GE Industrial Systems

C30 Controller

UR Series Instruction Manual

C30 Revision: 3.3x

Manual P/N: 1601-0088-**E2** (GEK-106405A)

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E200431
LISTED
MEASURING EQUIP.
36GN

Manufactured under an
ISO9000 Registered system.

GE Industrial Systems

ADDENDUM

This Addendum contains information that relates to the C30 Controller relay, version 3.3x. This addendum lists a number of information items that appear in the instruction manual GEK-106405A (revision **E2**) but are not included in the current C30 operations.

The following functions/items are not yet available with the current version of the C30 relay:

- Setting Groups Feature

NOTE

The UCA2 specifications are not yet finalized. There will be changes to the object models described in Appendix C: UCA/MMS Protocol.

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A. FLEXANALOG PARAMETERS

B. MODBUS COMMUNICATIONS

C. UCA/MMS COMMUNICATIONS

D. IEC 60870-5-104 COMMUNICATIONS

E. DNP COMMUNICATIONS

F. MISCELLANEOUS

INDEX

Please read this chapter to help guide you through the initial setup of your new relay.

1.1.1 CAUTIONS AND WARNINGS

WARNING CAUTION

Before attempting to install or use the relay, it is imperative that all WARNINGS and CAUTIONS in this manual are reviewed to help prevent personal injury, equipment damage, and/or downtime.

1.1.2 INSPECTION CHECKLIST

- Open the relay packaging and inspect the unit for physical damage.
- Check that the battery tab is intact on the power supply module (for additional details, see the Battery Tab section near the end of this chapter).
- View the rear nameplate and verify that the correct model has been ordered.

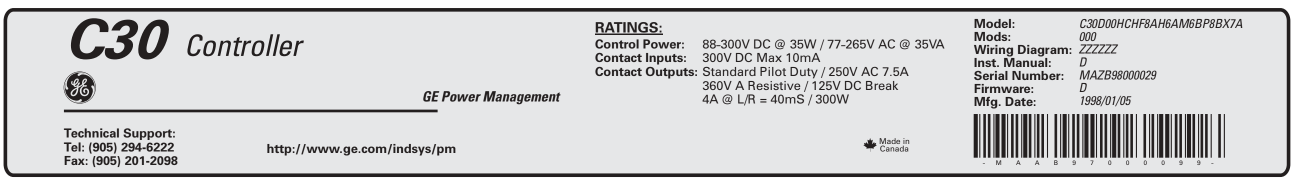

Figure 1–1: REAR NAMEPLATE (EXAMPLE)

- Ensure that the following items are included:
  - Instruction Manual
  - GE Multilin Products CD (includes the URPC software and manuals in PDF format)
  - mounting screws
  - registration card (attached as the last page of the manual)
- Fill out the registration form and mail it back to GE Multilin (include the serial number located on the rear nameplate).
- For product information, instruction manual updates, and the latest software updates, please visit the GE Multilin website at http://www.GEindustrial.com/multilin.

NOTE

If there is any noticeable physical damage, or any of the contents listed are missing, please contact GE Multilin immediately.

***GE MULTILIN* CONTACT INFORMATION AND CALL CENTER FOR PRODUCT SUPPORT:**

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HOME PAGE: http://www.GEindustrial.com/multilin

1.2.1 INTRODUCTION TO THE UR

Historically, substation protection, control, and metering functions were performed with electromechanical equipment. This first generation of equipment was gradually replaced by analog electronic equipment, most of which emulated the single-function approach of their electromechanical precursors. Both of these technologies required expensive cabling and auxiliary equipment to produce functioning systems.

Recently, digital electronic equipment has begun to provide protection, control, and metering functions. Initially, this equipment was either single function or had very limited multi-function capability, and did not significantly reduce the cabling and auxiliary equipment required. However, recent digital relays have become quite multi-functional, reducing cabling and auxiliaries significantly. These devices also transfer data to central control facilities and Human Machine Interfaces using electronic communications. The functions performed by these products have become so broad that many users now prefer the term IED (Intelligent Electronic Device).

It is obvious to station designers that the amount of cabling and auxiliary equipment installed in stations can be even further reduced, to 20% to 70% of the levels common in 1990, to achieve large cost reductions. This requires placing even more functions within the IEDs.

Users of power equipment are also interested in reducing cost by improving power quality and personnel productivity, and as always, in increasing system reliability and efficiency. These objectives are realized through software which is used to perform functions at both the station and supervisory levels. The use of these systems is growing rapidly.

High speed communications are required to meet the data transfer rates required by modern automatic control and monitoring systems. In the near future, very high speed communications will be required to perform protection signaling with a performance target response time for a command signal between two IEDs, from transmission to reception, of less than 5 milliseconds. This has been established by the Electric Power Research Institute, a collective body of many American and Canadian power utilities, in their Utilities Communications Architecture 2 (MMS/UCA2) project. In late 1998, some European utilities began to show an interest in this ongoing initiative.

IEDs with the capabilities outlined above will also provide significantly more power system data than is presently available, enhance operations and maintenance, and permit the use of adaptive system configuration for protection and control systems. This new generation of equipment must also be easily incorporated into automation systems, at both the station and enterprise levels. The GE Multilin Universal Relay (UR) has been developed to meet these goals.

1.2.2 HARDWARE ARCHITECTURE

a) UR BASIC DESIGN

The UR is a digital-based device containing a central processing unit (CPU) that handles multiple types of input and output signals. The UR can communicate over a local area network (LAN) with an operator interface, a programming device, or another UR device.

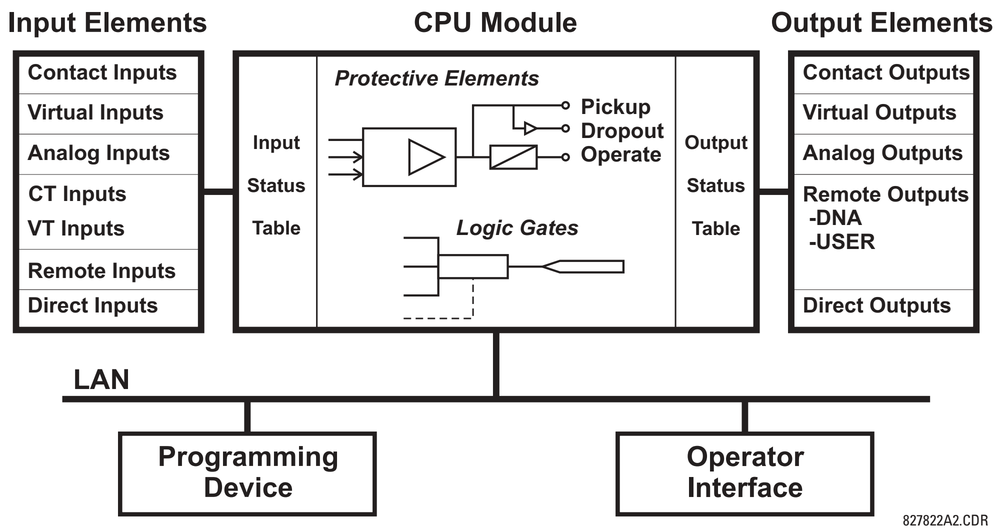


Figure 1–2: UR CONCEPT BLOCK DIAGRAM

The **CPU module** contains firmware that provides protection elements in the form of logic algorithms, as well as programmable logic gates, timers, and latches for control features.

Input elements accept a variety of analog or digital signals from the field. The UR isolates and converts these signals into logic signals used by the relay.

Output elements convert and isolate the logic signals generated by the relay into digital or analog signals that can be used to control field devices.

b) UR SIGNAL TYPES

The **contact inputs and outputs** are digital signals associated with connections to hard-wired contacts. Both 'wet' and 'dry' contacts are supported.

The **virtual inputs and outputs** are digital signals associated with UR internal logic signals. Virtual inputs include signals generated by the local user interface. The virtual outputs are outputs of FlexLogic™ equations used to customize the UR device. Virtual outputs can also serve as virtual inputs to FlexLogic™ equations.

The **analog inputs and outputs** are signals that are associated with transducers, such as Resistance Temperature Detectors (RTDs).

The **CT and VT inputs** refer to analog current transformer and voltage transformer signals used to monitor AC power lines. The UR supports 1 A and 5 A CTs.

The **remote inputs and outputs** provide a means of sharing digital point state information between remote UR devices. The remote outputs interface to the remote inputs of other UR devices. Remote outputs are FlexLogic™ operands inserted into UCA2 GOOSE messages and are of two assignment types: DNA standard functions and USER defined functions.

The **direct inputs and outputs** provide a means of sharing digital point states between a number of UR IEDs over a dedicated fiber (single or multimode), RS422, or G.703 interface. No switching equipment is required as the IEDs are connected directly in a ring or redundant (dual) ring configuration. This feature is optimized for speed and intended for pilot-aided schemes, distributed logic applications, or the extension of the input/output capabilities of a single UR chassis.

c) UR SCAN OPERATION

The UR device operates in a cyclic scan fashion. The UR reads the inputs into an input status table, solves the logic program (FlexLogic™ equation), and then sets each output to the appropriate state in an output status table. Any resulting task execution is priority interrupt-driven.

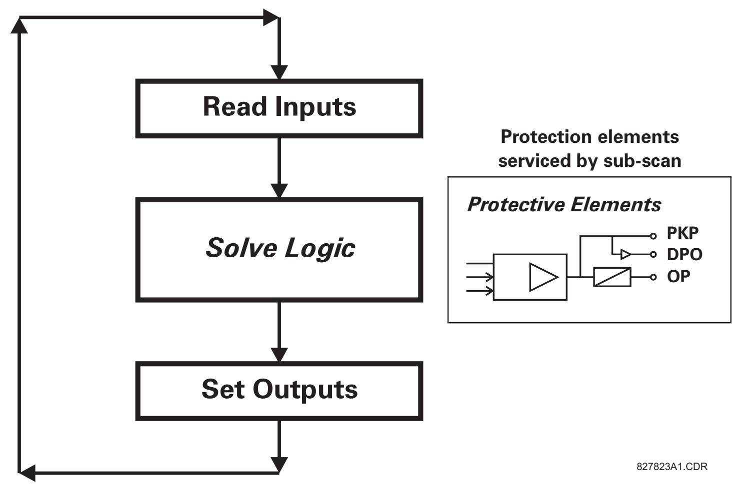


Figure 1–3: UR SCAN OPERATION

1.2.3 UR SOFTWARE ARCHITECTURE

The firmware (software embedded in the relay) is designed in functional modules which can be installed in any relay as required. This is achieved with Object-Oriented Design and Programming (OOD/OOP) techniques.

Object-Oriented techniques involve the use of 'objects' and 'classes'. An 'object' is defined as "a logical entity that contains both data and code that manipulates that data". A 'class' is the generalized form of similar objects. By using this concept, one can create a Protection Class with the Protection Elements as objects of the class such as Time Overcurrent, Instantaneous Overcurrent, Current Differential, Undervoltage, Overvoltage, Underfrequency, and Distance. These objects represent completely self-contained software modules. The same object-class concept can be used for Metering, I/O Control, HMI, Communications, or any functional entity in the system.

Employing OOD/OOP in the software architecture of the Universal Relay achieves the same features as the hardware architecture: modularity, scalability, and flexibility. The application software for any Universal Relay (e.g. Feeder Protection, Transformer Protection, Distance Protection) is constructed by combining objects from the various functionality classes. This results in a 'common look and feel' across the entire family of UR platform-based applications.

1.2.4 IMPORTANT CONCEPTS

As described above, the architecture of the UR relay is different from previous devices. In order to achieve a general understanding of this device, some sections of Chapter 5 are quite helpful. The most important functions of the relay are contained in "Elements". A description of UR elements can be found in the Introduction to Elements section in Chapter 5. An example of a simple element, and some of the organization of this manual, can be found in the Digital Elements settings section. An explanation of the use of inputs from CTs and VTs is in the Introduction to AC Sources section in Chapter 5. A description of how digital signals are used and routed within the relay is contained in the Introduction to FlexLogic™ section in Chapter 5.

1.3.1 REQUIREMENTS

The Faceplate keypad and display or the URPC software interface can be used to communicate with the relay.

The URPC software interface is the preferred method to edit settings and view actual values because the PC monitor can display more information in a simple comprehensible format.

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

- Pentium class or higher processor (Pentium II 300 MHz or higher recommended)
- Windows 95, 98, 98SE, ME, NT 4.0 (Service Pack 4 or higher), 2000, XP
- 64 MB of RAM (256 MB recommended)
- 40 MB of available hard drive space (100 MB recommended)
- Video capable of displaying 800 x 600 or higher in High Color mode (16-bit color)
- RS232 and/or Ethernet communications port to the relay

1.3.2 INSTALLATION

Refer to the following procedure to install the **URPC** software:

1. Insert the GE Multilin Products CD into your PC or direct your web browser to the GE Multilin website at http://www.GEindustrial.com/multilin (preferred method). The Products CD is essentially a snapshot of the GE Multilin website at the date printed on the CD; install from the website to ensure the most recent version of URPC.
2. If the Products CD does not start automatically, choose **Run** from the Windows® **Start** menu and type D:\SETUP.EXE.
3. Select the **Software** item from the **Resources** menu on the right of the GE Multilin welcome page.
4. Select the **C30 Controller** item from the list of protective relays shown.
5. The C30 Software page will be shown. Select the **URPC Software** item from the list and save the installation program to your local PC.
6. Run the installation program and follow the on-screen instructions. When the **Choose Destination Location** window appears and if the software is not to be located in the default directory, click **Browse** and type in the complete path name including the new directory name.
7. Click **Next** to continue with the installation procedure.
8. The default program group where the application will be added to is shown in the **Select Program Folder** window. If it is desired that the application be added to an already existing program group, choose the group name from the list shown.
9. Click **Next** to begin the installation process.
10. To launch the URPC application, click **Finish** in the Setup Complete window.
11. Subsequently, double click on the URPC software icon to activate the application.

NOTE

Refer to Chapter 4: Human Interfaces and the URPC Help File for additional information about the URPC software interface.

1.3.3 CONNECTING URPC WITH THE C30

This section is intended as a quick start guide to using the URPC software. Please refer to the URPC Help File and Chapter 4 of this manual for more information.

a) CONFIGURING AN ETHERNET CONNECTION

Before starting, verify that the Ethernet network cable is properly connected to the Ethernet port on the back of the relay. To setup the relay for Ethernet communications, it will be necessary to define a Site, then add the relay as a Device at that site.

1. Install and start the latest version of the URPC software (available from the GE Multilin Products CD or online from http://www.GEindustrial.com/multilin.
2. Select the **Online > Device Setup** menu item to open the Device Setup window and click the “Add Site” button to define a new site.
3. Enter the desired site name in the **Site Name** field. If desired, a short description of site can also be entered along with the display order of devices defined for the site. Click the “OK” button when complete.
4. The new site will appear in the upper-left list in the URPC window. Click on the new site name and then select the **Online > Device Setup** menu item to re-open the Device Setup window.
5. Click the “Add Device” button to define the new device.
6. Enter the desired name in the **Device Name** field and a description (optional) of the site.
7. Select “Ethernet” from the **Interface** drop-down list. This will display a number of interface parameters that must be entered for proper Ethernet functionality.
   - Enter the relay IP address (from SETTINGS ⇨ PRODUCT SETUP ⇨⇩ COMMUNICATIONS ⇨⇩ NETWORK ⇨ IP ADDRESS) in the **IP Address** field.
   - Enter the relay Modbus address (from the PRODUCT SETUP ⇨⇩ COMMUNICATIONS ⇨⇩ MODBUS PROTOCOL ⇨ MODBUS SLAVE ADDRESS setting) in the **Slave Address** field.
   - Enter the Modbus port address (from the PRODUCT SETUP ⇨⇩ COMMUNICATIONS ⇨⇩ MODBUS PROTOCOL ⇨⇩ MODBUS TCP PORT NUMBER setting) in the **Modbus Port** field.
8. Click the “Read Order Code” button to connect to the UR device and upload the order code. If an communications error occurs, ensure that the three URPC values entered in the previous step correspond to the relay setting values.
9. Click “OK” when the relay order code has been received. The new device will be added to the Site List window (or Online window) located in the top left corner of the main URPC window.

The Site Device has now been configured for Ethernet communications. Proceed to Section c) below to begin communications.

b) CONFIGURING AN RS232 CONNECTION

Before starting, verify that the RS232 serial cable is properly connected to the RS232 port on the front panel of the relay.

1. Install and start the latest version of the URPC software (available from the GE Multilin Products CD or online from http://www.GEindustrial.com/multilin.
2. Select the **Online > Device Setup** menu item to open the Device Setup window and click the “Add Site” button to define a new site.
3. Enter the desired site name in the **Site Name** field. If desired, a short description of site can also be entered along with the display order of devices defined for the site. Click the “OK” button when complete.
4. The new site will appear in the upper-left list in the URPC window. Click on the new site name and then select the **Online > Device Setup** menu item to re-open the Device Setup window.
5. Click the “Add Device” button to define the new device.
6. Enter the desired name in the **Device Name** field and a description (optional) of the site.
7. Select “Serial” from the **Interface** drop-down list. This will display a number of interface parameters that must be entered for proper Ethernet functionality.

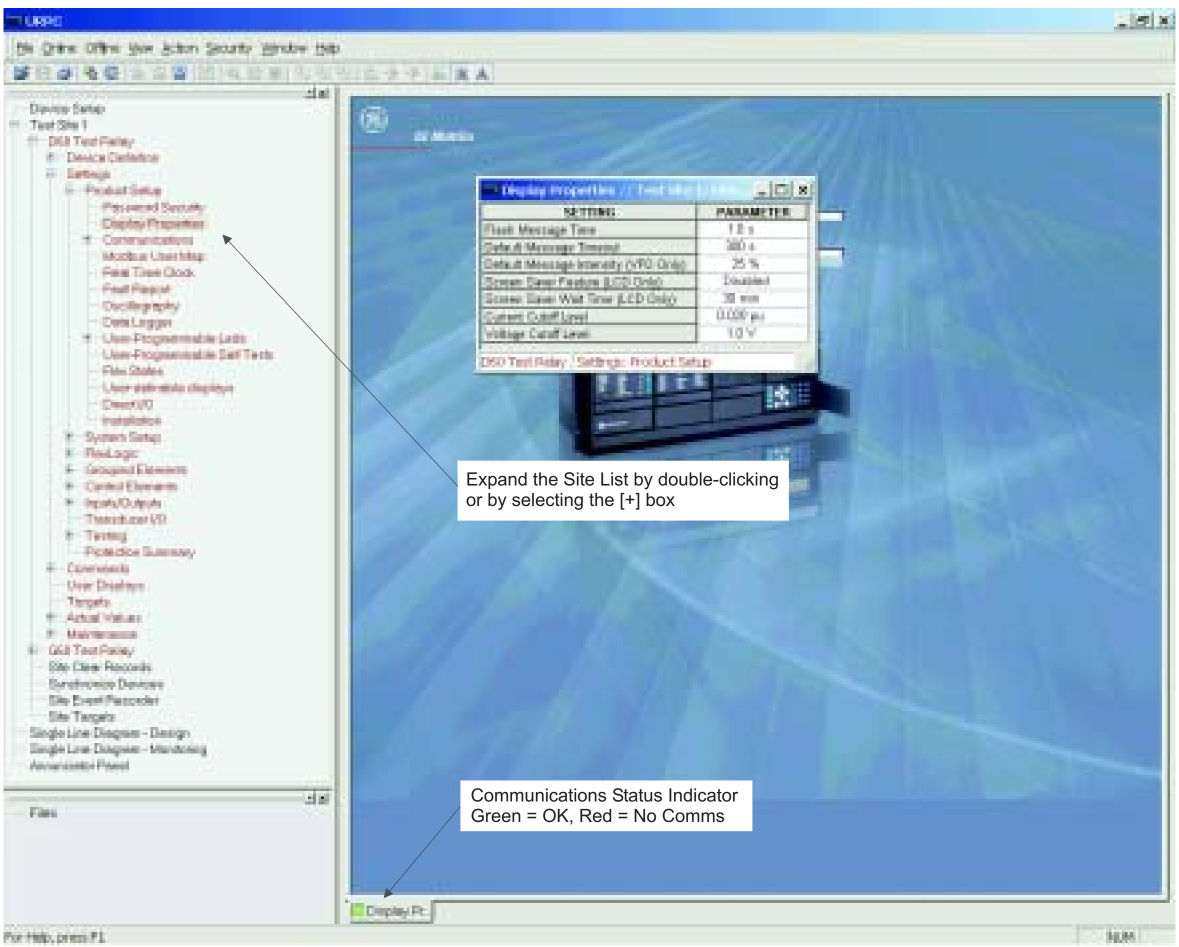
- Enter the relay slave address and COM port values (from the **SETTINGS ⇨ PRODUCT SETUP ⇨⇩ COMMUNICATIONS ⇨⇩ SERIAL PORTS** menu) in the **Slave Address** and **COM Port** fields.
- Enter the physical communications parameters (baud rate and parity settings) in their respective fields.

8. Click the “Read Order Code” button to connect to the UR device and upload the order code. If an communications error occurs, ensure that the URPC serial communications values entered in the previous step correspond to the relay setting values.
9. Click “OK” when the relay order code has been received. The new device will be added to the Site List window (or Online window) located in the top left corner of the main URPC window.

The Site Device has now been configured for RS232 communications. Proceed to Section c) Connecting to the Relay below to begin communications.

c) CONNECTING TO THE RELAY

1. Open the Display Properties window through the Site List tree as shown below:



2. The Display Properties window will open with a flashing status indicator on the lower left of the URPC window.
3. If the status indicator is red, verify that the Ethernet network cable is properly connected to the Ethernet port on the back of the relay and that the relay has been properly setup for communications (steps A and B earlier).
4. The Display Properties settings can now be edited, printed, or changed according to user specifications.

NOTE

Refer to Chapter 4 in this manual and the URPC Help File for more information about the using the URPC software interface.

1

1.4.1 MOUNTING AND WIRING

Please refer to Chapter 3: Hardware for detailed mounting and wiring instructions. Review all **WARNINGS** and **CAUTIONS** carefully.

1.4.2 COMMUNICATIONS

The URPC software communicates to the relay via the faceplate RS232 port or the rear panel RS485 / Ethernet ports. To communicate via the faceplate 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 COM1 or COM2 port as described in the CPU Communications Ports section of Chapter 3.

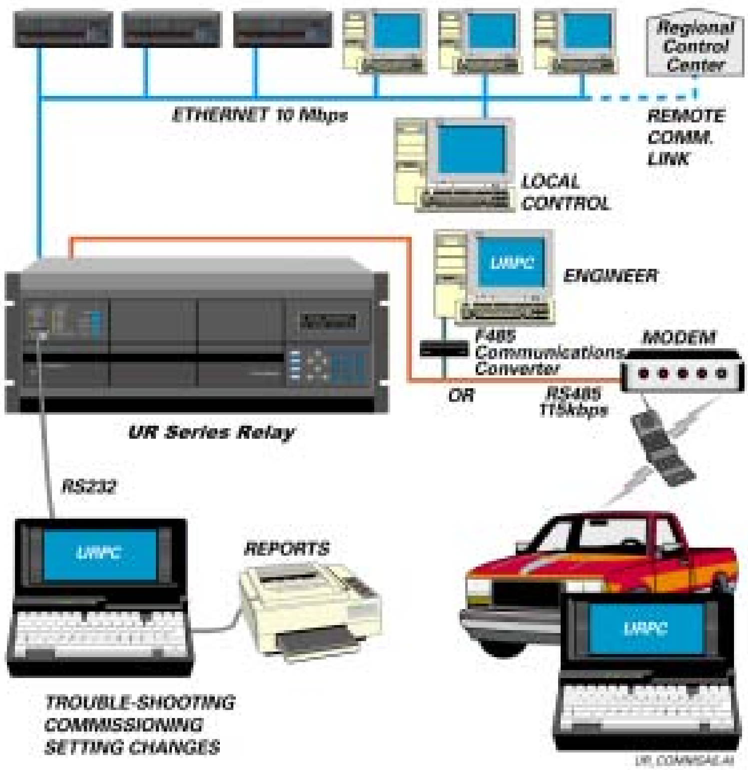


Figure 1–4: RELAY COMMUNICATIONS OPTIONS

To communicate through the C30 rear RS485 port from a PC RS232 port, the GE Multilin RS232/RS485 converter box is required. This device (catalog number F485) connects to the computer using a "straight-through" serial cable. A shielded twisted-pair (20, 22, or 24 AWG) connects the F485 converter to the C30 rear communications port. The converter terminals (+, –, GND) are connected to the C30 communication module (+, –, COM) terminals. Refer to the CPU Communications Ports section in Chapter 3 for option details. The line should be terminated with an R-C network (i.e. 120 Ω, 1 nF) as described in the Chapter 3.

1.4.3 FACEPLATE DISPLAY

All messages are displayed on a 2 × 20 character vacuum fluorescent display to make them visible under poor lighting conditions. An optional liquid crystal display (LCD) is also available. Messages are displayed in 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 message will automatically override the default message and appear on the display.

1.5.1 FACEPLATE KEYPAD

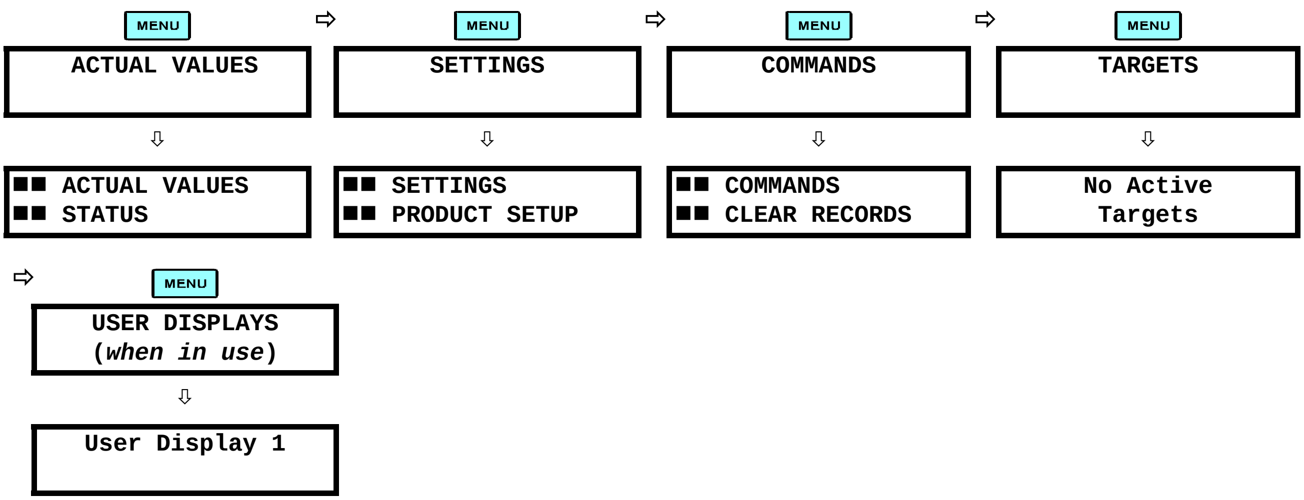
Display messages are organized into ‘pages’ under the following headings: Actual Values, Settings, Commands, and Targets. The MENU key navigates through these pages. Each heading page is broken down further into logical subgroups.

The ▲ ◄ MESSAGE ► ▼ keys navigate through the subgroups. The ▲ VALUE ▼ keys scroll increment or decrement numerical setting values when in programming mode. These keys also scroll through alphanumeric values in the text edit mode. Alternatively, values may also be entered with the numeric keypad.

The · key initiates and advance to the next character in text edit mode or enters a decimal point. The HELP key may be pressed at any time for context sensitive help messages. The ENTER key stores altered setting values.

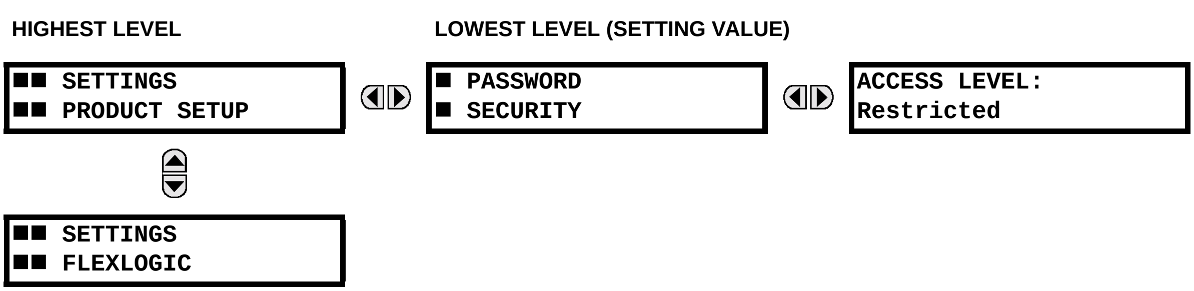
1.5.2 MENU NAVIGATION

Press the MENU key to select the desired header display page (top-level menu). The header title appears momentarily followed by a header display page menu item. Each press of the MENU key advances through the main heading pages as illustrated below.



1.5.3 MENU HIERARCHY

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



1.5.4 RELAY ACTIVATION

The relay is defaulted to the "Not Programmed" state when it leaves the factory. This safeguards against the installation of a relay whose settings have not been entered. When powered up successfully, the Trouble LED will be on and the In Service LED off. The relay in the "Not Programmed" state will block signaling of any output relay. These conditions will remain until the relay is explicitly put in the "Programmed" state.

Select the menu message SETTINGS ⇨ PRODUCT SETUP ⇨⇩ INSTALLATION ⇨ RELAY SETTINGS

```
RELAY SETTINGS:
Not Programmed
```

To put the relay in the "Programmed" state, press either of the ⏶ VALUE ⏷ keys once and then press ENTER. The faceplate Trouble LED will turn off and the In Service LED will turn on. The settings for the relay can be programmed manually (refer to Chapter 5) via the faceplate keypad or remotely (refer to the URPC Help file) via the URPC software interface.

1.5.5 BATTERY TAB

The battery tab is installed in the power supply module before the C30 shipped from the factory. The battery tab prolongs battery life in the event the relay is powered down for long periods of time before installation. The battery is responsible for backing up event records, oscillography, data logger, and real-time clock information when the relay is powered off. The battery failure self-test error generated by the relay is a minor and should not affect the relay functionality. When the relay is installed and ready for commissioning, the tab should be removed. The battery tab should be re-inserted if the relay is powered off for an extended period of time. If required, contact the factory for a replacement battery or battery tab.

1.5.6 RELAY PASSWORDS

It is recommended that passwords be set up for each security level and assigned to specific personnel. There are two user password security access levels, COMMAND and SETTING:

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 inputs
- clear event records
- clear oscillography records
- operate user-programmable pushbuttons

2. SETTING

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

NOTE

Refer to the Changing Settings section in Chapter 4 for complete instructions on setting up security level passwords.

1.5.7 FLEXLOGIC™ CUSTOMIZATION

FlexLogic™ equation editing is required for setting up user-defined logic for customizing the relay operations. See the FlexLogic™ section in Chapter 5 for additional details.

1.5.8 COMMISSIONING

Templated tables for charting all the required settings before entering them via the keypad are available from the GE Multilin website at http://www.GEindustrial.com/multilin.

2.1.1 OVERVIEW

The C30 relay is a microprocessor-based relay designed for power substation control and monitoring.

Diagnostic features include a sequence of records capable of storing 1024 time-tagged events. The internal clock used for time-tagging can be synchronized with an IRIG-B signal or via the SNTP protocol over the Ethernet port. This precise time stamping allows the sequence of events to be determined throughout the system. Events can also be programmed (via FlexLogic™ equations) to trigger oscillography data capture which may be set to record the measured parameters before and after the event for viewing on a personal computer (PC). These tools significantly reduce troubleshooting time and simplify report generation in the event of a system fault.

A faceplate RS232 port may be used to connect to a PC for the programming of settings and the monitoring of actual values. A variety of communications modules are available. Two rear RS485 ports allow independent access by operating and engineering staff. All serial ports use the Modbus® RTU protocol. The RS485 ports may be connected to system computers with baud rates up to 115.2 kbps. The RS232 port has a fixed baud rate of 19.2 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/UCA2, Modbus®/TCP, and TFTP protocols, and allows access to the relay via any standard web browser (UR web pages). The IEC 60870-5-104 protocol is supported on the Ethernet port. DNP 3.0 and IEC 60870-5-104 cannot be enabled at the same time.

The C30 IEDs use flash memory technology which allows field upgrading as new features are added.

Table 2–1: DEVICE FUNCTIONS

FUNCTION	FUNCTION
Contact Inputs (up to 96)	Modbus Communications
Contact Outputs (up to 64)	Modbus User Map
Control Pushbuttons	Non-Volatile Latches
Data Logger	Non-Volatile Selector Switch
Digital Counters (8)	Oscillography
Digital Elements (16)	Time Synchronization over SNTP
Direct Inputs/Outputs (32)	Transducer I/O
DNP 3.0 or IEC 60870-5-104 Communications	User Definable Displays
Event Recorder	User Programmable LEDs
FlexElements™	User Programmable Pushbuttons
FlexLogic™ Equations	User Programmable Self-Tests
MMS/UCA Communications	Virtual Inputs (32)
MMS/UCA Remote I/O (“GOOSE”)	Virtual Outputs (64)

2.1.2 ORDERING

2

The relay is available as a 19-inch rack horizontal mount unit or as a reduced size (¾) vertical mount unit, and consists of the following UR module functions: power supply, CPU, digital input/output, transducer 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 available relay modules are contained in Chapter 3: Hardware).

Table 2–2: C30 ORDER CODES

	C30	- *	00	- H	*	*	- F **	- H **	- M **	- P **	- U **	- W **	For Full Sized Horizontal Mount
	C30	- *	00	- V	*	*	- F **	- H **	- M **			- R **	For Reduced Sized Vertical Mount
BASE UNIT	C30												Base Unit
CPU		A											RS485 + RS485 (ModBus RTU, DNP)
		C											RS485 + 10BaseF (MMS/UCA2, Modbus TCP/IP, DNP)
		D											RS485 + Redundant 10BaseF (MMS/UCA2, Modbus TCP/IP, DNP)
SOFTWARE			00										No Software Options
MOUNT/ FACEPLATE				H	C								Horizontal (19” rack)
				H	P								Horizontal (19” rack) with User-Programmable Pushbuttons
				V	F								Vertical (3/4 rack)
POWER SUPPLY						H							125 / 250 V AC/DC
						L							24 to 48 V (DC only)
DIGITAL I/O								XX	XX	XX	XX	XX	No Module
							4A	4A	4A	4A	4A	4A	4 Solid-State (No Monitoring) MOSFET Outputs
							4B	4B	4B	4B	4B	4B	4 Solid-State (Voltage w/ opt Current) MOSFET Outputs
							4C	4C	4C	4C	4C	4C	4 Solid-State (Current w/ opt Voltage) MOSFET Outputs
							4L	4L	4L	4L	4L	4L	14 Form-A (No Monitoring) Latchable Outputs
							6A	6A	6A	6A	6A	6A	2 Form-A (Volt w/ opt Curr) & 2 Form-C Outputs, 8 Digital Inputs
							6B	6B	6B	6B	6B	6B	2 Form-A (Volt w/ opt Curr) & 4 Form-C Outputs, 4 Digital Inputs
							6C	6C	6C	6C	6C	6C	8 Form-C Outputs
							6D	6D	6D	6D	6D	6D	16 Digital Inputs
							6E	6E	6E	6E	6E	6E	4 Form-C Outputs, 8 Digital Inputs
							6F	6F	6F	6F	6F	6F	8 Fast Form-C Outputs
							6G	6G	6G	6G	6G	6G	4 Form-A (Voltage w/ opt Current) Outputs, 8 Digital Inputs
							6H	6H	6H	6H	6H	6H	6 Form-A (Voltage w/ opt Current) Outputs, 4 Digital Inputs
							6K	6K	6K	6K	6K	6K	4 Form-C & 4 Fast Form-C Outputs
							6L	6L	6L	6L	6L	6L	2 Form-A (Curr w/ opt Volt) & 2 Form-C Outputs, 8 Digital Inputs
							6M	6M	6M	6M	6M	6M	2 Form-A (Curr w/ opt Volt) & 4 Form-C Outputs, 4 Digital Inputs
							6N	6N	6N	6N	6N	6N	4 Form-A (Current w/ opt Voltage) Outputs, 8 Digital Inputs
							6P	6P	6P	6P	6P	6P	6 Form-A (Current w/ opt Voltage) Outputs, 4 Digital Inputs
							6R	6R	6R	6R	6R	6R	2 Form-A (No Monitoring) & 2 Form-C Outputs, 8 Digital Inputs
							6S	6S	6S	6S	6S	6S	2 Form-A (No Monitoring) & 4 Form-C Outputs, 4 Digital Inputs
							6T	6T	6T	6T	6T	6T	4 Form-A (No Monitoring) Outputs, 8 Digital Inputs
							6U	6U	6U	6U	6U	6U	6 Form-A (No Monitoring) Outputs, 4 Digital Inputs
TRANSDUCER I/O (maximum of 4 per unit)							5C	5C	5C	5C	5C	5C	8 RTD Inputs
							5E	5E	5E	5E	5E	5E	4 RTD Inputs, 4 dcmA Inputs
							5F	5F	5F	5F	5F	5F	8 dcmA Inputs
INTER-RELAY COMMUNICATIONS												7A	820 nm, multi-mode, LED, 1 Channel
												7B	1300 nm, multi-mode, LED, 1 Channel
												7C	1300 nm, single-mode, ELED, 1 Channel
												7D	1300 nm, single-mode, LASER, 1 Channel
												7H	820 nm, multi-mode, LED, 2 Channels
												7I	1300 nm, multi-mode, LED, 2 Channels
												7J	1300 nm, single-mode, ELED, 2 Channels
												7K	1300 nm, single-mode, LASER, 2 Channels
												7L	Channel 1 - RS422; Channel 2 - 820 nm, multi-mode, LED
												7M	Channel 1 - RS422; Channel 2 - 1300 nm, multi-mode, LED
												7N	Channel 1 - RS422; Channel 2 - 1300 nm, single-mode, ELED
												7P	Channel 1 - RS422; Channel 2 - 1300 nm, single-mode, LASER
												7R	G.703, 1 Channel
												7S	G.703, 2 Channels
												7T	RS422, 1 Channel
												7W	RS422, 2 Channels
												72	1550 nm, single-mode, LASER, 1 Channel
												73	1550 nm, single-mode, LASER, 2 Channel
												74	Channel 1 - RS422; Channel 2 - 1550 nm, single-mode, LASER
												76	IEEE C37.94, 820 nm, multi-mode, LED, 1 Channel
												77	IEEE C37.94, 820 nm, multi-mode, LED, 2 Channels

The order codes for replacement modules to be ordered separately are shown in the following table. When ordering a replacement CPU module or Faceplate, please provide the serial number of your existing unit.

Table 2–3: ORDER CODES FOR UR REPLACEMENT MODULES

	UR - ** -	
POWER SUPPLY	1H	125 / 250 V AC/DC
	1L	24 to 48 V (DC only)
CPU	9A	RS485 + RS485 (ModBus RTU, DNP 3.0)
	9C	RS485 + 10BaseF (MMS/UCA2, ModBus TCP/IP, DNP 3.0)
	9D	RS485 + Redundant 10BaseF (MMS/UCA2, ModBus TCP/IP, DNP 3.0)
FACEPLATE	3C	Horizontal Faceplate with Display & Keypad
	3F	Vertical Faceplate with Display & Keypad
DIGITAL I/O	4A	4 Solid-State (No Monitoring) MOSFET Outputs
	4B	4 Solid-State (Voltage w/ opt Current) MOSFET Outputs
	4C	4 Solid-State (Current w/ opt Voltage) MOSFET Outputs
	4L	14 Form-A (No Monitoring) Latchable Outputs
	6A	2 Form-A (Voltage w/ opt Current) & 2 Form-C Outputs, 8 Digital Inputs
	6B	2 Form-A (Voltage w/ opt Current) & 4 Form-C Outputs, 4 Digital Inputs
	6C	8 Form-C Outputs
	6D	16 Digital Inputs
	6E	4 Form-C Outputs, 8 Digital Inputs
	6F	8 Fast Form-C Outputs
	6G	4 Form-A (Voltage w/ opt Current) Outputs, 8 Digital Inputs
	6H	6 Form-A (Voltage w/ opt Current) Outputs, 4 Digital Inputs
	6K	4 Form-C & 4 Fast Form-C Outputs
	6L	2 Form-A (Current w/ opt Voltage) & 2 Form-C Outputs, 8 Digital Inputs
	6M	2 Form-A (Current w/ opt Voltage) & 4 Form-C Outputs, 4 Digital Inputs
	6N	4 Form-A (Current w/ opt Voltage) Outputs, 8 Digital Inputs
	6P	6 Form-A (Current w/ opt Voltage) Outputs, 4 Digital Inputs
	6R	2 Form-A (No Monitoring) & 2 Form-C Outputs, 8 Digital Inputs
	6S	2 Form-A (No Monitoring) & 4 Form-C Outputs, 4 Digital Inputs
	6T	4 Form-A (No Monitoring) Outputs, 8 Digital Inputs
	6U	6 Form-A (No Monitoring) Outputs, 4 Digital Inputs
CT/VT DSP	8A	Standard 4CT/4VT
	8B	Sensitive Ground 4CT/4VT
	8C	Standard 8CT
	8D	Sensitive Ground 8CT
L60 INTER-RELAY COMMUNICATIONS	7U	110/125 V, 20 mA Input/Output Channel Interface
	7V	48/60 V, 20 mA Input/Output Channel Interface
	7Y	125 V Input, 5V Output, 20 mA Channel Interface
	7Z	5 V Input, 5V Output, 20 mA Channel Interface
UR INTER-RELAY COMMUNICATIONS	7A	820 nm, multi-mode, LED, 1 Channel
	7B	1300 nm, multi-mode, LED, 1 Channel
	7C	1300 nm, single-mode, ELED, 1 Channel
	7D	1300 nm, single-mode, LASER, 1 Channel
	7E	Channel 1: G.703; Channel 2: 820 nm, multi-mode LED (L90 only)
	7F	Channel 1: G.703; Channel 2: 1300 nm, multi-mode LED (L90 only)
	7G	Channel 1: G.703; Channel 2: 1300 nm, single-mode ELED (L90 only)
	7Q	Channel 1: G.703; Channel 2: 820 nm, single-mode LASER (L90 only)
	7H	820 nm, multi-mode, LED, 2 Channels
	7I	1300 nm, multi-mode, LED, 2 Channels
	7J	1300 nm, single-mode, ELED, 2 Channels
	7K	1300 nm, single-mode, LASER, 2 Channels
	7L	Channel 1 - RS422; Channel 2 - 820 nm, multi-mode, LED
	7M	Channel 1 - RS422; Channel 2 - 1300 nm, multi-mode, LED
	7N	Channel 1 - RS422; Channel 2 - 1300 nm, single-mode, ELED
	7P	Channel 1 - RS422; Channel 2 - 1300 nm, single-mode, LASER
	7R	G.703, 1 Channel
	7S	G.703, 2 Channels
	7T	RS422, 1 Channel
	7W	RS422, 2 Channels
	72	1550 nm, single-mode, LASER, 1 Channel
	73	1550 nm, single-mode, LASER, 2 Channel
	74	Channel 1 - RS422; Channel 2 - 1550 nm, single-mode, LASER
	75	Channel 1 - G.703, Channel 2 - 1550 nm, single -mode, LASER (L90 only)
	76	IEEE C37.94, 820 nm, multi-mode, LED, 1 Channel
	77	IEEE C37.94, 820 nm, multi-mode, LED, 2 Channels
TRANSDUCER I/O	5C	8 RTD Inputs
	5E	4 dcmA Inputs, 4 RTD Inputs
	5F	8 dcmA Inputs

SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE

2.2.1 USER-PROGRAMMABLE ELEMENTS

2

FLEXLOGIC™

Programming language:	Reverse Polish Notation with graphical visualization (keypad programmable)
Lines of code:	512
Internal variables:	64
Supported operations:	NOT, XOR, OR (2 to 16 inputs), AND (2 to 16 inputs), NOR (2 to 16 inputs), NAND (2 to 16 inputs), Latch (Reset dominant), Edge Detectors, Timers
Inputs:	any logical variable, contact, or virtual input
Number of timers:	32
Pickup delay:	0 to 60000 (ms, sec., min.) in steps of 1
Dropout delay:	0 to 60000 (ms, sec., min.) in steps of 1

FLEXCURVES™

Number:	4 (A through D)
Reset points:	40 (0 through 1 of pickup)
Operate points:	80 (1 through 20 of pickup)
Time delay:	0 to 65535 ms in steps of 1

FLEX STATES

Number:	up to 256 logical variables grouped under 16 Modbus addresses
Programmability:	any logical variable, contact, or virtual input

FLEXELEMENTS™

Number of elements:	8
Operating signal:	any analog actual value, or two values in differential mode
Operating signal mode:	Signed or Absolute Value
Operating mode:	Level, Delta
Compensation direction:	Over, Under
Pickup Level:	–30.000 to 30.000 pu in steps of 0.001
Hysteresis:	0.1 to 50.0% in steps of 0.1
Delta dt:	20 ms to 60 days
Pickup & dropout delay:	0.000 to 65.535 s in steps of 0.001

NON-VOLATILE LATCHES

Type:	Set-dominant or Reset-dominant
Number:	16 (individually programmed)
Output:	Stored in non-volatile memory
Execution sequence:	As input prior to protection, control, and FlexLogic™

USER-PROGRAMMABLE LEDs

Number:	48 plus Trip and Alarm
Programmability:	from any logical variable, contact, or virtual input
Reset mode:	Self-reset or Latched

LED TEST

Initiation:	from any digital input or user-programmable condition
Number of tests:	3, interruptible at any time
Duration of full test:	approximately 3 minutes
Test sequence 1:	all LEDs on
Test sequence 2:	all LEDs off, one LED at a time on for 1 s
Test sequence 3:	all LEDs on, one LED at a time off for 1 s

USER-DEFINABLE DISPLAYS

Number of displays:	16
Lines of display:	2×20 alphanumeric characters
Parameters:	up to 5, any Modbus register addresses
Invoking and scrolling:	keypad, or any user-programmable condition, including pushbuttons

CONTROL PUSHBUTTONS

Number of pushbuttons:	3
Operation:	drive FlexLogic™ operands

USER-PROGRAMMABLE PUSHBUTTONS (OPTIONAL)

Number of pushbuttons:	12
Mode:	Self-Reset, Latched
Display message:	2 lines of 20 characters each

SELECTOR SWITCH

Upper Position Limit:	1 to 7 in steps of 1
Selecting mode:	Time-out or Acknowledge
Time-out timer:	3.0 to 60.0 s in steps of 0.1
Control inputs:	Step-up and 3-bit
Power-up mode:	Restore from non-volatile memory or synchronize to a 3-bit control input

2.2.2 MONITORING

OSCILLOGRAPHY

Maximum records:	64
Sampling rate:	64 samples per power cycle
Triggers:	Any element pickup, dropout or operate Digital input change of state Digital output change of state FlexLogic™ equation
Data:	AC input channels Element state Digital input state Digital output state
Data storage:	In non-volatile memory

EVENT RECORDER

Capacity:	1024 events
Time-tag:	to 1 microsecond
Triggers:	Any element pickup, dropout or operate Digital input change of state Digital output change of state Self-test events
Data storage:	In non-volatile memory

DATA LOGGER

Number of channels:	1 to 16
Parameters:	Any available analog actual value
Sampling rate:	1 sec.; 1, 5, 10, 15, 20, 30, 60 min.
Storage capacity:	(NN is dependent on memory)
1-second rate:	01 channel for NN days 16 channels for NN days
↓	↓
60-minute rate:	01 channel for NN days 16 channels for NN days

2.2.3 INPUTS

CONTACT INPUTS

Dry contacts:	1000 Ω maximum
Wet contacts:	300 V DC maximum
Selectable thresholds:	17 V, 33 V, 84 V, 166 V
Recognition time:	< 1 ms
Debounce timer:	0.0 to 16.0 ms in steps of 0.5

DCMA INPUTS

Current input (mA DC):	0 to –1, 0 to +1, –1 to +1, 0 to 5, 0 to 10, 0 to 20, 4 to 20 (programmable)
Input impedance:	379 Ω ±10%
Conversion range:	–1 to + 20 mA DC
Accuracy:	±0.2% of full scale
Type:	Passive

RTD INPUTS

Types (3-wire):	100 Ω Platinum, 100 & 120 Ω Nickel, 10 Ω Copper
Sensing current:	5 mA
Range:	–50 to +250°C
Accuracy:	±2°C
Isolation:	36 V pk-pk

IRIG-B INPUT

Amplitude modulation:	1 to 10 V pk-pk
DC shift:	TTL
Input impedance:	22 kΩ

REMOTE INPUTS (MMS GOOSE)

Number of input points: 32, configured from 64 incoming bit pairs
Number of remote devices:16
Default states on loss of comms.: On, Off, Latest/Off, Latest/On

DIRECT INPUTS

Number of input points: 32
No. of remote devices: 8
Default states on loss of comms.: On, Off, Latest/Off, Latest/On
Ring configuration: Yes, No
Data rate: 64 or 128 kbps
CRC: 32-bit
CRC alarm:
Responding to: Rate of messages failing the CRC
Monitoring message count: 10 to 10000 in steps of 1
Alarm threshold: 1 to 1000 in steps of 1
Unreturned message alarm:
Responding to: Rate of unreturned messages in the ring configuration
Monitoring message count: 10 to 10000 in steps of 1
Alarm threshold: 1 to 1000 in steps of 1

2

2.2.4 POWER SUPPLY

LOW RANGE
Nominal DC voltage: 24 to 48 V at 3 A
Min/max DC voltage: 20 / 60 V
NOTE: Low range is DC only.

HIGH RANGE
Nominal DC voltage: 125 to 250 V at 0.7 A
Min/max DC voltage: 88 / 300 V
Nominal AC voltage: 100 to 240 V at 50/60 Hz, 0.7 A
Min/max AC voltage: 88 / 265 V at 48 to 62 Hz

ALL RANGES
Volt withstand: 2 × Highest Nominal Voltage for 10 ms
Voltage loss hold-up: 50 ms duration at nominal
Power consumption: Typical = 35 VA; Max. = 75 VA

INTERNAL FUSE
RATINGS
Low range power supply: 7.5 A / 600 V
High range power supply: 5 A / 600 V
INTERRUPTING CAPACITY
AC: 100 000 A RMS symmetrical
DC: 10 000 A

2.2.5 OUTPUTS

FORM-A RELAY
Make and carry for 0.2 s: 30 A as per ANSI C37.90
Carry continuous: 6 A
Break at L/R of 40 ms: 0.25 A DC max. at 48 V
0.10 A DC max. at 125 V
Operate time: < 4 ms
Contact material: Silver alloy

LATCHING RELAY
Make and carry for 0.2 s: 30 A as per ANSI C37.90
Carry continuous: 6 A
Break at L/R of 40 ms: 0.25 A DC max.
Operate time: < 4 ms
Contact material: Silver alloy
Control: separate operate and reset inputs
Control mode: operate-dominant or reset-dominant

FORM-A VOLTAGE MONITOR
Applicable voltage: approx. 15 to 250 V DC
Trickle current: approx. 1 to 2.5 mA

FORM-A CURRENT MONITOR
Threshold current: approx. 80 to 100 mA

FORM-C AND CRITICAL FAILURE RELAY
Make and carry for 0.2 s: 10 A
Carry continuous: 6 A
Break at L/R of 40 ms: 0.25 A DC max. at 48 V
0.10 A DC max. at 125 V
Operate time: < 8 ms
Contact material: Silver alloy

FAST FORM-C RELAY
Make and carry: 0.1 A max. (resistive load)
Minimum load impedance:

INPUT VOLTAGE	IMPEDANCE	
	2 W RESISTOR	1 W RESISTOR
250 V DC	20 KΩ	50 KΩ
120 V DC	5 KΩ	2 KΩ
48 V DC	2 KΩ	2 KΩ
24 V DC	2 KΩ	2 KΩ

Note: values for 24 V and 48 V are the same due to a required 95% voltage drop across the load impedance.

Operate time: < 0.6 ms
INTERNAL LIMITING RESISTOR:
Power: 2 watts
Resistance: 100 ohms

CONTROL POWER EXTERNAL OUTPUT (FOR DRY CONTACT INPUT)
Capacity: 100 mA DC at 48 V DC
Isolation: ±300 Vpk

REMOTE OUTPUTS (MMS GOOSE)
Standard output points: 32
User output points: 32

DIRECT OUTPUTS
Output points: 32

2.2.6 COMMUNICATIONS

RS232

Front port: 19.2 kbps, Modbus® RTU

RS485

1 or 2 rear ports: Up to 115 kbps, Modbus® RTU, isolated together at 36 Vpk

Typical distance: 1200 m

ETHERNET PORT

10BaseF: 820 nm, multi-mode, supports half-duplex/full-duplex fiber optic with ST connector

Redundant 10BaseF: 820 nm, multi-mode, half-duplex/full-duplex fiber optic with ST connector

Power budget: 10 db

Max optical Ip power: –7.6 dBm

Typical distance: 1.65 km

SNTP clock synchronization error: <10 ms (typical)

2.2.7 INTER-RELAY COMMUNICATIONS

SHIELDED TWISTED-PAIR INTERFACE OPTIONS

INTERFACE TYPE	TYPICAL DISTANCE
RS422	1200 m
G.703	100 m

NOTE **RS422 distance is based on transmitter power and does not take into consideration the clock source provided by the user.**

LINK POWER BUDGET

EMITTER, FIBER TYPE	TRANSMIT POWER	RECEIVED SENSITIVITY	POWER BUDGET
820 nm LED, Multimode	–20 dBm	–30 dBm	10 dB
1300 nm LED, Multimode	–21 dBm	–30 dBm	9 dB
1300 nm ELED, Singlemode	–21 dBm	–30 dBm	9 dB
1300 nm Laser, Singlemode	–1 dBm	–30 dBm	29 dB
1550 nm Laser, Singlemode	+5 dBm	–30 dBm	35 dB

NOTE **These Power Budgets are calculated from the manufacturer's worst-case transmitter power and worst case receiver sensitivity.**

MAXIMUM OPTICAL INPUT POWER

EMITTER, FIBER TYPE	MAX. OPTICAL INPUT POWER
820 nm LED, Multimode	–7.6 dBm
1300 nm LED, Multimode	–11 dBm
1300 nm ELED, Singlemode	–14 dBm
1300 nm Laser, Singlemode	–14 dBm
1550 nm Laser, Singlemode	–14 dBm

TYPICAL LINK DISTANCE

EMITTER TYPE	FIBER TYPE	CONNECTOR TYPE	TYPICAL DISTANCE
820 nm LED	Multimode	ST	1.65 km
1300 nm LED	Multimode	ST	3.8 km
1300 nm ELED	Singlemode	ST	11.4 km
1300 nm Laser	Singlemode	ST	64 km
1550 nm Laser	Singlemode	ST	105 km

NOTE **Typical distances listed are based on the following assumptions for system loss. As actual losses will vary from one installation to another, the distance covered by your system may vary.**

CONNECTOR LOSSES (TOTAL OF BOTH ENDS)

ST connector 2 dB

FIBER LOSSES

820 nm multimode 3 dB/km

1300 nm multimode 1 dB/km

1300 nm singlemode 0.35 dB/km

1550 nm singlemode 0.25 dB/km

Splice losses: One splice every 2 km, at 0.05 dB loss per splice.

SYSTEM MARGIN

3 dB additional loss added to calculations to compensate for all other losses.

Compensated difference in transmitting and receiving (channel asymmetry) channel delays using GPS satellite clock: 10 ms

2.2.8 ENVIRONMENTAL

OPERATING TEMPERATURES

Cold: IEC 60028-2-1, 16 h at –40°C

Dry Heat: IEC 60028-2-2, 16 h at +85°C

OTHER

Humidity (noncondensing): IEC 60068-2-30, 95%, Variant 1, 6 days

Altitude: Up to 2000 m

Installation Category: II

2

2.2.9 TYPE TESTS

Electrical fast transient: ANSI/IEEE C37.90.1
IEC 61000-4-4
IEC 60255-22-4

Oscillatory transient: ANSI/IEEE C37.90.1
IEC 61000-4-12

Insulation resistance: IEC 60255-5

Dielectric strength: IEC 60255-6
ANSI/IEEE C37.90

Electrostatic discharge: EN 61000-4-2

Surge immunity: EN 61000-4-5

RFI susceptibility: ANSI/IEEE C37.90.2
IEC 61000-4-3
IEC 60255-22-3
Ontario Hydro C-5047-77

Conducted RFI: IEC 61000-4-6

Voltage dips/interruptions/variations:
IEC 61000-4-11
IEC 60255-11

Power frequency magnetic field immunity:
IEC 61000-4-8

Vibration test (sinusoidal): IEC 60255-21-1

Shock and bump: IEC 60255-21-2

NOTE **Type test report available upon request.**

2.2.10 PRODUCTION TESTS

THERMAL

Products go through a 12 h burn-in process at 60°C

2.2.11 APPROVALS

APPROVALS

UL Listed for the USA and Canada

Manufactured under an ISO9000 registered system.

CE:
LVD 73/23/EEC: IEC 1010-1
EMC 81/336/EEC: EN 50081-2, EN 50082-2

2.2.12 MAINTENANCE

MAINTENANCE

Cleaning: Normally, cleaning is not required; but for situations where dust has accumulated on the faceplate display, a dry cloth can be used.

3.1.1 PANEL CUTOUT

The relay is available as a 19-inch rack horizontal mount unit or as a reduced size (¾) vertical mount unit, with a removable faceplate. The modular design allows the relay to be easily upgraded or repaired by a qualified service person. The faceplate is hinged to allow easy access to the removable modules, and is itself removable to allow mounting on doors with limited rear depth. There is also a removable dust cover that fits over the faceplate, which must be removed when attempting to access the keypad or RS232 communications port.

