **Protected**. In protected mode, records will only be captured up until the buffer is full. In automatic overwrite mode, the oldest record will be overwritten as the buffer is filled up.

SETTING	PARAMETER
Number Of Records	7 x 32 cycles
Trigger Mode	Automatic Overwrite
Trigger Position	50 %
Trigger Source	NOP
Digital Channel 1	NOP
Digital Channel 2	NOP
Digital Channel 3	NOP
Digital Channel 4	NOP
Digital Channel 5	NOP
Digital Channel 6	NOP
Digital Channel 7	NOP
Digital Channel 8	NOP

0 to 100 %

11. In the PARAMETER column, click in the **Trigger Position** window. An *up/down* scroll button will appear.
12. Click on the scroll button to change the trigger position percentage (or type in the desired percentage over the existing amount). The trigger position is selectable from 0 to 100%, but is typically set to 50%.

Oscillography // Local Site It is: Feeder F30:...

SETTING	PARAMETER
Number Of Records	15 x 16 cycles
Trigger Mode	Automatic Overwrite
Trigger Position	50 %
Trigger Source	NOP
Digital Channel 1	NOP
Digital Channel 2	NOP
Digital Channel 3	NOP
Digital Channel 4	NOP
Digital Channel 5	NOP
Digital Channel 6	NOP
Digital Channel 7	NOP
Digital Channel 8	NOP
Digital Channel 9	NOP
Digital Channel 10	NOP
Digital Channel 11	NOP
Digital Channel 12	NOP
Digital Channel 13	NOP
Digital Channel 14	NOP
Digital Channel 15	NOP

13. In the PARAMETER column, click in the **Trigger Source** window. A scroll button will appear.
14. Click on the scroll button to open a selection window.

Virtual Input 29
Virtual Input 30
Virtual Input 31
Virtual Input 32
Virtual Output 1

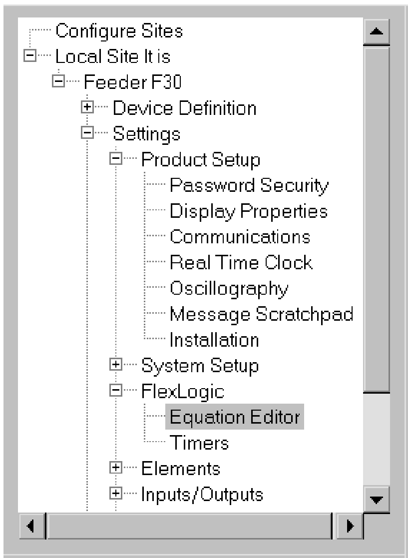
15. Select the desired trigger source.

The trigger source may be something simple as any particular element operating or picking-up, such as an instantaneous overcurrent. Or the trigger source may be something more complex, such as a virtual output.

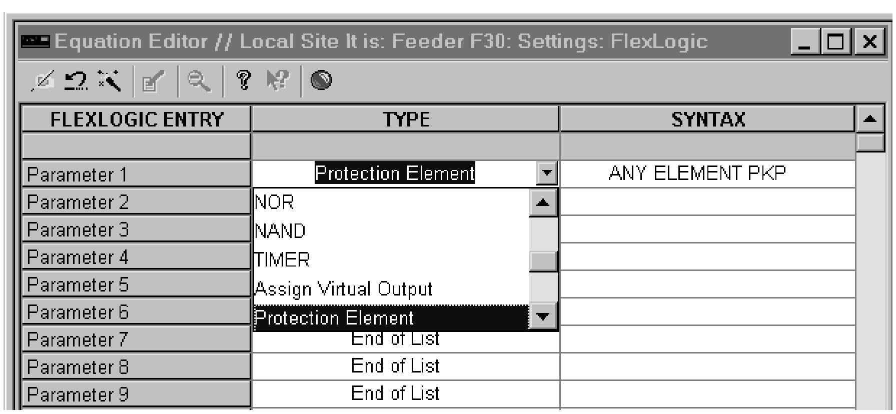
For example, if Virtual Output 1 is selected as the trigger source, a FlexLogic™ equation can be used to trigger the element.

a) Selecting a Protection Element

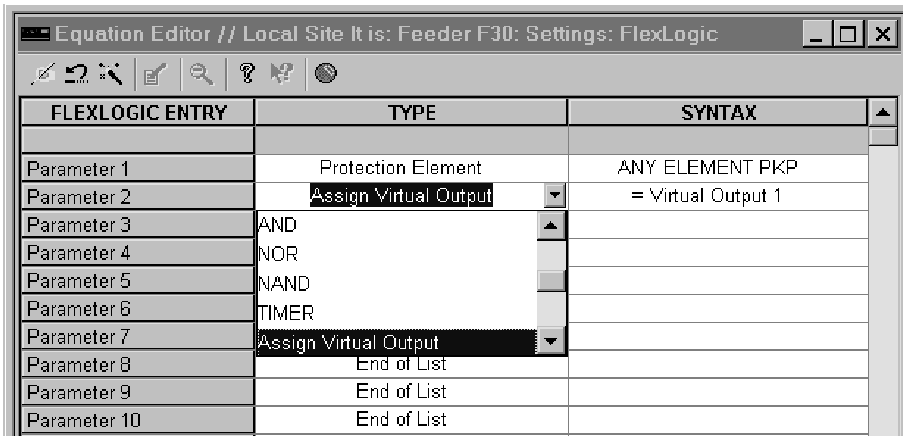
A protection element pickup can be selected and assigned to a particular virtual output. The Oscillography function can then use that virtual output as the trigger source. When any element operates, it will trigger Oscillography. If the oscillography trigger source is set to Virtual Output 1, use the FlexLogic™ equation editor to assign the protection element to Virtual Output 1.



1. Expand the **Settings > FlexLogic** directory.
2. Double click on **Equation Editor** to open the equation editor window.



3. In the TYPE column, click in the first **End of List** field. A scroll button will appear.
4. Click on the scroll button to open a selection window.
5. Select **Protection Element** in the **Parameter 1** row.



6. In the **Parameter 2** row, select **Assign Virtual Output 1**

4

4.5.1 FACEPLATE

The UR faceplate keypad/display interface is one of two alternate human interfaces supported. The alternate human interface is implemented via the URPC® software.

The faceplate is hinged to allow easy access to the removable modules. There is also a removable dust cover that fits over the faceplate which must be removed in order to access the keypad.

4.5.2 DISPLAY

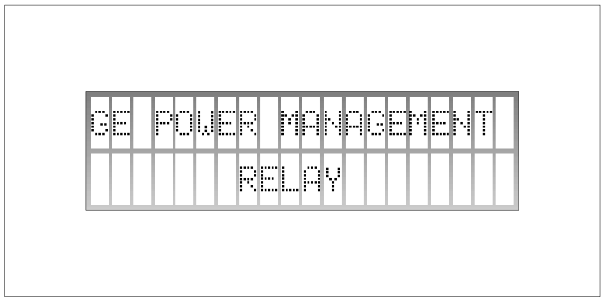


Figure 4–26: DISPLAY

All messages are displayed on a 2 x 20 character vacuum fluorescent display to make them visible under poor lighting conditions. Messages are displayed in plain English and do not require the aid of an instruction manual for deciphering. While the keypad and display are not actively being used, the display will default to defined messages. Any high priority event driven messages will automatically override the default messages and appear on the display.

4.5.3 KEYPAD

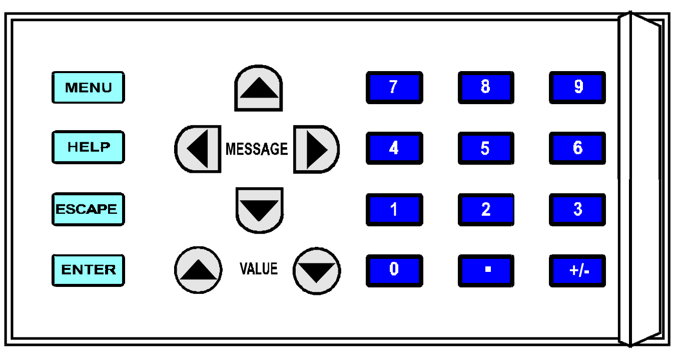


Figure 4–27: KEYPAD

Display messages are organized into pages under the main headings, Actual, Settings, Commands, and Targets. The MENU key is used to navigate through the main heading pages. Each main heading page is further broken down into logical subgroup messages. The ▲ ◀ MESSAGE ▶ ▼ keys may be used to navigate through the subgroups.

The ▲ VALUE ▼ keys are used to scroll through variables in the setting programming mode. They will increment and decrement numerical setting values. Alternatively, these values may be entered with the numeric keypad.

The ENTER key is used to store altered setting values. The HELP key may be pressed at any time for context sensitive help messages.

The key is used to initiate, and advance to, the next character in text edit mode or to enter a decimal point. The VALUE keys are used to scroll through alphanumeric values in text edit mode.

4.5.4 LED INDICATORS

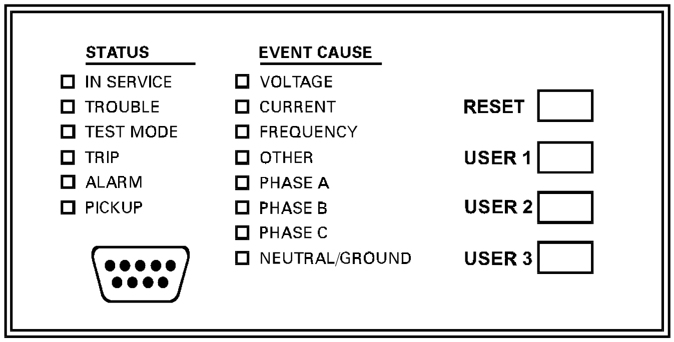


Figure 4–28: LED INDICATOR PANEL

There are several groups of LED indicators. The RESET key is used to reset any latched output, LED indicators, or event messages once the condition has been cleared. The RS232 port is intended for connection to a portable PC.

a) Status Indicators

- **IN SERVICE:** Indicates that control power is applied; all monitored I/O and internal systems are OK; the relay has been programmed.
- **TROUBLE:** Indicates that the relay has detected an internal problem.
- **TEST MODE:** Indicates that the relay is in test mode.
- **TRIP:** Indicates that an output relay selected to be a “Trip” type has operated. This indicator always latches and the Reset command must be initiated when no “Trip” type output relays are operated to reset this indicator.
- **ALARM:** Indicates that an output relay selected to be an “Alarm” type is currently operated. This indicator is never latched.
- **PICKUP:** Indicates that an element is picked up. This indicator is never latched.

b) Event Cause Indicators

Indicate the input type that was involved in a condition detected by an element that is operated or has a latched flag waiting to be reset.

- **VOLTAGE:** Indicates voltage was primarily involved.
- **CURRENT:** Indicates current was primarily involved.
- **FREQUENCY:** Indicates frequency primarily was involved.
- **OTHER:**
- **PHASE A:** Indicates phase A was involved.
- **PHASE B:** Indicates phase B was involved.
- **PHASE C:** Indicates phase C was involved.
- **NEUTRAL/GROUND:** Indicates neutral or ground was involved.

4.5.5 MENUS

a) Navigation

Press the MENU key to display the desired header display page. The header title will flash momentarily and the header display page will appear on the display. Each press of the MENU key advances through the main heading pages as illustrated.

MENU	⇨	MENU	⇨	MENU	⇨	MENU
ACTUAL		SETTINGS		COMMANDS		TARGETS
⇩		⇩		⇩		⇩
■■ A1 ACTUAL VALUES ■■ STATUS		■■ S1 SETTINGS ■■ PRODUCT SETUP		■ CLEAR RECORDS ■		No Active Targets

b) Hierarchy

The setting and actual value messages are setup in a hierarchical format. The header display pages are indicated by the double scroll bar characters (■■), while sub-header pages are indicated by a single scroll bar character (■). The header display pages are at the highest level of the hierarchy and the sub-header display pages fall below this level. The MESSAGE ▲ and MESSAGE ▼ keys are used to move within a group of headers, sub-headers, setting values or actual values. Continually pressing the MESSAGE ► key from a header display, displays more specific information for the header category. Conversely, continually pressing the ◄ MESSAGE key from a setting value or actual value display will return to the header display.

Highest Level				**Lowest Level (Setting Value)**
■■ S1 SETTINGS ■■ PRODUCT SETUP	◄►	■ PASSWORD ■ SECURITY	◄►	ACCESS LEVEL: Restricted
▼				
■■ S2 SETTINGS ■■ SYSTEM SETUP				

Below is a description of navigation for the relay:

■■ A1 ACTUAL VALUES ■■ STATUS	Press the MENU key until the header for the first actual values page appears. This page contains system and relay status information. Repeatedly press the MESSAGE keys to display the additional actual value headers.
■■ S1 SETTINGS ■■ PRODUCT SETUP	Press the MENU key until the header for the first page of settings appears. This page contains settings to configure the relay.
■■ S2 SETTINGS ■■ SYSTEM SETUP	Press the MESSAGE key to move to the next settings page. This page contains settings for entering the characteristics of the system being protected. Repeatedly press the MESSAGE keys to display the additional setting headers and then back to the first settings page header. The 'S' prefix indicates that the display is a setting page.
■ PASSWORD ■ SECURITY	From the settings page one header (S1), press the MESSAGE key once to display the first subheader as shown. Settings associated with this subheader are related to password security.
ACCESS LEVEL: Command	Press the MESSAGE key once more and this will display the associated settings for password security. Pressing the MESSAGE key repeatedly will display the remaining setting messages for this subheader.
■ PASSWORD ■ SECURITY	. Press the MESSAGE key once to move back to the first subheader message.
■ DISPLAY ■ PROPERTIES	Pressing the MESSAGE key will display the second setting subheader associated under the product setup (S1) header.
FLASH MESSAGE TIME: 4.0 s	Press the MESSAGE key once more and this will display the associated settings for display properties.
SCREEN SAVER WAIT TIME: 5 min	To view the remaining settings associated with the display properties subheader, repeatedly press the MESSAGE key. The last message appears as shown.

4

4.5.6 CHANGING SETTINGS

a) Entering Numerical Data

Each numerical setting has its own minimum, maximum, and increment value associated with it. These parameters define what values are acceptable for a setting.

```
NOM VT SEC VOLTAGE:
120.0 V
```

Move to message S2 SYSTEM SETUP / VOLTAGE SENSING / NOMINAL VT SECONDARY VOLTAGE.

```
MINIMUM:  50.0
MAXIMUM: 240.0
```

Press the HELP key and the context sensitive help messages.

Two methods of editing and storing a numerical setting value are available.

0 - 9 and . (DECIMAL) - The relay numeric keypad works the same as that of any electronic calculator. A number is entered one digit at a time. The leftmost digit is entered first and the rightmost digit is entered last. Pressing the MESSAGE ◄ key, before the ENTER key, returns the original value to the display.

▲ **VALUE** ▼ - The VALUE ▲ key increments the displayed value, by the step value, up to the maximum value allowed. While at the maximum value, pressing the VALUE ▲ key again will allow setting selection to continue from the minimum value. The VALUE ▼ key decrements the displayed value, by the step value, down to the minimum value. Again, continuing to press the VALUE ▼ key while at the minimum value will continue setting selection from the maximum value.

```
NOM VT SEC VOLTAGE:
69.0 V
```

As an example, let's set the nominal VT secondary voltage setting to 69.0 V. Press the appropriate numeric keys in the sequence '6 9 . 0'. The display message will change as the digits are being entered.

```
NEW SETTING
HAS BEEN STORED
```

Until the ENTER key is pressed, editing changes are not registered by the relay. Therefore, press the ENTER key to store the new value in memory. This flash message will momentarily appear as confirmation of the storing process. Numerical values which contain decimal places will be rounded if more decimal place digits are entered than specified by the step value.

b) Entering Enumeration Data

Enumeration settings have data values which are part of a set, whose members are explicitly defined by a name. A set is comprised of two or more members.

```
VT CONNECTION TYPE:
None
```

For example, the selections available for the 'VT CONNECTION TYPE:' are 'None', 'Delta' and 'Wye'.

Enumeration type values are changed using the ▲ **VALUE** ▼ keys. The VALUE ▲ key displays the next selection while the VALUE ▼ key displays the previous selection.

```
VT CONNECTION TYPE:
Wye
```

If the 'VT CONNECTION TYPE' needs to be set to 'Wye'.

Press the ▲ **VALUE** ▼ keys until the proper selection is displayed.

```
NEW SETTING
HAS BEEN STORED
```

Until the ENTER key is pressed, editing changes are not registered by the relay. Therefore, press the ENTER key to store the new value in memory. This flash message will momentarily appear as confirmation of the storing process.

Press the HELP key at any time for context sensitive help messages.

c) Entering Alphanumeric Text

Text settings have data values which are fixed in length, but user defined in character. They may be comprised of upper case letters, lower case letters, numerals, and a selection of special characters.

In order to allow the relay to be customized for specific applications, there are several places where text messages may be programmed. One example is the MESSAGE SCRATCHPAD. To enter alphanumeric text messages, the following procedure should be followed:

Example: to enter the text, “Breaker #1”

1. press . to enter text edit mode,
2. press the VALUE UP ▲ or VALUE DOWN ▼ key until 'B' appears, press . to advance the cursor to the next position,
3. repeat step 2 for the remaining characters: r,e,a,k,e,r, ,#,1
4. press ENTER to store
5. If you have any problems, press the HELP key and the following context sensitive help. Flash messages will sequentially appear for several seconds each. For the case of a text setting message, the HELP key displays how to edit and store a new value.

d) Relay Settings Not Programmed

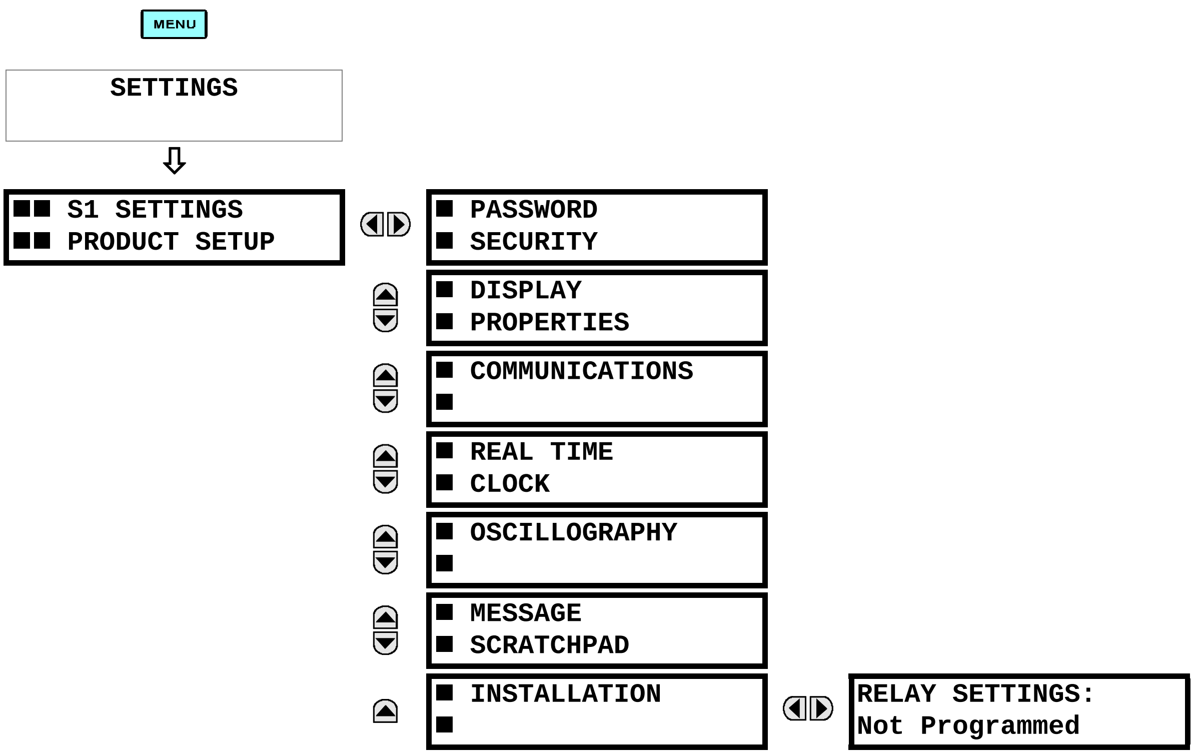
```
RELAY SETTINGS:
Not Programmed
```

When powered on successfully, the 'TROUBLE' indicator will be on and the IN SERVICE' indicator off and this message on the display. This indicates that the relay is in the 'Not Programmed' state and safeguards against the installation of a relay whose settings have not been entered. This message will remain until the relay is explicitly put in the 'Programmed' state.

To illustrate navigation through the message structure, an example of changing the 'RELAY SETTINGS: Not Programmed' mode to 'Programmed' is shown below.

1. Press the MENU key until the 'SETTINGS' header flashes momentarily and the ‘S1 SETTINGS PRODUCT SETUP’ message appears on the display.
2. Press the MESSAGE ▶ key until the 'PASSWORD SECURITY' message appears on the display.
3. Press the MESSAGE ▼ key until the 'INSTALLATION' message appears on the display.
4. Press the MESSAGE ▶ key until the 'RELAY SETTINGS: Not Programmed' message appears on the display.

4



5. When the 'RELAY SETTINGS: Not Programmed' message appears on the display, press the VALUE key or the VALUE key to change the selection to 'Programmed'.

6. Press the ENTER key.

```
RELAY SETTINGS:
Not Programmed
```

```
RELAY SETTINGS:
Programmed
```

ENTER

```
NEW SETTING
HAS BEEN STORED
```

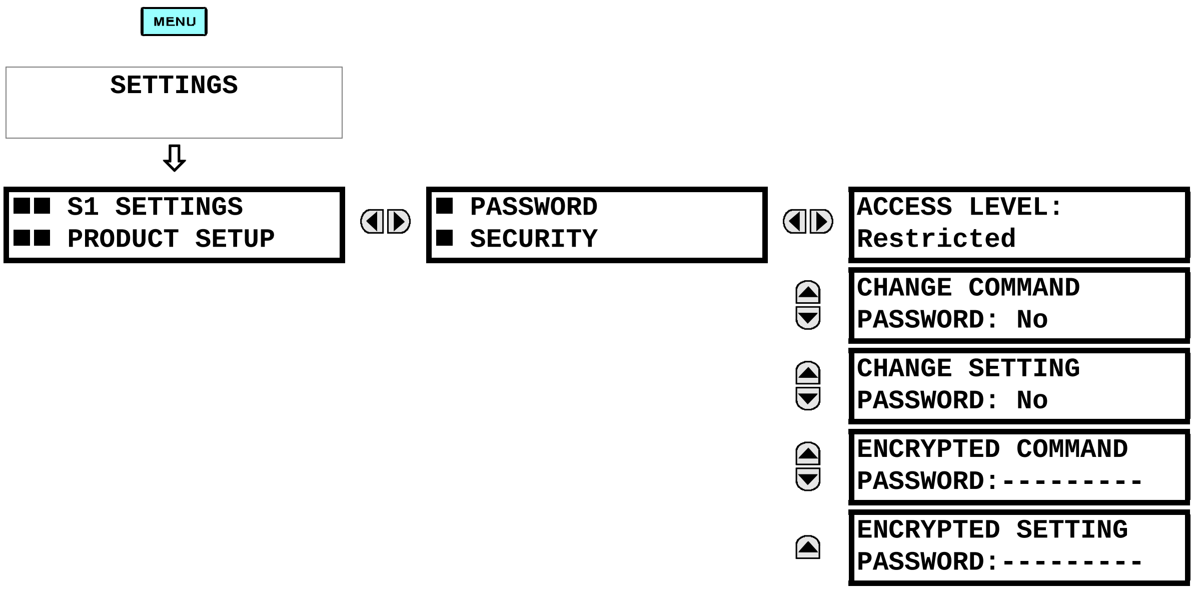
7. When the 'NEW SETTING HAS BEEN STORED' message appears, the relay will be in 'Programmed' state and the 'IN SERVICE' indicator will turn on.

4

e) Initial Password Setup

To illustrate navigation through the message structure, an example of changing a SETTING password is shown below.

1. Press the MENU key until the 'SETTINGS' header flashes momentarily and the ‘S1 SETTINGS PRODUCT SETUP’ message appears on the display.
2. Press the MESSAGE key until the ACCESS LEVEL: message appears on the display.
3. Press the MESSAGE key until the CHANGE SETTING PASSWORD: message appears on the display.



When the 'CHANGE SETTING PASSWORD' message appears on the display, press the VALUE ▲ key or the VALUE ▼ key to change the selection to Yes.

4. Press the ENTER key and the display will prompt you to 'ENTER NEW PASSWORD'.
5. Type in a numerical password and press the ENTER key.
6. When the 'VERIFY NEW PASSWORD' message is displayed, re-type in the same password and press the ENTER key.

```
CHANGE SETTING
PASSWORD: No
```

▼ ▲

```
CHANGE SETTING
PASSWORD: No
```

ENTER

```
ENTER NEW
PASSWORD:#########
```

ENTER

```
VERIFY NEW
PASSWORD:#########
```

ENTER

```
NEW PASSWORD
HAS BEEN STORED
```

7. When the 'NEW PASSWORD HAS BEEN STORED' message appears, your new SETTING password will be active.

f) Changing Existing Password

To change an existing password, follow the instructions in the previous section with the following exception. A message will prompt you to type in the existing password (for each security level) before a new password can be entered.

5.1.1 SETTINGS MAIN MENU

Table 5–1: SETTINGS MAIN MENU

■■ S1 SETTINGS ■■ PRODUCT SETUP	■ PASSWORD ■ SECURITY
	■ DISPLAY ■ PROPERTIES
	■ COMMUNICATIONS ■
	■ REAL TIME ■ CLOCK
	■ OSCILLOGRAPHY ■
	■ MESSAGE ■ SCRATCHPAD
	■ INSTALLATION ■
■■ S2 SETTINGS ■■ SYSTEM SETUP	■ CURRENT SENSING ■
	■ VOLTAGE SENSING ■
	■ POWER SYSTEM ■
	■ FLEXCURVE A ■
	■ FLEXCURVE B ■
■■ S3 SETTINGS ■■ FLEXLOGIC	■ FLEXLOGIC ■ EQUATION EDITOR
	■ FLEXLOGIC ■ TIMERS
■■ S4 SETTINGS ■■ ELEMENTS	■ CURRENT ELEMENTS ■
	■ VOLTAGE ELEMENTS ■
■■ S5 SETTINGS ■■ INPUTS / OUTPUTS	■ CONTACT INPUTS ■
	■ VIRTUAL INPUTS ■

5

Table 5–1: SETTINGS MAIN MENU (Continued)

```
                                    ■ CONTACT OUTPUTS
                                    ■

                                    ■ VIRTUAL OUTPUTS
                                    ■

■■ S6 SETTINGS                      ■ FORCE CONTACT
■■ TESTING                          ■ INPUTS

                                    ■ FORCE CONTACT
                                    ■ OUTPUTS
```

5

5.2.1 PASSWORD SECURITY

PATH: S1 PRODUCT SETUP ⇨ PASSWORD SECURITY

■ PASSWORD ■ SECURITY	◀▶	ACCESS LEVEL: Restricted	*Range: Restricted, Command, Setting, Factory Service*
MESSAGE	▲▼	CHANGE COMMAND PASSWORD: No	*Range: No, Yes*
MESSAGE	▲▼	CHANGE SETTING PASSWORD: No	*Range: No, Yes*
MESSAGE	▲▼	ENCRYPTED COMMAND PASSWORD: ---------	*Range: 0-999999999* *Note: --------- indicates no password*
MESSAGE	▲	ENCRYPTED SETTING PASSWORD: ---------	*Range: 0-999999999* *Note: --------- indicates no password*

There are three levels of password security in the relay: Command, Setting, and Factory Service. Operations under the supervision of the passwords are:

Command:Changes state of virtual inputs
Clears event records and associated snapshot or setting change records
Clears oscillography records

Setting: Permits changing of any setting.

Factory Service:For factory use only (enables a new Factory Service Menu)

When the relay is shipped from the factory, the command and setting passwords are defaulted to '0'. When a password is '0', the password security feature is disabled. When a non-zero password is programmed, entering the password is required for the appropriate access level for both the faceplate or any of the communication ports.

In order to gain write access to a given security level, select the ACCESS LEVEL or attempt access to that level (e.g. Attempts to change a setting and follow directions to enter the password that was previously programmed). If the password is correctly entered, access will be allowed. If no keys are pressed for longer than 30 minutes or control power is cycled, access from the faceplate will automatically become restricted. When a sequence of characters is entered by the user as a new password, that code must be again entered before the operations under the password security provided for that password are permitted.

If the programmed password is not known, consult the factory service department with the encrypted password.

NOTE: If the Setting password and Command password are set the same, the one password will allow access to commands and settings.

5.2.2 DISPLAY PROPERTIES

PATH: S1 PRODUCT SETUP ⇨⇩ DISPLAY PROPERTIES

■ DISPLAY ■ PROPERTIES		FLASH MESSAGE TIME: 4.0 s	*Range: 0.5 To 10.0 in Steps of 0.1*
	MESSAGE	DEFAULT MESSAGE TIMEOUT: 300 s	*Range: 10 To 900 in Steps of 1*
	MESSAGE	DEFAULT MESSAGE INTENSITY: 25 %	*Range: 25 %, 50 %, 75 %, 100 %*
	MESSAGE	SCREEN SAVER FEATURE: Disabled	*Range: Disabled, Enabled*
	MESSAGE	SCREEN SAVER WAIT TIME: 30 min	*Range: 0 - 65535 in Steps of 1*

Some of the relay message characteristics can be modified to suit different situations using the display properties settings.

Flash messages are status, warning, error, or information messages displayed for several seconds in response to certain key presses during setting programming. The time these messages remain on the display, overriding the normal messages, can be changed to accommodate different user reading rates.

If no keys are pressed for a period of time, then the relay will automatically scan a default message. This time can be modified to ensure messages remain on the screen long enough during programming or reading of actual values. To extend the life of the phosphor in the vacuum fluorescent display, the brightness of the display can be attenuated when default messages are being displayed. When interacting with the display using the faceplate keys, the display will always operate at full brightness.

As well, the relay is equipped with the ability to turn off the faceplate display using the screen saver feature. If the feature is enabled, the display will turn off after the elapsed screen saver wait time. Pressing any key or the occurrence of any target message will bring the display back to full brightness.

5.2.3 COMMUNICATIONS

PATH: S1 PRODUCT SETUP ⇨⇩ COMMUNICATIONS

■ COMMUNICATIONS ■	MODBUS SLAVE ADDRESS:254	*Range: 1 to 254 in Steps of 1*
MESSAGE	RS485 COM1 BAUD RATE: 115200	*Range: 300, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200-Only displayed if CPU type 9A is ordered*
MESSAGE	RS485 COM1 PARITY: None	*Range: None, Odd, Even* *Only displayed if CPU type 9A is ordered*
MESSAGE	RS485 COM2 BAUD RATE: 115200	*Only displayed if CPU type 9B, 9C or 9D ordered*
MESSAGE	RS485 COM2 PARITY: None	*Range: None, Odd, Even* *Only displayed if CPU type 9A is ordered*
MESSAGE	ETHERNET IP ADDRESS: 3.94.244.210	*Only displayed if CPU type 9B, 9C or 9D ordered*
MESSAGE	GATEWAY IP ADDRESS: 3.94.244.1	*Only displayed if CPU type 9B, 9C or 9D ordered*
MESSAGE	NETWORK ADDR (NSAP): 56554706	*Only displayed if CPU type 9B, 9C or 9D ordered*
MESSAGE	TARGET NAME: ur0	*Range: 20 character alpha-numeric* *Only displayed if CPU type 9C or 9D ordered and Target name must not contain any spaces*

The relay is equipped with three independent serial ports. The RS232 port on the faceplate is intended for local use and will respond regardless of the slave address programmed. Its baud rate is fixed at 19200 and parity is fixed as 'none'. The rear COM1 port type will depend on the CPU type ordered. It may be either an Ethernet port or RS485 port. The rear COM2 port is RS485.

The RS232 port may be connected to a personal computer running the relay PC software. This software may be used for downloading and uploading setting files, viewing measured parameters, and upgrading the relay firmware to the latest revision. For RS485 communications (supporting a subset of the Modbus® RTU protocol), each relay must have a unique address from 1-254. Address 0 is the broadcast address which all relays listen to. Addresses do not have to be sequential but no two relays can have the same address or conflicts resulting in errors will occur. Generally each relay added to the link will use the next higher address starting at 1. A maximum of 32 relays can be daisy chained and connected to a DCS, PLC or PC using the RS485 ports. The IP addresses setting messages will only appear if a relay is ordered with an Ethernet port. The Ethernet communications target name may be entered here. (The Ethernet port supports MMS\UCA 2.0 protocol.)

5.2.4 REAL TIME CLOCK

PATH: S1 PRODUCT SETUP ⇨⇩ REAL TIME CLOCK

■ REAL TIME ■ CLOCK	◀▶	DATE(MM/DD/YYYY): 01/01/1997	*Range: Month= 1 to 12, Day= 1 to 31, Year= 1990 to 2089*
MESSAGE	▲▼	TIME (HH:MM:SS): 00:00:00	*Range: Hour = 0 to 23, Minute = 0 to 59, Second = 0 to 59*
MESSAGE	▲	IRIG-B SIGNAL TYPE: None	*Range: None, DC Shift, Amplitude Modulated*

The time/date stamp is used to track events for diagnostic purposes. The date and time may be entered manually or synchronized to other relays using an IRIG-B signal. A battery backed internal clock runs continuously even when power is off. It has the same accuracy as an electronic watch, approximately +/- 1 minute per month. If the IRIG-B signal is not used, the clock must be periodically corrected either manually through the faceplate or via the clock setting over the relay serial link. If synchronization to other relays is not necessary, then entry of the time and date from the faceplate keys is adequate.