The vertical and horizontal case dimensions are shown below, 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 and the RS232 communications port. The relay is secured to the panel with the use of four screws supplied with the relay.

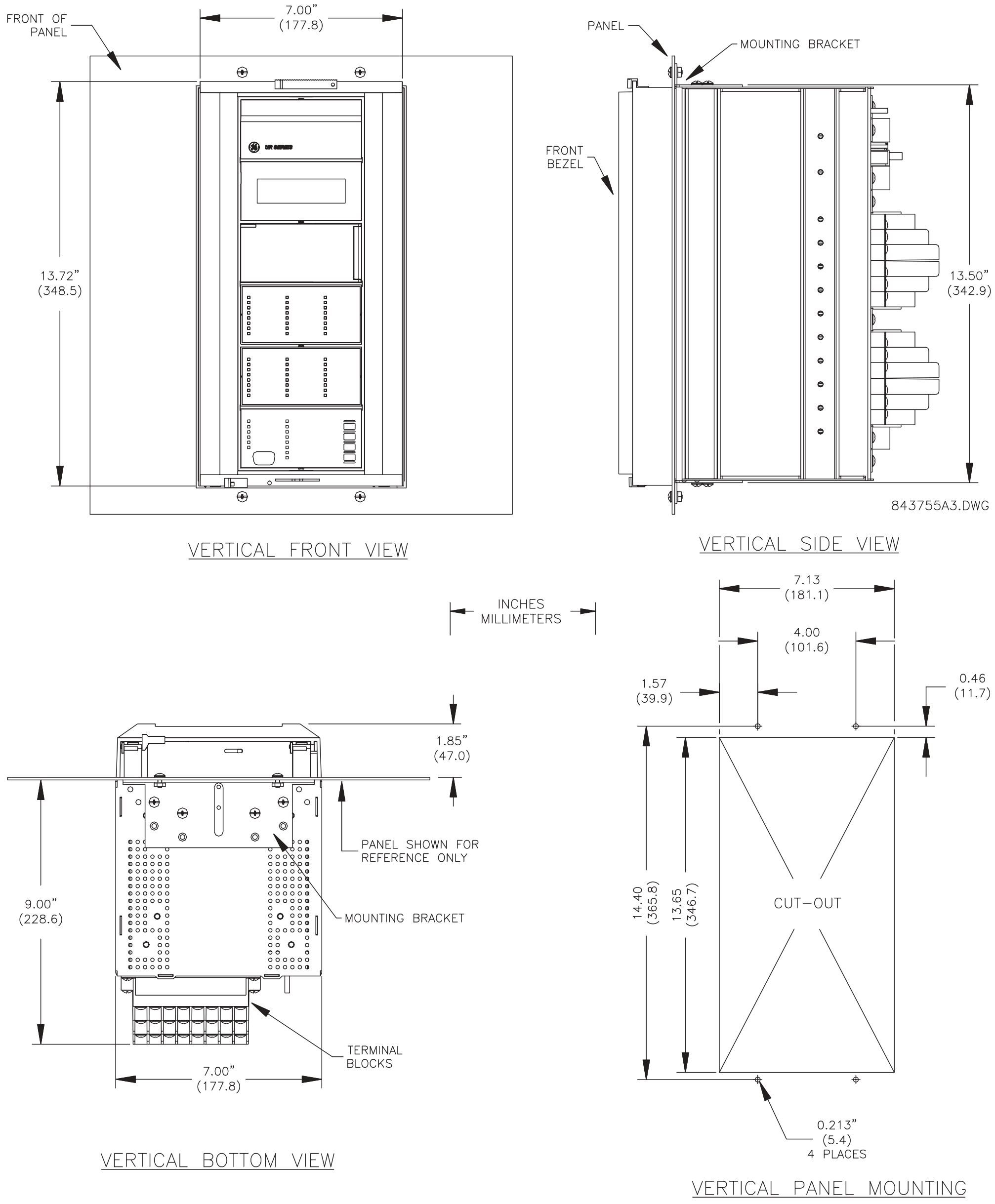


Figure 3–1: C30 VERTICAL MOUNTING AND DIMENSIONS

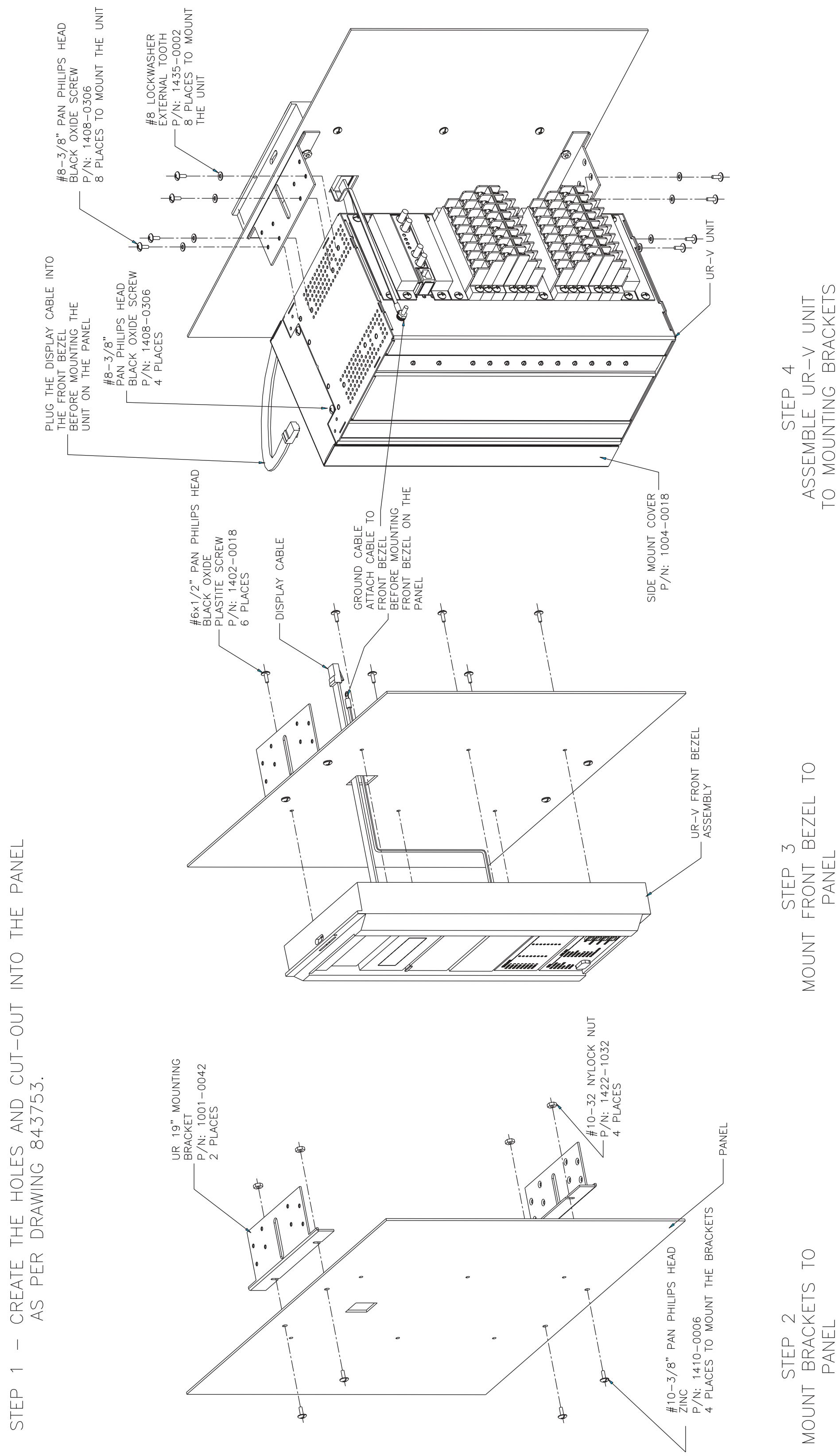


Figure 3–2: C30 VERTICAL SIDE MOUNTING INSTALLATION

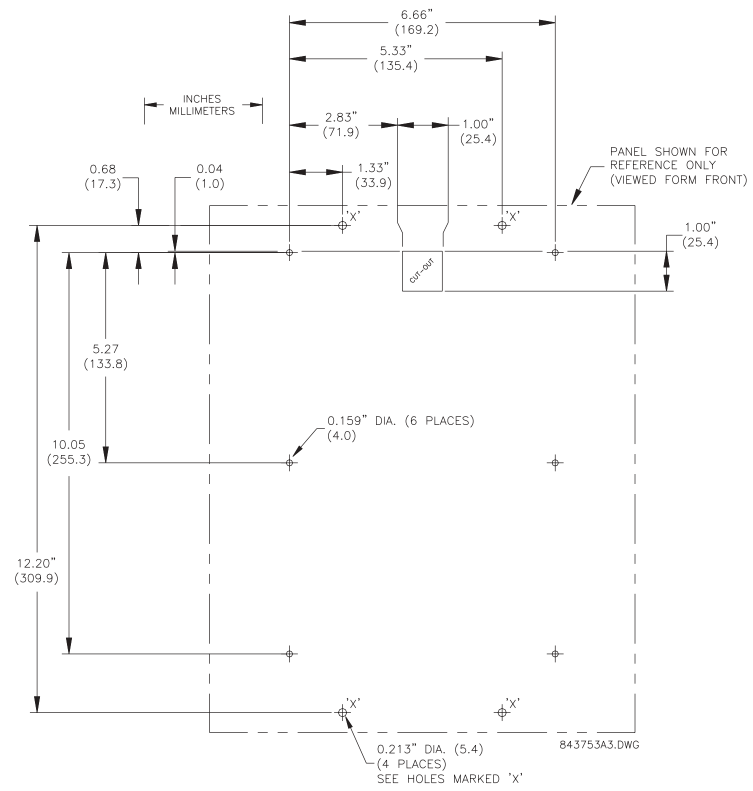


Figure 3–3: C30 VERTICAL SIDE MOUNTING REAR DIMENSIONS

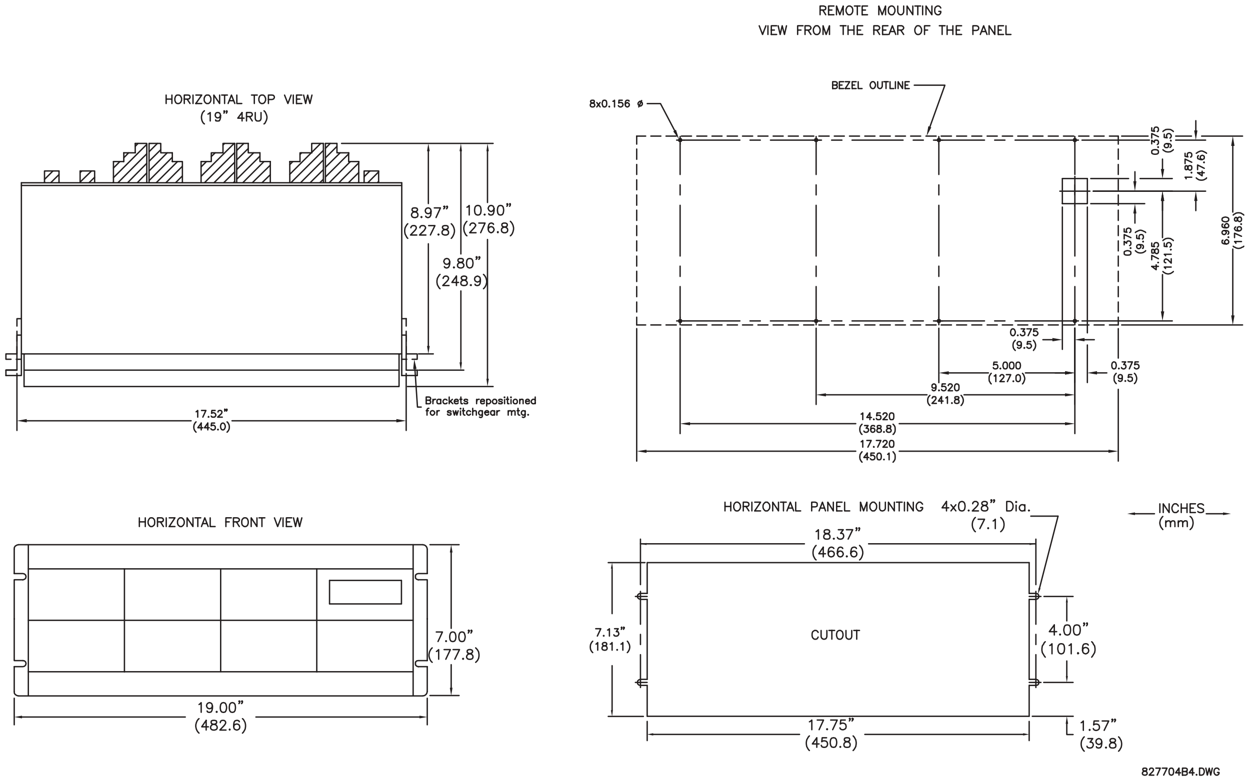


Figure 3–4: C30 HORIZONTAL MOUNTING AND DIMENSIONS

3.1.2 MODULE WITHDRAWAL AND 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!

WARNING

Proper electrostatic discharge protection (i.e. a static strap) must be used when coming in contact with modules while the relay is energized!

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 below. This allows for easy accessibility of the modules for withdrawal.

Figure 3–5: UR MODULE WITHDRAWAL/INSERTION

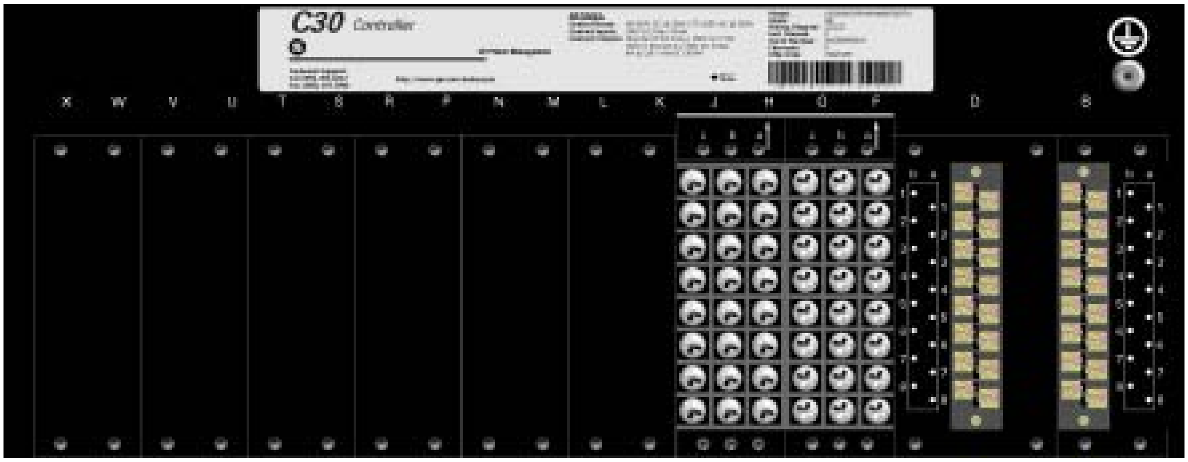
WITHDRAWAL: The ejector/inserter clips, located at the top and bottom of each module, must be pulled simultaneously to release the module for removal. Before performing this action, **control power must be removed from the relay**. Record the original location of the module to ensure that the same or replacement module is inserted into the correct slot.

INSERTION: 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.

NOTE

Type 9C and 9D CPU modules are equipped with 10Base-T and 10Base-F Ethernet connectors for communications. These connectors must be individually disconnected from the module before the it can be removed from the chassis.

3.1.3 REAR TERMINAL LAYOUT



834706A9.CDR

Figure 3–6: REAR TERMINAL VIEW

WARNING

Do not touch any rear terminals while the relay is energized!

The relay follows a convention with respect to terminal number assignments which are three characters long assigned in order by module slot position, row number, and column letter. Two-slot wide modules take their slot designation from the first slot position (nearest to CPU module) which is indicated by an arrow marker on the terminal block. See the following figure for an example of rear terminal assignments.

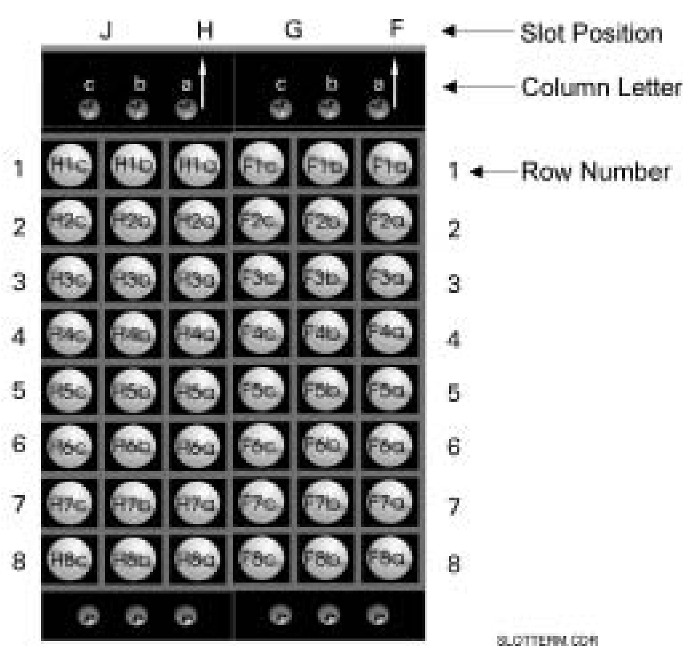


Figure 3–7: EXAMPLE OF MODULES IN F & H SLOTS

3.2.1 TYPICAL WIRING

This diagram is based on the following order code: C30-D00-HCH-F6B-H6E-M6G-P6K-U6D-W6D.

This diagram provides an example of how the relay is typically wired, not specifically how to wire your own relay. Please refer to the following pages for examples to help wire your relay correctly based on your relay configuration and order code.

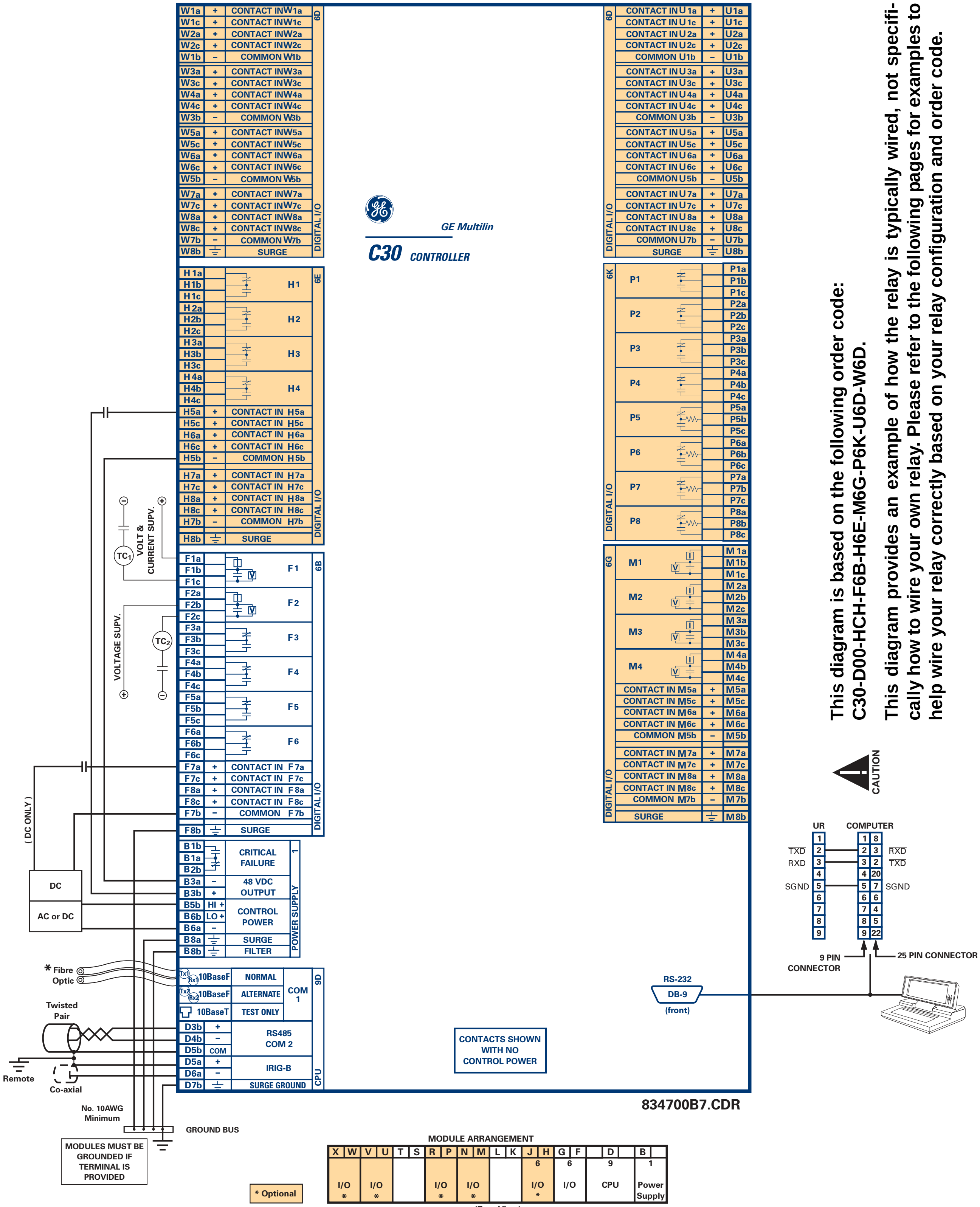


Figure 3–8: TYPICAL WIRING DIAGRAM

3.2.2 DIELECTRIC STRENGTH

The dielectric strength of UR module hardware is shown in the following table:

Table 3–1: DIELECTRIC STRENGTH OF UR MODULE HARDWARE

MODULE TYPE	MODULE FUNCTION	TERMINALS		DIELECTRIC STRENGTH (AC)
		FROM	TO	
1	Power Supply	High (+); Low (+); (–)	Chassis	2000 V AC for 1 minute [1]
1	Power Supply	48 V DC (+) and (–)	Chassis	2000 V AC for 1 minute [1]
1	Power Supply	Relay Terminals	Chassis	2000 V AC for 1 minute [1]
2	Reserved for Future	N/A	N/A	N/A
3	Reserved for Future	N/A	N/A	N/A
4	Reserved for Future	N/A	N/A	N/A
5	Analog I/O	All except 8b	Chassis	< 50 V DC
6	Digital I/O	All (See Precaution 2)	Chassis	2000 V AC for 1 minute
8	CT/VT	All	Chassis	2000 V AC for 1 minute
9	CPU	All except 7b	Chassis	< 50 VDC

[1] See TEST PRECAUTION 1 below.

Filter networks and transient protection clamps are used in module hardware to prevent damage caused by high peak voltage transients, radio frequency interference (RFI) and electromagnetic interference (EMI). These protective components **can be damaged** by application of the ANSI/IEEE C37.90 specified test voltage for a period longer than the specified one minute. For testing of dielectric strength where the test interval may exceed one minute, always observe the following precautions:

1. The connection from ground to the Filter Ground (Terminal 8b) and Surge Ground (Terminal 8a) must be removed before testing.
2. Some versions of the digital I/O module have a Surge Ground connection on Terminal 8b. On these module types, this connection must be removed before testing.

3

3.2.3 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!

NOTE

The C30 relay, like almost all electronic relays, contains electrolytic capacitors. These capacitors are well known to be subject to deterioration over time if voltage is not applied periodically. Deterioration can be avoided by powering the relays up once a year.

The power supply module can be ordered with either of two possible voltage ranges. Each range has a dedicated input connection for proper operation. The ranges are as shown below (see the Technical Specifications section for details):

- LO range: 24 to 48 V (DC only) nominal
- HI range: 125 to 250 V nominal

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

The power supply module provides 48 V DC power for dry contact input connections and a critical failure relay (see the Typical Wiring Diagram earlier). 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 on-going self-test diagnostic checks detect a critical failure (see the Self-Test Errors Table in Chapter 7) or control power is lost, the relay will de-energize.

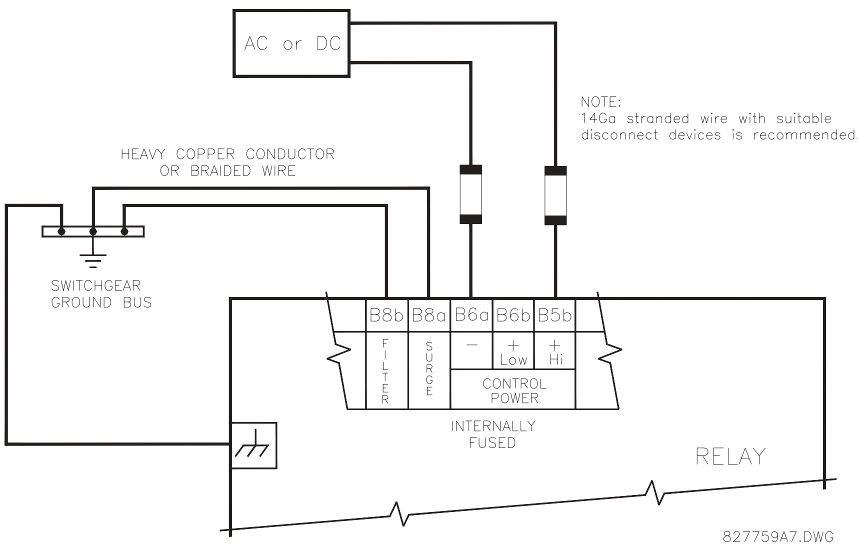


Figure 3–9: CONTROL POWER CONNECTION

3.2.4 CONTACT INPUTS/OUTPUTS

Every digital input/output module has 24 terminal connections. They are arranged as 3 terminals per row, with 8 rows in total. 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 output, there are options of using current or voltage detection for feature supervision, depending on the module ordered. The terminal configuration for contact inputs is different for the two applications. 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. However, this would 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 and diagrams on the following pages illustrate the module types (6A, etc.) and contact arrangements 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, these names are assigned by module slot position, row number, and column position.

UR RELAY FORM-A OUTPUT CONTACTS:

Some Form-A outputs include circuits to monitor the DC voltage across the output contact when it is open, and the DC current through the output contact when it is closed. Each of the monitors contains a level detector whose output is set to logic "On = 1" when the current in the circuit is above the threshold setting. The voltage monitor is set to "On = 1" when the current is above about 1 to 2.5 mA, and the current monitor is set to "On = 1" when the current exceeds about 80 to 100 mA. The voltage monitor is intended to check the health of the overall trip circuit, and the current monitor can be used to seal-in the output contact until an external contact has interrupted current flow. The block diagrams of the circuits are below above for the Form-A outputs with:

a) optional voltage monitor
b) optional current monitor
c) with no monitoring

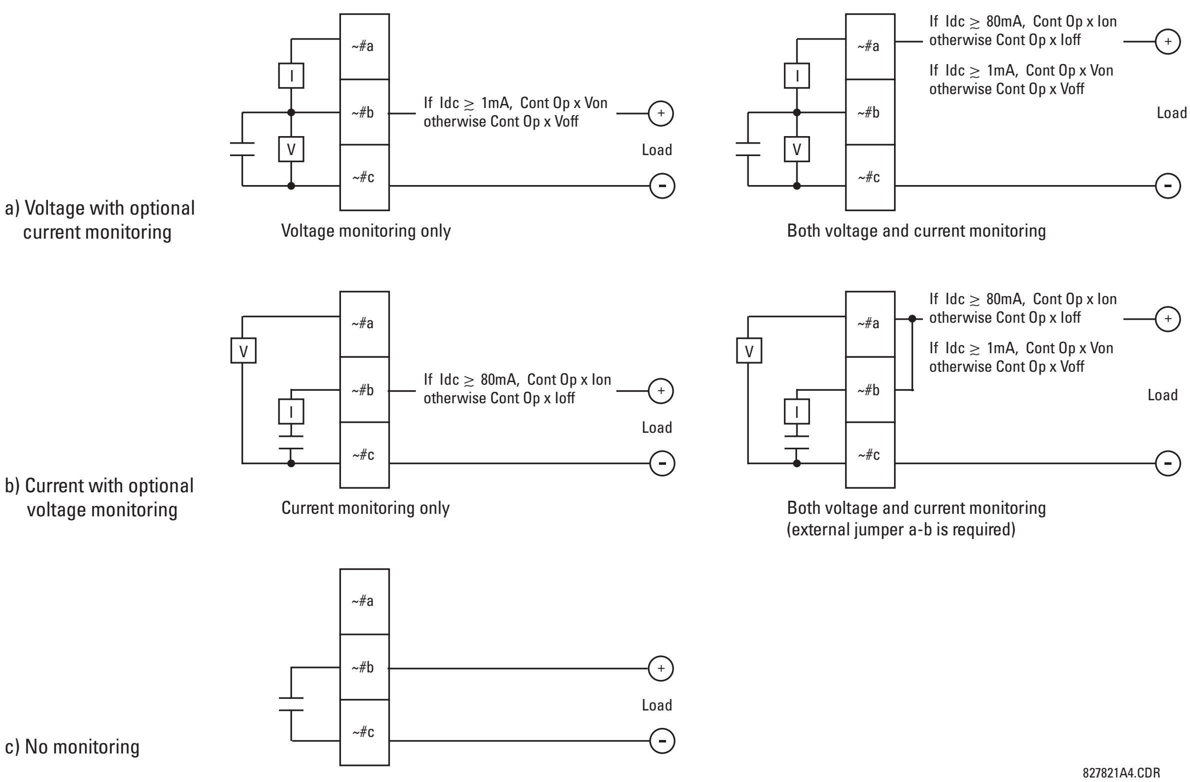


Figure 3–10: FORM-A CONTACT FUNCTIONS

The operation of voltage and current monitors is reflected with the corresponding FlexLogic™ operands (Cont Op # Von, Cont Op # Voff, Cont Op # Ion, and Cont Op # Ioff) which can be used in protection, control and alarm logic. The typical application of the voltage monitor is Breaker Trip Circuit Integrity monitoring; a typical application of the Current monitor is seal-in of the control command. Refer to the Digital Elements section of Chapter 5 for an example of how Form-A contacts can be applied for Breaker Trip Circuit Integrity Monitoring.

WARNING

Relay contacts must be considered unsafe to touch when the unit is energized! If the relay contacts need to be used for low voltage accessible applications, it is the customer's responsibility to ensure proper insulation levels!

NOTE

USE OF FORM-A OUTPUTS IN HIGH IMPEDANCE CIRCUITS

For Form-A output contacts internally equipped with a voltage measuring cIrcuit across the contact, the circuit has an impedance that can cause a problem when used in conjunction with external high input impedance monitoring equipment such as modern relay test set trigger circuits. These monitoring circuits may continue to read the Form-A contact as being closed after it has closed and subsequently opened, when measured as an impedance.

The solution to this problem is to use the voltage measuring trigger input of the relay test set, and connect the Form-A contact through a voltage-dropping resistor to a DC voltage source. If the 48 V DC output of the power supply is used as a source, a 500 Ω, 10 W resistor is appropriate. In this configuration, the voltage across either the Form-A contact or the resistor can be used to monitor the state of the output.

NOTE

Wherever a tilde "~" symbol appears, substitute with the Slot Position of the module; wherever a number sign "#" appears, substitute the contact number

NOTE

When current monitoring is used to seal-in the Form-A contact outputs, the FlexLogic™ operand driving the contact output should be given a reset delay of 10 ms to prevent damage of the output contact (in situations when the element initiating the contact output is bouncing, at values in the region of the pickup value).

Table 3–2: DIGITAL 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
~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
~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	OUTPUT OR INPUT
~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

~6F I/O MODULE	
TERMINAL ASSIGNMENT	OUTPUT
~1	Fast Form-C
~2	Fast Form-C
~3	Fast Form-C
~4	Fast Form-C
~5	Fast Form-C
~6	Fast Form-C
~7	Fast Form-C
~8	Fast Form-C

~6G I/O MODULE	
TERMINAL ASSIGNMENT	OUTPUT OR INPUT
~1	Form-A
~2	Form-A
~3	Form-A
~4	Form-A
~5a, ~5c	2 Inputs
~6a, ~6c	2 Inputs
~7a, ~7c	2 Inputs
~8a, ~8c	2 Inputs

~6H I/O MODULE	
TERMINAL ASSIGNMENT	OUTPUT OR INPUT
~1	Form-A
~2	Form-A
~3	Form-A
~4	Form-A
~5	Form-A
~6	Form-A
~7a, ~7c	2 Inputs
~8a, ~8c	2 Inputs

~6K I/O MODULE	
TERMINAL ASSIGNMENT	OUTPUT
~1	Form-C
~2	Form-C
~3	Form-C
~4	Form-C
~5	Fast Form-C
~6	Fast Form-C
~7	Fast Form-C
~8	Fast Form-C

~6L 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

~6M 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

~6N I/O MODULE	
TERMINAL ASSIGNMENT	OUTPUT OR INPUT
~1	Form-A
~2	Form-A
~3	Form-A
~4	Form-A
~5a, ~5c	2 Inputs
~6a, ~6c	2 Inputs
~7a, ~7c	2 Inputs
~8a, ~8c	2 Inputs

3

~6P I/O MODULE	
TERMINAL ASSIGNMENT	OUTPUT OR INPUT
~1	Form-A
~2	Form-A
~3	Form-A
~4	Form-A
~5	Form-A
~6	Form-A
~7a, ~7c	2 Inputs
~8a, ~8c	2 Inputs

~6R 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

~6S 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

~6T I/O MODULE	
TERMINAL ASSIGNMENT	OUTPUT OR INPUT
~1	Form-A
~2	Form-A
~3	Form-A
~4	Form-A
~5a, ~5c	2 Inputs
~6a, ~6c	2 Inputs
~7a, ~7c	2 Inputs
~8a, ~8c	2 Inputs

~6U I/O MODULE	
TERMINAL ASSIGNMENT	OUTPUT OR INPUT
~1	Form-A
~2	Form-A
~3	Form-A
~4	Form-A
~5	Form-A
~6	Form-A
~7a, ~7c	2 Inputs
~8a, ~8c	2 Inputs

~4A I/O MODULE	
TERMINAL ASSIGNMENT	OUTPUT
~1	Not Used
~2	Solid-State
~3	Not Used
~4	Solid-State
~5	Not Used
~6	Solid-State
~7	Not Used
~8	Solid-State

~4B I/O MODULE	
TERMINAL ASSIGNMENT	OUTPUT
~1	Not Used
~2	Solid-State
~3	Not Used
~4	Solid-State
~5	Not Used
~6	Solid-State
~7	Not Used
~8	Solid-State

~4C I/O MODULE	
TERMINAL ASSIGNMENT	OUTPUT
~1	Not Used
~2	Solid-State
~3	Not Used
~4	Solid-State
~5	Not Used
~6	Solid-State
~7	Not Used
~8	Solid-State

~4L I/O MODULE	
TERMINAL ASSIGNMENT	OUTPUT
~1	2 Outputs
~2	2 Outputs
~3	2 Outputs
~4	2 Outputs
~5	2 Outputs
~6	2 Outputs
~7	2 Outputs
~8	Not Used

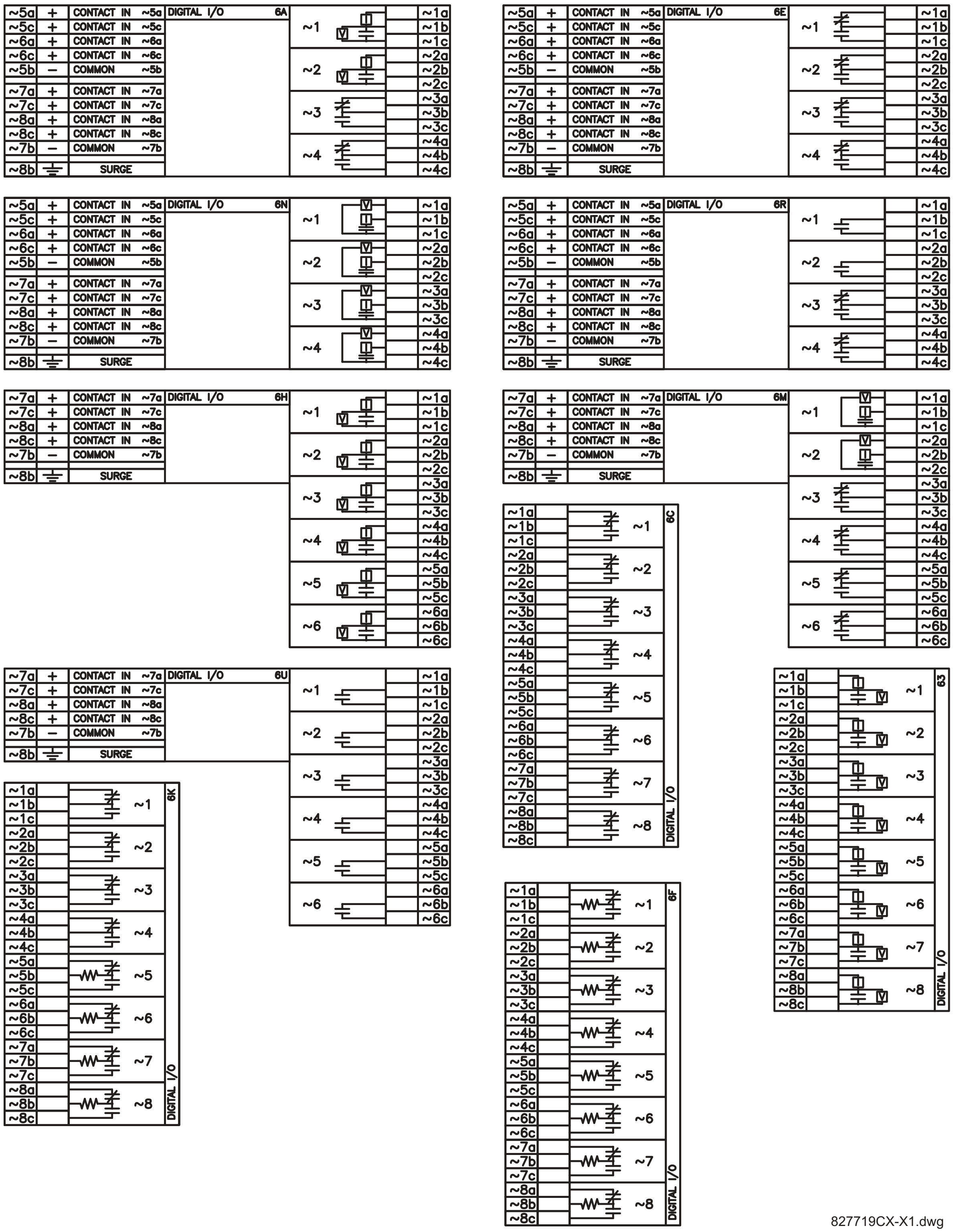


Figure 3–11: DIGITAL I/O MODULE WIRING (1 of 2)

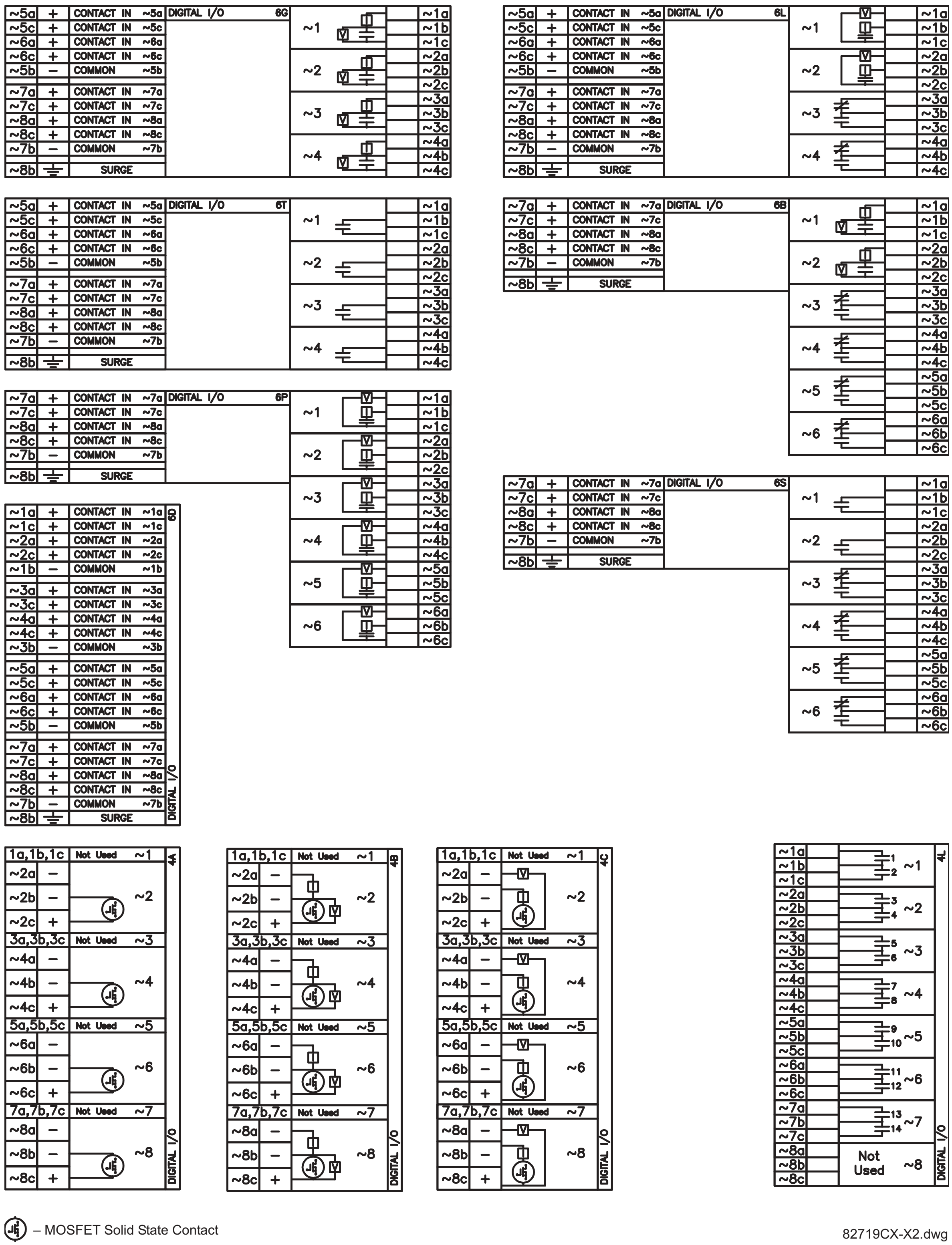


Figure 3–12: DIGITAL I/O MODULE WIRING (2 of 2)

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 positive 48 V DC 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 (negative) 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 (negative) terminal of each contact input group. The maximum external source voltage for this arrangement is 300 V DC.

The voltage threshold at which each group of four contact inputs will detect a closed contact input is programmable as 17 V DC for 24 V sources, 33 V DC for 48 V sources, 84 V DC for 110 to 125 V sources, and 166 V DC for 250 V sources.

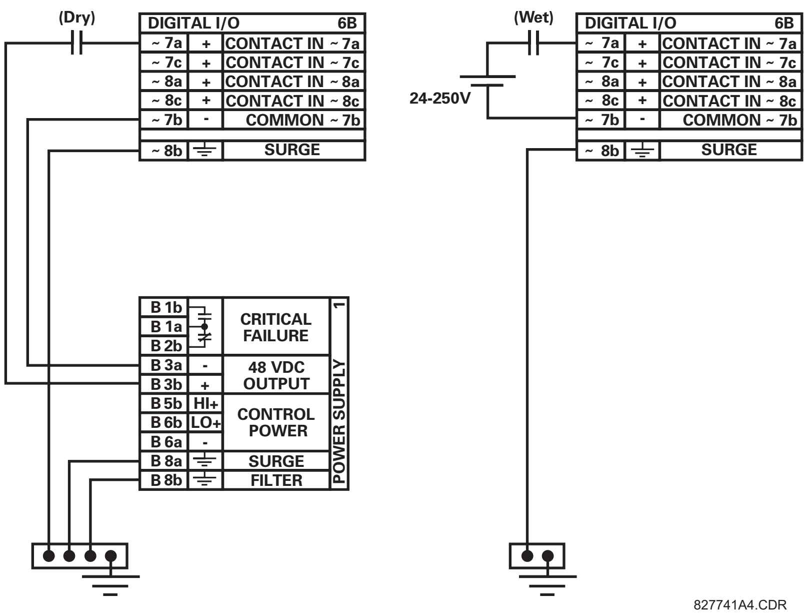


Figure 3–13: DRY AND WET CONTACT INPUT CONNECTIONS

NOTE

Wherever a tilde “~” symbol appears, substitute with the Slot Position of the module.

Contact outputs may be ordered as Form-A or Form-C. 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 presence 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 output contacts.

NOTE

There is no provision in the relay to detect a DC ground fault on 48 V DC control power external output. We recommend using an external DC supply.

3.2.5 TRANSDUCER INPUTS/OUTPUTS

Transducer input/output modules can receive input signals from external dcmA output transducers (dcmA In) or resistance temperature detectors (RTD). Hardware and software is provided to receive signals from these external transducers and convert these signals into a digital format for use as required.

Every transducer input/output module has a total of 24 terminal connections. These connections are arranged as three terminals per row with a total of eight rows. A given row may be used for either inputs or outputs, with terminals in column "a" having positive polarity and terminals in column "c" having negative polarity. Since an entire row is used for a single input/output channel, the name of the channel is assigned using the module slot position and row number.

Each module also requires that a connection from an external ground bus be made to Terminal 8b. The figure below illustrates the transducer module types (5C, 5E, and 5F) and channel arrangements that may be ordered for the relay.

NOTE

Wherever a tilde “~” symbol appears, substitute with the Slot Position of the module.

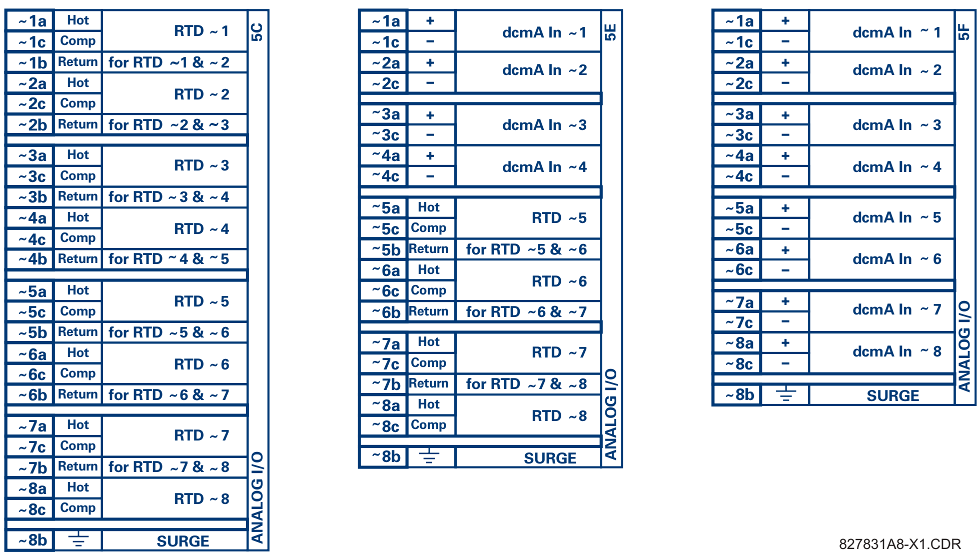


Figure 3–14: TRANSDUCER I/O MODULE WIRING

3.2.6 RS232 FACEPLATE PORT

A 9-pin RS232C serial port is located on the relay's faceplate for programming with a portable (personal) computer. All that is required to use this interface is a personal computer running the URPC software provided with the relay. Cabling for the RS232 port is shown in the following figure for both 9 pin and 25 pin connectors.

Note that the baud rate for this port is fixed at **19200 bps**.

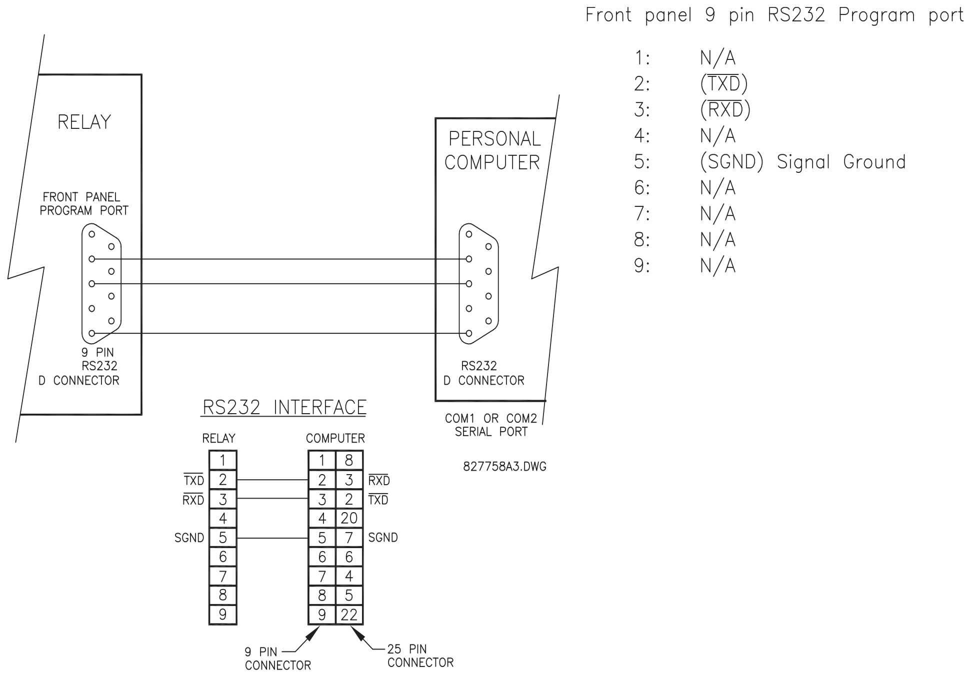


Figure 3–15: RS232 FACEPLATE PORT CONNECTION

3.2.7 CPU COMMUNICATION PORTS

a) OPTIONS

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.

CPU TYPE	COM1	COM2
9A	RS485	RS485
9C	10BASE-F	RS485
9D	Redundant 10Base-F	RS485

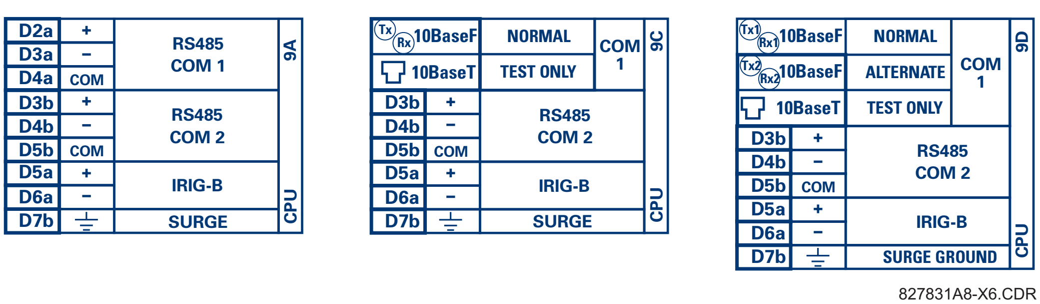


Figure 3–16: CPU MODULE COMMUNICATIONS WIRING

b) RS485 PORTS

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, when provided. 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 optocoupled data interface also acts to reduce noise coupling. To ensure maximum reliability, all equipment should have similar transient protection devices installed.

Both ends of the RS485 circuit should also be terminated with an impedance as shown below.

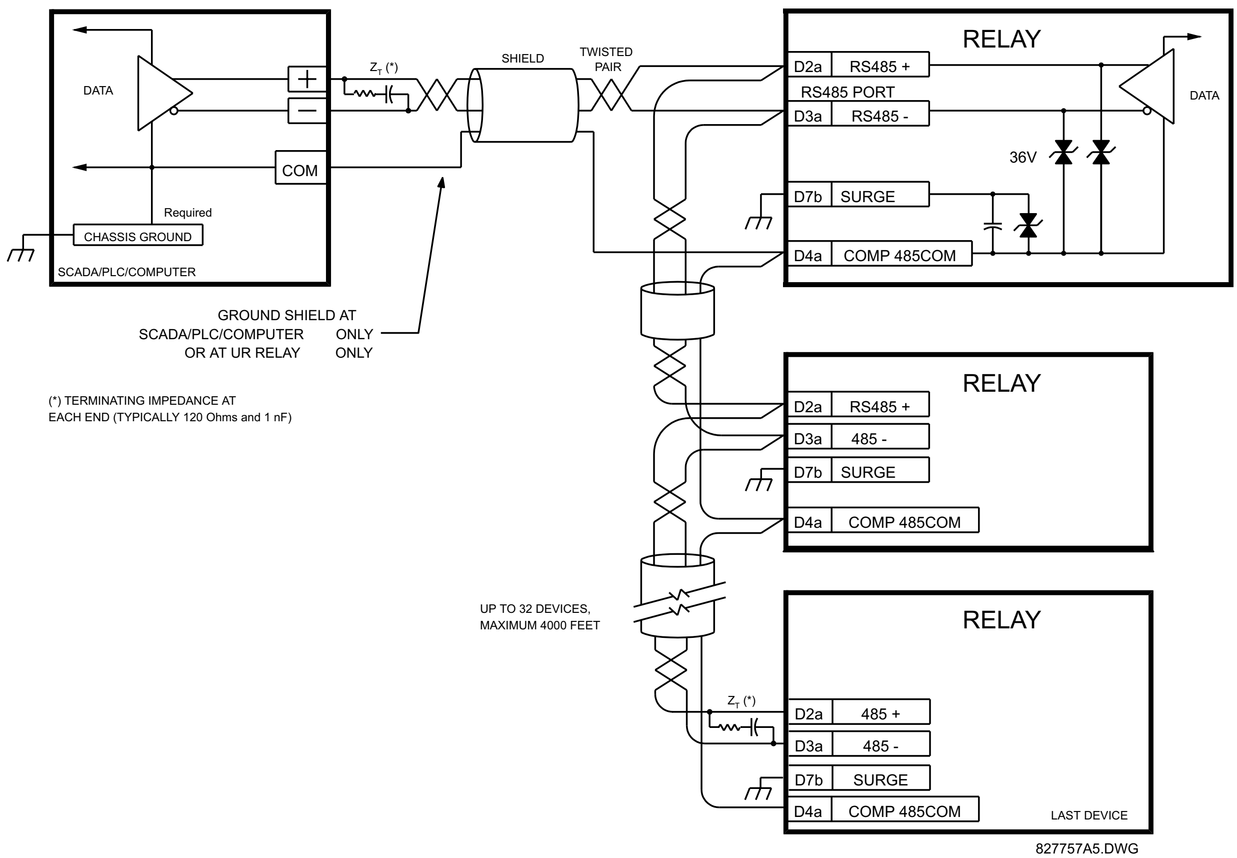


Figure 3–17: RS485 SERIAL CONNECTION

c) 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 ANY FIBER 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 types 9C and 9D. The 9D CPU has a 10BaseF 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 or less in diameter. For optical power budgeting, splices are required every 1 km for the transmitter/receiver pair (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 dis-engage the ST type connector, only a quarter turn of the coupling is required.

3.2.8 IRIG-B

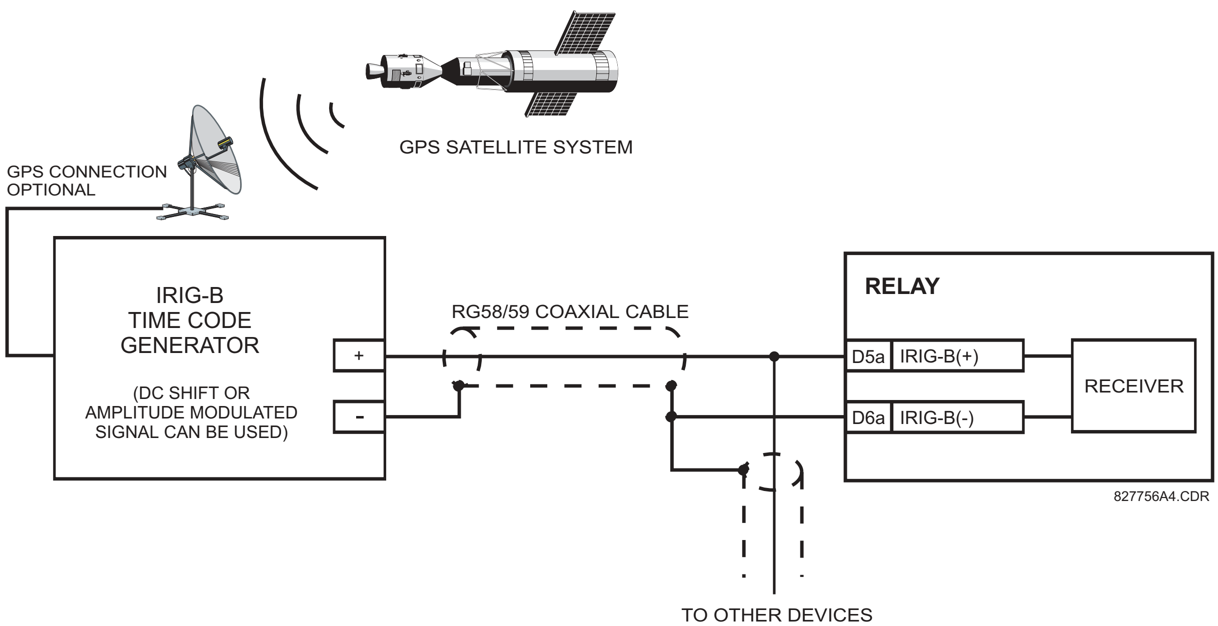


Figure 3–18: IRIG-B CONNECTION

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.