Enter the current date using two digits for the month, two digits for the day, and four digits for the year. For example, July 15, 1994 would be entered as 07 15 1994. If entered from the faceplate, the new date will take effect the moment the ENTER key is pressed. Enter the current time, by using two digits for the hour in 24 hour time, two digits for the minutes, and two digits for the seconds. If entered from the faceplate, the new time will take effect the moment the ENTER key is pressed. For example, 3:05 PM would be entered as 15 05 00, with the ENTER key pressed at exactly 3:05 PM. An IRIG-B signal may be connected to the relay to synchronize the clock to a known time base and to other relays. If an IRIG-B signal is used, only the current year needs to be entered.

If the relay serial communication link is used, then all the relays can keep time in synchronization with each other. A new clock time is loaded into the relay via the communications port by a remote computer broadcast (address 0) for all the relays connected on the communications channel. Then all relays in the system begin timing at the approximately the same instant (+/- a few ms).

5.2.5 OSCILLOGRAPHY

PATH: S1 PRODUCT SETUP ⇨⇩ OSCILLOGRAPHY

■ OSCILLOGRAPHY ■	◀▶	NUMBER OF RECORDS: 15 x 16 Cycles	*Range: 1 x 128, 3 x 64, 7 x 32, 15 x 16, 31 x 8*
MESSAGE	▲▼	TRIGGER MODE: Automatic Overwrite	*Range: Automatic Overwrite, Protected*
MESSAGE	▲▼	TRIGGER POSITION: 50 %	*Range: 0 To 100 in Steps of 1*
MESSAGE	▲▼	TRIGGER SOURCE: Any Element OP	*Range: FlexLogic™ Operand*
		: :	
MESSAGE	▲	DIGITAL CHANNEL 32: No Operation	*Range: FlexLogic™ Operand*

Oscillography records contain waveforms captured at the sampling rate as well as other relay data at the point of trigger. Oscillography records are triggered by a programmable FlexLogic™ operand. Multiple oscillography records may be captured simultaneously.

The number of records vs. the number of cycles of each record can be configured as per the following chart:

5

Table 5–2: NUMBER OF RECORDS VS. NUMBER OF CYCLES

Number of Records	Length of Record (cycles/channel)
31	8
15	16
7	32
3	64
1	128

Caution: When oscillography settings are altered, all oscillography records will be cleared.

The trigger position is programmable as a percent of the total buffer size (e.g. 10%, 50%, 75%, etc.). A new record may automatically overwrite an older record if the trigger mode is set to 'Automatic Overwrite'. The signal that can trigger ocsillography may be any FlexLogic™ parameter (virtual output, element state, contact input, or virtual input). The relay sampling rate is 64 samples per cycle.

Note: For an explanation on FlexLogic™ see section INTRODUCTION TO FLEXLOGIC™.

5.2.6 MESSAGE SCRATCHPAD

PATH: S1 PRODUCT SETUP ⇨⇩ MESSAGE SCRATCHPAD

■ MESSAGE ■ SCRATCHPAD	◁▷	Text 1	*Range: 2 x 20 alphanumeric*
MESSAGE	△▽	Text 2	*Range: 2 x 20 alphanumeric*
MESSAGE	△▽	Text 3	*Range: 2 x 20 alphanumeric*
MESSAGE	△▽	Text 4	*Range: 2 x 20 alphanumeric*
MESSAGE	△	Text 5	*Range: 2 x 20 alphanumeric*

Up to 5 message can be programmed in the Message Scratchpad area. These messages may be notes that pertain to the installation of the relay. This might be useful for reminding operators to perform certain tasks. The messages may be entered from the keypad or the communications port.

To enter a 40 character message:

1. Select the user text message to be edited.
2. Press the [•] key to enter text edit mode.
3. Use the △ VALUE ▽ key to scroll through the alphanumeric characters. A space is selected like a character.
4. Press the [•] key to advance the cursor to the next position.
5. Repeat step 3 and continue entering characters until the desired message is displayed.
6. The HELP key may be pressed at any time for context sensitive help messages.
7. Press the MENU key to store the new settings.

5

5.2.7 INSTALLATION

PATH: S1 PRODUCT SETUP ⇨⇩ INSTALLATION

■ INSTALLATION ■	◁▷	RELAY SETTINGS: Not Programmed	*Range: Not Programmed, Programmed*
MESSAGE	△▽	SITE NAME: Site-1	*Range: 20 characters to specify a unique relay name*
MESSAGE	△	RELAY IDENTIFIER: UR	*Range: 20 characters to specify a unique relay name*

In order to safeguard against the installation of a relay whose settings have not been entered, the relay will not allow signaling of any output relay until this setting is set to ‘PROGRAMMED’. The setting is defaulted to ‘NOT PROGRAMMED’ when the relay leaves the factory. The ‘SETTINGS HAVE NOT BEEN PROGRAMMED’ self-test error message is displayed automatically until the relay is put into the programmed state.

The site name and relay identifier settings allow the user to uniquely identify a site and relay. These settings will appear when reports are generated.

5.3.1 CURRENT SENSING

PATH: S1 PRODUCT SETUP ⇨ CURRENT SENSING

■ CURRENT SENSING ■	◀▶	PHASE CT PRIMARY: 100 A	Range: Restricted, Command, Setting, Factory Service
MESSAGE	▲▼	PHASE CT SECONDARY: 5 A	Range: 1 A, 5 A
MESSAGE	▲▼	GROUND CT PRIMARY 100 A	Range: 1 To 50000 in Steps of 1
MESSAGE	▲	GROUND CT SECONDARY: 5 A	Range: 1 A, 5 A

These settings are critical for all features that have settings specified in secondary amperes. When the relay is ordered, the CT/VT module must be specified to include a standard or sensitive ground input. As the phase CTs are connected in Wye (star), the calculated phasor sum of the three phase currents (IA + IB + IC = Neutral Current = 3I0) is used as the input for the neutral overcurrent elements. In addition, a zero sequence (core balance) CT which senses current in all of the circuit primary conductors, or a CT in a neutral grounding conductor may also be used. For this configuration, the ground CT primary rating must be entered. To detect low level ground fault currents, the sensitive ground input may be used. In this case, the sensitive ground CT primary rating must be entered. For more details on CT connections, refer to the wiring section of the HARDWARE chapter.

Enter the rated CT primary current values. For both 1000:5 or 1000:1 CTs, the entry would be 1000. For correct operation, the CT secondary rating must match the setting (which must also correspond to the specific CT connections used) as all elements are programmed in secondary amperes.

5

5.3.2 VOLTAGE SENSING

PATH: S1 PRODUCT SETUP ⇨⇩ VOLTAGE SENSING

■ VOLTAGE SENSING ■	◀▶	VT CONNECTION TYPE: None	Range: None, Wye, Delta
MESSAGE	▲▼	NOM VT SEC VOLTAGE: 120.0 V	Range: 50.0 To 240.0 in Steps of 1
MESSAGE	▲	VT RATIO: 120.0 :1	Range: 0.1 To 24000.0 in Steps of 0.1

With VTs installed, the relay can be used to perform voltage measurements, as well as power calculations. Enter 'None' if VTs are not to be used. If VTs are used, enter the VT connection made to the system as 'Wye' or 'Delta'. An open-delta source VT connection would be entered as 'Delta'. See the typical wiring diagram in the HARDWARE chapter for details. The Nominal VT Secondary Voltage setting is the voltage across the VT secondary winding when nominal voltage is applied to the primary. On a source of 13.8 kV line-line at nominal voltage, with a 14400:120 Volt VT in the open-delta connection, the voltage to be entered is 115 V. For the wye connection, the voltage to be entered is $115 / \sqrt{3} = 66.4$ V. Enter the VT primary to secondary turns ratio, for a 14400:120 VT, the entry would be 120.0 (14400 / 120 = 120.0).

5.3.3 POWER SYSTEM

PATH: S1 PRODUCT SETUP ⇨⇩ POWER SENSING

■ POWER SYSTEM ■	◀▶	NOMINAL FREQUENCY: 60 Hz	*Range: 25 To 60 in Steps of 1*
MESSAGE	▲	PHASE ROTATION: ABC	*Range: ABC, ACB*

Enter the nominal power system frequency. This value is used as a default to set the digital sampling rate if the system frequency cannot be measured from the IA or VA channels of the CT/VT module. The phase sequence of the power system is required to properly calculate sequence components and power parameters.

5

5.4.1 FLEXCURVE™ A / FLEXCURVE™ B

PATH: S2 SYSTEM SETUP ⇨⇩ FLEXCURVE A

```
■ FLEXCURVE A
■
```

```
FLEXCURVE A TIME AT
1.03 x PKP: 0 ms
```

Range: 0 To 65535 in Steps of 1

The custom FlexCurve™ has settings for entering times to operate/reset at the following pickup levels: 0.00 - 0.98 and 1.03 - 20.0. These points are then converted to two continuous curves by linear interpolation between data points. To enter a custom FlexCurve™, enter the desired operate/reset time for each pickup point for the desired protection curve.

Table 5–3: FLEXCURVE™ TABLE

Reset	Time (ms)	Reset	Time (ms)	Operate	Time (ms)	Operate	Time (ms)	Operate	Time (ms)	Operate	Time (ms)
0.00		0.68		1.03		2.9		4.9		10.5	
0.05		0.70		1.05		3.0		5.0		11.0	
0.10		0.72		1.1		3.1		5.1		11.5	
0.15		0.74		1.2		3.2		5.2		12.0	
0.20		0.76		1.3		3.3		5.3		12.5	
0.25		0.78		1.4		3.4		5.4		13.0	
0.30		0.80		1.5		3.5		5.5		13.5	
0.35		0.82		1.6		3.6		5.6		14.0	
0.40		0.84		1.7		3.7		5.7		14.5	
0.45		0.86		1.8		3.8		5.8		15.0	
0.48		0.88		1.9		3.9		5.9		15.5	
0.50		0.90		2.0		4.0		6.0		16.0	
0.52		0.91		2.1		4.1		6.5		16.5	
0.54		0.92		2.2		4.2		7.0		17.0	
0.56		0.93		2.3		4.3		7.5		17.5	
0.58		0.94		2.4		4.4		8.0		18.0	
0.60		0.95		2.5		4.5		8.5		18.5	
0.62		0.96		2.6		4.6		9.0		19.0	
0.64		0.97		2.7		4.7		9.5		19.5	
0.66		0.98		2.8		4.8		10.0		20.0	

5.5.1 INTRODUCTION TO FLEXLOGIC™

In order to provide maximum flexibility to the user of a UR relay, the arrangement of internal digital logic combines fixed and user programmed parameters. Logic upon which individual features are designed is fixed, and all other logic from digital input signals through elements or combinations of elements to digital outputs, is variable. The user has complete control of all variable logic through FlexLogic™. In general, the system receives analog and digital inputs which it uses to produce analog and digital outputs. The major sub-systems of the relay involved in this process are shown in the following figure.

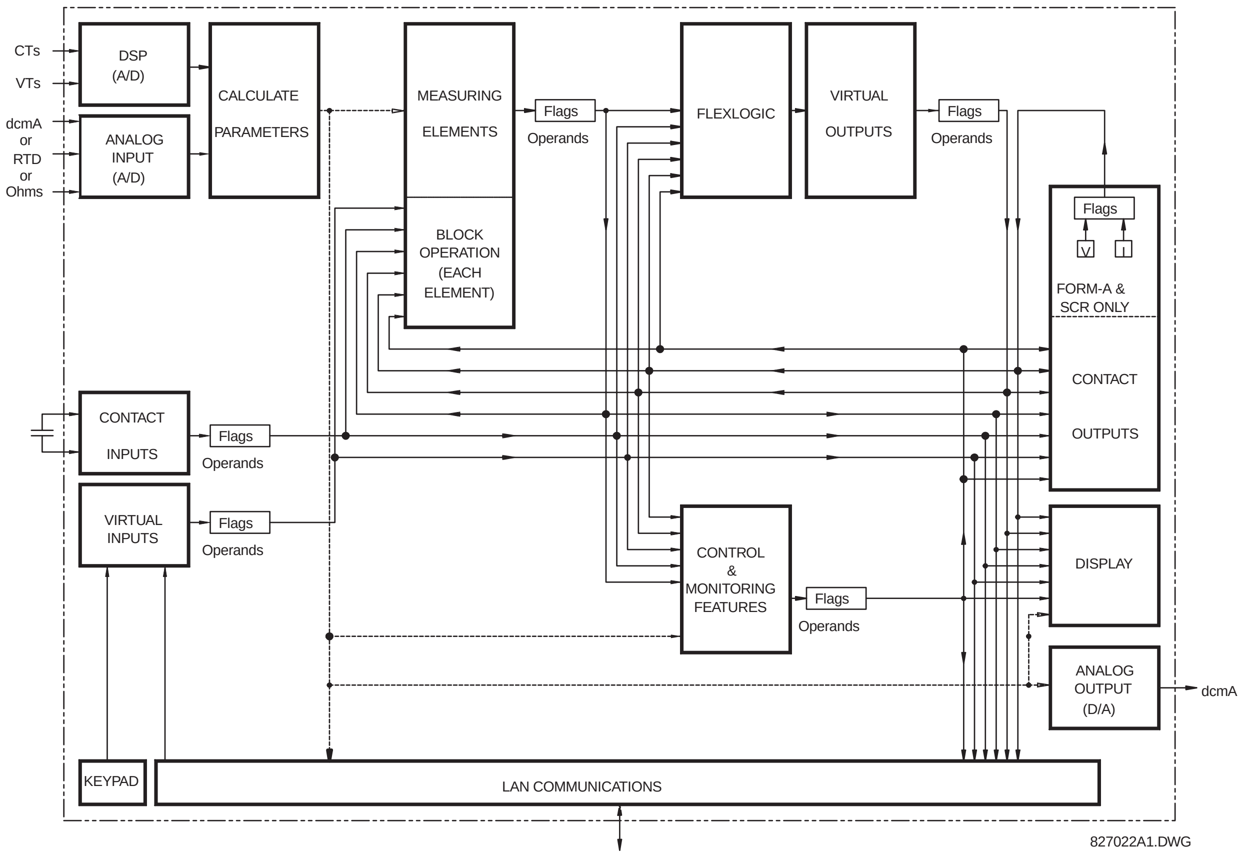


Figure 5–1: UR ARCHITECTURE OVERVIEW

The states of all digital signals used in the relay are represented by flags (or FlexLogic™ operands, which are described in a later section). A digital "1" is represented by a 'set' flag. As shown above, an external contact change-of-state can be used to block a measuring element from operating, as an input to a control feature, a FlexLogic™ equation, or to operate a contact output. The state of the contact input can be displayed locally or viewed remotely via the communications facilities provided. If it is desired to have a simple scheme where a contact input is used to block a measuring element, this selection is made when programming the element. If more complex logic is required, it is implemented in FlexLogic™. For example, if it is desired to have the closed state of contact input H7a and the operated state of the phase undervoltage element block the operation of the phase time overcurrent element, the two input states are programmed in a FlexLogic™ equation to AND the two inputs to produce a virtual output which is then selected when programming the phase time overcurrent to be used as a blocking input. Virtual outputs can only be created by FlexLogic™ equations.

Traditionally, protective relay logic has been relatively limited. Any unusual applications involving interlocks, blocking, or supervisory functions had to be hardwired using contact inputs and outputs. FlexLogic™ minimizes the requirement for auxiliary components and wiring while making more complex schemes possible.

The logic that determines the interaction of inputs, elements, and outputs is field programmable through the use of logic equations ('postfix' notation) that are sequentially processed. The use of virtual inputs and outputs in addition to hardware is available internally and on the communication ports for other relays to use (distributed FlexLogic™).

FlexLogic™ allows users to customize the relay through a series of equations which consist of operators and operands. The operands are the states of inputs, elements, and outputs. The operators are logic gates, timers and latches (with set and reset inputs). A system of sequential operations allows any combination of specified operands to be assigned as inputs to specified operators to create an output. The final output of an equation is a numbered register called a "VIRTUAL OUTPUT". Virtual outputs can be used as an input operand in any equation, including the equation which generates the output, as a seal-in or other type of feedback.

A FlexLogic™ equation consists of parameters which are either operands or operators. Operands have logic states of 1 or 0. Operators provide a defined function, such as AND gate or Timer. Each equation defines the combinations of parameters to be used to set a VIRTUAL OUTPUT flag. Evaluation of an equation results in either a 1 (= ON, i.e. flag set), or 0 (= OFF, i.e. flag not set). Each equation is evaluated at least 4 times every power system cycle.

The characteristics of the different types of operands are listed in the table FLEXLOGIC™ OPERAND CHARACTERISTICS. The operators available in FlexLogic™ are listed in the table FLEXLOGIC™ OPERANDS.

Table 5–4: FLEXLOGIC™ OPERAND CHARACTERISTICS

INPUTS	INPUT IS '1' (= ON) IF...
element pickup (PKP)	The tested parameter is presently above the pickup setting of an element which responds to rising values or below the pickup setting of an element which responds to falling values
element operate (OP)	The tested parameter has been above/below the pickup setting of the element for the programmed time delay.
contact inputs	The logic input contact is presently in the programmed ON state.
virtual inputs	The virtual input is presently in the ON state.
virtual outputs	The virtual output flag is presently in the set state.(i.e. evaluation of the FlexLogic™ equation results in a '1')

Some of the protection features on the relay, such as phase time overcurrent, contain a measuring element for each of the phases A, B and C. Each phase element sets individual flags, shown on the feature logic diagrams. To provide increased flexibility and minimize programming effort, FlexLogic™ automatically calculates two operands from the flags of these elements. These flags are "Any 2" and "All 3." The "Any 2" flag is set if any combination of two (or more) phase flags is set. The "All 3" flag is set if all three phase flags are set. Note that if the "All 3" flag is set the "Any 2" flag will also be set.

Refer to table FLEXLOGIC™ OPERANDS, for a complete list of the operands available to FlexLogic™ in the relay.

Table 5–5: FLEXLOGIC™ OPERANDS

Operand Type	Operand Syntax	
Element State	ANY ELEMENT PKP	“Any Element” is all those listed in this table
	ANY ELEMENT OP	“Any Element” is all those listed in this table
	PHASE TOC1 PKP	Any one phase of TOC1 is picked up
	PHASE TOC1 OP	Any one phase of TOC1 is operated
	PHASE TOC1 PKP A	Phase A of TOC1 is picked up
	PHASE TOC1 PKP B	Phase B of TOC1 is picked up
	PHASE TOC1 PKP C	Phase C of TOC1 is picked up
	PHASE TOC1 OP A	Phase A of TOC1 is operated
	PHASE TOC1 OP B	Phase B of TOC1 is operated
	PHASE TOC1 OP C	Phase C of TOC1 is operated
	PHASE TOC2 . . .	Same set of operands as shown for Phase TOC1
	PHASE IOC1 . . .	Same set of operands as shown for Phase TOC1
	PHASE IOC2 . . .	Same set of operands as shown for Phase TOC1
	NEUTRAL TOC1 PKP	Neutral TOC1 is picked up
	NEUTRAL TOC1 OP	Neutral TOC1 is operated
	NEUTRAL IOC1 . . .	Same set of operands as shown for NEUTRAL TOC1
	NEUTRAL IOC2. . .	Same set of operands as shown for NEUTRAL TOC1
	GROUND TOC1. . .	Same set of operands as shown for NEUTRAL TOC1
	GROUND IOC1. . .	Same set of operands as shown for NEUTRAL TOC1
	GROUND IOC2. . .	Same set of operands as shown for NEUTRAL TOC1
	SNS GROUND TOC1. . .	Same set of operands as shown for NEUTRAL TOC1
	SNS GROUND IOC1. . .	Same set of operands as shown for NEUTRAL TOC1
	SNS GROUND IOC2. . .	Same set of operands as shown for NEUTRAL TOC1
	PHASE UV1 PKP	Any one phase of UV1 is picked up
	PHASE UV1 OP	Any one phase of UV1 is operated
	PHASE UV1 PKP A	Phase A of UV1 is picked up
	PHASE UV1 PKP B	Phase B of UV1 is picked up
	PHASE UV1 PKP C	Phase C of UV1 is picked up
	PHASE UV1 OP A	Phase A of UV1 is operated
	PHASE UV1 OP B	Phase B of UV1 is operated
	PHASE UV1 OP C	Phase C of UV1 is operated
	PHASE UV2 PKP	Any one phase of UV2 is picked up
	PHASE UV2 OP	Any one phase of UV2 is operated
	PHASE UV2 PKP A	Phase A of UV2 is picked up
	PHASE UV2 PKP B	Phase B of UV2 is picked up
	PHASE UV2 PKP C	Phase C of UV2 is picked up
	PHASE UV2 OP A	Phase A of UV2 is operated
	PHASE UV2 OP B	Phase B of UV2 is operated
	PHASE UV2 OP C	Phase C of UV2 is operated
No Operation	No Operation	Does nothing & may be used as delimiter in equation list Used as ‘Disable’ or ‘Off‘ by other features

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Table 5–5: FLEXLOGIC™ OPERANDS (Continued)

Operand Type	Operand Syntax	
Contact Input	Contact I/P H5a ON	(will not appear unless ordered)
	Contact I/P H5c ON	(will not appear unless ordered)
	Contact I/P H6a ON	(will not appear unless ordered)
	Contact I/P H6c ON	(will not appear unless ordered)
	Contact I/P H7a ON	(will not appear unless ordered)
	Contact I/P H7c ON	(will not appear unless ordered)
	Contact I/P H8a ON	(will not appear unless ordered)
	Contact I/P H8c ON	(will not appear unless ordered)
	:	
	:	
Virtual Input	Virtual I/P 1 ON	Flag is set, logic=1
	:	Flag is set, logic=1
	Virtual I/P 32 ON	Flag is set, logic=1
Virtual Output	Virtual O/P 1 ON	Flag is set, logic=1
	:	Flag is set, logic=1
	Virtual O/P 64 ON	Flag is set, logic=1

The characteristics of the logic gates are tabulated in table FLEXLOGIC™ GATE CHARACTERISTICS, and the operators available in FlexLogic™ are listed in table FLEXLOGIC™ OPERATORS.

Table 5–6: FLEXLOGIC™ GATE CHARACTERISTICS

GATES	NUMBER OF INPUTS	OUTPUT IS ‘1’ (= ON) IF...
Not	1	input is ‘0’
Or	2 to 16	any input is ‘1’
And	2 to 16	all inputs are ‘1’
Nor	2 to 16	all inputs are ‘0’
Nand	2 to 16	any input is ‘0’
Xor	2	only one input is ‘1’

Table 5–7: FLEXLOGIC™ OPERATORS

Operator Type	Operator Syntax	Description
Logic Gate	NOT	Logical Not
	XOR(2)	2 input exclusive Or gate
	LATCH (S,R)	Latch (Set, Reset)
	OR(2) : OR(16)	2 input Or gate : 16 input Or gate
	AND(2) : AND(16)	2 input And gate : 16 input And gate
	NOR(2) : NOR(16)	2 input Nor gate : 16 input Nor gate
	NAND(2) : NAND(16)	2 input Nand gate : 16 input Nand gate
Timer	TIMER 1 : TIMER 32	Timer as configured in FlexLogic™ Timers settings
Assign Virtual Output	= Virtual Output 1 : = Virtual Output 64	Assigns previous parameter to a Virtual Output
Editor	Insert Delete	Used to insert a parameter in an equation list Used to delete a parameter from an equation list
End	End	The first ‘End’ encountered signifies the last entry in the list of FlexLogic™ parameters that is processed.

5

a) FLEXLOGIC™ RULES

The sequence of entries in the linear array of parameters must follow these general rules:

1. Any contact input, virtual input/output, element operand or logic gate operator can be used any number of times. Timers and virtual output assignments may only be used once.
2. Operands must precede the operator in the equation.
3. Operators have only one output. (Assign to virtual output if more than one output required)
4. Assigning the output of an operator to a Virtual Output terminates an equation.
5. The 'END' parameter must be placed after the last parameter used, (which will be an assignment of a Virtual Output) to signal no further processing is required.

b) FLEXLOGIC™ EVALUATION

Each equation is evaluated in the order in which the parameters have been entered.

CAUTION: FlexLogic™ provides latches which by definition have a memory action, remaining in the set state after the set input has been asserted. When making changes to programming, all FlexLogic™ equations are re-compiled when any new setting is entered, so all latches are automatically reset. If it is required to re-initialize FlexLogic™ during testing, for example, it is suggested to power the unit down and then back up.

5.5.2 FLEXLOGIC™ EXAMPLE

An example of the process used to implement a particular set of logic required in an application follows. The sequence of the steps outlined is quite important, as it should minimize the work necessary to develop the settings to be applied to the relay. Note that the example presented below in Figure 5–2: FLEXLOGIC™ EXAMPLE, is intended to demonstrate the procedure, not to solve a specific application situation. In the example it is assumed that some logic has already been programmed to produce Virtual Output 1 and Virtual Output 2, and is only a part of the full set of equations used. When using FlexLogic™, it is important to make a note when each Virtual Output is used.

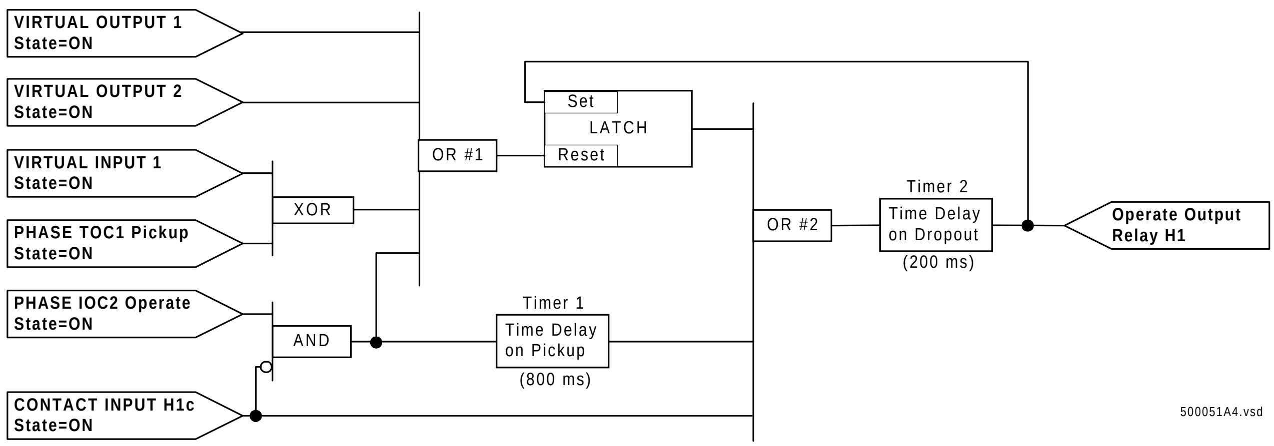

Figure 5–2: FLEXLOGIC™ EXAMPLE

The initial step in the process is to inspect the logic diagram to determine that the required logic can be implemented with the types of operators provided by FlexLogic™. If this is not true, the logic will have to be altered until this condition is satisfied. Once this is done, count the inputs to each gate to check that the number of inputs does not exceed the limits available in FlexLogic™, which is unlikely but possible. If the number of inputs is too high, subdivide the inputs into multiple gates to produce an equivalent. For example, if it is required to have 25 inputs to an AND gate, connect inputs 1 through 16 to one AND (16), 17 through 25 to another AND (9), and the outputs from these two gates to an AND (2).

Inspect each operator between the initial operands and final virtual outputs to determine if the output from the operator is used as an input to more than one following operator. If so the output of this operator must be assigned as a Virtual Output. In the example shown in Figure 5–2: FLEXLOGIC™ EXAMPLE, the output of the AND gate is used as an input to both OR #1 and Timer 1, and must therefore be made a Virtual Output, and assigned the next available number. The final output must also be assigned to a Virtual Output, in the example Virtual Output 4, which will be programmed in the contact output section to operate relay H1.

We have now determined that the required logic can be implemented in FlexLogic™ with two FlexLogic™ equations, with outputs of Virtual Output 3 and Virtual Output 4 as shown in Figure 5–3: FLEXLOGIC™ EXAMPLE WITH VIRTUAL OUTPUTS.

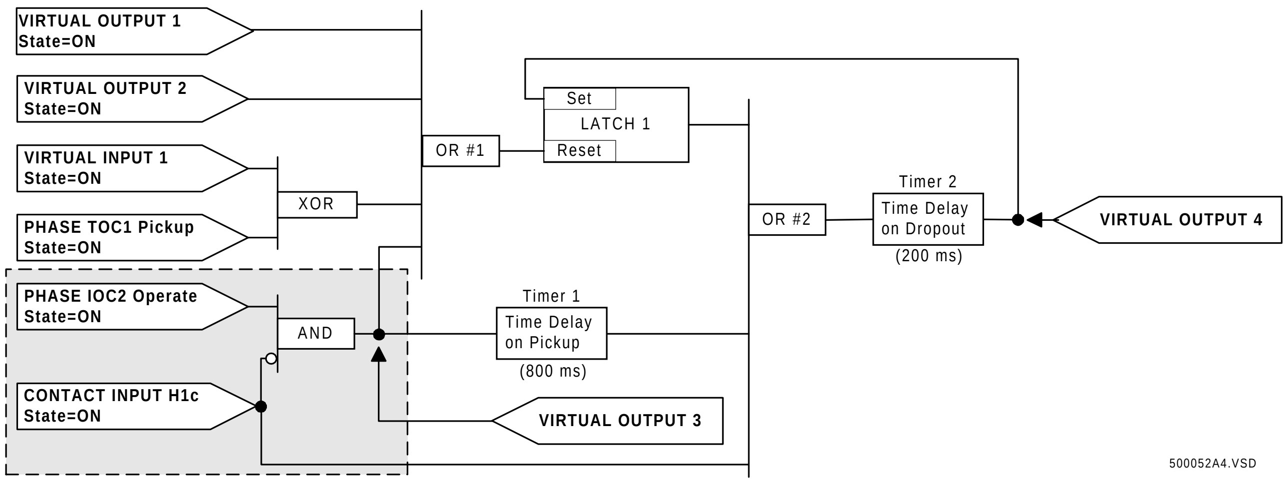

Figure 5–3: FLEXLOGIC™ EXAMPLE WITH VIRTUAL OUTPUTS

The next step is to prepare a logic diagram for the equation to produce Virtual Output 3, as this output will be used later as an operand in the equation for Virtual Output 4. (Create the equation for every output which will be used as an operand first, so that when these operands are required they will already have been evaluated and assigned to a specific Virtual Output.) The logic for Virtual Output 3 is shown in Figure 5–4: LOGIC FOR VIRTUAL OUTPUT 3, with the final output assigned.

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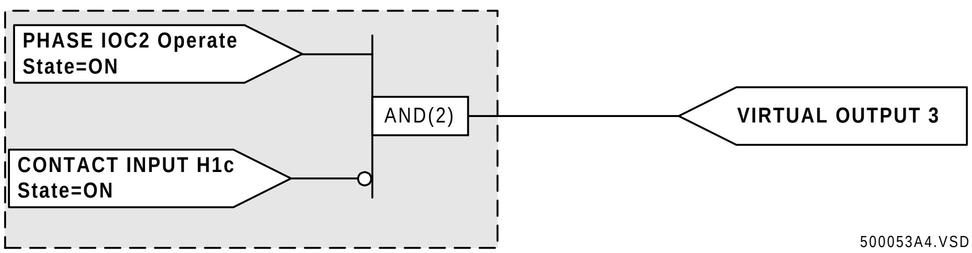

Figure 5–4: LOGIC FOR VIRTUAL OUTPUT 3

At the completion of this step prepare a logic diagram for Virtual Output 4, replacing the logic ahead of Virtual Output 3 with a symbol identified as Virtual Output 3, as shown in Figure 5–5: LOGIC FOR VIRTUAL OUTPUT 4.

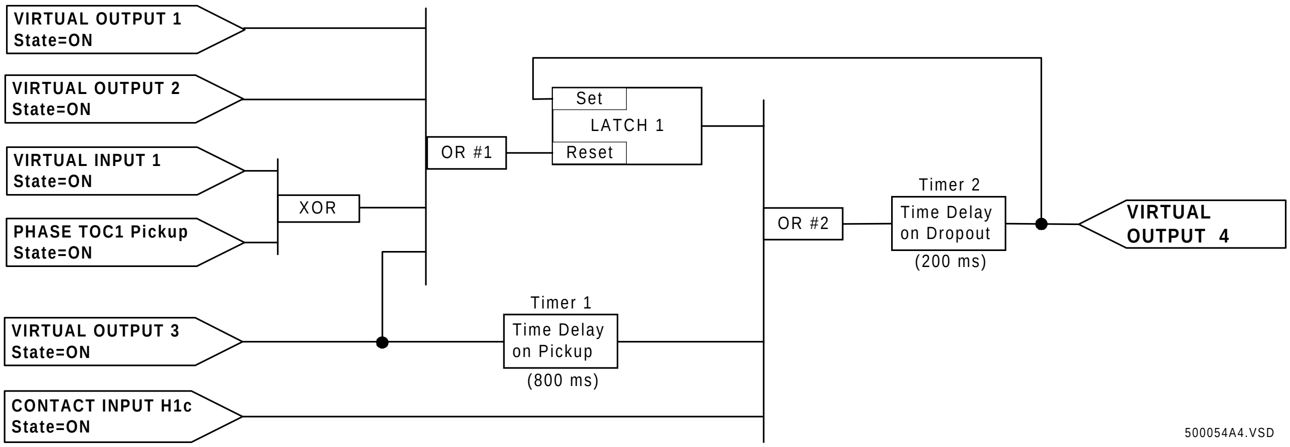

Figure 5–5: LOGIC FOR VIRTUAL OUTPUT 4

We can now program the FlexLogic™ equation for Virtual Output 3 by translating the logic into the available FlexLogic™ parameters. The equation is formed one parameter at a time, until the required logic is complete. It is generally easier to start at the output end of the equation and work back towards the input in this process, as shown below. It is also recommended to list operator inputs from bottom to top. For demonstration, the final output will be arbitrarily identified as parameter 99, and each preceding parameter decremented by one in turn. Until one is accustomed to using FlexLogic™, it is suggested that a worksheet with a series of cells marked with the arbitrary parameter numbers be prepared, as shown in Figure 5–6: FLEXLOGIC™ WORKSHEET.

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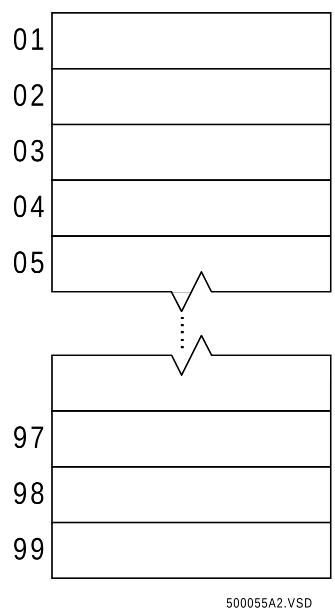

Figure 5–6: FLEXLOGIC™ WORKSHEET

Following the procedure outlined, we will start with parameter 99, as follows below.

99: The final output of the equation is Virtual Output 3, which is created by the operator “= VIRTUAL OUTPUT n”. This parameter is therefore “= VIRTUAL OUTPUT 3”. All equations are terminated by this parameter and the total set of required logic must be terminated by the operator “END”.

98: The gate preceding the output is an AND, which in this case requires two inputs. The operator for this gate is a two input AND so the parameter is “AND (2)”. Note that FlexLogic™ rules require that the number of inputs to most types of operators must be specified to identify the operands for the gate. As the two-input AND will operate on the two operands preceding it, we now must specify these inputs, starting with the lower.

97: This lower input to the AND gate must be passed through an inverter (the NOT operator) so the next parameter is “NOT”. The NOT operator will act upon the operand immediately preceding it, so we must next specify the input to the inverter.

96: The input to the NOT gate is operand “CONTACT INPUT H1c”.

95: The last step in the procedure is to specify the upper input to the AND gate, which is operand “PHASE IOC2 OP”.

The equation for VIRTUAL OUTPUT 3 can now be formed by writing the parameters in numerical order:

- [95] PHASE IOC2 OP
- [96] CONTACT INPUT H1c
- [97] NOT
- [98] AND (2)
- [99] = VIRTUAL OUTPUT 3

It is now possible to check that this selection of parameters will produce the required logic by converting the set of parameters into a logic diagram. The result of this process is shown as Figure 5–7: FLEXLOGIC™ EQUATION & LOGIC FOR VIRTUAL OUTPUT 3, which is compared to Figure 5–4: LOGIC FOR VIRTUAL OUTPUT 3 as a check.

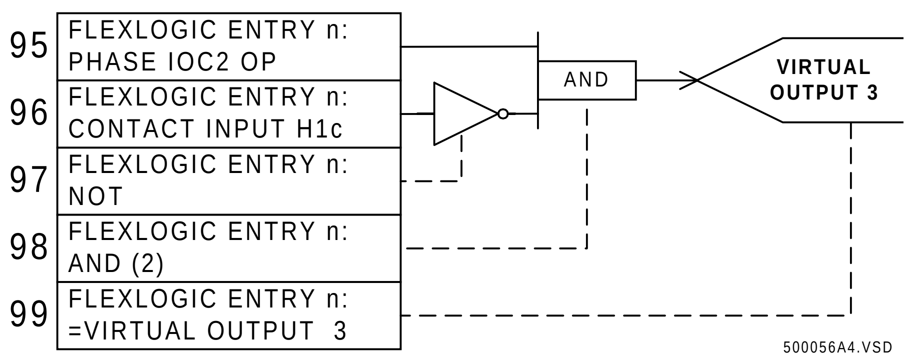

Figure 5–7: FLEXLOGIC™ EQUATION & LOGIC FOR VIRTUAL OUTPUT 3

Repeating the process described for VIRTUAL OUTPUT 3, we select the FlexLogic™ parameters for VIRTUAL OUTPUT 4.

99: The final output of the equation is VIRTUAL OUTPUT 4 which is parameter "= VIRTUAL OUTPUT 4".

98: The operator preceding the output is Timer 2, which is operand "TIMER 2". Note the settings required for the timer are established in the timer programming section.

97: The operator preceding Timer 2 is a three-input OR, which is parameter "OR (3)".

96: The lowest input to OR2 is operand "CONTACT INPUT H1c".

95: The center input to OR2 is operand "TIMER 1".

94: The input to Timer 1 is operand "VIRTUAL OUTPUT 3".

93: The upper input to OR2 is operand "LATCH".

92: There are two inputs to a latch, and the input immediately preceding the latch is the reset, so the next operand must be OR1, which is parameter "OR (4)".

91: The lowest input to OR1 is operand "VIRTUAL OUTPUT 3".

90: The input just above the lowest input to OR1 is operand "XOR".

89: The lower input to XOR1 is operand "PHASE TOC1 PKP".

88: The upper input to XOR1 is operand "VIRTUAL INPUT 1".

87: The input just below the upper input to OR1 is operand "VIRTUAL OUTPUT 2".

86: The upper input to OR1 is operand "VIRTUAL OUTPUT 1".

85: The last parameter is used to set the latch, and is operand "VIRTUAL OUTPUT 4".

The equation for VIRTUAL OUTPUT 4 is:

- [85] VIRTUAL OUTPUT 4
- [86] VIRTUAL OUTPUT 1
- [87] VIRTUAL OUTPUT 2
- [88] VIRTUAL INPUT 1
- [89] PHASE TOC1 PKP
- [90] XOR
- [91] VIRTUAL OUTPUT 3
- [92] OR (4)
- [93] LATCH
- [94] VIRTUAL OUTPUT 3
- [95] TIMER 1
- [96] CONTACT INPUT H1C
- [97] OR (3)
- [98] TIMER 2
- [99] = VIRTUAL OUTPUT 4

It is now possible to check that the selection of parameters will produce the required logic by converting the set of parameters into a logic diagram. The result of this process is shown as Figure 5–8: FLEXLOGIC™ EQUATION & LOGIC FOR VIRTUAL OUTPUT 4, which is compared to Figure 5–5: LOGIC FOR VIRTUAL OUTPUT 4 as a check.

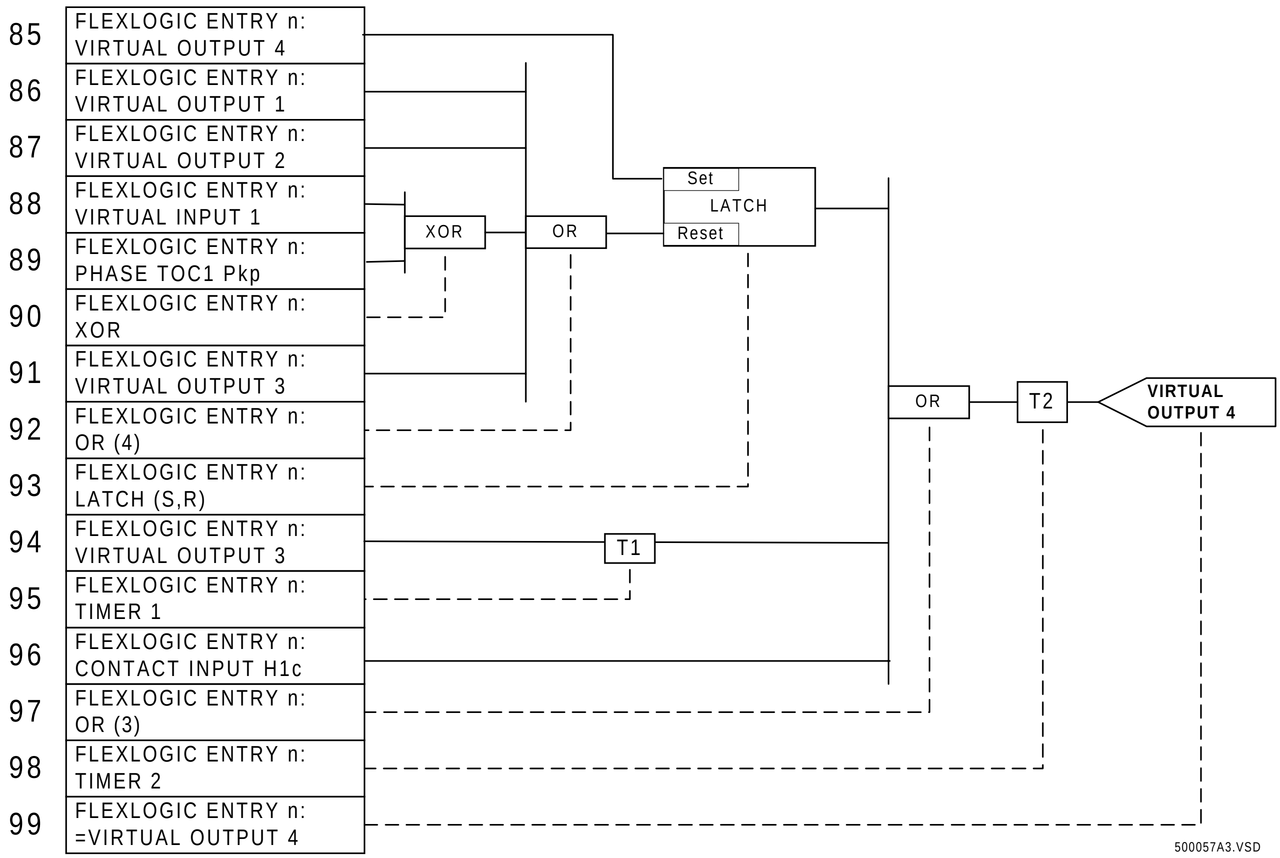

Figure 5–8: FLEXLOGIC™ EQUATION & LOGIC FOR VIRTUAL OUTPUT 4

We can now write the complete FlexLogic™ expression required to implement the required logic, making an effort to assemble the equation in an order where Virtual Outputs that will be used as inputs to operators are created before needed. In cases where a lot of processing is required to perform considerable logic this may be difficult to achieve, but in most cases will not cause problems because all of the logic is calculated at least 4 times per power frequency cycle. The possibility of a problem caused by sequential processing emphasizes the necessity to test the performance of FlexLogic™ before it is placed in service.

In the following example, VIRTUAL OUTPUT 3 is used as an input to both Latch 1 and Timer 1 as arranged the order shown below.

- PHASE IOC2 OP
- CONTACT INPUT H1C
- NOT
- AND (2)
- = VIRTUAL OUTPUT 3
- NO OPERATION;used as a Delimiter between equations
- VIRTUAL OUTPUT 4
- VIRTUAL OUTPUT 1
- VIRTUAL OUTPUT 2
- VIRTUAL INPUT 1
- PHASE TOC1 PKP
- XOR
- VIRTUAL OUTPUT 3
- OR (4)
- LATCH
- VIRTUAL OUTPUT 3
- TIMER 1
- CONTACT INPUT H1C
- OR (3)
- TIMER 2
- = VIRTUAL OUTPUT 4
- END

In the expression above, the VIRTUAL OUTPUT 4 input to the four-input OR is listed before it is created. This is typical of a form of feedback, in this case used to create a seal-in effect with the latch, and is correct.

A set of FlexLogic™ equations must always be terminated by the “END” operator. The FlexLogic™ equation editor can be setup to debug a set of equations by placing an “END” operator within the FlexLogic™ equations. The FlexLogic™ equation will then only be evaluated up to the first “END” operator.

5.5.3 FLEXLOGIC™ EQUATIONS

PATH: S3 FLEXLOGIC ⇨ FLEXLOGIC EQUATION EDITOR

■ FLEXLOGIC ■ EQUATION EDITOR	FLEXLOGIC ENTRY 1: PHASE TOC1 OP	Range: FlexLogic™ parameters
MESSAGE	FLEXLOGIC ENTRY 2: PHASE IOC1 OP	Range: FlexLogic™ parameters
MESSAGE	FLEXLOGIC ENTRY 3: NEUTRAL TOC1 OP	Range: FlexLogic™ parameters
MESSAGE	FLEXLOGIC ENTRY 4: NEUTRAL IOC1 OP	Range: FlexLogic™ parameters
MESSAGE	FLEXLOGIC ENTRY 5: GROUND TOC1 OP	Range: FlexLogic™ parameters
MESSAGE	FLEXLOGIC ENTRY 6: GROUND IOC1 OP	Range: FlexLogic™ parameters
MESSAGE	FLEXLOGIC ENTRY 7: OR(6)	Range: FlexLogic™ parameters
MESSAGE	FLEXLOGIC ENTRY 8: = VIRTUAL OUTPUT 1	Range: FlexLogic™ parameters
MESSAGE	FLEXLOGIC ENTRY 9: PHASE TOC2 OP	Range: FlexLogic™ parameters
MESSAGE	FLEXLOGIC ENTRY 10: PHASE IOC2 OP	Range: FlexLogic™ parameters
MESSAGE	FLEXLOGIC ENTRY 11: NEUTRAL IOC2 OP	Range: FlexLogic™ parameters
MESSAGE	FLEXLOGIC ENTRY 12: GROUND IOC2 OP	Range: FlexLogic™ parameters
MESSAGE	FLEXLOGIC ENTRY 13: OR(4)	Range: FlexLogic™ parameters
MESSAGE	FLEXLOGIC ENTRY 14: = VIRTUAL OUTPUT 2	Range: FlexLogic™ parameters
MESSAGE	FLEXLOGIC ENTRY 15: END	Range: FlexLogic™ parameters

The default selections for FlexLogic™ equations in the relay create two outputs. The operation of all overcurrent elements with a suffix of ‘1’ are inputs to a single OR whose output is assigned to VIRTUAL OUTPUT 1. The operation of all Overcurrent elements with a suffix of ‘2’ are inputs to another OR gate whose output is assigned to VIRTUAL OUTPUT 2. This default programming is shown above. Elements which are set to “Disabled” will never set an associated flag to ‘1’ to be changed for simple applications.

The default virtual outputs are programmed to produce contact operations in the Contact Outputs section. VIRTUAL OUTPUT 1 is programmed to operate output relays H1 and H3; VIRTUAL OUTPUT 2 is programmed to operate output relay H2.

The +/-‘ key may be used when editing FlexLogic™ equations from the keypad to quickly scan through major parameter types.

5.5.4 FLEXLOGIC™ TIMERS 1-32

■ FLEXLOGIC ■ TIMER 1	◀▶	TIMER 1 TYPE: millisecond	*Range: millisecond, second, minute*
MESSAGE	▲▼	TIMER 1 PICKUP DELAY: 0	*Range: 0 - 60000*
MESSAGE	▲	TIMER 1 DROPOUT DELAY: 0	*Range: 0 - 60000*

Timers 2 through 32 have identical settings. These timers can be used as operators for the FlexLogic™ equations. Each timer consists of both a time delay to pickup and a time delay to dropout function. To use only one of these functions, set the delay of the function that is not required to ‘0’.

5.6.1 INVERSE TIME OVERCURRENT CURVE CHARACTERISTICS

The inverse time overcurrent curves may be either IEEE, IEC, GE Type IAC, or I^2t standard curve shapes. This allows for simplified coordination with downstream devices. If however, none of these curve shapes is adequate, the FlexCurve™ may be used to customize the inverse time curve characteristics. Definite time is also an option that may be appropriate if only simple protection is required.

Table 5–8: OVERCURRENT CURVE TYPES

IEEE	IEC	GE Type IAC	Other
IEEE Extremely Inv.	IEC Curve A (BS142)	IAC Extremely Inv.	I^2t
IEEE Very Inverse	IEC Curve B (BS142)	IAC Very Inverse	Flexcurve A
IEEE Moderately Inv.	IEC Curve C (BS142)	IAC Inverse	Flexcurve B
		IAC Short Inverse	Definite Time

A time dial multiplier setting allows selection of a multiple of the base curve shape (where the time dial multiplier = 1) that is selected with the curve shape setting. Unlike the electromechanical time dial equivalent, operate times are directly proportional to the time multiplier setting value. For example, all times for a multiplier of 10 are 10 times the multiplier 1 or base curve values. Setting the multiplier to zero results in an instantaneous response to all current levels above pickup.

Time overcurrent time calculations are made with an internal “energy capacity” memory variable. When this variable indicates that the energy capacity has reached 100%, a time overcurrent element will operate. If less than 100% is accumulated in this variable and the current falls below the dropout threshold of 97–98% of the pickup value, the variable must be reduced. Two methods of this resetting operation are available, “Instantaneous” and “Timed”. The Instantaneous selection is intended for applications with other relays, such as most static relays, which set the energy capacity directly to zero when the current falls below the reset threshold. The “Timed” selection can be used where the relay must coordinate with electromechanical relays. With this setting, the energy capacity variable is decremented according to the equation provided.

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Note: Graphs of standard time-current curves on 11”x17” log-log graph paper are available upon request from the GE Multilin literature department. The original files are also available in PDF format on the UR Software Installation CD and the GE Power Management Home Page.

a) IEEE CURVES

The IEEE time overcurrent curve shapes conform to industry standard curves and fit into the IEEE C37.112-1996 curve classifications for extremely, very, and moderately inverse. The IEEE curves are derived from the formulae:

$$T = TDM \times \frac{A}{\left(\frac{I}{I_{pickup}}\right)^p - 1} + B \qquad T_{RESET} = TDM \times \left[\frac{t_r}{\left(\frac{I}{I_{pickup}}\right)^2 - 1}\right]$$

where:

T = Operate Time (sec)
TDM = Multiplier Setting
I = Input Current
I_{pickup} = Pickup Current Setting
A, B, p = Constants
T_{RESET} = reset time in sec. (assuming energy capacity is 100% and RESET:Timed)
t_r = characteristic constant

Table 5–9: IEEE INVERSE TIME CURVE CONSTANTS

ANSI CURVE SHAPE	CONSTANTS			
	A	B	p	t_r
EXTREMELY INVERSE	28.2	0.1217	2.0000	29.1
VERY INVERSE	19.61	0.491	2.0000	21.6
MODERATELY INVERSE	0.0515	0.1140	0.02000	4.85

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Table 5–10: IEEE Curve Operate Times (in seconds)

Multiplier	Current (I / Ipickup)									
(M)	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
IEEE EXTREMELY INVERSE										
0.5	11.341	4.761	1.823	1.001	0.648	0.464	0.355	0.285	0.237	0.203
1.0	22.682	9.522	3.647	2.002	1.297	0.927	0.709	0.569	0.474	0.407
2.0	45.363	19.043	7.293	4.003	2.593	1.855	1.418	1.139	0.948	0.813
4.0	90.727	38.087	14.587	8.007	5.187	3.710	2.837	2.277	1.897	1.626
6.0	136.090	57.130	21.880	12.010	7.780	5.564	4.255	3.416	2.845	2.439
8.0	181.454	76.174	29.174	16.014	10.374	7.419	5.674	4.555	3.794	3.252
10.0	226.817	95.217	36.467	20.017	12.967	9.274	7.092	5.693	4.742	4.065
IEEE VERY INVERSE										
0.5	8.090	3.514	1.471	0.899	0.654	0.526	0.450	0.401	0.368	0.345
1.0	16.179	7.028	2.942	1.798	1.308	1.051	0.900	0.802	0.736	0.689
2.0	32.358	14.055	5.885	3.597	2.616	2.103	1.799	1.605	1.472	1.378
4.0	64.716	28.111	11.769	7.193	5.232	4.205	3.598	3.209	2.945	2.756
6.0	97.074	42.166	17.654	10.790	7.849	6.308	5.397	4.814	4.417	4.134
8.0	129.432	56.221	23.538	14.387	10.465	8.410	7.196	6.418	5.889	5.513
10.0	161.790	70.277	29.423	17.983	13.081	10.513	8.995	8.023	7.361	6.891
IEEE MODERATELY INVERSE										
0.5	3.220	1.902	1.216	0.973	0.844	0.763	0.706	0.663	0.630	0.603
1.0	6.439	3.803	2.432	1.946	1.688	1.526	1.412	1.327	1.260	1.207
2.0	12.878	7.606	4.864	3.892	3.377	3.051	2.823	2.653	2.521	2.414
4.0	25.756	15.213	9.729	7.783	6.753	6.102	5.647	5.307	5.041	4.827
6.0	38.634	22.819	14.593	11.675	10.130	9.153	8.470	7.960	7.562	7.241
8.0	51.512	30.426	19.458	15.567	13.507	12.204	11.294	10.614	10.083	9.654
10.0	64.390	38.032	24.322	19.458	16.883	15.255	14.117	13.267	12.604	12.068

b) IEC CURVES

For European applications, the relay offers three standard curves defined in IEC 255-4 and British standard BS142. These are defined as IEC Curve A, IEC Curve B, and IEC Curve C. The formulae for these curves is:

$$'T = TDM \times \frac{K}{\left(\frac{I}{I_{pickup}}\right)^{E} - 1} + B \qquad T_{RESET} = TDM \times \left[\frac{t_r}{\left(\frac{I}{I_{pickup}}\right)^{2} - 1}\right]$$

where:

T =	Operate Time (sec)
TDM =	Multiplier Setting
I =	Input Current
I_{pickup} =	Pickup Current Setting
K, E =	Constants
T_{RESET} =	Reset Time in sec. (assuming energy capacity is 100% and RESET:Timed)
t_r =	Characteristic Constant

Table 5–11: IEC (BS) INVERSE TIME CURVE CONSTANTS

IEC (BS) CURVE SHAPE	CONSTANTS		
	K	E	t_r
IEC CURVE A (BS1 42)	0.140	0.020	9.7
IEC CURVE B (BS1 42)	13.500	1.000	43.2
IEC CURVE C (BS1 42)	80.000	2.000	58.2
SHORT INVERSE	0.050	0.040	0.500

Table 5–12: IEC Curve Trip Times (in seconds)

Multiplier (M)	Current (I / Ipu) 1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
IEC CURVE A										
0.05	0.860	0.501	0.315	0.249	0.214	0.192	0.176	0.165	0.156	0.149
0.10	1.719	1.003	0.630	0.498	0.428	0.384	0.353	0.330	0.312	0.297
0.20	3.439	2.006	1.260	0.996	0.856	0.767	0.706	0.659	0.623	0.594
0.40	6.878	4.012	2.521	1.992	1.712	1.535	1.411	1.319	1.247	1.188
0.60	10.317	6.017	3.781	2.988	2.568	2.302	2.117	1.978	1.870	1.782
0.80	13.755	8.023	5.042	3.984	3.424	3.070	2.822	2.637	2.493	2.376
1.00	17.194	10.029	6.302	4.980	4.280	3.837	3.528	3.297	3.116	2.971
IEC CURVE B										
0.05	1.350	0.675	0.338	0.225	0.169	0.135	0.113	0.096	0.084	0.075
0.10	2.700	1.350	0.675	0.450	0.338	0.270	0.225	0.193	0.169	0.150
0.20	5.400	2.700	1.350	0.900	0.675	0.540	0.450	0.386	0.338	0.300
0.40	10.800	5.400	2.700	1.800	1.350	1.080	0.900	0.771	0.675	0.600
0.60	16.200	8.100	4.050	2.700	2.025	1.620	1.350	1.157	1.013	0.900
0.80	21.600	10.800	5.400	3.600	2.700	2.160	1.800	1.543	1.350	1.200
1.00	27.000	13.500	6.750	4.500	3.375	2.700	2.250	1.929	1.688	1.500
IEC CURVE C										
0.05	3.200	1.333	0.500	0.267	0.167	0.114	0.083	0.063	0.050	0.040
0.10	6.400	2.667	1.000	0.533	0.333	0.229	0.167	0.127	0.100	0.081
0.20	12.800	5.333	2.000	1.067	0.667	0.457	0.333	0.254	0.200	0.162
0.40	25.600	10.667	4.000	2.133	1.333	0.914	0.667	0.508	0.400	0.323
0.60	38.400	16.000	6.000	3.200	2.000	1.371	1.000	0.762	0.600	0.485
0.80	51.200	21.333	8.000	4.267	2.667	1.829	1.333	1.016	0.800	0.646
1.00	64.000	26.667	10.000	5.333	3.333	2.286	1.667	1.270	1.000	0.808
IEC SHORT TIME										
0.05	0.153	0.089	0.056	0.044	0.038	0.034	0.031	0.029	0.027	0.026
0.10	0.306	0.178	0.111	0.088	0.075	0.067	0.062	0.058	0.054	0.052
0.20	0.612	0.356	0.223	0.175	0.150	0.135	0.124	0.115	0.109	0.104
0.40	1.223	0.711	0.445	0.351	0.301	0.269	0.247	0.231	0.218	0.207
0.60	1.835	1.067	0.668	0.526	0.451	0.404	0.371	0.346	0.327	0.311
0.80	2.446	1.423	0.890	0.702	0.602	0.538	0.494	0.461	0.435	0.415
1.00	3.058	1.778	1.113	0.877	0.752	0.673	0.618	0.576	0.544	0.518

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c) IAC CURVES

The curves for the General Electric type IAC relay family are derived from the formula:

$$T = TDM \times \left[A + \frac{B}{\left(\frac{I}{I_{pickup}} - C\right)} + \frac{D}{\left(\frac{I}{I_{pickup}} - C\right)^2} + \frac{E}{\left(\frac{I}{I_{pickup}} - C\right)^3} \right]$$

$$T_{RESET} = TDM \times \left[\frac{t_r}{\left(\frac{I}{I_{pickup}}\right)^2 - 1} \right]$$

T = Operate Time (sec)
TDM = Multiplier Setting
I = Input Current
I_{pickup} = Pickup Current Setting
A, B, C, D, E = Constants
T_{RESET} = Reset Time in sec. (assuming energy capacity is 100% and RESET:Timed)
t_r = Characteristic Constant

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Table 5–13: GE TYPE IAC INVERSE TIME CURVE CONSTANTS

IAC CURVE SHAPE	CONSTANTS					
	A	B	C	D	E	t_r
IAC EXTREME INVERSE	0.0040	0.6379	0.6200	1.7872	0.2461	6.008
IAC VERY INVERSE	0.0900	0.7955	0.1000	-1.2885	7.9586	4.678
IAC INVERSE	0.2078	0.8630	0.8000	-0.4180	0.1947	0.990
IAC SHORT INVERSE	0.0428	0.0609	0.6200	-0.0010	0.0221	0.222

Table 5–14: IAC Curve Trip Times (in seconds)

Multiplier	Current (I / Ipu)									
(M)	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
IAC EXTREMELY INVERSE										
0.5	1.699	0.749	0.303	0.178	0.123	0.093	0.074	0.062	0.053	0.046
1.0	3.398	1.498	0.606	0.356	0.246	0.186	0.149	0.124	0.106	0.093
2.0	6.796	2.997	1.212	0.711	0.491	0.372	0.298	0.248	0.212	0.185
4.0	13.591	5.993	2.423	1.422	0.983	0.744	0.595	0.495	0.424	0.370
6.0	20.387	8.990	3.635	2.133	1.474	1.115	0.893	0.743	0.636	0.556
8.0	27.183	11.987	4.846	2.844	1.966	1.487	1.191	0.991	0.848	0.741
10.0	33.979	14.983	6.058	3.555	2.457	1.859	1.488	1.239	1.060	0.926
IAC VERY INVERSE										
0.5	1.451	0.656	0.269	0.172	0.133	0.113	0.101	0.093	0.087	0.083
1.0	2.901	1.312	0.537	0.343	0.266	0.227	0.202	0.186	0.174	0.165
2.0	5.802	2.624	1.075	0.687	0.533	0.453	0.405	0.372	0.349	0.331
4.0	11.605	5.248	2.150	1.374	1.065	0.906	0.810	0.745	0.698	0.662
6.0	17.407	7.872	3.225	2.061	1.598	1.359	1.215	1.117	1.046	0.992
8.0	23.209	10.497	4.299	2.747	2.131	1.813	1.620	1.490	1.395	1.323
10.0	29.012	13.121	5.374	3.434	2.663	2.266	2.025	1.862	1.744	1.654
IAC NORMALLY INVERSE										
0.5	0.578	0.375	0.266	0.221	0.196	0.180	0.168	0.160	0.154	0.148
1.0	1.155	0.749	0.532	0.443	0.392	0.360	0.337	0.320	0.307	0.297
2.0	2.310	1.499	1.064	0.885	0.784	0.719	0.674	0.640	0.614	0.594
4.0	4.621	2.997	2.128	1.770	1.569	1.439	1.348	1.280	1.229	1.188
6.0	6.931	4.496	3.192	2.656	2.353	2.158	2.022	1.921	1.843	1.781
8.0	9.242	5.995	4.256	3.541	3.138	2.878	2.695	2.561	2.457	2.375
10.0	11.552	7.494	5.320	4.426	3.922	3.597	3.369	3.201	3.072	2.969
IAC SHORT INVERSE										
0.5	0.072	0.047	0.035	0.031	0.028	0.027	0.026	0.026	0.025	0.025
1.0	0.143	0.095	0.070	0.061	0.057	0.054	0.052	0.051	0.050	0.049
2.0	0.286	0.190	0.140	0.123	0.114	0.108	0.105	0.102	0.100	0.099
4.0	0.573	0.379	0.279	0.245	0.228	0.217	0.210	0.204	0.200	0.197
6.0	0.859	0.569	0.419	0.368	0.341	0.325	0.314	0.307	0.301	0.296
8.0	1.145	0.759	0.559	0.490	0.455	0.434	0.419	0.409	0.401	0.394
10.0	1.431	0.948	0.699	0.613	0.569	0.542	0.524	0.511	0.501	0.493

d) I^2t

The curves for the I^2t are derived from the formula:

$$T = TDM \times \left[\frac{100}{\left(\frac{I}{I_{pickup}} \right)^2} \right] \qquad T_{RESET} = TDM \times \left[\frac{-100}{\left(\frac{I}{I_{pickup}} \right)^{-2}} \right]$$

where:

T = Operate Time (sec)
TDM = Multiplier Setting
I = Input Current
I_{pickup} = Pickup Current Setting
T_{RESET} = Reset Time in sec. (assuming energy capacity is 100% and RESET:Timed)

Table 5–15: I^2t Curve Trip Times (in seconds)

Multiplier	Current (I/Ipu)									
(M)	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
0.01	0.44	0.25	0.11	0.06	0.04	0.03	0.02	0.02	0.01	0.01
0.10	4.44	2.50	1.11	0.63	0.40	0.28	0.20	0.16	0.12	0.10
1.00	44.44	25.00	11.11	6.25	4.00	2.78	2.04	1.56	1.23	1.00
10.00	444.44	250.00	111.11	62.50	40.00	27.78	20.41	15.63	12.35	10.00
100.00	4444.4	2500.0	1111.1	625.00	400.00	277.78	204.08	156.25	123.46	100.00
600.00	26666.7	15000.0	6666.7	3750.0	2400.0	1666.7	1224.5	937.50	740.74	600.00

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e) FlexCurve™

The custom FlexCurve™ is described in detail in section 5.4.1 FLEXCURVE™ A / FLEXCURVE™ B. The curves for the FlexCurves™ are derived from the formulae:

$$T = TDM \times \left[\text{FlexcurveTime}@\left(\frac{I}{I_{pickup}}\right)\right] \qquad \text{When } \left(\frac{I}{I_{pickup}}\right) \geq 1.00$$

$$T_{RESET} = TDM \times \left[\text{FlexcurveTime}@\left(\frac{I}{I_{pickup}}\right)\right] \qquad \text{When } \left(\frac{I}{I_{pickup}}\right) \leq 0.98$$

where:

T =	Operate Time (sec)
TDM =	Multiplier Setting
I =	Input Current
I_{pickup} =	Pickup Current Setting
T_{RESET} =	Reset Time in sec. (assuming energy capacity is 100% and RESET:Timed)

f) DEFINITE TIME CURVE

The definite time curve shape operates as soon as the pickup level is exceeded for a specified period of time. The base definite time curve delay is seconds The curve multiplier of 0.00 - 600.00 makes this delay adjustable from instantaneous to 600.00 seconds in steps of 10 ms.

$$T = TDM \text{ in seconds, } when \quad I > I_{pickup}$$

$$T_{RESET} = -TDM \text{ in seconds}$$

where:

T =	Operate Time (sec)
M =	Multiplier Setting
I =	Input Current
I_{pickup} =	Pickup Current Setting
T_{RESET} =	Reset Time in sec. (assuming energy capacity is 100% and RESET:Timed)

5.7.1 CURRENT ELEMENTS MENU

PATH: S4 ELEMENTS ⇨ CURRENT ELEMENTS

■ CURRENT ■ ELEMENTS	■ PHASE TOC1 ■
MESSAGE	■ PHASE TOC2 ■
MESSAGE	■ PHASE IOC1 ■
MESSAGE	■ PHASE IOC2 ■
MESSAGE	■ NEUTRAL TOC1 ■
MESSAGE	■ NEUTRAL IOC1 ■
MESSAGE	■ NEUTRAL IOC2 ■
MESSAGE	■ GROUND TOC1 ■
MESSAGE	■ GROUND IOC1 ■
MESSAGE	■ GROUND IOC2 ■
MESSAGE	■ SNS GROUND TOC1 ■
MESSAGE	■ SNS GROUND IOC1 ■
MESSAGE	■ SNS GROUND IOC2 ■

The relay current elements menu consists of two time overcurrent elements for phase; one time overcurrent for each of ground and neutral; and two instantaneous overcurrent elements for each of phase, ground, and neutral currents. These elements can be used for tripping, alarming, or other functions. Under each menu heading are configuration settings for the element .

a) PHASE TOC1 / PHASE TOC2

PATH: S4 ELEMENTS ⇨ CURRENT ELEMENTS ⇨ PHASE TOC1

■ PHASE TOC1 ■	PHASE TOC1 FUNCTION: Disabled	*Range: Disabled, Enabled*
MESSAGE	PHASE TOC1 INPUT: Fundamental	*Range: Fundamental, RMS*
MESSAGE	PHASE TOC1 PICKUP: 1.05 A	*Range: 0.05 To 23.00 in Steps of 0.01 (1A CT)* *Range: 0.25 To 115.00 in Steps of 0.05 (5A CT)*
MESSAGE	PHASE TOC1 CURVE: ANSI Ext Inv	*See Overcurrent Curve Types table*
MESSAGE	PHASE TOC1 TD MULTIPLIER: 1.00	*Range: 0.00 To 600.00 in Steps of 0.01*
MESSAGE	PHASE TOC1 RESET: Instantaneous	*Range: Instantaneous, Timed*
MESSAGE	PHASE TOC1 BLK: No Operation	*Range: Flexlogic™ Operand*
MESSAGE	PHASE TOC1 TARGET: Self-reset	*Range: Self-reset, Latched*
MESSAGE	PHASE TOC1 EVENTS: Disabled	*Range: Disabled, Enabled*

The phase time overcurrent element may be used to give a desired time-delay operating characteristic versus the applied current or as a simple definite time element. The phase current input quantities may be programmed as Fundamental phasor RMS magnitude or total waveform RMS magnitude as required by the application. Two methods of resetting operation are available “Linear” and “Instantaneous”. (refer to section INVERSE TIME OVERCURRENT CURVE CHARACTERISTICS, for details on curve setup, trip times, and reset operation).