3.3.1 DESCRIPTION

The C30 Direct I/O feature makes use of the Type 7 series of communications modules. These modules are also used by the L90 Line Differential Relay for inter-relay communications. The Direct I/O feature uses the communications channel(s) provided by these modules to exchange digital state information between relays. This feature is available on all UR relays models except for the L60 and L90 Line relays.

The communications channels are normally connected in a ring configuration as shown below. The transmitter of one module is connected to the receiver of the next module. The transmitter of this second module is then connected to the receiver of the next module in the ring. This is continued to form a communications ring. The figure below illustrates a ring of four UR relays with the following connections: UR1-Tx to UR2-Rx, UR2-Tx to UR3-Rx, UR3-Tx to UR4-Rx, and UR4-Tx to UR1-Rx. The maximum number of UR relays that can be connected in a single ring is eight.

3

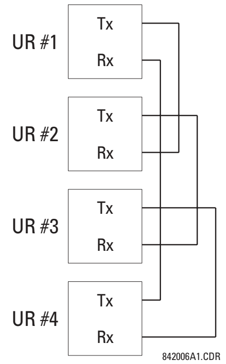


Figure 3–19: DIRECT I/O SINGLE CHANNEL CONNECTION

The following diagram shows the interconnection for dual-channel Type 7 communications modules. Two channel modules allow for a redundant ring configuration. That is, two rings can be created to provide an additional independent data path. The required connections are as follows: UR1-Tx1 to UR2-Rx1, UR2-Tx1 to UR3-Rx1, UR3-Tx1 to UR4-Rx1, and UR4-Tx1 to UR1-Rx1 for the first ring; and UR1-Tx2 to UR2-Rx2, UR2-Tx2 to UR3-Rx2, UR3-Tx2 to UR4-Rx2, and UR4-Tx2 to UR1-Rx2 for the second ring.

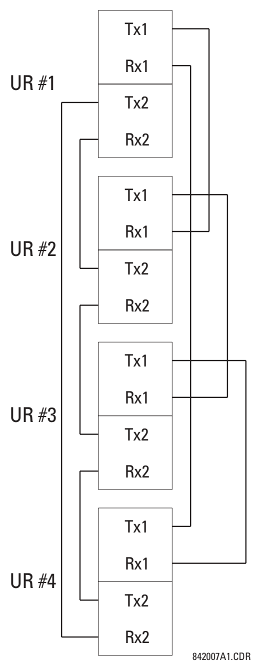


Figure 3–20: DIRECT I/O DUAL CHANNEL CONNECTION

The following diagram shows the interconnection for three UR-series relays using two independent communication channels. UR1 and UR3 have single Type 7 communication modules; UR2 has a dual-channel module. The two communication channels can be of different types, depending on the Type 7 modules used. To allow the Direct I/O data to ‘cross-over’ from Channel 1 to Channel 2 on UR2, the **DIRECT I/O CHANNEL CROSSOVER** setting should be “Enabled” on UR2. This forces UR2 to forward messages received on Rx1 out Tx2, and messages received on Rx2 out Tx1.

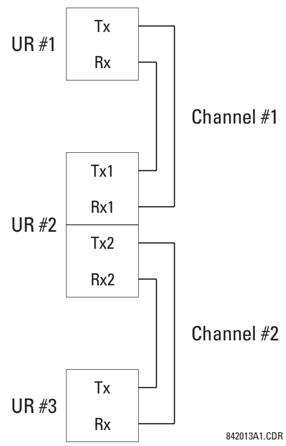


Figure 3–21: DIRECT I/O SINGLE/DUAL CHANNEL COMBINATION CONNECTION

The interconnection requirements are described in further detail in this section for each specific variation of Type 7 communications module. These modules are listed in the following table. All fiber modules use ST type connectors.

Table 3–3: CHANNEL COMMUNICATION OPTIONS

MODULE TYPE	SPECIFICATION
7A	820 nm, multi-mode, LED, 1 Channel
7B	1300 nm, multi-mode, LED, 1 Channel
7C	1300 nm, single-mode, ELED, 1 Channel
7D	1300 nm, single-mode, LASER, 1 Channel
7H	820 nm, multi-mode, LED, 2 Channels
7I	1300 nm, multi-mode, LED, 2 Channels
7J	1300 nm, single-mode, ELED, 2 Channels
7K	1300 nm, single-mode, LASER, 2 Channels
7L	Channel 1: RS422, Channel: 820 nm, multi-mode, LED
7M	Channel 1: RS422, Channel 2: 1300 nm, multi-mode, LED
7N	Channel 1: RS422, Channel 2: 1300 nm, single-mode, ELED
7P	Channel 1: RS422, Channel 2: 1300 nm, single-mode, LASER
7R	G.703, 1 Channel
7S	G.703, 2 Channels
7T	RS422, 1 Channel
7W	RS422, 2 Channels
72	1550 nm, single-mode, LASER, 1 Channel
73	1550 nm, single-mode, LASER, 2 Channel
74	Channel 1 - RS422; Channel 2 - 1550 nm, single-mode, LASER
76	IEEE C37.94, 820 nm, multi-mode, LED, 1 Channel
77	IEEE C37.94, 820 nm, multi-mode, LED, 2 Channels

CAUTION

OBSERVING ANY FIBER TRANSMITTER OUTPUT MAY CAUSE INJURY TO THE EYE.

3.3.2 FIBER: LED AND ELED TRANSMITTERS

The following figure shows the configuration for the 7A, 7B, 7C, 7H, 7I, and 7J fiber-only modules.

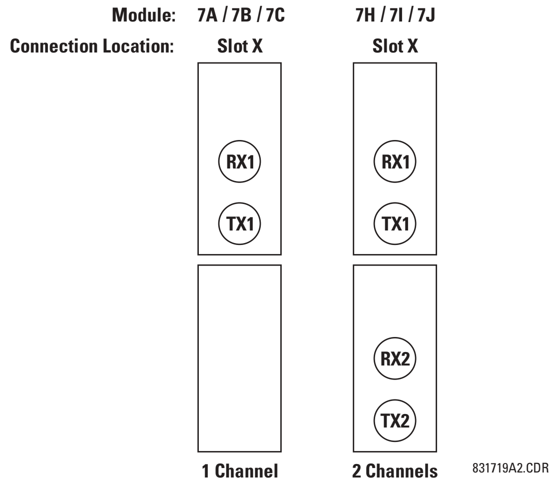


Figure 3–22: LED AND ELED FIBER MODULES

3.3.3 FIBER-LASER TRANSMITTERS

The following figure shows the configuration for the 72, 73, 7D, and 7K fiber-laser module.

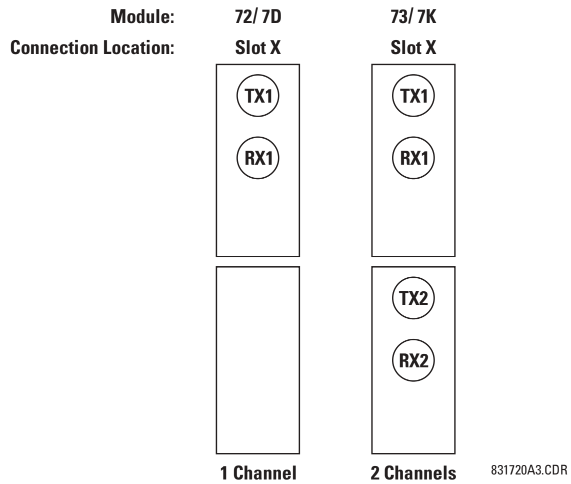


Figure 3–23: LASER FIBER MODULES

WARNING

When using a LASER Interface, attenuators may be necessary to ensure that you do not exceed Maximum Optical Input Power to the receiver.

3.3.4 G.703 INTERFACE

a) DESCRIPTION

The following figure shows the 64K ITU G.703 co-directional interface configuration.

AWG 22 twisted shielded pair is recommended for external connections, with the shield grounded only at one end. Connecting the shield to Pin X1a or X6a grounds the shield since these pins are internally connected to ground. Thus, if Pin X1a or X6a is used, do not ground at the other end. This interface module is protected by surge suppression devices.

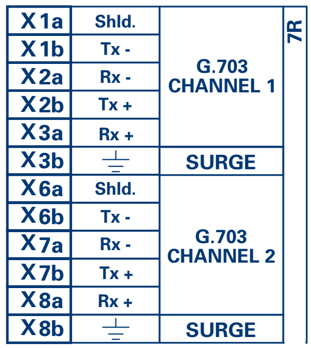


Figure 3–24: G.703 INTERFACE CONFIGURATION

The following figure shows the typical pin interconnection between two G.703 interfaces. For the actual physical arrangement of these pins, see the Rear Terminal Assignments section earlier in this chapter. All pin interconnections are to be maintained for a connection to a multiplexer.

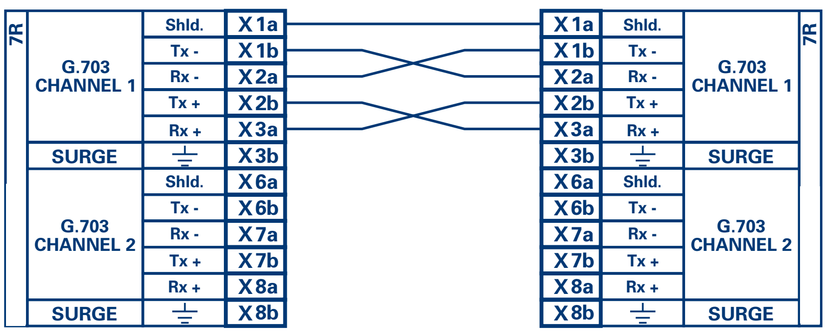


Figure 3–25: TYPICAL PIN INTERCONNECTION BETWEEN TWO G.703 INTERFACES

NOTE

Pin nomenclature may differ from one manufacturer to another. Therefore, it is not uncommon to see pinouts numbered TxA, TxB, RxA and RxB. In such cases, it can be assumed that “A” is equivalent to “+” and “B” is equivalent to “–”.

b) G.703 SELECTION SWITCH PROCEDURES

1. Remove the G.703 module (7R or 7S):

   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.
2. Remove the module cover screw.
3. Remove the top cover by sliding it towards the rear and then lift it upwards.
4. Set the Timing Selection Switches (Channel 1, Channel 2) to the desired timing modes.
5. Replace the top cover and the cover screw.
6. Re-insert the G.703 module 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.

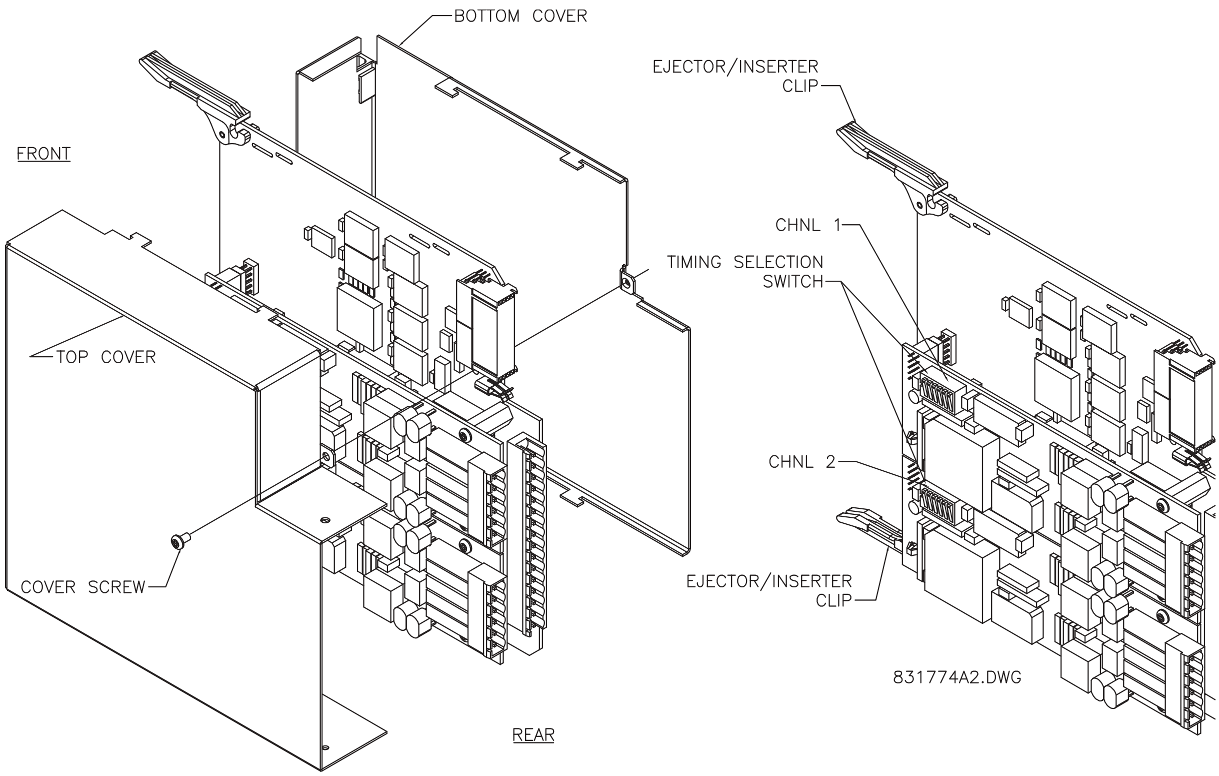


Figure 3–26: G.703 TIMING SELECTION SWITCH SETTING

Table 3–4: G.703 TIMING SELECTIONS

SWITCHES	FUNCTION
S1	OFF → Octet Timing Disabled ON → Octet Timing 8 kHz
S5 and S6	S5 = OFF and S6 = OFF → Loop Timing Mode S5 = ON and S6 = OFF → Internal Timing Mode S5 = OFF and S6 = ON → Minimum Remote Loopback Mode S5 = ON and S6 = ON → Dual Loopback Mode

c) OCTET TIMING (SWITCH S1)

If Octet Timing is enabled (ON), this 8 kHz signal will be asserted during the violation of Bit 8 (LSB) necessary for connecting to higher order systems. When L90's are connected back to back, Octet Timing should be disabled (OFF).

d) TIMING MODES (SWITCHES S5 AND S6)

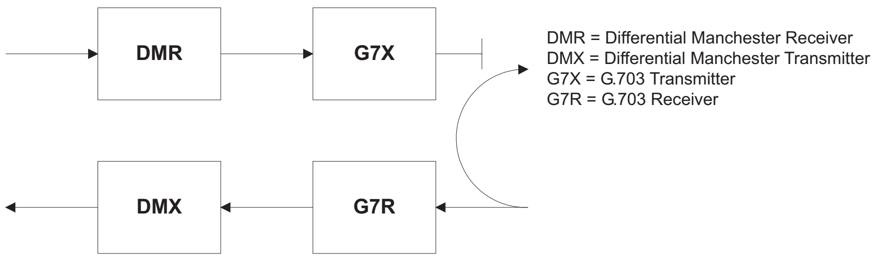
- **Internal Timing Mode:** The system clock generated internally. Therefore, the G.703 timing selection should be in the Internal Timing Mode for back-to-back (UR-to-UR) connections. For Back to Back Connections, set for Octet Timing (S1 = OFF) and Timing Mode = Internal Timing (S5 = ON and S6 = OFF).
- **Loop Timing Mode:** The system clock is derived from the received line signal. Therefore, the G.703 timing selection should be in Loop Timing Mode for connections to higher order systems. For connection to a higher order system (UR-to-multiplexer, factory defaults), set to Octet Timing (S1 = ON) and set Timing Mode = Loop Timing (S5 = OFF and S6 = OFF).

3

e) TEST MODES (SWITCHES S5 AND S6)

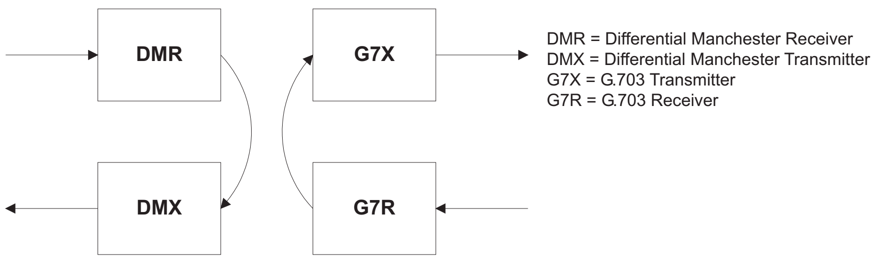
MINIMUM REMOTE LOOPBACK MODE:

In Minimum Remote Loopback mode, the multiplexer is enabled to return the data from the external interface without any processing to assist in diagnosing G.703 Line Side problems irrespective of clock rate. Data enters from the G.703 inputs, passes through the data stabilization latch which also restores the proper signal polarity, passes through the multiplexer and then returns to the transmitter. The Differential Received Data is processed and passed to the G.703 Transmitter module after which point the data is discarded. The G.703 Receiver module is fully functional and continues to process data and passes it to the Differential Manchester Transmitter module. Since timing is returned as it is received, the timing source is expected to be from the G.703 line side of the interface.



DUAL LOOPBACK MODE:

In Dual Loopback Mode, the multiplexers are active and the functions of the circuit are divided into two with each Receiver/ Transmitter pair linked together to deconstruct and then reconstruct their respective signals. Differential Manchester data enters the Differential Manchester Receiver module and then is returned to the Differential Manchester Transmitter module. Likewise, G.703 data enters the G.703 Receiver module and is passed through to the G.703 Transmitter module to be returned as G.703 data. Because of the complete split in the communications path and because, in each case, the clocks are extracted and reconstructed with the outgoing data, in this mode there must be two independent sources of timing. One source lies on the G.703 line side of the interface while the other lies on the Differential Manchester side of the interface.



3.3.5 RS422 INTERFACE

a) DESCRIPTION

The following figure shows the RS422 2-Terminal interface configuration at 64K baud. AWG 22 twisted shielded pair is recommended for external connections. This interface module is protected by surge suppression devices which optically isolated.

SHIELD TERMINATION

The shield pins (6a and 7b) are internally connected to the ground pin (8a). Proper shield termination is as follows:

Site 1: Terminate shield to pins 6a and/or 7b; Site 2: Terminate shield to ‘COM’ pin 2b.

The clock terminating impedance should match the impedance of the line.

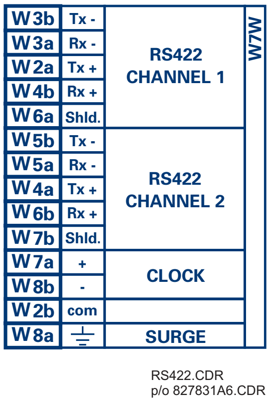


Figure 3–27: RS422 INTERFACE CONFIGURATION

The following figure shows the typical pin interconnection between two RS422 interfaces. All pin interconnections are to be maintained for a connection to a multiplexer.

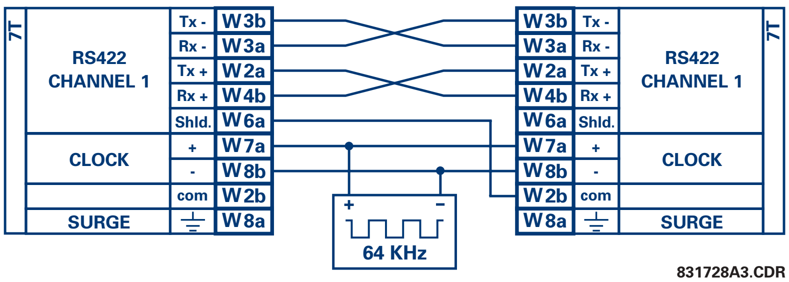


Figure 3–28: TYPICAL PIN INTERCONNECTION BETWEEN TWO RS422 INTERFACES

b) TWO CHANNEL APPLICATIONS VIA MULTIPLEXERS

The RS422 Interface may be used for ‘1 channel’ or ‘2 channel’ applications over SONET/SDH and/or Multiplexed systems. When used in 1 channel applications, the RS422 interface links to higher order systems in a typical fashion observing Tx, Rx, and Send Timing connections. However, when used in 2 channel applications, certain criteria have to be followed due to the fact that there is 1 clock input for the two RS422 channels. The system will function correctly if the following connections are observed and your Data Module has a feature called Terminal Timing. Terminal Timing is a common feature to most Synchronous Data Units that allows the module to accept timing from an external source. Using the Terminal Timing feature, 2 channel applications can be achieved if these connections are followed: The Send Timing outputs from the Multiplexer - Data Module 1, will connect to the Clock inputs of the UR–RS422 interface in the usual fashion. In addition, the Send Timing outputs of Data Module 1 will also be paralleled to the Terminal Timing inputs of Data Module 2. By using this configuration the timing for both Data Modules and both UR–RS422 channels will be derived from a single clock source. As a result, data sampling for both of the UR–RS422 channels will be synchronized via the Send Timing leads on Data Module 1 as shown in the following figure. If the Terminal Timing feature is not available or this type of connection is not desired, the G.703 interface is a viable option that does not impose timing restrictions.

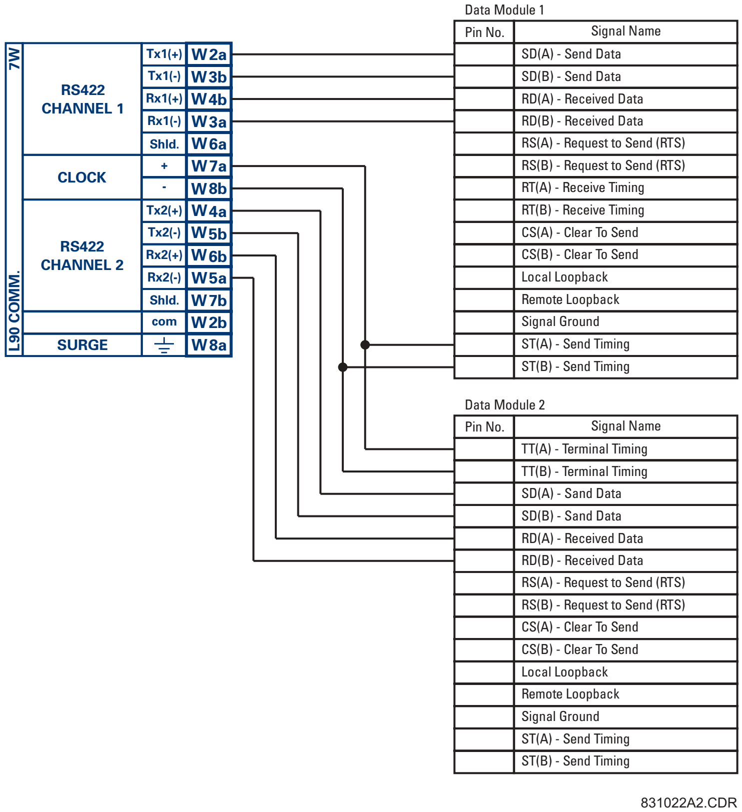


Figure 3–29: TIMING CONFIGURATION FOR RS422 TWO-CHANNEL, 3-TERMINAL APPLICATION

Data Module 1 provides timing to the C30 RS422 interface via the ST(A) and ST(B) outputs. Data Module 1 also provides timing to Data Module 2 TT(A) and TT(B) inputs via the ST(A) and AT(B) outputs. The Data Module pin numbers have been omitted in the figure above since they may vary depending on the manufacturer.

c) TRANSIT TIMING

The RS422 Interface accepts one clock input for Transmit Timing. It is important that the rising edge of the 64 kHz Transmit Timing clock of the Multiplexer Interface is sampling the data in the center of the Transmit Data window. Therefore, it is important to confirm Clock and Data Transitions to ensure Proper System Operation. For example, the following figure shows the positive edge of the Tx Clock in the center of the Tx Data bit.

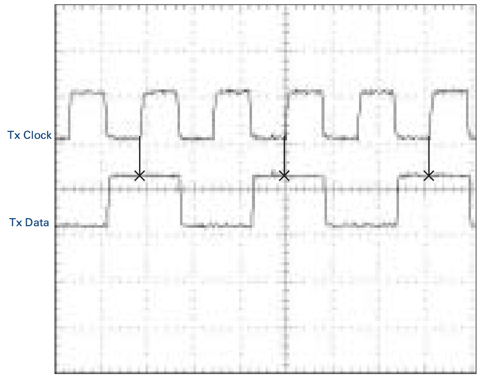


Figure 3–30: CLOCK AND DATA TRANSITIONS

d) RECEIVE TIMING

The RS422 Interface utilizes NRZI-MARK Modulation Code and; therefore, does not rely on an Rx Clock to recapture data. NRZI-MARK is an edge-type, invertible, self-clocking code.

To recover the Rx Clock from the data-stream, an integrated DPLL (Digital Phase Lock Loop) circuit is utilized. The DPLL is driven by an internal clock, which is over-sampled 16X, and uses this clock along with the data-stream to generate a data clock that can be used as the SCC (Serial Communication Controller) receive clock.

3.3.6 RS422 AND FIBER INTERFACE

The following figure shows the combined RS422 plus Fiber interface configuration at 64K baud. The 7L, 7M, 7N, 7P, and 74 modules are used in 2-terminal with a redundant channel or 3-terminal configurations where Channel 1 is employed via the RS422 interface (possibly with a multiplexer) and Channel 2 via direct fiber.

AWG 22 twisted shielded pair is recommended for external RS422 connections and the shield should be grounded only at one end. For the direct fiber channel, power budget issues should be addressed properly.

WARNING **When using a LASER Interface, attenuators may be necessary to ensure that you do not exceed Maximum Optical Input Power to the receiver.**

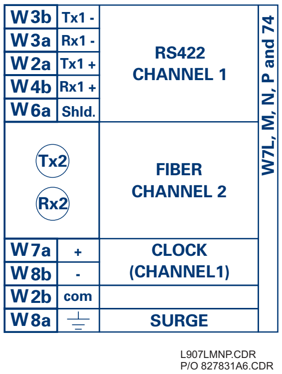


Figure 3–31: RS422 AND FIBER INTERFACE CONNECTION

Connections shown above are for multiplexers configured as DCE (Data Communications Equipment) units.

3.3.7 G.703 AND FIBER INTERFACE

The figure below shows the combined G.703 plus Fiber interface configuration at 64K baud. The 7E, 7F, 7G, 7Q, and 75 modules are used in configurations where Channel 1 is employed via the G.703 interface (possibly with a multiplexer) and Channel 2 via direct fiber. AWG 22 twisted shielded pair is recommended for external G.703 connections connecting the shield to Pin 1A at one end only. For the direct fiber channel, power budget issues should be addressed properly. See previous sections for more details on the G.703 and Fiber interfaces.

WARNING **When using a LASER Interface, attenuators may be necessary to ensure that you do not exceed Maximum Optical Input Power to the receiver.**

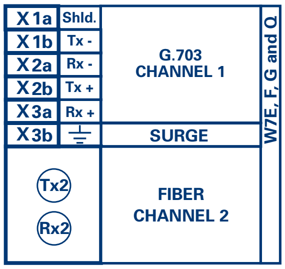


Figure 3–32: G.703 AND FIBER INTERFACE CONNECTION

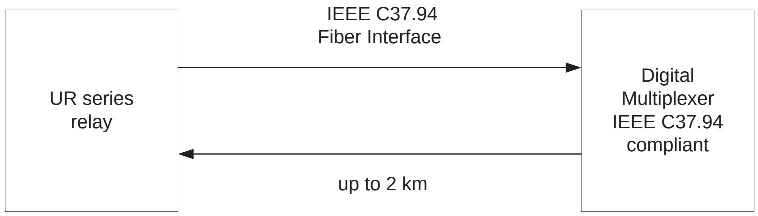
3.3.8 IEEE C37.94 INTERFACE

The UR series IEEE C37.94 communication modules (76 and 77) are designed to interface with IEEE C37.94 compliant digital multiplexer and/or an IEEE C37.94 compliant interface converter for use with Direct I/O applications on firmware revision 3.3x. The IEEE C37.94 Standard defines a point to point optical link for synchronous data between a multiplexer and a teleprotection device. This data is typically 64 kbps but the standard provides for speeds up to 64*n* kbps, where *n* = 1, 2, …12. The UR series C37.94 communication module is 64 kbps only with *n* fixed at 1. The frame is a valid International Telecommunications Union (ITU-T) recommendation G.704 pattern from the standpoint of framing and data rate. The frame is 256 bits and is repeated at a frame rate of 8000 Hz, with a resultant bit rate of 2048 kbps.

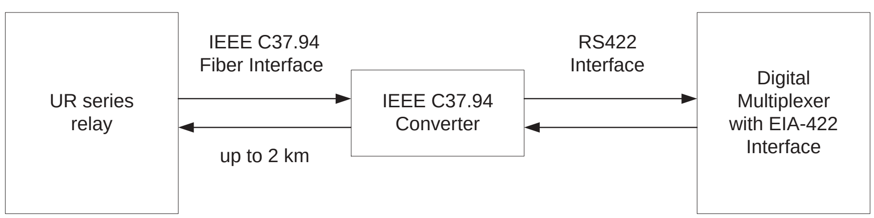
The specifications for the module are as follows:

IEEE standard: C37.94 for 1 × 64 kbps optical fiber interface
Fiber optic cable type: 50 mm or 62.5 mm core diameter optical fiber
Fiber optic mode: multi-mode
Fiber optic cable length: up to 2 km
Fiber optic connector: Type ST
Wavelength: 830 ±40 nm
Connection: as per all fiber optic connections, a Tx to Rx connection is required.

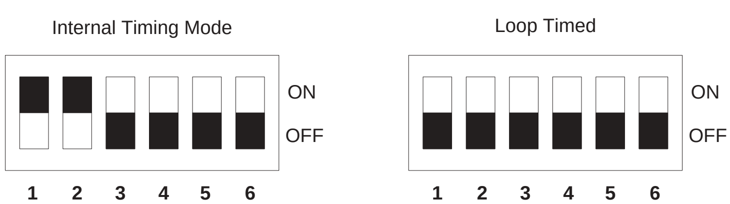
The UR series C37.94 communication module can be connected directly to an compliant digital multiplexer that supports the IEEE C37.94 standard as shown below.



The UR series C37.94 communication module can be connected to the electrical interface (G.703, RS422, or X.21) of a non-compliant digital multiplexer via an optical-to-electrical interface converter that supports the IEEE C37.94 standard as shown below.



The UR series C37.94 communication module has six (6) switches that are used to set the clock configuration. The functions of the control switches is shown below.



Switch	Internal	Loop Timed
1	ON	OFF
2	ON	OFF
3	OFF	OFF
4	OFF	OFF
5	OFF	OFF
6	OFF	OFF

For the Internal Timing Mode, the system clock is generated internally; therefore, the timing switch selection should be Internal Timing for Relay 1 and Loop Timed for Relay 2. There must be only one timing source configured.

For the Looped Timing Mode, the system clock is derived from the received line signal; therefore, the timing selection should be in Loop Timing Mode for connections to higher order systems.

The C37.94 communications module cover removal procedure is as follows:

1. Remove the C37.94 module (76 or 77):

   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.
2. Remove the module cover screw.
3. Remove the top cover by sliding it towards the rear and then lift it upwards.
4. Set the Timing Selection Switches (Channel 1, Channel 2) to the desired timing modes (see description above).
5. Replace the top cover and the cover screw.
6. Re-insert the C37.94 module 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

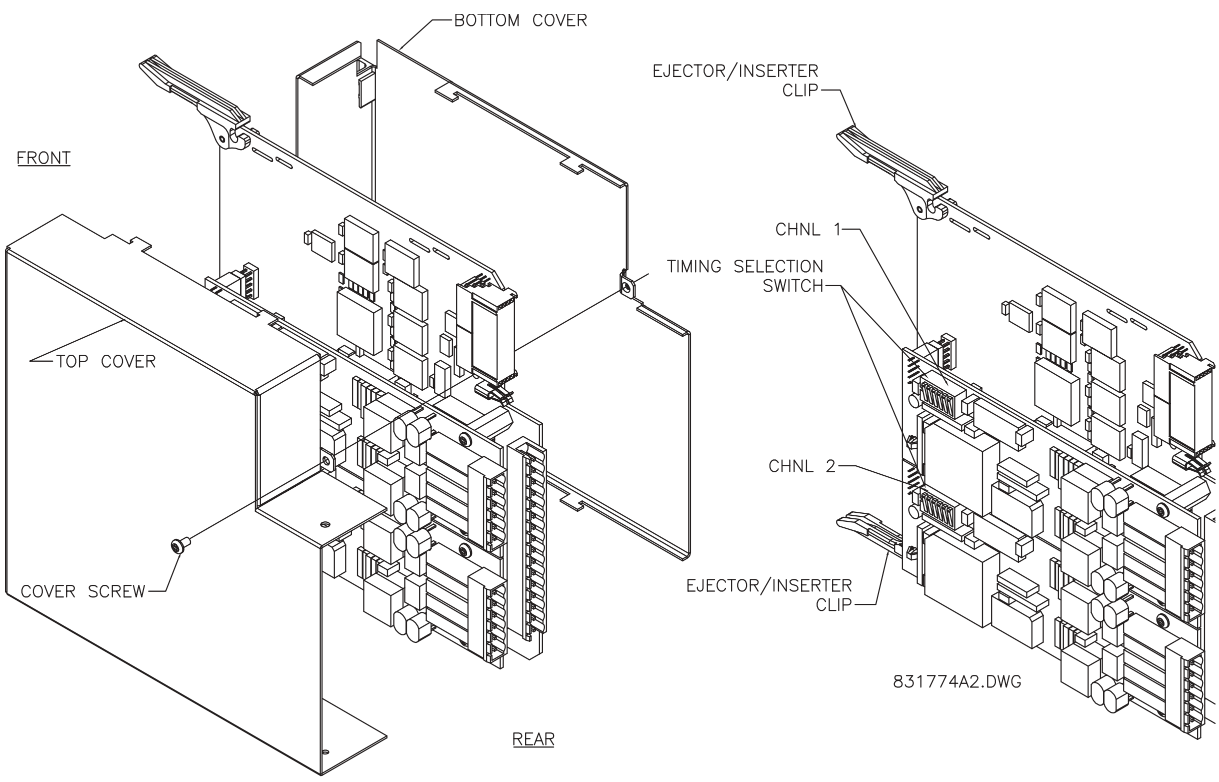


Figure 3–33: C37.94 TIMING SELECTION SWITCH SETTING

4.1.1 INTRODUCTION

The URPC software provides a graphical user interface (GUI) as one of two human interfaces to a UR device. The alternate human interface is implemented via the device's faceplate keypad and display (see Faceplate Interface section in this chapter).

URPC provides a single facility to configure, monitor, maintain, and trouble-shoot the operation of relay functions, connected over local or wide area communication networks. It can be used while disconnected (i.e. off-line) or connected (i.e. on-line) to a UR device. In off-line mode, settings files can be created 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 C30 relay, can be run from any computer supporting Microsoft Windows® 95, 98, or NT. This chapter provides a summary of the basic URPC software interface features. The URPC Help File provides details for getting started and using the URPC software interface.

4.1.2 CREATING A SITE LIST

To start using the URPC software, a site definition and device definition must first be created. See the URPC Help File or refer to the Connecting URPC with the C30 section in Chapter 1 for details.

4.1.3 URPC SOFTWARE OVERVIEW

a) ENGAGING A DEVICE

The URPC software may be used in on-line mode (relay connected) to directly communicate with a UR relay. Communicating relays are organized and grouped by communication interfaces and into sites. Sites may contain any number of relays selected from the UR product series.

b) USING SETTINGS FILES

The URPC software interface supports three ways of handling changes to relay settings:

- In off-line mode (relay disconnected) to create or edit relay settings files for later download to communicating relays.
- While connected to a communicating relay to directly modify any relay settings via relay data view windows, and then save the settings to the relay.
- 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 the following types of relay settings:

- Device Definition
- Product Setup
- FlexLogic™
- Control Elements
- Inputs/Outputs
- Testing

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

c) CREATING FLEXLOGIC™ EQUATIONS

You can create or edit a FlexLogic™ equation in order to customize the relay. You can subsequently view the automatically generated logic diagram.

d) VIEWING ACTUAL VALUES

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

e) VIEWING TRIGGERED EVENTS

While the interface is in either on-line or off-line mode, you can view and analyze data generated by triggered specified parameters, via one of the following:

- **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 and digital states are used to provide a visual display of power system and relay operation data captured during specific triggered events.

f) FILE SUPPORT

- **Execution:** Any URPC file which is double clicked or opened will launch the application, or provide focus to the already opened application. If the file was a settings file (has a URS extension) which had been removed from the Settings List tree menu, it will be added back to the Settings List tree menu.
- **Drag and Drop:** The Site List and Settings List control bar windows are each mutually a drag source and a drop target for device-order-code-compatible files or individual menu items. Also, the Settings List control bar window and any Windows Explorer directory folder are each mutually a file drag source and drop target.

  New 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. Files or individual menu items which are dropped in the selected device menu in the Site List window will automatically be sent to the on-line communicating device.

g) FIRMWARE UPGRADES

The firmware of a UR device can be upgraded, locally or remotely, via the URPC® software. The corresponding instructions are provided by the URPC® Help program under the topic “Upgrading Firmware”.

NOTE

Modbus addresses assigned to firmware modules, features, settings, and corresponding data items (i.e. default values, min/max values, data type, and item size) may change slightly from version to version of firmware. The addresses are rearranged when new features are added or existing features are enhanced or modified. The “EEPROM DATA ERROR” message displayed after upgrading/downgrading the firmware is a resettable, self-test message intended to inform users that the Modbus addresses have changed with the upgraded firmware. This message does not signal any problems when appearing after firmware upgrades.

4.1.4 URPC MAIN WINDOW

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

a. Title bar which shows the pathname of the active data view

b. Main window menu bar

c. Main window tool bar

d. Site List control bar window

e. Settings List control bar window

f. Device data view window(s), with common tool bar

g. Settings File data view window(s), with common tool bar

h. Workspace area with data view tabs

i. Status bar

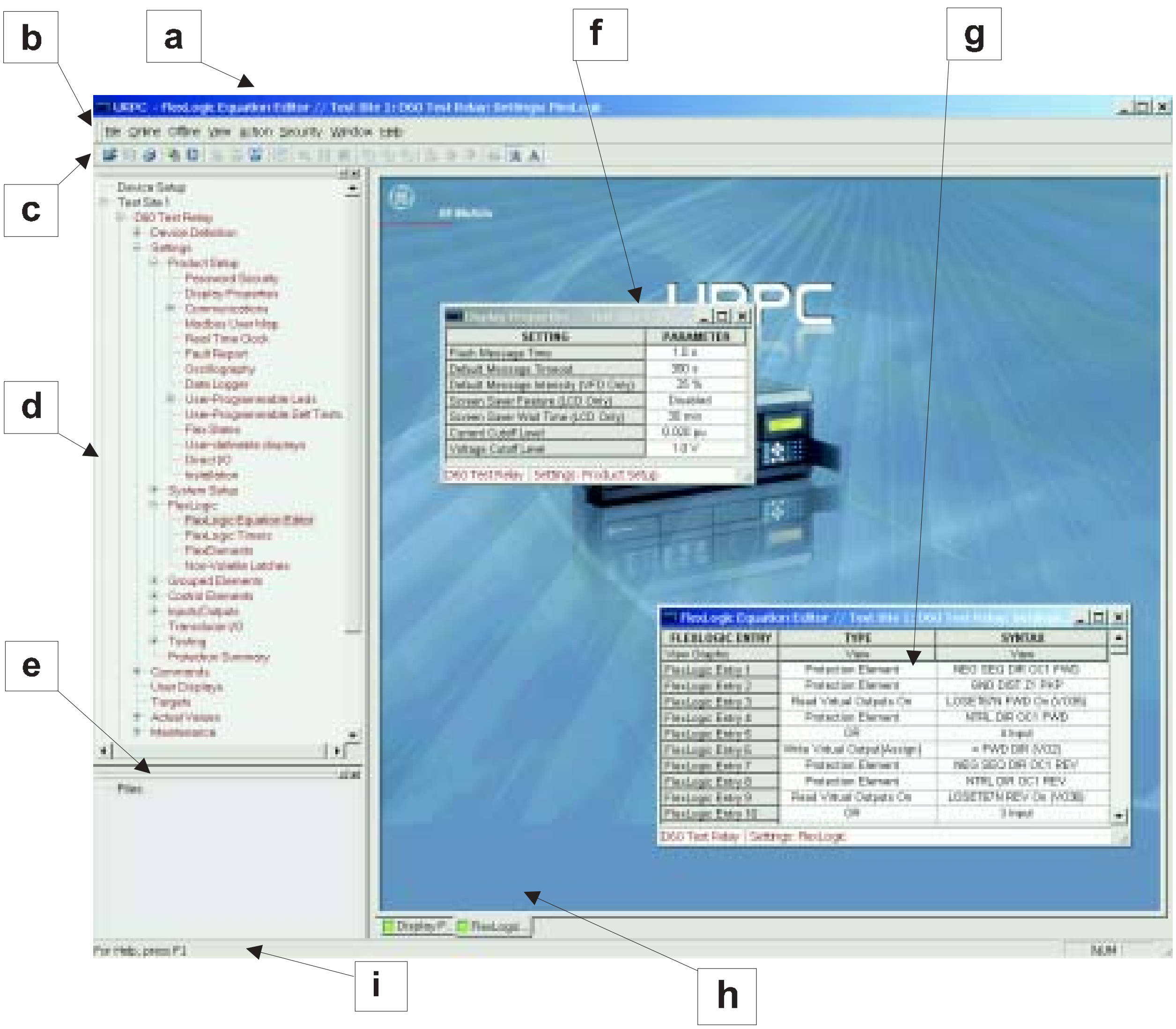


Figure 4–1: URPC SOFTWARE MAIN WINDOW

4.2.1 FACEPLATE

The keypad/display/LED interface is one of two alternate human interfaces supported. The other alternate human interface is implemented via the URPC software. The UR faceplate interface is available in two configurations: horizontal or vertical. The faceplate interface consists of several functional panels.

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 panel. The following two figures show the horizontal and vertical arrangement of faceplate panels.

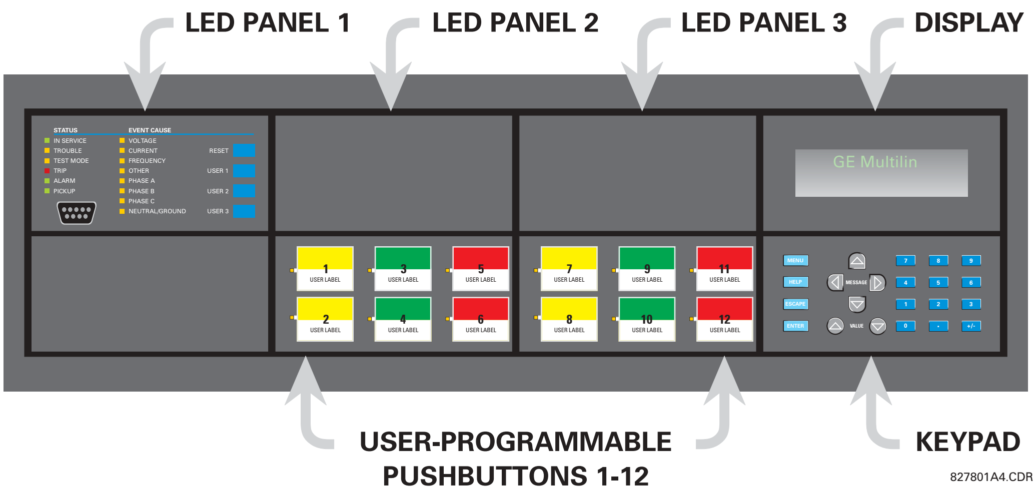


Figure 4–2: UR HORIZONTAL FACEPLATE PANELS

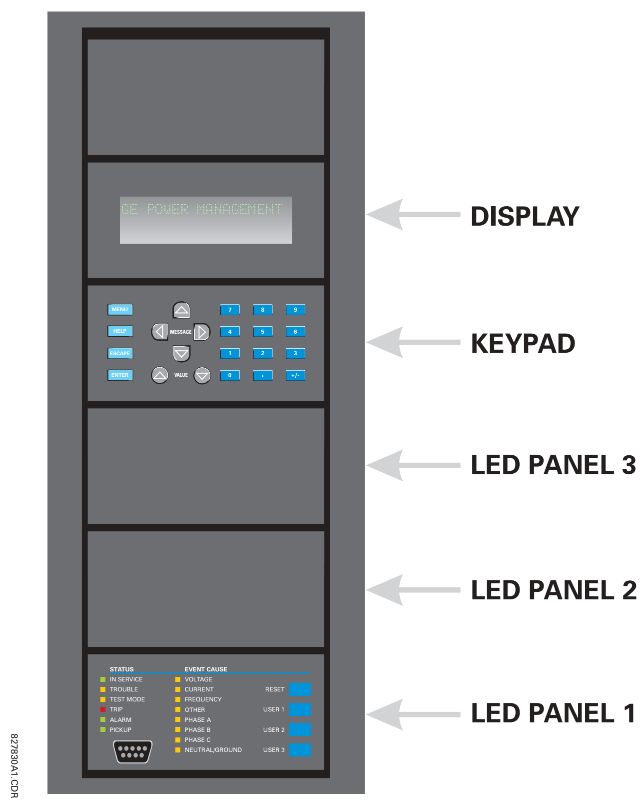


Figure 4–3: UR VERTICAL FACEPLATE PANELS

4.2.2 LED INDICATORS

a) LED PANEL 1

This panel provides several LED indicators, several keys, and a communications port. The RESET key is used to reset any latched LED indicator or target message, once the condition has been cleared (these latched conditions can also be reset via the **SETTINGS ⇨⇩ INPUT/OUTPUTS ⇨⇩ RESETTING** menu). The USER keys are not used in this unit. The RS232 port is intended for connection to a portable PC.

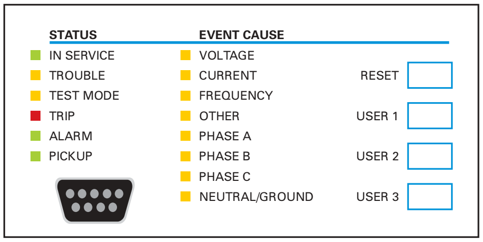


Figure 4–4: LED PANEL 1

STATUS INDICATORS:

- **IN SERVICE**: Indicates that control power is applied; all monitored inputs/outputs 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 the selected FlexLogic™ operand serving as a Trip switch has operated. This indicator always latches; the RESET command must be initiated to allow the latch to be reset.
- **ALARM**: Indicates that the selected FlexLogic™ operand serving as an Alarm switch has operated. This indicator is never latched.
- **PICKUP**: Indicates that an element is picked up. This indicator is never latched.

EVENT CAUSE INDICATORS:

These 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**: Not used.
- **CURRENT**: Not used.
- **FREQUENCY**: Not used.
- **OTHER**: Indicates a digital element was involved.
- **PHASE A**: Not used.
- **PHASE B**: Not used.
- **PHASE C**: Not used.
- **NEUTRAL/GROUND**: Not used.

b) LED PANELS 2 AND 3

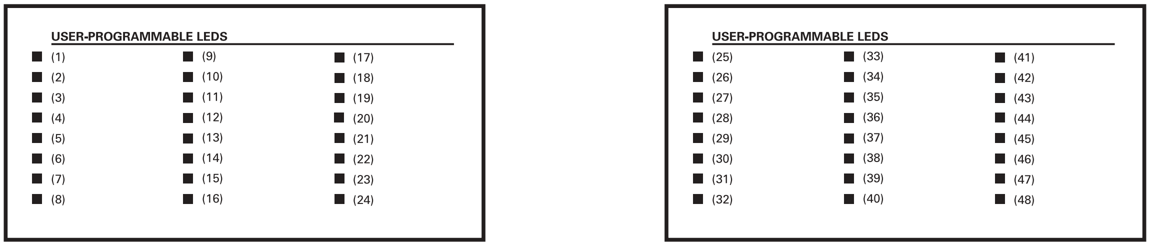


Figure 4–5: LED PANELS 2 AND 3 (INDEX TEMPLATES)

These panels provide 48 amber LED indicators whose operation is controlled by the user. Support for applying a customized label beside every LED is provided. User customization of LED operation is of maximum benefit in installations where languages other than English are used to communicate with operators. Refer to Chapter 5 for instructions on programming these LEDs.

4

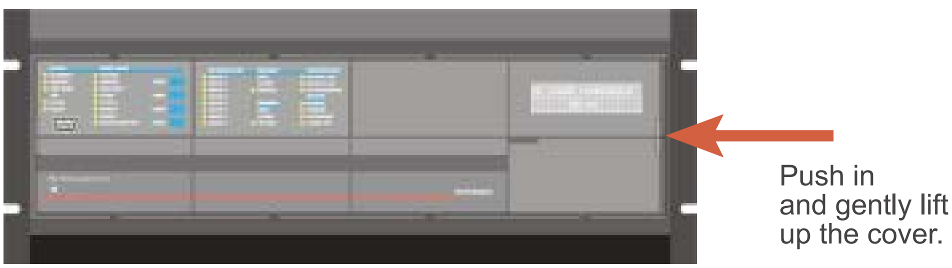
c) CUSTOM LABELING OF LEDS

Custom labeling of an LED-only panel is facilitated through a Microsoft Word file available from the following URL:

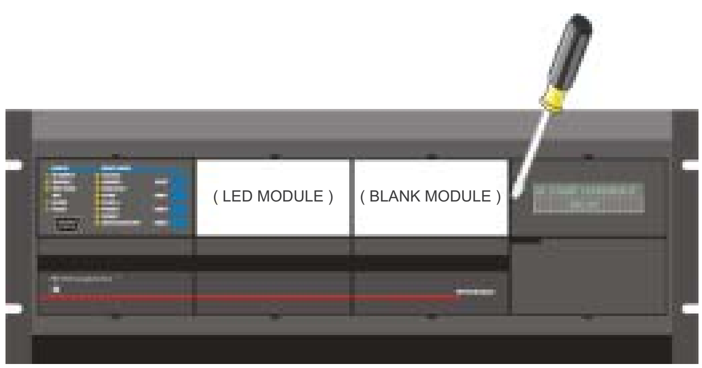
http://www.GEindustrial.com/multilin/support/ur/

This file provides templates and instructions for creating appropriate labeling for the LED panel. The following procedures are contained in the downloadable file. The panel templates provide relative LED locations and located example text (x) edit boxes. The following procedure demonstrates how to install/uninstall the custom panel labeling.

1. Remove the clear Lexan Front Cover (GE Multilin Part Number: 1501-0014).



2. Pop out the LED Module and/or the Blank Module with a screwdriver as shown below. Be careful not to damage the plastic.



3. Place the left side of the customized module back to the front panel frame, then snap back the right side.
4. Put the clear Lexan Front Cover back into place.

d) CUSTOMIZING THE DISPLAY MODULE

The following items are required to customize the UR display module:

- Black and white or color printer (color preferred)
- Microsoft Word 97 or later software
- 1 each of: 8.5" x 11" white paper, exacto knife, ruler, custom display module (GE Multilin Part Number: 1516-0069), and a custom module cover (GE Multilin Part Number: 1502-0015)

1. Open the LED panel customization template with Microsoft Word. Add text in places of the **LED x** text placeholders on the template(s). Delete unused place holders as required.
2. When complete, save the Word file to your local PC for future use.
3. Print the template(s) to a local printer.
4. From the printout, cut-out the Background Template from the three windows, using the cropmarks as a guide.
5. Put the Background Template on top of the custom display module (GE Multilin Part Number: 1513-0069) and snap the clear custom module cover (GE Multilin Part Number: 1502-0015) over it and the templates.

4.2.3 KEYPAD

All messages are displayed on a 2 × 20 character vacuum fluorescent display to make them visible under poor lighting conditions. An optional liquid crystal display (LCD) is also available. Messages are displayed in 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 message will automatically override the default message and appear on the display.

4.2.4 DISPLAY

Display messages are organized into 'pages' under the following headings: Actual Values, Settings, Commands, and Targets. The MENU key navigates through these pages. Each heading page is broken down further into logical subgroups.

The ▲ ◀ MESSAGE ▶ ▼ keys navigate through the subgroups. The ▲ VALUE ▼ keys scroll increment or decrement numerical setting values when in programming mode. These keys also scroll through alphanumeric values in the text edit mode. Alternatively, values may also be entered with the numeric keypad.

The . key initiates and advance to the next character in text edit mode or enters a decimal point. The HELP key may be pressed at any time for context sensitive help messages. The ENTER key stores altered setting values.

4.2.5 MENUS

a) NAVIGATION

Press the MENU key to select the desired header display page (top-level menu). The header title appears momentarily followed by a header display page menu item. Each press of the MENU key advances through the main heading pages as illustrated below.

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

⇨ MENU
USER DISPLAYS
(when in use)
      ⇩
User Display 1
```

b) HIERARCHY

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

```
HIGHEST LEVEL                  LOWEST LEVEL (SETTING VALUE)

■■ SETTINGS          ◀▶   ■ PASSWORD     ◀▶   ACCESS LEVEL:
■■ PRODUCT SETUP          ■ SECURITY          Restricted
        ▲
        ▼
■■ SETTINGS
■■ FLEXLOGIC
```

c) EXAMPLE MENU NAVIGATION SCENARIO

```
■■ 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 other actual value headers.

⇩

```
■■ 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.

⇩

```
■■ SETTINGS
■■ FLEXLOGIC
```

Press the MESSAGE ▼ key to move to the next Settings page. This page contains settings for FlexLogic™. Repeatedly press the ▲ MESSAGE ▼ keys to display the other setting headers and then back to the first Settings page header.

⇩

```
■ PASSWORD
■ SECURITY
```

From the Settings page one header (Product Setup), press the MESSAGE ► key once to display the first sub-header (Password Security).

⇩

```
ACCESS LEVEL:
Restricted
```

Press the MESSAGE ► key once more and this will display the first setting for Password Security. Pressing the MESSAGE ▼ key repeatedly will display the remaining setting messages for this sub-header.

⇩

```
■ PASSWORD
■ SECURITY
```

Press the MESSAGE ◄ key once to move back to the first sub-header message.

⇩

```
■ DISPLAY
■ PROPERTIES
```

Pressing the MESSAGE ▼ key will display the second setting sub-header associated with the Product Setup header.

⇩

```
FLASH MESSAGE
TIME: 1.0 s
```

Press the MESSAGE ► key once more and this will display the first setting for Display Properties.

⇩

```
DEFAULT MESSAGE
INTENSITY: 25%
```

To view the remaining settings associated with the Display Properties subheader, repeatedly press the MESSAGE ▼ key. The last message appears as shown.

4

4.2.6 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.

```
FLASH MESSAGE
TIME:   1.0 s
```
⇩
```
MINIMUM:    0.5
MAXIMUM:   10.0
```

For example, select the **SETTINGS ⇨ PRODUCT SETUP ⇨⇩ DISPLAY PROPERTIES ⇨ FLASH MESSAGE TIME** setting.

Press the HELP key to view the minimum and maximum values. Press the HELP key again to view the next context sensitive help message.

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

- **0 to 9** and ▪ (decimal point): 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 or pressing the ESCAPE 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 the setting selection to continue upward from the minimum value. The VALUE ▼ key decrements the displayed value by the step value, down to the minimum value. While at the minimum value, pressing the VALUE ▼ key again will allow the setting selection to continue downward from the maximum value.

```
FLASH MESSAGE
TIME:   2.5 s
```
⇩
```
NEW SETTING
HAS BEEN STORED
```

As an example, set the flash message time setting to 2.5 seconds. Press the appropriate numeric keys in the sequence “2 . 5". The display message will change as the digits are being entered.

Until ENTER is pressed, editing changes are not registered by the relay. Therefore, press ENTER 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-off 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.