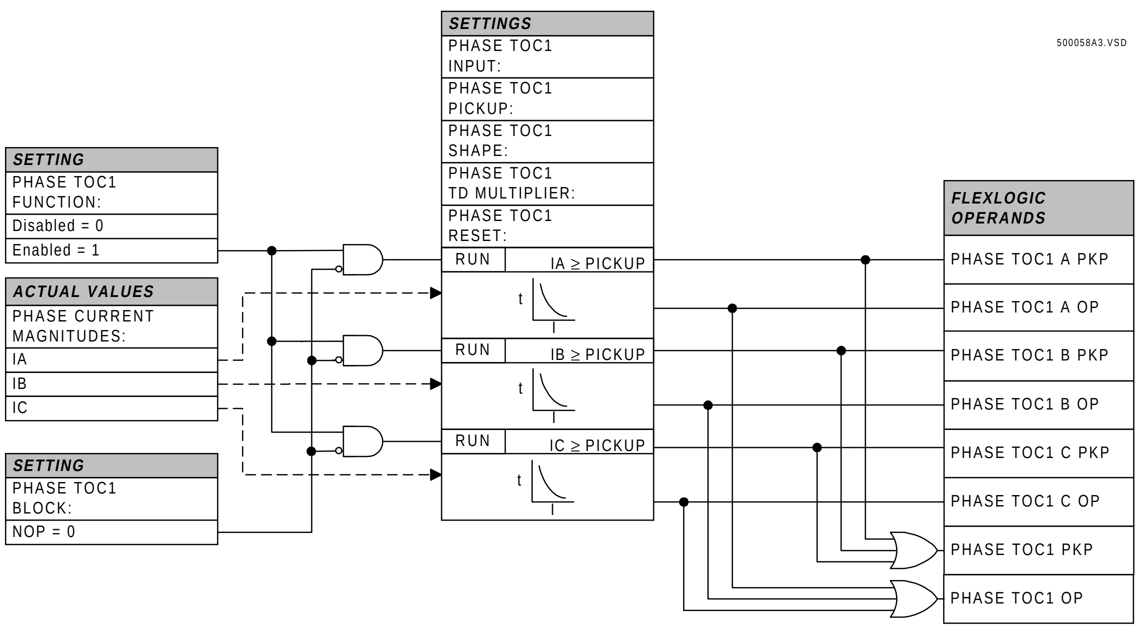


Figure 5–9: PHASE TOC1 SCHEME LOGIC

b) PHASE IOC1 / PHASE IOC2

PATH: S4 ELEMENTS ⇨ CURRENT ELEMENTS ⇨⇩ PHASE IOC1

■ PHASE IOC1 ■	PHASE IOC1 FUNCTION: Disabled	*Range: Disabled, Enabled*
MESSAGE	PHASE IOC1 PICKUP: 1.05 A	*Range: 0.05 To 23.00 in Steps of 0.01 (1A CT)* *Range: 0.25 To 115.00 in Steps of 0.05 (5A CT)*
MESSAGE	PHASE IOC1 PICKUP DELAY: 0.00 s	*Range: 0.00 To 600.00 in Steps of 0.01*
MESSAGE	PHASE IOC1 RESET DELAY: 0.00 s	*Range: 0.00 To 600.00 in Steps of 0.01*
MESSAGE	PHASE IOC1 BLK: No Operation	*Range: Flexlogic™ Operand*
MESSAGE	PHASE IOC1 TARGET: Self-reset	*Range: Self-reset, Latched*
MESSAGE	PHASE IOC1 EVENTS: Disabled	*Range: Disabled, Enabled*

The phase instantaneous overcurrent element may be used as an instantaneous element with no intentional delay or as a definite time element. The input current is the fundamental phasor RMS magnitude.

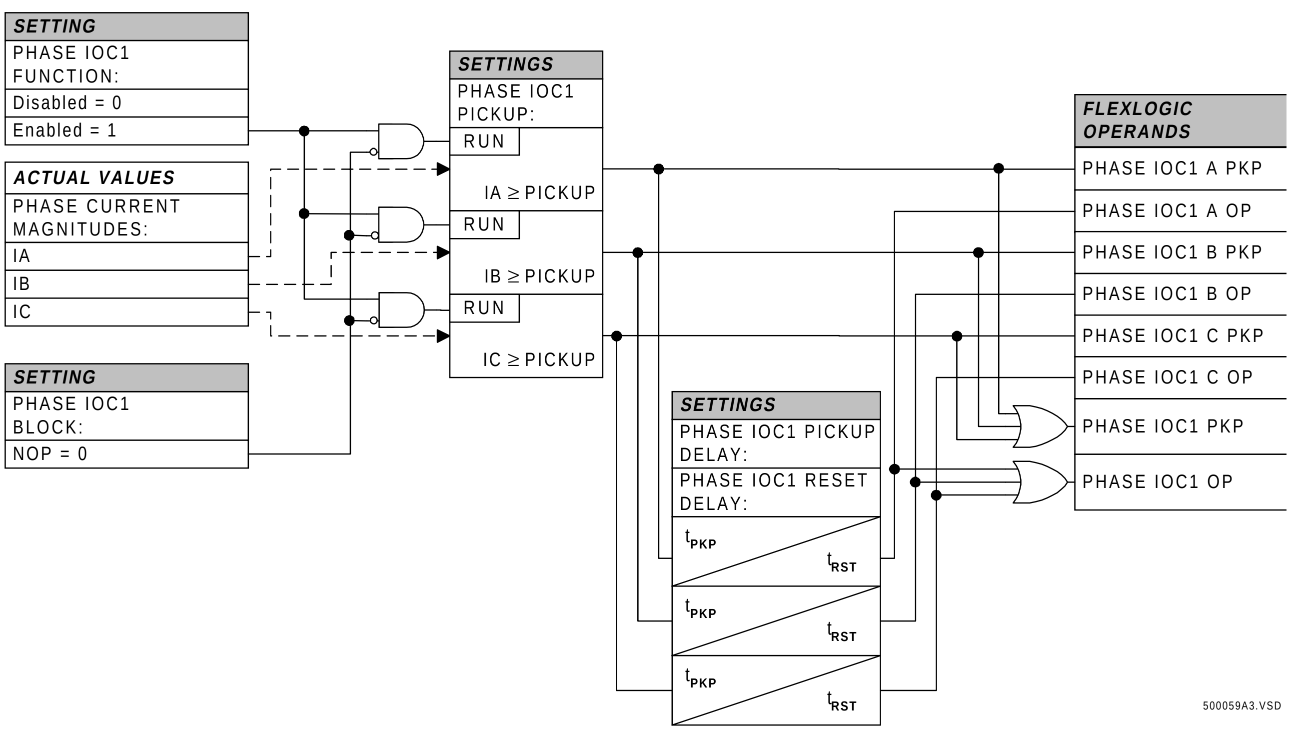


Figure 5–10: PHASE IOC1 SCHEME LOGIC

c) NEUTRAL TOC1

PATH: S4 ELEMENTS ⇨ CURRENT ELEMENTS ⇨⇩ NEUTRAL TOC1

■ NEUTRAL TOC1 ■	NEUTRAL TOC1 FUNCTION: Disabled	*Range: Disabled, Enabled*
MESSAGE	NEUTRAL TOC1 INPUT: Fundamental	*Range: Fundamental, RMS*
MESSAGE	NEUTRAL TOC1 PICKUP: 1.05 A	*Range: 0.05 To 23.00 in Steps of 0.01 (1A CT)* *Range: 0.25 To 115.00 in Steps of 0.05 (5A CT)*
MESSAGE	NEUTRAL TOC1 CURVE: ANSI Ext Inv	*See Formats Type Definition Table*
MESSAGE	NEUTRAL TOC1 TD MULTIPLIER: 1.00	*Range: 0.00 To 600.00 in Steps of 0.01*
MESSAGE	NEUTRAL TOC1 RESET: Instantaneous	*Range: Instantaneous, Timed*
MESSAGE	NEUTRAL TOC1 BLK: No Operation	*Range: Flexlogic™ Operand*
MESSAGE	NEUTRAL TOC1 TARGET: Self-reset	*Range: Self-reset, Latched*
MESSAGE	NEUTRAL TOC1 EVENTS: Disabled	*Range: Disabled, Enabled*

5

The neutral time overcurrent element may be used to give a desired time-delay operating characteristic versus the applied current or as a simple definite time element. The neutral current input value is a quantity calculated as 3Io from the phase currents and may be programmed as fundamental phasor RMS magnitude or total waveform RMS magnitude as required by the application. Two methods of resetting operation are available "Linear" and "Instantaneous". (refer to section INVERSE TIME OVERCURRENT CURVE CHARACTERISTICS, for details on curve setup, trip times, and reset operation).

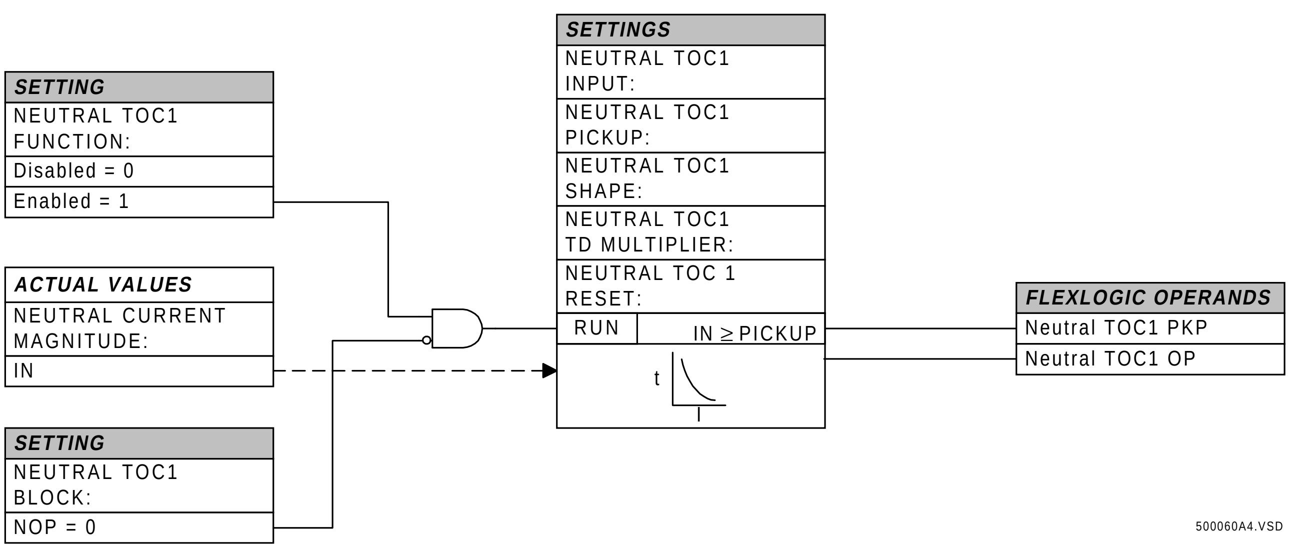


Figure 5–11: NEUTRAL TOC1 SCHEME LOGIC

d) NEUTRAL IOC1 / NEUTRAL IOC2

PATH: S4 ELEMENTS ⇨ CURRENT ELEMENTS ⇨⇩ NEUTRAL IOC1

		Display	Range
■ NEUTRAL IOC1 ■		NEUTRAL IOC1 FUNCTION: Disabled	*Range: Disabled, Enabled*
	MESSAGE	NEUTRAL IOC1 PICKUP: 1.05 A	*Range: 0.05 To 23.00 in Steps of 0.01 (1A CT)* *Range: 0.25 To 115.00 in Steps of 0.05 (5A CT)*
	MESSAGE	NEUTRAL IOC1 PICKUP DELAY: 0.00 s	*Range: 0.00 To 600.00 in Steps of 0.01*
	MESSAGE	NEUTRAL IOC1 RESET DELAY: 0.00 s	*Range: 0.00 To 600.00 in Steps of 0.01*
	MESSAGE	NEUTRAL IOC1 BLK: No Operation	*Range: Flexlogic™ Operand*
	MESSAGE	NEUTRAL IOC1 TARGET: Self-reset	*Range: Self-reset, Latched*
	MESSAGE	NEUTRAL IOC1 EVENTS: Disabled	*Range: Disabled, Enabled*

The neutral instantaneous overcurrent element may be used as an instantaneous element with no intentional delay or as a definite time element. The neutral current input value is a quantity calculated as 3Io from the phase currents and is the fundamental phasor RMS magnitude.

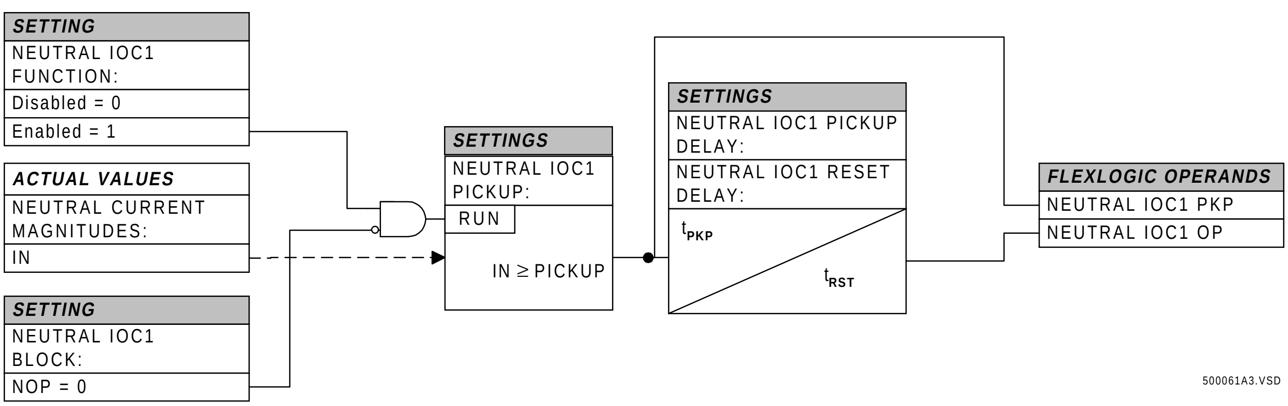


Figure 5–12: NEUTRAL IOC1 SCHEME LOGIC

e) GROUND TOC1

PATH: S4 ELEMENTS ⇨ CURRENT ELEMENTS ⇨⇩ GROUND TOC1

	Display	Range
■ GROUND TOC1 ■	GROUND TOC1 FUNCTION: Disabled	*Range: Disabled, Enabled*
MESSAGE	GROUND TOC1 INPUT: Fundamental	*Range: Fundamental, RMS*
MESSAGE	GROUND TOC1 PICKUP: 1.05 A	*Range: 0.05 To 23.00 in Steps of 0.01 (1A CT)* *Range: 0.25 To 115.00 in Steps of 0.05 (5A CT)*
MESSAGE	GROUND TOC1 CURVE: ANSI Ext Inv	*See Formats Type Definition Table*
MESSAGE	GROUND TOC1 TD MULTIPLIER: 1.00	*Range: 0.00 To 600.00 in Steps of 0.01*
MESSAGE	GROUND TOC1 RESET: Instantaneous	*Range: Instantaneous, Timed*
MESSAGE	GROUND TOC1 BLK: No Operation	*Range: Flexlogic™ Operand*
MESSAGE	GROUND TOC1 TARGET: Self-reset	*Range: Self-reset, Latched*
MESSAGE	GROUND TOC1 EVENTS: Disabled	*Range: Disabled, Enabled*

The ground time overcurrent element may be used to give a desired time-delay operating characteristic versus the applied current or as a simple definite time element. The ground current input value is the quantity measured by the ground input CT and is the fundamental phasor RMS magnitude. Two methods of resetting operation are available “Linear” and “Instantaneous”. (refer to section INVERSE TIME OVERCURRENT CURVE CHARACTERISTICS, for details on curve setup, trip times, and reset operation).

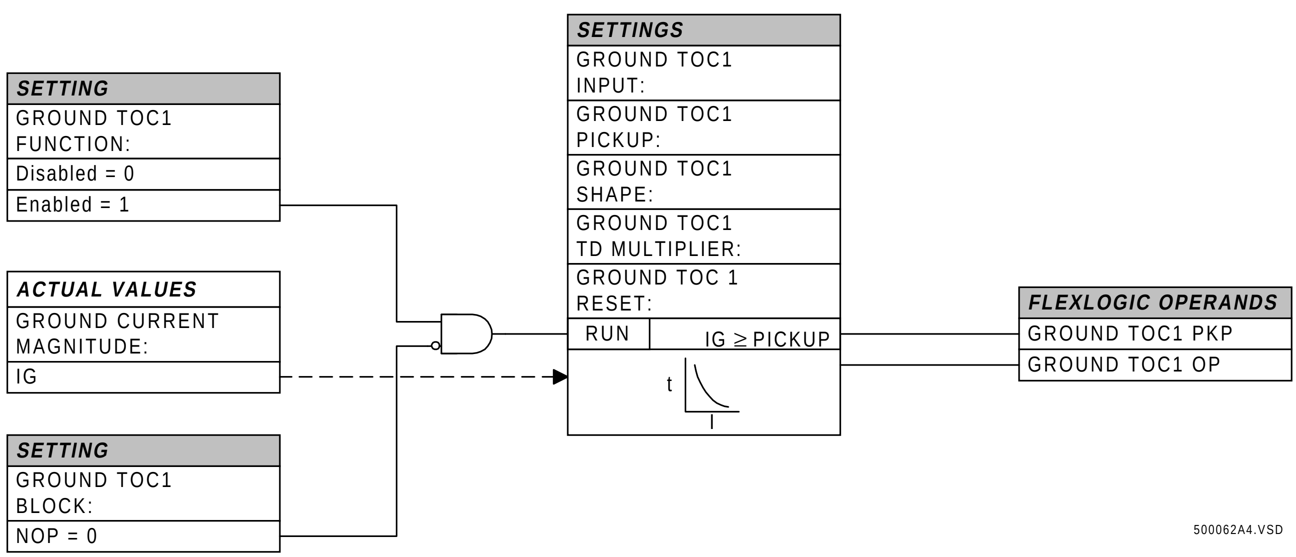


Figure 5–13: GROUND TOC1 SCHEME LOGIC

f) GROUND IOC1 / GROUND IOC2

PATH: S4 ELEMENTS ⇨ CURRENT ELEMENTS ⇨⇩ GROUND IOC1

■ GROUND IOC1 ■	GROUND IOC1 FUNCTION: Disabled	*Range: Disabled, Enabled*
MESSAGE	GROUND IOC1 PICKUP: 1.05 A	*Range: 0.05 To 23.00 in Steps of 0.01 (1A CT)* *Range: 0.25 To 115.00 in Steps of 0.05 (5A CT)*
MESSAGE	GROUND IOC1 PICKUP DELAY: 0.00 s	*Range: 0.00 To 600.00 in Steps of 0.01*
MESSAGE	GROUND IOC1 RESET DELAY: 0.00 s	*Range: 0.00 To 600.00 in Steps of 0.01*
MESSAGE	GROUND IOC1 BLK: No Operation	*Range: Flexlogic™ Operand*
MESSAGE	GROUND IOC1 TARGET: Self-reset	*Range: Self-reset, Latched*
MESSAGE	GROUND IOC1 EVENTS: Disabled	*Range: Disabled, Enabled*

The ground instantaneous overcurrent element may be used as an instantaneous element with no intentional delay or as a definite time element. The ground current input value is the quantity measured by the ground input CT and is the fundamental phasor RMS magnitude.

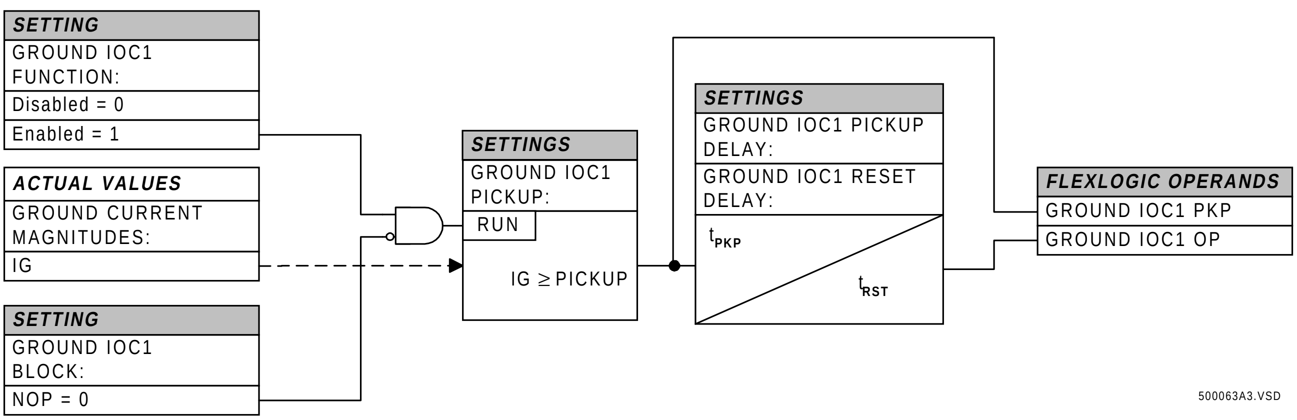


Figure 5–14: GROUND IOC1 SCHEME LOGIC

g) SENSITIVE GROUND TOC1

PATH: S4 ELEMENTS ⇨ CURRENT ELEMENTS ⇨⇩ SNS GROUND TOC1

■ SNS GROUND TOC1 ■	SNS GROUND TOC1 FUNCTION: Disabled	*Range: Disabled, Enabled*
MESSAGE	SNS GROUND TOC1 INPUT: Fundamental	*Range: Fundamental, RMS*
MESSAGE	SNS GROUND TOC1 PICKUP: 1.05 A	*Range: 0.005 to 2.300 in Steps of 0.001 (1A CT)* *Range: 0.025 to 11.50 in Steps of 0.005 (5A CT)*
MESSAGE	SNS GROUND TOC1 CURVE: ANSI Ext Inv	*See Formats Type Definition Table*
MESSAGE	SNS GROUND TOC1 TD MULTIPLIER: 1.00	*Range: 0.00 To 600.00 in Steps of 0.01*
MESSAGE	SNS GROUND TOC1 RESET: Instantaneous	*Range: Instantaneous, Timed*
MESSAGE	SNS GROUND TOC1 BLK: No Operation	*Range: Flexlogic™ Operand*
MESSAGE	SNS GROUND TOC1 TARGET: Self-reset	*Range: Self-reset, Latched*
MESSAGE	SNS GROUND TOC1 EVENTS: Disabled	*Range: Disabled, Enabled*

These messages will appear instead of the Ground TOC1 messages if the sensitive ground module (8B) is ordered. The ground pickup range will be 10 times more sensitive than the normal ground pickup. The sensitive ground time overcurrent element may be used to give a desired time-delay operating characteristic versus the applied current or as a simple definite time element. The ground current input value is the quantity measured by the sensitive ground input CT and is the fundamental phasor RMS magnitude. Two methods of resetting operation are available; “Linear” and “Instantaneous”. (Refer to section INVERSE TIME OVERCURRENT CURVE CHARACTERISTICS, for details on curve setup, trip times, and reset operation.)

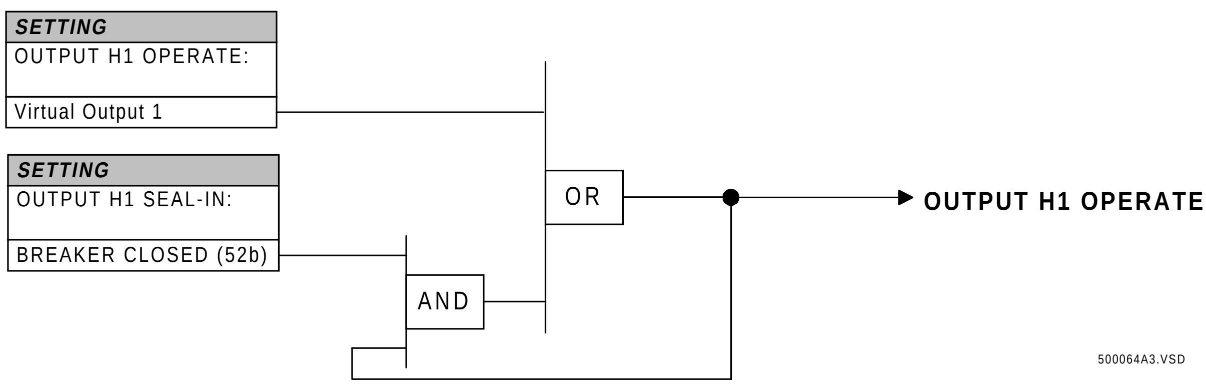


Figure 5–15: SENSITIVE GROUND TOC1 SCHEME LOGIC

h) SENSITIVE GROUND IOC1 / SENSITIVE GROUND IOC2

PATH: S4 ELEMENTS ⇨ CURRENT ELEMENTS ⇨⇩ SNS GROUND IOC1

■ SNS GROUND IOC1 ■	SNS GROUND IOC1 FUNCTION: Disabled	*Range: Disabled, Enabled*
MESSAGE	SNS GROUND IOC1 PICKUP: 1.050 A	*Range: 0.005 To 2.300 in Steps of 0.001 (1A CT)* *Range: 0.025 To 11.500 in Steps of 0.005 (5A CT)*
MESSAGE	SNS GROUND IOC1 PKP DELAY: 0.00 s	*Range: 0.00 To 600.00 in Steps of 0.01*
MESSAGE	SNS GROUND IOC1 RST DELAY: 0.00 s	*Range: 0.00 To 600.00 in Steps of 0.01*
MESSAGE	SNS GROUND IOC1 BLK: No Operation	*Range: Flexlogic™ Operand*
MESSAGE	SNS GROUND IOC1 TARGET: Self-reset	*Range: Self-reset, Latched*
MESSAGE	SNS GROUND IOC1 EVENTS: Disabled	*Range: Disabled, Enabled*

These messages will appear instead of the Ground IOC1 and Ground IOC2 messages if the sensitive ground module (8B) is ordered. The ground pickup range will be 10 times more sensitive than the normal ground pickup. The ground instantaneous overcurrent element may be used as an instantaneous element with no intentional delay or as a definite time element. The ground current input value is the quantity measured by the ground input CT and is the fundamental phasor RMS magnitude.

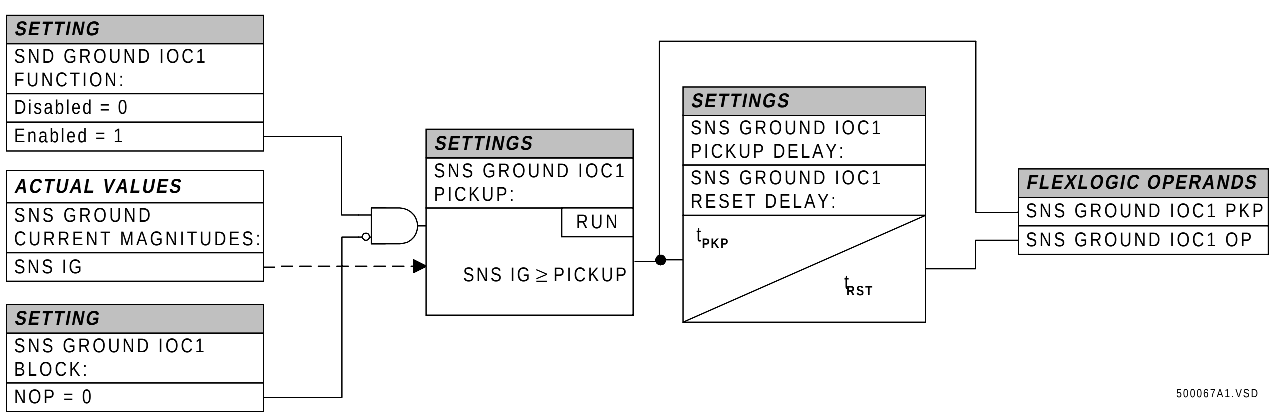


Figure 5–16: GROUND IOC1 SCHEME LOGIC

5.7.2 VOLTAGE ELEMENTS MENU

PATH: S4 ELEMENTS ⇨⇩ VOLTAGE ELEMENTS

```
■ VOLTAGE            ◀▶   ■ PHASE
■ ELEMENTS                ■ UNDERVOLTAGE 1

             MESSAGE  ▲   ■ PHASE
                          ■ UNDERVOLTAGE 2
```

There are two undervoltage protection elements (Phase Undervoltage 1 / 2) which can be used for a variety of applications such as:

Undervoltage Protection: For voltage sensitive loads, such as induction motors, a drop in voltage will result in an increase in the drawn current, which may cause dangerous overheating in the motor. The undervoltage protection feature can be used to either cause a trip or generate an alarm when the voltage drops below a specified voltage setting for a specified time delay.

Permissive Functions: The undervoltage feature may be used to block the functioning of external devices by operating an output relay, when the voltage falls below the specified voltage setting. The undervoltage feature may also be used to block the functioning of other elements through the block feature of those elements

Source Transfer Schemes: In the event of an undervoltage, a transfer signal may be generated to transfer a load from its normal source to a standby or emergency power source.

a) UNDERVOLTAGE INVERSE TIME CHARACTERISTICS

The undervoltage elements can be programmed to have an inverse time delay characteristic. The undervoltage delay setting defines a family of curves as illustrated by the following equation and figure.

$$T = \frac{D}{\left(1 - \frac{V}{V_{pickup}}\right)}$$

where:

T = Operating Time
D = Undervoltage Delay Setting (0.00 gives instantaneous operate)
V = Secondary Voltage applied to the relay
V_{pickup} = Pickup Level

Note: At 0% of pickup the operating time equals the Undervoltage Delay Setting.

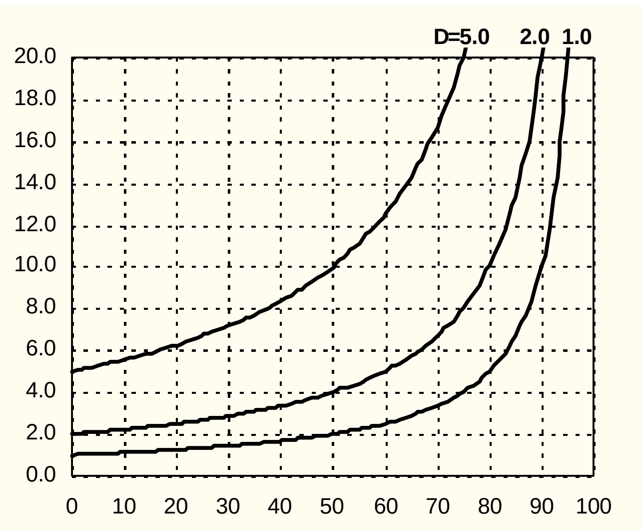


Figure 5–17: Inverse Time Undervoltage Curves

5

b) PHASE UV1 / PHASE UV2

PATH: S4 ELEMENTS ⇨⇩ VOLTAGE ELEMENTS ⇨ PHASE UNDERVOLTAGE1

	Display	Range
■ PHASE ■ UNDERVOLTAGE 1	PHASE UV1 FUNCTION: Disabled	*Range: Disabled, Enabled*
MESSAGE	PHASE UV1 PICKUP: 100.00 V	*Range: 0.00 To 250.00 in Steps of 0.01*
MESSAGE	PHASE UV1 CURVE: Definite Time	*Range: Definite Time, Inverse Time*
MESSAGE	PHASE UV1 DELAY: 1.00 s	*Range: 0.00 To 600.00 in Steps of 0.01*
MESSAGE	PHASE UV1 MINIMUM VOLTAGE: 10 V	*Range: 0 To 200 in Steps of 1*
MESSAGE	PHASE UV1 BLOCK NOP	*Range: Flexlogic^{TM} Operand*
MESSAGE	PHASE UV1 TARGET: Self-reset	*Range: Self-reset, Latched*
MESSAGE	PHASE UV1 EVENTS: Disabled	*Range: Disabled, Enabled*

The phase undervoltage element may be used to give a desired time-delay operating characteristic versus the applied fundamental voltage (phase to ground for wye VT connection or phase to phase for delta VT connection) or as a simple definite time element. The element resets instantaneously if the applied voltage exceeds the dropout voltage. The delay setting selects the minimum operating time of the phase undervoltage element. The minimum voltage setting selects the operating voltage below which the element is blocked (a setting of '0' will allow a dead source to be considered a fault condition).

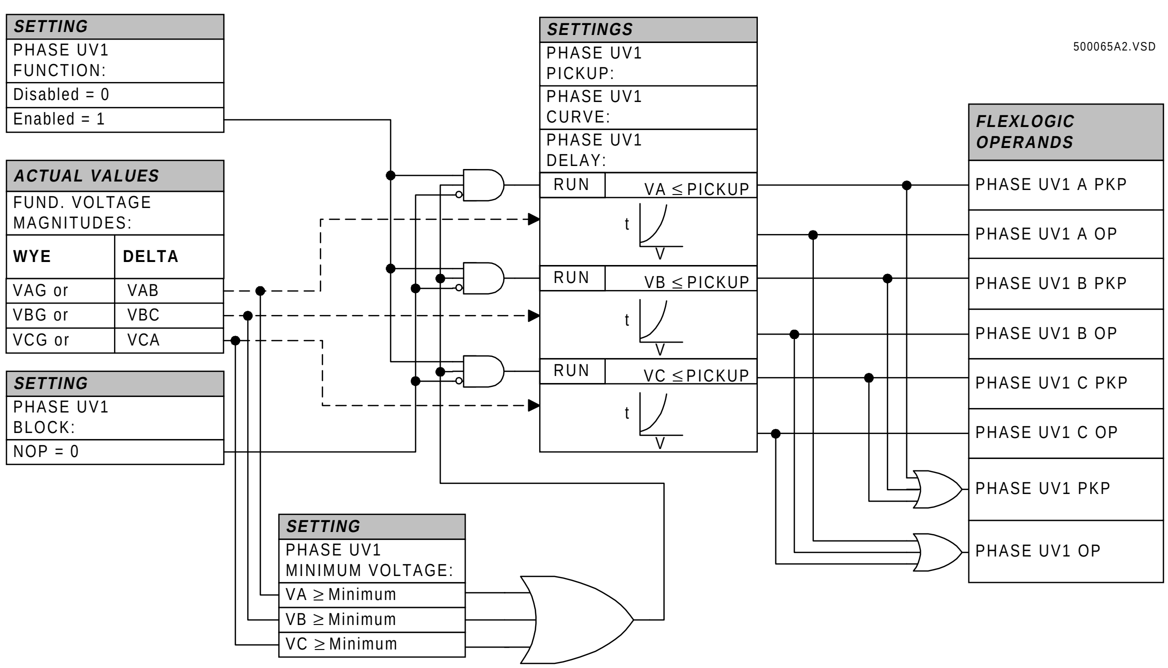


Figure 5–18: PHASE UV1 SCHEME LOGIC

5.8.1 OVERVIEW

The input and output configuration of the relay may be ordered to suit the application. Several different I/O module types may be ordered for 1 or more slot positions in the rack. The contact inputs and outputs will be assigned as shown in the tables below, designated by slot position and terminal position.

Table 5–16: I/O MODULE ASSIGNMENTS

~6A I/O MODULE	
Terminal Assignment	**Output or Input**
~1	Form-A
~2	Form-A
~3	Form-C
~4	Form-C
~5a, ~5c	2 Inputs
~6a, ~6c	2 Inputs
~7a, ~7c	2 Inputs
~8a, ~8c	2 Inputs

~6B I/O MODULE	
Terminal Assignment	**Output or Input**
~1	Form-A
~2	Form-A
~3	Form-C
~4	Form-C
~5	Form-C
~6	Form-C
~7a, ~7c	2 Inputs
~8a, ~8c	2 Inputs

~6C I/O MODULE	
Terminal Assignment	**Output or Input**
~1	Form-C
~2	Form-C
~3	Form-C
~4	Form-C
~5	Form-C
~6	Form-C
~7	Form-C
~8	Form-C

~6D I/O MODULE	
Terminal Assignment	**Output or Inputs**
~1a, ~1c	2 Inputs
~2a, ~2c	2 Inputs
~3a, ~3c	2 Inputs
~4a, ~4c	2 Inputs
~5a, ~5c	2 Inputs
~6a, ~6c	2 Inputs
~7a, ~7c	2 Inputs
~8a, ~8c	2 Inputs

~6E I/O MODULE	
Terminal Assignment	**Outputs or Inputs**
~1	Form-C
~2	Form-C
~3	Form-C
~4	Form-C
~5a, ~5c	2 Inputs
~6a, ~6c	2 Inputs
~7a, ~7c	2 Inputs
~8a, ~8c	2 Inputs

NOTE: substitute the slot position where a tilde "~" appears

5.8.2 CONTACT INPUTS MENU

PATH: S5 INPUTS/OUTPUTS ⇨ CONTACT INPUTS

```
■ CONTACT INPUTS          ◄►   ■ CONTACT INPUT
■                              ■ CONFIGURATIONS

                 MESSAGE  ▲    ■ CONTACT INPUT
                               ■ THRESHOLDS
```

The contact inputs menu consists of configuration settings for each individual contact input as well as voltage thresholds for each group of four contact inputs.

a) CONTACT INPUT CONFIGURATIONS

PATH: S5 INPUTS/OUTPUTS ⇨ CONTACT INPUTS ⇨ CONTACT INPUT CONFIGURATIONS ⇨ CONTACT INPUT H5a

```
■ CONTACT INPUT H5a       ◄►   CONTACT INPUT H5a          Range: Disabled, Enabled
■                              FUNCTION: Disabled

                 MESSAGE  ▲▼   CONTACT I/P H5a ID:        Range: 20 character alphanumeric
                               Contact Input H5a

                 MESSAGE  ▲▼   CONTACT INPUT H5a          Range: Open, Closed
                               'ON' STATE: Closed

                 MESSAGE  ▲    CONTACT INPUT H5a          Range: Disabled, Enabled
                               EVENTS: Disabled
```

The contact input function may be 'Enabled' or 'Disabled'. If disabled, the input state will be forced to 'OFF' (Logic 0) regardless of the state of the input. A twenty character alphanumeric ID may be assigned to a contact input which will be used for diagnostic purposes. The contact input 'ON' (or logic 1) state can be set to correspond to when the contact input is either 'Open' or 'Closed'. If contact input events are set to 'Enabled', every change in the contact input state will trigger an event.

Example: To use contact input H5a as a status input from the breaker 52b contact to seal-in the trip relay, program it as follows:

```
■ CONTACT INPUT H5a       ◄►   CONTACT INPUT H5a
■                              FUNCTION: Enabled

                 MESSAGE  ▲▼   CONTACT I/P H5a ID:
                               Breaker Closed (52b)

                 MESSAGE  ▲▼   CONTACT INPUT H5a
                               'ON' STATE: Open

                 MESSAGE  ▲    CONTACT INPUT H5a
                               EVENTS: Enabled
```

(NOTE: 52b is closed when the breaker is open and open when the breaker is closed)

5

b) CONTACT INPUT THRESHOLDS

PATH: S5 INPUTS/OUTPUTS ⇨ CONTACT INPUTS ⇨⇩ CONTACT INPUT THRESHOLDS

■ CONTACT INPUT ■ THRESHOLDS	◀▶	I/P H5a,H5c,H6a,H6c THRESHOLD: 30 Vdc	*Range: 16, 30, 80, 140 Vdc*
MESSAGE	▲	I/P H7a,H7c,H8a,H8c THRESHOLD: 30 Vdc	*Range: 16, 30, 80, 140 Vdc*

Contact inputs are isolated in groups of four to allow connection of wet contacts from different voltage sources. The contact input threshold determines the minimum voltage required to detect a closed contact input. This value should be selected to 16 for 24 volt sources, 30 for 48 volt sources, 80 for 110-125 volt sources and 140 for 250 volt sources.

5.8.3 VIRTUAL INPUTS 1 - 32

PATH: S5 INPUTS/OUTPUTS ⇨⇩ VIRTUAL INPUTS ⇨ VIRTUAL INPUT 1

■ VIRTUAL INPUT 1 ■	◀▶	VIRTUAL INPUT 1 FUNCTION: Disabled	*Range: Disabled, Enabled*
MESSAGE	▲▼	VIRTUAL INPUT 1 ID: VIRTUAL INPUT 1	*Range: 20 character alphanumeric*
MESSAGE	▲▼	VIRTUAL INPUT 1 TYPE: Normal	*Range: Normal, Self-reset*
MESSAGE	▲	VIRTUAL INPUT 1 EVENTS: Disabled	*Range: Disabled, Enabled*

There are 32 virtual inputs that may be controlled through the keypad (Commands) or communications ports. The virtual input function may be 'Enabled' or 'Disabled'. If disabled, the input will be forced to 'OFF' (Logic 0) regardless of any attempt to alter the input. A twenty character alphanumeric ID may be assigned to a virtual input which can be used for diagnostic purposes. The virtual input type may be programmed as 'Normal' or 'Self-reset'. If set to Normal, the virtual input follows the state as programmed 'On' or 'Off'. If set to Self-reset and the virtual input is turned 'On', after one pass through the evaluation of the FlexLogic™ equations, the input will be automatically set to 'Off'. If virtual input events are set to 'Enabled', every change in the virtual input state will trigger an event.

5.8.4 CONTACT OUTPUTS

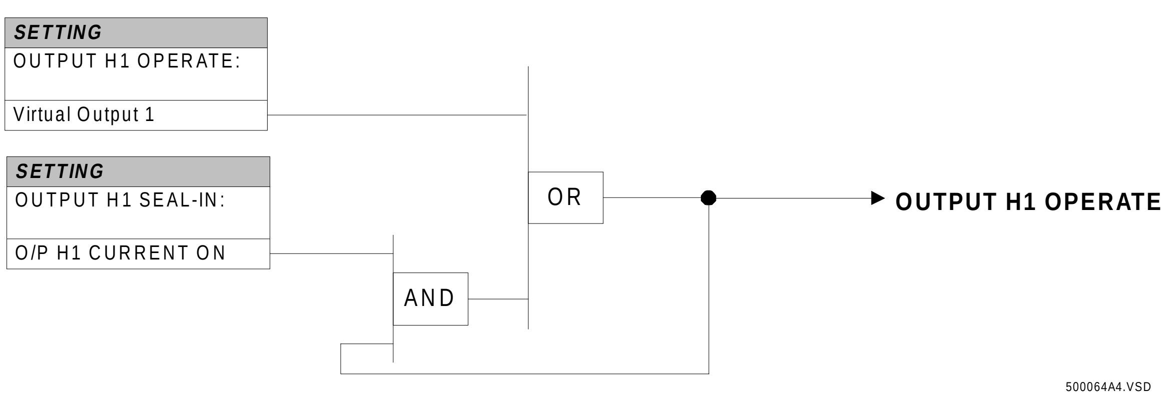
PATH: S5 INPUTS/OUTPUTS ⇨⇩ CONTACT OUTPUTS ⇨ CONTACT OUTPUT H1

■ CONTACT OUTPUT H1 ■	CONTACT OUTPUT H1 ID CONTACT OUTPUT	*Range: 16 character alphanumeric*
MESSAGE	CONTACT OUTPUT H1 TYPE: Trip	*Range: Trip, Alarm, Other*
MESSAGE	OUTPUT H1 OPERATE: Virtual Output 1	*Range: Flexlogic™ operand*
MESSAGE	OUTPUT H1 SEAL-IN: NO OPERATION	*Range: Flexlogic™ operand*
MESSAGE	CONTACT OUTPUT H1 EVENTS: Enabled	*Range: Disabled, Enabled*

An ID may be assigned to each contact output. If the CONTACT OUTPUT TYPE is selected as “Trip” or “Alarm” the appropriate LED indicator will activate when the contact output operates. If “Other” is selected as the CONTACT OUTPUT TYPE, the contact output will operate without activating any LEDs. The signal that can operate a contact output may be any FlexLogic™ operand (virtual output, element state, contact input, or virtual input). An additional FlexLogic™ operand may be used to seal-in the relay. Any change of state of a contact output can be logged as an event if programmed to do so.

Example: The trip circuit current is monitored by providing a current threshold detector in series with each Form-A contact. The monitor will set a flag at approximately 15-20 mA. The name of the Flex-Logic™ operand set by the monitor consists of the output relay designation, followed by the name of the flag; e.g. Output H1 Current On.

In most breaker control circuits, the trip coil is connected in series with a breaker auxiliary contact used to interrupt current flow after the breaker has tripped, to prevent damage to the less robust initiating contact. This can be done by monitoring an auxiliary contact on the breaker which opens when the breaker has tripped, but this scheme is subject to incorrect operation caused by differences in timing between breaker auxiliary contact change-of-state and interruption of current in the trip circuit. The most dependable protection of the initiating contact is provided by directly measuring current in the tripping circuit, and using this parameter to control resetting of the initiating relay. This scheme is often called "trip seal-in".



VIRTUAL OUTPUTS 1 - 64

PATH: S5 INPUTS/OUTPUTS ⇨⇩ CONTACT OUTPUTS ⇨ VIRTUAL OUTPUT 1

```
■ VIRTUAL OUTPUT 1        VIRTUAL OUTPUT 1 ID:     Range: 16 character alphanumeric
■                         Virtual Output 1

               MESSAGE    VIRTUAL OUTPUT 1         Range: Disabled, Enabled
                          EVENTS: Disabled
```

There are 64 virtual outputs that may be assigned in FlexLogic™. If not assigned, the output will be forced to 'OFF' (Logic 0). Virtual outputs are resolved each pass through the evaluation of the FlexLogic™ equations. An ID may be assigned to each virtual output. Any change of state of a virtual output can be logged as an event if programmed to do so.

Example: If Virtual Output 1 is the trip signal from FlexLogic™ and the trip relay is used to signal events, the settings would be programmed as follows:

```
■ VIRTUAL OUTPUT 1        VIRTUAL OUTPUT ID:
■                         TRIP

               MESSAGE    VIRTUAL OUTPUT 1
                          EVENTS: Disabled
```

PATH: S6 TESTING

The relay provides test settings to verify that the relay is functional using simulated conditions to test all contact inputs and outputs. While the relay is in TEST MODE, the feature being tested overrides normal functioning of the relay. During this time the TEST MODE LED will remain on. Once out of TEST MODE, the normal functioning of the relay will be restored.

5.9.1 FORCE CONTACT INPUTS

PATH: S6 TESTING ⇨ FORCE CONTACT INPUTS

■ FORCE CONTACT ■ INPUTS	◀▶	FORCE CONTACT INPUT H5a: Open	*Range: Disabled, Open, Closed*
MESSAGE	▲▼	FORCE CONTACT INPUT H5c: Open	*Range: Disabled, Open, Closed*
MESSAGE	▲▼	FORCE CONTACT INPUT H6a: Open	*Range: Disabled, Open, Closed*
MESSAGE	▲▼	FORCE CONTACT INPUT H6c: Open	*Range: Disabled, Open, Closed*
MESSAGE	▲▼	FORCE CONTACT INPUT H7a: Open	*Range: Disabled, Open, Closed*
MESSAGE	▲▼	FORCE CONTACT INPUT H7c: Open	*Range: Disabled, Open, Closed*
MESSAGE	▲▼	FORCE CONTACT INPUT H8a: Open	*Range: Disabled, Open, Closed*
MESSAGE	▲	FORCE CONTACT INPUT H8c: Open	*Range: Disabled, Open, Closed*

The Force Contact Inputs test feature of the relay provides a method of performing checks on the function of all contact inputs. Once enabled, the relay will be placed into Test Mode, allowing this feature to override the normal function of contact inputs. The TEST MODE LED will be ON indicating that the relay is in test mode. The state of each contact input may be programmed as “Open” or “Closed”. All contact input operations return to normal when all settings for this feature are disabled.

5.9.2 FORCE CONTACT OUTPUTS

PATH: S6 TESTING ⇨⇩ FORCE CONTACT OUTPUTS

■ FORCE CONTACT ■ OUTPUTS	◀▶	FORCE CONTACT OUTPUT H1: Disabled	*Range: Disabled, Energized, De-energized, Freeze*
MESSAGE	▲▼	FORCE CONTACT OUTPUT H2: Disabled	*Range: Disabled, Energized, De-energized, Freeze*
MESSAGE	▲▼	FORCE CONTACT OUTPUT H3: Disabled	*Range: Disabled, Energized, De-energized, Freeze*
MESSAGE	▲	FORCE CONTACT OUTPUT H4: Disabled	*Range: Disabled, Energized, De-energized, Freeze*

The Force Contact Output test feature of the relay, provides a method of performing checks on all contact outputs. Once enabled, the relay will be placed into a Test Mode, allowing this feature to override the normal function of contact outputs. The TEST MODE LED will be ON. The state of each contact output may be programmed as Disabled, Energized, De-energized or Freeze. The Freeze option maintains the output contact in the state at which it was frozen. All contact output operations return to normal when all the settings for this feature are disabled.

6.1.1 ACTUAL VALUES MAIN MENU

■■ A1 ACTUAL VALUES ■■ STATUS	■ CONTACT INPUTS ■
	■ VIRTUAL INPUTS ■
	■ CONTACT OUTPUTS ■
	■ VIRTUAL OUTPUTS ■
	■ CLOCK ■
■■ A2 ACTUAL VALUES ■■ METERING	■ CURRENT ■
	■ VOLTAGE ■
	■ POWER ■
	■ FREQUENCY ■
■■ A3 ACTUAL VALUES ■■ RECORDS	■ EVENT RECORD ■
■■ A4 ACTUAL VALUES ■■ PRODUCT INFO	■ MODEL INFORMATION ■

6.1.2 CONTACT INPUTS

PATH: A1 ACTUAL VALUES STATUS ⇨ CONTACT INPUTS

```
■ CONTACT INPUTS          ◀▶   CONTACT INPUT H5a
■                              STATUS: Off (Open)

                 MESSAGE  ▲▼   CONTACT INPUT H5c
                               STATUS: Off (Open)

                 MESSAGE  ▲▼   CONTACT INPUT H6a
                               STATUS: Off (Open)

                 MESSAGE  ▲▼   CONTACT INPUT H6c
                               STATUS: Off (Open)

                 MESSAGE  ▲▼   CONTACT INPUT H7a
                               STATUS: Off (Open)

                 MESSAGE  ▲▼   CONTACT INPUT H7c
                               STATUS: Off (Open)

                 MESSAGE  ▲▼   CONTACT INPUT H8a
                               STATUS: Off (Open)

                 MESSAGE  ▲    CONTACT INPUT H8c
                               STATUS: Off (Open)
```

The status of the contact inputs will be displayed here. The example shown is for a ‘6A I/O Module’.

The first line of the display will indicate the ID of the contact input.

e.g. H5a refers to the contact input located at slot H, terminal 5a.

The second line of the display will indicate the status of the contact input. Both the logical state as well as the physical state will be indicated.

e.g. Off (Open) indicates logical state Off and physical state Open.

If the setting for the contact input ‘On’ state is programmed as ‘Closed’ the status will be ‘Off’ (0) (Open) or ‘On’ (1) (Closed). Conversely, if the setting for the contact input ‘On’ state is programmed as ‘Open’ the status will be ‘Off’ (0) (Closed) or ‘On’ (1) (Open).

Table 6–1: Programmed ‘On’ State

PROGRAMMED ‘On’ STATE	LOGICAL STATE	PHYSICAL STATE
Open	On (1)	Open
	Off (0)	Closed
Closed	On (1)	Closed
	Off (0)	Open

6

6.1.3 VIRTUAL INPUTS

PATH: A1 ACTUAL VALUES STATUS ⇨⇩ VIRTUAL INPUTS

```
■ VIRTUAL INPUTS          VIRTUAL INPUT 1
■                         STATUS: Off

              MESSAGE     VIRTUAL INPUT 2
                          STATUS: Off

              MESSAGE     VIRTUAL INPUT 3
                          STATUS: Off

              MESSAGE     VIRTUAL INPUT 4
                          STATUS: Off
                                :
                                :
              MESSAGE     VIRTUAL INPUT 31
                          STATUS: Off

              MESSAGE     VIRTUAL INPUT 32
                          STATUS: Off
```

The status of the 32 virtual inputs will be displayed here. The first line of the display will indicate the ID of the virtual input as programmed. The second line of the display indicates the status of the virtual input. This will show the logical state ‘Off’ (0) or ‘On’ (1).

6.1.4 CONTACT OUTPUTS

PATH: A1 ACTUAL VALUES STATUS ⇨⇩ CONTACT OUTPUTS

```
■ CONTACT OUPUTS          CONTACT OUTPUT H1
■                         STATUS: Off

              MESSAGE     CONTACT OUTPUT H2
                          STATUS: Off

              MESSAGE     CONTACT OUTPUT H3
                          STATUS: Off

              MESSAGE     CONTACT OUTPUT H4
                          STATUS: Off
```

The status of the contact outputs will be displayed here. The example shown is for a ‘6A I/O Module’.

The first line of the display will indicate the ID of the contact output.

e.g. H1 refers to the contact output located at slot H, terminal row 1.

The second line of the display will indicate the status of the contact output.

This will show the logical state:’Off’ (0)physical state not operated

‘On’ (1) physical state operated

6

6.1.5 VIRTUAL OUTPUTS

PATH: A1 ACTUAL VALUES STATUS ⇨⇩ VIRTUAL OUTPUTS

```
■ VIRTUAL OUTPUTS          VIRTUAL OUTPUT 1
■                          STATUS: Off

                 MESSAGE   VIRTUAL OUTPUT 2
                           STATUS: Off

                 MESSAGE   VIRTUAL OUTPUT 3
                           STATUS: Off

                           VIRTUAL OUTPUT 4
                           STATUS: Off
                                  :
                                  :
                 MESSAGE   VIRTUAL OUTPUT 63
                           STATUS: Off

                 MESSAGE   VIRTUAL OUTPUT 64
                           STATUS: Off
```

The status of all virtual outputs that can be assigned in the FlexLogic™ equations will be displayed here. The first line of the display will indicate the ID number of the virtual output. The second line will display the status of the virtual output. The status will show the logical state ‘Off’ (0) or ‘On’ (1) as calculated by the FlexLogic™ equation for that output.

6.1.6 CLOCK

6

PATH: A1 ACTUAL VALUES STATUS ⇨⇩CLOCK

```
■ CLOCK                    Thu Apr 30 1998
■                          10:26:14
```

The current date and time is displayed here. The time is displayed using the 24 hour clock. If the date or time has never been programmed, the message will display “Unavailable”.

6.2.1 CURRENT

PATH: A2 ACTUAL VALUES METERING ⇨⇩ CURRENT

```
■ CURRENT                    AVERAGE RMS PHASE
■                            CURRENT:      0 A

MESSAGE                      IA:     0  IB:    0
                             IC:     0  A rms

MESSAGE                      IN CALCULATED:
                                    0 A rms

MESSAGE                      IA FUNDAMENTAL:
                                 0 A at 0.0°

MESSAGE                      IB FUNDAMENTAL:
                                 0 A at -120.0°

MESSAGE                      IC FUNDAMENTAL:
                                 0 A at -240.0°

MESSAGE                      IN FUNDAMENTAL:
                                 0 A at    0.0°

MESSAGE                      IG MEASURED:
                                 0 A rms

MESSAGE                      IG FUNDAMENTAL:
                                 0 A at    0.0°
```

Primary current values measured are displayed here in both total waveform RMS and fundamental phasor RMS form. All angles are shown as negative (lagging) with respect to the reference phasor. The reference phasor is based on the VT CONNECTION TYPE setting. In the event the voltage into the VA channel is 0 volts, then the voltage into the VB channel is used as reference. In the event the voltage into the VA and VB channels are both 0 volts, then the voltage into the VC channel is used as reference. If the voltage into the VA, VB, and VC channels are all 0 volts, IA will be used as the reference phasor (followed by IB, then IC)

Table 6–2: Reference Phasor

Reference Phasor	VT Connection Type
IA	None
VAG	Wye
VAB	Delta (ABC rotation)
VAC	Delta (ACB rotation)

IN is the 3Io current calculated by the relay from the three phase inputs and IG is the measured current from the ground input channel. The displayed current magnitudes will auto-range based on the CT primary setting for a given input based on the table below. (IA, IB, IC, IN per the phase CT primary setting and IG per the ground CT primary setting). A second table shows the ranges for the sensitive ground input if a sensitive ground CT/VT module is ordered.

Table 6–3: CURRENT RANGES

CT Primary Setting	Display Range
1 A	0.000 - 99.999 A
2-19 A	0.00 - 999.99 A
20 -199A	0.0 - 9999.9 A
200 - 1999 A	0 - 99999 A
2000 - 19999 A	0.00 - 999.99 kA
20000 - 50000	0.0 - 9999.9 kA

Table 6–4: CURRENT RANGES - SENSITIVE GROUND

Sensitive Ground CT Primary Setting	Display Range
1 -19 A	0.00 - 99.999 A
20 -199 A	0.0 - 999.99 A
200 - 1999 A	0 - 9999.9 A
2000 - 19999 A	0.00 - 99999 A
20000 - 50000 A	0.0 - 999.99 kA

6.2.2 VOLTAGE

PATH: A2 ACTUAL VALUES METERING ⇨⇩VOLTAGE

■ VOLTAGE ■	◁▷	AVERAGE RMS PHASE VOLTAGE: 0 V	*displayed if VT Connection Type is set to 'Wye'*
MESSAGE	△▽	VA: 0 VB: 0 VC: 0 V RMS ϕ-G	*displayed if VT Connection Type is set to 'Wye'*
MESSAGE	△▽	VAG FUNDAMENTAL: 0 V at 0.0°	*displayed if VT Connection Type is set to 'Wye'*
MESSAGE	△▽	VBG FUNDAMENTAL: 0 V at 0.0°	*displayed if VT Connection Type is set to 'Wye'*
MESSAGE	△▽	VCG FUNDAMENTAL: 0 V at 0.0°	*displayed if VT Connection Type is set to 'Wye'*
MESSAGE	△▽	AVERAGE RMS LINE VOLTAGE: 0 V	*not displayed if VT Connection Type is set to 'None'*
MESSAGE	△▽	VAB: 0 VBC: 0 VCA: 0 V RMS ϕ-ϕ	*not displayed if VT Connection Type is set to 'None'*
MESSAGE	△▽	VAB FUNDAMENTAL: 0 V at 0.00°	*not displayed if VT Connection Type is set to 'None'*
MESSAGE	△▽	VBC FUNDAMENTAL: 0 V at 0.00°	*not displayed if VT Connection Type is set to 'None'*
MESSAGE	△	VCA FUNDAMENTAL: 0 V at 0.00°	*not displayed if VT Connection Type is set to 'None'*

Primary voltage values measured are displayed here in both total waveform RMS and fundamental phasor RMS form. All angles are shown as negative (lagging) with respect to the reference phasor. The reference phasor is based on the VT CONNECTION TYPE setting. In the event the voltage into the VA channel is 0 volts, then the voltage into the VB channel is used as reference. In the event the voltage into the VA and VB channels are both 0 volts, then the voltage into the VC channel is used as reference. If the voltage into the VA, VB, and VC channels are all 0 volts, IA will be used as the reference phasor (followed by IB, then IC).

6

Table 6–5: Reference Phasor

Reference Phasor	VT Connection Type
IA	None
VAG	Wye
VAB	Delta (ABC rotation)
VAC	Delta (ACB rotation)

The displayed phase to phase voltage is dependent upon rotation. The following table indicates the actual phase to phase voltage measured for each displayed voltage and rotation.

Table 6–6: PHASE TO PHASE VOLTAGE

Displayed Voltage	ABC Rotation	ACB Rotation
VA	VAB	VAC
VB	VBC	VBA
VVC	VCA	VCB

The displayed voltage magnitudes will auto-range based on the VT Ratio setting based on the table below.

Table 6–7: AUTO-RANGE DISPLAYED VOLTAGE MAGNETUDES

VT Ratio Setting			Display Setting		
0.1:1	-	1.9:1	0.00	-	999.99 V
2.0:1	-	19.9:1	0.0	-	9999.9 V
20.0:1	-	199.9:1	0	-	99999 V
200.0:1	-	1999.9:1	0.00	-	999.99 kV
2000.0:1	-	24000.0:1	0.0	-	9999.9 kV

6

If VT Connection Type is programmed as ‘None’ the following flash message will appear when an attempt is made to enter this group of messages.

```
THIS FEATURE NOT
PROGRAMMED
```

6.2.3 POWER

PATH: A2 ACTUAL VALUES METERING ⇨⇩POWER

■ 3 PHASE POWER ■ QUANTITIES	◁▷	REAL POWER 3φ: 0 W	*not displayed if VT Connection Type is set to 'None'*
MESSAGE	△▽	REACTIVE POWER 3φ: 0 var	*not displayed if VT Connection Type is set to 'None'*
MESSAGE	△▽	APPARENT POWER 3φ: 0 VA	*not displayed if VT Connection Type is set to 'None'*
MESSAGE	△▽	TRUE PF 3φ: 1.000	*not displayed if VT Connection Type is set to 'None'*
■ PHASE A POWER ■ QUANTITIES	◁▷	REAL POWER φA: 0 W	*displayed if VT Connection Type is set to 'Wye'*
MESSAGE	△▽	REACTIVE POWER φA: 0 var	*displayed if VT Connection Type is set to 'Wye'*
MESSAGE	△▽	APPARENT POWER φA: 0 VA	*displayed if VT Connection Type is set to 'Wye'*
MESSAGE	△▽	TRUE PF φA: 1.000	*displayed if VT Connection Type is set to 'Wye'*
■ PHASE B POWER ■ QUANTITIES	◁▷	REAL POWER φB: 0 W	*displayed if VT Connection Type is set to 'Wye'*
MESSAGE	△▽	REACTIVE POWER φB: 0 var	*displayed if VT Connection Type is set to 'Wye'*
MESSAGE	△▽	APPARENT POWER φB: 0 VA	*displayed if VT Connection Type is set to 'Wye'*
MESSAGE	△▽	TRUE PF φB: 1.000 lag	*displayed if VT Connection Type is set to 'Wye'*
■ PHASE C POWER ■ QUANTITIES	◁▷	REAL POWER φC: 0 W	*displayed if VT Connection Type is set to 'Wye'*
MESSAGE	△▽	REACTIVE POWER φC: 0 var	*displayed if VT Connection Type is set to 'Wye'*
MESSAGE	△▽	APPARENT POWER φC: 0 VA	*displayed if VT Connection Type is set to 'Wye'*
MESSAGE	△▽	TRUE PF φC: 1.000 lag	*displayed if VT Connection Type is set to 'Wye'*

A true power factor of 1.000 will be displayed when current and/or voltage levels are below the minimum measurable levels. Primary total waveform RMS power quantities calculated are displayed here. Signed values for watts and vars indicate direction of flow as illustrated in the following diagrams.

6

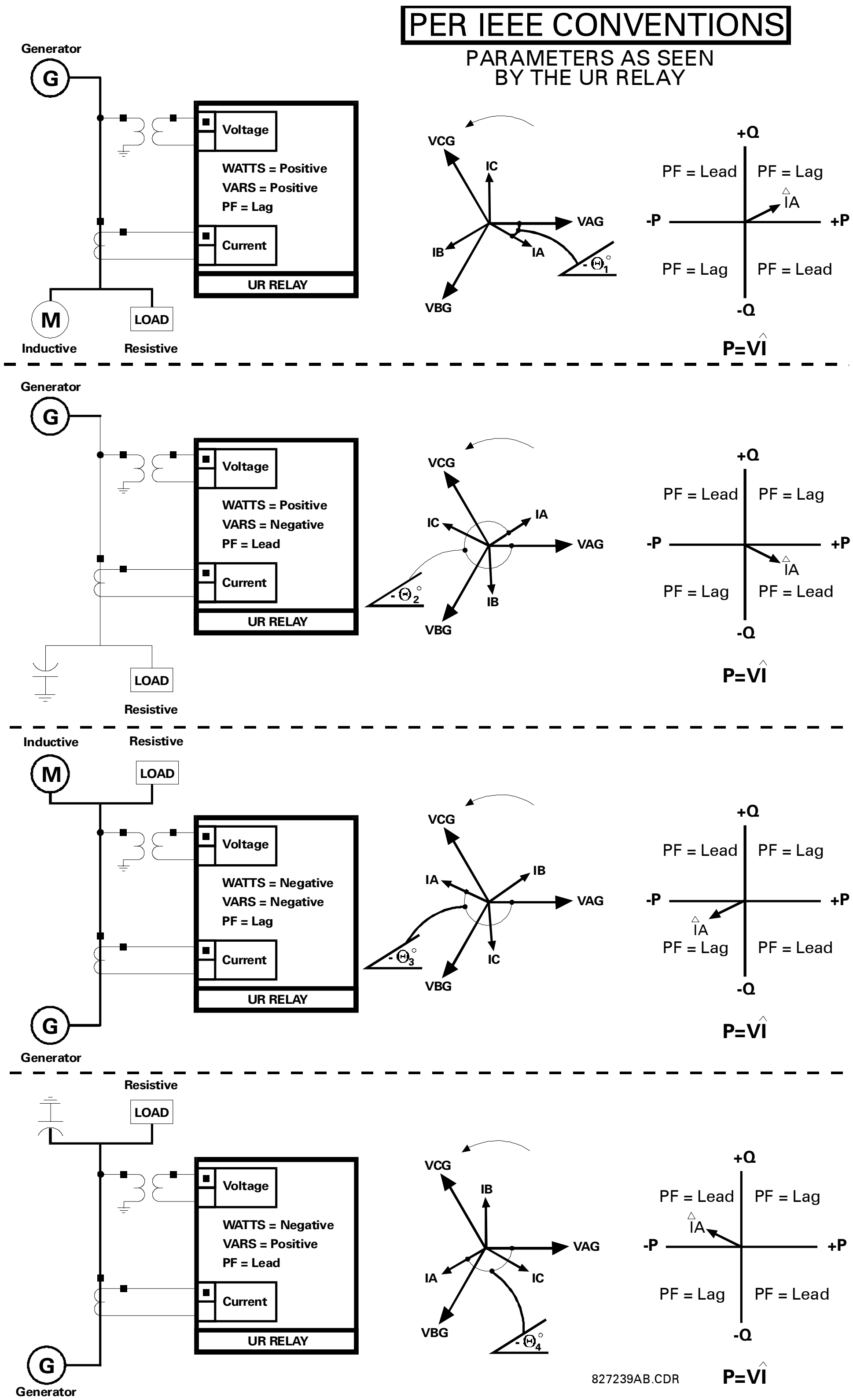


Figure 6–1: FLOW DIRECTION OF SIGNED VALUES FOR WATTS AND VARS

Power quantities are shown for real (or active power in W), reactive power (var), apparent power (VA), and true power factor (or total power factor). True power factor is defined as real power divided by apparent power (RMS). Real power, reactive power and apparent power are all displayed in RMS only. The displayed power quantity magnitudes will auto-range based on the Phase CT Primary, VT Ratio, and Nominal VT Secondary Voltage settings based on the table below.