```
ACCESS LEVEL:
Restricted
```

For example, the selections available for **ACCESS LEVEL** are "Restricted", "Command", "Setting", and "Factory Service".

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

```
ACCESS LEVEL:
Setting
```
⇩
```
NEW SETTING
HAS BEEN STORED
```

If the **ACCESS LEVEL** needs to be "Setting", press the VALUE keys until the proper selection is displayed. Press HELP at any time for the context sensitive help messages.

Changes are not registered by the relay until the ENTER key is pressed. Pressing ENTER stores the new value in memory. This flash message momentarily appears as confirmation of the storing process.

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.

There are several places where text messages may be programmed to allow the relay to be customized for specific applications. One example is the Message Scratchpad. Use the following procedure to enter alphanumeric text messages.

For example: to enter the text, “Breaker #1”

1. Press ■ to enter text edit mode.
2. Press the VALUE keys until the character '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 the text.
5. If you have any problem, press HELP to view context sensitive help. Flash messages will sequentially appear for several seconds each. For the case of a text setting message, pressing HELP displays how to edit and store new values.

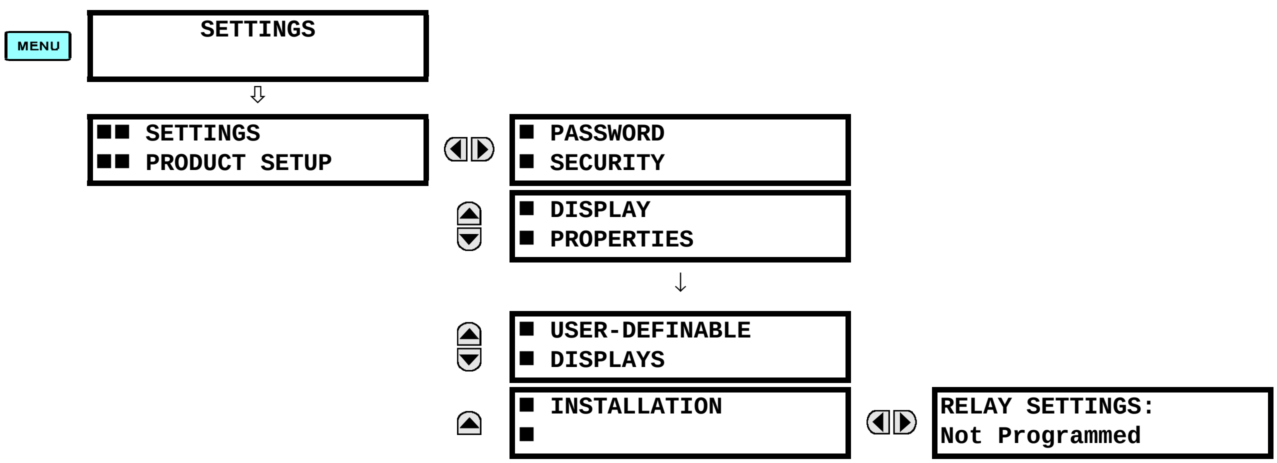
d) ACTIVATING THE RELAY

RELAY SETTINGS:
Not Programmed

When the relay is powered up, the Trouble LED will be on, the In Service LED off, and this message displayed, indicating the relay is in the "Not Programmed" state and is safeguarding (output relays blocked) against the installation of a relay whose settings have not been entered. This message remains until the relay is explicitly put in the "Programmed" state.

To change the **RELAY SETTINGS:** "Not Programmed" mode to "Programmed", proceed as follows:

1. Press the MENU key until the **SETTINGS** header flashes momentarily and the **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 is displayed.



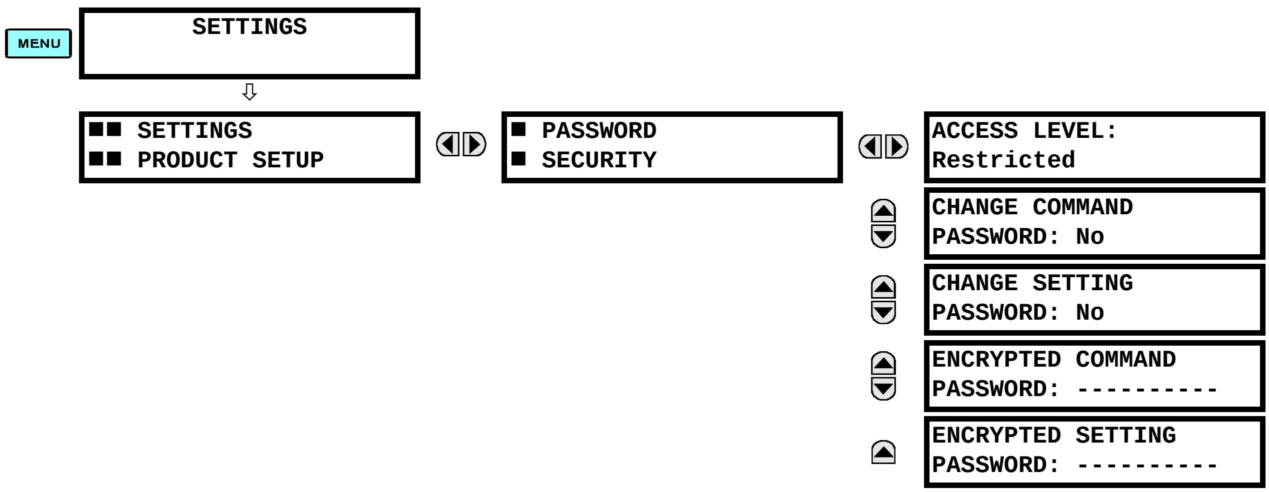
5. After the **RELAY SETTINGS: Not Programmed** message appears on the display, press the VALUE keys change the selection to "Programmed".
6. Press the ENTER key.

7. When the "NEW SETTING HAS BEEN STORED" message appears, the relay will be in "Programmed" state and the In Service LED will turn on.

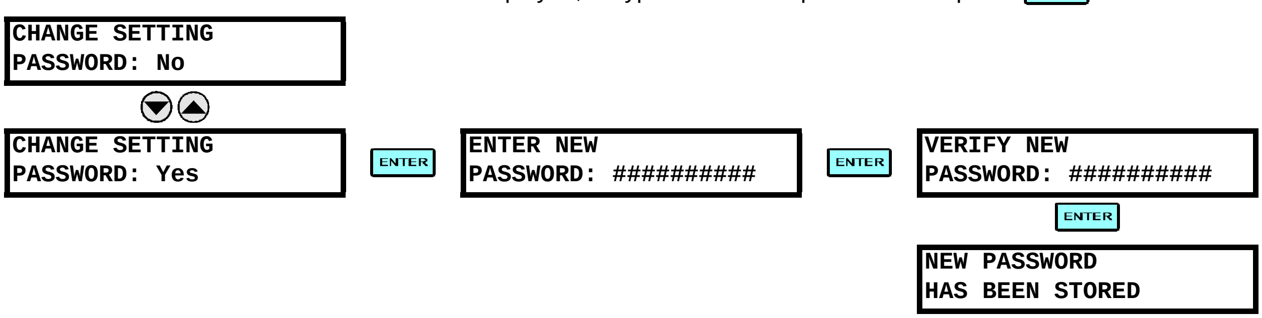
e) ENTERING INITIAL PASSWORDS

To enter the initial Setting (or Command) Password, proceed as follows:

1. Press the MENU key until the 'SETTINGS' header flashes momentarily and the ‘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 (or COMMAND) PASSWORD:’ message appears on the display.



4. After the 'CHANGE...PASSWORD' message appears on the display, press the VALUE ▲ key or the VALUE ▼ key to change the selection to Yes.
5. Press the ENTER key and the display will prompt you to 'ENTER NEW PASSWORD'.
6. Type in a numerical password (up to 10 characters) and press the ENTER key.
7. When the 'VERIFY NEW PASSWORD' is displayed, re-type in the same password and press ENTER.



8. When the 'NEW PASSWORD HAS BEEN STORED' message appears, your new Setting (or Command) 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.

In the event that a password has been lost (forgotten), submit the corresponding Encrypted Password from the **PASSWORD SECURITY** menu to the Factory for decoding.

5.1.1 SETTINGS MAIN MENU

■■ SETTINGS ■■ PRODUCT SETUP	■ PASSWORD ■ SECURITY	See page 5-4.
	■ DISPLAY ■ PROPERTIES	See page 5-5.
	■ CLEAR RELAY RECORDS ■	See page 5-6.
	■ COMMUNICATIONS ■	See page 5-7.
	■ MODBUS USER MAP ■	See page 5-13.
	■ REAL TIME ■ CLOCK	See page 5-13.
	■ OSCILLOGRAPHY ■	See page 5-14.
	■ DATA LOGGER ■	See page 5-16.
	■ USER-PROGRAMMABLE ■ LEDS	See page 5-17.
	■ USER-PROGRAMMABLE ■ SELF TESTS	See page 5-20.
	■ CONTROL ■ PUSHBUTTONS	See page 5-20.
	■ USER-PROGRAMMABLE ■ PUSHBUTTONS	See page 5-21.
	■ FLEX STATE ■ PARAMETERS	See page 5-23.
	■ USER-DEFINABLE ■ DISPLAYS	See page 5-23.
	■ DIRECT I/O ■	See page 5-25.
	■ INSTALLATION ■	See page 5-30.
■■ SETTINGS ■■ FLEXLOGIC	■ FLEXLOGIC ■ EQUATION EDITOR	See page 5-41.
	■ FLEXLOGIC ■ TIMERS	See page 5-41.
	■ FLEXELEMENTS ■	See page 5-42.
	■ NON-VOLATILE ■ LATCHES	See page 5-46.

Menu	Submenu	Reference
■■ SETTINGS ■■ CONTROL ELEMENTS	■ SETTING GROUPS ■	See page 5-47.
	■ SELECTOR SWITCH ■	See page 5-47.
	■ DIGITAL ELEMENTS ■	See page 5-53.
	■ DIGITAL COUNTERS ■	See page 5-56.
■■ SETTINGS ■■ INPUTS / OUTPUTS	■ CONTACT INPUTS ■	See page 5-58.
	■ VIRTUAL INPUTS ■	See page 5-60.
	■ CONTACT OUTPUTS ■	See page 5-61.
	■ LATCHING OUTPUTS ■	See page 5-61.
	■ VIRTUAL OUTPUTS ■	See page 5-63.
	■ REMOTE DEVICES ■	See page 5-64.
	■ REMOTE INPUTS ■	See page 5-65.
	■ REMOTE OUTPUTS ■ DNA BIT PAIRS	See page 5-66.
	■ REMOTE OUTPUTS ■ UserSt BIT PAIRS	See page 5-67.
	■ RESETTING ■	See page 5-67.
	■ DIRECT INPUTS ■	See page 5-67.
	■ DIRECT OUTPUTS ■	See page 5-67.
■■ SETTINGS ■■ TRANSDUCER I/O	■ DCMA INPUTS ■	See page 5-71.
	■ RTD INPUTS ■	See page 5-72.
■■ SETTINGS ■■ TESTING	TEST MODE FUNCTION:	See page 5-73.
	■ FORCE CONTACT ■ INPUTS	See page 5-73.
	■ FORCE CONTACT ■ OUTPUTS	See page 5-74.

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5.1.2 INTRODUCTION TO ELEMENTS

The main characteristics of an element are shown on the element logic diagram. This includes the input(s), settings, fixed logic, and the output operands generated (abbreviations used on scheme logic diagrams are defined in Appendix F).

- **FUNCTION setting:** This setting programs the element to be operational when selected as "Enabled". The factory default is "Disabled". Once programmed to "Enabled", any element associated with the Function becomes active and all options become available.
- **NAME setting:** This setting is used to uniquely identify the element.
- **PICKUP DELAY setting:** This setting sets a time-delay-on-pickup, or on-delay, for the duration between the Pickup and Operate output states.
- **RESET DELAY setting:** This setting is used to set a time-delay-on-dropout, or off-delay, for the duration between the Operate output state and the return to logic 0 after the input transits outside the defined pickup range.
- **BLOCK setting:** The default output operand state of all comparators is a logic 0 or “flag not set”. The comparator remains in this default state until a logic 1 is asserted at the RUN input, allowing the test to be performed. If the RUN input changes to logic 0 at any time, the comparator returns to the default state. The RUN input is used to supervise the comparator. The BLOCK input is used as one of the inputs to RUN control.
- **TARGET setting:** This setting is used to define the operation of an element target message. When set to Disabled, no target message or illumination of a faceplate LED indicator is issued upon operation of the element. When set to Self-Reset, the target message and LED indication follow the Operate state of the element, and self-resets once the operate element condition clears. When set to Latched, the target message and LED indication will remain visible after the element output returns to logic 0 - until a RESET command is received by the relay.
- **EVENTS setting:** This setting is used to control whether the Pickup, Dropout or Operate states are recorded by the event recorder. When set to Disabled, element pickup, dropout or operate are not recorded as events. When set to Enabled, events are created for:

  (Element) PKP (pickup)
  (Element) DPO (dropout)
  (Element) OP (operate)

  The DPO event is created when the measure and decide comparator output transits from the pickup state (logic 1) to the dropout state (logic 0). This could happen when the element is in the operate state if the reset delay time is not ‘0’.

5.2.1 PASSWORD SECURITY

PATH: SETTINGS ⇨ PRODUCT SETUP ⇨ PASSWORD SECURITY

■ PASSWORD ■ SECURITY	◁▷	ACCESS LEVEL: Restricted	Range: Restricted, Command, Setting, Factory Service (for factory use only)
MESSAGE	△▽	CHANGE COMMAND PASSWORD: No	Range: No, Yes
MESSAGE	△▽	CHANGE SETTING PASSWORD: No	Range: No, Yes
MESSAGE	△▽	ENCRYPTED COMMAND PASSWORD: ----------	Range: 0 to 9999999999 Note: ---------- indicates no password
MESSAGE	△	ENCRYPTED SETTING PASSWORD: ----------	Range: 0 to 9999999999 Note: ---------- indicates no password

Two levels of password security are provided: **Command** and **Setting**. Operations under password supervision are:

- **COMMAND:** changing the state of virtual inputs, clearing the event records, clearing the oscillography records, changing the date and time, clearing the data logger
- **SETTING:** changing any setting, test mode operation

The Command and Setting passwords are defaulted to "Null" when the relay is shipped from the factory. When a password is set to "Null", the password security feature is disabled.

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Programming a password code is required to enable each access level. A password consists of 1 to 10 numerical characters. When a **CHANGE ... PASSWORD** setting is set to "Yes", the following message sequence is invoked:

1. ENTER NEW PASSWORD: ____________
2. VERIFY NEW PASSWORD: ____________
3. NEW PASSWORD HAS BEEN STORED

To gain write access to a "Restricted" setting, set **ACCESS LEVEL** to "Setting" and then change the setting, or attempt to change the setting and follow the prompt to enter the programmed password. 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, accessibility will automatically revert to the "Restricted" level.

If an entered password is lost (or forgotten), consult the factory with the corresponding **ENCRYPTED PASSWORD**.

The C30 provides a means to raise an alarm upon failed password entry. Should password verification fail while accessing a password-protected level of the relay (either settings or commands), the UNAUTHORIZED ACCESS FlexLogic™ operand is asserted. The operand can be programmed to raise an alarm via contact outputs or communications. This feature can be used to protect against both unauthorized and accidental access attempts.

The UNAUTHORISED ACCESS operand is reset with the **COMMANDS ⇨⇩ CLEAR RECORDS ⇨⇩ RESET UNAUTHORISED ALARMS** command. Therefore, to apply this feature with security, the command level should be password-protected.

The operand does not generate events or targets. If these are required, the operand can be assigned to a digital element programmed with event logs and/or targets enabled.

NOTE

If the SETTING and COMMAND passwords are identical, this one password allows access to both commands and settings.

NOTE

When URPC is used to access a particular level, the user will continue to have access to that level as long as there are open windows in URPC. To re-establish the Password Security feature, all URPC windows must be closed for at least 30 minutes.

5.2.2 DISPLAY PROPERTIES

PATH: SETTINGS ⇨ PRODUCT SETUP ⇨⇩ DISPLAY PROPERTIES

■ DISPLAY ■ PROPERTIES		FLASH MESSAGE TIME: 1.0 s	*Range: 0.5 to 10.0 s in steps of 0.1*
	MESSAGE	DEFAULT MESSAGE TIMEOUT: 300 s	*Range: 10 to 900 s in steps of 1*
	MESSAGE	DEFAULT MESSAGE INTENSITY: 25 %	*Range: 25%, 50%, 75%, 100%* *Visible only if a VFD is installed*
	MESSAGE	SCREEN SAVER FEATURE: Disabled	*Range: Disabled, Enabled* *Visible only if an LCD is installed*
	MESSAGE	SCREEN SAVER WAIT TIME: 30 min	*Range: 1 to 65535 min. in steps of 1* *Visible only if an LCD is installed*
	MESSAGE	CURRENT CUT-OFF LEVEL: 0.020 pu	*Range: 0.002 to 0.020 pu in steps of 0.001*
	MESSAGE	VOLTAGE CUT-OFF LEVEL: 1.0 V	*Range: 0.1 to 1.0 V secondary in steps of 0.1*

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

- **FLASH MESSAGE TIME:** Flash messages are status, warning, error, or information messages displayed for several seconds in response to certain key presses during setting programming. These messages override any normal messages. The duration of a flash message on the display can be changed to accommodate different reading rates.
- **DEFAULT MESSAGE TIMEOUT:** If the keypad is inactive for a period of time, the relay automatically reverts to a default message. The inactivity time is modified via this setting to ensure messages remain on the screen long enough during programming or reading of actual values.
- **DEFAULT MESSAGE INTENSITY:** To extend phosphor life in the vacuum fluorescent display, the brightness can be attenuated during default message display. During keypad interrogation, the display always operates at full brightness.
- **SCREEN SAVER FEATURE and SCREEN SAVER WAIT TIME:** These settings are only visible if the C30 has a liquid crystal display (LCD) and control its backlighting. When the **SCREEN SAVER FEATURE** is "Enabled", the LCD backlighting is turned off after the **DEFAULT MESSAGE TIMEOUT** followed by the **SCREEN SAVER WAIT TIME**, providing that no keys have been pressed and no target messages are active. When a keypress occurs or a target becomes active, the LCD backlighting is turned on.
- **CURRENT CUT-OFF LEVEL:** This setting modifies the current cut-off threshold. Very low currents (1 to 2% of the rated value) are very susceptible to noise. Some customers prefer very low currents to display as zero, while others prefer the current be displayed even when the value reflects noise rather than the actual signal. The C30 applies a cut-off value to the magnitudes and angles of the measured currents. If the magnitude is below the cut-off level, it is substituted with zero. This applies to phase and ground current phasors as well as true RMS values and symmetrical components. The cut-off operation applies to quantities used for metering, protection, and control, as well as those used by communications protocols. Note that the cut-off level for the sensitive ground input is 10 times lower that the **CURRENT CUT-OFF LEVEL** setting value. Raw current samples available via oscillography are not subject to cut-off.
- **VOLTAGE CUT-OFF LEVEL:** This setting modifies the voltage cut-off threshold. Very low secondary voltage measurements (at the fractional volt level) can be affected by noise. Some customers prefer these low voltages to be displayed as zero, while others prefer the voltage to be displayed even when the value reflects noise rather than the actual signal. The C30 applies a cut-off value to the magnitudes and angles of the measured voltages. If the magnitude is below the cut-off level, it is substituted with zero. This operation applies to phase and auxiliary voltages, and symmetrical components. The cut-off operation applies to quantities used for metering, protection, and control, as well as those used by communications protocols. Raw samples of the voltages available via oscillography are not subject cut-off.

NOTE

Lower the VOLTAGE CUT-OFF LEVEL and CURRENT CUT-OFF LEVEL with care as the relay accepts lower signals as valid measurements. Unless dictated otherwise by a specific application, the default settings of "0.02 pu" for CURRENT CUT-OFF LEVEL and "1.0 V" for VOLTAGE CUT-OFF LEVEL are recommended.

5.2.3 CLEAR RELAY RECORDS

PATH: SETTINGS ⇨ PRODUCT SETUP ⇨⇩ CLEAR RELAY RECORDS

■ CLEAR RELAY ■ RECORDS	◁▷	CLEAR EVENT RECORDS: Off	Range: FlexLogic™ operand
MESSAG	△▽	CLEAR OSCILLOGRAPHY? No	Range: FlexLogic™ operand
MESSAG	△▽	CLEAR DATA LOGGER: Off	Range: FlexLogic™ operand
MESSAG	△▽	RESET UNAUTH ACCESS: Off	Range: FlexLogic™ operand
MESSAG	△	CLEAR DIR I/O STATS: Off	Range: FlexLogic™ operand. Valid only for units with Direct I/O module.

The C30 allows selected records to be cleared from user-programmable conditions with FlexLogic™ operands. Setting user-programmable pushbuttons to clear specific records are typical applications for these commands. The C30 responds to rising edges of the configured FlexLogic™ operands. As such, the operand must be asserted for at least 50 ms to take effect.

Clearing records with user-programmable operands is not protected by the command password. However, user-programmable pushbuttons are protected by the command password. Thus, if they are used to clear records, the user-programmable pushbuttons can provide extra security if required.

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APPLICATION EXAMPLE:

User-Programmable Pushbutton 1 is to be used to clear demand records. The following settings should be applied.

Assign the Clear Demand function to Pushbutton 1 by making the following change in the SETTINGS ⇨ PRODUCT SETUP ⇨⇩ CLEAR RELAY RECORDS menu:

CLEAR DEMAND: "PUSHBUTTON 1 ON"

Set the properties for User-Programmable Pushbutton 1 by making the following changes in the SETTINGS ⇨ PRODUCT SETUP ⇨⇩ USER-PROGRAMMABLE PUSHBUTTONS ⇨ USER PUSHBUTTON 1 menu:

PUSHBUTTON 1 FUNCTION: "Self-reset"
PUSHBTN 1 DROP-OUT TIME: "0.20 s"

5.2.4 COMMUNICATIONS

a) MAIN MENU

PATH: SETTINGS ⇨ PRODUCT SETUP ⇨⇩ COMMUNICATIONS

■ COMMUNICATIONS ■	■ SERIAL PORTS ■	See below.
MESSAGE	■ NETWORK ■	See page 5–8.
MESSAGE	■ MODBUS PROTOCOL ■	See page 5–8.
MESSAGE	■ DNP PROTOCOL ■	See page 5–9.
MESSAGE	■ UCA/MMS PROTOCOL ■	See page 5–11.
MESSAGE	■ WEB SERVER ■ HTTP PROTOCOL	See page 5–11.
MESSAGE	■ TFTP PROTOCOL ■	See page 5–11.
MESSAGE	■ IEC 60870-5-104 ■ PROTOCOL	See page 5–12.
MESSAGE	■ SNTP PROTOCOL ■	See page 5–13.

b) SERIAL PORTS

PATH: SETTINGS ⇨ PRODUCT SETUP ⇨⇩ COMMUNICATIONS ⇨ SERIAL PORTS

■ SERIAL PORTS ■	RS485 COM1 BAUD RATE: 19200	*Range: 300, 1200, 2400, 4800, 9600, 14400, 19200, 28800, 33600, 38400, 57600, 115200. Only active if CPU 9A is ordered.*
MESSAGE	RS485 COM1 PARITY: None	*Range: None, Odd, Even Only active if CPU Type 9A is ordered*
MESSAGE	RS485 COM1 RESPONSE MIN TIME: 0 ms	*Range: 0 to 1000 ms in steps of 10 Only active if CPU Type 9A is ordered*
MESSAGE	RS485 COM2 BAUD RATE: 19200	*Range: 300, 1200, 2400, 4800, 9600, 14400, 19200, 28800, 33600, 38400, 57600, 115200*
MESSAGE	RS485 COM2 PARITY: None	*Range: None, Odd, Even*
MESSAGE	RS485 COM2 RESPONSE MIN TIME: 0 ms	*Range: 0 to 1000 ms in steps of 10*

The C30 is equipped with up to 3 independent serial communication ports. The faceplate RS232 port is intended for local use and has fixed parameters of 19200 baud and no parity. The rear COM1 port type will depend on the CPU ordered: it may be either an Ethernet or an RS485 port. The rear COM2 port is RS485. The RS485 ports have settings for baud rate and parity. It is important that these parameters agree with the settings used on the computer or other equipment that is connected to these ports. Any of these ports may be connected to a personal computer running URPC. This software is used for downloading or uploading setting files, viewing measured parameters, and upgrading the relay firmware to the latest version. A maximum of 32 relays can be daisy-chained and connected to a DCS, PLC or PC using the RS485 ports.

NOTE

For each RS485 port, the minimum time before the port will transmit after receiving data from a host can be set. This feature allows operation with hosts which hold the RS485 transmitter active for some time after each transmission.

c) NETWORK

PATH: SETTINGS ⇨ PRODUCT SETUP ⇨⇩ COMMUNICATIONS ⇨⇩ NETWORK

■ NETWORK ■		IP ADDRESS: 0.0.0.0	Range: Standard IP address format Only active if CPU Type 9C or 9D is ordered.
	MESSAGE	SUBNET IP MASK: 0.0.0.0	Range: Standard IP address format Only active if CPU Type 9C or 9D is ordered.
	MESSAGE	GATEWAY IP ADDRESS: 0.0.0.0	Range: Standard IP address format Only active if CPU Type 9C or 9D is ordered.
	MESSAGE	■ OSI NETWORK ■ ADDRESS (NSAP)	Range: Press the MESSAGE ⇨ key to enter the **OSI NETWORK ADDRESS**. Only active if CPU Type 9C or 9D is ordered.
	MESSAGE	ETHERNET OPERATION MODE: Half-Duplex	Range: Half-Duplex, Full-Duplex Only active if CPU Type 9C or 9D is ordered.
	MESSAGE	ETHERNET PRI LINK MONITOR: Disabled	Range: Disabled, Enabled Only active if CPU Type 9C or 9D is ordered.
	MESSAGE	ETHERNET SEC LINK MONITOR: Disabled	Range: Disabled, Enabled Only active if CPU Type 9D is ordered.

These messages appear only if the C30 is ordered with an Ethernet card. The **ETHERNET PRI LINK MONITOR** and **ETHERNET SEC LINK MONITOR** settings allow internal self-test targets to be triggered when either the Primary or Secondary ethernet link status indicates a connection loss. When both channels are healthy, the primary Ethernet link will be the active link. In the event of a communication failure on the primary Ethernet link, the secondary link becomes the active link until the primary link failure has been rectified.

The IP addresses are used with DNP/Network, Modbus/TCP, MMS/UCA2, IEC 60870-5-104, TFTP, and HTTP protocols. The NSAP address is used with the MMS/UCA2 protocol over the OSI (CLNP/TP4) stack only. Each network protocol has a setting for the **TCP/UDP PORT NUMBER**. These settings are used only in advanced network configurations and should normally be left at their default values, but may be changed if required (for example, to allow access to multiple URs behind a router). By setting a different **TCP/UDP PORT NUMBER** for a given protocol on each UR, the router can map the URs to the same external IP address. The client software (URPC, for example) must be configured to use the correct port number if these settings are used.

NOTE

When the NSAP address, any TCP/UDP Port Number, or any User Map setting (when used with DNP) is changed, it will not become active until power to the relay has been cycled (OFF/ON).

WARNING

Do not set more than one protocol to use the same TCP/UDP PORT NUMBER, as this will result in unreliable operation of those protocols.

d) MODBUS PROTOCOL

PATH: SETTINGS ⇨ PRODUCT SETUP ⇨⇩ COMMUNICATIONS ⇨⇩ MODBUS PROTOCOL

■ MODBUS PROTOCOL ■		MODBUS SLAVE ADDRESS: 254	Range: 1 to 254 in steps of 1
	MESSAGE	MODBUS TCP PORT NUMBER: 502	Range: 1 to 65535 in steps of 1

The serial communication ports utilize the Modbus protocol, unless configured for DNP operation (see the DNP Protocol description below). This allows the URPC software to be used. The UR operates as a Modbus slave device only. When using Modbus protocol on the RS232 port, the C30 will respond regardless of the **MODBUS SLAVE ADDRESS** programmed. For the RS485 ports each C30 must have a unique address from 1 to 254. Address 0 is the broadcast address which all Modbus slave devices listen to. Addresses do not have to be sequential, but no two devices can have the same address or conflicts resulting in errors will occur. Generally, each device added to the link should use the next higher address starting at 1. Refer to Appendix B for more information on the Modbus protocol.

e) DNP PROTOCOL

PATH: SETTINGS ⇨ PRODUCT SETUP ⇨⇩ COMMUNICATIONS ⇨⇩ DNP PROTOCOL

■ DNP PROTOCOL ■	◁▷	DNP PORT: NONE	Range: NONE, COM1 - RS485, COM2 - RS485, FRONT PANEL - RS232, NETWORK
MESSAGE	△▽	DNP ADDRESS: 255	Range: 0 to 65519 in steps of 1
MESSAGE	△▽	■ DNP NETWORK ■ CLIENT ADDRESSES	Range: Press the MESSAGE ⇨ key to enter the DNP NETWORK CLIENT ADDRESSES
MESSAGE	△▽	DNP TCP/UDP PORT NUMBER: 20000	Range: 1 to 65535 in steps of 1
MESSAGE	△▽	DNP UNSOL RESPONSE FUNCTION: Disabled	Range: Enabled, Disabled
MESSAGE	△▽	DNP UNSOL RESPONSE TIMEOUT: 5 s	Range: 0 to 60 s in steps of 1
MESSAGE	△▽	DNP UNSOL RESPONSE MAX RETRIES: 10	Range: 1 to 255 in steps of 1
MESSAGE	△▽	DNP UNSOL RESPONSE DEST ADDRESS: 1	Range: 0 to 65519 in steps of 1
MESSAGE	△▽	USER MAP FOR DNP ANALOGS: Disabled	Range: Enabled, Disabled
MESSAGE	△▽	NUMBER OF SOURCES IN ANALOG LIST: 1	Range: 1 to 6 in steps of 1
MESSAGE	△▽	DNP CURRENT SCALE FACTOR: 1	Range: 0.01. 0.1, 1, 10, 100, 1000
MESSAGE	△▽	DNP VOLTAGE SCALE FACTOR: 1	Range: 0.01. 0.1, 1, 10, 100, 1000
MESSAGE	△▽	DNP POWER SCALE FACTOR: 1	Range: 0.01. 0.1, 1, 10, 100, 1000
MESSAGE	△▽	DNP ENERGY SCALE FACTOR: 1	Range: 0.01. 0.1, 1, 10, 100, 1000
MESSAGE	△▽	DNP OTHER SCALE FACTOR: 1	Range: 0.01. 0.1, 1, 10, 100, 1000
MESSAGE	△▽	DNP CURRENT DEFAULT DEADBAND: 30000	Range: 0 to 65535 in steps of 1
MESSAGE	△▽	DNP VOLTAGE DEFAULT DEADBAND: 30000	Range: 0 to 65535 in steps of 1
MESSAGE	△▽	DNP POWER DEFAULT DEADBAND: 30000	Range: 0 to 65535 in steps of 1
MESSAGE	△▽	DNP ENERGY DEFAULT DEADBAND: 30000	Range: 0 to 65535 in steps of 1
MESSAGE	△▽	DNP OTHER DEFAULT DEADBAND: 30000	Range: 0 to 65535 in steps of 1
MESSAGE	△▽	DNP TIME SYNC IIN PERIOD: 1440 min	Range: 1 to 10080 min. in steps of 1

MESSAGE	DNP MESSAGE FRAGMENT SIZE: 240	Range: 30 to 2048 in steps of 1
MESSAGE	■ DNP BINARY INPUTS ■ USER MAP	

The C30 supports the Distributed Network Protocol (DNP) version 3.0. The C30 can be used as a DNP slave device connected to a single DNP master (usually an RTU or a SCADA master station). Since the C30 maintains one set of DNP data change buffers and connection information, only one DNP master should actively communicate with the C30 at one time. The **DNP PORT** setting selects the communications port assigned to the DNP protocol; only a single port can be assigned. Once DNP is assigned to a serial port, the Modbus protocol is disabled on that port. Note that COM1 can be used only in non-ethernet UR relays. When this setting is set to "Network", the DNP protocol can be used over either TCP/IP or UDP/IP. Refer to Appendix E for more information on the DNP protocol. The **DNP ADDRESS** setting is the DNP slave address. This number identifies the C30 on a DNP communications link. Each DNP slave should be assigned a unique address. The **DNP NETWORK CLIENT ADDRESS** setting can force the C30 to respond to a maximum of five specific DNP masters.

The **DNP UNSOL RESPONSE FUNCTION** should be "Disabled" for RS485 applications since there is no collision avoidance mechanism. The **DNP UNSOL RESPONSE TIMEOUT** sets the time the C30 waits for a DNP master to confirm an unsolicited response. The **DNP UNSOL RESPONSE MAX RETRIES** setting determines the number of times the C30 retransmits an unsolicited response without receiving confirmation from the master; a value of "255" allows infinite re-tries. The **DNP UNSOL RESPONSE DEST ADDRESS** is the DNP address to which all unsolicited responses are sent. The IP address to which unsolicited responses are sent is determined by the C30 from the current TCP connection or the most recent UDP message.

The **USER MAP FOR DNP ANALOGS** setting allows the large pre-defined Analog Inputs points list to be replaced by the much smaller Modbus User Map. This can be useful for users wishing to read only selected Analog Input points from the C30. See Appendix E for more information.

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The **NUMBER OF SOURCES IN ANALOG LIST** setting allows the selection of the number of current/voltage source values that are included in the Analog Inputs points list. This allows the list to be customized to contain data for only the sources that are configured. This setting is relevant only when the User Map is not used.

The **DNP SCALE FACTOR** settings are numbers used to scale Analog Input point values. These settings group the C30 Analog Input data into types: current, voltage, power, energy, and other. Each setting represents the scale factor for all Analog Input points of that type. For example, if the **DNP VOLTAGE SCALE FACTOR** setting is set to a value of 1000, all DNP Analog Input points that are voltages will be returned with values 1000 times smaller (e.g. a value of 72000 V on the C30 will be returned as 72). These settings are useful when Analog Input values must be adjusted to fit within certain ranges in DNP masters. Note that a scale factor of 0.1 is equivalent to a multiplier of 10 (i.e. the value will be 10 times larger).

The **DNP DEFAULT DEADBAND** settings determine when to trigger unsolicited responses containing Analog Input data. These settings group the C30 Analog Input data into types: current, voltage, power, energy, and other. Each setting represents the default deadband value for all Analog Input points of that type. For example, to trigger unsolicited responses from the C30 when any current values change by 15 A, the **DNP CURRENT DEFAULT DEADBAND** setting should be set to "15". Note that these settings are the deadband default values. DNP Object 34 points can be used to change deadband values, from the default, for each individual DNP Analog Input point. Whenever power is removed and re-applied to the C30, the default deadbands will be in effect.

The **DNP TIME SYNC IIN PERIOD** setting determines how often the Need Time Internal Indication (IIN) bit is set by the C30. Changing this time allows the DNP master to send time synchronization commands more or less often, as required.

The **DNP MESSAGE FRAGMENT SIZE** setting determines the size, in bytes, at which message fragmentation occurs. Large fragment sizes allow for more efficient throughput; smaller fragment sizes cause more application layer confirmations to be necessary which can provide for more robust data transfer over noisy communication channels.

The **DNP BINARY INPUTS USER MAP** setting allows for the creation of a custom DNP Binary Inputs points list. The default DNP Binary Inputs list on the C30 contains 928 points representing various binary states (contact inputs and outputs, virtual inputs and outputs, protection element states, etc.). If not all of these points are required in the DNP master, a custom Binary Inputs points list can be created by selecting up to 58 blocks of 16 points. Each block represents 16 Binary Input points. Block 1 represents Binary Input points 0 to 15, block 2 represents Binary Input points 16 to 31, block 3 represents Binary Input points 32 to 47, etc. The minimum number of Binary Input points that can be selected is 16 (1 block). If all of the **BIN INPUT BLOCK X** settings are set to "Not Used", the standard list of 928 points will be in effect. The C30 will form the Binary Inputs points list from the **BIN INPUT BLOCK X** settings up to the first occurrence of a setting value of "Not Used".

NOTE

When using the User Maps for DNP data points (Analog Inputs and/or Binary Inputs) for relays with ethernet installed, check the "DNP Points Lists" C30 web page to ensure the desired points lists are created. This web page can be viewed using a web browser by entering the C30 IP address to access the C30 "Main Menu", then by selecting the "Device Information Menu" > "DNP Points Lists" menu item.

f) UCA/MMS PROTOCOL

PATH: SETTINGS ⇨ PRODUCT SETUP ⇨⇩ COMMUNICATIONS ⇨⇩ UCA/MMS PROTOCOL

■ UCA/MMS PROTOCOL ■	DEFAULT GOOSE UPDATE TIME: 60 s	Range: 1 to 60 s in steps of 1. See UserSt Bit Pairs in the Remote Outputs section of this Chapter.
MESSAGE	UCA LOGICAL DEVICE: UCADevice	Range: Up to 16 alphanumeric characters representing the name of the UCA logical device.
MESSAGE	UCA/MMS TCP PORT NUMBER: 102	Range: 1 to 65535 in steps of 1
MESSAGE	GOOSE FUNCTION: Enabled	Range: Disabled, Enabled
MESSAGE	GLOBE.ST.LocRemDS: Off	Range: FlexLogic™ operand

The C30 supports the Manufacturing Message Specification (MMS) protocol as specified by the Utility Communication Architecture (UCA). UCA/MMS is supported over two protocol stacks: TCP/IP over ethernet and TP4/CLNP (OSI) over ethernet. The C30 operates as a UCA/MMS server. The Remote Inputs/Outputs section in this chapter describe the peer-to-peer GOOSE message scheme.

The **UCA LOGICAL DEVICE** setting represents the MMS domain name (UCA logical device) where all UCA objects are located. The **GOOSE FUNCTION** setting allows for the blocking of GOOSE messages from the C30. This can be used during testing or to prevent the relay from sending GOOSE messages during normal operation. The **GLOBE.ST.LocRemDS** setting selects a FlexLogic™ operand to provide the state of the UCA GLOBE.ST.LocRemDS data item. Refer to Appendix C: UCA/MMS Communications for additional details on the C30 UCA/MMS support.

g) WEB SERVER HTTP PROTOCOL

PATH: SETTINGS ⇨ PRODUCT SETUP ⇨⇩ COMMUNICATIONS ⇨⇩ WEB SERVER HTTP PROTOCOL

■ WEB SERVER ■ HTTP PROTOCOL	HTTP TCP PORT NUMBER: 80	Range: 1 to 65535 in steps of 1

The C30 contains an embedded web server and is capable of transferring web pages to a web browser such as Microsoft Internet Explorer or Netscape Navigator. This feature is available only if the C30 has the ethernet option installed. The web pages are organized as a series of menus that can be accessed starting at the C30 "Main Menu". Web pages are available showing DNP and IEC 60870-5-104 points lists, Modbus registers, Event Records, Fault Reports, etc. The web pages can be accessed by connecting the UR and a computer to an ethernet network. The Main Menu will be displayed in the web browser on the computer simply by entering the IP address of the C30 into the "Address" box on the web browser.

h) TFTP PROTOCOL

PATH: SETTINGS ⇨ PRODUCT SETUP ⇨⇩ COMMUNICATIONS ⇨⇩ TFTP PROTOCOL

■ TFTP PROTOCOL ■	TFTP MAIN UDP PORT NUMBER: 69	Range: 1 to 65535 in steps of 1
MESSAGE	TFTP DATA UDP PORT 1 NUMBER: 0	Range: 0 to 65535 in steps of 1
MESSAGE	TFTP DATA UDP PORT 2 NUMBER: 0	Range: 0 to 65535 in steps of 1

The Trivial File Transfer Protocol (TFTP) can be used to transfer files from the UR over a network. The C30 operates as a TFTP server. TFTP client software is available from various sources, including Microsoft Windows NT. The `dir.txt` file obtained from the C30 contains a list and description of all available files (event records, oscillography, etc.).

i) IEC 60870-5-104 PROTOCOL

PATH: SETTINGS ⇨ PRODUCT SETUP ⇨⇩ COMMUNICATIONS ⇨⇩ IEC 60870-5-104 PROTOCOL

■ IEC 60870-5-104 ■ PROTOCOL	◁▷	IEC 60870-5-104 FUNCTION: Disabled	*Range: Enabled, Disabled*
MESSAGE	△▽	IEC TCP PORT NUMBER: 2404	*Range: 1 to 65535 in steps of 1*
MESSAGE	△▽	IEC COMMON ADDRESS OF ASDU: 0	*Range: 0 to 65535 in steps of 1*
MESSAGE	△▽	IEC CYCLIC DATA PERIOD: 60 s	*Range: 1 to 65535 s in steps of 1*
MESSAGE	△▽	NUMBER OF SOURCES IN MMENC1 LIST: 1	*Range: 1 to 6 in steps of 1*
MESSAGE	△▽	IEC CURRENT DEFAULT THRESHOLD: 30000	*Range: 0 to 65535 in steps of 1*
MESSAGE	△▽	IEC VOLTAGE DEFAULT THRESHOLD: 30000	*Range: 0 to 65535 in steps of 1*
MESSAGE	△▽	IEC POWER DEFAULT THRESHOLD: 30000	*Range: 0 to 65535 in steps of 1*
MESSAGE	△▽	IEC ENERGY DEFAULT THRESHOLD: 30000	*Range: 0 to 65535 in steps of 1*
MESSAGE	△	IEC OTHER DEFAULT THRESHOLD: 30000	*Range: 0 to 65535 in steps of 1*

The C30 supports the IEC 60870-5-104 protocol. The C30 can be used as an IEC 60870-5-104 slave device connected to a single master (usually either an RTU or a SCADA master station). Since the C30 maintains one set of IEC 60870-5-104 data change buffers, only one master should actively communicate with the C30 at one time. For situations where a second master is active in a "hot standby" configuration, the UR supports a second IEC 60870-5-104 connection providing the standby master sends only IEC 60870-5-104 Test Frame Activation messages for as long as the primary master is active.

The **NUMBER OF SOURCES IN MMENC1 LIST** setting allows the selection of the number of current/voltage source values that are included in the M_ME_NC_1 (Measured value, short floating point) Analog points list. This allows the list to be customized to contain data for only the sources that are configured.

The **IEC ------- DEFAULT THRESHOLD** settings are the values used by the UR to determine when to trigger spontaneous responses containing M_ME_NC_1 analog data. These settings group the UR analog data into types: current, voltage, power, energy, and other. Each setting represents the default threshold value for all M_ME_NC_1 analog points of that type. For example, in order to trigger spontaneous responses from the UR when any current values change by 15 A, the **IEC CURRENT DEFAULT THRESHOLD** setting should be set to 15. Note that these settings are the default values of the deadbands. P_ME_NC_1 (Parameter of measured value, short floating point value) points can be used to change threshold values, from the default, for each individual M_ME_NC_1 analog point. Whenever power is removed and re-applied to the UR, the default thresholds will be in effect.

NOTE

The IEC 60870-5-104 and DNP protocols can not be used at the same time. When the IEC 60870-5-104 FUNCTION setting is set to "Enabled", the DNP protocol will not be operational. When this setting is changed it will not become active until power to the relay has been cycled (Off/On).

j) SNTP PROTOCOL

PATH: SETTINGS ⇨ PRODUCT SETUP ⇨⇩ COMMUNICATIONS ⇨⇩ SNTP PROTOCOL

■ TFTP PROTOCOL ■	◁▷	SNTP FUNCTION: Disabled	Range: Enabled, Disabled
MESSAGE	△▽	SNTP SERVER IP ADDR: 0.0.0.0	Range: 1 to 65535 in steps of 1
MESSAGE	△	SNTP UDP PORT NUMBER: 123	Range: 0 to 65535 in steps of 1

The C30 supports the Simple Network Time Protocol specified in RFC-2030. With SNTP, the C30 can obtain clock time over an Ethernet network. The C30 acts as an SNTP client to receive time values from an SNTP/NTP server, usually a dedicated product using a GPS receiver to provide an accurate time. Both unicast and broadcast SNTP are supported.

If SNTP functionality is enabled at the same time as IRIG-B, the IRIG-B signal provides the time value to the C30 clock for as long as a valid signal is present. If the IRIG-B signal is removed, the time obtained from the SNTP server is used. If either SNTP or IRIG-B is enabled, the C30 clock value cannot be changed using the front panel keypad.

To use SNTP in unicast mode, **SNTP SERVER IP ADDR** must be set to the SNTP/NTP server IP address. Once this address is set and **SNTP FUNCTION** is "Enabled", the C30 attempts to obtain time values from the SNTP/NTP server. Since many time values are obtained and averaged, it generally takes three to four minutes until the C30 clock is closely synchronized with the SNTP/NTP server. It may take up to one minute for the C30 to signal an SNTP self-test error if the server is offline.

To use SNTP in broadcast mode, set the **SNTP SERVER IP ADDR** setting to "0.0.0.0" and **SNTP FUNCTION** to "Enabled". The C30 then listens to SNTP messages sent to the "all ones" broadcast address for the subnet. The C30 waits up to eighteen minutes (>1024 seconds) without receiving an SNTP broadcast message before signaling an SNTP self-test error.

The UR does not support the multicast or anycast SNTP functionality.

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5.2.5 MODBUS USER MAP

PATH: SETTINGS ⇨ PRODUCT SETUP ⇨⇩ MODBUS USER MAP

■ MODBUS USER MAP ■	◁▷	ADDRESS 1: 0 VALUE: 0	Range: 0 to 65535 in steps of 1
		↓	
MESSAGE	△	ADDRESS 256: 0 VALUE: 0	Range: 0 to 65535 in steps of 1

The Modbus User Map provides read-only access for up to 256 registers. To obtain a memory map value, enter the desired address in the **ADDRESS** line (this value must be converted from hex to decimal format). The corresponding value is displayed in the **VALUE** line. A value of "0" in subsequent register **ADDRESS** lines automatically returns values for the previous **ADDRESS** lines incremented by "1". An address value of "0" in the initial register means "none" and values of "0" will be displayed for all registers. Different **ADDRESS** values can be entered as required in any of the register positions.

NOTE

These settings can also be used with the DNP protocol. See the DNP Analog Input Points section in Appendix E for details.

5.2.6 REAL TIME CLOCK

PATH: SETTINGS ⇨ PRODUCT SETUP ⇨⇩ REAL TIME CLOCK

■ REAL TIME ■ CLOCK	◁▷	IRIG-B SIGNAL TYPE: None	Range: None, DC Shift, Amplitude Modulated

The date and time for the relay clock can be synchronized to other relays using an IRIG-B signal. It has the same accuracy as an electronic watch, approximately ±1 minute per month. 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. See also the **COMMANDS ⇩ SET DATE AND TIME** menu for manually setting the relay clock.

5.2.7 OSCILLOGRAPHY

PATH: SETTINGS ⇨ PRODUCT SETUP ⇨⇩ OSCILLOGRAPHY

■ OSCILLOGRAPHY ■	
NUMBER OF RECORDS: 15	Range: *1 to 64 in steps of 1*
TRIGGER MODE: Automatic Overwrite	Range: *Automatic Overwrite, Protected*
TRIGGER POSITION: 50%	Range: *0 to 100 in steps of 1*
TRIGGER SOURCE: Off	Range: *FlexLogic™ operand*
AC INPUT WAVEFORMS: 16 samples/cycle	Range: *Off; 8, 16, 32, 64 samples/cycle*
■ DIGITAL CHANNELS ■	Range: *2 to 63 channels*
DIGITAL CHANNEL 1: Off	Range: *FlexLogic™ operand*
↓	
DIGITAL CHANNEL 63: Off	Range: *FlexLogic™ operand*
■ ANALOG CHANNELS ■	Range: *1 to 16 channels*
ANALOG CHANNEL 1: Off	Range: *Off, any FlexAnalog parameter* *See Appendix A: FlexAnalog Parameters for complete list.*
↓	
ANALOG CHANNEL 16: Off	Range: *Off, any FlexAnalog parameter* *See Appendix A: FlexAnalog Parameters for complete list.*

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** is selectable, but the number of cycles captured in a single record varies considerably based on other factors such as sample rate. There is a fixed amount of data storage for oscillography; the more data captured, the less the number of cycles captured per record. See the **ACTUAL VALUES ⇨⇩ RECORDS ⇨⇩ OSCILLOGRAPHY** menu to view the number of cycles captured per record. The following table provides sample configurations with corresponding cycles/record.

Table 5–1: OSCILLOGRAPHY CYCLES/RECORD EXAMPLE

# RECORDS	# CT/VTS	SAMPLE RATE	# DIGITALS	# ANALOGS	CYCLES/ RECORD
1	1	8	0	0	1872.0
1	1	16	16	0	1685.0
8	1	16	16	0	266.0
8	1	16	16	4	219.5
8	2	16	16	4	93.5
8	2	16	64	16	93.5
8	2	32	64	16	57.6
8	2	64	64	16	32.3
32	2	64	64	16	9.5

A new record may automatically overwrite an older record if **TRIGGER MODE** is set to “Automatic Overwrite”.

The **TRIGGER POSITION** is programmable as a percent of the total buffer size (e.g. 10%, 50%, 75%, etc.). A trigger position of 25% consists of 25% pre- and 75% post-trigger data.

The **TRIGGER SOURCE** is always captured in oscillography and may be any FlexLogic™ parameter (element state, contact input, virtual output, etc.). The relay sampling rate is 64 samples per cycle.

The **AC INPUT WAVEFORMS** setting determines the sampling rate at which AC input signals (i.e. current and voltage) are stored. Reducing the sampling rate allows longer records to be stored. This setting has no effect on the internal sampling rate of the relay which is always 64 samples per cycle, i.e. it has no effect on the fundamental calculations of the device.

An **ANALOG CHANNEL** setting selects the metering actual value recorded in an oscillography trace. The length of each oscillography trace depends in part on the number of parameters selected here. Parameters set to ‘Off’ are ignored. The parameters available in a given relay are dependent on: (a) the type of relay, (b) the type and number of CT/VT hardware modules installed, and (c) the type and number of Analog Input hardware modules installed. Upon startup, the relay will automatically prepare the parameter list. A list of all possible analog metering actual value parameters is presented in Appendix A: FlexAnalog Parameters. The parameter index number shown in any of the tables is used to expedite the selection of the parameter on the relay display. It can be quite time-consuming to scan through the list of parameters via the relay keypad/ display - entering this number via the relay keypad will cause the corresponding parameter to be displayed.

All eight CT/VT module channels are stored in the oscillography file. The CT/VT module channels are named as follows:

<slot_letter><terminal_number>—<I or *V><phase A*, *B*, or *C*, or *4th input>*

The fourth current input in a bank is called IG, and the fourth voltage input in a bank is called VX. For example, F2-IB designates the IB signal on Terminal 2 of the CT/VT module in slot F. If there are no CT/VT modules and Analog Input modules, no analog traces will appear in the file; only the digital traces will appear.

WARNING

When the NUMBER OF RECORDS setting is altered, all oscillography records will be CLEARED.

5.2.8 DATA LOGGER

PATH: SETTINGS ⇨⇩ PRODUCT SETUP ⇨⇩ DATA LOGGER

■ DATA LOGGER ■		DATA LOGGER RATE: 1 min	Range: 1 sec; 1 min, 5 min, 10 min, 15 min, 20 min, 30 min, 60 min
	MESSAGE	DATA LOGGER CHNL 1: Off	Range: Off, any FlexAnalog parameter. See Appendix A: FlexAnalog Parameters for complete list.
	MESSAGE	DATA LOGGER CHNL 2: Off	Range: Off, any FlexAnalog parameter. See Appendix A: FlexAnalog Parameters for complete list.
		↓	
	MESSAGE	DATA LOGGER CHNL 16: Off	Range: Off, any FlexAnalog parameter. See Appendix A: FlexAnalog Parameters for complete list.
	MESSAGE	DATA LOGGER CONFIG: 0 CHNL x 0.0 DAYS	Range: Not applicable - shows computed data only

The data logger samples and records up to 16 analog parameters at a user-defined sampling rate. This recorded data may be downloaded to the URPC software and displayed with 'parameters' on the vertical axis and 'time' on the horizontal axis. All data is stored in non-volatile memory, meaning that the information is retained when power to the relay is lost.

For a fixed sampling rate, the data logger can be configured with a few channels over a long period or a larger number of channels for a shorter period. The relay automatically partitions the available memory between the channels in use.

5

NOTE

Changing any setting affecting Data Logger operation will clear any data that is currently in the log.

- **DATA LOGGER RATE:** This setting selects the time interval at which the actual value data will be recorded.
- **DATA LOGGER CHNL 1 (16):** This setting selects the metering actual value that is to be recorded in Channel 1(16) of the data log. The parameters available in a given relay are dependent on: the type of relay, the type and number of CT/VT hardware modules installed, and the type and number of Analog Input hardware modules installed. Upon startup, the relay will automatically prepare the parameter list. A list of all possible analog metering actual value parameters is shown in Appendix A: Flexanalog Parameters. The parameter index number shown in any of the tables is used to expedite the selection of the parameter on the relay display. It can be quite time-consuming to scan through the list of parameters via the relay keypad/display – entering this number via the relay keypad will cause the corresponding parameter to be displayed.
- **DATA LOGGER CONFIG:** This display presents the total amount of time the Data Logger can record the channels not selected to "Off" without over-writing old data.

5.2.9 USER-PROGRAMMABLE LEDS

a) MAIN MENU

PATH: SETTINGS ⇨ PRODUCT SETUP ⇨⇩ USER-PROGRAMMABLE LEDS

■ USER-PROGRAMMABLE ■ LEDS		■ LED TEST ■	See below
	MESSAGE	■ TRIP & ALARM ■ LEDS	See page 5–19.
	MESSAGE	■ USER-PROGRAMMABLE ■ LED1	See page 5–19.
	MESSAGE	■ USER-PROGRAMMABLE ■ LED2	
		↓	
	MESSAGE	■ USER-PROGRAMMABLE ■ LED48	

b) LED TEST

PATH: SETTINGS ⇨ PRODUCT SETUP ⇨⇩ USER-PROGRAMMABLE LEDS ⇨ LED TEST

■ LED TEST ■		LED TEST FUNCTION: Disabled	*Range: Disabled, Enabled.*
	MESSAGE	LED TEST CONTROL: Off	*Range: FlexLogic™ operand*

When enabled, the LED Test can be initiated from any digital input or user-programmable condition such as user-programmable pushbutton. The control operand is configured under the **LED TEST CONTROL** setting. The test covers all LEDs, including the LEDs of the optional user-programmable pushbuttons.

The test consists of three stages.

Stage 1: All 62 LEDs on the relay are illuminated. This is a quick test to verify if any of the LEDs is “burned”. This stage lasts as long as the control input is on, up to a maximum of 1 minute. After 1 minute, the test will end.

Stage 2: All the LEDs are turned off, and then one LED at a time turns on for 1 second, then back off. The test routine starts at the top left panel, moving from the top to bottom of each LED column. This test checks for hardware failures that lead to more than one LED being turned on from a single logic point. This stage can be interrupted at any time.

Stage 3: All the LEDs are turned on. One LED at a time turns off for 1 second, then back on. The test routine starts at the top left panel moving from top to bottom of each column of the LEDs. This test checks for hardware failures that lead to more than one LED being turned off from a single logic point. This stage can be interrupted at any time.

When testing is in progress, the LEDs are controlled by the test sequence, rather than the protection, control, and monitoring features. However, the LED control mechanism accepts all the changes to LED states generated by the relay and stores the actual LED states (On or Off) in memory. When the test completes, the LEDs reflect the actual state resulting from relay response during testing. The Reset pushbutton will not clear any targets when the LED Test is in progress.

A dedicated FlexLogic™ operand, LED TEST IN PROGRESS, is set for the duration of the test. When the test sequence is initiated, the LED Test Initiated event is stored in the Event Recorder.

The entire test procedure is user-controlled. In particular, Stage 1 can last as long as necessary, and Stages 2 and 3 can be interrupted. The test responds to the position and rising edges of the control input defined by the **LED TEST CONTROL** setting. The control pulses must last at least 250 ms to take effect. The following diagram explains how the test is executed.

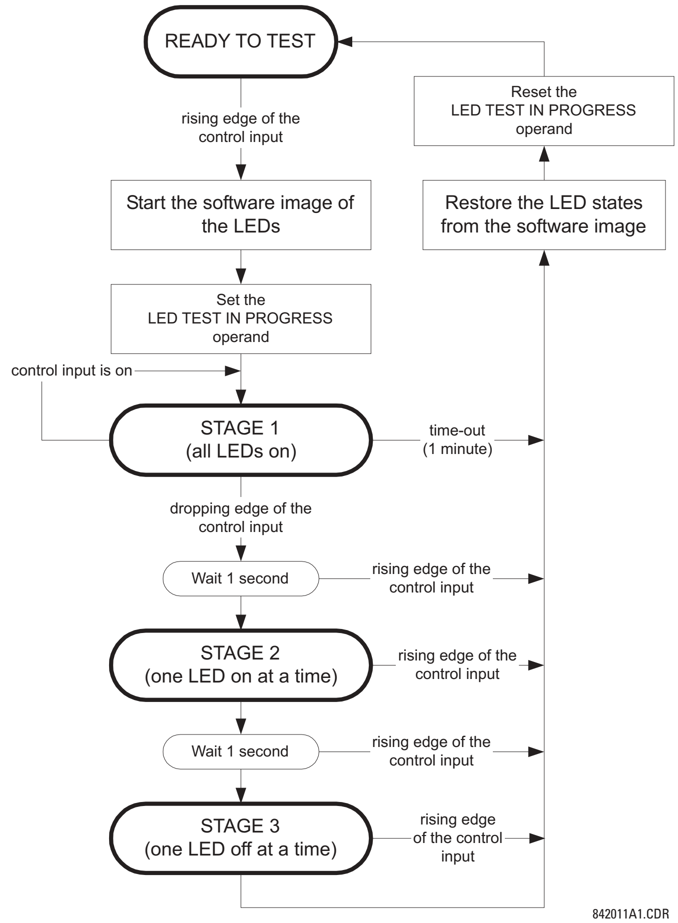

Figure 5–1: LED TEST SEQUENCE

APPLICATION EXAMPLE 1:

Assume one needs to check if any of the LEDs is "burned" through User-Programmable Pushbutton 1. The following settings should be applied.

Configure User-Programmable Pushbutton 1 by making the following entries in the **SETTINGS ⇨ PRODUCT SETUP ⇨⇩ USER-PROGRAMMABLE PUSHBUTTONS ⇨ USER PUSHBUTTON 1** menu:

PUSHBUTTON 1 FUNCTION: "Self-reset"
PUSHBTN 1 DROP-OUT TIME: "0.10 s"

Configure the LED test to recognize User-Programmable Pushbutton 1 by making the following entries in the **SETTINGS ⇨ PRODUCT SETUP ⇨⇩ USER-PROGRAMMABLE LEDS ⇨ LED TEST** menu:

LED TEST FUNCTION: "Enabled"
LED TEST CONTROL: "PUSHBUTTON 1 ON"

The test will be initiated when the User-Programmable Pushbutton 1 is pressed. The pushbutton should remain pressed for as long as the LEDs are being visually inspected. When finished, the pushbutton should be released. The relay will then automatically start Stage 2. At this point forward, test may be aborted by pressing the pushbutton.

APPLICATION EXAMPLE 2:

Assume one needs to check if any LEDs are "burned" as well as exercise one LED at a time to check for other failures. This is to be performed via User-Programmable Pushbutton 1.

After applying the settings in Application Example 1, hold down the pushbutton as long as necessary to test all LEDs. Next, release the pushbutton to automatically start Stage 2. Once Stage 2 has started, the pushbutton can be released. When Stage 2 is completed, Stage 3 will automatically start. The test may be aborted at any time by pressing the pushbutton.

c) TRIP AND ALARM LEDS

PATH: SETTINGS ⇨ PRODUCT SETUP ⇨⇩ USER-PROGRAMMABLE LEDS ⇨⇩ TRIP & ALARM LEDS

■ TRIP & ALARM ■ LEDS	TRIP LED INPUT: Disabled	Range: Disabled, Enabled