Table 6–8: DISPLAY POWER QUANTITY MAGNITUDES

Pn= Phase CT Primary x VT Ratio x Nom VT Sec Voltage	Display Range
Pn < 500 kVA	-99999.99 to +99999.99 kW, kvar, kVA
500 kVA ≤ Pn < 5 MVA	-999999.9 to +999999.9 kW, kvar, kVA
5 MVA ≤ Pn < 50 MVA	-9999.999 to +9999.999 MW, Mvar, MVA
50 MVA ≤ Pn	-21474.83 to +21474.83 MW, Mvar, MVA

If VT Connection Type is programmed as ‘None’ the following flash message will appear when an attempt is made to enter any of the power quantities groups of messages.

```
THIS FEATURE NOT
PROGRAMMED
```

If VT Connection Type is programmed as ‘Delta’ the following flash message will appear when an attempt is made to enter any of the individual phase power quantities groups of messages.

```
THIS FEATURE NOT
PROGRAMMED
```

6

6.2.4 FREQUENCY

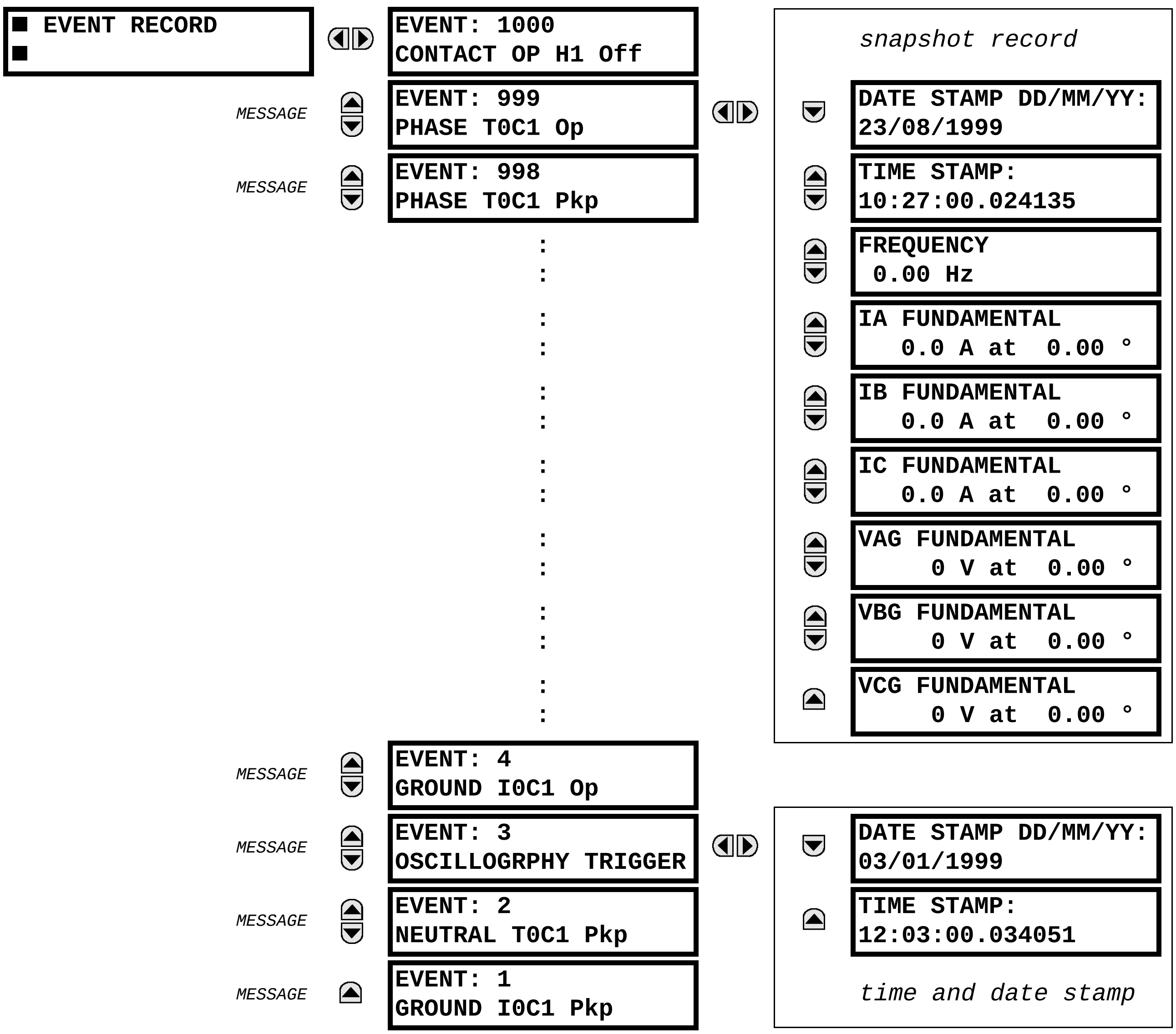
PATH: A2 ACTUAL VALUES METERING ⇨⇩ FREQUENCY

```
■ FREQUENCY            FREQUENCY
■                      0.00 Hz
```

Frequency is displayed here. Frequency is measured from the VAG input for ‘Wye’, the VA input for ‘Delta’ or the IA input if voltages are not available.

6.3.1 EVENT RECORDER

PATH: A3 ACTUAL VALUES RECORDS ⇨⇩ EVENT RECORD



The event record refers to the contextual data associated with the last 1024 events, listed in chronological order from most recent to oldest. If all 1024 event records have been filled, the oldest event will be removed as a new event is added.

All events will have the event identifier number, cause, time and date stamp associated with the event trigger. In addition, a snapshot record is always recorded for trips and self-test errors. It can also be enabled for element pickup/dropout as well as contact input, virtual input, alarm output, other output and/or virtual output state changes. The last 256 events of these types may have a 'snapshot record'. This record contains frequency, current and voltage information at the time of the event. Voltage quantities will be phase to ground for Wye connection and phase to phase for Delta connections.

6.4.1 MODEL INFORMATION

PATH: A4 ACTUAL VALUES PRODUCT INFO ⇨⇩ MODEL INFORMATION

■ MODEL INFORMATION ■	ORDER CODE LINE 1: F30-A00-HCH-F8A-H6A	
MESSAGE	ORDER CODE LINE 2:	*only shown if order code longer than one line*
MESSAGE	ORDER CODE LINE 3:	*only shown if order code longer than two lines*
MESSAGE	ORDER CODE LINE 4:	*only shown if order code longer than three lines*
MESSAGE	SERIAL NUMBER: MAGB98001211	
MESSAGE	MANUFACTURING DATE: 22/05/1998	
MESSAGE	MODIFICATION FILE NUMBER: 000	
MESSAGE	F30 FEEDER RELAY REVISION: 0.01	
MESSAGE	ETHERNET MAC ADDRESS 00-00-00-00-00-00	

The product's order code, serial number, date of manufacture and modification file number are displayed here. A modification number of 000 indicates that there are no modifications.

6

7.1.1 COMMANDS MAIN MENU

```
            COMMANDS

MESSAGE     ■ CLEAR EVENT
            ■ RECORDS

MESSAGE     ■ LAMPTEST
            ■

MESSAGE     ■ SET VIRTUAL
            ■ INPUTS
```

7.1.2 CLEAR EVENT RECORDS

PATH: COMMANDS ⇩ MODEL INFORMATION

```
■ CLEAR RECORDS          CLEAR EVENT RECORDS:
■                        No
```

By changing the command to ‘Yes’ and entering, all event records will be cleared and the following flash message will appear:

```
COMMAND
EXECUTED
```

This command setting will then automatically revert to ‘No’.

7.1.3 LAMPTEST

PATH: COMMANDS ⇩LAMPTEST

```
■ LAMPTEST               LAMPTEST:   No
■
```

By changing the command to ‘Yes’ and entering, all LEDs and display pixels will be turned on for the programmed ‘FLASH MESSAGE TIME’. This command setting will then automatically revert to ‘No’.

7.1.4 SET VIRTUAL INPUTS

PATH: COMMANDS ⇩ VIRTUAL INPUTS

■ VIRTUAL INPUTS ■		VIRTUAL INPUT 1 Off
	MESSAGE	VIRTUAL INPUT 2 Off
	MESSAGE	VIRTUAL INPUT 3 Off
		: :
	MESSAGE	VIRTUAL INPUT 31 Off
	MESSAGE	VIRTUAL INPUT 32 Off

The state of the 32 virtual inputs may be changed here. The first line of the display indicates the ID of the virtual input. The second line indicates the current status of the virtual inputs. This status will be a logical state 'Off' (0) or 'On' (1).

After changing the logical state of a virtual input the following flash message will appear:

```
COMMAND
EXECUTED
```

7

7.2.1 TARGETS

```
TARGETS
```

MESSAGE	◄►	PHASE TOC1: OP: A B -	*Displayed only if targets for this element active*
MESSAGE	▲▼	GROUND TOC1: PKP:	*Displayed only if targets for this element active*
MESSAGE	▲	PHASE IOC 2: LATCHED: - B -	*Displayed only if targets for this element active*

The status of any active targets will be displayed here. If no targets are active it will display:

```
NO ACTIVE
TARGETS
```

When there are no targets active, the first target to become active will cause the display to immediately default to that message. If there are active targets and the user is navigating through other messages, when the default message timer times out (i.e. the keypad has not been used for a determined period of time) the display will again default back to the target messages.

The range of variables for the target messages is described below. Phase information will be included if applicable. If a target messages status changes the status with the highest priority will be displayed.

Table 7–1: TARGET MESSAGE PRIORITY STATUS

Priority	Active Status	Description
1	OP	element operated and still picked up
2	PKP	element picked up and timing out
3	LATCHED	element had operated but has dropped out

7

If a self test error is detected, a message will appear indicating the cause of the error.

For example:

```
RELAY NOT PROGRAMMED
:SELF TEST ERROR
```

7.2.2 RELAY SELF-TESTS

The relay performs a number of diagnostic checks on itself to ensure its integrity. Self-test errors shown in the table below will de-energize the critical fail relay on the power supply module and all other output relays, generate a target message and event, extinguishing the faceplate IN SERVICE indicator and turn the TROUBLE indicator on.

Table 7–2: SELF TEST ERROR MESSAGES

SELF-TEST ERROR	SELF-RESET TARGET MESSAGE	DESCRIPTION OF PROBLEM	WHAT TO DO
RELAY NOT PROGRAMMED	Yes	S1 Product Setup\Installation setting indicating relay programmed not set.	Program all settings (especially the one under S1 Product Setup\Installation).
EQUIPMENT MISMATCH	Yes	Configuration of modules does not match the order code stored in the CPU.	Check all module types against the order code, make sure they are inserted properly, cycle control power (if problem persists, contact factory).
UNIT NOT CALIBRATED	Yes	Settings indicate the unit is not calibrated.	Contact the factory.
FLEXLOGIC ERR TOKEN	Yes	Flexlogic equations do not compile properly.	Finish all equation editing and use self test to debug any errors.
EEPROM CORRUPTED	No	The non-volatile memory has been corrupted.	Contact the factory.
• A/D RESET FAILURE • A/D INT. MISSING • A/D VOLT REF. FAIL • NO DSP INTERRUPTS • DSP CHECKSUM FAILED	No	CT/VT module with digital signal processor may have a problem.	Cycle control power (if the problem recurs contact the factory).

7

The following tables are provided to keep a record of settings to be used on a relay.

8.1.1 S1 SETTINGS - PRODUCT SETUP

PASSWORD SECURITY	
Access Level	
Command Password	
Setting Password	
Encrypted Command Password	
Encrypted Setting Password	

DISPLAY PROPERTIES	
Flash Message Time	
Default Message Timeout	
Default Message Intensity	
Screen Saver Feature	
Screen Saver Wait Time	

COMMUNICATIONS	
Modbus Slave Address	
RS485 Com1 Baud Rate	
RS485 Com1 Parity	
RS485 Com2 Baud Rate	
RS485 Com2 Parity	
Ethernet IP Address	
Gateway IP Address	
Network Address (NSAP)	
Target Name	

REAL TIME CLOCK	
Date	
Time	
IRIG-B Signal Type	

OSCILLOGRAPHY	
Number of Records	
Trigger Mode	
Trigger Position	
Trigger Source	
Digital Channel 1	
Digital Channel 2	
Digital Channel 3	
Digital Channel 4	
Digital Channel 5	
Digital Channel 6	
Digital Channel 7	
Digital Channel 8	
Digital Channel 9	
Digital Channel 10	
Digital Channel 11	
Digital Channel 12	
Digital Channel 13	
Digital Channel 14	
Digital Channel 15	
Digital Channel 16	
Digital Channel 17	
Digital Channel 18	
Digital Channel 19	
Digital Channel 20	
Digital Channel 21	
Digital Channel 22	
Digital Channel 23	
Digital Channel 24	
Digital Channel 25	
Digital Channel 26	
Digital Channel 27	
Digital Channel 28	
Digital Channel 29	
Digital Channel 30	
Digital Channel 31	
Digital Channel 32	

MESSAGE SCRATCHPAD
TEXT 1
TEXT 2
TEXT 3
TEXT 4
TEXT 5

INSTALLATION	
Relay Settings	
Site Name	
Relay Identifier	

8.2.1 S2 SETTINGS - SYSTEM SETUP

CURRENT SENSING	
Phase CT Primary	
Phase CT secondary	
Ground CT Primary	
Ground CT Secondary	

VOLTAGE SENSING	
VT Connection Type	
Nom VT Sec Voltage	
VT Ratio	

POWER SYSTEM	
Nominal Frequency	
Phase Rotation	

Table 8–1: FLEXCURVE A

Reset	Time (ms)	Reset	Time (ms)	Operate	Time (ms)	Operate	Time (ms)	Operate	Time (ms)	Operate	Time (ms)
0.00		0.68		1.03		2.9		4.9		10.5	
0.05		0.70		1.05		3.0		5.0		11.0	
0.10		0.72		1.1		3.1		5.1		11.5	
0.15		0.74		1.2		3.2		5.2		12.0	
0.20		0.76		1.3		3.3		5.3		12.5	
0.25		0.78		1.4		3.4		5.4		13.0	
0.30		0.80		1.5		3.5		5.5		13.5	
0.35		0.82		1.6		3.6		5.6		14.0	
0.40		0.84		1.7		3.7		5.7		14.5	
0.45		0.86		1.8		3.8		5.8		15.0	
0.48		0.88		1.9		3.9		5.9		15.5	
0.50		0.90		2.0		4.0		6.0		16.0	
0.52		0.91		2.1		4.1		6.5		16.5	
0.54		0.92		2.2		4.2		7.0		17.0	
0.56		0.93		2.3		4.3		7.5		17.5	
0.58		0.94		2.4		4.4		8.0		18.0	
0.60		0.95		2.5		4.5		8.5		18.5	
0.62		0.96		2.6		4.6		9.0		19.0	
0.64		0.97		2.7		4.7		9.5		19.5	
0.66		0.98		2.8		4.8		10.0		20.0	

Table 8–2: FLEXCURVE B

Reset	Time (ms)	Reset	Time (ms)	Operate	Time (ms)	Operate	Time (ms)	Operate	Time (ms)	Operate	Time (ms)
0.00		0.68		1.03		2.9		4.9		10.5	
0.05		0.70		1.05		3.0		5.0		11.0	
0.10		0.72		1.1		3.1		5.1		11.5	
0.15		0.74		1.2		3.2		5.2		12.0	
0.20		0.76		1.3		3.3		5.3		12.5	
0.25		0.78		1.4		3.4		5.4		13.0	
0.30		0.80		1.5		3.5		5.5		13.5	
0.35		0.82		1.6		3.6		5.6		14.0	
0.40		0.84		1.7		3.7		5.7		14.5	
0.45		0.86		1.8		3.8		5.8		15.0	
0.48		0.88		1.9		3.9		5.9		15.5	
0.50		0.90		2.0		4.0		6.0		16.0	
0.52		0.91		2.1		4.1		6.5		16.5	
0.54		0.92		2.2		4.2		7.0		17.0	
0.56		0.93		2.3		4.3		7.5		17.5	
0.58		0.94		2.4		4.4		8.0		18.0	
0.60		0.95		2.5		4.5		8.5		18.5	
0.62		0.96		2.6		4.6		9.0		19.0	
0.64		0.97		2.7		4.7		9.5		19.5	
0.66		0.98		2.8		4.8		10.0		20.0	

8.3.1 S3 SETTINGS - FLEXLOGIC™

FLEXLOGIC™ EQUATION EDITOR	
FlexLogic Entry 1	
FlexLogic Entry 2	
FlexLogic Entry 3	
FlexLogic Entry 4	
FlexLogic Entry 5	
FlexLogic Entry 6	
FlexLogic Entry 7	
FlexLogic Entry 8	
FlexLogic Entry 9	
FlexLogic Entry 10	
FlexLogic Entry 11	
FlexLogic Entry 12	
FlexLogic Entry 13	
FlexLogic Entry 14	
FlexLogic Entry 15	

FLEXLOGIC™ TIMER 1	
Timer 1 Type	
Timer 1 Pickup	
Timer 1 Dropout Delay	

FLEXLOGIC™ TIMER 2	
Timer 2 Type	
Timer 2 Pickup	
Timer 2 Dropout Delay	

FLEXLOGIC™ TIMER 3	
Timer 3 Type	
Timer 3 Pickup	
Timer 3 Dropout Delay	

FLEXLOGIC™ TIMER 4	
Timer 4 Type	
Timer 4 Pickup	
Timer 4 Dropout Delay	

FLEXLOGIC™ TIMER 5	
Timer 5 Type	
Timer 5 Pickup	
Timer 5 Dropout Delay	

FLEXLOGIC™ TIMER 6	
Timer 6 Type	
Timer 6 Pickup	
Timer 6 Dropout Delay	

FLEXLOGIC™ TIMER 7	
Timer 7 Type	
Timer 7 Pickup	
Timer 7 Dropout Delay	

FLEXLOGIC™ TIMER 8	
Timer 8 Type	
Timer 8 Pickup	
Timer 8 Dropout Delay	

FLEXLOGIC™ TIMER 9	
Timer 9 Type	
Timer 9 Pickup	
Timer 9 Dropout Delay	

FLEXLOGIC™ TIMER 10	
Timer 10 Type	
Timer 10 Pickup	
Timer 10 Dropout Delay	

FLEXLOGIC™ TIMER 11	
Timer 11 Type	
Timer 11 Pickup	
Timer 11 Dropout Delay	

FLEXLOGIC™ TIMER 12	
Timer 12 Type	
Timer 12 Pickup	
Timer 12 Dropout Delay	

FLEXLOGIC™ TIMER 13	
Timer 13 Type	
Timer 13 Pickup	
Timer 13 Dropout Delay	

FLEXLOGIC™ TIMER 14	
Timer 14 Type	
Timer 14 Pickup	
Timer 14 Dropout Delay	

FLEXLOGIC™ TIMER 15	
Timer 15 Type	
Timer 15 Pickup	
Timer 15 Dropout Delay	

FLEXLOGIC™ TIMER 16	
Timer 16 Type	
Timer 16 Pickup	
Timer 16 Dropout Delay	

FLEXLOGIC™ TIMER 17	
Timer 17 Type	
Timer 17 Pickup	
Timer 17 Dropout Delay	

FLEXLOGIC™ TIMER 18	
Timer 18 Type	
Timer 18 Pickup	
Timer 18 Dropout Delay	

FLEXLOGIC™ TIMER 19	
Timer 19 Type	
Timer 19 Pickup	
Timer 19 Dropout Delay	

FLEXLOGIC™ TIMER 20	
Timer 20 Type	
Timer 20 Pickup	
Timer 20 Dropout Delay	

FLEXLOGIC™ TIMER 21	
Timer 21 Type	
Timer 21 Pickup	
Timer 21 Dropout Delay	

FLEXLOGIC™ TIMER 22	
Timer 22 Type	
Timer 22 Pickup	
Timer 22 Dropout Delay	

FLEXLOGIC™ TIMER 23	
Timer 23 Type	
Timer 23 Pickup	
Timer 23 Dropout Delay	

FLEXLOGIC™ TIMER 24	
Timer 24 Type	
Timer 24 Pickup	
Timer 24 Dropout Delay	

FLEXLOGIC™ TIMER 25	
Timer 25 Type	
Timer 25 Pickup	
Timer 25 Dropout Delay	

FLEXLOGIC™ TIMER 26	
Timer 26 Type	
Timer 26 Pickup	
Timer 26 Dropout Delay	

FLEXLOGIC™ TIMER 27	
Timer 27 Type	
Timer 27 Pickup	
Timer 27 Dropout Delay	

FLEXLOGIC™ TIMER 28	
Timer 28 Type	
Timer 28 Pickup	
Timer 28 Dropout Delay	

FLEXLOGIC™ TIMER 29	
Timer 29 Type	
Timer 29 Pickup	
Timer 29 Dropout Delay	

FLEXLOGIC™ TIMER 30	
Timer 30 Type	
Timer 30 Pickup	
Timer 30 Dropout Delay	

FLEXLOGIC™ TIMER 31	
Timer 31 Type	
Timer 31 Pickup	
Timer 31 Dropout Delay	

FLEXLOGIC™ TIMER 32	
Timer 32 Type	
Timer 32 Pickup	
Timer 32 Dropout Delay	

8.4.1 S4 SETTINGS - ELEMENTS

a) CURRENT ELEMENTS

PHASE TOC1	
Phase TOC1 Function	
Phase TOC1 Input	
Phase TOC1 Pickup	
Phase TOC1 Curve	
Phase TOC1 TD Multiplier	
Phase TOC1 Reset	
Phase TOC1 BLK	
Phase TOC1 Target	
Phase TOC1 Events	

PHASE TOC2	
Phase TOC2 Function	
Phase TOC2 Input	
Phase TOC2 Pickup	
Phase TOC2 Curve	
Phase TOC2 TD Multiplier	
Phase TOC2 Reset	
Phase TOC2 BLK	
Phase TOC2 Target	
Phase TOC2 Events	

PHASE IOC1	
Phase IOC1 Function	
Phase IOC1 Pickup	
Phase IOC1 Pickup Delay	
Phase IOC1 Reset Delay	
Phase IOC1 BLK	
Phase IOC1 Target	
Phase IOC1 Events	

PHASE IOC2	
Phase IOC2 Function	
Phase IOC2 Pickup	
Phase IOC2 Pickup Delay	
Phase IOC2 Reset Delay	
Phase IOC2 BLK	
Phase IOC2 Target	
Phase IOC2 Events	

NEUTRAL TOC1	
Neutral TOC1 Function	
Neutral TOC1 Input	
Neutral TOC1 Pickup	
Neutral TOC1 Curve	
Neutral TOC1 TD Multiplier	
Neutral TOC1 Reset	
Neutral TOC1 BLK	
Neutral TOC1 Target	
Neutral TOC1 Events	

NEUTRAL IOC1	
Neutral IOC1 Function	
Neutral IOC1 Pickup	
Neutral IOC1 Pickup Delay	
Neutral IOC1 Reset Delay	
Neutral IOC1 BLK	
Neutral IOC1 Target	
Neutral IOC1 Events	

NEUTRAL IOC2	
Neutral IOC2 Function	
Neutral IOC2 Pickup	

NEUTRAL IOC2	
Neutral IOC2 Pickup Delay	
Neutral IOC2 Reset Delay	
Neutral IOC2 BLK	
Neutral IOC2 Target	
Neutral IOC2 Events	

GROUND TOC1	
Ground TOC1 Function	
Ground TOC1 Input	
Ground TOC1 Pickup	
Ground TOC1 Curve	
Ground TOC1 TD Multiplier	
Ground TOC1 Reset	
Ground TOC1 BLK	
Ground TOC1 Target	
Ground TOC1 Events	

GROUND IOC1	
Ground IOC1 Function	
Ground IOC1 Pickup	
Ground IOC1 Pickup Delay	
Ground IOC1 Reset Delay	
Ground IOC1 BLK	
Ground IOC1 Target	
Ground IOC1 Events	

GROUND IOC2	
Ground IOC2 Function	
Ground IOC2 Pickup	
Ground IOC2 Pickup Delay	
Ground IOC2 Reset Delay	
Ground IOC2 BLK	
Ground IOC2 Target	
Ground IOC2 Events	

SNS GROUND TOC1	
SNS Ground TOC1 Function	
SNS Ground TOC1 Input	
SNS Ground TOC1 Pickup	
SNS Ground TOC1 Curve	
SNS Ground TOC1 TD Multiplier	
SNS Ground TOC1 Reset	
SNS Ground TOC1 BLK	
SNS Ground TOC1 Target	
SNS Ground TOC1 Events	

SNS GROUND IOC1	
SNS Ground IOC1 Function	
SNS Ground IOC1 Pickup	
SNS Ground IOC1 PKP Delay	
SNS Ground IOC1 RST Delay	
SNS Ground IOC1 BLK	
SNS Ground IOC1 Target	
SNS Ground IOC1 Events	

SNS GROUND IOC2	
SNS Ground IOC2 Function	
SNS Ground IOC2 Pickup	
SNS Ground IOC2 PKP Delay	
SNS Ground IOC2 RST Delay	
SNS Ground IOC2 BLK	
SNS Ground IOC2 Target	
SNS Ground IOC2 Events	

b) VOLTAGE ELEMENTS

PHASE UNDERVOLTAGE1	
Phase UV1 Function	
Phase UV1 Pickup	
Phase UV1 Curve	
Phase UV1 Delay	
Phase UV1 Minimum Voltage	
Phase UV1 Block	
Phase UV1 Target	
Phase UV1 Events	

PHASE UNDERVOLTAGE2	
Phase UV2 Function	
Phase UV2 Pickup	
Phase UV2 Curve	
Phase UV2 Delay	
Phase UV2 Minimum Voltage	
Phase UV2 Block	
Phase UV2 Target	
Phase UV2 Events	

8.5.1 S5 SETTINGS - INPUTS / OUTPUTS

a) CONTACT INPUTS

Table 8–3: CONTACT INPUT CONFIGURATION

CONTACT INPUT	CONTACT INPUT FUNCTION	CONTACT INPUT ID	CONTACT INPUT ’ON’ STATE	CONTACT INPUT EVENTS

Table 8–4: CONTACT INPUT THRESHOLDS

CONTACT INPUT	THRESHOLD

b) VIRTUAL INPUTS

VIRTUAL INPUT 1	
Virtual Input 1 Function	
Virtual Input 1 ID	
Virtual Input 1 Type	
Virtual Input 1 Events	

VIRTUAL INPUT 2	
Virtual Input 2 Function	
Virtual Input 2 ID	
Virtual Input 2 Type	
Virtual Input 2 Events	

VIRTUAL INPUT 3	
Virtual Input 3 Function	
Virtual Input 3 ID	
Virtual Input 3 Type	
Virtual Input 3 Events	

VIRTUAL INPUT 4	
Virtual Input 4 Function	
Virtual Input 4 ID	
Virtual Input 4 Type	
Virtual Input 4 Events	

VIRTUAL INPUT 5	
Virtual Input 5 Function	
Virtual Input 5 ID	
Virtual Input 5 Type	
Virtual Input 5 Events	

VIRTUAL INPUT 6	
Virtual Input 6 Function	
Virtual Input 6 ID	
Virtual Input 6 Type	
Virtual Input 6 Events	

VIRTUAL INPUT 7	
Virtual Input 7 Function	
Virtual Input 7 ID	
Virtual Input 7 Type	
Virtual Input 7 Events	

VIRTUAL INPUT 8	
Virtual Input 8 Function	
Virtual Input 8 ID	
Virtual Input 8 Type	
Virtual Input 8 Events	

VIRTUAL INPUT 9	
Virtual Input 9 Function	
Virtual Input 9 ID	
Virtual Input 9 Type	
Virtual Input 9 Events	

VIRTUAL INPUT 10	
Virtual Input 10 Function	
Virtual Input 10 ID	
Virtual Input 10 Type	
Virtual Input 10 Events	

VIRTUAL INPUT 11	
Virtual Input 11 Function	
Virtual Input 11 ID	
Virtual Input 11 Type	
Virtual Input 11 Events	

VIRTUAL INPUT 12	
Virtual Input 12 Function	
Virtual Input 12 ID	
Virtual Input 12 Type	
Virtual Input 12 Events	

VIRTUAL INPUT 13	
Virtual Input 13 Function	
Virtual Input 13 ID	
Virtual Input 13 Type	
Virtual Input 13 Events	

VIRTUAL INPUT 14	
Virtual Input 14 Function	
Virtual Input 14 ID	
Virtual Input 14 Type	
Virtual Input 14 Events	

VIRTUAL INPUT 15	
Virtual Input 15 Function	
Virtual Input 15 ID	
Virtual Input 15 Type	
Virtual Input 15 Events	

VIRTUAL INPUT 16	
Virtual Input 16 Function	
Virtual Input 16 ID	
Virtual Input 16 Type	
Virtual Input 16 Events	

VIRTUAL INPUT 17	
Virtual Input 17 Function	
Virtual Input 17 ID	
Virtual Input 17 Type	
Virtual Input 17 Events	

VIRTUAL INPUT 18	
Virtual Input 18 Function	
Virtual Input 18 ID	
Virtual Input 18 Type	
Virtual Input 18 Events	

VIRTUAL INPUT 19	
Virtual Input 19 Function	
Virtual Input 19 ID	
Virtual Input 19 Type	
Virtual Input 19 Events	

VIRTUAL INPUT 20	
Virtual Input 20 Function	
Virtual Input 20 ID	
Virtual Input 20 Type	
Virtual Input 20 Events	

VIRTUAL INPUT 21	
Virtual Input 21 Function	
Virtual Input 21 ID	
Virtual Input 21 Type	
Virtual Input 21 Events	

VIRTUAL INPUT 22	
Virtual Input 22 Function	
Virtual Input 22 ID	
Virtual Input 22 Type	
Virtual Input 22 Events	

VIRTUAL INPUT 23	
Virtual Input 23 Function	
Virtual Input 23 ID	
Virtual Input 23 Type	
Virtual Input 23 Events	

VIRTUAL INPUT 24	
Virtual Input 24 Function	
Virtual Input 24 ID	
Virtual Input 24 Type	
Virtual Input 24 Events	

VIRTUAL INPUT 25	
Virtual Input 25 Function	
Virtual Input 25 ID	
Virtual Input 25 Type	
Virtual Input 25 Events	

VIRTUAL INPUT 26	
Virtual Input 26 Function	
Virtual Input 26 ID	
Virtual Input 26 Type	
Virtual Input 26 Events	

VIRTUAL INPUT 27	
Virtual Input 27 Function	
Virtual Input 27 ID	
Virtual Input 27 Type	
Virtual Input 27 Events	

VIRTUAL INPUT 28	
Virtual Input 28 Function	
Virtual Input 28 ID	
Virtual Input 28 Type	
Virtual Input 28 Events	

VIRTUAL INPUT 29	
Virtual Input 29 Function	
Virtual Input 29 ID	
Virtual Input 29 Type	
Virtual Input 29 Events	

VIRTUAL INPUT 30	
Virtual Input 30 Function	
Virtual Input 30 ID	
Virtual Input 30 Type	
Virtual Input 30 Events	

VIRTUAL INPUT 31	
Virtual Input 31 Function	
Virtual Input 31 ID	
Virtual Input 31 Type	
Virtual Input 31 Events	

VIRTUAL INPUT 32	
Virtual Input 32 Function	
Virtual Input 32 ID	
Virtual Input 32 Type	
Virtual Input 32 Events	

c) CONTACT OUTPUTS

Table 8–5: CONTACT OUTPUT CONFIGURATION

CONTACT OUPTUT	CONTACT OUTPUT ID	CONTACT OUTPUT TYPE	CONTACT OUTPUT OPERATE	CONTACT OUTPUT SEAL-IN	CONTACT OUTPUT EVENTS

Table 8–5: CONTACT OUTPUT CONFIGURATION

CONTACT OUPTUT	CONTACT OUTPUT ID	CONTACT OUTPUT TYPE	CONTACT OUTPUT OPERATE	CONTACT OUTPUT SEAL-IN	CONTACT OUTPUT EVENTS

d) VIRTUAL OUTPUTS

Table 8–6: VIRTUAL OUTPUTS

VIRTUAL OUTPUT	VIRTUAL OUTPUT ID	VIRTUAL OUTPUT EVENTS
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		

Table 8–6: VIRTUAL OUTPUTS (Continued)

VIRTUAL OUTPUT	VIRTUAL OUTPUT ID	VIRTUAL OUTPUT EVENTS
24		
25		
26		
27		
28		
29		
30		
31		
32		
33		
34		
35		
36		
37		
38		
39		
40		
41		
42		
43		
44		
45		
46		
47		
48		

Table 8–6: VIRTUAL OUTPUTS (Continued)

VIRTUAL OUTPUT	VIRTUAL OUTPUT ID	VIRTUAL OUTPUT EVENTS
49		
50		
51		
52		
53		
54		
55		
56		
57		
58		
59		
60		
61		
62		
63		
64		

A.1.1 OVERVIEW

The UR type relays communicate with other computerized equipment such as programmable logic controllers, personal computers, or plant master computers using the AEG Modicon or Modbus® RTU protocol. Following are some general notes:

- The units always act as slave devices meaning that they never initiate communications; they only listen and respond to requests issued by a master computer.
- For Modbus®, a subset of the Remote Terminal Unit (RTU) format of the protocol is supported, which allows extensive monitoring, programming and control functions using read and write register commands.

A.1.2 PHYSICAL LAYER

The Modbus® RTU protocol is hardware-independent so that the physical layer can be any of a variety of standard hardware configurations including RS232, RS485, fiber optics, 10BaseT, 10BaseF ethernet, etc. The unit includes a front panel RS232 port and two rear terminal communications ports, which may be configured as RS485, fiber optic, 10BaseT, or 10 Base F. Data flow is half duplex in all configurations. See Chapter 3 HARDWARE for details on wiring.

Each data byte is transmitted in an asynchronous format consisting of 1 start bit, 8 data bits, 1 stop bit, and possibly 1 parity bit. This produces a 10 or 11 bit data frame. This is important for transmission through modems at high bit rates (11 bit data frames are not supported by many modems at baud rates greater than 300).

The baud rate and parity are independently programmable for each communications port. Baud rates of 300, 1200, 2400, 4800, 9600, 19200, 38400, 57600, or 115200 bps are available. Even, odd, and no parity are available. See Chapter 5 SETTINGS: PRODUCT SETUP for further details.

The master device in any system must know the address of the slave device with which it is to communicate. The unit will not act on a request from a master if the address in the request does not match the relay's slave address (unless the address is the broadcast address -- see below).

A single setting selects the slave address used for all ports with the exception that for the front panel port the relay will accept any address when the Modbus® RTU protocol is used. The slave address is otherwise the same regardless of the protocol in use, but note that the broadcast address is 0 for Modbus®. The relay recognizes and processes a master request (under conditions that are protocol-specific) if the broadcast address is used but never returns a response.

A.1.3 DATA LINK LAYER

Communications takes place in packets which are groups of asychronously framed byte data. The master transmits a packet to the slave and the slave responds with a packet. The end of a packet is marked by 'deadtime' on the communications line. The following describes general format for both transmit and receive packets. For exact details on packet formatting refer to subsequent sections describing each function code.

Modbus® Packet Format:	SLAVE ADDRESS	1 byte
	FUNCTION CODE	1 byte
	DATA	N bytes
	CRC	2 bytes
	DEAD TIME	3.5 bytes transmission time

SLAVE ADDRESS

This is the address of the slave device that is intended to receive the packet sent by the master and perform the desired action. Each slave device on a communication bus must have a unique address to prevent bus contention. All of the relay's ports have the same address which is programmable from 1 to 254; see Chapter 5 for details. Only the addressed slave will respond to a packet that starts with its address. Note that the front port is an exception to this rule; it will act on a message containing any slave address.

A master transmit packet with a slave address of 0 indicates a broadcast command. All slaves on the communication link will take action based on the packet, but none will respond to the master. Broadcast mode is only recognized when associated with FUNCTION CODE 05h. For any other function code, a packet with broadcast mode slave address 0 will be ignored.

FUNCTION CODE

This is one of the supported functions codes of the unit which tells the slave what action to perform. See the SUPPORTED FUNCTION CODES section for complete details. An exception response from the slave is indicated by setting the high order bit of the function code in the response packet. See section EXCEPTION RESPONSES for further details.

DATA

This will be a variable number of bytes depending on the function code. This may include actual values, settings, or addresses sent by the master to the slave or by the slave to the master.

CRC

This is a two byte error checking code. The RTU version of Modbus® includes a 16 bit cyclic redundancy check (CRC-16) with every packet which is an industry standard method used for error detection. If a Multilin Modbus® slave device receives a packet in which an error is indicated by the CRC, the slave device will not act upon or respond to the packet thus preventing any erroneous operations. See the following section CRC-16 ALGORITHM for a description of how to calculate the CRC.

DEAD TIME

A packet is terminated when no data is received for a period of 3.5 byte transmission times (about 15 ms at 2400 bps, 2 ms at 19200 bps, and 300us at 115200 bps). Consequently, the transmitting device must not allow gaps between bytes longer than this interval. Once the dead time has expired without a new byte transmission, all slaves start listening for a new packet from the master except for the addressed slave.

A.1.4 CRC-16 ALGORITHM

The CRC-16 algorithm essentially treats the entire data stream (data bits only; start, stop and parity ignored) as one continuous binary number. This number is first shifted left 16 bits and then divided by a characteristic polynomial (11000000000000101B). The 16 bit remainder of the division is appended to the end of the packet, MSByte first. The resulting packet including CRC, when divided by the same polynomial at the receiver will give a zero remainder if no transmission errors have occurred. This algorithm requires the characteristic polynomial to be reverse bit ordered. The most significant bit of the characteristic polynomial is dropped, since it does not affect the value of the remainder.

Note: A C programming language implementation of the CRC algorithm will be provided upon request.

Symbols:	**-->**	data transfer
	A	16 bit working register
	A_{low}	low order byte of A
	A_{high}	high order byte of A
	CRC	16 bit CRC-16 result
	i,j	loop counters
	(+)	logical EXCLUSIVE-OR operator
	N	total number of data bytes
	D_i	i-th data byte (i = 0 to N-1)
	G	16 bit characteristic polynomial = 1010000000000001 (binary) with MSbit dropped and bit order reversed
	shr (x)	right shift operator (th LSbit of x is shifted into a carry flag, a '0' is shifted into the MSbit of x, all other bits are shifted right one location)

Algorithm	**1.**	**FFFF (hex) --> A**	
	2.	**0 --> i**	
	3.	**0 --> j**	
	4.	**Di (+) A_{low} --> A_{low}**	
	5.	**j + 1 --> j**	
	6.	**shr (A)**	
	7.	**Is there a carry?**	**No: go to 8** **Yes: G (+) A --> A and continue.**
	8.	**Is j = 8?**	**No: go to 5** **Yes: continue**
	9.	**i + 1 --> i**	
	10.	**Is i = N?**	**No: go to 3** **Yes: continue**
	11.	**A --> CRC**	

A

A.2.1 SUPPORTED FUNCTION CODES

Modbus® officially defines function codes from 1 to 127 though only a small subset is generally needed. The relay supports some of these functions, as summarized in the following table. Subsequent sections describe each function code in detail.

Table A–1: SUPPORTED MODBUS® FUNCTION CODES

FUNCTION CODE		MODBUS® DEFINITION	MULTILIN DEFINITION
HEX	DEC		
03	3	Read Holding Registers	Read Actual Values or Settings
04	4	Read Holding Registers	Read Actual Values or Settings
05	5	Force Single Coil	Execute Operation
06	6	Preset Single Register	Store Single Setting
10	16	Preset Multiple Registers	Store Multiple Settings

A.2.2 FUNCTION CODE 03H / 04H - READ ACTUAL VALUES OR SETTINGS

This function code allows the master to read one or more consecutive data registers (actual values or settings) from an relay. Data registers are always 16 bit (two byte) values transmitted high order byte first. The maximum number of registers that can be read in a single packet is 120. See the section MEMORY MAP for exact details on the data registers.

Since some PLC implementations of Modbus® only support one of function codes 03h and 04h, the relay interpretation allows either function code to be used for reading one or more consecutive data registers. The data starting address will determine the type of data being read. Function codes 03h and 04h are therefore identical.

The following table shows the format of the master and slave packets. The example shows a master device requesting 3 register values starting at address 4050h from slave device 11h (17 dec); the slave device responds with the values 40, 300, and 0 from registers 4050h, 4051h, and 4052h respectively.

Table A–2: MASTER AND SLAVE DEVICE PACKET TRANSMISSION EXAMPLE

Master Transmission		Slave Response	
Packet Format	Example (hex)	Packet Format	Example (hex)
SLAVE ADDRESS	11	SLAVE ADDRESS	11
FUNCTION CODE	04	FUNCTION CODE	04
DATA STARTING ADDRESS - hi	40	BYTE COUNT	06
DATA STARTING ADDRESS - lo	50	DATA #1 - hi	00
NUMBER OF REGISTERS - hi	00	DATA #1 - lo	28
NUMBER OF REGISTERS - lo	03	DATA #2 - hi	01
CRC - lo	A7	DATA #2 - lo	2C
CRC - hi	4A	DATA #3 - hi	00
		DATA #3 - lo	00
		CRC - lo	0D
		CRC - hi	60

A.2.3 FUNCTION CODE 05H - EXECUTE OPERATION

This function code allows the master to perform various operations in the relay. Available operations are in the table SUMMARY OF OPERATION CODES.

The following table shows the format of the master and slave packets. The example shows a master device requesting the slave device 11H (17 dec) to perform a reset. The hi and lo CODE VALUE bytes always have the values ‘FF’ and ‘00’ respectively and are a remnant of the original Modbus® definition of this function code.

Table A–3: MASTER AND SLAVE DEVICE PACKET TRANSMISSION EXAMPLE

Master Transmission		Slave Response	
Packet Format	**Example (hex)**	**Packet Format**	**Example (hex)**
SLAVE ADDRESS	11	SLAVE ADDRESS	11
FUNCTION CODE	05	FUNCTION CODE	05
OPERATION CODE - hi	00	OPERATION CODE - hi	00
OPERATION CODE - lo	01	OPERATION CODE - lo	01
CODE VALUE - hi	FF	CODE VALUE - hi	FF
CODE VALUE - lo	00	CODE VALUE - lo	00
CRC - lo	DF	CRC - lo	DF
CRC - hi	6A	CRC - hi	6A

Table A–4: SUMMARY OF OPERATION CODES (for Function Code 05h)

OPERATION CODE (hex)	DEFINITION	DESCRIPTION
0000	NO OPERATION	Does not do anything.
0001	RESET	Performs the same function as the front panel *RESET* key.
0002	FUNCTION A	Performs the same function as the front panel *FUNCTION A* key.
0003	FUNCTION B	Performs the same function as the front panel *FUNCTION B* key.
0004	FUNCTION C	Performs the same function as the front panel *FUNCTION C* key.
0005	CLEAR EVENT RECORDS	Performs the same function as the front panel *CLEAR EVENT RECORDS* command.
0006	CLEAR OSCILLOGRAPHY	Clears all oscillography records.
1000 -101F	VIRTUAL IN 1-32 ON/OFF	Sets the states of Virtual Inputs 1 to 32 either “ON” or “OFF”.

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A.2.4 FUNCTION CODE 06H - STORE SINGLE SETTING

This function code allows the master to modify the contents of a single setting register in an relay. Setting registers are always 16 bit (two byte) values transmitted high order byte first.

The following table shows the format of the master and slave packets. The example shows a master device storing the value 200 at memory map address 4051h to slave device 11h (17 dec).

Table A–5: MASTER AND SLAVE DEVICE PACKET TRANSMISSION EXAMPLE

Master Transmission		Slave Response	
Packet Format	**Example (hex)**	**Packet Format**	**Example (hex)**
SLAVE ADDRESS	11	SLAVE ADDRESS	11
FUNCTION CODE	06	FUNCTION CODE	06
DATA STARTING ADDRESS - hi	40	DATA STARTING ADDRESS - hi	40
DATA STARTING ADDRESS - lo	51	DATA STARTING ADDRESS - lo	51
DATA - hi	00	DATA - hi	00
DATA - lo	C8	DATA - lo	C8
CRC - lo	CE	CRC - lo	CE
CRC - hi	DD	CRC - hi	DD

A.2.5 FUNCTION CODE 10H - STORE MULTIPLE SETTINGS

This function code allows the master to modify the contents of a one or more consecutive setting registers in an relay. Setting registers are 16 bit (two byte) values transmitted high order byte first. The maximum number of setting registers that can be stored in a single packet is 60. The following table shows the format of the master and slave packets. The example shows a master device storing the value 200 at memory map address 4051h, and the value 1 at memory map address 4052h to slave device 11h (17 dec).

Table A–6: MASTER AND SLAVE DEVICE PACKET TRANSMISSION EXAMPLE

Master Transmission		Slave Response	
Packet Format	**Example (hex)**	**Packet Format**	**Example (hex)**
SLAVE ADDRESS	11	SLAVE ADDRESS	11
FUNCTION CODE	10	FUNCTION CODE	10
DATA STARTING ADDRESS - hi	40	DATA STARTING ADDRESS - hi	40
DATA STARTING ADDRESS - lo	51	DATA STARTING ADDRESS - lo	51
NUMBER OF SETTINGS - hi	00	NUMBER OF SETTINGS - hi	00
NUMBER OF SETTINGS - lo	02	NUMBER OF SETTINGS - lo	02
BYTE COUNT	04	CRC - lo	07
DATA #1 - high order byte	00	CRC - hi	64
DATA #1 - low order byte	C8		
DATA #2 - high order byte	00		
DATA #2 - low order byte	01		
CRC - low order byte	12		
CRC - high order byte	62		

A.3.1 EXCEPTION RESPONSES

Programming or operation errors happen because of illegal data in a packet, hardware or software problems in the slave device, etc. These errors result in an exception response from the slave. The relay implements the error codes listed in the EXCEPTION RESPONSE ERROR CODES table. The slave detecting one of these errors sends a response packet to the master with the high order bit of the function code set to 1.

The following table shows the format of the master and slave packets. The example shows a master device sending the unsupported function code 39h to slave device 11.

Table A–7: MASTER AND SLAVE DEVICE PACKET TRANSMISSION EXAMPLE

Master Transmission		Slave Response	
Packet Format	**Example (hex)**	**Packet Format**	**Example (hex)**
SLAVE ADDRESS	11	SLAVE ADDRESS	11
FUNCTION CODE	39	FUNCTION CODE	B9
CRC - low order byte	CD	ERROR CODE	01
CRC - high order byte	F2	CRC - low order byte	93
		CRC - high order byte	95

Table A–8: SUMMARY OF OPERATION CODES (for Function Code 05h)

OPERATION CODE (hex)	DEFINITION	DESCRIPTION
0000	NO OPERATION	Does not do anything.
0001	RESET	Performs the same function as the front panel *RESET* key.
0002	FUNCTION A	Performs the same function as the front panel *FUNCTION A* key.
0003	FUNCTION B	Performs the same function as the front panel *FUNCTION B* key.
0004	FUNCTION C	Performs the same function as the front panel *FUNCTION C* key.
0005	CLEAR EVENT RECORDS	Performs the same function as the front panel *CLEAR EVENT RECORDS* command.
0006	CLEAR OSCILLOGRAPHY	Clears all oscillography records.
1000 -101F	VIRTUAL IN 1-32 ON/OFF	Sets the states of Virtual Inputs 1 to 32 either “ON” or “OFF”.

- Some implementations of Modbus® may not support these exception responses.

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A.4.1 READING THE EVENT RECORDER

a) Basics

1. Read 3400..3404 to get information about the event recorder
2. Write 1 to 3406 to clear the event recorder
3. Write appropriate values to 3420..3424 to start a file transfer – any write to these registers clears 3425 to zero.
4. Read up to 124 registers from 3425 to get a block of data
5. If the block is OK, read again (starting from 3425) to read the next block. You'll find that 3425 has changed to reflect the "high water mark", so register 3427 will contain the two bytes which follow after the last one you read so far

b) Details

3400 - Events_Since_Last_Clear
Indicates the total number of events, even though only the last 1024 are held in the relay.

3402 - Number_of_Available_Events
Will never exceed 1024.

3404 - Event_Recorder_Last_Cleared_Date
Read only. This register is automatically updated when the event recorder is cleared, either via communications (register 3406) or MMI.

3406 - Event_Recorder_Clear_Command
Writing 1 clears the event recorder. Reading will always show zero.

3420 - Event_File_First_Event
Write the event number of the first event you wish to extract from the relay. Zero is a special case, meaning "starting with the oldest available event".

3422 - Event_File_Last_Event
Write the event number of the last event you wish to extract from the relay. Zero is a special case, meaning "ending with the newest available event".

3424 - Event_File_Type
Write the type of file you wish to read (see format F142).

3425 - Event_File_Position
Indicates the number of characters read so far. It increments automatically as described below.

3427 - Event_File_Access [123]
Read the text here. The first register contains the first two characters. The next register contains the next two characters, and so on. Whenever you read Event_File_Acces[n], Event_File_Position changes to 2 times (1+n). The data doesn't actually change until you re-read Event_File_Position, though, so you can use several reads to obtain a block without disturbing the position counter. You can also get a re-transmission of a block by reading Event_File_Access without reading Event_File_Position.

c) File Formats

Each line ends with CR, LF (0x0D, 0x0A).

At the start of the file, there are format descriptions. Each is one line, like so:
FORMAT,<format name>,<field 1 name>,<field 2 name>, …

The rest of the lines each conform to one of the formats, like so:
<format name>,<field 1 value>,<field 2 value>, …

Special characters work with the normal Windows fonts. This aspect will probably change in the future by, for example, using "deg." instead of the degree symbol.

"Normal" file format:

FORMAT,SHORT_EVENT,Event Number,Date/Time,Cause

FORMAT,SNAPSHOT_EVENT,Event Number,Date/Time,Cause,Frequency,Phase A Current Magnitude,Phase A Current Angle,Phase B Current Magnitude,Phase B Current Angle,Phase C Current Magnitude,Phase C Current Angle,Phase AG Voltage Magnitude,Phase AG Voltage Angle,Phase BG Voltage Magnitude,Phase BG Voltage Angle,Phase CG Voltage Magnitude,Phase CG Voltage Angle

SHORT_EVENT,1,May 12 1998 14:17:31.000000,EVENTS CLEARED

SNAPSHOT_EVENT,2,May 12 1998 14:18:45.000000,PHASE IOC1 PKP A,0.00 Hz,3897.4 A,0.00 °,0.0 A,0.00 °,3897.4 A,-120.00 °,0 V,0.00 °,0 V,0.00 °,0 V,0.00 °

SNAPSHOT_EVENT,3,May 12 1998 14:18:45.000000,PHASE IOC1 PKP C,0.00 Hz,3897.4 A,0.00 °,0.0 A,0.00 °,3897.4 A,-120.00 °,0 V,0.00 °,0 V,0.00 °,0 V,0.00 °

SNAPSHOT_EVENT,4,May 12 1998 14:18:47.000000,PHASE IOC1 PKP A,0.00 Hz,461.5 A,0.00 °,0.0 A,0.00 °,461.5 A,-120.00 °,0 V,0.00 °,0 V,0.00 °,0 V,0.00 °

SNAPSHOT_EVENT,5,May 12 1998 14:18:47.000000,PHASE IOC1 PKP C,0.00 Hz,461.5 A,0.00 °,0.0 A,0.00 °,461.5 A,-120.00 °,0 V,0.00 °,0 V,0.00 °,0 V,0.00 °

SNAPSHOT_EVENT,6,May 12 1998 14:18:48.000000,PHASE IOC1 OP A,0.00 Hz,1333.3 A,0.00 °,0.0 A,0.00 °,1333.3 A,-120.00 °,0 V,0.00 °,0 V,0.00 °,0 V,0.00 °

SNAPSHOT_EVENT,7,May 12 1998 14:18:48.000000,PHASE IOC1 OP C,0.00 Hz,1333.3 A,0.00 °,0.0 A,0.00 °,1333.3 A,-120.00 °,0 V,0.00 °,0 V,0.00 °,0 V,0.00 °

SHORT_EVENT,8,May 12 1998 14:18:48.000000,Contact O/P H1 ON

SHORT_EVENT,9,May 12 1998 14:18:49.000000,Contact O/P H1 OFF

"Headers only" file format:

FORMAT,SHORT_EVENT,Event Number,Date/Time,Cause

SHORT_EVENT,1,May 12 1998 14:17:31.000000,EVENTS CLEARED

SHORT_EVENT,2,May 12 1998 14:18:45.000000,PHASE IOC1 PKP A

SHORT_EVENT,3,May 12 1998 14:18:45.000000,PHASE IOC1 PKP C

SHORT_EVENT,4,May 12 1998 14:18:47.000000,PHASE IOC1 PKP A

SHORT_EVENT,5,May 12 1998 14:18:47.000000,PHASE IOC1 PKP C

SHORT_EVENT,6,May 12 1998 14:18:48.000000,PHASE IOC1 OP A

SHORT_EVENT,7,May 12 1998 14:18:48.000000,PHASE IOC1 OP C

SHORT_EVENT,8,May 12 1998 14:18:48.000000,Contact O/P H1 ON

SHORT_EVENT,9,May 12 1998 14:18:49.000000,Contact O/P H1 OFF

A.4.2 READING OSCILLOGRAPHY DATA

Oscillography data can be read from the UR memory map in COMTRADE file format (as per IEEE PC37.111) via the Modbus® registers found in the address range 3000h to 30A0h. In order to understand the description that follows, familiarity with the Oscillography settings is required; refer to Chapter 5 SETTINGS - S1 PRODUCT SETUP for details.

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The Oscillography_Number_of_Triggers register is incremented by one every time a new oscillography file is triggered (captured). Oscillography_Number_of_Triggers register is cleared to zero when oscillography data is cleared. When a new trigger occurs, the associated oscillography file is assigned a file identifier number equal to the incremented value of this register; the newest file will have a number equal to the Oscillography_Number_of_Triggers register. This register can be used to determine if any new data has been captured by periodically reading it to see if the value has changed; if the number has increased then there is new data available.

The Oscillography_Number_of_Records setting specifies the maximum number of files (and the number of cycles of data per file) that can be stored in memory of the relay. The Oscillography_Available_Records register specifies the actual number of files that are stored and still available to be read out of the relay.

Writing 'Yes' (i.e. the value 1) to the Oscillography_Clear_Data register clears oscillography data files, clears both Oscillography_Number_of_Triggers and Oscillography_Available_Records registers to zero, and sets the Oscillography_Last_Cleared_Date to the present date and time.

Writing the desired file identifier number to the Oscillography_File_Identifier register specifies to the relay which record is to be read. For example, to read oscillography record number 3, the value 3 must first be written to this register.

Writing the desired file type to the Oscillography_File_Type register specifies to the relay which COMTRADE file (i.e. data, configuration, or header file) is to be read. For example, to read the configuration file of the oscillography record, 'Configuration File' (i.e. the value 1) must first be written to this register.

Now that the record number and file type have been selected, the specified file can be read from the relay using the Oscillography_File_Size, Oscillography_File_Position, and Oscillography_File_Access registers. The Oscillography_File_Size register specifies the number of 16-bit registers (or pairs of 8-bit characters) in the file. The Oscillography_File_Access is actually an array of 123 registers (Modbus® addresses 3026h to 30A0h) from which the file contents can be read. For the purposes of the description that follows, Oscillography_File_Access[0] refers to Modbus® address 3026h, Oscillography_File_Access[1] to Modbus® address 3027h, and so on, up to Oscillography_File_Access[122], which refers to Modbus® address 30A0h.

Since most files will have a file size much greater than 123 registers, the Oscillography_File_Access registers are only a window into the file to be read, and Oscillography_File_Position register is the offset into the file from which the data is accessible. When the Oscillography_File_Position register is 0, Oscillography_File_Access[0] contains the 1st 16-bit register (or pair of 8-bit characters) of the file, Oscillography_File_Access[1] the 2nd 16-bit register, and so on. After setting the Oscillography_File_Position register to 123, Oscillography_File_Access[0] will contain the 124th 16-bit register of the file, Oscillography_File_Access[1] the 125th 16-bit register, and so on. The Oscillography_File_Position register, therefore specifies which register in the file will be accessed.

One way the data of a file can be read is by alternately writing to the Oscillography_File_Position register, and reading from the Oscillography_File_Access registers. To read a file for which the Oscillography_File_Size is 260 registers, for example, would be as follows:

1. Write 0 to Oscillography_File_Position.
2. Read Oscillography_File_Access[0] to Oscillography_File_Access[122]. These are the first 123 registers of the file.
3. Write 123 to Oscillography_File_Position.
4. Read Oscillography_File_Access[0] to Oscillography_File_Access[122]. These are the next 123 registers of the file.
5. Write 246 to Oscillography_File_Position.
6. Read Oscillography_File_Access[0] to Oscillography_File_Access[13]. These are the last 14 registers of the file.

Although this procedure will work, there is an easier way. A feature has been built into the Oscillography_File_Position register to make writing to it unnecessary. The Oscillography_File_Position register keeps track of the number of registers last read via the Oscillography_File_Access registers. Subsequent reading of the contents of the Oscillography_File_Position register automatically updates the Oscillography_File_Position to point to the next block of unread registers in the file. Using this convenience, reading a 260 register size file would be as follows:

1. Write 0 to Oscillography_File_Position.
2. Read Oscillography_File_Position and Oscillography_File_Access[0] to Oscillography_File_Access[122] (in one 125 register Modbus® read command). Oscillography_File_Position will be 0, and the first 123 registers of the file will have been read.
3. Read Oscillography_File_Position and Oscillography_File_Access[0] to Oscillography_File_Access[122] (in one 125 register Modbus® read command). Oscillography_File_Position will be 123, and the next 123 registers of the file will have been read.
4. Read Oscillography_File_Position and Oscillography_File_Access[0] to Oscillography_File_Access[13] (in one 16 register Modbus® read command). Oscillography_File_Position will be 246, and the last 14 registers of the file will have been read.

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A.5.1 MODBUS® MEMORY MAP DATA FORMATS

Table A–9: MODBUS MEMORY MAP DATA FORMATS *(Sheet 1 of 8)*

Format Name	Format Type/Bitmask	Format Definition
F001	**UINT16**	**UNSIGNED 16 BIT INTEGER**
F002	**SINT16**	**SIGNED 16 BIT INTEGER**
F003	**UINT32**	**UNSIGNED 32 BIT INTEGER (2 registers)**
		High order word is stored in the first register.
		Low order word is stored in the second register.
F004	**SINT32**	**SIGNED 32 BIT INTEGER (2 registers)**
		High order word is stored in the first register.
		Low order word is stored in the second register.
F011	**UINT16**	**FLEXCURVE DATA (120 POINTS)**
		A FlexCurve is an array of 120 consecutive data points (x,y) which are interpolated
		to generate a smooth curve. The y-axis is the user defined trip or operation time
		setting; the x-axis is the pickup ratio and is pre-defined. Refer to format F119 for
		a listing of the pickup ratios; the enumeration value for the pickup ratio indicates
		the offset into the FlexCurve base address where the corresponding time value is stored.
F013	**POWER_FACTOR**	**POWER FACTOR (SIGNED 16 BIT INTEGER)**
		Positive values indicate lagging power factor; negative values indicate leading.
F040	**UINT48**	**48-BIT UNSIGNED INTEGER**
F050	**UINT32**	**TIME and DATE (UNSIGNED 32 BIT INTEGER)**
		Gives the current time in seconds elapsed since 00:00:00 January 1, 1970.
F060	**FLOATING_POINT**	**IEE FLOATING POINT (32 bits)**
F100	**ENUMERATION**	**VT CONNECTION TYPE**
	0	None
	1	Wye
	2	Delta
F101	**ENUMERATION**	**MESSAGE DISPLAY INTENSITY**
	0	25 %
	1	50 %
	2	75 %
	3	100 %
F102	**ENUMERATION**	**DISABLED/ENABLED**
	0	Disabled
	1	Enabled
F103	**ENUMERATION**	**CURVE SHAPES**
	0	IEEE Mod Inv
	1	IEEE Very Inv
	2	IEEE Ext Inv
	3	IEC Curve A
	4	IEC Curve B
	5	IEC Curve C
	6	IEC Short Inv
	7	IAC Ext Inv
	8	IAC Very Inv
	9	IAC Inverse
	10	IAC Short Inv
	11	I^2t
	12	Definite Time
	13	Flexcurve A
	14	Flexcurve B
F104	**ENUMERATION**	**RESET TYPE**
	0	Instantaneous
	1	Timed
F106	**ENUMERATION**	**PHASE ROTATION**

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Table A–9: MODBUS MEMORY MAP DATA FORMATS *(Sheet 2 of 8)*

Format Name	Format Type/Bitmask	Format Definition
	0	ABC
	1	ACB
F107	**ENUMERATION**	**CONTACT STATE**
	0	Open
	1	Closed
F108	**ENUMERATION**	**OFF/ON**
	0	Off
	1	On
F109	**ENUMERATION**	**CONTACT OUTPUT OPERATION**
	0	Self-reset
	1	Latched
F110	**ENUMERATION**	**CONTACT OUTPUT TYPE**
	0	Trip
	1	Alarm
	2	Other
F111	**ENUMERATION**	**UNDERVOLATAGE CURVE SHAPES**
	0	Definite Time
	1	Inverse Time
F112	**ENUMERATION**	**RS485 BAUD RATES**
	0	300
	1	1200
	2	2400
	3	4800
	4	9600
	5	19200
	6	38400
	7	57600
	8	115200
F113	**ENUMERATION**	**PARITY**
	0	None
	1	Odd
	2	Even
F114	**ENUMERATION**	**IRIG-B SIGNAL TYPE**
	0	None
	1	DC Shift
	2	Amplitude Modulated
F118	**ENUMERATION**	**OSCILLOGRAPHY MODE**
	0	Automatic Overwrite
	1	Protected
F119	**ENUMERATION**	**FLEXCURVE PICKUP RATIOS**
	0	0.00
	1	0.05
	2	0.10
	3	0.15
	4	0.20
	5	0.25
	6	0.30
	7	0.35
	8	0.40
	9	0.45
	10	0.48
	11	0.50
	12	0.52
	13	0.54
	14	0.56
	15	0.58

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Table A–9: MODBUS MEMORY MAP DATA FORMATS *(Sheet 3 of 8)*

Format Name	Format Type/Bitmask	Format Definition
	16	0.60
	17	0.62
	18	0.64
	19	0.66
	20	0.68
	21	0.70
	22	0.72
	23	0.74
	24	0.76
	25	0.78
	26	0.80
	27	0.82
	28	0.84
	29	0.86
	30	0.88
	31	0.90
	32	0.91
	33	0.92
	34	0.93
	35	0.94
	36	0.95
	37	0.96
	38	0.97
	39	0.98
	40	1.03
	41	1.05
	42	1.10
	43	1.20
	44	1.30
	45	1.40
	46	1.50
	47	1.60
	48	1.70
	49	1.80
	50	1.90
	51	2.00
	52	2.10
	53	2.20
	54	2.30
	55	2.40
	56	2.50
	57	2.60
	58	2.70
	59	2.80
	60	2.90
	61	3.00
	62	3.10
	63	3.20
	64	3.30
	65	3.40
	66	3.50
	67	3.60
	68	3.70
	69	3.80
	70	3.90
	71	4.00

Table A–9: MODBUS MEMORY MAP DATA FORMATS *(Sheet 4 of 8)*

Format Name	Format Type/Bitmask	Format Definition
	72	4.10
	73	4.20
	74	4.30
	75	4.40
	76	4.50
	77	4.60
	78	4.70
	79	4.80
	80	4.90
	81	5.00
	82	5.10
	83	5.20
	84	5.30
	85	5.40
	86	5.50
	87	5.60
	88	5.70
	89	5.80
	90	5.90
	91	6.00
	92	6.50
	93	7.00
	94	7.50
	95	8.00
	96	8.50
	97	9.00
	98	9.50
	99	10.00
	100	10.50
	101	11.00
	102	11.50
	103	12.00
	104	12.50
	105	13.00
	106	13.50
	107	14.00
	108	14.50
	109	15.00
	110	15.50
	111	16.00
	112	16.50
	113	17.00
	114	17.50
	115	18.00
	116	18.50
	117	19.00
	118	19.50
	119	20.00
F121	**ENUMERATION**	**UR PRODUCT CODE**
	0	To be determined.
	1	Based on order code.
F122	**ENUMERATION**	**ELEMENT INPUT SIGNAL TYPE**
	0	Fundamental
	1	RMS
F123	**ENUMERATION**	**CT SECONDARY**
	0	1 A

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Table A–9: MODBUS MEMORY MAP DATA FORMATS *(Sheet 5 of 8)*

Format Name	Format Type/Bitmask	Format Definition
	1	5 A
F124	**ENUMERATION**	**LIST OF ELEMENTS**
	0	All Elements
	1	PHASE TOC1
	2	PHASE TOC2
	3	PHASE IOC1
	4	PHASE IOC2
	10	NEUTRAL TOC1
	11	NEUTRAL IOC1
	12	NEUTRAL IOC2
	20	87L DIFF
	21	IT TRIP
	22	OPEN POLE
	23	PHASE SELECT
	24	87L PHASE COMP
	25	50DD
	26	CT FAIL
	27	CONT MONITOR
	40	GROUND TOC1
	41	GROUND IOC1
	42	GROUND IOC2
	43	SNS GROUND IOC1
	44	SNS GROUND IOC2
	45	SNS GROUND TOC1
	50	PHASE UV1
	51	PHASE UV2
F125	**ENUMERATION**	**ACCESS LEVEL**
	0	Restricted
	1	Command
	2	Setting
	3	Factory Service
F126	**ENUMERATION**	**NO/YES CHOICE**
	0	No
	1	Yes
F127	**ENUMERATION**	**VIRTUAL INPUT TYPE**
	0	Normal
	1	Self-Reset
F128	**ENUMERATION**	**CONTACT INPUT THRESHOLD**
	0	16 Vdc
	1	30 Vdc
	2	80 Vdc
	3	140 Vdc
F129	**ENUMERATION**	**FLEXLOGIC TIMER TYPE**
	0	millisecond
	1	second
	2	minute
F131	**ENUMERATION**	**FORCED CONTACT OUTPUT STATE**
	0	Disabled
	1	Energized
	2	De-energized
	3	Freeze
F133	**ENUMERATION**	**PROGRAM STATE**
	0	Not Programmed
	1	Programmed
F135	**ENUMERATION**	**GAIN CALIBRATION**
	0	x1

Table A–9: MODBUS MEMORY MAP DATA FORMATS *(Sheet 6 of 8)*

Format Name	Format Type/Bitmask	Format Definition
	1	x16
F136	**ENUMERATION**	**NUMBER OF OSCILLOGRAPHY RECORDS**
	0	31 x 8 cycles
	1	15 x 16 cycles
	2	7 x 32 cycles
	3	3 x 64 cycles
	4	1 x 128 cycles
F138	**ENUMERATION**	**OSCILLOGRAPHY FILE TYPE**
	0	Data File
	1	Configuration File
	2	Header File
F140	**ENUMERATION**	**CURRENT, SENS CURRENT, VOLTAGE, DISABLED**
	0	Disabled
	1	Current
	2	Voltage
	3	Sens Current
F141	**ENUMERATION**	**SELF TEST ERROR**
	0	Any Self-Tests
	1	IRIG-B FAILURE
	2	A/D RESET FAILURE
	3	A/D CAL FAILURE
	4	NO DSP INTERRUPTS
	5	A/D INT MISSING
	6	A/D VOLT REF. FAIL
	7	UNIT NOT CALIBRATED
	8	EEPROM CORRUPTED
	9	CLOCK NOT SET
	10	FLASH MEMORY FAILURE
	11	FACTORY SERVICE MODE
	12	PROTOTYPE SOFTWARE
	13	FLEXLOGIC ERR TOKEN
	14	EQUIPMENT MISMATCH
	15	RAM CODE FAILURE
	16	RELAY NOT PROGRAMMED
	17	DSP CHECKSUM FAILED
	18	DSP FAILED
F142	**ENUMERATION**	**EVENT RECORDER ACCESS FILE TYPE**
	0	All Record Data
	1	Headers Only
F143	**UINT32**	**32 BIT ERROR CODE (F141 specifies the bit number)**
		A bit valu of 0 = no error, 1 = error
F144	**ENUMERATION**	**FORCED CONTACT INPUT STATE**
	0	Disabled
	1	Open
	2	Closed
F145	**ENUMERATION**	**ALPHABET LETTER**
	0	null
	1	A
	2	B
	3	C
	4	D
	5	E
	6	F
	7	G
	8	H
	9	I