MESSAGE	ALARM LED INPUT: Off	Range: FlexLogic™ operand

The Trip and Alarm LEDs are on LED Panel 1. Each indicator can be programmed to become illuminated when the selected FlexLogic™ operand is in the Logic 1 state.

d) USER-PROGRAMMABLE LED 1(48)

PATH: SETTINGS ⇨ PRODUCT SETUP ⇨⇩ USER-PROGRAMMABLE LEDS ⇨⇩ USER-PROGRAMMABLE LED 1(48)

■ USER-PROGRAMMABLE ■ LED 1	LED 1 OPERAND: Off	Range: FlexLogic™ operand
MESSAGE	LED 1 TYPE: Self-Reset	Range: Self-Reset, Latched

There are 48 amber LEDs across the relay faceplate LED panels. Each of these indicators can be programmed to illuminate when the selected FlexLogic™ operand is in the Logic 1 state.

- LEDs 1 through 24 inclusive are on LED Panel 2; LEDs 25 through 48 inclusive are on LED Panel 3.

Refer to the LED Indicators section in Chapter 4 for the locations of these indexed LEDs. This menu selects the operands to control these LEDs. Support for applying user-customized labels to these LEDs is provided. If the **LED X TYPE** setting is “Self-Reset” (default setting), the LED illumination will track the state of the selected LED operand. If the **LED X TYPE** setting is ‘Latched’, the LED, once lit, remains so until reset by the faceplate RESET button, from a remote device via a communications channel, or from any programmed operand, even if the LED operand state de-asserts.

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Table 5–2: RECOMMENDED SETTINGS FOR LED PANEL 2 LABELS

SETTING	PARAMETER	SETTING	PARAMETER
LED 1 Operand	Off	LED 13 Operand	Off
LED 2 Operand	Off	LED 14 Operand	Off
LED 3 Operand	Off	LED 15 Operand	Off
LED 4 Operand	Off	LED 16 Operand	Off
LED 5 Operand	Off	LED 17 Operand	Off
LED 6 Operand	Off	LED 18 Operand	Off
LED 7 Operand	Off	LED 19 Operand	Off
LED 8 Operand	Off	LED 20 Operand	Off
LED 9 Operand	Off	LED 21 Operand	Off
LED 10 Operand	Off	LED 22 Operand	Off
LED 11 Operand	Off	LED 23 Operand	Off
LED 12 Operand	Off	LED 24 Operand	Off

5.2.10 USER-PROGRAMMABLE SELF TESTS

PATH: SETTINGS ⇨ PRODUCT SETUP ⇨⇩ USER-PROGRAMMABLE SELF TESTS

■ USER-PROGRAMMABLE ■ SELF TESTS		DIRECT RING BREAK FUNCTION: Enabled	*Range: Disabled, Enabled.* *Valid for units equipped with Direct I/O Module.*
	MESSAGE	DIRECT DEVICE OFF FUNCTION: Enabled	*Range: Disabled, Enabled.* *Valid for units equipped with Direct I/O Module.*
	MESSAGE	REMOTE DEVICE OFF FUNCTION: Enabled	*Range: Disabled, Enabled.* *Valid for units equipped with CPU Type C or D.*
	MESSAGE	PRI. ETHERNET FAIL FUNCTION: Disabled	*Range: Disabled, Enabled.* *Valid for units equipped with CPU Type C or D.*
	MESSAGE	SEC. ETHERNET FAIL FUNCTION: Disabled	*Range: Disabled, Enabled.* *Valid for units equipped with CPU Type D.*
	MESSAGE	BATTERY FAIL FUNCTION: Enabled	*Range: Disabled, Enabled.*
	MESSAGE	SNTP FAIL FUNCTION: Enabled	*Range: Disabled, Enabled.* *Valid for units equipped with CPU Type C or D.*
	MESSAGE	IRIG-B FAIL FUNCTION: Enabled	*Range: Disabled, Enabled.*

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All major self-test alarms are reported automatically with their corresponding FlexLogic™ operands, events, and targets. Most of the Minor Alarms can be disabled if desired.

When in the “Disabled” mode, minor alarms will not assert a FlexLogic™ operand, write to the event recorder, display target messages. Moreover, they will not trigger the **ANY MINOR ALARM** or **ANY SELF-TEST** messages. When in the “Enabled” mode, minor alarms continue to function along with other major and minor alarms. Refer to the Relay Self-Tests section in Chapter 7 for additional information on major and minor self-test alarms.

5.2.11 CONTROL PUSHBUTTONS

PATH: SETTINGS ⇨ PRODUCT SETUP ⇨⇩ CONTROL PUSHBUTTONS ⇨ CONTROL PUSHBUTTON 1(3)

■ CONTROL ■ PUSHBUTTON 1		CONTROL PUSHBUTTON 1 FUNCTION: Disabled	*Range: Disabled, Enabled*
	MESSAGE	CONTROL PUSHBUTTON 1 EVENTS: Disabled	*Range: Disabled, Enabled*

The three standard pushbuttons located on the top left panel of the faceplate are user-programmable and can be used for various applications such as performing an LED test, switching setting groups, and invoking and scrolling though user-programmable displays, etc. The location of the control pushbuttons in shown below.

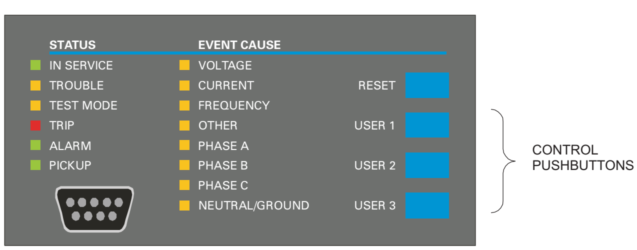

Figure 5–2: CONTROL PUSHBUTTONS

The control pushbuttons are typically not used for critical operations. As such, they are not protected by the control password. However, by supervising their output operands, the user can dynamically enable or disable the control pushbuttons for security reasons.

Each control pushbutton asserts its own FlexLogic™ operand, CONTROL PUSHBTN 1(3) ON. These operands should be configured appropriately to perform the desired function. The operand remains asserted as long as the pushbutton is pressed and resets when the pushbutton is released. A dropout delay of 100 ms is incorporated to ensure fast pushbutton manipulation will be recognized by various features that may use control pushbuttons as inputs.

An event is logged in the Event Record (as per used setting) when a control pushbutton is pressed; no event is logged when the pushbutton is released. The faceplate keys (including control keys) cannot be operated simultaneously – a given key must be released before the next one can be pressed.

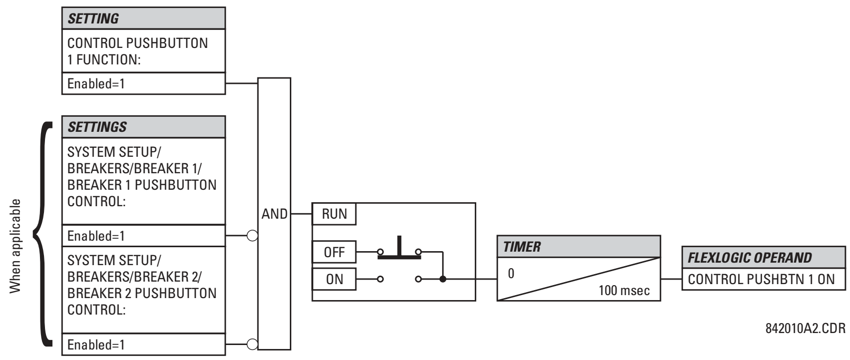

Figure 5–3: CONTROL PUSHBUTTON LOGIC

5.2.12 USER-PROGRAMMABLE PUSHBUTTONS

PATH: SETTINGS ⇨ PRODUCT SETUP ⇨⇩ USER-PROGRAMMABLE PUSHBUTTONS ⇨ USER PUSHBUTTON 1(12)

■ USER PUSHBUTTON 1 ■		PUSHBUTTON 1 FUNCTION: Disabled	Range: Self-Reset, Latched, Disabled
	MESSAGE	PUSHBTN 1 ID TEXT:	Range: Up to 20 alphanumeric characters
	MESSAGE	PUSHBTN 1 ON TEXT:	Range: Up to 20 alphanumeric characters
	MESSAGE	PUSHBTN 1 OFF TEXT:	Range: Up to 20 alphanumeric characters
	MESSAGE	PUSHBTN 1 DROP-OUT TIME: 0.00 s	Range: 0 to 60.00 s in steps of 0.01
	MESSAGE	PUSHBUTTON 1 TARGETS: Disabled	Range: Self-Reset, Latched, Disabled
	MESSAGE	PUSHBUTTON 1 EVENTS: Disabled	Range: Disabled, Enabled

The C30 has 12 optional user-programmable pushbuttons available, each configured via 12 identical menus. The pushbuttons provide an easy and error-free method of manually entering digital information (On, Off) into FlexLogic™ equations as well as protection and control elements. Typical applications include breaker control, autorecloser blocking, ground protection blocking, and setting groups changes.

The user-configurable pushbuttons are shown below. They can be custom labeled with a factory-provided template, available online at www.GEindustrial.com/multilin.

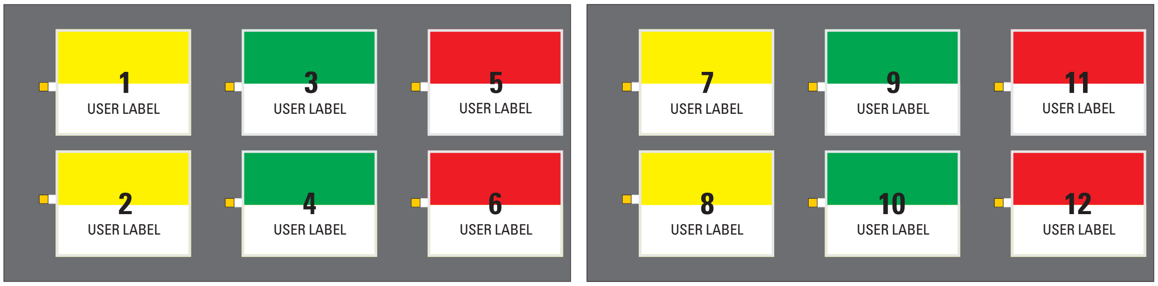

Figure 5–4: USER-PROGRAMMABLE PUSHBUTTONS

Each pushbutton asserts its own On and Off FlexLogic™ operands, respectively. FlexLogic™ operands should be used to program desired pushbutton actions. The operand names are PUSHBUTTON 1 ON and PUSHBUTTON 1 OFF.

A pushbutton may be programmed to latch or self-reset. An indicating LED next to each pushbutton signals the present status of the corresponding "On" FlexLogic™ operand. When set to "Latched", the state of each pushbutton is stored in non-volatile memory which is maintained during any supply power loss.

Pushbuttons states can be logged by the Event Recorder and displayed as target messages. User-defined messages can also be associated with each pushbutton and displayed when the pushbutton is ON.

- **PUSHBUTTON 1 FUNCTION:** This setting selects the characteristic of the pushbutton. If set to “Disabled”, the pushbutton is deactivated and the corresponding FlexLogic™ operands (both “On” and “Off”) are de-asserted. If set to “Self-reset”, the control logic of the pushbutton asserts the “On” corresponding FlexLogic™ operand as long as the pushbutton is being pressed. As soon as the pushbutton is released, the FlexLogic™ operand is de-asserted. The “Off” operand is asserted/de-asserted accordingly.

  If set to “Latched”, the control logic alternates the state of the corresponding FlexLogic™ operand between “On” and “Off” on each push of the button. When operating in “Latched” mode, FlexLogic™ operand states are stored in non-volatile memory. Should power be lost, the correct pushbutton state is retained upon subsequent power up of the relay.
- **PUSHBTN 1 ID TEXT:** This setting specifies the top 20-character line of the user-programmable message and is intended to provide ID information of the pushbutton. Refer to the User-Definable Displays section for instructions on how to enter alphanumeric characters from the keypad.
- **PUSHBTN 1 ON TEXT:** This setting specifies the bottom 20-character line of the user-programmable message and is displayed when the pushbutton is in the “on” position. Refer to the User-Definable Displays section for instructions on entering alphanumeric characters from the keypad.
- **PUSHBTN 1 OFF TEXT:** This setting specifies the bottom 20-character line of the user-programmable message and is displayed when the pushbutton is activated from the On to the Off position and the **PUSHBUTTON 1 FUNCTION** is “Latched”. This message is not displayed when the **PUSHBUTTON 1 FUNCTION** is “Self-reset” as the pushbutton operand status is implied to be “Off” upon its release. All user text messaging durations for the pushbuttons are configured with the **PRODUCT SETUP ⇨⇩ DISPLAY PROPERTIES ⇨ FLASH MESSAGE TIME** setting.
- **PUSHBTN 1 DROP-OUT TIME:** This setting specifies a drop-out time delay for a pushbutton in the self-reset mode. A typical applications for this setting is providing a select-before-operate functionality. The selecting pushbutton should have the drop-out time set to a desired value. The operating pushbutton should be logically ANDed with the selecting pushbutton in FlexLogic™. The selecting pushbutton LED remains on for the duration of the drop-out time, signaling the time window for the intended operation.

For example, consider a relay with the following settings: **PUSHBTN 1 ID TEXT**: “AUTORECLOSER”, **PUSHBTN 1 ON TEXT**: “DISABLED - CALL 2199", and **PUSHBTN 1 OFF TEXT**: “ENABLED”. When Pushbutton 1 changes its state to the “On” position, the following **AUTOCLOSER DISABLED – Call 2199** message is displayed: When Pushbutton 1 changes its state to the “Off” position, the message will change to **AUTORECLOSER ENABLED**.

NOTE

User-programmable pushbuttons require a type HP relay faceplate. If an HP-type faceplate was ordered separately, the relay order code must be changed to indicate the HP faceplate option. This can be done via URPC with the **Maintenance > Enable Pushbutton** command.

5.2.13 FLEX STATE PARAMETERS

PATH: SETTINGS ⇨ PRODUCT SETUP ⇨⇩ FLEX STATE PARAMETERS

■ FLEX STATE ■ PARAMETERS	PARAMETER 1: Off	Range: FlexLogic™ Operand
MESSAGE	PARAMETER 2: Off	Range: FlexLogic™ Operand
	↓	
MESSAGE	PARAMETER 256: Off	Range: FlexLogic™ Operand

This feature provides a mechanism where any of 256 selected FlexLogic™ operand states can be used for efficient monitoring. The feature allows user-customized access to the FlexLogic™ operand states in the relay. The state bits are packed so that 16 states may be read out in a single Modbus register. The state bits can be configured so that all of the states which are of interest to the user are available in a minimum number of Modbus registers.

The state bits may be read out in the "Flex States" register array beginning at Modbus address 900 hex. 16 states are packed into each register, with the lowest-numbered state in the lowest-order bit. There are 16 registers in total to accommodate the 256 state bits.

5.2.14 USER-DEFINABLE DISPLAYS

a) MAIN MENU

PATH: SETTINGS ⇨ PRODUCT SETUP ⇨⇩ USER-DEFINABLE DISPLAYS

■ USER-DEFINABLE ■ DISPLAYS	INVOKE AND SCROLL: Off	Range: FlexLogic™ operand
MESSAGE	■ USER DISPLAY 1 ■	Range: up to 20 alphanumeric characters
	↓	
MESSAGE	■ USER DISPLAY 16 ■	Range: up to 20 alphanumeric characters

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This menu provides a mechanism for manually creating up to 16 user-defined information displays in a convenient viewing sequence in the **USER DISPLAYS** menu (between the **TARGETS** and **ACTUAL VALUES** top-level menus). The sub-menus facilitate text entry and Modbus Register data pointer options for defining the User Display content.

Once programmed, the user-definable displays can be viewed in two ways.

- **KEYPAD**: Use the Menu key to select the USER DISPLAYS menu item to access the first user-definable display (note that only the programmed screens are displayed). The screens can be scrolled using the Up and Down keys. The display disappears after the default message time-out period specified by the PRODUCT SETUP ⇨⇩ DISPLAY PROPERTIES ⇨⇩ DEFAULT MESSAGE TIMEOUT setting.
- **USER-PROGRAMMABLE CONTROL INPUT**: The user-definable displays also respond to the INVOKE AND SCROLL setting. Any FlexLogic™ operand (in particular, the user-programmable pushbutton operands), can be used to navigate the programmed displays.

  On the rising edge of the configured operand (such as when the pushbutton is pressed), the displays are invoked by showing the last user-definable display shown during the previous activity. From this moment onward, the operand acts exactly as the Down key and allows scrolling through the configured displays. The last display wraps up to the first one. The INVOKE AND SCROLL input and the Down keypad key operate concurrently.

  The INVOKE AND SCROLL input is active since the last activity for the time specified by the DEFAULT MESSAGE TIMEOUT setting. When this time expires, the feature resets and the next activity of the input invokes the first display. The INVOKE AND SCROLL pulses must last for at least 250 ms to take effect.

b) USER DISPLAY 1(16)

PATH: SETTINGS ⇨ PRODUCT SETUP ⇨⇩ USER-DEFINABLE DISPLAYS ⇨ USER DISPLAY 1(16)

■ USER DISPLAY 1 ■	◀▶	DISP 1 TOP LINE:	Range: up to 20 alphanumeric characters
MESSAGE	▲▼	DISP 1 BOTTOM LINE:	Range: up to 20 alphanumeric characters
MESSAGE	▲▼	DISP 1 ITEM 1 0	Range: 0 to 65535 in steps of 1
MESSAGE	▲▼	DISP 1 ITEM 2 0	Range: 0 to 65535 in steps of 1
MESSAGE	▲▼	DISP 1 ITEM 3 0	Range: 0 to 65535 in steps of 1
MESSAGE	▲▼	DISP 1 ITEM 4 0	Range: 0 to 65535 in steps of 1
MESSAGE	▲	DISP 1 ITEM 5: 0	Range: 0 to 65535 in steps of 1

Any existing system display can be automatically copied into an available User Display by selecting the existing display and pressing the [ENTER] key. The display will then prompt **ADD TO USER DISPLAY LIST?**. After selecting "Yes", a message indicates that the selected display has been added to the user display list. When this type of entry occurs, the sub-menus are automatically configured with the proper content – this content may subsequently be edited.

This menu is used **to enter** user-defined text and/or user-selected Modbus-registered data fields into the particular User Display. Each User Display consists of two 20-character lines (top and bottom). The Tilde (~) character is used to mark the start of a data field - the length of the data field needs to be accounted for. Up to 5 separate data fields (**ITEM 1(5)**) can be entered in a User Display - the *n*th Tilde (~) refers to the *n*th item.

A User Display may be entered from the faceplate keypad or the URPC interface (preferred for convenience). The following procedure shows how to enter text characters in the top and bottom lines from the faceplate keypad:

1. Select the line to be edited.
2. Press the [▪] key to enter text edit mode.
3. Use either Value key to scroll through the 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 text is displayed.
6. The [HELP] key may be pressed at any time for context sensitive help information.
7. Press the [ENTER] key to store the new settings.

To enter a numerical value for any of the 5 items (the *decimal form* of the selected Modbus address) from the faceplate keypad, use the number keypad. Use the value of '0' for any items not being used. Use the [HELP] key at any selected system display (Setting, Actual Value, or Command) which has a Modbus address, to view the *hexadecimal form* of the Modbus address, then manually convert it to decimal form before entering it (URPC usage conveniently facilitates this conversion).

Use the [MENU] key to go to the User Displays menu **to view** the user-defined content. The current user displays will show in sequence, changing every 4 seconds. While viewing a User Display, press the [ENTER] key and then select the 'Yes" option **to remove** the display from the user display list. Use the [MENU] key again **to exit** the User Displays menu.

An example User Display setup and result is shown below:

■ USER DISPLAY 1 ■		DISP 1 TOP LINE: Current X ~ A	Shows user-defined text with first Tilde marker.
MESSAGE		DISP 1 BOTTOM LINE: Current Y ~ A	Shows user-defined text with second Tilde marker.
MESSAGE		DISP 1 ITEM 1: 6016	Shows decimal form of user-selected Modbus Register Address, corresponding to first Tilde marker.
MESSAGE		DISP 1 ITEM 2: 6357	Shows decimal form of user-selected Modbus Register Address, corresponding to 2nd Tilde marker.
MESSAGE		DISP 1 ITEM 3: 0	This item is not being used - there is no corresponding Tilde marker in Top or Bottom lines.
MESSAGE		DISP 1 ITEM 4: 0	This item is not being used - there is no corresponding Tilde marker in Top or Bottom lines.
MESSAGE		DISP 1 ITEM 5: 0	This item is not being used - there is no corresponding Tilde marker in Top or Bottom lines.

USER DISPLAYS	→	Current X 0.850 A Current Y 0.327 A	Shows the resultant display content.

5.2.15 DIRECT I/O

a) MAIN MENU

PATH: SETTINGS ⇨ PRODUCT SETUP ⇨⇩ DIRECT I/O

■ DIRECT I/O ■		DIRECT OUTPPUT DEVICE ID: 1	*Range: 1 to 8*
MESSAGE		DIRECT I/O CH1 RING CONFIGURATION: Yes	*Range: Yes, No*
MESSAGE		DIRECT I/O CH2 RING CONFIGURATION: Yes	*Range: Yes, No*
MESSAGE		DIRECT I/O DATA RATE: 64 kbps	*Range: 64 kbps, 128 kbps*
MESSAGE		DIRECT I/O CHANNEL CROSSOVER: Disabled	*Range: Disabled, Enabled*
MESSAGE		■ CRC ALARM CH1 ■	See page 5–29.
MESSAGE		■ CRC ALARM CH2 ■	See page 5–29.
MESSAGE		■ UNRETURNED ■ MESSAGES ALARM CH1	See page 5–30.
MESSAGE		■ UNRETURNED ■ MESSAGES ALARM CH2	See page 5–30.

Direct I/Os are intended for exchange of status information (inputs and outputs) between UR relays connected directly via Type-7 UR digital communications cards. The mechanism is very similar to UCA GOOSE, except that communications takes place over a non-switchable isolated network and is optimized for speed. On Type 7 cards that support two channels,

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Direct Output messages are sent from both channels simultaneously. This effectively sends Direct Output messages both ways around a ring configuration. On Type 7 cards that support one channel, Direct Output messages are sent only in one direction. Messages will be resent (forwarded) when it is determined that the message did not originate at the receiver.

Direct Output message timing is similar to GOOSE message timing. Integrity messages (with no state changes) are sent at least every 500 ms. Messages with state changes are sent within the main pass scanning the inputs and asserting the outputs unless the communication channel bandwidth has been exceeded. Two Self-Tests are performed and signaled by the following FlexLogic™ operands:

1. DIRECT RING BREAK (Direct I/O Ring Break). This FlexLogic™ operand indicates that Direct Output messages sent from a UR are not being received back by the UR.
2. DIRECT DEVICE X OFF (Direct Device Offline). This FlexLogic™ operand indicates that Direct Output messages from at least one Direct Device are not being received.

Direct I/O settings are similar to Remote I/O settings. The equivalent of the Remote Device name strings for Direct I/O, is the Direct Output Device ID.

The **DIRECT OUTPUT DEVICE ID** identifies this UR in all Direct Output messages. All UR IEDs in a ring should have unique numbers assigned. The IED ID is used to identify the sender of the Direct I/O message.

If the Direct I/O scheme is configured to operate in a ring (**DIRECT I/O RING CONFIGURATION**: "Yes"), all Direct Output messages should be received back. If not, the Direct I/O Ring Break Self Test is triggered. The self-test error is signaled by the DIRECT RING BREAK FlexLogic™ operand.

Select the **DIRECT I/O DATA RATE** to match the capabilities of the communications channel. Back-to-back connections of the local relays may be set to 128 kbps. All IEDs communicating over Direct I/Os must be set to the same data rate. UR IEDs equipped with dual-channel communications cards apply the same data rate to both channels. Delivery time for Direct I/O messages is approximately 0.2 of a power system cycle at 128 kbps and 0.4 of a power system cycle at 64 kbps, per each "bridge".

The **DIRECT I/O CHANNEL CROSSOVER** setting applies to C30s with dual-channel communication cards and allows crossing over messages from Channel 1 to Channel 2. This places all UR IEDs into one Direct I/O network regardless of the physical media of the two communication channels.

The following application examples illustrate the basic concepts for Direct I/O configuration. Please refer to the Inputs/Outputs section later in this chapter for information on configuring FlexLogic™ operands (flags, bits) to be exchanged.

EXAMPLE 1: EXTENDING THE I/O CAPABILITIES OF A UR RELAY

Consider an application that requires additional quantities of digital inputs and/or output contacts and/or lines of programmable logic that exceed the capabilities of a single UR chassis. The problem is solved by adding an extra UR IED, such as the C30, to satisfy the additional I/Os and programmable logic requirements. The two IEDs are connected via single-channel digital communication cards as shown in the figure below.

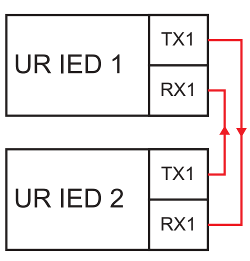

Figure 5–5: INPUT/OUTPUT EXTENSION VIA DIRECT I/OS

In the above application, the following settings should be applied:

UR IED 1: **DIRECT OUTPUT DEVICE ID:** "1"
DIRECT I/O RING CONFIGURATION: "Yes"
DIRECT I/O DATA RATE: "128 kbps"

UR IED 2: **DIRECT OUTPUT DEVICE ID:** "2"
DIRECT I/O RING CONFIGURATION: "Yes"
DIRECT I/O DATA RATE: "128 kbps"

The message delivery time is about 0.2 of power cycle in both ways (at 128 kbps); i.e., from Device 1 to Device 2, and from Device 2 to Device 1. Different communications cards can be selected by the user for this back-to-back connection (fiber, G.703, or RS422).

EXAMPLE 2: INTERLOCKING BUSBAR PROTECTION

A simple interlocking busbar protection scheme could be accomplished by sending a blocking signal from downstream devices, say 2, 3, and 4, to the upstream device that monitors a single incomer of the busbar, as shown below.

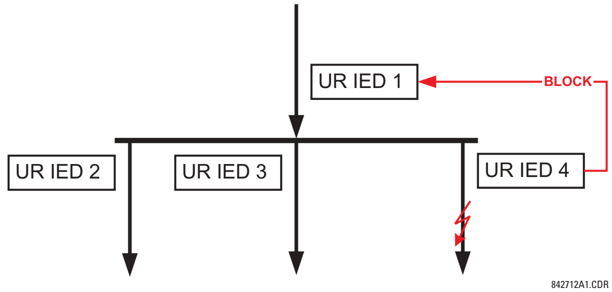

Figure 5–6: SAMPLE INTERLOCKING BUSBAR PROTECTION SCHEME

For increased reliability, a dual-ring configuration (shown below) is recommended for this application.

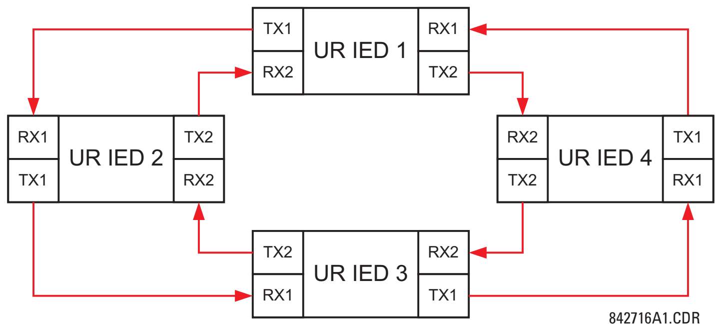

Figure 5–7: INTERLOCKING BUS PROTECTION SCHEME VIA DIRECT I/OS

In the above application, the following settings should be applied:

UR IED 1: **DIRECT OUTPUT DEVICE ID:** “1”
DIRECT I/O RING CONFIGURATION: “Yes”

UR IED 2: **DIRECT OUTPUT DEVICE ID:** “2”
DIRECT I/O RING CONFIGURATION: “Yes”

UR IED 3: **DIRECT OUTPUT DEVICE ID:** “3”
DIRECT I/O RING CONFIGURATION: “Yes”

UR IED 4: **DIRECT OUTPUT DEVICE ID:** “4”
DIRECT I/O RING CONFIGURATION: “Yes”

Message delivery time is approximately 0.2 of power system cycle (at 128 kbps) times number of "bridges" between the origin and destination. Dual-ring configuration effectively reduces the maximum "communications distance" by a factor of two.

In this configuration the following delivery times are expected (at 128 kbps) if both rings are healthy:

IED 1 to IED 2: 0.2 of power system cycle; IED 1 to IED 3: 0.4 of power system cycle;
IED 1 to IED 4: 0.2 of power system cycle; IED 2 to IED 3: 0.2 of power system cycle;
IED 2 to IED 4: 0.4 of power system cycle; IED 3 to IED 4: 0.2 of power system cycle

If one ring is broken (say TX2/RX2) the delivery times are as follows:

IED 1 to IED 2: 0.2 of power system cycle; IED 1 to IED 3: 0.4 of power system cycle;
IED 1 to IED 4: 0.6 of power system cycle; IED 2 to IED 3: 0.2 of power system cycle;
IED 2 to IED 4: 0.4 of power system cycle; IED 3 to IED 4: 0.2 of power system cycle

A coordinating timer for this bus protection scheme could be selected to cover the worst case scenario (0.4 of power system cycle). Upon detecting a broken ring, the coordination time should be adaptively increased to 0.6 of power system cycle. The complete application requires addressing a number of issues such as failure of both the communications rings, failure or out-of-service conditions of one of the relays, etc. Self-monitoring flags of the Direct I/O feature would be primarily used to address these concerns.

EXAMPLE 3: PILOT-AIDED SCHEMES

Consider the three-terminal line protection application shown below:

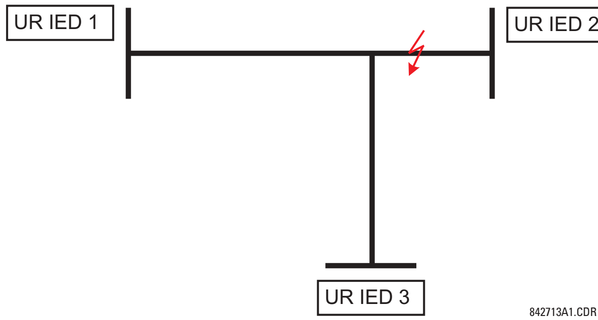

Figure 5–8: THREE-TERMINAL LINE APPLICATION

A permissive pilot-aided scheme could be implemented in a two-ring configuration as shown below (IEDs 1 and 2 constitute a first ring, while IEDs 2 and 3 constitute a second ring):

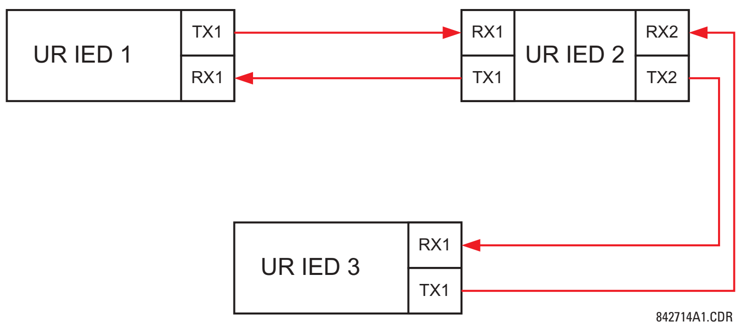

Figure 5–9: SINGLE-CHANNEL OPEN LOOP CONFIGURATION

In the above application, the following settings should be applied:

UR IED 1: **DIRECT OUTPUT DEVICE ID:** "1"
DIRECT I/O RING CONFIGURATION: "Yes"

UR IED 2: **DIRECT OUTPUT DEVICE ID:** "2"
DIRECT I/O RING CONFIGURATION: "Yes"

UR IED 3: **DIRECT OUTPUT DEVICE ID:** "3"
DIRECT I/O RING CONFIGURATION: "Yes"

In this configuration the following delivery times are expected (at 128 kbps):

IED 1 to IED 2: 0.2 of power system cycle; IED 1 to IED 3: 0.5 of power system cycle;
IED 2 to IED 3: 0.2 of power system cycle

In the above scheme, IEDs 1 and 3 do not communicate directly. IED 2 must be configured to forward the messages as explained in the INPUTS/OUTPUTS section. A blocking pilot-aided scheme should be implemented with more security and, ideally, faster message delivery time. This could be accomplished using a dual-ring configuration as shown below.

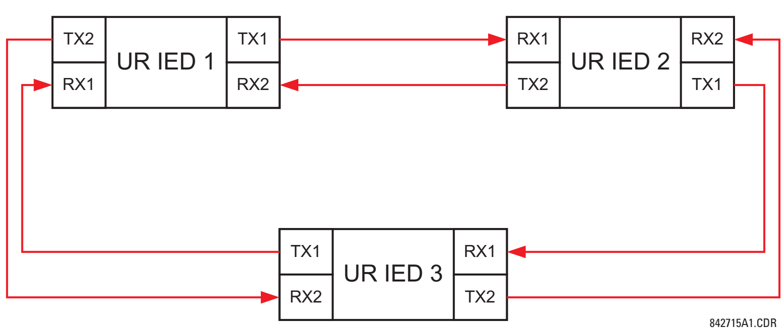

Figure 5–10: DUAL-CHANNEL CLOSED LOOP (DUAL-RING) CONFIGURATION

In the above application, the following settings should be applied:

UR IED 1: **DIRECT OUTPUT DEVICE ID:** "1"
DIRECT I/O RING CONFIGURATION: "Yes"

UR IED 2: **DIRECT OUTPUT DEVICE ID:** "2"
DIRECT I/O RING CONFIGURATION: "Yes"

UR IED 3: **DIRECT OUTPUT DEVICE ID:** "3"
DIRECT I/O RING CONFIGURATION: "Yes"

In this configuration the following delivery times are expected (at 128 kbps) if both the rings are healthy:

IED 1 to IED 2: 0.2 of power system cycle; IED 1 to IED 3: 0.2 of power system cycle;
IED 2 to IED 3: 0.2 of power system cycle

The two communications configurations could be applied to both permissive and blocking schemes. Speed, reliability and cost should be taken into account when selecting the required architecture.

b) CRC ALARM CH1(2)

PATH: SETTINGS ⇨ PRODUCT SETUP ⇨⇩ DIRECT I/O ⇨⇩ CRC ALARM CH1(2)

■ CRC ALARM CH1 ■	◁▷	CRC ALARM CH1 FUNCTION: Disabled	*Range: Enabled, Disabled*
MESSAGE	△▽	CRC ALARM CH1 MESSAGE COUNT: 600	*Range: 100 to 10000 in steps of 1*
MESSAGE	△▽	CRC ALARM CH1 THRESHOLD: 10	*Range: 1 to 1000 in steps of 1*
MESSAGE	△	CRC ALARM CH1 EVENTS: Disabled	*Range: Enabled, Disabled*

The C30 checks integrity of the incoming Direct I/O messages using a 32-bit CRC. The CRC Alarm function is available for monitoring the communication medium noise by tracking the rate of messages failing the CRC check. The monitoring function counts all incoming messages, including messages that failed the CRC check. A separate counter adds up messages that failed the CRC check. When the failed CRC counter reaches the user-defined level specified by the **CRC ALARM CH1 THRESHOLD** setting within the user-defined message count **CRC ALARM 1 CH1 COUNT**, the DIR IO CH1 CRC ALARM FlexLogic™ operand is set.

When the total message counter reaches the user-defined maximum specified by the **CRC ALARM CH1 MESSAGE COUNT** setting, both the counters reset and the monitoring process is restarted.

The operand shall be configured to drive an output contact, user-programmable LED, or selected communication-based output. Latching and acknowledging conditions - if required - should be programmed accordingly.

The CRC Alarm function is available on a per-channel basis. The total number of Direct I/O messages that failed the CRC check is available as the **ACTUAL VALUES ⇨ STATUS ⇨⇩ DIRECT INPUTS ⇨⇩ CRC FAIL COUNT CH1(2)** actual value.

Message Count and Length of the Monitoring Window:

To monitor communications integrity, the relay sends 2 messages per second (at 64 kbps) or 4 messages per second (128 kbps) even if there is no change in the Direct Outputs. For example, setting the **CRC ALARM CH1 MESSAGE COUNT** to "10000", corresponds a time window of about 80 minutes at 64 kbps and 40 minutes at 128 kbps. If the messages are sent faster as a result of Direct Outputs activity, the monitoring time interval will shorten. This should be taken into account when determining the **CRC ALARM CH1 MESSAGE COUNT** setting. For example, if the requirement is a maximum monitoring time interval of 10 minutes at 64 kbps, then the **CRC ALARM CH1 MESSAGE COUNT** should be set to $10 \times 60 \times 2 = 1200$.

Correlation of Failed CRC and Bit Error Rate (BER):

The CRC check may fail if one or more bits in a packet are corrupted. Therefore, an exact correlation between the CRC fail rate and the BER is not possible. Under certain assumptions an approximation can be made as follows. A Direct I/O packet containing 20 bytes results in 160 bits of data being sent and therefore, a transmission of 63 packets is equivalent to 10,000 bits. A BER of 10^{-4} implies 1 bit error for every 10,000 bits sent/received. Assuming the best case of only 1 bit error in a failed packet, having 1 failed packet for every 63 received is about equal to a BER of 10^{-4}.

c) UNRETURNED MESSAGES ALARM CH1(2)

PATH: SETTINGS ⇨ PRODUCT SETUP ⇨⇩ DIRECT I/O ⇨⇩ UNRETURNED MESSAGES ALARM CH1(2)

■ UNRETURNED ■ MESSAGES ALARM CH1		UNRET MSGS ALARM CH1 FUNCTION: Disabled	Range: Enabled, Disabled
MESSAGE		UNRET MSGS ALARM CH1 MESSAGE COUNT: 600	Range: 100 to 10000 in steps of 1
MESSAGE		UNRET MSGS ALARM CH1 THRESHOLD: 10	Range: 1 to 1000 in steps of 1
MESSAGE		UNRET MSGS ALARM CH1 EVENTS: Disabled	Range: Enabled, Disabled

The C30 checks integrity of the Direct I/O communication ring by counting unreturned messages. In the ring configuration, all messages originating at a given device should return within a pre-defined period of time. The Unreturned Messages Alarm function is available for monitoring the integrity of the communication ring by tracking the rate of unreturned messages. This function counts all the outgoing messages and a separate counter adds the messages have failed to return. When the unreturned messages counter reaches the user-definable level specified by the **UNRET MSGS ALARM CH1 THRESHOLD** setting and within the user-defined message count **UNRET MSGS ALARM CH1 COUNT**, the DIR IO CH1 UNRET ALM FlexLogic™ operand is set.

When the total message counter reaches the user-defined maximum specified by the **UNRET MSGS ALARM CH1 MESSAGE COUNT** setting, both the counters reset and the monitoring process is restarted.

The operand shall be configured to drive an output contact, user-programmable LED, or selected communication-based output. Latching and acknowledging conditions, if required, should be programmed accordingly.

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The Unreturned Messages Alarm function is available on a per-channel basis and is active only in the ring configuration. The total number of unreturned Direct I/O messages is available as the ACTUAL VALUES ⇨ STATUS ⇨⇩ DIRECT INPUTS ⇨⇩ UNRETURNED MSG COUNT CH1(2) actual value.

5.2.16 INSTALLATION

PATH: SETTINGS ⇨ PRODUCT SETUP ⇨⇩ INSTALLATION

■ INSTALLATION ■		RELAY SETTINGS: Not Programmed	Range: Not Programmed, Programmed
MESSAGE		RELAY NAME: Relay-1	Range: up to 20 alphanumeric characters

To safeguard against the installation of a relay without any entered settings, the unit will not allow signaling of any output relay until **RELAY SETTINGS** is set to "Programmed". This setting is defaulted to "Not Programmed" when at the factory. The UNIT NOT PROGRAMMED self-test error message is displayed until the relay is put into the "Programmed" state.

The **RELAY NAME** setting allows the user to uniquely identify a relay. This name will appear on generated reports. This name is also used to identify specific devices which are engaged in automatically sending/receiving data over the Ethernet communications channel using the UCA2/MMS protocol.

5.3.1 INTRODUCTION TO FLEXLOGIC™

To provide maximum flexibility to the user, 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 a generic UR relay involved in this process are shown below.

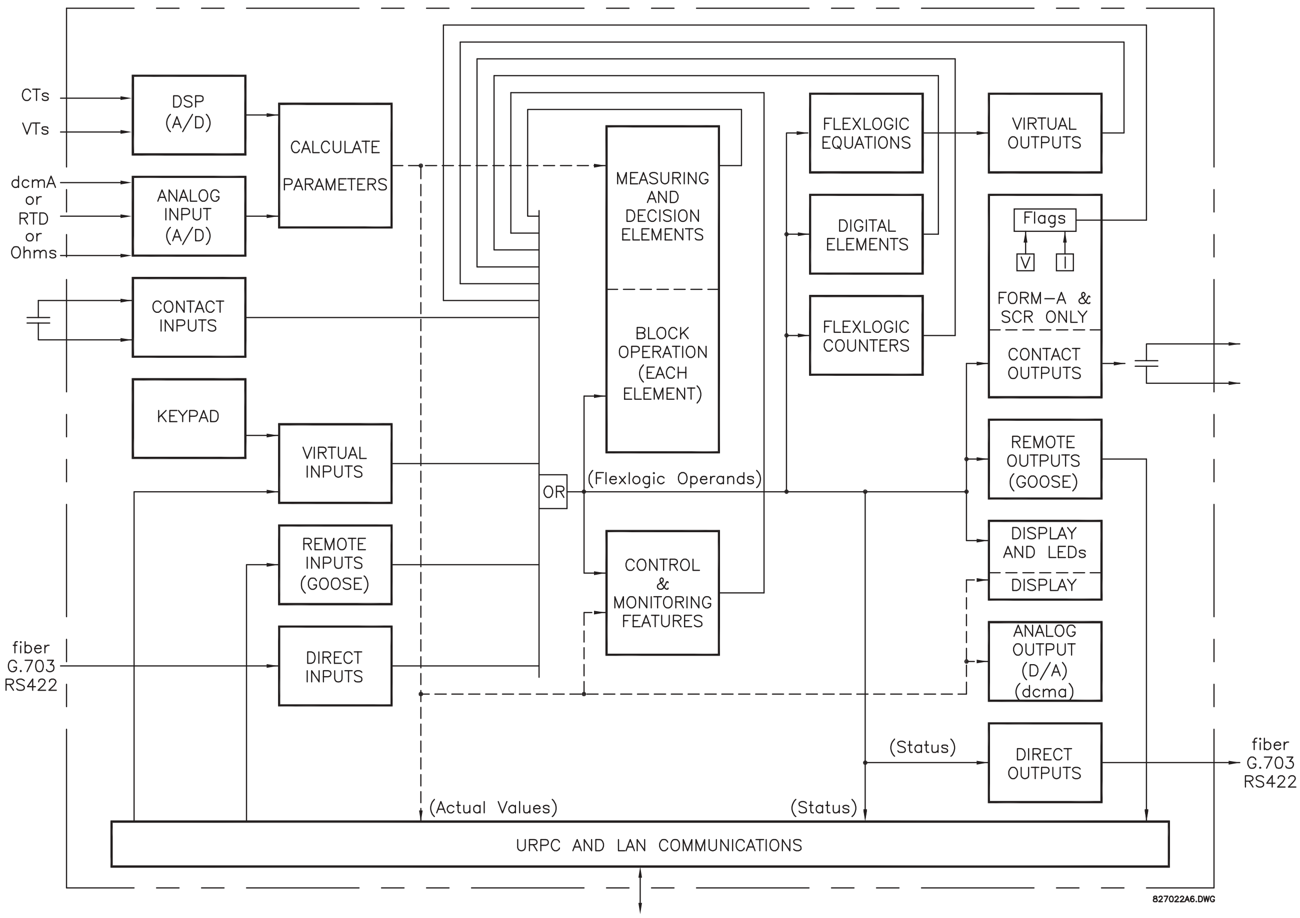

Figure 5–11: UR ARCHITECTURE OVERVIEW

The states of all digital signals used in the UR are represented by flags (or FlexLogic™ operands, which are described later in this section). A digital "1" is represented by a 'set' flag. Any external contact change-of-state can be used to block an element from operating, as an input to a control feature in 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 a simple scheme where a contact input is used to block an element is desired, this selection is made when programming the element. This capability also applies to the other features that set flags: elements, virtual inputs, remote inputs, schemes, and human operators.

If more complex logic than presented above is required, it is implemented via 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 control input states are programmed in a FlexLogic™ equation. This equation ANDs the two control 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 hard-wired using contact inputs and outputs. FlexLogic™ minimizes the requirement for auxiliary components and wiring while making more complex schemes possible.

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The logic that determines the interaction of inputs, elements, schemes and outputs is field programmable through the use of logic equations 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 that consist of operators and operands. The operands are the states of inputs, elements, schemes 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 that generates the output, as a seal-in or other type of feedback.

A FlexLogic™ equation consists of parameters that are either operands or operators. Operands have a logic state of 1 or 0. Operators provide a defined function, such as an AND gate or a 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.

Some types of operands are present in the relay in multiple instances; e.g. contact and remote inputs. These types of operands are grouped together (for presentation purposes only) on the faceplate display. The characteristics of the different types of operands are listed in the table below.

Table 5–3: UR FLEXLOGIC™ OPERAND TYPES

OPERAND TYPE	STATE	EXAMPLE FORMAT	CHARACTERISTICS [INPUT IS '1' (= ON) IF...]
Contact Input	On	Cont Ip On	Voltage is presently applied to the input (external contact closed).
	Off	Cont Ip Off	Voltage is presently not applied to the input (external contact open).
Contact Output (type Form-A contact only)	Voltage On	Cont Op 1 VOn	Voltage exists across the contact.
	Voltage Off	Cont Op 1 VOff	Voltage does not exists across the contact.
	Current On	Cont Op 1 IOn	Current is flowing through the contact.
	Current Off	Cont Op 1 IOff	Current is not flowing through the contact.
Direct Input	On	DIRECT INPUT 1 On	The direct input is presently in the ON state.
Element (Digital)	Pickup	Dig Element 1 PKP	The input operand is at logic 1.
	Dropout	Dig Element 1 DPO	This operand is the logical inverse of the above PKP operand.
	Operate	Dig Element 1 OP	The input operand has been at logic 1 for the programmed pickup delay time, or has been at logic 1 for this period and is now at logic 0 but the reset timer has not finished timing.
Element (Digital Counter)	Higher than	Counter 1 HI	The number of pulses counted is above the set number.
	Equal to	Counter 1 EQL	The number of pulses counted is equal to the set number.
	Lower than	Counter 1 LO	The number of pulses counted is below the set number.
Fixed	On	On	Logic 1
	Off	Off	Logic 0
Remote Input	On	REMOTE INPUT 1 On	The remote input is presently in the ON state.
Virtual Input	On	Virt Ip 1 On	The virtual input is presently in the ON state.
Virtual Output	On	Virt Op 1 On	The virtual output is presently in the set state (i.e. evaluation of the equation which produces this virtual output results in a "1").

The operands available for this relay are listed alphabetically by types in the following table.

Table 5–4: C30 FLEXLOGIC™ OPERANDS (Sheet 1 of 2)

OPERAND TYPE	OPERAND SYNTAX	OPERAND DESCRIPTION
CONTROL PUSHBUTTONS	CONTROL PUSHBTN n ON	Control Pushbutton *n* (*n* = 1 to 3) is being pressed.
DIRECT DEVICES	DIRECT DEVICE 1 On ↓ DIRECT DEVICE 8 On DIRECT DEVICE 1 Off ↓ DIRECT DEVICE 8 Off	Flag is set, logic=1 ↓ Flag is set, logic=1 Flag is set, logic=1 ↓ Flag is set, logic=1
DIRECT I/O CHANNEL MONITORING	DIR IO CH1(2) CRC ALARM DIR IO CRC ALARM DIR IO CH1(2) UNRET ALM DIR IO UNRET ALM	The rate of Direct Input messages received on Channel 1(2) and failing the CRC exceeded the user-specified level. The rate of Direct Input messages failing the CRC exceeded the user-specified level on Channel 1 or 2. The rate of returned Direct I/O messages on Channel 1(2) exceeded the user-specified level (ring configurations only). The rate of returned Direct I/O messages exceeded the user-specified level on Channel 1 or 2 (ring configurations only).
ELEMENT: Digital Counter	Counter 1 HI Counter 1 EQL Counter 1 LO ↓ Counter 8 HI Counter 8 EQL Counter 8 LO	Digital Counter 1 output is ‘more than’ comparison value Digital Counter 1 output is ‘equal to’ comparison value Digital Counter 1 output is ‘less than’ comparison value ↓ Digital Counter 8 output is ‘more than’ comparison value Digital Counter 8 output is ‘equal to’ comparison value Digital Counter 8 output is ‘less than’ comparison value
ELEMENT: Digital Element	Dig Element 1 PKP Dig Element 1 OP Dig Element 1 DPO ↓ Dig Element 16 PKP Dig Element 16 OP Dig Element 16 DPO	Digital Element 1 is picked up Digital Element 1 is operated Digital Element 1 is dropped out ↓ Digital Element 16 is picked up Digital Element 16 is operated Digital Element 16 is dropped out
ELEMENT: FlexElements™	FxE 1 PKP FxE 1 OP FxE 1 DPO ↓ FxE 8 PKP FxE 8 OP FxE 8 DPO	FlexElement™ 1 has picked up FlexElement™ 1 has operated FlexElement™ 1 has dropped out ↓ FlexElement™ 8 has picked up FlexElement™ 8 has operated FlexElement™ 8 has dropped out
ELEMENT Non-Volatile Latches	LATCH 1 ON LATCH 1 OFF ↓ LATCH 16 ON LATCH 16 OFF	Non-Volatile Latch 1 is ON (Logic = 1) Non-Voltage Latch 1 is OFF (Logic = 0) ↓ Non-Volatile Latch 16 is ON (Logic = 1) Non-Voltage Latch 16 is OFF (Logic = 0)
ELEMENT: Selector Switch	SELECTOR 1 POS Y SELECTOR 1 BIT 0 SELECTOR 1 BIT 1 SELECTOR 1 BIT 2 SELECTOR 1 STP ALARM SELECTOR 1 BIT ALARM SELECTOR 1 ALARM SELECTOR 1 PWR ALARM	Selector Switch 1 is in Position Y (mutually exclusive operands). First bit of the 3-bit word encoding position of Selector 1. Second bit of the 3-bit word encoding position of Selector 1. Third bit of the 3-bit word encoding position of Selector 1. Position of Selector 1 has been pre-selected with the stepping up control input but not acknowledged. Position of Selector 1 has been pre-selected with the 3-bit control input but not acknowledged. Position of Selector 1 has been pre-selected but not acknowledged. Position of Selector Switch 1 is undetermined when the relay powers up and synchronizes to the 3-bit input.
	SELECTOR 2	Same set of operands as shown above for SELECTOR 1
FIXED OPERANDS	Off	Logic = 0. Does nothing and may be used as a delimiter in an equation list; used as ‘Disable’ by other features.
	On	Logic = 1. Can be used as a test setting.
INPUTS/OUTPUTS: Contact Inputs	Cont Ip 1 On Cont Ip 2 On ↓ Cont Ip 1 Off Cont Ip 2 Off ↓	(will not appear unless ordered) (will not appear unless ordered) ↓ (will not appear unless ordered) (will not appear unless ordered) ↓

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Table 5–4: C30 FLEXLOGIC™ OPERANDS (Sheet 2 of 2)

OPERAND TYPE	OPERAND SYNTAX	OPERAND DESCRIPTION
INPUTS/OUTPUTS: Contact Outputs, Current (from detector on Form-A output only)	Cont Op 1 IOn Cont Op 2 IOn ↓	(will not appear unless ordered) (will not appear unless ordered) ↓
	Cont Op 1 IOff Cont Op 2 IOff ↓	(will not appear unless ordered) (will not appear unless ordered) ↓
INPUTS/OUTPUTS: Contact Outputs, Voltage (from detector on Form-A output only)	Cont Op 1 VOn Cont Op 2 VOn ↓	(will not appear unless ordered) (will not appear unless ordered) ↓
	Cont Op 1 VOff Cont Op 2 VOff ↓	(will not appear unless ordered) (will not appear unless ordered) ↓
INPUTS/OUTPUTS Direct Inputs	DIRECT INPUT 1 On ↓ DIRECT INPUT 32 On	Flag is set, logic=1 ↓ Flag is set, logic=1
INPUTS/OUTPUTS: Remote Inputs	REMOTE INPUT 1 On ↓ REMOTE INPUT 32 On	Flag is set, logic=1 ↓ Flag is set, logic=1
INPUTS/OUTPUTS: Virtual Inputs	Virt Ip 1 On ↓ Virt Ip 32 On	Flag is set, logic=1 ↓ Flag is set, logic=1
INPUTS/OUTPUTS: Virtual Outputs	Virt Op 1 On ↓ Virt Op 64 On	Flag is set, logic=1 ↓ Flag is set, logic=1
LED TEST	LED TEST IN PROGRESS	An LED test has been initiated and has not finished.
REMOTE DEVICES	REMOTE DEVICE 1 On ↓ REMOTE DEVICE 16 On	Flag is set, logic=1 ↓ Flag is set, logic=1
	REMOTE DEVICE 1 Off ↓ REMOTE DEVICE 16 Off	Flag is set, logic=1 ↓ Flag is set, logic=1
RESETTING	RESET OP RESET OP (COMMS) RESET OP (OPERAND) RESET OP (PUSHBUTTON)	Reset command is operated (set by all 3 operands below) Communications source of the reset command Operand (assigned in the **INPUTS/OUTPUTS** ⇨⇩ **RESETTING** menu) source of the reset command Reset key (pushbutton) source of the reset command
SELF-DIAGNOSTICS	ANY MAJOR ERROR ANY MINOR ERROR ANY SELF-TEST BATTERY FAIL DIRECT DEVICE OFF DIRECT RING BREAK DSP ERROR EEPROM DATA ERROR EQUIPMENT MISMATCH FLEXLOGIC ERR TOKEN IRIG-B FAILURE LATCHING OUT ERROR LOW ON MEMORY NO DSP INTERRUPTS PRI ETHERNET FAIL PROGRAM MEMORY PROTOTYPE FIRMWARE REMOTE DEVICE OFF SEC ETHERNET FAIL SNTP FAILURE SYSTEM EXCEPTION UNIT NOT CALIBRATED UNIT NOT PROGRAMMED WATCHDOG ERROR	Any of the major self-test errors generated (major error) Any of the minor self-test errors generated (minor error) Any self-test errors generated (generic, any error) See description in Chapter 7: Commands and Targets.
UNAUTHORIZED ACCESS ALARM	UNAUTHORIZED ACCESS	Asserted when a password entry fails while accessing a password-protected level of the relay.
USER-PROGRAMMABLE PUSHBUTTONS	PUSHBUTTON x ON PUSHBUTTON x OFF	Pushbutton Number x is in the 'On' position Pushbutton Number x is in the 'Off' position

Some operands can be re-named by the user. These are the names of the breakers in the breaker control feature, the ID (identification) of contact inputs, the ID of virtual inputs, and the ID of virtual outputs. If the user changes the default name/ID of any of these operands, the assigned name will appear in the relay list of operands. The default names are shown in the FlexLogic™ Operands table above.

The characteristics of the logic gates are tabulated below, and the operators available in FlexLogic™ are listed in the Flex-Logic™ Operators table.

Table 5–5: 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 5–6: FLEXLOGIC™ OPERATORS

TYPE	SYNTAX	DESCRIPTION	NOTES
Editor	INSERT	Insert a parameter in an equation list.	
	DELETE	Delete a parameter from an equation list.	
End	END	The first END encountered signifies the last entry in the list of processed FlexLogic™ parameters.	
One Shot	POSITIVE ONE SHOT	One shot that responds to a positive going edge.	A ‘one shot’ refers to a single input gate that generates a pulse in response to an edge on the input. The output from a ‘one shot’ is True (positive) for only one pass through the FlexLogic™ equation. There is a maximum of 32 ‘one shots’.
	NEGATIVE ONE SHOT	One shot that responds to a negative going edge.	
	DUAL ONE SHOT	One shot that responds to both the positive and negative going edges.	
Logic Gate	NOT	Logical Not	Operates on the previous parameter.
	OR(2) ↓ OR(16)	2 input OR gate ↓ 16 input OR gate	Operates on the 2 previous parameters. ↓ Operates on the 16 previous parameters.
	AND(2) ↓ AND(16)	2 input AND gate ↓ 16 input AND gate	Operates on the 2 previous parameters. ↓ Operates on the 16 previous parameters.
	NOR(2) ↓ NOR(16)	2 input NOR gate ↓ 16 input NOR gate	Operates on the 2 previous parameters. ↓ Operates on the 16 previous parameters.
	NAND(2) ↓ NAND(16)	2 input NAND gate ↓ 16 input NAND gate	Operates on the 2 previous parameters. ↓ Operates on the 16 previous parameters.
	XOR(2)	2 input Exclusive OR gate	Operates on the 2 previous parameters.
	LATCH (S,R)	Latch (Set, Reset) - reset-dominant	The parameter preceding LATCH(S,R) is the Reset input. The parameter preceding the Reset input is the Set input.
Timer	TIMER 1 ↓ TIMER 32	Timer set with FlexLogic™ Timer 1 settings. ↓ Timer set with FlexLogic™ Timer 32 settings.	The timer is started by the preceding parameter. The output of the timer is TIMER #.
Assign Virtual Output	= Virt Op 1 ↓ = Virt Op 64	Assigns previous FlexLogic™ parameter to Virtual Output 1. ↓ Assigns previous FlexLogic™ parameter to Virtual Output 64.	The virtual output is set by the preceding parameter

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5.3.2 FLEXLOGIC™ RULES

When forming a FlexLogic™ equation, the sequence in the linear array of parameters must follow these general rules:

1. Operands must precede the operator which uses the operands as inputs.
2. Operators have only one output. The output of an operator must be used to create a virtual output if it is to be used as an input to two or more operators.
3. Assigning the output of an operator to a Virtual Output terminates the equation.
4. A timer operator (e.g. "TIMER 1") or virtual output assignment (e.g. " = Virt Op 1") may only be used once. If this rule is broken, a syntax error will be declared.

5.3.3 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. However, they are *volatile*; i.e. they reset on the re-application of control power.

When making changes to settings, all FlexLogic™ equations are re-compiled whenever any new setting value is entered, so all latches are automatically reset. If it is necessary to re-initialize FlexLogic™ during testing, for example, it is suggested to power the unit down and then back up.

5.3.4 FLEXLOGIC™ EXAMPLE

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This section provides an example of implementing logic for a typical application. The sequence of the steps is quite important as it should minimize the work necessary to develop the relay settings. Note that the example presented in the figure below is intended to demonstrate the procedure, not to solve a specific application situation.

In the example below, it is assumed that logic has already been programmed to produce Virtual Outputs 1 and 2, and is only a part of the full set of equations used. When using FlexLogic™, it is important to make a note of each Virtual Output used – a Virtual Output designation (1 to 64) can only be properly assigned once.

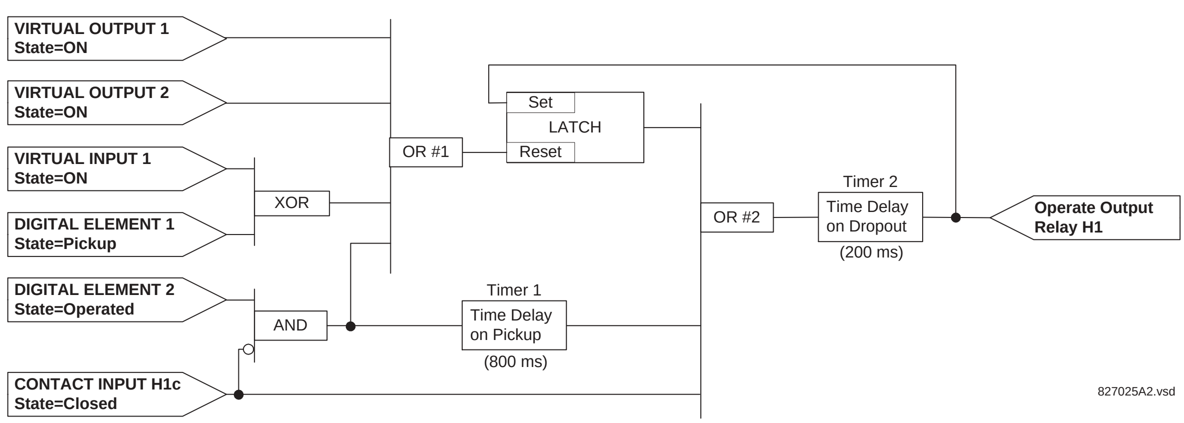

Figure 5–12: EXAMPLE LOGIC SCHEME

1. Inspect the example logic diagram to determine if the required logic can be implemented with the FlexLogic™ operators. If this is not possible, the logic must be altered until this condition is satisfied. Once this is done, count the inputs to each gate to verify that the number of inputs does not exceed the FlexLogic™ limits, 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 25 inputs to an AND gate are required, connect Inputs 1 through 16 to AND(16), 17 through 25 to AND(9), and the outputs from these two gates to 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 operator output must be assigned as a Virtual Output.

For the example shown above, 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 (i.e. Virtual Output 3). The final output must also be assigned to a Virtual Output as Virtual Output 4, which will be programmed in the contact output section to operate relay H1 (i.e. Output Contact H1).

Therefore, the required logic can be implemented with two FlexLogic™ equations with outputs of Virtual Output 3 and Virtual Output 4 as shown below.

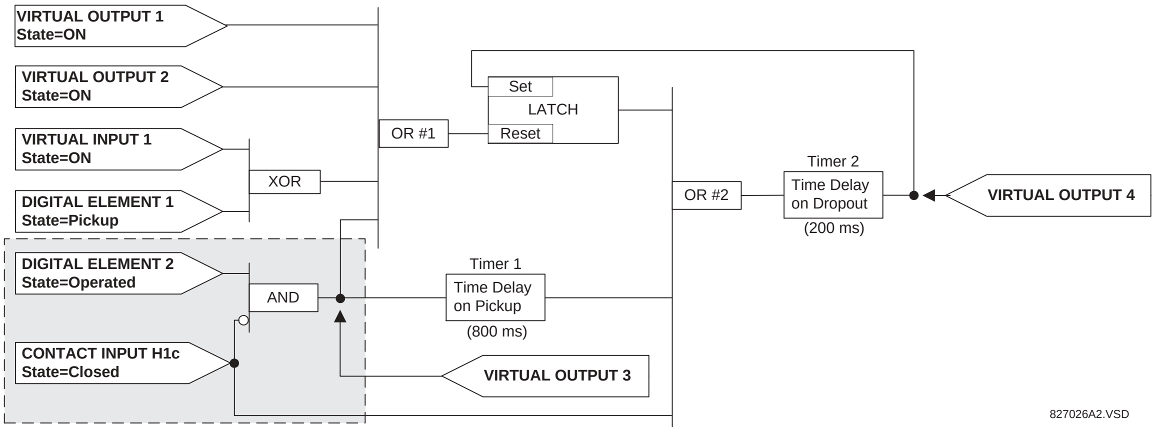

Figure 5–13: LOGIC EXAMPLE WITH VIRTUAL OUTPUTS

2. Prepare a logic diagram for the equation to produce Virtual Output 3, as this output will be used as an operand in the Virtual Output 4 equation (create the equation for every output that 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 below with the final output assigned.

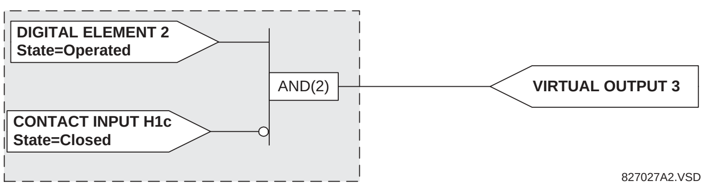

Figure 5–14: LOGIC FOR VIRTUAL OUTPUT 3

3. 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 below.

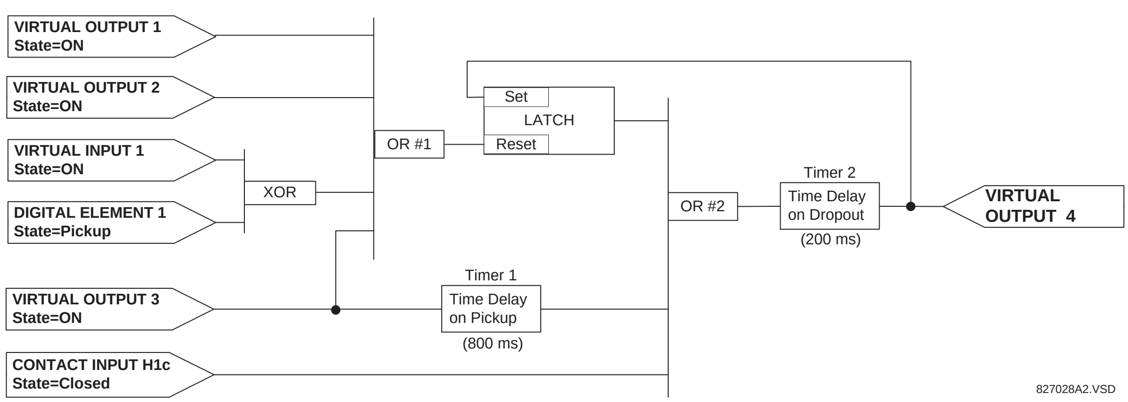

Figure 5–15: LOGIC FOR VIRTUAL OUTPUT 4

4. Program the FlexLogic™ equation for Virtual Output 3 by translating the logic into 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, as shown in the following steps. 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 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 below.

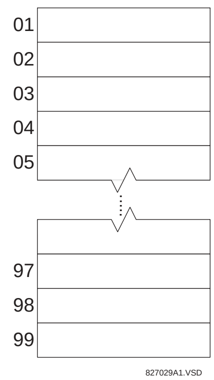

Figure 5–16: FLEXLOGIC™ WORKSHEET

5. Following the procedure outlined, start with parameter 99, as follows:

99: The final output of the equation is Virtual Output 3, which is created by the operator "= Virt Op n". This parameter is therefore "= Virt Op 3."

98: The gate preceding the output is an AND, which in this case requires two inputs. The operator for this gate is a 2-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 2-input AND will operate on the two operands preceding it, these inputs must be specified, 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 acts upon the operand immediately preceding it, so specify the inverter input next.

96: The input to the NOT gate is to be contact input H1c. The ON state of a contact input can be programmed to be set when the contact is either open or closed. Assume for this example the state is to be ON for a closed contact. The operand is therefore “Cont Ip H1c On”.

95: The last step in the procedure is to specify the upper input to the AND gate, the operated state of digital element 2. This operand is "DIG ELEM 2 OP".

Writing the parameters in numerical order can now form the equation for VIRTUAL OUTPUT 3:

```
[95] DIG ELEM 2 OP
[96] Cont Ip H1c On
[97] NOT
[98] AND(2)
[99] = Virt Op 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 below, which is compared to the Logic for Virtual Output 3 diagram as a check.

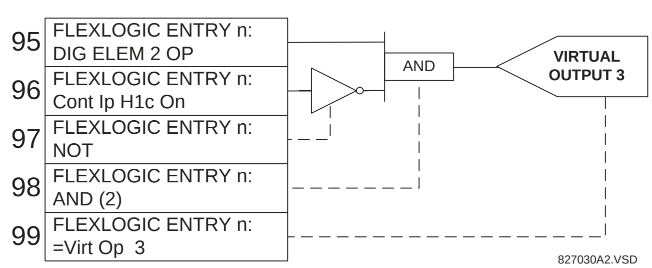

Figure 5–17: FLEXLOGIC™ EQUATION FOR VIRTUAL OUTPUT 3

6. Repeating the process described for VIRTUAL OUTPUT 3, select the FlexLogic™ parameters for Virtual Output 4.

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

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

97: The operator preceding Timer 2 is OR #2, a 3-input OR, which is parameter “OR(3)”.

96: The lowest input to OR #2 is operand “Cont Ip H1c On”.

95: The center input to OR #2 is operand “TIMER 1".

94: The input to Timer 1 is operand “Virt Op 3 On".

93: The upper input to OR #2 is operand “LATCH (S,R)”.

92: There are two inputs to a latch, and the input immediately preceding the latch reset is OR #1, a 4-input OR, which is parameter “OR(4)”.

91: The lowest input to OR #1 is operand “Virt Op 3 On".

90: The input just above the lowest input to OR #1 is operand “XOR(2)”.

89: The lower input to the XOR is operand “DIG ELEM 1 PKP”.

88: The upper input to the XOR is operand “Virt Ip 1 On".

87: The input just below the upper input to OR #1 is operand “Virt Op 2 On".

86: The upper input to OR #1 is operand “Virt Op 1 On".

85: The last parameter is used to set the latch, and is operand “Virt Op 4 On".

The equation for VIRTUAL OUTPUT 4 is:

```
[85] Virt Op 4 On
[86] Virt Op 1 On
[87] Virt Op 2 On
[88] Virt Ip 1 On
[89] DIG ELEM 1 PKP
[90] XOR(2)
[91] Virt Op 3 On
[92] OR(4)
[93] LATCH (S,R)
[94] Virt Op 3 On
[95] TIMER 1
[96] Cont Ip H1c On
[97] OR(3)
[98] TIMER 2
[99] = Virt Op 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 below, which is compared to the Logic for Virtual Output 4 diagram as a check.

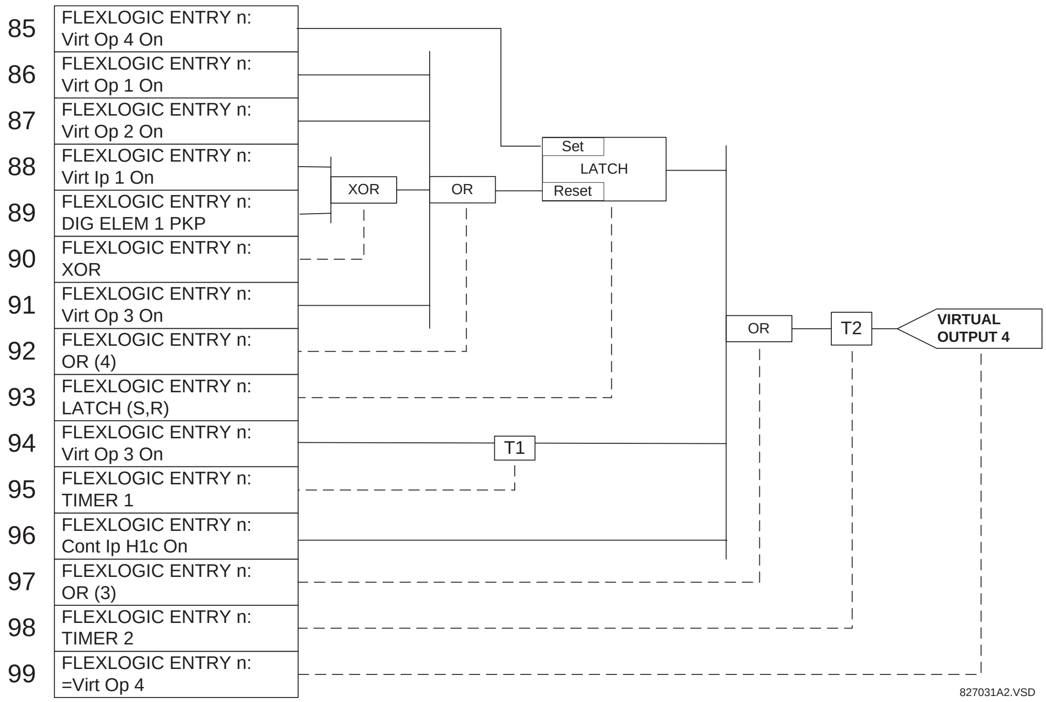

Figure 5–18: FLEXLOGIC™ EQUATION FOR VIRTUAL OUTPUT 4

7. Now write the complete FlexLogic™ expression required to implement the 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 logic, this may be difficult to achieve, but in most cases will not cause problems as all 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 equation, Virtual Output 3 is used as an input to both Latch 1 and Timer 1 as arranged in the order shown below:

```
DIG ELEM 2 OP
Cont Ip H1c On
NOT
AND(2)
= Virt Op 3
Virt Op 4 On
Virt Op 1 On
Virt Op 2 On
Virt Ip 1 On
DIG ELEM 1 PKP
XOR(2)
Virt Op 3 On
OR(4)
LATCH (S,R)
Virt Op 3 On
TIMER 1
Cont Ip H1c On
OR(3)
TIMER 2
= Virt Op 4
END
```

   In the expression above, the Virtual Output 4 input to the 4-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.

8. The logic should always be tested after it is loaded into the relay, in the same fashion as has been used in the past. Testing can be simplified by placing an "END" operator within the overall set of FlexLogic™ equations. The equations will then only be evaluated up to the first "END" operator.

   The "On" and "Off" operands can be placed in an equation to establish a known set of conditions for test purposes, and the "INSERT" and "DELETE" commands can be used to modify equations.

5.3.5 FLEXLOGIC™ EQUATION EDITOR

PATH: SETTINGS ⇨⇩ FLEXLOGIC ⇨ FLEXLOGIC EQUATION EDITOR

■ FLEXLOGIC ■ EQUATION EDITOR	◀▶	FLEXLOGIC ENTRY 1: END	*Range: FlexLogic™ parameters*
		↓	
MESSAGE	▲	FLEXLOGIC ENTRY 512: END	*Range: FlexLogic™ parameters*

There are 512 FlexLogic™ entries available, numbered from 1 to 512, with default 'END' entry settings. If a "Disabled" Element is selected as a FlexLogic™ entry, the associated state flag will never be set to '1'. The '+/–' key may be used when editing FlexLogic™ equations from the keypad to quickly scan through the major parameter types.

5.3.6 FLEXLOGIC™ TIMERS

PATH: SETTINGS ⇨⇩ FLEXLOGIC ⇨⇩ FLEXLOGIC TIMERS ⇨ FLEXLOGIC TIMER 1(32)

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

There are 32 identical FlexLogic™ timers available. These timers can be used as operators for FlexLogic™ equations.

- **TIMER 1 TYPE:** This setting is used to select the time measuring unit.
- **TIMER 1 PICKUP DELAY:** Sets the time delay to pickup. If a pickup delay is not required, set this function to "0".
- **TIMER 1 DROPOUT DELAY:** Sets the time delay to dropout. If a dropout delay is not required, set this function to "0".

5.3.7 FLEXELEMENTS™

PATH: SETTING ⇨⇩ FLEXLOGIC ⇨⇩ FLEXELEMENTS ⇨ FLEXELEMENT 1(8)

■ FLEXELEMENT 1 ■	FLEXELEMENT 1 FUNCTION: Disabled	Range: Disabled, Enabled
MESSAGE	FLEXELEMENT 1 NAME: FxE1	Range: up to 6 alphanumeric characters
MESSAGE	FLEXELEMENT 1 +IN Off	Range: Off, any analog actual value parameter
MESSAGE	FLEXELEMENT 1 -IN Off	Range: Off, any analog actual value parameter
MESSAGE	FLEXELEMENT 1 INPUT MODE: Signed	Range: Signed, Absolute
MESSAGE	FLEXELEMENT 1 COMP MODE: Level	Range: Level, Delta
MESSAGE	FLEXELEMENT 1 DIRECTION: Over	Range: Over, Under
MESSAGE	FLEXELEMENT 1 PICKUP: 1.000 pu	Range: –90.000 to 90.000 pu in steps of 0.001
MESSAGE	FLEXELEMENT 1 HYSTERESIS: 3.0%	Range: 0.1 to 50.0% in steps of 0.1
MESSAGE	FLEXELEMENT 1 dt UNIT: milliseconds	Range: milliseconds, seconds, minutes
MESSAGE	FLEXELEMENT 1 dt: 20	Range: 20 to 86400 in steps of 1
MESSAGE	FLEXELEMENT 1 PKP DELAY: 0.000 s	Range: 0.000 to 65.535 s in steps of 0.001
MESSAGE	FLEXELEMENT 1 RST DELAY: 0.000 s	Range: 0.000 to 65.535 s in steps of 0.001
MESSAGE	FLEXELEMENT 1 BLOCK: Off	Range: FlexLogic™ operand
MESSAGE	FLEXELEMENT 1 TARGET: Self-reset	Range: Self-reset, Latched, Disabled
MESSAGE	FLEXELEMENT 1 EVENTS: Disabled	Range: Disabled, Enabled

A FlexElement™ is a universal comparator that can be used to monitor any analog actual value calculated by the relay or a net difference of any two analog actual values of the same type. The effective operating signal could be treated as a signed number or its absolute value could be used as per user's choice.

The element can be programmed to respond either to a signal level or to a rate-of-change (delta) over a pre-defined period of time. The output operand is asserted when the operating signal is higher than a threshold or lower than a threshold as per user's choice.

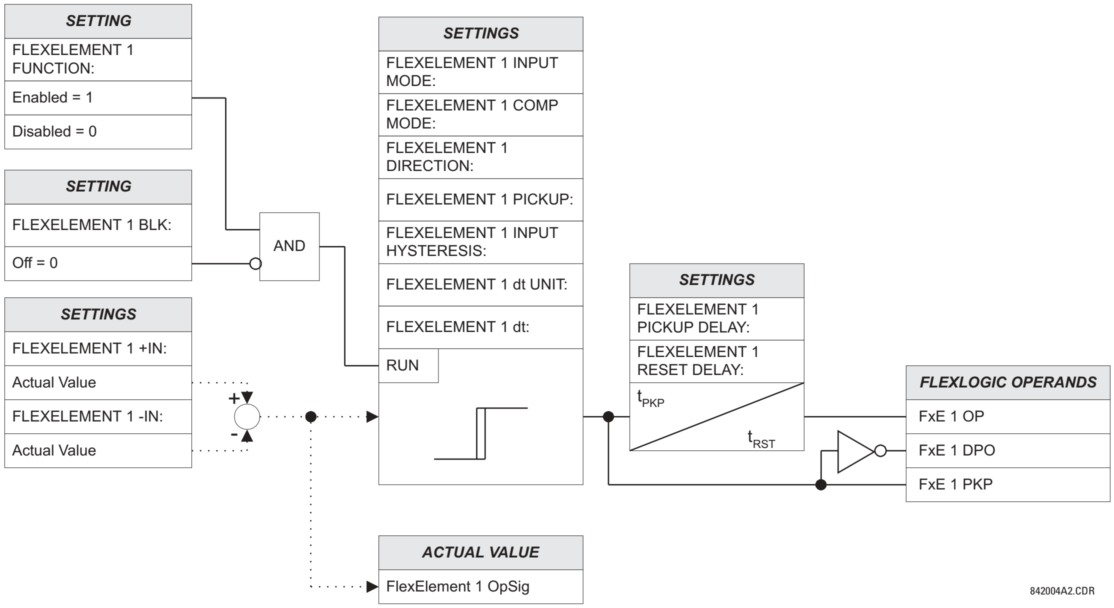

Figure 5–19: FLEXELEMENT™ SCHEME LOGIC

The **FLEXELEMENT 1 +IN** setting specifies the first (non-inverted) input to the FlexElement™. Zero is assumed as the input if this setting is set to "Off". For proper operation of the element at least one input must be selected. Otherwise, the element will not assert its output operands.

This **FLEXELEMENT 1 –IN** setting specifies the second (inverted) input to the FlexElement™. Zero is assumed as the input if this setting is set to "Off". For proper operation of the element at least one input must be selected. Otherwise, the element will not assert its output operands. This input should be used to invert the signal if needed for convenience, or to make the element respond to a differential signal such as for a top-bottom oil temperature differential alarm. The element will not operate if the two input signals are of different types, for example if one tries to use active power and phase angle to build the effective operating signal.

The element responds directly to the differential signal if the **FLEXELEMENT 1 INPUT MODE** setting is set to "Signed". The element responds to the absolute value of the differential signal if this setting is set to "Absolute". Sample applications for the "Absolute" setting include monitoring the angular difference between two phasors with a symmetrical limit angle in both directions; monitoring power regardless of its direction, or monitoring a trend regardless of whether the signal increases of decreases.

The element responds directly to its operating signal – as defined by the **FLEXELEMENT 1 +IN**, **FLEXELEMENT 1 –IN** and **FLEXELEMENT 1 INPUT MODE** settings – if the **FLEXELEMENT 1 COMP MODE** setting is set to "Threshold". The element responds to the rate of change of its operating signal if the **FLEXELEMENT 1 COMP MODE** setting is set to "Delta". In this case the **FLEXELEMENT 1 dt UNIT** and **FLEXELEMENT 1 dt** settings specify how the rate of change is derived.

The **FLEXELEMENT 1 DIRECTION** setting enables the relay to respond to either high or low values of the operating signal. The following figure explains the application of the **FLEXELEMENT 1 DIRECTION**, **FLEXELEMENT 1 PICKUP** and **FLEXELEMENT 1 HYSTERESIS** settings.

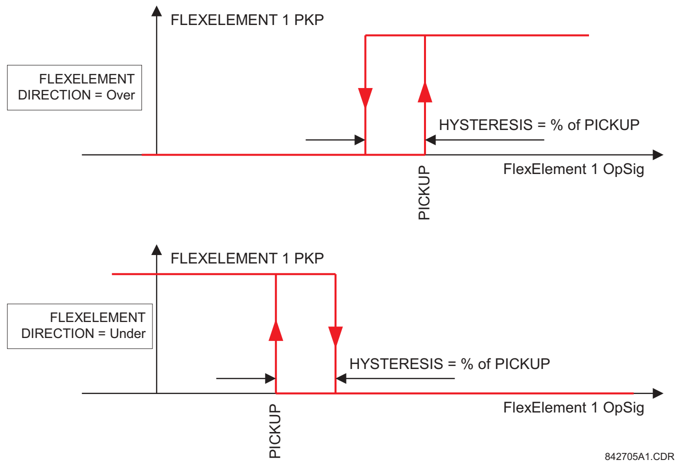

Figure 5–20: FLEXELEMENT™ DIRECTION, PICKUP, AND HYSTERESIS

In conjunction with the **FLEXELEMENT 1 INPUT MODE** setting the element could be programmed to provide two extra characteristics as shown in the figure below.

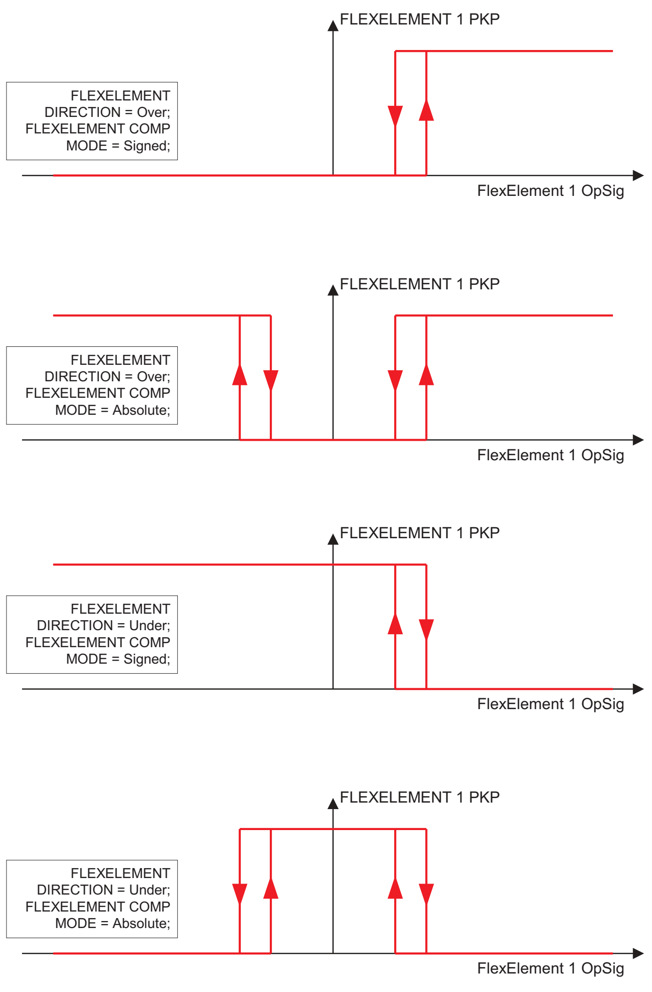

Figure 5–21: FLEXELEMENT™ INPUT MODE SETTING

The **FLEXELEMENT 1 PICKUP** setting specifies the operating threshold for the effective operating signal of the element. If set to “Over”, the element picks up when the operating signal exceeds the **FLEXELEMENT 1 PICKUP** value. If set to “Under”, the element picks up when the operating signal falls below the **FLEXELEMENT 1 PICKUP** value.

The **FLEXELEMENT 1 HYSTERESIS** setting controls the element dropout. It should be noticed that both the operating signal and the pickup threshold can be negative facilitating applications such as reverse power alarm protection. The FlexElement™ can be programmed to work with all analog actual values measured by the relay. The **FLEXELEMENT 1 PICKUP** setting is entered in pu values using the following definitions of the base units:

Table 5–7: FLEXELEMENT™ BASE UNITS

dcmA	BASE = maximum value of the **DCMA INPUT MAX** setting for the two transducers configured under the +IN and –IN inputs.
FREQUENCY	f_{BASE} = 1 Hz
PHASE ANGLE	φ_{BASE} = 360 degrees (see the UR angle referencing convention)
POWER FACTOR	PF_{BASE} = 1.00
RTDs	BASE = 100°C
SOURCE CURRENT	I_{BASE} = maximum nominal primary RMS value of the +IN and –IN inputs
SOURCE POWER	P_{BASE} = maximum value of $V_{BASE} \times I_{BASE}$ for the +IN and –IN inputs
SOURCE VOLTAGE	V_{BASE} = maximum nominal primary RMS value of the +IN and –IN inputs

The **FLEXELEMENT 1 HYSTERESIS** setting defines the pickup–dropout relation of the element by specifying the width of the hysteresis loop as a percentage of the pickup value as shown in the FlexElement™ Direction, Pickup, and Hysteresis diagram.

The **FLEXELEMENT 1 DT UNIT** setting specifies the time unit for the setting **FLEXELEMENT 1 dt**. This setting is applicable only if **FLEXELEMENT 1 COMP MODE** is set to “Delta”. The **FLEXELEMENT 1 DT** setting specifies duration of the time interval for the rate of change mode of operation. This setting is applicable only if **FLEXELEMENT 1 COMP MODE** is set to “Delta”.

This **FLEXELEMENT 1 PKP DELAY** setting specifies the pickup delay of the element. The **FLEXELEMENT 1 RST DELAY** setting specifies the reset delay of the element.

5.3.8 NON-VOLATILE LATCHES

PATH: SETTINGS ⇨⇩ FLEXLOGIC ⇨⇩ NON-VOLATILE LATCHES ⇨ LATCH 1(16)

		Range
■ LATCH 1 ■	LATCH 1 FUNCTION: Disabled	Range: *Self-Reset, Latched, Disabled*
MESSAGE	LATCH 1 TYPE: Reset Dominant	Range: *Reset Dominant, Set Dominant*
MESSAGE	LATCH 1 SET: Off	Range: *FlexLogic™ operand*
MESSAGE	LATCH 1 RESET: Off	Range: *FlexLogic™ operand*
MESSAGE	LATCH 1 TARGET: Self-reset	Range: *Self-reset, Latched, Disabled*
MESSAGE	LATCH 1 EVENTS: Disabled	Range: *Disabled, Enabled*

The non-volatile latches provide a permanent logical flag that is stored safely and will not reset upon reboot after the relay is powered down. Typical applications include sustaining operator commands or permanently block relay functions, such as Autorecloser, until a deliberate HMI action resets the latch. The settings, logic, and element operation are described below:

- **LATCH 1 TYPE**: This setting characterizes Latch 1 to be Set- or Reset-dominant.
- **LATCH 1 SET**: If asserted, the specified FlexLogic™ operands 'sets' Latch 1.
- **LATCH 1 RESET**: If asserted, the specified FlexLogic™ operand 'resets' Latch 1.

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LATCH N TYPE	LATCH N SET	LATCH N RESET	LATCH N ON	LATCH N OFF
Reset Dominant	ON	OFF	ON	OFF
	OFF	OFF	Previous State	Previous State
	ON	ON	OFF	ON
	OFF	ON	OFF	ON
Set Dominant	ON	OFF	ON	OFF
	ON	ON	ON	OFF
	OFF	OFF	Previous State	Previous State
	OFF	ON	OFF	ON

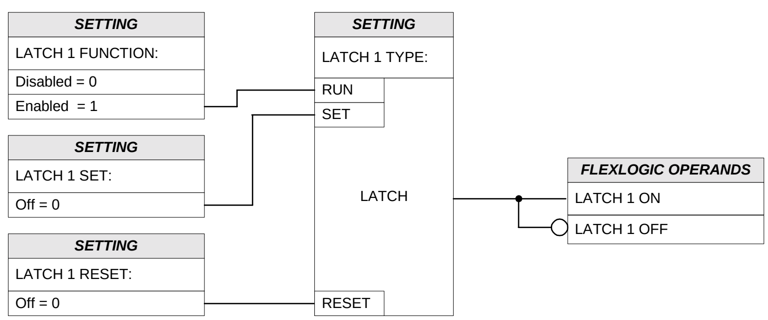


Figure 5–22: NON-VOLATILE LATCH OPERATION TABLE (N=1 TO 16) AND LOGIC

5.4.1 OVERVIEW

Control elements are generally used for control rather than protection. See the Introduction to Elements section at the beginning of this chapter for further information.

5.4.2 SETTING GROUPS

NOTE

Although the Settings Groups menu is displayed, this version of the C30 does not use the Setting Groups feature since there are no DSP functions. As such, the Setting Groups functions do not operate at this time.

5.4.3 SELECTOR SWITCH

PATH: SETTINGS ⇨⇩ CONTROL ELEMENTS ⇨⇩ SELECTOR SWITCH ⇨ SELECTOR SWITCH 1(2)

■ SELECTOR SWITCH 1 ■	SELECTOR 1 FUNCTION: Disabled	Range: Disabled, Enabled
MESSAGE	SELECTOR 1 FULL RANGE: 7	Range: 1 to 7 in steps of 1
MESSAGE	SELECTOR 1 TIME-OUT: 5.0 s	Range: 3.0 to 60.0 s in steps of 0.1
MESSAGE	SELECTOR 1 STEP-UP: Off	Range: FlexLogic™ operand
MESSAGE	SELECTOR 1 STEP-UP MODE: Time-out	Range: Time-out, Acknowledge
MESSAGE	SELECTOR 1 ACK: Off	Range: FlexLogic™ operand
MESSAGE	SELECTOR 1 3BIT A0: Off	Range: FlexLogic™ operand
MESSAGE	SELECTOR 1 3BIT A1: Off	Range: FlexLogic™ operand
MESSAGE	SELECTOR 1 3BIT A2: Off	Range: FlexLogic™ operand
MESSAGE	SELECTOR 1 3BIT MODE: Time-out	Range: Time-out, Acknowledge
MESSAGE	SELECTOR 1 3BIT ACK: Off	Range: FlexLogic™ operand
MESSAGE	SELECTOR 1 POWER-UP MODE: Restore	Range: Restore, Synchronize
MESSAGE	SELECTOR 1 TARGETS: Disabled	Range: Disabled, Enabled
MESSAGE	SELECTOR 1 EVENTS: Disabled	Range: Disabled, Enabled

The Selector Switch element is intended to replace a mechanical selector switch. Typical applications include setting group control or control of multiple logic sub-circuits in user-programmable logic.

The element provides for two control inputs. The step-up control allows stepping through selector position one step at a time with each pulse of the control input, such as a user-programmable pushbutton. The 3-bit control input allows setting the selector to the position defined by a 3-bit word.

The element allows pre-selecting a new position without applying it. The pre-selected position gets applied either after time-out or upon acknowledgement via separate inputs (user setting). The selector position is stored in non-volatile memory. Upon power-up, either the previous position is restored or the relay synchronizes to the current 3-bit word (user setting). Basic alarm functionality alerts the user under abnormal conditions; e.g. the 3-bit control input being out of range.

- **SELECTOR 1 FULL RANGE**: This setting defines the upper position of the selector. When stepping up through available positions of the selector, the upper position wraps up to the lower position (Position 1). When using a direct 3-bit control word for programming the selector to a desired position, the change would take place only if the control word is within the range of 1 to the **SELECTOR FULL RANGE**. If the control word is outside the range, an alarm is established by setting the SELECTOR ALARM FlexLogic™ operand for 3 seconds.
- **SELECTOR 1 TIME-OUT:** This setting defines the time-out period for the selector. This value is used by the relay in the following two ways. When the **SELECTOR STEP-UP MODE** is “Time-out”, the setting specifies the required period of inactivity of the control input after which the pre-selected position is automatically applied. When the **SELECTOR STEP-UP MODE** is “Acknowledge”, the setting specifies the period of time for the acknowledging input to appear. The timer is re-started by any activity of the control input. The acknowledging input must come before the **SELECTOR 1 TIME-OUT** timer expires; otherwise, the change will not take place and an alarm will be set.
- **SELECTOR 1 STEP-UP**: This setting specifies a control input for the selector switch. The switch is shifted to a new position at each rising edge of this signal. The position changes incrementally, wrapping up from the last (**SELECTOR 1 FULL RANGE**) to the first (Position 1). Consecutive pulses of this control operand must not occur faster than every 50 ms. After each rising edge of the assigned operand, the time-out timer is restarted and the **SELECTOR 1 CHANGE FROM *Y* TO Z** target message is displayed, where ***Y*** is the present position and ***Z*** the pre-selected position. The message is displayed for the time specified by the **FLASH MESSAGE TIME** setting. The pre-selected position is applied after the selector times out (“Time-out” mode), or when the acknowledging signal appears before the element times out (“Acknowledge” mode). When the new position is applied, the relay displays the **SELECTOR 1 CHANGE FROM *Y* TO Z** message. Typically, a user-programmable pushbutton is configured as the stepping up control input.

5

- **SELECTOR 1 STEP-UP MODE**: This setting defines the selector mode of operation. When set to “Time-out”, the selector will change its position after a pre-defined period of inactivity at the control input. The change is automatic and does not require any explicit confirmation of the intent to change the selector's position. When set to “Acknowledge”, the selector will change its position only after the intent is confirmed through a separate acknowledging signal. If the acknowledging signal does not appear within a pre-defined period of time, the selector does not accept the change and an alarm is established by setting the SELECTOR STP ALARM output FlexLogic™ operand for 3 seconds.
- **SELECTOR 1 ACK**: This setting specifies an acknowledging input for the stepping up control input. The pre-selected position is applied on the rising edge of the assigned operand. This setting is active only under “Acknowledge” mode of operation. The acknowledging signal must appear within the time defined by the **SELECTOR 1 TIME-OUT** setting after the last activity of the control input. A user-programmable pushbutton is typically configured as the acknowledging input.
- **SELECTOR 1 3BIT A0, A1, and A2**: These settings specify a 3-bit control input of the selector. The 3-bit control word pre-selects the position using the following encoding convention:

A2	A1	A0	POSITION
0	0	0	rest
0	0	1	1
0	1	0	2
0	1	1	3
1	0	0	4
1	0	1	5
1	1	0	6
1	1	1	7

The “rest” position (0, 0, 0) does not generate an action and is intended for situations when the device generating the 3-bit control word is having a problem. When **SELECTOR 1 3BIT MODE** is “Time-out”, the pre-selected position is applied in **SELECTOR 1 TIME-OUT** seconds after the last activity of the 3-bit input. When **SELECTOR 1 3BIT MODE** is “Acknowledge”, the pre-selected position is applied on the rising edge of the **SELECTOR 1 3BIT ACK** acknowledging input.

The stepping up control input (**SELECTOR 1 STEP-UP**) and the 3-bit control inputs (**SELECTOR 1 3BIT A0** through **A2**) lockout mutually: once the stepping up sequence is initiated, the 3-bit control input is inactive; once the 3-bit control sequence is initiated, the stepping up input is inactive.

- **SELECTOR 1 3BIT MODE**: This setting defines the selector mode of operation. When set to “Time-out”, the selector changes its position after a pre-defined period of inactivity at the control input. The change is automatic and does not require explicit confirmation to change the selector position. When set to “Acknowledge”, the selector changes its position only after confirmation via a separate acknowledging signal. If the acknowledging signal does not appear within a pre-defined period of time, the selector rejects the change and an alarm established by invoking the SELECTOR BIT ALARM FlexLogic™ operand for 3 seconds.
- **SELECTOR 1 3BIT ACK**: This setting specifies an acknowledging input for the 3-bit control input. The pre-selected position is applied on the rising edge of the assigned FlexLogic™ operand. This setting is active only under the “Acknowledge” mode of operation. The acknowledging signal must appear within the time defined by the **SELECTOR TIME-OUT** setting after the last activity of the 3-bit control inputs. Note that the stepping up control input and 3-bit control input have independent acknowledging signals (**SELECTOR 1 ACK** and **SELECTOR 1 3BIT ACK**, accordingly).
- **SELECTOR 1 POWER-UP MODE**: This setting specifies behavior of the element on power up of the relay. When set to “Restore”, the last selector position, stored in non-volatile memory, is restored after powering up the relay. When set to “Synchronize”, the selector sets to the current 3-bit control input after powering up the relay. This operation does not wait for time-out or the acknowledging input. When powering up, the rest position (0, 0, 0) and the out-of-range 3-bit control words are also ignored, the output is set to Position 0 (no output operand selected), and an alarm is established (SELECTOR 1 PWR ALARM). If the position restored from memory is out-of-range, Position 0 (no output operand selected) is applied and an alarm is set (SELECTOR 1 PWR ALARM).
- **SELECTOR 1 EVENTS**: If enabled, the following events are logged:

EVENT NAME	DESCRIPTION
SELECTOR 1 CHANGED FROM *Y* TO *Z*	Selector 1 changed its position to from Y to Z.
SELECTOR 1 STEP-UP ALARM	The selector position pre-selected via the stepping up control input has not been confirmed before the time out.
SELECTOR 1 3-BIT ALARM	The selector position pre-selected via the 3-bit control input has not been confirmed before the time out.

The following figures illustrate the operation of the Selector Switch. In these diagrams, “T” represents a time-out setting.

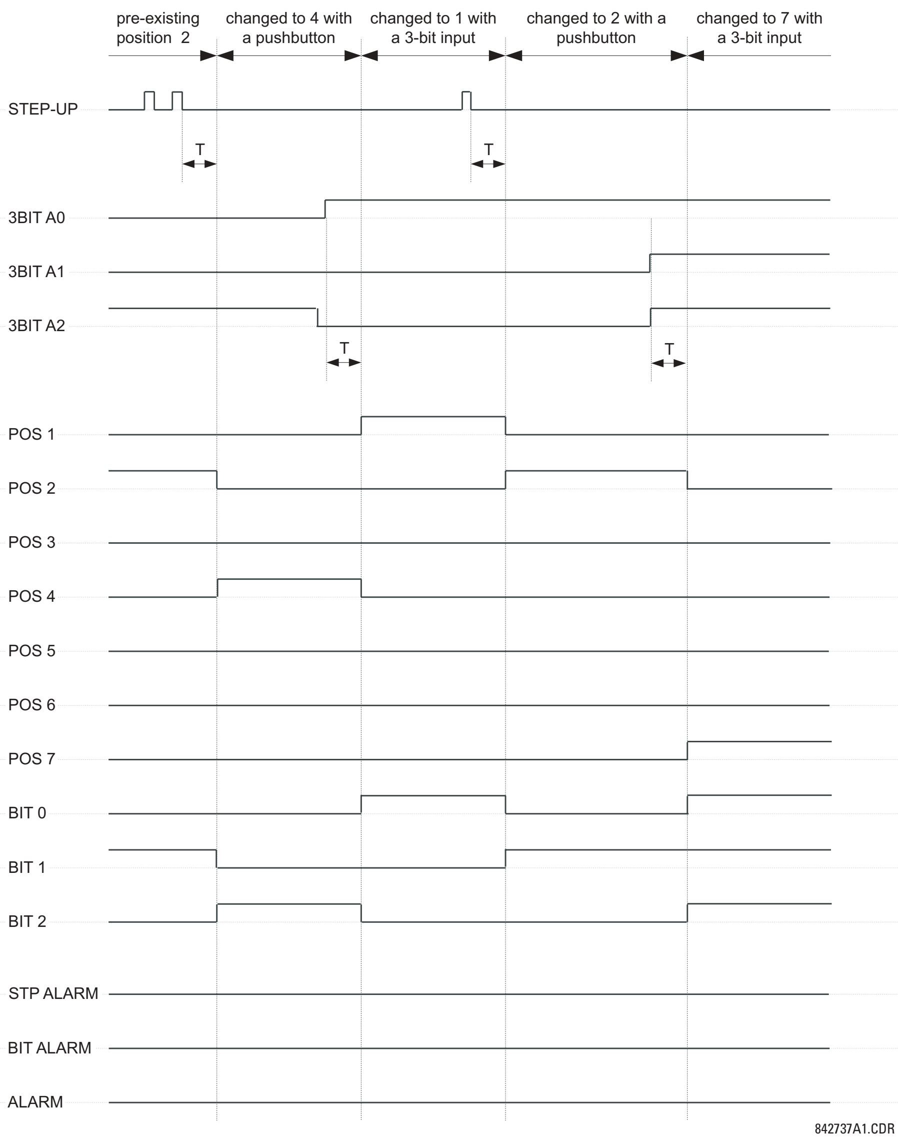


Figure 5–23: TIME-OUT MODE

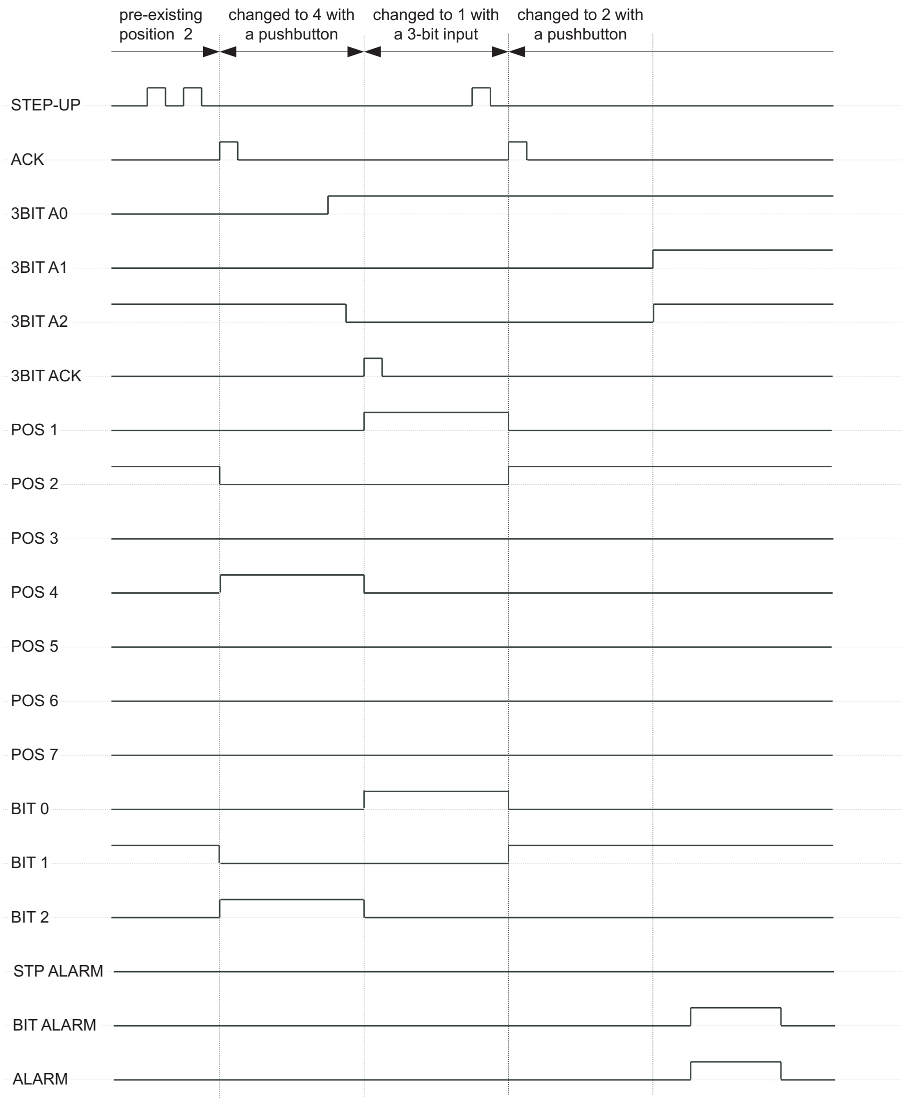


Figure 5–24: ACKNOWLEDGE MODE

APPLICATION EXAMPLE

Consider an application where the selector switch is used to control Setting Groups 1 through 4 in the relay. The setting groups are to be controlled from both User-Programmable Pushbutton 1 and from an external device via Contact Inputs 1 through 3. The active setting group shall be available as an encoded 3-bit word to the external device and SCADA via output contacts 1 through 3. The pre-selected setting group shall be applied automatically after 5 seconds of inactivity of the control inputs. When the relay powers up, it should synchronize the setting group to the 3-bit control input.

Make the following changes to Setting Group Control in the **SETTINGS ⇨⇩ CONTROL ELEMENTS ⇨ SETTING GROUPS** menu:

SETTING GROUPS FUNCTION: "Enabled"
SETTING GROUPS BLK: "Off"
GROUP 2 ACTIVATE ON: "SELECTOR 1 POS 2"
GROUP 3 ACTIVATE ON: "SELECTOR 1 POS 3"
GROUP 4 ACTIVATE ON: "SELECTOR 1 POS 4"
GROUP 5 ACTIVATE ON: "Off"
GROUP 6 ACTIVATE ON: "Off"

Make the following changes to Selector Switch element in the **SETTINGS ⇨⇩ CONTROL ELEMENTS ⇨⇩ SELECTOR SWITCH ⇨ SELECTOR SWITCH 1** menu to assign control to User Programmable Pushbutton 1 and Contact Inputs 1 through 3:

SELECTOR 1 FUNCTION: "Enabled"
SELECTOR 1 FULL-RANGE: "4"
SELECTOR 1 STEP-UP MODE: "Time-out"
SELECTOR 1 TIME-OUT: "5.0 s"
SELECTOR 1 STEP-UP: "PUSHBUTTON 1 ON"
SELECTOR 1 ACK: "Off"
SELECTOR 1 3BIT A0: "CONT IP 1 ON"
SELECTOR 1 3BIT A1: "CONT IP 2 ON"
SELECTOR 1 3BIT A2: "CONT IP 3 ON"
SELECTOR 1 3BIT MODE: "Time-out"
SELECTOR 1 3BIT ACK: "Off"
SELECTOR 1 POWER-UP MODE: "Synchronize"

Now, assign the contact output operation (assume the H6E module) to the Selector Switch element by making the following changes in the **SETTINGS ⇨⇩ INPUTS/OUTPUTS ⇨⇩ CONTACT OUTPUTS** menu:

OUTPUT H1 OPERATE: "SELECTOR 1 BIT 0"
OUTPUT H2 OPERATE: "SELECTOR 1 BIT 1"
OUTPUT H3 OPERATE: "SELECTOR 1 BIT 2"

5

Finally, assign configure User-Programmable Pushbutton 1 by making the following changes in the **SETTINGS ⇨ PRODUCT SETUP ⇨⇩ USER-PROGRAMMABLE PUSHBUTTONS ⇨ USER PUSHBUTTON 1** menu:

PUSHBUTTON 1 FUNCTION: "Self-reset"
PUSHBUTTON 1 DROP-OUT TIME: "0.10 s"

The logic for the selector switch is shown below:

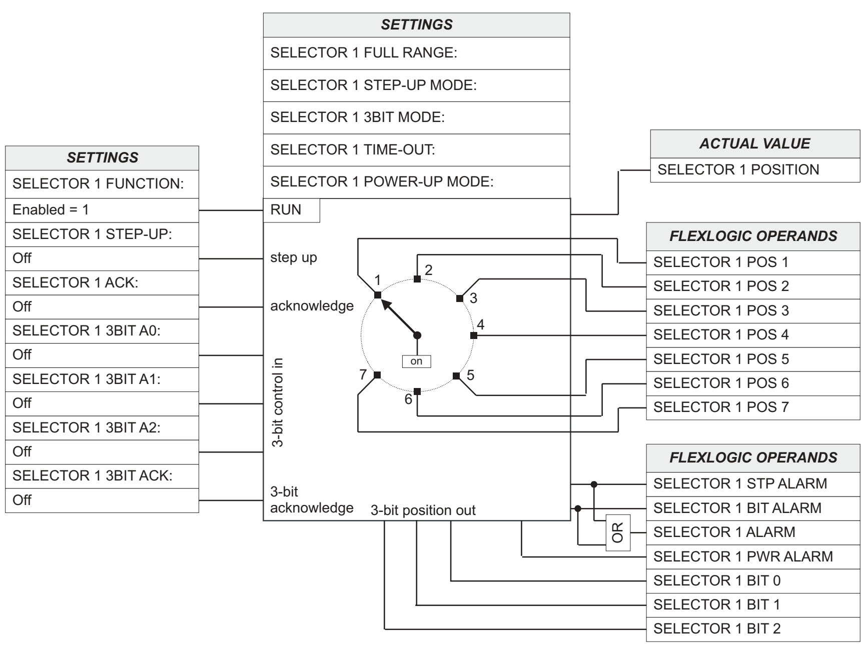


Figure 5–25: SELECTOR SWITCH LOGIC

5.4.4 DIGITAL ELEMENTS

PATH: SETTINGS ⇨⇩ CONTROL ELEMENTS ⇨⇩ DIGITAL ELEMENTS ⇨ DIGITAL ELEMENT 1(16)

■ DIGITAL ELEMENT 1 ■	DIGITAL ELEMENT 1 FUNCTION: Disabled	Range: Disabled, Enabled
MESSAGE	DIG ELEM 1 NAME: Dig Element 1	Range: 16 alphanumeric characters
MESSAGE	DIG ELEM 1 INPUT: Off	Range: FlexLogic™ operand
MESSAGE	DIG ELEM 1 PICKUP DELAY: 0.000 s	Range: 0.000 to 999999.999 s in steps of 0.001
MESSAGE	DIG ELEM 1 RESET DELAY: 0.000 s	Range: 0.000 to 999999.999 s in steps of 0.001
MESSAGE	DIG ELEM 1 BLOCK: Off	Range: FlexLogic™ operand
MESSAGE	DIGITAL ELEMENT 1 TARGET: Self-reset	Range: Self-reset, Latched, Disabled
MESSAGE	DIGITAL ELEMENT 1 EVENTS: Disabled	Range: Disabled, Enabled

There are 16 identical Digital Elements available, numbered 1 to 16. A Digital Element can monitor any FlexLogic™ operand and present a target message and/or enable events recording depending on the output operand state. The digital element settings include a 'name' which will be referenced in any target message, a blocking input from any selected FlexLogic™ operand, and a timer for pickup and reset delays for the output operand.

- **DIGITAL ELEMENT 1 INPUT:** Selects a FlexLogic™ operand to be monitored by the Digital Element.
- **DIGITAL ELEMENT 1 PICKUP DELAY:** Sets the time delay to pickup. If a pickup delay is not required, set to "0".
- **DIGITAL ELEMENT 1 RESET DELAY:** Sets the time delay to reset. If a reset delay is not required, set to "0".

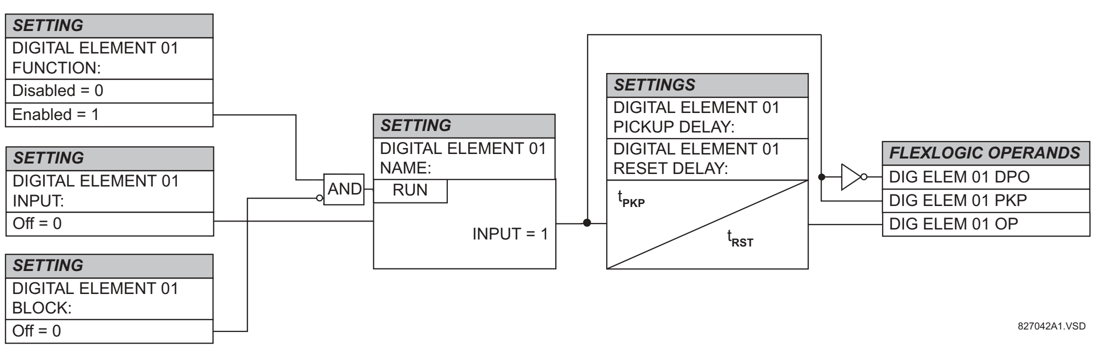


Figure 5–26: DIGITAL ELEMENT SCHEME LOGIC

CIRCUIT MONITORING APPLICATIONS:

Some versions of the digital input modules include an active Voltage Monitor circuit connected across Form-A contacts. The Voltage Monitor circuit limits the trickle current through the output circuit (see Technical Specifications for Form-A).

As long as the current through the Voltage Monitor is above a threshold (see Technical Specifications for Form-A), the FlexLogic™ operand "Cont Op # VOn" will be set. (# represents the output contact number). If the output circuit has a high resistance or the DC current is interrupted, the trickle current will drop below the threshold and the FlexLogic™ operand "Cont Op # VOff" will be set. Consequently, the state of these operands can be used as indicators of the integrity of the circuits in which Form-A contacts are inserted.

EXAMPLE 1: BREAKER TRIP CIRCUIT INTEGRITY MONITORING

In many applications it is desired to monitor the breaker trip circuit integrity so problems can be detected before a trip operation is required. The circuit is considered to be healthy when the Voltage Monitor connected across the trip output contact detects a low level of current, well below the operating current of the breaker trip coil. If the circuit presents a high resistance, the trickle current will fall below the monitor threshold and an alarm would be declared.

In most breaker control circuits, the trip coil is connected in series with a breaker auxiliary contact which is open when the breaker is open (see diagram below). To prevent unwanted alarms in this situation, the trip circuit monitoring logic must include the breaker position.

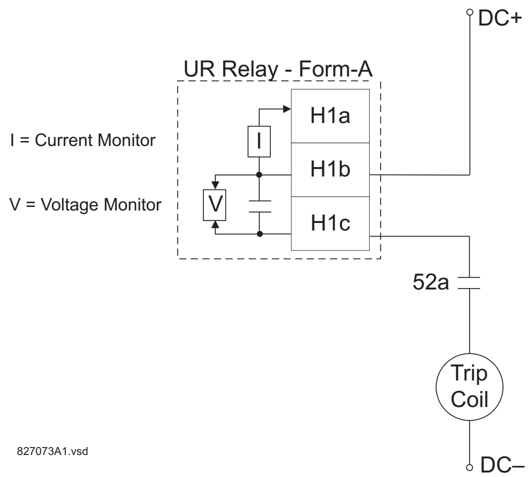


Figure 5–27: TRIP CIRCUIT EXAMPLE 1

Assume the output contact H1 is a trip contact. Using the contact output settings, this output will be given an ID name, e.g. “Cont Op 1". Assume a 52a breaker auxiliary contact is connected to contact input H7a to monitor breaker status. Using the contact input settings, this input will be given an ID name, e.g. “Cont Ip 1" and will be set “ON” when the breaker is closed. Using Digital Element 1 to monitor the breaker trip circuit, the settings will be:

■ DIGITAL ELEMENT 1 ■		DIGITAL ELEMENT 1 FUNCTION: Enabled
	MESSAGE	DIG ELEM 1 NAME: Bkr Trip Cct Out
	MESSAGE	DIG ELEM 1 INPUT: Cont Op 1 VOff
	MESSAGE	DIG ELEM 1 PICKUP DELAY: 0.200 s
	MESSAGE	DIG ELEM 1 RESET DELAY: 0.100 s
	MESSAGE	DIG ELEM 1 BLOCK: Cont Ip 1 Off
	MESSAGE	DIGITAL ELEMENT 1 TARGET: Self-reset
	MESSAGE	DIGITAL ELEMENT 1 EVENTS: Enabled

NOTE

The PICKUP DELAY setting should be greater than the operating time of the breaker to avoid nuisance alarms.

EXAMPLE 2: BREAKER TRIP CIRCUIT INTEGRITY MONITORING

If it is required to monitor the trip circuit continuously, independent of the breaker position (open or closed), a method to maintain the monitoring current flow through the trip circuit when the breaker is open must be provided (as shown in the figure below). This can be achieved by connecting a suitable resistor (see figure below) across the auxiliary contact in the trip circuit. In this case, it is not required to supervise the monitoring circuit with the breaker position – the **BLOCK** setting is selected to “Off”. In this case, the settings will be:

```
■ DIGITAL ELEMENT  1                 DIGITAL ELEMENT  1
■                                    FUNCTION: Enabled

                        MESSAGE      DIG ELEM  1 NAME:
                                     Bkr Trip Cct Out

                        MESSAGE      DIG ELEM  1 INPUT:
                                     Cont Op 1 VOff

                        MESSAGE      DIG ELEM  1 PICKUP
                                     DELAY:      0.200 s

                        MESSAGE      DIG ELEM  1 RESET
                                     DELAY:      0.100 s

                        MESSAGE      DIG ELEM  1 BLOCK:
                                     Off

                        MESSAGE      DIGITAL ELEMENT  1
                                     TARGET: Self-reset

                        MESSAGE      DIGITAL ELEMENT  1
                                     EVENTS: Enabled
```

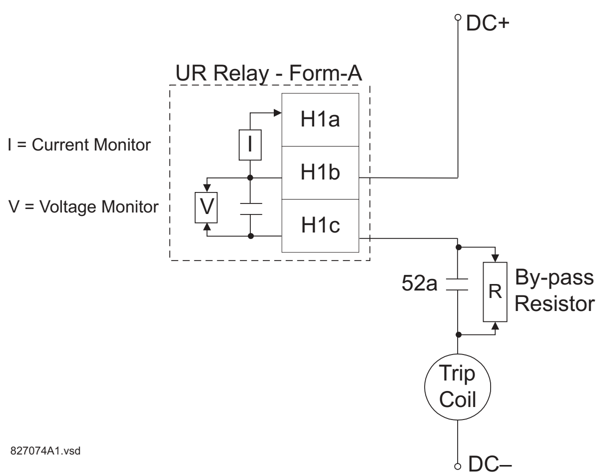


Table 5–8: VALUES OF RESISTOR ‘R’

POWER SUPPLY (V DC)	RESISTANCE (OHMS)	POWER (WATTS)
24	1000	2
30	5000	2
48	10000	2
110	25000	5
125	25000	5
250	50000	5

Figure 5–28: TRIP CIRCUIT EXAMPLE 2

5.4.5 DIGITAL COUNTERS

PATH: SETTINGS ⇨⇩ CONTROL ELEMENTS ⇨⇩ DIGITAL COUNTERS ⇨ COUNTER 1(8)

■ COUNTER 1 ■	COUNTER 1 FUNCTION: Disabled	Range: Disabled, Enabled
MESSAGE	COUNTER 1 NAME: Counter 1	Range: 12 alphanumeric characters
MESSAGE	COUNTER 1 UNITS:	Range: 6 alphanumeric characters
MESSAGE	COUNTER 1 PRESET: 0	Range: –2,147,483,648 to +2,147,483,647
MESSAGE	COUNTER 1 COMPARE: 0	Range: –2,147,483,648 to +2,147,483,647
MESSAGE	COUNTER 1 UP: Off	Range: FlexLogic™ operand
MESSAGE	COUNTER 1 DOWN: Off	Range: FlexLogic™ operand
MESSAGE	COUNTER 1 BLOCK: Off	Range: FlexLogic™ operand
MESSAGE	CNT1 SET TO PRESET: Off	Range: FlexLogic™ operand
MESSAGE	COUNTER 1 RESET: Off	Range: FlexLogic™ operand
MESSAGE	COUNT1 FREEZE/RESET: Off	Range: FlexLogic™ operand
MESSAGE	COUNT1 FREEZE/COUNT: Off	Range: FlexLogic™ operand

There are 8 identical digital counters, numbered from 1 to 8. A digital counter counts the number of state transitions from Logic 0 to Logic 1. The counter is used to count operations such as the pickups of an element, the changes of state of an external contact (e.g. breaker auxiliary switch), or pulses from a watt-hour meter.

- **COUNTER 1 UNITS:** Assigns a label to identify the unit of measure pertaining to the digital transitions to be counted. The units label will appear in the corresponding Actual Values status.
- **COUNTER 1 PRESET:** Sets the count to a required preset value before counting operations begin, as in the case where a substitute relay is to be installed in place of an in-service relay, or while the counter is running.
- **COUNTER 1 COMPARE:** Sets the value to which the accumulated count value is compared. Three FlexLogic™ output operands are provided to indicate if the present value is 'more than (HI)', 'equal to (EQL)', or 'less than (LO)' the set value.
- **COUNTER 1 UP:** Selects the FlexLogic™ operand for incrementing the counter. If an enabled UP input is received when the accumulated value is at the limit of +2,147,483,647 counts, the counter will rollover to –2,147,483,648.
- **COUNTER 1 DOWN:** Selects the FlexLogic™ operand for decrementing the counter. If an enabled DOWN input is received when the accumulated value is at the limit of –2,147,483,648 counts, the counter will rollover to +2,147,483,647.
- **COUNTER 1 BLOCK:** Selects the FlexLogic™ operand for blocking the counting operation. All counter operands are blocked.

- **CNT1 SET TO PRESET:** Selects the FlexLogic™ operand used to set the count to the preset value. The counter will be set to the preset value in the following situations:
  1. When the counter is enabled and the **CNT1 SET TO PRESET** operand has the value 1 (when the counter is enabled and **CNT1 SET TO PRESET** operand is 0, the counter will be set to 0).
  2. When the counter is running and the **CNT1 SET TO PRESET** operand changes the state from 0 to 1 (**CNT1 SET TO PRESET** changing from 1 to 0 while the counter is running has no effect on the count).
  3. When a reset or reset/freeze command is sent to the counter and the **CNT1 SET TO PRESET** operand has the value 1 (when a reset or reset/freeze command is sent to the counter and the **CNT1 SET TO PRESET** operand has the value 0, the counter will be set to 0).
- **COUNTER 1 RESET:** Selects the FlexLogic™ operand for setting the count to either "0" or the preset value depending on the state of the **CNT1 SET TO PRESET** operand.
- **COUNTER 1 FREEZE/RESET:** Selects the FlexLogic™ operand for capturing (freezing) the accumulated count value into a separate register with the date and time of the operation, and resetting the count to "0".
- **COUNTER 1 FREEZE/COUNT:** Selects the FlexLogic™ operand for capturing (freezing) the accumulated count value into a separate register with the date and time of the operation, and continuing counting. The present accumulated value and captured frozen value with the associated date/time stamp are available as actual values. If control power is interrupted, the accumulated and frozen values are saved into non-volatile memory during the power down operation.

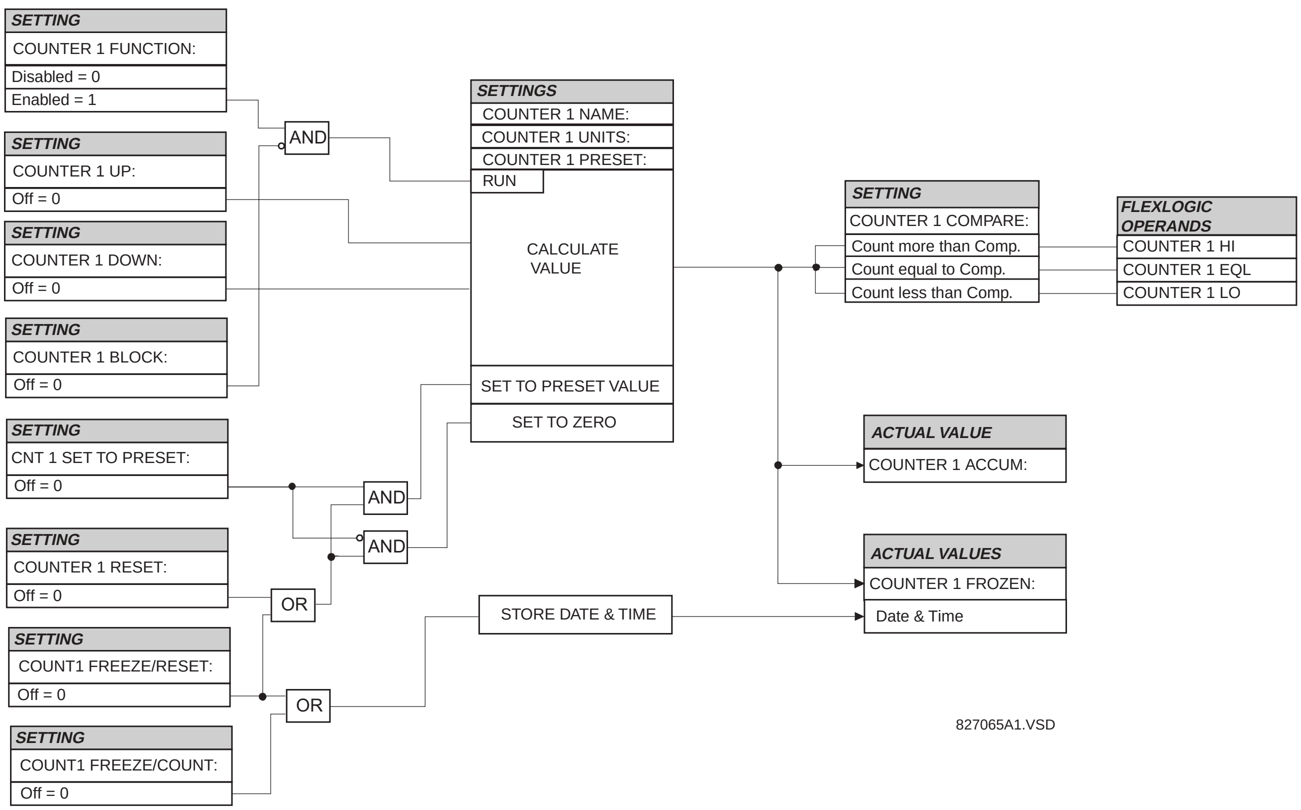


Figure 5–29: DIGITAL COUNTER SCHEME LOGIC

5

5.5.1 CONTACT INPUTS

PATH: SETTINGS ⇨⇩ INPUTS/OUTPUTS ⇨ CONTACT INPUTS

```
■ CONTACT INPUTS
■
```

```
■ CONTACT INPUT H5a
■
```

MESSAGE	CONTACT INPUT H5a ID: Cont Ip 1	Range: up to 12 alphanumeric characters
MESSAGE	CONTACT INPUT H5a DEBNCE TIME: 2.0 ms	Range: 0.0 to 16.0 ms in steps of 0.5
MESSAGE	CONTACT INPUT H5a EVENTS: Disabled	Range: Disabled, Enabled

↓

```
■ CONTACT INPUT xxx
■
```

```
■ CONTACT INPUT
■ THRESHOLDS
```

MESSAGE	Ips H5a,H5c,H6a,H6c THRESHOLD: 33 Vdc	Range: 17, 33, 84, 166 Vdc
MESSAGE	Ips H7a,H7c,H8a,H8c THRESHOLD: 33 Vdc	Range: 17, 33, 84, 166 Vdc
	↓	
MESSAGE	Ips xxx,xxx,xxx,xxx THRESHOLD: 33 Vdc	Range: 17, 33, 84, 166 Vdc

The contact inputs menu contains configuration settings for each contact input as well as voltage thresholds for each group of four contact inputs. Upon startup, the relay processor determines (from an assessment of the installed modules) which contact inputs are available and then display settings for only those inputs.

An alphanumeric ID may be assigned to a contact input for diagnostic, setting, and event recording purposes. The "Contact Ip X On" (Logic 1) FlexLogic™ operand corresponds to contact input "X" being closed, while "Contact Input X Off" corresponds to contact input "X" being open. The **CONTACT INPUT DEBNCE TIME** defines the time required for the contact to overcome 'contact bouncing' conditions. As this time differs for different contact types and manufacturers, set it as a maximum contact debounce time (per manufacturer specifications) plus some margin to ensure proper operation. If **CONTACT INPUT EVENTS** is set to "Enabled", every change in the contact input state will trigger an event.

A raw status is scanned for all Contact Inputs synchronously at the constant rate of 0.5 ms as shown in the figure below. The DC input voltage is compared to a user-settable threshold. A new contact input state must be maintained for a user-settable debounce time in order for the C30 to validate the new contact state. In the figure below, the debounce time is set at 2.5 ms; thus the 6th sample in a row validates the change of state (mark no.1 in the diagram). Once validated (debounced), the contact input asserts a corresponding FlexLogic™ operand and logs an event as per user setting.

A time stamp of the first sample in the sequence that validates the new state is used when logging the change of the contact input into the Event Recorder (mark no. 2 in the diagram).

Protection and control elements, as well as FlexLogic™ equations and timers, are executed eight times in a power system cycle. The protection pass duration is controlled by the frequency tracking mechanism. The FlexLogic™ operand reflecting the debounced state of the contact is updated at the protection pass following the validation (marks no. 3 and 4 on the figure below). The update is performed at the beginning of the protection pass so all protection and control functions, as well as FlexLogic™ equations, are fed with the updated states of the contact inputs.

The FlexLogic™ operand response time to the contact input change is equal to the debounce time setting plus up to one protection pass (variable and depending on system frequency if frequency tracking enabled). If the change of state occurs just after a protection pass, the recognition is delayed until the subsequent protection pass; that is, by the entire duration of the protection pass. If the change occurs just prior to a protection pass, the state is recognized immediately. Statistically a delay of half the protection pass is expected. Owing to the 0.5 ms scan rate, the time resolution for the input contact is below 1msec.

For example, 8 protection passes per cycle on a 60 Hz system correspond to a protection pass every 2.1 ms. With a contact debounce time setting of 3.0 ms, the FlexLogic™ operand-assert time limits are: 3.0 + 0.0 = 3.0 ms and 3.0 + 2.1 = 5.1 ms. These time limits depend on how soon the protection pass runs after the debouncing time.

Regardless of the contact debounce time setting, the contact input event is time-stamped with a 1 µs accuracy using the time of the first scan corresponding to the new state (mark no. 2 below). Therefore, the time stamp reflects a change in the DC voltage across the contact input terminals that was not accidental as it was subsequently validated using the debounce timer. Keep in mind that the associated FlexLogic™ operand is asserted/de-asserted later, after validating the change.

The debounce algorithm is symmetrical: the same procedure and debounce time are used to filter the LOW-HIGH (marks no.1, 2, 3, and 4 in the figure below) and HIGH-LOW (marks no. 5, 6, 7, and 8 below) transitions.

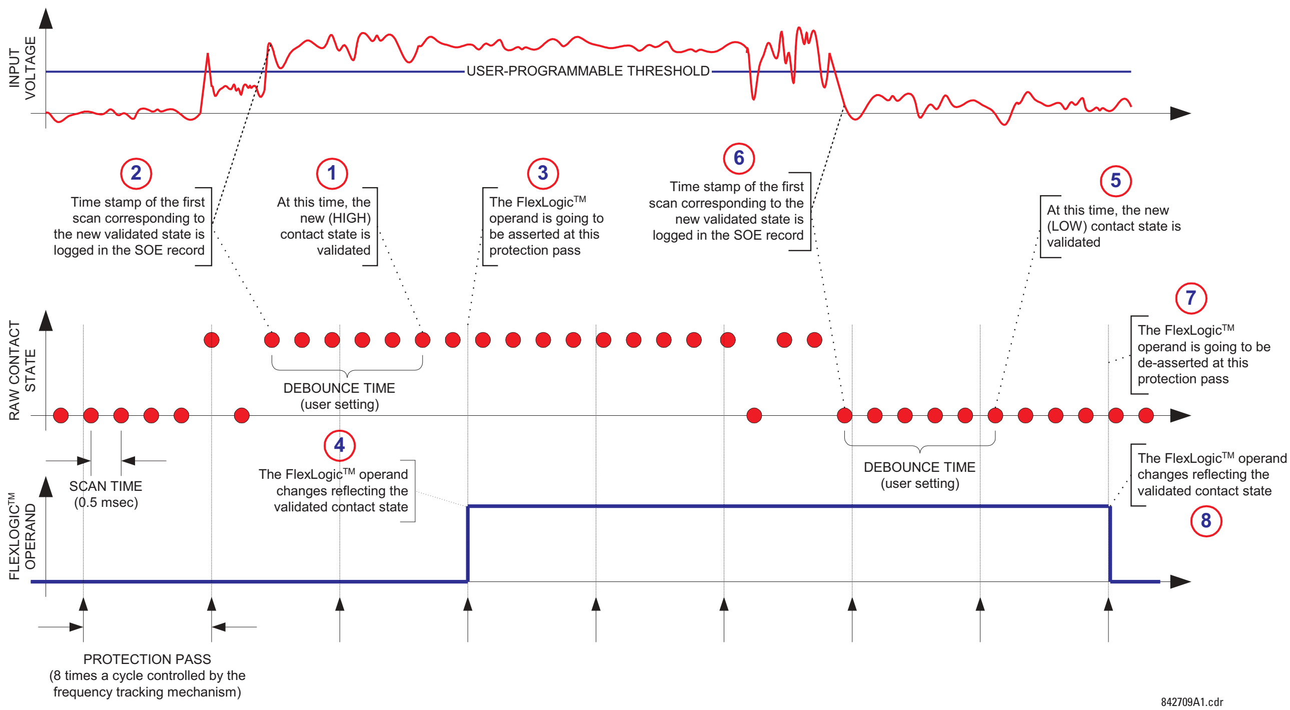


Figure 5–30: INPUT CONTACT DEBOUNCING MECHANISM AND TIME-STAMPING SAMPLE TIMING

Contact inputs are isolated in groups of four to allow connection of wet contacts from different voltage sources for each group. The **CONTACT INPUT THRESHOLDS** determine the minimum voltage required to detect a closed contact input. This value should be selected according to the following criteria: 16 for 24 V sources, 30 for 48 V sources, 80 for 110 to 125 V sources and 140 for 250 V sources.

For example, to use contact input H5a as a status input from the breaker 52b contact to seal-in the trip relay and record it in the Event Records menu, make the following settings changes:

CONTACT INPUT H5A ID: "Breaker Closed (52b)"
CONTACT INPUT H5A EVENTS: "Enabled"

Note that the 52b contact is closed when the breaker is open and open when the breaker is closed.

5.5.2 VIRTUAL INPUTS

PATH: SETTINGS ⇨⇩ INPUTS/OUTPUTS ⇨⇩ VIRTUAL INPUTS ⇨

Menu		Setting	Range
■ VIRTUAL INPUT 1 ■		VIRTUAL INPUT 1 FUNCTION: Disabled	*Range: Disabled, Enabled*
	MESSAGE	VIRTUAL INPUT 1 ID: Virt Ip 1	*Range: Up to 12 alphanumeric characters*
	MESSAGE	VIRTUAL INPUT 1 TYPE: Latched	*Range: Self-Reset, Latched*
	MESSAGE	VIRTUAL INPUT 1 EVENTS: Disabled	*Range: Disabled, Enabled*
■ VIRTUAL INPUT 2 ■		*As above for Virtual Input 1*	
↓		↓	
■ VIRTUAL INPUT 32 ■		*As above for Virtual Input 1*	
■ UCA SBO TIMER ■		UCA SBO TIMEOUT: 30 s	*Range: 1 to 60 s in steps of 1*

5

There are 32 virtual inputs that can be individually programmed to respond to input signals from the keypad (COMMANDS menu) and communications protocols. All virtual input operands are defaulted to OFF = 0 unless the appropriate input signal is received. **Virtual input states are preserved through a control power loss**.

If the **VIRTUAL INPUT x FUNCTION** is to "Disabled", the input will be forced to 'OFF' (Logic 0) regardless of any attempt to alter the input. If set to "Enabled", the input operates as shown on the logic diagram and generates output FlexLogic™ operands in response to received input signals and the applied settings.

There are two types of operation: Self-Reset and Latched. If **VIRTUAL INPUT x TYPE** is "Self-Reset", when the input signal transits from OFF = 0 to ON = 1, the output operand will be set to ON = 1 for only one evaluation of the FlexLogic™ equations and then return to OFF = 0. If set to "Latched", the virtual input sets the state of the output operand to the same state as the most recent received input, ON =1 or OFF = 0.

NOTE

The "Self-Reset" operating mode generates the output operand for a single evaluation of the FlexLogic™ equations. If the operand is to be used anywhere other than internally in a FlexLogic™ equation, it will likely have to be lengthened in time. A FlexLogic™ timer with a delayed reset can perform this function.

The Select-Before-Operate timer sets the interval from the receipt of an Operate signal to the automatic de-selection of the virtual input, so that an input does not remain selected indefinitely (used only with the UCA Select-Before-Operate feature).

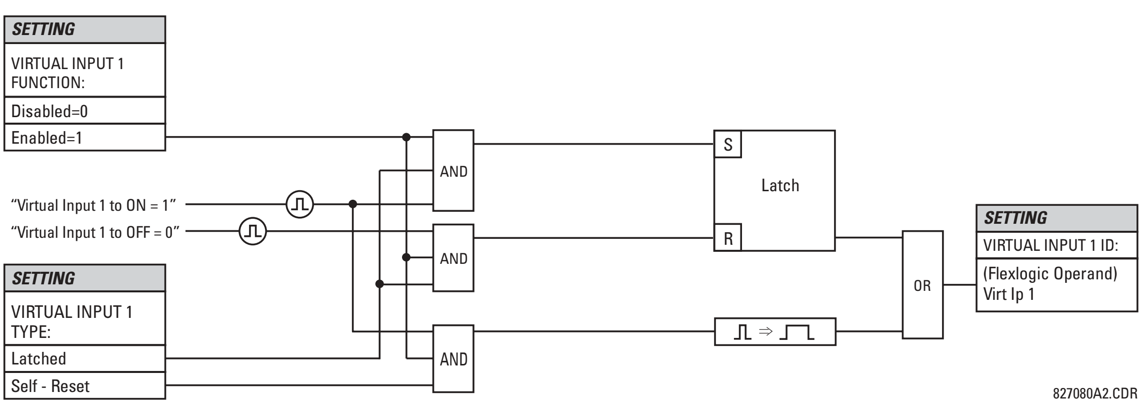


Figure 5–31: VIRTUAL INPUTS SCHEME LOGIC

5.5.3 CONTACT OUTPUTS

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

■ CONTACT OUTPUT H1 ■	◀▶	CONTACT OUTPUT H1 ID Cont Op 1	*Range: Up to 12 alphanumeric characters*
MESSAGE	▲▼	OUTPUT H1 OPERATE: Off	*Range: FlexLogic™ operand*
MESSAGE	▲▼	OUTPUT H1 SEAL-IN: Off	*Range: FlexLogic™ operand*
MESSAGE	▲	CONTACT OUTPUT H1 EVENTS: Enabled	*Range: Disabled, Enabled*

Upon startup of the relay, the main processor will determine from an assessment of the modules installed in the chassis which contact outputs are available and present the settings for only these outputs.

An ID may be assigned to each contact output. 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 some Form-A contacts (see the Trip Circuit Example in the Digital Elements section). The monitor will set a flag (see the Specifications for Form-A). The name of the FlexLogic™ operand set by the monitor, consists of the output relay designation, followed by the name of the flag; e.g. ‘Cont Op 1 IOn’ or ‘Cont Op 1 IOff’.

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".

This can be realized in the UR using the ‘Cont Op 1 IOn’ FlexLogic™ operand to seal-in the Contact Output as follows:

CONTACT OUTPUT H1 ID: “Cont Op 1"
OUTPUT H1 OPERATE: *any suitable FlexLogic™ operand*
OUTPUT H1 SEAL-IN: “Cont Op 1 IOn”
CONTACT OUTPUT H1 EVENTS: “Enabled”

5.5.4 LATCHING OUTPUTS

PATH: SETTINGS ⇨⇩ INPUTS/OUTPUTS ⇨⇩ LATCHING OUTPUTS ⇨ LATCHING OUTPUT H1a

■ LATCHING ■ OUTPUT H1a	◀▶	OUTPUT H1a ID L-Cont Op 1	*Range: Up to 12 alphanumeric characters*
MESSAGE	▲▼	OUTPUT H1a OPERATE: Off	*Range: FlexLogic™ operand*
MESSAGE	▲▼	OUTPUT H1a RESET: Off	*Range: FlexLogic™ operand*
MESSAGE	▲▼	OUTPUT H1a TYPE: Operate-dominant	*Range: Operate-dominant, Reset-dominant*
MESSAGE	▲	OUTPUT H1a EVENTS: Disabled	*Range: Disabled, Enabled*

The C30 latching output contacts are mechanically bi-stable and controlled by two separate (open and close) coils. As such they retain their position even if the relay is not powered up. The relay recognizes all latching output contact cards and populates the setting menu accordingly. On power up, the relay reads positions of the latching contacts from the hardware before executing any other functions of the relay (such as protection and control features or FlexLogic™).

The latching output modules, either as a part of the relay or as individual modules, are shipped from the factory with all latching contacts opened. It is highly recommended to double-check the programming and positions of the latching contacts when replacing a module.

Since the relay asserts the output contact and reads back its position, it is possible to incorporate self-monitoring capabilities for the latching outputs. If any latching outputs exhibits a discrepancy, the **LATCHING OUTPUT ERROR** self-test error is declared. The error is signaled by the LATCHING OUT ERROR FlexLogic™ operand, event, and target message.

- **OUTPUT H1 OPERATE**: This setting specifies a FlexLogic™ operand to operate the 'close coil' of the contact. The relay will seal-in this input to safely close the contact. Once the contact is closed, any activity exhibited by this input, such as subsequent chattering, will not have any effect.
- **OUTPUT H1 RESET**: This setting specifies a FlexLogic™ operand to operate the 'trip coil' of the contact. The relay will seal-in this input to safely open the contact. Once the contact is opened, any activity exhibited by this input, such as subsequent chattering, will not have any effect.
- **OUTPUT H1 TYPE**: This setting specifies the contact response under conflicting control inputs; that is, when both the operate and reset signals are applied. With both control inputs applied simultaneously, the contact will close if set to "Operate-dominant" and will open if set to "Reset-dominant".

Application Example 1:

5

A latching output contact H1a is to be controlled from two user-programmable pushbuttons (buttons number 1 and 2). The following settings should be applied.

Program the Latching Outputs by making the following changes in the **SETTINGS ⇨⇩ INPUTS/OUTPUT ⇨⇩ LATCHING OUTPUTS ⇨ LATCHING OUTPUT H1a** menu (assuming an H4L module):

OUTPUT H1a OPERATE: "PUSHBUTTON 1 ON"
OUTPUT H1a RESET: "PUSHBUTTON 2 ON"

Program the pushbuttons by making the following changes in the **PRODUCT SETUP ⇨⇩ USER-PROGRAMMABLE PUSHBUTTONS ⇨⇩ USER PUSHBUTTON 1** and **USER PUSHBUTTON 2** menus:

PUSHBUTTON 1 FUNCTION: "Self-reset"
PUSHBTN 1 DROP-OUT TIME: "0.00 s"

PUSHBUTTON 2 FUNCTION: "Self-reset"
PUSHBTN 2 DROP-OUT TIME: "0.00 s"

Application Example 2:

A relay, having two latching contacts H1a and H1c, is to be programmed. The H1a contact is to be a Type-a contact, while the H1c contact is to be a Type-b contact (Type-a means closed after exercising the operate input; Type-b means closed after exercising the reset input). The relay is to be controlled from virtual outputs: VO1 to operate and VO2 to reset.

Program the Latching Outputs by making the following changes in the **SETTINGS ⇨⇩ INPUTS/OUTPUT ⇨⇩ LATCHING OUTPUTS ⇨ LATCHING OUTPUT H1a** and **LATCHING OUTPUT H1c** menus (assuming an H4L module):

OUTPUT H1a OPERATE: "VO1"
OUTPUT H1a RESET: "VO2"

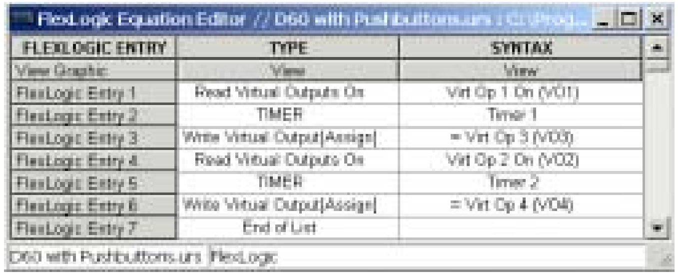
OUTPUT H1c OPERATE: "VO2"
OUTPUT H1c RESET: "VO1"

Since the two physical contacts in this example are mechanically separated and have individual control inputs, they will not operate at exactly the same time. A discrepancy in the range of a fraction of a maximum operating time may occur. Therefore, a pair of contacts programmed to be a multi-contact relay will not guarantee any specific sequence of operation (such as make before break). If required, the sequence of operation must be programmed explicitly by delaying some of the control inputs as shown in the next application example.

Application Example 3:

A make before break functionality must be added to the preceding example. An overlap of 20 ms is required to implement this functionality as described below:

Write the following FlexLogic™ equation (URPC example shown):



FlexLogic Equation Editor // D60 with Pushbuttons.urs : C:\Prog...

FLEXLOGIC ENTRY	TYPE	SYNTAX
View Graphic	View	View
FlexLogic Entry 1	Read Virtual Outputs On	Virt Op 1 On (VO1)
FlexLogic Entry 2	TIMER	Timer 1
FlexLogic Entry 3	Write Virtual Output[Assign]	= Virt Op 3 (VO3)
FlexLogic Entry 4	Read Virtual Outputs On	Virt Op 2 On (VO2)
FlexLogic Entry 5	TIMER	Timer 2
FlexLogic Entry 6	Write Virtual Output[Assign]	= Virt Op 4 (VO4)
FlexLogic Entry 7	End of List	

D60 with Pushbuttons.urs FlexLogic

Both timers (Timer 1 and Timer 2) should be set to 20 ms pickup and 0 ms dropout.

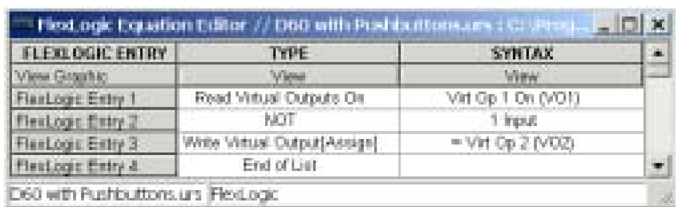
Program the Latching Outputs by making the following changes in the **SETTINGS ⇨⇩ INPUTS/OUTPUT ⇨⇩ LATCHING OUTPUTS ⇨ LATCHING OUTPUT H1a** and **LATCHING OUTPUT H1c** menus (assuming an H4L module):

OUTPUT H1a OPERATE: "VO1"
OUTPUT H1a RESET: "VO4"
OUTPUT H1c OPERATE: "VO2"
OUTPUT H1c RESET: "VO3"

Application Example 4:

A latching contact H1a is to be controlled from a single virtual output VO1. The contact should stay closed as long as VO1 is high, and should stay opened when VO1 is low. Program the relay as follows.

Write the following FlexLogic™ equation (URPC example shown):



FlexLogic Equation Editor // D60 with Pushbuttons.urs : C:\Prog...

FLEXLOGIC ENTRY	TYPE	SYNTAX
View Graphic	View	View
FlexLogic Entry 1	Read Virtual Outputs On	Virt Op 1 On (VO1)
FlexLogic Entry 2	NOT	1 Input
FlexLogic Entry 3	Write Virtual Output[Assign]	= Virt Op 2 (VO2)
FlexLogic Entry 4	End of List	

D60 with Pushbuttons.urs FlexLogic

Program the Latching Outputs by making the following changes in the **SETTINGS ⇨⇩ INPUTS/OUTPUT ⇨⇩ LATCHING OUTPUTS ⇨ LATCHING OUTPUT H1a** menu (assuming an H4L module):

OUTPUT H1a OPERATE: "VO1"
OUTPUT H1a RESET: "VO2"

5.5.5 VIRTUAL OUTPUTS

PATH: SETTINGS ⇨⇩ INPUTS/OUTPUTS ⇨⇩ VIRTUAL OUTPUTS ⇨ VIRTUAL OUTPUT 1

```
■ VIRTUAL OUTPUT  1        VIRTUAL OUTPUT  1 ID      Range: Up to 12 alphanumeric characters
■                          Virt Op 1

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

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

For 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 ID: "Trip"
VIRTUAL OUTPUT 1 EVENTS: "Disabled"

5.5.6 REMOTE DEVICES

a) REMOTE I/O OVERVIEW

Remote inputs and outputs, which are a means of exchanging information regarding the state of digital points between remote devices, are provided in accordance with the Electric Power Research Institute's (EPRI) UCA2 "Generic Object Oriented Substation Event (GOOSE)" specifications.

NOTE **The UCA2 specification requires that communications between devices be implemented on Ethernet communications facilities. For UR relays, Ethernet communications is provided only on the type 9C and 9D versions of the CPU module.**

The sharing of digital point state information between GOOSE equipped relays is essentially an extension to FlexLogic™ to allow distributed FlexLogic™ by making operands available to/from devices on a common communications network. In addition to digital point states, GOOSE messages identify the originator of the message and provide other information required by the communication specification. All devices listen to network messages and capture data from only those messages that have originated in selected devices.

GOOSE messages are designed to be short, high priority and with a high level of reliability. The GOOSE message structure contains space for 128 bit pairs representing digital point state information. The UCA specification provides 32 "DNA" bit pairs, which are status bits representing pre-defined events. All remaining bit pairs are "UserSt" bit pairs, which are status bits representing user-definable events. The UR implementation provides 32 of the 96 available UserSt bit pairs.

The UCA2 specification includes features that are used to cope with the loss of communication between transmitting and receiving devices. Each transmitting device will send a GOOSE message upon a successful power-up, when the state of any included point changes, or after a specified interval (the "default update" time) if a change-of-state has not occurred. The transmitting device also sends a "hold time" which is set to three times the programmed default time, which is required by the receiving device.

Receiving devices are constantly monitoring the communications network for messages they require, as recognized by the identification of the originating device carried in the message. Messages received from remote devices include the message "hold" time for the device. The receiving relay sets a timer assigned to the originating device to the "hold" time interval, and if it has not received another message from this device at time-out, the remote device is declared to be non-communicating, so it will use the programmed default state for all points from that specific remote device. This mechanism allows a receiving device to fail to detect a single transmission from a remote device which is sending messages at the slowest possible rate, as set by its "default update" timer, without reverting to use of the programmed default states. If a message is received from a remote device before the "hold" time expires, all points for that device are updated to the states contained in the message and the hold timer is restarted. The status of a remote device, where 'Offline' indicates 'non-communicating', can be displayed.

The GOOSE facility provides for 32 remote inputs and 64 remote outputs.

b) LOCAL DEVICES: ID OF DEVICE FOR TRANSMITTING GOOSE MESSAGES

In a UR relay, the device ID that identifies the originator of the message is programmed in the **SETTINGS ⇨ PRODUCT SETUP ⇨⇩ INSTALLATION ⇨⇩ RELAY NAME** setting.

c) REMOTE DEVICES: ID OF DEVICE FOR RECEIVING GOOSE MESSAGES

PATH: SETTINGS ⇨⇩ INPUTS/OUTPUTS ⇨⇩ REMOTE DEVICES ⇨ REMOTE DEVICE 1(16)

```
■ REMOTE DEVICE  1        REMOTE DEVICE  1 ID:
■                         Remote Device 1
```

Range: up to 20 alphanumeric characters

Sixteen Remote Devices, numbered from 1 to 16, can be selected for setting purposes. A receiving relay must be programmed to capture messages from only those originating remote devices of interest. This setting is used to select specific remote devices by entering (bottom row) the exact identification (ID) assigned to those devices.

5.5.7 REMOTE INPUTS

PATH: SETTINGS ⇨⇩ INPUTS/OUTPUTS ⇨⇩ REMOTE INPUTS ⇨ REMOTE INPUT 1(32)

■ REMOTE INPUT 1 ■	◀▶	REMOTE IN 1 DEVICE: Remote Device 1	Range: 1 to 16 inclusive
MESSAGE	▲▼	REMOTE IN 1 BIT PAIR: None	Range: None, DNA-1 to DNA-32, UserSt-1 to UserSt-32
MESSAGE	▲▼	REMOTE IN 1 DEFAULT STATE: Off	Range: On, Off, Latest/On, Latest/Off
MESSAGE	▲	REMOTE IN 1 EVENTS: Disabled	Range: Disabled, Enabled

Remote Inputs which create FlexLogic™ operands at the receiving relay, are extracted from GOOSE messages originating in remote devices. The relay provides 32 Remote Inputs, each of which can be selected from a list consisting of 64 selections: DNA-1 through DNA-32 and UserSt-1 through UserSt-32. The function of DNA inputs is defined in the UCA2 specifications and is presented in the UCA2 DNA Assignments table in the Remote Outputs section. The function of UserSt inputs is defined by the user selection of the FlexLogic™ operand whose state is represented in the GOOSE message. A user must program a DNA point from the appropriate FlexLogic™ operand.

Remote Input 1 must be programmed to replicate the logic state of a specific signal from a specific remote device for local use. This programming is performed via the three settings shown above.

REMOTE IN 1 DEVICE selects the number (1 to 16) of the Remote Device which originates the required signal, as previously assigned to the remote device via the setting **REMOTE DEVICE NN ID** (see the Remote Devices section). **REMOTE IN 1 BIT PAIR** selects the specific bits of the GOOSE message required.

5

The **REMOTE IN 1 DEFAULT STATE** setting selects the logic state for this point if the local relay has just completed startup or the remote device sending the point is declared to be non-communicating. The following choices are available:

- Setting **REMOTE IN 1 DEFAULT STATE** to “On” value defaults the input to Logic 1.
- Setting **REMOTE IN 1 DEFAULT STATE** to “Off” value defaults the input to Logic 0.
- Setting **REMOTE IN 1 DEFAULT STATE** to “Latest/On” freezes the input in case of lost communications. If the latest state is not known, such as after relay power-up but before the first communication exchange, the input will default to Logic 1. When communication resumes, the input becomes fully operational.
- Setting **REMOTE IN 1 DEFAULT STATE** to “Latest/Off” freezes the input in case of lost communications. If the latest state is not known, such as after relay power-up but before the first communication exchange, the input will default to Logic 0. When communication resumes, the input becomes fully operational.

NOTE

For additional information on the GOOSE specification, refer to the Remote Devices section in this chapter and to Appendix C: UCA/MMS Communications.

5.5.8 REMOTE OUTPUTS

a) DNA BIT PAIRS

PATH: SETTINGS ⇨⇩ INPUTS/OUTPUTS ⇨⇩ REMOTE OUTPUTS DNA BIT PAIRS ⇨ REMOTE OUPUTS DNA- 1 BIT PAIR

■ REMOTE OUTPUTS ■ DNA- 1 BIT PAIR	◀▶	DNA- 1 OPERAND: Off	*Range: FlexLogic™ Operand*
MESSAGE	▲	DNA- 1 EVENTS: Disabled	*Range: Disabled, Enabled*

Remote Outputs (1 to 32) are FlexLogic™ operands inserted into GOOSE messages that are transmitted to remote devices on a LAN. Each digital point in the message must be programmed to carry the state of a specific FlexLogic™ operand. The above operand setting represents a specific DNA function (as shown in the following table) to be transmitted.

Table 5–9: UCA DNA2 ASSIGNMENTS

DNA	DEFINITION	INTENDED FUNCTION	LOGIC 0	LOGIC 1
1	OperDev		Trip	Close
2	Lock Out		LockoutOff	LockoutOn
3	Initiate Reclosing	Initiate remote reclose sequence	InitRecloseOff	InitRecloseOn
4	Block Reclosing	Prevent/cancel remote reclose sequence	BlockOff	BlockOn
5	Breaker Failure Initiate	Initiate remote breaker failure scheme	BFIOff	BFIOn
6	Send Transfer Trip	Initiate remote trip operation	TxXfrTripOff	TxXfrTripOn
7	Receive Transfer Trip	Report receipt of remote transfer trip command	RxXfrTripOff	RxXfrTripOn
8	Send Perm	Report permissive affirmative	TxPermOff	TxPermOn
9	Receive Perm	Report receipt of permissive affirmative	RxPermOff	RxPermOn
10	Stop Perm	Override permissive affirmative	StopPermOff	StopPermOn
11	Send Block	Report block affirmative	TxBlockOff	TxBlockOn
12	Receive Block	Report receipt of block affirmative	RxBlockOff	RxBlockOn
13	Stop Block	Override block affirmative	StopBlockOff	StopBlockOn
14	BkrDS	Report breaker disconnect 3-phase state	Open	Closed
15	BkrPhsADS	Report breaker disconnect phase A state	Open	Closed
16	BkrPhsBDS	Report breaker disconnect phase B state	Open	Closed
17	BkrPhsCDS	Report breaker disconnect phase C state	Open	Closed
18	DiscSwDS		Open	Closed
19	Interlock DS		DSLockOff	DSLockOn
20	LineEndOpen	Report line open at local end	Open	Closed
21	Status	Report operating status of local GOOSE device	Offline	Available
22	Event		EventOff	EventOn
23	Fault Present		FaultOff	FaultOn
24	Sustained Arc	Report sustained arc	SustArcOff	SustArcOn
25	Downed Conductor	Report downed conductor	DownedOff	DownedOn
26	Sync Closing		SyncClsOff	SyncClsOn
27	Mode	Report mode status of local GOOSE device	Normal	Test
28→32	Reserved			

NOTE

For more information on GOOSE specifications, see the Remote I/O Overview in the Remote Devices section.

b) USERST BIT PAIRS

PATH: SETTINGS ⇨⇩ INPUTS/OUTPUTS ⇨⇩ REMOTE OUTPUTS UserSt BIT PAIRS ⇨ REMOTE OUTPUTS UserSt- 1 BIT PAIR

```
■ REMOTE OUTPUTS
■ UserSt- 1 BIT PAIR
```

	UserSt- 1 OPERAND: Off	Range: *FlexLogic™ operand*
MESSAGE	UserSt- 1 EVENTS: Disabled	Range: *Disabled, Enabled*

Remote Outputs 1 to 32 originate as GOOSE messages to be transmitted to remote devices. Each digital point in the message must be programmed to carry the state of a specific FlexLogic™ operand. The setting above is used to select the operand which represents a specific UserSt function (as selected by the user) to be transmitted.

The following setting represents the time between sending GOOSE messages when there has been no change of state of any selected digital point. This setting is located in the **PRODUCT SETUP ⇨⇩ COMMUNICATIONS ⇨⇩ UCA/MMS PROTOCOL** settings menu.

DEFAULT GOOSE UPDATE TIME: 60 s	Range: *1 to 60 s in steps of 1*

NOTE

For more information on GOOSE specifications, see the Remote I/O Overview in the Remote Devices section.

5.5.9 RESETTING

PATH: SETTINGS ⇨⇩ INPUTS/OUTPUTS ⇨⇩ RESETTING

```
■ RESETTING
■
```

RESET OPERAND: Off	Range: *FlexLogic™ operand*

Some events can be programmed to latch the faceplate LED event indicators and the target message on the display. Once set, the latching mechanism will hold all of the latched indicators or messages in the set state after the initiating condition has cleared until a RESET command is received to return these latches (not including FlexLogic™ latches) to the reset state. The RESET command can be sent from the faceplate RESET button, a remote device via a communications channel, or any programmed operand.

When the RESET command is received by the relay, two FlexLogic™ operands are created. These operands, which are stored as events, reset the latches if the initiating condition has cleared. The three sources of RESET commands each create the FlexLogic™ operand "RESET OP". Each individual source of a RESET command also creates its individual operand RESET OP (PUSHBUTTON), RESET OP (COMMS) or RESET OP (OPERAND) to identify the source of the command. The setting shown above selects the operand that will create the RESET OP (OPERAND) operand.

5.5.10 DIRECT INPUTS/OUTPUTS

a) DIRECT INPUTS

PATH: SETTINGS ⇨⇩ INPUTS/OUTPUTS ⇨⇩ DIRECT INPUTS ⇨ DIRECT INPUT 1(32)

```
■ DIRECT INPUT  1
■
```

	DIRECT INPUT 1 DEVICE ID: 1	Range: *1 to 8*
MESSAGE	DIRECT INPUT 1 BIT NUMBER: 1	Range: *1 to 32*
MESSAGE	DIRECT INPUT 1 DEFAULT STATE: Off	Range: *On, Off, Latest/On, Latest/Off*
MESSAGE	DIRECT INPUT 1 EVENTS: Disabled	Range: *Enabled, Disabled*

These settings specify how the Direct Input information is processed. The **DIRECT INPUT DEVICE ID** represents the source of this Direct Input. The specified Direct Input is driven by the device identified here.

The **DIRECT INPUT 1 BIT NUMBER** is the bit number to extract the state for this Direct Input. Direct Input *x* is driven by the bit identified here as **DIRECT INPUT 1 BIT NUMBER**. This corresponds to the Direct Output Number of the sending device.

The **DIRECT INPUT 1 DEFAULT STATE** represents the state of the Direct Input when the associated Direct Device is offline. The following choices are available:

- Setting **DIRECT INPUT 1 DEFAULT STATE** to "On" value defaults the input to Logic 1.
- Setting **DIRECT INPUT 1 DEFAULT STATE** to "Off" value defaults the input to Logic 0.
- Setting **DIRECT INPUT 1 DEFAULT STATE** to "Latest/On" freezes the input in case of lost communications. If the latest state is not known, such as after relay power-up but before the first communication exchange, the input will default to Logic 1. When communication resumes, the input becomes fully operational.
- Setting **DIRECT INPUT 1 DEFAULT STATE** to "Latest/Off" freezes the input in case of lost communications. If the latest state is not known, such as after relay power-up but before the first communication exchange, the input will default to Logic 0. When communication resumes, the input becomes fully operational.

b) DIRECT OUTPUTS

PATH: SETTINGS ⇨⇩ INPUTS/OUTPUTS ⇨⇩ DIRECT OUTPUTS ⇨ DIRECT OUTPUT 1(32)

■ DIRECT OUTPUT 1 ■	DIRECT OUT 1 OPERAND: Off	Range: FlexLogic™ operand
MESSAGE	DIRECT OUTPUT 1 EVENTS: Disabled	Range: Enabled, Disabled

The **DIR OUT 1 OPERAND** is the FlexLogic™ operand that determines the state of this Direct Output.

c) APPLICATION EXAMPLES

The example introduced in the Product Setup section for Direct I/Os is continued below to illustrate usage of the Direct Inputs and Outputs.

EXAMPLE 1: EXTENDING I/O CAPABILITIES OF A C30 RELAY

Consider an application that requires additional quantities of digital inputs and/or output contacts and/or lines of programmable logic that exceed the capabilities of a single UR chassis. The problem is solved by adding an extra UR IED, such as the C30, to satisfy the additional I/Os and programmable logic requirements. The two IEDs are connected via single-channel digital communication cards as shown below.

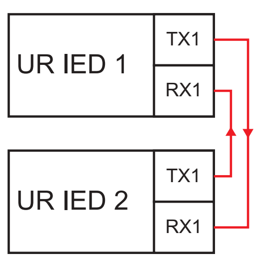


Figure 5–32: INPUT/OUTPUT EXTENSION VIA DIRECT I/OS

Assume Contact Input 1 from UR IED 2 is to be used by UR IED 1. The following settings should be applied (Direct Input 5 and bit number 12 are used, as an example):

UR IED 1: **DIRECT INPUT 5 DEVICE ID** = "2"
DIRECT INPUT 5 BIT NUMBER = "12"

UR IED 2: **DIRECT OUT 12 OPERAND** = "Cont Ip 1 On"

The "Cont Ip 1 On" operand of UR IED 2 is now available in UR IED 1 as "DIRECT INPUT 5 ON".

EXAMPLE 2: INTERLOCKING BUSBAR PROTECTION

A simple interlocking busbar protection scheme can be accomplished by sending a blocking signal from downstream devices, say 2, 3 and 4, to the upstream device that monitors a single incomer of the busbar, as shown in the figure below.

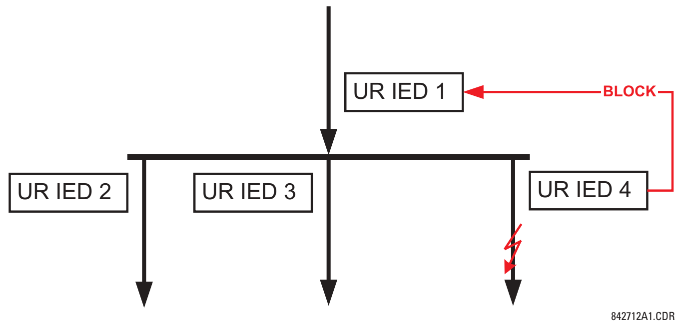


Figure 5–33: SAMPLE INTERLOCKING BUSBAR PROTECTION SCHEME

Assume that Phase IOC1 is used by Devices 2, 3, and 4 to block Device 1. If not blocked, Device 1 would trip the bus upon detecting a fault and applying a short coordination time delay.

The following settings should be applied (assume Bit 3 is used by all 3 devices to sent the blocking signal and Direct Inputs 7, 8, and 9 are used by the receiving device to monitor the three blocking signals):

UR IED 2: **DIRECT OUT 3 OPERAND**: "PHASE IOC1 OP"

UR IED 3: **DIRECT OUT 3 OPERAND**: "PHASE IOC1 OP"

UR IED 4: **DIRECT OUT 3 OPERAND**: "PHASE IOC1 OP"

UR IED 1: **DIRECT INPUT 7 DEVICE ID**: "2"
DIRECT INPUT 7 BIT NUMBER: "3"
DIRECT INPUT 7 DEFAULT STATE: select "On" for security, select "Off" for dependability

DIRECT INPUT 8 DEVICE ID: "3"
DIRECT INPUT 8 BIT NUMBER: "3"
DIRECT INPUT 8 DEFAULT STATE: select "On" for security, select "Off" for dependability

DIRECT INPUT 9 DEVICE ID: "4"
DIRECT INPUT 9 BIT NUMBER: "3"
DIRECT INPUT 9 DEFAULT STATE: select "On" for security, select "Off" for dependability

Now the three blocking signals are available in UR IED 1 as "DIRECT INPUT 7 ON", "DIRECT INPUT 8 ON", and "DIRECT INPUT 9 ON". Upon losing communications or a device, the scheme is inclined to block (if any default state is set to "ON"), or to trip the bus on any overcurrent condition (all default states set to "OFF").

EXAMPLE 2: PILOT-AIDED SCHEMES

Consider a three-terminal line protection application shown in the figure below.

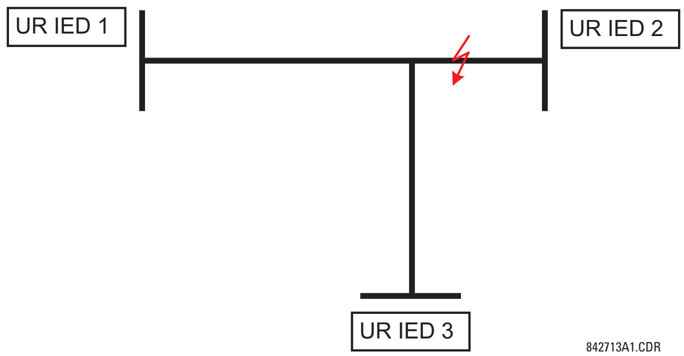


Figure 5–34: THREE-TERMINAL LINE APPLICATION

Assume the Hybrid Permissive Overreaching Transfer Trip (Hybrid POTT) scheme is applied using the architecture shown below. The scheme output operand HYB POTT TX1 is used to key the permission.

5

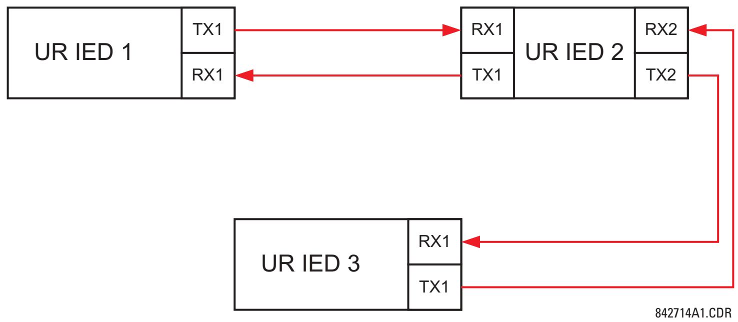


Figure 5–35: SINGLE-CHANNEL OPEN-LOOP CONFIGURATION

In the above architecture, Devices 1 and 3 do not communicate directly. Therefore, Device 2 must act as a "bridge". The following settings should be applied:

UR IED 1: **DIRECT OUT 2 OPERAND:** "HYB POTT TX1"
DIRECT INPUT 5 DEVICE ID: "2"
DIRECT INPUT 5 BIT NUMBER: "2" (this is a message from IED 2)
DIRECT INPUT 6 DEVICE ID: "2"
DIRECT INPUT 6 BIT NUMBER: "4" (effectively, this is a message from IED 3)

UR IED 3: **DIRECT OUT 2 OPERAND:** "HYB POTT TX1"
DIRECT INPUT 5 DEVICE ID: "2"
DIRECT INPUT 5 BIT NUMBER: "2" (this is a message from IED 2)
DIRECT INPUT 6 DEVICE ID: "2"
DIRECT INPUT 6 BIT NUMBER: "3" (effectively, this is a message from IED 1)

UR IED 2: **DIRECT INPUT 5 DEVICE ID:** "1"
DIRECT INPUT 5 BIT NUMBER: "2"
DIRECT INPUT 6 DEVICE ID: "3"
DIRECT INPUT 6 BIT NUMBER: "2"
DIRECT OUT 2 OPERAND: "HYB POTT TX1"
DIRECT OUT 3 OPERAND: "DIRECT INPUT 5" (forward a message from 1 to 3)
DIRECT OUT 4 OPERAND: "DIRECT INPUT 6" (forward a message from 3 to 1)

Signal flow between the three IEDs is shown in the figure below:

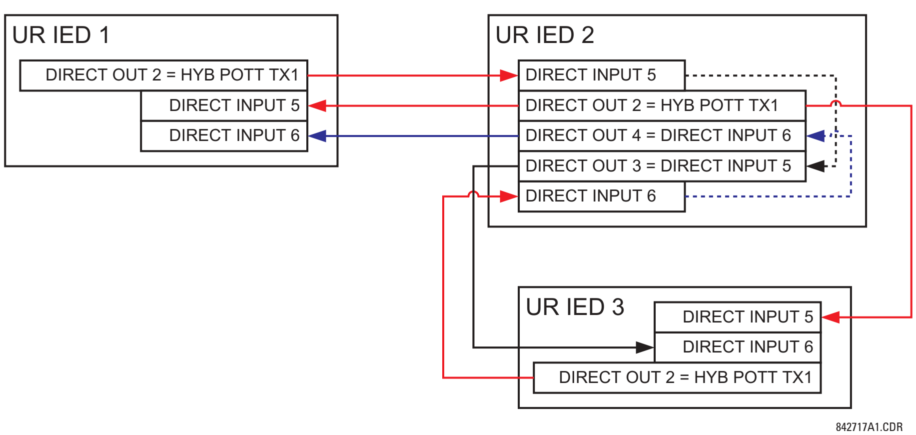


Figure 5–36: SIGNAL FLOW FOR DIRECT I/O EXAMPLE 3

In three-terminal applications, both the remote terminals must grant permission to trip. Therefore, at each terminal, Direct Inputs 5 and 6 should be ANDed in FlexLogic™ and the resulting operand configured as the permission to trip (**HYB POTT RX1** setting).

5

5.6.1 DCMA INPUTS

PATH: SETTINGS ⇨⇩ TRANSDUCER I/O ⇨⇩ DCMA INPUTS

```
■ DCMA INPUTS          ◄►   ■ DCMA INPUT H1
■                           ■
                              ↓
                              ↓
              MESSAGE  ▲    ■ DCMA INPUT U8
                            ■
```

Hardware and software is provided to receive signals from external transducers and convert these signals into a digital format for use as required. The relay will accept inputs in the range of –1 to +20 mA DC, suitable for use with most common transducer output ranges; all inputs are assumed to be linear over the complete range. Specific hardware details are contained in Chapter 3.

Before the dcmA input signal can be used, the value of the signal measured by the relay must be converted to the range and quantity of the external transducer primary input parameter, such as DC voltage or temperature. The relay simplifies this process by internally scaling the output from the external transducer and displaying the actual primary parameter.

dcmA input channels are arranged in a manner similar to CT and VT channels. The user configures individual channels with the settings shown here.