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Table A–9: MODBUS MEMORY MAP DATA FORMATS *(Sheet 7 of 8)*

Format Name	Format Type/Bitmask	Format Definition
	10	J
	11	K
	12	L
	13	M
	14	N
	15	O
	16	P
	17	Q
	18	R
	19	S
	20	T
	21	U
	22	V
	23	W
	24	X
	25	Y
	26	Z
F146	**ENUMERATION**	**MISC. EVENT CAUSES**
	0	EVENTS CLEARED
	1	OSCILLOGRAPHY TRIG'D
F200	**TEXT40**	**40 CHARACTER ASCII TEXT**
		20 registers -16 Bits: 1st Char MSB, 2nd Char. LSB
F201	**TEXT8**	**8 CHARACTER ASCII PASSCODE**
		4 registers -16 Bits: 1st Char MSB, 2nd Char. LSB
F202	**TEXT20**	**20 CHARACTER ASCII TEXT**
		10 registers -16 Bits: 1st Char MSB, 2nd Char. LSB
F203	**TEXT16**	**16 CHARACTER ASCII TEXT**
F204	**TEXT80**	**80 CHARACTER ASCII TEXT**
F300	**UINT16**	**FLEXLOGIC BASE TYPE (6 bit type)**
		The FLEXLOGIC BASE TYPE is 6 bits and is combined with a 10 bit descriptor
		to form a 16 bit value. The combined bits are of the form : PTTTTTDDDDDDDDDD
		where P bit if set, indicates that the flexlogic type is associated with a protection element state
		and T represents bits for the BASE type, and D represents bits for the descriptor.
		The values in square brackets indicate the base type and
		the values in round brackets indicate the descriptor range.
		[0] NOP (0) this operator does nothing and is ignored and it may be used as a delimiter
		[1] CONTACT INPUTS (1 - 8)
		[2] VIRTUAL INPUTS (1-25)
		[3] VIRTUAL OUTPUTS (1-64)
		[4] CONTACT OUTPUTS (1-64)
		INSERT (Via Keypad only)
		[16]END
		[17] NOT (0)
		[18] 2 INPUT XOR (0)
		[19] LATCH SET/RESET (0)
		[20] OR (2-16 INPUTS)
		[21] AND (2-16 INPUTS)
		[22] NOR (2-16 INPUTS)
		[23] NAND (2-16 INPUTS)
		[24] TIMER (1-16)
		[25] ASSIGN VIRTUAL OUTPUT (1 - 64)
		[26]SELF-TEST ERROR (See F141 for range)
		[31] MISCELLANEOUS EVENTS (See F146 for range)
		[32-63] ELEMENT STATES (Refer to Memory Map Element States Section)
F500	**UINT16**	**PACKED BITFIELD**

Table A–9: MODBUS MEMORY MAP DATA FORMATS *(Sheet 8 of 8)*

Format Name	Format Type/Bitmask	Format Definition
		First register indicates I/O state with bits 0-15 corresponding to I/0 state 1-16
		Second register indicates I/O state with bits 0-15 corresponding to I/0 state 17-32
		Third register indicates I/O state with bits 0-15 corresponding to I/0 state 33-48
		Fourth register indicates I/O state with bits 0-15 corresponding to I/0 state 49-64
		A bit value of 0 = Off, 1 = On
F504	**BITFIELD**	**TARGET STATE (F124 provides the index associated with the Element State Array)**
	0	Pickup (0=Off, 1=On)
	1	Operate (0=Off, 1=On)
	2	Latched (0=Off, 1=On)
	3	Phase A (0=Off, 1=On)
	4	Phase B (0=Off, 1=On)
	5	Phase C (0=Off, 1=On)
	6	Ground (0=Off, 1=On)

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A.5.2 MODBUS® MEMORY MAP

Table A–10: MODBUS MEMORY MAP *(Sheet 1 of 7)*

addr	Register Name	Range	Units	Step	Format	Factory Defaults
	Product Information (Read Only)					
0000	UR_Product_Type	0 to 1	---	1	F121	0
0002	Product_Version	0.00 to 655.35	---	0.01	F001	1
	Product Information (Read Only -- Written by Factory)					
0010	Serial_Number	---	---	---	F202	0
0020	Manufacturing_Date	0 to 4294967295	---	1	F003	0
0022	Modification_Number	0 to 65535	---	1	F001	0
0040	Order_Code	---	---	---	F204	Order Code x .
	Self Test Targets (Read Only)					
0200	Self_Test_States	0 to 4294967295	0	1	F143	0
	Digital I/O Commands (Read/Write Command)					
0400	Virtual_Input_x_State [32]	0 to 1	---	1	F108	0
	Element Targets (Read Only)					
1000	Element_States [1024]	---	---	---	F504	0
	Digital I/O (Read Only)					
1500	Contact_Input_States [4]	0 to 65535	---	1	F500	0
1508	Virtual_Input_States [4]	0 to 65535	---	1	F500	0
1510	Contact_Output_States [4]	0 to 65535	---	1	F500	0
1518	Contact_Output_Current_States [4]	0 to 65535	---	1	F500	0
1520	Contact_Output_Voltage_States [4]	0 to 65535	---	1	F500	0
1528	Virtual_Output_States [4]	0 to 65535	---	1	F500	0
	Frequency (Read Only)					
1700	Frequency	5.00 to 90.00	Hz	0.01	F001	0
	Phase Currents (Read Only)					
1802	Average_Phase_Current_RMS	0.000 to 99.999	A	0.001	F060	0
1804	Phase_A_Current_RMS	0.000 to 99.999	A rms	0.001	F060	0
1806	Phase_B_Current_RMS	0.000 to 99.999	A rms	0.001	F060	0
1808	Phase_C_Current_RMS	0.000 to 99.999	A rms	0.001	F060	0
180A	Neutral_Current_RMS	0.000 to 99.999	A rms	0.001	F060	0
180C	Phase_A_Current_Magnitude	0.000 to 99.999	A	0.001	F060	0
180E	Phase_A_Current_Angle	-359.9 to 0.0	°	0.1	F002	0
180F	Phase_B_Current_Magnitude	0.000 to 99.999	A	0.001	F060	0
1811	Phase_B_Current_Angle	-359.9 to 0.0	°	0.1	F002	0
1812	Phase_C_Current_Magnitude	0.000 to 99.999	A	0.001	F060	0
1814	Phase_C_Current_Angle	-359.9 to 0.0	°	0.1	F002	0
1815	Neutral_Current_Magnitude	0.000 to 99.999	A	0.001	F060	0
1817	Neutral_Current_Angle	-359.9 to 0.0	°	0.1	F002	0
	Ground Current (Read Only)					
1821	Ground_Current_RMS	0.000 to 99.999	A rms	0.001	F060	0
1823	Ground_Current_Magnitude	0.000 to 99.999	A	0.001	F060	0
1825	Ground_Current_Angle	-359.9 to 0.0	°	0.1	F002	0
1827	Sns_Ground_Current_RMS	0.000 to 99.999	A rms	0.001	F060	0
1829	Sns_Ground_Current_Magnitude	0.000 to 99.999	A	0.001	F060	0
	Voltages (Read Only)					
2000	Average_Phase_Voltage_RMS	0.000 to 99.999	V	0.001	F060	0
2002	Phase_AG_Voltage_RMS	0.000 to 99.999	V rms	0.001	F060	0
2004	Phase_BG_Voltage_RMS	0.000 to 99.999	V rms	0.001	F060	0
2006	Phase_CG_Voltage_RMS	0.000 to 99.999	V rms	0.001	F060	0
200A	Phase_AG_Voltage_Magnitude	0.000 to 99.999	V	0.001	F060	0
200C	Phase_AG_Voltage_Angle	-359.9 to 0.0	°	0.1	F002	0
200D	Phase_BG_Voltage_Magnitude	0.000 to 99.999	V	0.001	F060	0

Table A–10: MODBUS MEMORY MAP *(Sheet 2 of 7)*

addr	Register Name	Range	Units	Step	Format	Factory Defaults
200F	Phase_BG_Voltage_Angle	-359.9 to 0.0	°	0.1	F002	0
2010	Phase_CG_Voltage_Magnitude	0.000 to 99.999	V	0.001	F060	0
2012	Phase_CG_Voltage_Angle	-359.9 to 0.0	°	0.1	F002	0
201E	Average_Line_Voltage_RMS	0.000 to 99.999	V	0.001	F060	0
2020	Line_AB_Voltage_RMS	0.000 to 99.999	V rms	0.001	F060	0
2022	Line_BC_Voltage_RMS	0.000 to 99.999	V rms	0.001	F060	0
2024	Line_CA_Voltage_RMS	0.000 to 99.999	V rms	0.001	F060	0
2026	Line_AB_Voltage_Magnitude	0.000 to 99.999	V	0.001	F060	0
2028	Line_AB_Voltage_Angle	-359.9 to 0.0	°	0.1	F002	0
2029	Line_BC_Voltage_Magnitude	0.000 to 99.999	V	0.001	F060	0
202B	Line_BC_Voltage_Angle	-359.9 to 0.0	°	0.1	F002	0
202C	Line_CA_Voltage_Magnitude	0.000 to 99.999	V	0.001	F060	0
202E	Line_CA_Voltage_Angle	-359.9 to 0.0	°	0.1	F002	0
	Power (Read Only)					
2E02	Three_Phase_Real_Power	-2147483.647 to	W	0.001	F060	0
2E04	Three_Phase_Reactive_Power	-2147483.647 to	var	0.001	F060	0
2E06	Three_Phase_Apparent_Power	-2147483.647 to	VA	0.001	F060	0
2E0A	Three_Phase_True_PF	-.999 to 1.000	---	0.001	F013	0
2E0C	Phase_A_Real_Power	-2147483.647 to	W	0.001	F060	0
2E0E	Phase_A_Reactive_Power	-2147483.647 to	var	0.001	F060	0
2E10	Phase_A_Apparent_Power	-2147483.647 to	VA	0.001	F060	0
2E14	Phase_A_True_PF	-.999 to 1.000	---	0.001	F013	0
2E16	Phase_B_Real_Power	-2147483.647 to	W	0.001	F060	0
2E18	Phase_B_Reactive_Power	-2147483.647 to	var	0.001	F060	0
2E1A	Phase_B_Apparent_Power	-2147483.647 to	VA	0.001	F060	0
2E1E	Phase_B_True_PF	-.999 to 1.000	---	0.001	F013	0
2E20	Phase_C_Real_Power	-2147483.647 to	W	0.001	F060	0
2E22	Phase_C_Reactive_Power	-2147483.647 to	var	0.001	F060	0
2E24	Phase_C_Apparent_Power	-2147483.647 to	VA	0.001	F060	0
2E28	Phase_C_True_PF	-.999 to 1.000	---	0.001	F013	0
	Oscillography Status and Access Registers (Read Only)					
3000	Oscillography_Number_of_Triggers	0 to 65535	---	1	F001	0
3001	Oscillography_Available_Records	0 to 65535	---	1	F001	0
3002	Oscillography_Last_Cleared_Date	0 to 400000000	---	1	F003	0
	Oscillography Status and Access Registers (Read/ Write Command)					
3004	Oscillography_Clear_Data	0 to 1	---	1	F126	0
	Oscillography File Transfer (Read/Write)					
3020	Oscillography_File_Identifier	0 to 65535	---	1	F001	0
3021	Oscillography_File_Type	0 to 2	---	1	F138	0
	Oscillography File Transfer (Read Only)					
3022	Oscillography_File_Size	0 to 4294967295	---	1	F003	0
3024	Oscillography_File_Position	0 to 4294967295	---	1	F003	0
3026	Oscillography_File_Access [123]	0 to 65535	---	1	F001	0
	Event Recorder (Read Only)					
3400	Events_Since_Last_Clear	0 to 4294967295	---	1	F003	0
3402	Number_of_Available_Events	0 to 4294967295	---	1	F003	0
3404	Event_Recorder_Last_Cleared_Date	---	---	---	F050	0
	Event Recorder (Read/Write Command)					
3406	Event_Recorder_Clear_Command	0 to 1	---	1	F126	0
	Event Recorder File Transfer (Read/Write)					
3420	Event_File_First_Event	0 to 4294967295	---	1	F003	0
3422	Event_File_Last_Event	0 to 4294967295	---	1	F003	0
3424	Event_File_Type	0 to 1	---	1	F142	0

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Table A–10: MODBUS MEMORY MAP *(Sheet 3 of 7)*

addr	Register Name	Range	Units	Step	Format	Factory Defaults
	Event Recorder File Transfer (Read Only)					
3425	Event_File_Position	0 to 4294967295	---	1	F003	0
3427	Event_File_Access [123]	0 to 65535	---	1	F001	0
	Passwords (Read Only)					
4000	Encrypted_Command_Password	0 to 4294967295	---	1	F003	0
4002	Encrypted_Setting_Password	0 to 4294967295	---	1	F003	0
	Preferences (Read/Write Setting)					
4050	Flash_Message_Time	0.5 to 10.0	s	0.1	F001	40
4051	Default_Message_Timeout	10 to 900	s	1	F001	300
4052	Default_Message_Intensity	0 to 3	---	1	F101	0
4053	Screen_Saver_Feature	0 to 1	---	1	F102	0
4054	Screen_Saver_Wait_Time	1 to 65535	min	1	F001	30
	Communications (Read/Write Setting)					
4080	Modbus_Slave_Address	1 to 254	---	1	F001	254
4083	RS485_Com1_Baud_Rate	0 to 8	---	1	F112	8
4084	RS485_Com1_Parity	0 to 2	---	1	F113	0
4085	RS485_Com2_Baud_Rate	0 to 8	---	1	F112	8
4086	RS485_Com2_Parity	0 to 2	---	1	F113	0
4087	Ethernet_IP_Address	---	---	---	F003	56554706
4089	Gateway_IP_Address	---	---	---	F003	56554497
408B	Network_Address_NSAP	0 to 4294967295	---	1	F003	56554706
408D	Target_Name	---	---	---	F202	relay1
	Clock (Read/Write Setting)					
41A0	Current_Date	---	---	---	F050	0
	Real Time Clock (Read/Write Setting)					
41A4	IRIG_B_Signal_Type	0 to 2	---	1	F114	0
	Oscillography (Read/Write Setting)					
41C0	Oscillography_Number_of_Records	0 to 4	---	1	F136	1
41C1	Oscillography_Trigger_Mode	0 to 1	---	1	F118	0
41C2	Oscillography_Trigger_Position	0 to 100	%	1	F001	50
41C3	Oscillography_Trigger_Source	---	---	---	F300	0
41E4	Oscillography_Digital_Channel_X [256]	---	---	---	F300	0
	Scratchpad (Read/Write Setting)					
4300	Scratchpad_1	---	---	---	F200	Text 1
4328	Scratchpad_2	---	---	---	F200	Text 2
4350	Scratchpad_3	---	---	---	F200	Text 3
4378	Scratchpad_4	---	---	---	F200	Text 4
43A0	Scratchpad_5	---	---	---	F200	Text 5
	Installation (Read/Write Setting)					
43E0	Relay_Programmed_State	0 to 1	---	1	F133	0
43E1	Relay_Name	---	---	---	F202	Site-1
43EB	Relay_Identifier	---	---	---	F202	UR
	Current Sensing (Read/Write Setting)					
4480	Phase_CT_Primary	1 to 50000	A	1	F001	100
4481	Phase_CT_Secondary	0 to 1	---	1	F123	1
4482	Ground_CT_Primary	1 to 50000	A	1	F001	100
4483	Ground_CT_Secondary	0 to 1	---	1	F123	1
	Voltage Sensing (Read/Write Setting)					
4500	VT_Connection_Type	0 to 2	---	1	F100	0
4501	VT_Secondary_Voltage	50.0 to 240.0	V	0.1	F001	1200
4502	VT_Ratio	0.1 to 24000.0	:1	0.1	F003	1200
	Power System (Read/Write Setting)					
4600	Nominal_Frequency	25 to 60	Hz	1	F001	60
4601	Phase_Rotation	0 to 1	---	1	F106	0
	FlexCurve A (Read/Write Setting)					

Table A–10: MODBUS MEMORY MAP *(Sheet 4 of 7)*

addr	Register Name	Range	Units	Step	Format	Factory Defaults
4800	FlexCurve_A [120]	0 to 65535	ms	1	F011	0
	FlexCurve B (Read/Write Setting)					
48F0	FlexCurve_B [120]	0 to 65535	ms	1	F011	0
	Flexlogic (Read/Write Setting)					
5000	FlexLogic_Entry [512]	---	---	---	F300	16384
	Flexlogic Timers [32] (Read/Write Setting)					
5800	Timer_x_Type	0 to 2	---	1	F129	0
5801	Timer_x_Pickup_Delay	0 to 60000	---	1	F001	0
5802	Timer_x_Dropout_Delay	0 to 60000	---	1	F001	0
5803	Timer_x_Reserved [5]	0 to 65535	---	1	F001	0
	Phase TOC1 (Read/Write Grouped Setting)					
5900	Phase_TOC1_Function	0 to 1	---	1	F102	0
5901	Phase_TOC1_Input	0 to 1	---	1	F122	0
5902	Phase_TOC1_Pickup	0.05 to 115.00	A	0.01	F001	105
5903	Phase_TOC1_Curve	0 to 14	---	1	F103	0
5904	Phase_TOC1_Multiplier	0.00 to 600.00	---	0.01	F001	100
5905	Phase_TOC1_Reset	0 to 1	---	1	F104	0
5906	Phase_TOC1_Block	---	---	---	F300	0
5907	Phase_TOC1_Target	0 to 1	---	1	F109	0
5908	Phase_TOC1_Events	0 to 1	---	1	F102	0
	Phase TOC2 (Read/Write Grouped Setting)					
5910	Phase_TOC2_Function	0 to 1	---	1	F102	0
5911	Phase_TOC2_Input	0 to 1	---	1	F122	0
5912	Phase_TOC2_Pickup	0.05 to 115.00	A	0.01	F001	105
5913	Phase_TOC2_Curve	0 to 14	---	1	F103	0
5914	Phase_TOC2_Multiplier	0.00 to 600.00	---	0.01	F001	100
5915	Phase_TOC2_Reset	0 to 1	---	1	F104	0
5916	Phase_TOC2_Block	---	---	---	F300	0
5917	Phase_TOC2_Target	0 to 1	---	1	F109	0
5918	Phase_TOC2_Events	0 to 1	---	1	F102	0
	Phase IOC1 (Read/Write Grouped Setting)					
5A00	Phase_IOC1_Function	0 to 1	---	1	F102	0
5A01	Phase_IOC1_Pickup	0.05 to 115.00	A	0.01	F001	105
5A02	Phase_IOC1_Delay	0.00 to 600.00	s	0.01	F001	0
5A03	Phase_IOC1_Reset_Delay	0.00 to 600.00	s	0.01	F001	0
5A04	Phase_IOC1_Block	---	---	---	F300	0
5A05	Phase_IOC1_Target	0 to 1	---	1	F109	0
5A06	Phase_IOC1_Events	0 to 1	---	1	F102	0
	Phase IOC2 (Read/Write Grouped Setting)					
5A10	Phase_IOC2_Function	0 to 1	---	1	F102	0
5A11	Phase_IOC2_Pickup	0.05 to 115.00	A	0.01	F001	105
5A12	Phase_IOC2_Delay	0.00 to 600.00	s	0.01	F001	0
5A13	Phase_IOC2_Reset_Delay	0.00 to 600.00	s	0.01	F001	0
5A14	Phase_IOC2_Block	---	---	---	F300	0
5A15	Phase_IOC2_Target	0 to 1	---	1	F109	0
5A16	Phase_IOC2_Events	0 to 1	---	1	F102	0
	Neutral TOC1 (Read/Write Grouped Setting)					
5B00	Neutral_TOC1_Function	0 to 1	---	1	F102	0
5B01	Neutral_TOC1_Input	0 to 1	---	1	F122	0
5B02	Neutral_TOC1_Pickup	0.05 to 115.00	A	0.01	F001	105
5B03	Neutral_TOC1_Curve	0 to 14	---	1	F103	0
5B04	Neutral_TOC1_Multiplier	0.00 to 600.00	---	0.01	F001	100
5B05	Neutral_TOC1_Reset	0 to 1	---	1	F104	0
5B06	Neutral_TOC1_Block	---	---	---	F300	0
5B07	Neutral_TOC1_Target	0 to 1	---	1	F109	0

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Table A–10: MODBUS MEMORY MAP *(Sheet 5 of 7)*

addr	Register Name	Range	Units	Step	Format	Factory Defaults
5B08	Neutral_TOC1_Events	0 to 1	---	1	F102	0
	Neutral IOC1 (Read/Write Grouped Setting)					
5C00	Neutral_IOC1_Function	0 to 1	---	1	F102	0
5C01	Neutral_IOC1_Pickup	0.05 to 115.00	A	0.01	F001	105
5C02	Neutral_IOC1_Delay	0.00 to 600.00	s	0.01	F001	0
5C03	Neutral_IOC1_Reset_Delay	0.00 to 600.00	s	0.01	F001	0
5C04	Neutral_IOC1_Block	---	---	---	F300	0
5C05	Neutral_IOC1_Target	0 to 1	---	1	F109	0
5C06	Neutral_IOC1_Events	0 to 1	---	1	F102	0
	Neutral IOC2 (Read/Write Grouped Setting)					
5C10	Neutral_IOC2_Function	0 to 1	---	1	F102	0
5C11	Neutral_IOC2_Pickup	0.05 to 115.00	A	0.01	F001	105
5C12	Neutral_IOC2_Delay	0.00 to 600.00	s	0.01	F001	0
5C13	Neutral_IOC2_Reset_Delay	0.00 to 600.00	s	0.01	F001	0
5C14	Neutral_IOC2_Block	---	---	---	F300	0
5C15	Neutral_IOC2_Target	0 to 1	---	1	F109	0
5C16	Neutral_IOC2_Events	0 to 1	---	1	F102	0
	Ground TOC1 (Read/Write Grouped Setting)					
5D00	Ground_TOC1_Function	0 to 1	---	1	F102	0
5D01	Ground_TOC1_Input	0 to 1	---	1	F122	0
5D02	Ground_TOC1_Pickup	0.05 to 115.00	A	0.01	F001	105
5D03	Ground_TOC1_Curve	0 to 14	---	1	F103	0
5D04	Ground_TOC1_Multiplier	0.00 to 600.00	---	0.01	F001	100
5D05	Ground_TOC1_Reset	0 to 1	---	1	F104	0
5D06	Ground_TOC1_Block	---	---	---	F300	0
5D07	Ground_TOC1_Target	0 to 1	---	1	F109	0
5D08	Ground_TOC1_Events	0 to 1	---	1	F102	0
	Sns Ground TOC1 (Read/Write Grouped Setting)					
5D20	Sns_Ground_TOC1_Function	0 to 1	---	1	F102	0
5D21	Sns_Ground_TOC1_Input	0 to 1	---	1	F122	0
5D22	Sns_Ground_TOC1_Pickup	0.005 to 11.500	A	0.001	F001	1050
5D23	Sns_Ground_TOC1_Curve	0 to 14	---	1	F103	0
5D24	Sns_Ground_TOC1_Multiplier	0.00 to 600.00	---	0.01	F001	100
5D25	Sns_Ground_TOC1_Reset	0 to 1	---	1	F104	0
5D26	Sns_Ground_TOC1_Block	---	---	---	F300	0
5D27	Sns_Ground_TOC1_Target	0 to 1	---	1	F109	0
5D28	Sns_Ground_TOC1_Events	0 to 1	---	1	F102	0
	Ground IOC1 (Read/Write Grouped Setting)					
5E00	Ground_IOC1_Function	0 to 1	---	1	F102	0
5E01	Ground_IOC1_Pickup	0.05 to 115.00	A	0.01	F001	105
5E02	Ground_IOC1_Delay	0.00 to 600.00	s	0.01	F001	0
5E03	Ground_IOC1_Reset_Delay	0.00 to 600.00	s	0.01	F001	0
5E04	Ground_IOC1_Block	---	---	---	F300	0
5E05	Ground_IOC1_Target	0 to 1	---	1	F109	0
5E06	Ground_IOC1_Events	0 to 1	---	1	F102	0
	Ground IOC2 (Read/Write Grouped Setting)					
5E10	Ground_IOC2_Function	0 to 1	---	1	F102	0
5E11	Ground_IOC2_Pickup	0.05 to 115.00	A	0.01	F001	105
5E12	Ground_IOC2_Delay	0.00 to 600.00	s	0.01	F001	0
5E13	Ground_IOC2_Reset_Delay	0.00 to 600.00	s	0.01	F001	0
5E14	Ground_IOC2_Block	---	---	---	F300	0
5E15	Ground_IOC2_Target	0 to 1	---	1	F109	0
5E16	Ground_IOC2_Events	0 to 1	---	1	F102	0
	Sns Ground IOC1 (Read/Write Grouped Setting)					
5E40	Sns_Ground_IOC1_Function	0 to 1	---	1	F102	0

Table A–10: MODBUS MEMORY MAP *(Sheet 6 of 7)*

addr	Register Name	Range	Units	Step	Format	Factory Defaults
5E41	Sns_Ground_IOC1_Pickup	0.005 to 11.500	A	0.001	F001	1050
5E42	Sns_Ground_IOC1_Delay	0.00 to 600.00	s	0.01	F001	0
5E43	Sns_Ground_IOC1_Reset_Delay	0.00 to 600.00	s	0.01	F001	0
5E44	Sns_Ground_IOC1_Block	---	---	---	F300	0
5E45	Sns_Ground_IOC1_Target	0 to 1	---	1	F109	0
5E46	Sns_Ground_IOC1_Events	0 to 1	---	1	F102	0
	Sns Ground IOC2 (Read/Write Grouped Setting)					
5E60	Sns_Ground_IOC2_Function	0 to 1	---	1	F102	0
5E61	Sns_Ground_IOC2_Pickup	0.005 to 11.500	A	0.001	F001	1050
5E62	Sns_Ground_IOC2_Delay	0.00 to 600.00	s	0.01	F001	0
5E63	Sns_Ground_IOC2_Reset_Delay	0.00 to 600.00	s	0.01	F001	0
5E64	Sns_Ground_IOC2_Block	---	---	---	F300	0
5E65	Sns_Ground_IOC2_Target	0 to 1	---	1	F109	0
5E66	Sns_Ground_IOC2_Events	0 to 1	---	1	F102	0
	Phase Undervoltage1 (Read/Write Grouped Setting)					
7000	Phase_UV1_Function	0 to 1	---	1	F102	0
7001	Phase_UV1_Pickup	0.00 to 250.00	V	0.01	F001	10000
7002	Phase_UV1_Curve	0 to 1	---	1	F111	0
7003	Phase_UV1_Delay	0.00 to 600.00	s	0.01	F001	100
7004	Phase_UV1_Minimum_Voltage	0.00 to 200.00	V	0.01	F001	1000
7005	Phase_UV1_Block	---	---	---	F300	0
7006	Phase_UV1_Target	0 to 1	---	1	F109	0
7007	Phase_UV1_Events	0 to 1	---	1	F102	0
	Phase Undervoltage2 (Read/Write Grouped Setting)					
7010	Phase_UV2_Function	0 to 1	---	1	F102	0
7011	Phase_UV2_Pickup	0.00 to 250.00	V	0.01	F001	10000
7012	Phase_UV2_Curve	0 to 1	---	1	F111	0
7013	Phase_UV2_Delay	0.00 to 600.00	s	0.01	F001	100
7014	Phase_UV2_Minimum_Voltage	0.00 to 200.00	V	0.01	F001	1000
7015	Phase_UV2_Block	---	---	---	F300	0
7016	Phase_UV2_Target	0 to 1	---	1	F109	0
7017	Phase_UV2_Events	0 to 1	---	1	F102	0
	Contact Inputs [64] (Read/Write Setting)					
C000	Contact_Input_x_Function	0 to 1	---	1	F102	0
C001	Contact_Input_x_Name	---	---	---	F202	Contact Input x .
C00B	Contact_Input_x_On_State	0 to 1	---	1	F107	1
C00C	Contact_Input_x_Events	0 to 1	---	1	F102	0
C00D	Contact_Input_x_Reserved [3]	0 to 0	---	0	F001	0
	Contact Input Thresholds (Read/Write Setting)					
C600	Contact_Input_x_Threshold [16]	0 to 3	---	1	F128	1
	Virtual Inputs [32] (Read/Write Setting)					
C690	Virtual_Input_x_Function	0 to 1	---	1	F102	0
C691	Virtual_Input_x_Name	---	---	---	F202	Virtual Input x .
C69B	Virtual_Input_x_Programmed_Type	0 to 1	---	1	F127	1
C69C	Virtual_Input_x_Events	0 to 1	---	1	F102	0
C69D	Virtual_Input_x_Reserved [3]	0 to 0	---	0	F001	0
	Virtual Outputs [64] (Read/Write Setting)					
CC90	Virtual_Output_x_Name	---	---	---	F202	Virtual Output x .
	0 to 1	---	1	F102	0	
CC9B	Virtual_Output_x_Reserved [5]	0 to 0	---	0	F001	0
	Contact Outputs [64] (Read/Write Setting)					

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Table A–10: MODBUS MEMORY MAP *(Sheet 7 of 7)*

addr	Register Name	Range	Units	Step	Format	Factory Defaults
D290	Contact_Output_x_Name	---	---	---	F202	Contact Output x .
D29A	Contact_Output_x_Operation	---	---	---	F300	0
D29B	Contact_Output_x_Sealin	---	---	---	F300	0
D29C	Contact_Output_x_Type	0 to 2	---	1	F110	0
D29D	Contact_Output_x_Events	0 to 1	---	1	F102	1
D29E	Contact_Output_x_Reserved [2]	0 to 0	---	0	F001	0
	Force Contact Inputs (Read/Write Setting)					
D8B0	Force_Contact_Input_x_State [64]	0 to 2	---	1	F144	0
	Force Contact Outputs (Read/Write Setting)					
D910	Force_Contact_Output_x_State [64]	0 to 3	---	1	F131	0

B.1.1 OVERVIEW OF UCA

The Utility Communications Architecture (UCA) version 2.0 represents an attempt by utilities and vendors of electronic equipment to produce standardized communications systems. There is a set of reference documents available from the Electric Power Research Institute (EPRI) and vendors of UCA/MMS software libraries that document the complete capabilities of the UCA. This appendix provides a description of the subset of UCA/MMS features that are supported by a UR type relay. The reference document set includes:

Introduction to UCA Version 2.0

- Generic Object Models for Substation & Feeder Equipment (GOMSFE)
- Common Application Service Models (CASM) and Mapping to MMS
- UCA Version 2.0 Profiles

B.1.2 COMMUNICATION PROFILE

The UCA specifies a number of possibilities for communicating with electronic devices based on the OSI Reference Model. A UR relay uses a 7 layer OSI stack (TP4/CLNP profile). Refer to the “UCA Version 2.0 Profiles” reference document for details. The TP4/CLNP profile requires the UR relay to have a network address or Network Service Access Point (NSAP) in order to establish a communication link. This address can be set from the COMMUNICATIONS section in the SETTINGS, PAGE 1 section of MMI messages.

B.1.3 MANUFACTURING MESSAGE SPECIFICATION (MMS)

The UCA specifies the use of the Manufacturing Message Specification (MMS) at the upper (Application) layer for transfer of real-time data. This protocol has been in existence for a number of years and provides a set of services suitable for transfer of data within a substation LAN environment. Data can be grouped to form objects and mapped to MMS services. Refer to the “GOMSFE” and “CASM” reference documents for details.

B.1.4 DESCRIPTION OF SUPPORTED OBJECTS

The “GOMSFE” document describes a number of communication objects. Within these objects are items some of which are mandatory and some of which are optional depending on the implementation. The UR relay supports the following GOMSFE objects:

- IOC (used for UR relay IOC protection elements)
- TOC (used for UR relay TOC protection elements)
- MU (used for UR relay metering quantities)

Since MMS implementations are inherently self-describing, the exact structure of these objects can be seen by connecting to a UR relay with an MMS browser such as the MMS Object Explorer in AX-S4 MMS from Sisco Inc. All variable names follow the GOMSFE guidelines.

B

GE MULTILIN RELAY WARRANTY

General Electric Multilin Inc. (GE Multilin) warrants each relay it manufactures to be free from defects in material and workmanship under normal use and service for a period of 24 months from date of shipment from factory.

In the event of a failure covered by warranty, GE Multilin will undertake to repair or replace the relay providing the warrantor determined that it is defective and it is returned with all transportation charges prepaid to an authorized service centre or the factory. Repairs or replacement under warranty will be made without charge.

Warranty shall not apply to any relay which has been subject to misuse, negligence, accident, incorrect installation or use not in accordance with instructions nor any unit that has been altered outside a GE Multilin authorized factory outlet.

GE Multilin is not liable for special, indirect or consequential damages or for loss of profit or for expenses sustained as a result of a relay malfunction, incorrect application or adjustment.

For complete text of Warranty (including limitations and disclaimers), refer to GE Multilin Standard Conditions of Sale.

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