The channels are arranged in sub-modules of two channels, numbered from 1 through 8 from top to bottom. On power-up, the relay will automatically generate configuration settings for every channel, based on the order code, in the same general manner that is used for CTs and VTs. Each channel is assigned a slot letter followed by the row number, 1 through 8 inclusive, which is used as the channel number. The relay generates an actual value for each available input channel.

Settings are automatically generated for every channel available in the specific relay as shown below for the first channel of a type 5F transducer module installed in slot M.

```
■ DCMA INPUT M1        ◄►   DCMA INPUT M1           Range: Disabled, Enabled
■                           FUNCTION: Disabled

              MESSAGE  ▲▼   DCMA INPUT M1 ID:       Range: up to 20 alphanumeric characters
                            DCMA Ip 1

              MESSAGE  ▲▼   DCMA INPUT M1           Range: 6 alphanumeric characters
                            UNITS: µA

              MESSAGE  ▲▼   DCMA INPUT M1           Range: 0 to –1 mA, 0 to +1 mA, –1 to +1 mA, 0 to 5 mA,
                            RANGE: 0 to -1 mA              0 to 10mA, 0 to 20 mA, 4 to 20 mA

              MESSAGE  ▲▼   DCMA INPUT M1 MIN       Range: –9999.999 to +9999.999 in steps of 0.001
                            VALUE:     0.000

              MESSAGE  ▲    DCMA INPUT M1 MAX       Range: –9999.999 to +9999.999 in steps of 0.001
                            VALUE:     0.000
```

The function of the channel may be either "Enabled" or "Disabled." If "Disabled", no actual values are created for the channel. An alphanumeric "ID" is assigned to each channel; this ID will be included in the channel actual value, along with the programmed units associated with the parameter measured by the transducer, such as Volt, °C, MegaWatts, etc. This ID is also used to reference the channel as the input parameter to features designed to measure this type of parameter. The **DCMA INPUT XX RANGE** setting specifies the mA DC range of the transducer connected to the input channel.

The **DCMA INPUT XX MIN VALUE** and **DCMA INPUT XX MAX VALUE** settings are used to program the span of the transducer in primary units. For example, a temperature transducer might have a span from 0 to 250°C; in this case the **DCMA INPUT XX MIN VALUE** value is "0" and the **DCMA INPUT XX MAX VALUE** value is "250". Another example would be a Watt transducer with a span from –20 to +180 MW; in this case the **DCMA INPUT XX MIN VALUE** value would be "–20" and the **DCMA INPUT XX MAX VALUE** value "180". Intermediate values between the min and max values are scaled linearly.

5.6.2 RTD INPUTS

PATH: SETTINGS ⇨⇩ TRANSDUCER I/O ⇨⇩ RTD INPUTS

```
■ RTD INPUTS          ◀▶   ■ RTD INPUT H1
■                          ■
                              ↓
                              ↓
            MESSAGE   ▲    ■ RTD INPUT U8
                           ■
```

Hardware and software is provided to receive signals from external Resistance Temperature Detectors and convert these signals into a digital format for use as required. These channels are intended to be connected to any of the RTD types in common use. Specific hardware details are contained in Chapter 3.

RTD input channels are arranged in a manner similar to CT and VT channels. The user configures individual channels with the settings shown here.

The channels are arranged in sub-modules of two channels, numbered from 1 through 8 from top to bottom. On power-up, the relay will automatically generate configuration settings for every channel, based on the order code, in the same general manner that is used for CTs and VTs. Each channel is assigned a slot letter followed by the row number, 1 through 8 inclusive, which is used as the channel number. The relay generates an actual value for each available input channel.

Settings are automatically generated for every channel available in the specific relay as shown below for the first channel of a type 5C transducer module installed in slot M.


```
■ RTD INPUT M5        ◀▶   RTD INPUT M5           Range: Disabled, Enabled
■                          FUNCTION: Disabled

            MESSAGE   ▲▼   RTD INPUT M5 ID:       Range: Up to 20 alphanumeric characters
                           RTD Ip 1

            MESSAGE   ▲    RTD INPUT M5 TYPE:     Range: 100Ω Nickel, 10Ω Copper, 100Ω Platinum,
                           100Ω Nickel                   120Ω Nickel
```

The function of the channel may be either “Enabled” or “Disabled.” If Disabled, there will not be an actual value created for the channel. An alphanumeric “ID” is assigned to the channel; this ID will be included in the channel actual values. It is also used to reference the channel as the input parameter to features designed to measure this type of parameter. Selecting the type of RTD connected to the channel configures the channel.

Actions based on RTD overtemperature, such as trips or alarms, are done in conjunction with the FlexElements™ feature. In FlexElements™, the operate level is scaled to a base of 100°C. For example, a trip level of 150°C is achieved by setting the operate level at 1.5 pu. FlexElement™ operands are available to FlexLogic™ for further interlocking or to operate an output contact directly.

5.7.1 TEST MODE

PATH: SETTINGS ⇨⇩ TESTING ⇨ TEST MODE

■■ SETTINGS ■■ TESTING	◁▷	TEST MODE FUNCTION: Disabled	Range: Disabled, Enabled
MESSAGE	△	TEST MODE INITIATE: On	Range: FlexLogic™ operand

The relay provides test settings to verify that functionality using simulated conditions for contact inputs and outputs. The Test Mode is indicated on the relay faceplate by a flashing Test Mode LED indicator.

To initiate the Test mode, the **TEST MODE FUNCTION** setting must be "Enabled" and the **TEST MODE INITIATE** setting must be set to Logic 1. In particular:

- To initiate Test Mode through relay settings, set **TEST MODE INITIATE** to "On". The Test Mode starts when the **TEST MODE FUNCTION** setting is changed from "Disabled" to "Enabled".
- To initiate Test Mode through a user-programmable condition, such as FlexLogic™ operand (pushbutton, digital input, communication-based input, or a combination of these), set **TEST MODE FUNCTION** to "Enabled" and set **TEST MODE INITIATE** to the desired operand. The Test Mode starts when the selected operand assumes a Logic 1 state.

When in Test Mode, the C30 remains fully operational, allowing for various testing procedures. In particular, the protection and control elements, FlexLogic™, and communication-based inputs and outputs function normally.

The only difference between the normal operation and the Test Mode is the behavior of the input and output contacts. The former can be forced to report as open or closed or remain fully operational; the latter can be forced to open, close, freeze, or remain fully operational. The response of the digital input and output contacts to the Test Mode is programmed individually for each input and output using the Force Contact Inputs and Force Contact Outputs test functions described in the following sections.

5.7.2 FORCE CONTACT INPUTS

PATH: SETTINGS ⇨⇩ TESTING ⇨⇩ FORCE CONTACT INPUTS

■ FORCE CONTACT ■ INPUTS	◁▷	FORCE Cont Ip 1: Disabled	Range: Disabled, Open, Closed
MESSAGE	△▽	FORCE Cont Ip 2: Disabled	Range: Disabled, Open, Closed
		↓	
MESSAGE	△	FORCE Cont Ip xx: Disabled	Range: Disabled, Open, Closed

The relay digital inputs (contact inputs) could be pre-programmed to respond to the Test Mode in the following ways:

- If set to "Disabled", the input remains fully operational. It is controlled by the voltage across its input terminals and can be turned on and off by external circuitry. This value should be selected if a given input must be operational during the test. This includes, for example, an input initiating the test, or being a part of a user pre-programmed test sequence.
- If set to "Open", the input is forced to report as opened (Logic 0) for the entire duration of the Test Mode regardless of the voltage across the input terminals.
- If set to "Closed", the input is forced to report as closed (Logic 1) for the entire duration of the Test Mode regardless of the voltage across the input terminals.

The Force Contact Inputs feature provides a method of performing checks on the function of all contact inputs. Once enabled, the relay is 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 "Disabled", "Open", or "Closed". All contact input operations return to normal when all settings for this feature are disabled.

5.7.3 FORCE CONTACT OUTPUTS

PATH: SETTINGS ⇨⇩ TESTING ⇨⇩ FORCE CONTACT OUTPUTS

■ FORCE CONTACT ■ OUTPUTS	◀▶	FORCE Cont Op 1: Disabled	*Range: Disabled, Energized, De-energized, Freeze*
MESSAGE	▲▼	FORCE Cont Op 2: Disabled	*Range: Disabled, Energized, De-energized, Freeze*
		↓	
MESSAGE	▲	FORCE Cont Op xx: Disabled	*Range: Disabled, Energized, De-energized, Freeze*

The relay contact outputs can be pre-programmed to respond to the Test Mode.

If set to “Disabled”, the contact output remains fully operational. If operates when its control operand is Logic 1 and will resets when its control operand is Logic 0. If set to “Energize”, the output will close and remain closed for the entire duration of the Test Mode, regardless of the status of the operand configured to control the output contact. If set to “De-energize”, the output will open and remain opened for the entire duration of the Test Mode regardless of the status of the operand configured to control the output contact. If set to “Freeze”, the output retains its position from before entering the Test Mode, regardless of the status of the operand configured to control the output contact.

These settings are applied two ways. First, external circuits may be tested by energizing or de-energizing contacts. Second, by controlling the output contact state, relay logic may be tested and undesirable effects on external circuits avoided.

5

Example 1: Initiating a Test from User-Programmable Pushbutton 1

The Test Mode should be initiated from User-Programmable Pushbutton 1. The pushbutton will be programmed as “Latched” (pushbutton pressed to initiate the test, and pressed again to terminate the test). During the test, Digital Input 1 should remain operational, Digital Inputs 2 and 3 should open, and Digital Input 4 should close. Also, Contact Output 1 should freeze, Contact Output 2 should open, Contact Output 3 should close, and Contact Output 4 should remain fully operational. The required settings are shown below.

To enable User-Programmable Pushbutton 1 to initiate the Test mode, make the following changes in the **SETTINGS ⇨⇩ TESTING ⇨ TEST MODE** menu:

TEST MODE FUNCTION: “Enabled” and **TEST MODE INITIATE:** “PUSHBUTTON 1 ON”

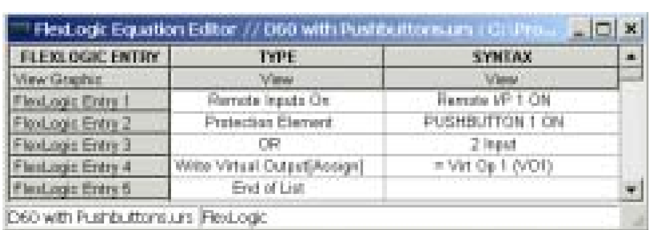
Make the following changes to configure the Contact I/Os. In the **SETTINGS ⇨⇩ TESTING ⇨⇩ FORCE CONTACT INPUTS** and **FORCE CONTACT INPUTS** menus, set:

FORCE Cont Ip 1: “Disabled”, **FORCE Cont Ip 2:** “Open”, **FORCE Cont Ip 3:** “Open”, and **FORCE Cont Ip 4:** “Closed”
FORCE Cont Op 1: “Freeze”, **FORCE Cont Op 2:** “De-energized”, **FORCE Cont Op 3:** “Open”, and **FORCE Cont Op 4:** “Disabled”

Example 2: Initiating a Test from User-Programmable Pushbutton 1 or through Remote Input 1

The Test should be initiated locally from User-Programmable Pushbutton 1 or remotely through Remote Input 1. Both the pushbutton and the remote input will be programmed as “Latched”. The required settings are shown below.

Write the following FlexLogic™ equation (URPC example shown):



Set the User Programmable Pushbutton as latching by changing **SETTINGS ⇨ PRODUCT SETUP ⇨⇩ USER-PROGRAMMABLE PUSHBUTTONS ⇨ USER PUSHBUTTON 1 ⇨ PUSHBUTTON 1 FUNCTION** to “Latched”. To enable either Pushbutton 1 or Remote Input 1 to initiate the Test mode, make the following changes in the **SETTINGS ⇨⇩ TESTING ⇨ TEST MODE** menu:

TEST MODE FUNCTION: “Enabled” and **TEST MODE INITIATE:** “VO1”

6.1.1 ACTUAL VALUES MAIN MENU

■■ ACTUAL VALUES ■■ STATUS	■ CONTACT INPUTS ■	See page 6-3.
	■ VIRTUAL INPUTS ■	See page 6-3.
	■ REMOTE INPUTS ■	See page 6-3.
	■ CONTACT OUTPUTS ■	See page 6-4.
	■ VIRTUAL OUTPUTS ■	See page 6-4.
	■ REMOTE DEVICES ■ STATUS	See page 6-4.
	■ REMOTE DEVICES ■ STATISTICS	See page 6-5.
	■ SELECTOR SWITCHES ■	See page 6-5.
	■ DIGITAL COUNTERS ■	See page 6-5.
	■ FLEX STATES ■	See page 6-5.
	■ ETHERNET ■	See page 6-6.
	■ DIRECT INPUTS ■	See page 6-6.
	■ DIRECT DEVICES ■ STATUS	See page 6-7.

■■ ACTUAL VALUES ■■ METERING	■ FLEXELEMENTS ■	See page 6-8.
	■ TRANSDUCER I/O ■ DCMA INPUTS	See page 6-8.
	■ TRANSDUCER I/O ■ RTD INPUTS	See page 6-8.

■■ ACTUAL VALUES ■■ RECORDS	■ EVENT RECORDS ■	See page 6-9.
	■ OSCILLOGRAPHY ■	See page 6-9.
	■ DATA LOGGER ■	See page 6-9.

■■ ACTUAL VALUES ■■ PRODUCT INFO		■ MODEL INFORMATION ■	See page 6-10.
		■ FIRMWARE REVISIONS ■	See page 6-10.

6.2.1 CONTACT INPUTS

PATH: ACTUAL VALUES ⇨ STATUS ⇨ CONTACT INPUTS

```
■ CONTACT INPUTS          Cont Ip 1
■                         Off
                              ↓
                              ↓
MESSAGE                   Cont Ip xx
                          Off
```

The present status of the contact inputs is shown here. The first line of a message display indicates the ID of the contact input. For example, ‘Cont Ip 1’ refers to the contact input in terms of the default name-array index. The second line of the display indicates the logic state of the contact input.

6.2.2 VIRTUAL INPUTS

PATH: ACTUAL VALUES ⇨ STATUS ⇨⇩ VIRTUAL INPUTS

```
■ VIRTUAL INPUTS          Virt Ip 1
■                         Off
                              ↓
                              ↓
MESSAGE                   Virt Ip 32
                          Off
```

The present status of the 32 virtual inputs is shown here. The first line of a message display indicates the ID of the virtual input. For example, ‘Virt Ip 1’ refers to the virtual input in terms of the default name-array index. The second line of the display indicates the logic state of the virtual input.

6

6.2.3 REMOTE INPUTS

PATH: ACTUAL VALUES ⇨ STATUS ⇨⇩ REMOTE INPUTS

```
■ REMOTE INPUTS           REMOTE INPUT  1      Range: On, Off
■                         STATUS: Off
                              ↓
                              ↓
MESSAGE                   REMOTE INPUT 32      Range: On, Off
                          STATUS: Off
```

The present state of the 32 remote inputs is shown here.

The state displayed will be that of the remote point unless the remote device has been established to be "Offline" in which case the value shown is the programmed default state for the remote input.

6.2.4 CONTACT OUTPUTS

PATH: ACTUAL VALUES ⇨ STATUS ⇨⇩ CONTACT OUTPUTS

```
■ CONTACT OUTPUTS        Cont Op 1
■                        Off
                              ↓
MESSAGE                  Cont Op xx
                         Off
```

The present state of the contact outputs is shown here. The first line of a message display indicates the ID of the contact output. For example, ‘Cont Op 1’ refers to the contact output in terms of the default name-array index. The second line of the display indicates the logic state of the contact output.

NOTE

For Form-A outputs, the state of the voltage(V) and/or current(I) detectors will show as: Off, VOff, IOff, On, VOn, and/or IOn. For Form-C outputs, the state will show as Off or On.

6.2.5 VIRTUAL OUTPUTS

PATH: ACTUAL VALUES ⇨ STATUS ⇨⇩ VIRTUAL OUTPUTS

```
■ VIRTUAL OUTPUTS        Virt Op 1
■                        Off
                              ↓
MESSAGE                  Virt Op 64
                         Off
```

The present state of up to 64 virtual outputs is shown here. The first line of a message display indicates the ID of the virtual output. For example, ‘Virt Op 1’ refers to the virtual output in terms of the default name-array index. The second line of the display indicates the logic state of the virtual output, as calculated by the FlexLogic™ equation for that output.

6

6.2.6 REMOTE DEVICES

a) STATUS

PATH: ACTUAL VALUES ⇨ STATUS ⇨⇩ REMOTE DEVICES STATUS

```
■ REMOTE DEVICES         All REMOTE DEVICES       Range: Yes, No
■ STATUS                 ONLINE: No

MESSAGE                  REMOTE DEVICE  1         Range: Online, Offline
                         STATUS: Offline
                              ↓
MESSAGE                  REMOTE DEVICE 16         Range: Online, Offline
                         STATUS: Offline
```

The present state of up to 16 programmed Remote Devices is shown here. The **ALL REMOTE DEVICES ONLINE** message indicates whether or not all programmed Remote Devices are online. If the corresponding state is "No", then at least one required Remote Device is not online.

b) STATISTICS

PATH: ACTUAL VALUES ⇨ STATUS ⇨⇩ REMOTE DEVICES STATISTICS ⇨ REMOTE DEVICE 1(16)

```
■ REMOTE DEVICE  1        REMOTE DEVICE  1
■                         StNum:         0

MESSAGE                   REMOTE DEVICE  1
                          SqNum:         0
```

Statistical data (2 types) for up to 16 programmed Remote Devices is shown here.

The **StNum** number is obtained from the indicated Remote Device and is incremented whenever a change of state of at least one DNA or UserSt bit occurs. The **SqNum** number is obtained from the indicated Remote Device and is incremented whenever a GOOSE message is sent. This number will rollover to zero when a count of 4,294,967,295 is incremented.

6.2.7 SELECTOR SWITCHES

PATH: ACTUAL VALUES ⇨ STATUS ⇨⇩ SELECTOR SWITCHES

```
■ SELECTOR SWITCHES       SELECTOR SWITCH 1       Range: Current Position / 7
■                         POSITION: 1/7

MESSAGE                   SELECTOR SWITCH 2       Range: Current Position / 7
                          POSITION: 1/7
```

The display shows both the current position and the full range. The current position only (an integer from 0 through 7) is the actual value.

6.2.8 DIGITAL COUNTERS

PATH: ACTUAL VALUES ⇨ DIGITAL COUNTERS ⇨⇩ DIGITAL COUNTERS ⇨ DIGITAL COUNTERS Counter 1(8)

```
■ DIGITAL COUNTERS        Counter 1      ACCUM:
■ Counter 1                        0

MESSAGE                   Counter 1     FROZEN:
                                   0

MESSAGE                   Counter 1     FROZEN:
                          YYYY/MM/DD HH:MM:SS

MESSAGE                   Counter 1     MICROS:
                                   0
```

The present status of the 8 digital counters is shown here. The status of each counter, with the user-defined counter name, includes the accumulated and frozen counts (the count units label will also appear). Also included, is the date/time stamp for the frozen count. The **Counter n MICROS** value refers to the microsecond portion of the time stamp.

6.2.9 FLEX STATES

PATH: ACTUAL VALUES ⇨ STATUS ⇨⇩ FLEX STATES

```
■ FLEX STATES             PARAM   1: Off          Range: Off, On
■                         Off
                                  ↓
MESSAGE                   PARAM 256: Off          Range: Off, On
                          Off
```

There are 256 FlexState bits available. The second line value indicates the state of the given FlexState bit.

6

6.2.10 ETHERNET

PATH: ACTUAL VALUES ⇨ STATUS ⇨⇩ ETHERNET

■ ETHERNET ■		ETHERNET PRI LINK STATUS: OK	Range: Fail, OK
MESSAGE		ETHERNET SEC LINK STATUS: OK	Range: Fail, OK

6.2.11 DIRECT INPUTS

PATH: ACTUAL VALUES ⇨ STATUS ⇨⇩ DIRECT INPUTS

■ DIRECT INPUTS ■	AVG MSG RETURN TIME CH1: 0 ms
MESSAGE	UNRETURNED MSG COUNT CH1: 0
MESSAGE	CRC FAIL COUNT CH1: 0
MESSAGE	AVG MSG RETURN TIME CH2: 0 ms
MESSAGE	UNRETURNED MSG COUNT CH2: 0
MESSAGE	CRC FAIL COUNT CH2: 0
MESSAGE	DIRECT INPUT 1: On
	↓
MESSAGE	DIRECT INPUT 32: On

The **AVERAGE MSG RETURN TIME** is the time taken for Direct Output messages to return to the sender in a Direct I/O ring configuration (this value is not applicable for non-ring configurations). This is a rolling average calculated for the last 10 messages. There are two return times for dual-channel communications modules.

The **UNRETURNED MSG COUNT** values (one per communications channel) count the Direct Output messages that do not make the trip around the communications ring. The **CRC FAIL COUNT** values (one per communications channel) count the Direct Output messages that have been received but fail the CRC check. High values for either of these counts may indicate on a problem with wiring, the communication channel, or the relay(s). The **UNRETURNED MSG COUNT** and **CRC FAIL COUNT** values can be cleared using the **CLEAR DIRECT I/O COUNTERS** command.

The **DIRECT INPUT x** values represent the state of the *x*-th Direct Input.

6.2.12 DIRECT DEVICES STATUS

PATH: ACTUAL VALUES ⇨ STATUS ⇨⇩ DIRECT DEVICES STATUS

■ DIRECT DEVICES ■ STATUS		◀▶	DIRECT DEVICE 1 STATUS: Offline
	MESSAGE	▲▼	DIRECT DEVICE 2 STATUS: Offline
			↓
	MESSAGE	▲	DIRECT DEVICE 8 STATUS: Offline

These actual values represent the state of Direct Devices 1 through 8.

6

6.3.1 FLEXELEMENTS™

PATH: ACTUAL VALUES ⇨⇩ METERING ⇨⇩ FLEXELEMENTS ⇨ FLEXELEMENT 1(8)

```
■ FLEXELEMENT 1          FLEXELEMENT 1 OpSig:
■                        0.000 pu
```

The operating signals for the FlexElements are displayed in pu values using the following definitions of the base units.

Table 6–1: FLEXELEMENT™ BASE UNITS

dcmA	BASE = maximum value of the **DCMA INPUT MAX** setting for the two transducers configured under the +IN and –IN inputs.
RTDs	BASE = 100°C

6.3.2 TRANSDUCER I/O

PATH: ACTUAL VALUES ⇨⇩ METERING ⇨⇩ TRANSDUCER I/O DCMA INPUTS ⇨ DCMA INPUT xx

```
■ DCMA INPUT xx          DCMA INPUT xx
■                        0.000 mA
```

Actual values for each dcmA input channel that is Enabled are displayed with the top line as the programmed Channel “ID” and the bottom line as the value followed by the programmed units.

PATH: ACTUAL VALUES ⇨⇩ METERING ⇨⇩ TRANSDUCER I/O RTD INPUTS ⇨ RTD INPUT xx

```
■ RTD INPUT xx           RTD INPUT xx
■                        -50 °C
```

Actual values for each RTD input channel that is Enabled are displayed with the top line as the programmed Channel “ID” and the bottom line as the value.

6

6.4.1 EVENT RECORDS

PATH: ACTUAL VALUES ⇨⇩ RECORDS ⇨⇩ EVENT RECORDS

```
■ EVENT RECORDS          EVENT: XXXX
■                        RESET OP(PUSHBUTTON)
                                 ↓
MESSAGE                  EVENT: 3                EVENT 3
                         POWER ON                DATE: 2000/07/14

MESSAGE                  EVENT: 2                EVENT 3
                         POWER OFF               TIME: 14:53:00.03405

MESSAGE                  EVENT: 1                Date and Time Stamps
                         EVENTS CLEARED
```

The Event Records menu shows the contextual data associated with up to the last 1024 events, listed in chronological order from most recent to oldest. If all 1024 event records have been filled, the oldest record will be removed as a new record is added. Each event record shows the event identifier/sequence number, cause, and date/time stamp associated with the event trigger. Refer to the **COMMANDS ⇩ CLEAR RECORDS** menu for clearing event records.

6.4.2 OSCILLOGRAPHY

PATH: ACTUAL VALUES ⇨⇩ RECORDS ⇨⇩ OSCILLOGRAPHY

```
■ OSCILLOGRAPHY          FORCE TRIGGER?           Range: No, Yes
■                        No

MESSAGE                  NUMBER OF TRIGGERS:
                              0

MESSAGE                  AVAILABLE RECORDS:
                              0

MESSAGE                  CYCLES PER RECORD:
                            0.0

MESSAGE                  LAST CLEARED DATE:
                         2000/07/14 015:40:16
```

This menu allows the user to view the number of triggers involved and number of oscillography traces available. The ‘cycles per record’ value is calculated to account for the fixed amount of data storage for oscillography. See the Oscillography section of Chapter 5 for further details.

A trigger can be forced here at any time by setting "Yes" to the **FORCE TRIGGER?** command. Refer to the **COMMANDS ⇨⇩ CLEAR RECORDS** menu for clearing the oscillography records.

6.4.3 DATA LOGGER

PATH: ACTUAL VALUES ⇨⇩ RECORDS ⇨⇩ DATA LOGGER

```
■ DATA LOGGER            OLDEST SAMPLE TIME:
■                        2000/01/14 13:45:51

MESSAGE                  NEWEST SAMPLE TIME:
                         2000/01/14 15:21:19
```

The **OLDEST SAMPLE TIME** is the time at which the oldest available samples were taken. It will be static until the log gets full, at which time it will start counting at the defined sampling rate. The **NEWEST SAMPLE TIME** is the time the most recent samples were taken. It counts up at the defined sampling rate. If Data Logger channels are defined, then both values are static.

Refer to the **COMMANDS ⇨⇩ CLEAR RECORDS** menu for clearing data logger records.

6.5.1 MODEL INFORMATION

PATH: ACTUAL VALUES ⇨⇩ PRODUCT INFO ⇨ MODEL INFORMATION

■ MODEL INFORMATION ■	◁▷	ORDER CODE LINE 1: C30-A00-HCH-F8A-H8A-	*Example code shown*
MESSAGE	△▽	ORDER CODE LINE 2:	
MESSAGE	△▽	ORDER CODE LINE 3:	
MESSAGE	△▽	ORDER CODE LINE 4:	
MESSAGE	△▽	SERIAL NUMBER:	
MESSAGE	△▽	ETHERNET MAC ADDRESS 000000000000	
MESSAGE	△▽	MANUFACTURING DATE: 0	*Range: YYYY/MM/DD HH:MM:SS*
MESSAGE	△	OPERATING TIME: 0:00:00	

The product order code, serial number, Ethernet MAC address, date/time of manufacture, and operating time are shown here.

6.5.2 FIRMWARE REVISIONS

6

PATH: ACTUAL VALUES ⇨⇩ PRODUCT INFO ⇨⇩ FIRMWARE REVISIONS

■ FIRMWARE REVISIONS ■	◁▷	C30 Controller REVISION: 3.30	*Range: 0.00 to 655.35 Revision number of the application firmware.*
MESSAGE	△▽	MODIFICATION FILE NUMBER: 0	*Range: 0 to 65535 (ID of the MOD FILE) Value is 0 for each standard firmware release.*
MESSAGE	△▽	BOOT PROGRAM REVISION: 1.12	*Range: 0.00 to 655.35 Revision number of the boot program firmware.*
MESSAGE	△▽	FRONT PANEL PROGRAM REVISION: 0.08	*Range: 0.00 to 655.35 Revision number of faceplate program firmware.*
MESSAGE	△▽	COMPILE DATE: 2000/09/08 04:55:16	*Range: Any valid date and time. Date and time when product firmware was built.*
MESSAGE	△	BOOT DATE: 2000/05/11 16:41:32	*Range: Any valid date and time. Date and time when the boot program was built.*

The shown data is illustrative only. A modification file number of 0 indicates that, currently, no modifications have been installed.

7.1.1 COMMANDS MENU

```
MENU
COMMANDS
    ⇩
MESSAGE    ■■ COMMANDS
           ■■ VIRTUAL INPUTS

MESSAGE    ■■ COMMANDS
           ■■ CLEAR RECORDS

MESSAGE    ■■ COMMANDS
           ■■ SET DATE AND TIME

MESSAGE    ■■ COMMANDS
           ■■ RELAY MAINTENANCE
```

The Commands menu contains relay directives intended for operations personnel. All commands can be protected from unauthorized access via the Command Password; see the Password Security section of Chapter 5. The following flash message appears after successfully command entry:

```
COMMAND
EXECUTED
```

7.1.2 VIRTUAL INPUTS

PATH: COMMANDS ⇩ COMMANDS VIRTUAL INPUTS

```
■■ COMMANDS              Virt Ip 1      Range: Off, On
■■ VIRTUAL INPUTS        Off
                            ↓
                            ↓
MESSAGE                  Virt Ip 32     Range: Off, On
                         Off
```

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

7.1.3 CLEAR RECORDS

PATH: COMMANDS ⇩ COMMANDS CLEAR RECORDS

■■ COMMANDS ■■ CLEAR RECORDS	CLEAR EVENT RECORDS? No	*Range: No, Yes*
	CLEAR OSCILLOGRAPHY? No	*Range: No, Yes*
	CLEAR DATA LOGGER? No	*Range: No, Yes*
	RESET UNAUTHORIZED ACCESS: No	*Range: No, Yes*
	CLEAR DIRECT I/O COUNTERS: No	*Range: No, Yes* *Valid only for units with Direct I/O module.*
	CLEAR ALL RELAY RECORDS: No	*Range: No, Yes*

This menu contains commands for clearing historical data such as the Event Records. Data is cleard by changing a command setting to "Yes" and pressing the ENTER key. After clearing data, the command setting automatically reverts to "No".

7.1.4 SET DATE AND TIME

PATH: COMMANDS ⇩ SET DATE AND TIME

■■ COMMANDS ■■ SET DATE AND TIME	SET DATE AND TIME: 2000/01/14 13:47:03	*(YYYY/MM/DD HH:MM:SS)*

The date and time can be entered here via the faceplate keypad only if the IRIG-B signal is not in use. The time setting is based on the 24-hour clock. The complete date, as a minimum, must be entered to allow execution of this command. The new time will take effect at the moment the ENTER key is clicked.

7.1.5 RELAY MAINTENANCE

PATH: COMMANDS ⇩ RELAY MAINTENANCE

■■ COMMANDS ■■ RELAY MAINTENANCE	PERFORM LAMPTEST? No	*Range: No, Yes*
	UPDATE ORDER CODE? No	*Range: No, Yes*

This menu contains commands for relay maintenance purposes. Commands are activated by changing a command setting to “Yes” and pressing the ENTER key. The command setting will then automatically revert to “No”.

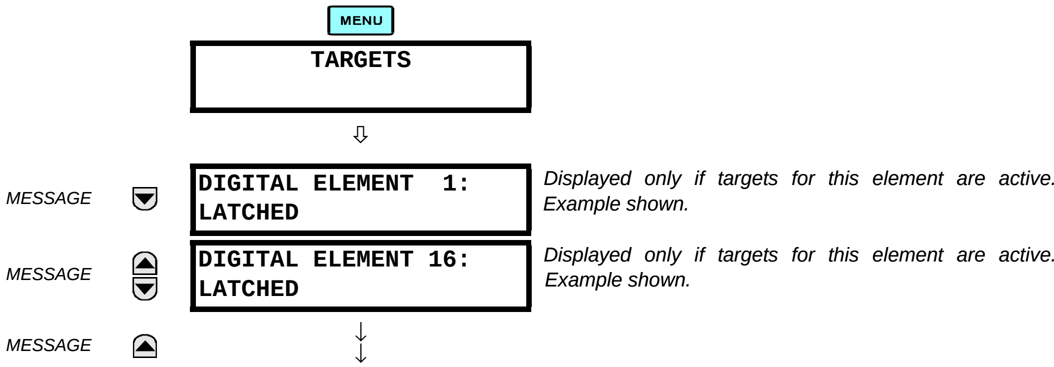
The **PERFORM LAMPTEST** command turns on all faceplate LEDs and display pixels for a short duration. The **UPDATE ORDER CODE** command causes the relay to scan the backplane for the hardware modules and update the order code to match. If an update occurs, the following message is shown.

```
UPDATING...
PLEASE WAIT
```

There is no impact if there have been no changes to the hardware modules. When an update does not occur, the **ORDER CODE NOT UPDATED** message will be shown.

7

7.2.1 TARGETS MENU



The status of any active targets will be displayed in the Targets menu. If no targets are active, the display will read **No Active Targets**:

7.2.2 TARGET MESSAGES

When there are no active targets, 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, and 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 message.

The range of variables for the target messages is described below. Phase information will be included if applicable. If a target message 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 timed out
3	LATCHED	element had operated but has dropped out

If a self test error is detected, a message appears indicating the cause of the error. For example **UNIT NOT PROGRAMMED** indicates that the minimal relay settings have not been programmed.

7.2.3 RELAY SELF-TESTS

The relay performs a number of self-test diagnostic checks to ensure device integrity. The two types of self-tests (major and minor) are listed in the tables below. When either type of self-test error occurs, the Trouble LED Indicator will turn on and a target message displayed. All errors record an event in the event recorder. Latched errors can be cleared by pressing the RESET key, providing the condition is no longer present.

Major self-test errors also result in the following:

- the critical fail relay on the power supply module is de-energized
- all other output relays are de-energized and are prevented from further operation
- the faceplate In Service LED indicator is turned off
- a RELAY OUT OF SERVICE event is recorded

Most of the minor self-test errors can be disabled. Refer to the settings in the User-Programmable Self-Tests section in Chapter 5 for additional details.

Table 7–2: MAJOR SELF-TEST ERROR MESSAGES

SELF-TEST ERROR MESSAGE	LATCHED TARGET MESSAGE?	DESCRIPTION OF PROBLEM	HOW OFTEN THE TEST IS PERFORMED	WHAT TO DO
EQUIPMENT MISMATCH with 2nd-line detail message	No	Configuration of modules does not match the order code stored in the CPU.	On power up; thereafter, the backplane is checked for missing cards every 5 seconds.	Check all modules against the order code, ensure they are inserted properly, and cycle control power (if problem persists, contact factory).
FLEXLOGIC ERR TOKEN with 2nd-line detail message	No	FlexLogic™ equations do not compile properly.	Event driven; whenever FlexLogic™ equations are modified.	Finish all equation editing and use self test to debug any errors.
LATCHING OUTPUT ERROR	No	Discrepancy in the position of a latching contact between relay firmware and hardware has been detected.	Every 1/8th of a cycle.	Latching output module failed. Replace the Module.
PROGRAM MEMORY Test Failed	Yes	Error was found while checking Flash memory.	Once flash is uploaded with new firmware.	Contact the factory.
UNIT NOT CALIBRATED	No	Settings indicate the unit is not calibrated.	On power up.	Contact the factory.
UNIT NOT PROGRAMMED	No	**PRODUCT SETUP** ⇨⇩ **INSTALLATION** setting indicates relay is not in a programmed state.	On power up and whenever the **RELAY PROGRAMMED** setting is altered.	Program all settings (especially those under **PRODUCT SETUP** ⇨⇩ **INSTALLATION**).

Table 7–3: MINOR SELF-TEST ERROR MESSAGES

SELF-TEST ERROR MESSAGE	LATCHED TARGET MESSAGE	DESCRIPTION OF PROBLEM	HOW OFTEN THE TEST IS PERFORMED	WHAT TO DO
BATTERY FAIL	Yes	Battery is not functioning.	Monitored every 5 seconds. Reported after 1 minute if problem persists.	Replace the battery.
DIRECT RING BREAK	No	Direct I/O settings configured for a ring, but the connection is not in a ring.	Every second.	Check Direct I/O configuration and/or wiring.
DIRECT DEVICE OFF	No	Direct Device is configured but not connected	Every second.	Check Direct I/O configuration and/or wiring.
EEPROM DATA ERROR	Yes	The non-volatile memory has been corrupted.	On power up only.	Contact the factory.
IRIG-B FAILURE	No	Bad IRIG-B input signal.	Monitored whenever an IRIG-B signal is received.	Ensure IRIG-B cable is connected, check cable functionality (i.e. look for physical damage or perform continuity test), ensure IRIG-B receiver is functioning, and check input signal level (it may be less than specification). If none of these apply, contact the factory.
LATCHING OUT ERROR	Yes	Latching output failure.	Event driven.	Contact the factory.
LOW ON MEMORY	Yes	Memory is close to 100% capacity	Monitored every 5 seconds.	Contact the factory.
PRI ETHERNET FAIL	Yes	Primary Ethernet connection failed	Monitored every 2 seconds	Check connections.
PROTOTYPE FIRMWARE	Yes	A prototype version of the firmware is loaded.	On power up only.	Contact the factory.
REMOTE DEVICE OFF	No	One or more GOOSE devices are not responding	Event driven. Occurs when a device programmed to receive GOOSE messages stops receiving. Every 1 to 60 s., depending on GOOSE packets.	Check GOOSE setup
SEC ETHERNET FAIL	Yes	Sec. Ethernet connection failed	Monitored every 2 seconds	Check connections.
SNTP FAILURE	No	SNTP server not responding.	10 to 60 seconds.	Check SNTP configuration and/or network connections.
SYSTEM EXCEPTION	Yes	Abnormal restart from modules being removed/inserted when powered-up, abnormal DC supply, or internal relay failure.	Event driven.	Contact the factory.
WATCHDOG ERROR	No	Some tasks are behind schedule	Event driven.	Contact the factory.

Table A–1: FLEXANALOG PARAMETERS

SETTING	DISPLAY TEXT	DESCRIPTION
39425	FlexElement 1 OpSig	FlexElement 1 Actual
39427	FlexElement 2 OpSig	FlexElement 2 Actual
39429	FlexElement 3 OpSig	FlexElement 3 Actual
39431	FlexElement 4 OpSig	FlexElement 4 Actual
39433	FlexElement 5 OpSig	FlexElement 5 Actual
39435	FlexElement 6 OpSig	FlexElement 6 Actual
39437	FlexElement 7 OpSig	FlexElement 7 Actual
39439	FlexElement 8 OpSig	FlexElement 8 Actual
40960	Communications Group	Communications Group
40971	Active Setting Group	Current Setting Group

B.1.1 INTRODUCTION

The UR series relays support a number of communications protocols to allow connection to equipment such as personal computers, RTUs, SCADA masters, and programmable logic controllers. The Modicon Modbus RTU protocol is the most basic protocol supported by the UR. Modbus is available via RS232 or RS485 serial links or via ethernet (using the Modbus/TCP specification). The following description is intended primarily for users who wish to develop their own master communication drivers and applies to the serial Modbus RTU protocol. Note that:

- The UR always acts as a slave device, meaning that it never initiates communications; it only listens and responds to requests issued by a master computer.
- For Modbus®, a subset of the Remote Terminal Unit (RTU) protocol format is supported that allows extensive monitoring, programming, and control functions using read and write register commands.

B.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 and RS485. The relay includes a faceplate (front panel) RS232 port and two rear terminal communications ports that may be configured as RS485, fiber optic, 10BaseT, or 10BaseF. Data flow is half-duplex in all configurations. See Chapter 3 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 can be 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, 14400, 19200, 28800, 33600, 38400, 57600, or 115200 bps are available. Even, odd, and no parity are available. Refer to the Communications section of Chapter 5 for further details.

The master device in any system must know the address of the slave device with which it is to communicate. The relay 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 faceplate port, the relay will accept any address when the Modbus® RTU protocol is used.

B.1.3 DATA LINK LAYER

Communications takes place in packets which are groups of asynchronously 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 'dead-time' 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.

Table B–1: MODBUS PACKET FORMAT

DESCRIPTION	SIZE
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 to perform the desired action. Each slave device on a communications 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 faceplate port is an exception to this rule; it will act on a message containing any slave address.

  A master transmit packet with slave address 0 indicates a broadcast command. All slaves on the communication link take action based on the packet, but none 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.

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- **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 the Exception Responses section 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 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 CRC-16 Algorithm section for details on calculating 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 300 µs 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.

B.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.

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

Table B–2: CRC-16 ALGORITHM

SYMBOLS:	-->	data transfer
	A	16 bit working register
	Alow	low order byte of A
	Ahigh	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
	Di	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 (+) Alow --> Alow	
	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	

B.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.

FUNCTION CODE		MODBUS DEFINITION	GE 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

B.2.2 READ ACTUAL VALUES OR SETTINGS (FUNCTION CODE 03/04H)

This function code allows the master to read one or more consecutive data registers (actual values or settings) from a relay. Data registers are always 16 bit (two byte) values transmitted with high order byte first. The maximum number of registers that can be read in a single packet is 125. See the Modbus Memory Map table 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 decimal); the slave device responds with the values 40, 300, and 0 from registers 4050h, 4051h, and 4052h, respectively.

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

MASTER TRANSMISSION	
PACKET FORMAT	EXAMPLE (HEX)
SLAVE ADDRESS	11
FUNCTION CODE	04
DATA STARTING ADDRESS - high	40
DATA STARTING ADDRESS - low	50
NUMBER OF REGISTERS - high	00
NUMBER OF REGISTERS - low	03
CRC - low	A7
CRC - high	4A

SLAVE RESPONSE	
PACKET FORMAT	EXAMPLE (HEX)
SLAVE ADDRESS	11
FUNCTION CODE	04
BYTE COUNT	06
DATA #1 - high	00
DATA #1 - low	28
DATA #2 - high	01
DATA #2 - low	2C
DATA #3 - high	00
DATA #3 - low	00
CRC - low	0D
CRC - high	60

B.2.3 EXECUTE OPERATION (FUNCTION CODE 05H)

This function code allows the master to perform various operations in the relay. Available operations are shown in the Summary of Operation Codes table below.

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 high and low 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 B–4: 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 - high	00	OPERATION CODE - high	00
OPERATION CODE - low	01	OPERATION CODE - low	01
CODE VALUE - high	FF	CODE VALUE - high	FF
CODE VALUE - low	00	CODE VALUE - low	00
CRC - low	DF	CRC - low	DF
CRC - high	6A	CRC - high	6A

Table B–5: SUMMARY OF OPERATION CODES FOR FUNCTION 05H

OPERATION CODE (HEX)	DEFINITION	DESCRIPTION
0000	NO OPERATION	Does not do anything.
0001	RESET	Performs the same function as the faceplate RESET key.
0005	CLEAR EVENT RECORDS	Performs the same function as the faceplate **CLEAR EVENT RECORDS** menu command.
0006	CLEAR OSCILLOGRAPHY	Clears all oscillography records.
1000 to 101F	VIRTUAL IN 1-32 ON/OFF	Sets the states of Virtual Inputs 1 to 32 either "ON" or "OFF".

B.2.4 STORE SINGLE SETTING (FUNCTION CODE 06H)

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 B–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	06	FUNCTION CODE	06
DATA STARTING ADDRESS - high	40	DATA STARTING ADDRESS - high	40
DATA STARTING ADDRESS - low	51	DATA STARTING ADDRESS - low	51
DATA - high	00	DATA - high	00
DATA - low	C8	DATA - low	C8
CRC - low	CE	CRC - low	CE
CRC - high	DD	CRC - high	DD

B.2.5 STORE MULTIPLE SETTINGS (FUNCTION CODE 10H)

This function code allows the master to modify the contents of a one or more consecutive setting registers in a 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 decimal).

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

MASTER TRANSMISSION	
PACKET FORMAT	**EXAMPLE (HEX)**
SLAVE ADDRESS	11
FUNCTION CODE	10
DATA STARTING ADDRESS - hi	40
DATA STARTING ADDRESS - lo	51
NUMBER OF SETTINGS - hi	00
NUMBER OF SETTINGS - lo	02
BYTE COUNT	04
DATA #1 - high order byte	00
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

SLAVE RESPONSE	
PACKET FORMAT	**EXMAPLE (HEX)**
SLAVE ADDRESS	11
FUNCTION CODE	10
DATA STARTING ADDRESS - hi	40
DATA STARTING ADDRESS - lo	51
NUMBER OF SETTINGS - hi	00
NUMBER OF SETTINGS - lo	02
CRC - lo	07
CRC - hi	64

B.2.6 EXCEPTION RESPONSES

Programming or operation errors usually happen because of illegal data in a packet. These errors result in an exception response from the slave. 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 B–8: MASTER AND SLAVE DEVICE PACKET TRANSMISSION EXAMPLE

MASTER TRANSMISSION	
PACKET FORMAT	**EXAMPLE (HEX)**
SLAVE ADDRESS	11
FUNCTION CODE	39
CRC - low order byte	CD
CRC - high order byte	F2

SLAVE RESPONSE	
PACKET FORMAT	**EXAMPLE (HEX)**
SLAVE ADDRESS	11
FUNCTION CODE	B9
ERROR CODE	01
CRC - low order byte	93
CRC - high order byte	95

B.3.1 OBTAINING RELAY FILES VIA MODBUS

a) DESCRIPTION

The UR relay has a generic file transfer facility, meaning that you use the same method to obtain all of the different types of files from the unit. The Modbus registers that implement file transfer are found in the "Modbus File Transfer (Read/Write)" and "Modbus File Transfer (Read Only)" modules, starting at address 3100 in the Modbus Memory Map. To read a file from the UR relay, use the following steps:

1. Write the filename to the "Name of file to read" register using a write multiple registers command. If the name is shorter than 80 characters, you may write only enough registers to include all the text of the filename. Filenames are not case sensitive.
2. Repeatedly read all the registers in "Modbus File Transfer (Read Only)" using a read multiple registers command. It is not necessary to read the entire data block, since the UR relay will remember which was the last register you read. The "position" register is initially zero and thereafter indicates how many bytes (2 times the number of registers) you have read so far. The "size of..." register indicates the number of bytes of data remaining to read, to a maximum of 244.
3. Keep reading until the "size of..." register is smaller than the number of bytes you are transferring. This condition indicates end of file. Discard any bytes you have read beyond the indicated block size.
4. If you need to re-try a block, read only the "size of.." and "block of data", without reading the position. The file pointer is only incremented when you read the position register, so the same data block will be returned as was read in the previous operation. On the next read, check to see if the position is where you expect it to be, and discard the previous block if it is not (this condition would indicate that the UR relay did not process your original read request).

The UR relay retains connection-specific file transfer information, so files may be read simultaneously on multiple Modbus connections.

b) OTHER PROTOCOLS

All the files available via Modbus may also be retrieved using the standard file transfer mechanisms in other protocols (for example, TFTP or MMS).

c) COMTRADE, OSCILLOGRAPHY, AND DATA LOGGER FILES

Oscillography and data logger files are formatted using the COMTRADE file format per IEEE PC37.111 Draft 7c (02 September 1997). The files may be obtained in either text or binary COMTRADE format.

d) READING OSCILLOGRAPHY FILES

Familiarity with the oscillography feature is required to understand the following description. Refer to the Oscillography section in Chapter 5 for additional details.

The Oscillography Number of Triggers register is incremented by one every time a new oscillography file is triggered (captured) and 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 number is 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 new data is available.

The Oscillography Number of Records register 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 the Oscillography Number of Triggers and Oscillography Available Records registers to zero, and sets the Oscillography Last Cleared Date to the present date and time.

To read binary COMTRADE oscillography files, read the following filenames:

`OSCnnnn.CFG` and `OSCnnn.DAT`

Replace “nnn” with the desired oscillography trigger number. For ASCII format, use the following file names

`OSCAnnnn.CFG` and `OSCAnnn.DAT`

e) READING DATA LOGGER FILES

Familiarity with the data logger feature is required to understand this description. Refer to the Data Logger section of Chapter 5 for details. To read the entire data logger in binary COMTRADE format, read the following files.

`datalog.cfg` and `datalog.dat`

To read the entire data logger in ASCII COMTRADE format, read the following files.

`dataloga.cfg` and `dataloga.dat`

To limit the range of records to be returned in the COMTRADE files, append the following to the filename before writing it:

- To read from a specific time to the end of the log: <space> startTime
- To read a specific range of records: <space> startTime <space> endTime
- Replace <startTime> and <endTime> with Julian dates (seconds since Jan. 1 1970) as numeric text.

f) READING EVENT RECORDER FILES

To read the entire event recorder contents in ASCII format (the only available format), use the following filename:

`EVT.TXT`

To read from a specific record to the end of the log, use the following filename:

`EVTnnn.TXT` (replace “nnn” with the desired starting record number)

B.3.2 MODBUS PASSWORD OPERATION

The COMMAND password is set up at memory location 4000. Storing a value of “0” removes COMMAND password protection. When reading the password setting, the encrypted value (zero if no password is set) is returned. COMMAND security is required to change the COMMAND password. Similarly, the SETTING password is set up at memory location 4002. These are the same settings and encrypted values found in the **SETTINGS ⇨ PRODUCT SETUP ⇨⇩ PASSWORD SECURITY** menu via the keypad. Enabling password security for the faceplate display will also enable it for Modbus, and vice-versa.

To gain COMMAND level security access, the COMMAND password must be entered at memory location 4008. To gain SETTING level security access, the SETTING password must be entered at memory location 400A. The entered SETTING password must match the current SETTING password setting, or must be zero, to change settings or download firmware.

COMMAND and SETTING passwords each have a 30-minute timer. Each timer starts when you enter the particular password, and is re-started whenever you “use” it. For example, writing a setting re-starts the SETTING password timer and writing a command register or forcing a coil re-starts the COMMAND password timer. The value read at memory location 4010 can be used to confirm whether a COMMAND password is enabled or disabled (0 for Disabled). The value read at memory location 4011 can be used to confirm whether a SETTING password is enabled or disabled.

COMMAND or SETTING password security access is restricted to the particular port or particular TCP/IP connection on which the entry was made. Passwords must be entered when accessing the relay through other ports or connections, and the passwords must be re-entered after disconnecting and re-connecting on TCP/IP.

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Table B–9: MODBUS MEMORY MAP (Sheet 1 of 26)

ADDR	REGISTER NAME	RANGE	UNITS	STEP	FORMAT	DEFAULT
Product Information (Read Only)						
0000	UR Product Type	0 to 65535	---	1	F001	0
0002	Product Version	0 to 655.35	---	0.01	F001	1
Product Information (Read Only -- Written by Factory)						
0010	Serial Number	---	---	---	F203	“0”
0020	Manufacturing Date	0 to 4294967295	---	1	F050	0
0022	Modification Number	0 to 65535	---	1	F001	0
0040	Order Code	---	---	---	F204	“Order Code x “
0090	Ethernet MAC Address	---	---	---	F072	0
0093	Reserved (13 items)	---	---	---	F001	0
00A0	CPU Module Serial Number	---	---	---	F203	(none)
00B0	CPU Supplier Serial Number	---	---	---	F203	(none)
00C0	Ethernet Sub Module Serial Number (8 items)	---	---	---	F203	(none)
Self Test Targets (Read Only)						
0200	Self Test States (2 items)	0 to 4294967295	0	1	F143	0
Front Panel (Read Only)						
0204	LED Column x State (10 items)	0 to 65535	---	1	F501	0
0220	Display Message	---	---	---	F204	(none)
0248	Last Key Pressed	0 to 42	---	1	F530	0 (None)
Keypress Emulation (Read/Write)						
0280	Simulated keypress -- write zero before each keystroke	0 to 38	---	1	F190	0 (No key -- use between real keys)
Virtual Input Commands (Read/Write Command) (32 modules)						
0400	Virtual Input x State	0 to 1	---	1	F108	0 (Off)
0401	...Repeated for module number 2					
0402	...Repeated for module number 3					
0403	...Repeated for module number 4					
0404	...Repeated for module number 5					
0405	...Repeated for module number 6					
0406	...Repeated for module number 7					
0407	...Repeated for module number 8					
0408	...Repeated for module number 9					
0409	...Repeated for module number 10					
040A	...Repeated for module number 11					
040B	...Repeated for module number 12					
040C	...Repeated for module number 13					
040D	...Repeated for module number 14					
040E	...Repeated for module number 15					
040F	...Repeated for module number 16					
0410	...Repeated for module number 17					
0411	...Repeated for module number 18					
0412	...Repeated for module number 19					
0413	...Repeated for module number 20					
0414	...Repeated for module number 21					
0415	...Repeated for module number 22					
0416	...Repeated for module number 23					
0417	...Repeated for module number 24					
0418	...Repeated for module number 25					
0419	...Repeated for module number 26					
041A	...Repeated for module number 27					
041B	...Repeated for module number 28					

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Table B–9: MODBUS MEMORY MAP (Sheet 2 of 26)

ADDR	REGISTER NAME	RANGE	UNITS	STEP	FORMAT	DEFAULT
041C	...Repeated for module number 29					
041D	...Repeated for module number 30					
041E	...Repeated for module number 31					
041F	...Repeated for module number 32					
Digital Counter States (Read Only Non-Volatile) (8 modules)						
0800	Digital Counter x Value	-2147483647 to 2147483647	---	1	F004	0
0802	Digital Counter x Frozen	-2147483647 to 2147483647	---	1	F004	0
0804	Digital Counter x Frozen Time Stamp	0 to 4294967295	---	1	F050	0
0806	Digital Counter x Frozen Time Stamp us	0 to 4294967295	---	1	F003	0
0808	...Repeated for module number 2					
0810	...Repeated for module number 3					
0818	...Repeated for module number 4					
0820	...Repeated for module number 5					
0828	...Repeated for module number 6					
0830	...Repeated for module number 7					
0838	...Repeated for module number 8					
FlexStates (Read Only)						
0900	FlexState Bits (16 items)	0 to 65535	---	1	F001	0
Element States (Read Only)						
1000	Element Operate States (64 items)	0 to 65535	---	1	F502	0
User Displays Actuals (Read Only)						
1080	Formatted user-definable displays (8 items)	---	---	---	F200	(none)
Modbus User Map Actuals (Read Only						
1200	User Map Values (256 items)	0 to 65535	---	1	F001	0
Element Targets (Read Only)						
14C0	Target Sequence	0 to 65535	---	1	F001	0
14C1	Number of Targets	0 to 65535	---	1	F001	0
Element Targets (Read/Write)						
14C2	Target to Read	0 to 65535	---	1	F001	0
Element Targets (Read Only)						
14C3	Target Message	---	---	---	F200	“.”
Digital I/O States (Read Only)						
1500	Contact Input States (6 items)	0 to 65535	---	1	F500	0
1508	Virtual Input States (2 items)	0 to 65535	---	1	F500	0
1510	Contact Output States (4 items)	0 to 65535	---	1	F500	0
1518	Contact Output Current States (4 items)	0 to 65535	---	1	F500	0
1520	Contact Output Voltage States (4 items)	0 to 65535	---	1	F500	0
1528	Virtual Output States (4 items)	0 to 65535	---	1	F500	0
1530	Contact Output Detectors (4 items)	0 to 65535	---	1	F500	0
Remote I/O States (Read Only)						
1540	Remote Device x States	0 to 65535	---	1	F500	0
1542	Remote Input States (2 items)	0 to 65535	---	1	F500	0
1550	Remote Devices Online	0 to 1	---	1	F126	0 (No)
Remote Device Status (Read Only) (16 modules)						
1551	Remote Device x StNum	0 to 4294967295	---	1	F003	0
1553	Remote Device x SqNum	0 to 4294967295	---	1	F003	0
1555	...Repeated for module number 2					
1559	...Repeated for module number 3					
155D	...Repeated for module number 4					
1561	...Repeated for module number 5					
1565	...Repeated for module number 6					
1569	...Repeated for module number 7					
156D	...Repeated for module number 8					

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Table B–9: MODBUS MEMORY MAP (Sheet 3 of 26)

ADDR	REGISTER NAME	RANGE	UNITS	STEP	FORMAT	DEFAULT
1571	...Repeated for module number 9					
1575	...Repeated for module number 10					
1579	...Repeated for module number 11					
157D	...Repeated for module number 12					
1581	...Repeated for module number 13					
1585	...Repeated for module number 14					
1589	...Repeated for module number 15					
158D	...Repeated for module number 16					
Platform Direct I/O States (Read Only)						
15C0	Direct Input States (6 items)	0 to 65535	---	1	F500	0
15C8	Platform Direct Outputs Average Msg Return Time 1	0 to 65535	ms	1	F001	0
15C9	Platform Direct Outputs Average Msg Return Time 2	0 to 65535	ms	1	F001	0
15D0	Direct Device States	0 to 65535	---	1	F500	0
15D1	Reserved					
15D2	Platform Direct I/O CRC Fail Count 1	0 to 65535	---	1	F001	0
15D3	Platform Direct I/O CRC Fail Count 2	0 to 65535	---	1	F001	0
Ethernet Fibre Channel Status (Read/Write)						
1610	Ethernet Primary Fibre Channel Status	0 to 2	---	1	F134	0 (Fail)
1611	Ethernet Secondary Fibre Channel Status	0 to 2	---	1	F134	0 (Fail)
Data Logger Actuals (Read Only)						
1618	Data Logger Channel Count	0 to 16	CHNL	1	F001	0
1619	Time of oldest available samples	0 to 4294967295	seconds	1	F050	0
161B	Time of newest available samples	0 to 4294967295	seconds	1	F050	0
161D	Data Logger Duration	0 to 999.9	DAYS	0.1	F001	0
Passwords Unauthorized Access (Read/Write Command)						
2230	Reset Unauthorized Access	0 to 1	---	1	F126	0 (No)
Fault Location (Read Only)						
2350	Prefault Phase A Current Magnitude	0 to 999999.999	A	0.001	F060	0
2352	Prefault Phase B Current Magnitude	0 to 999999.999	A	0.001	F060	0
2354	Prefault Phase C Current Magnitude	0 to 999999.999	A	0.001	F060	0
2356	Prefault Zero Seq Current	0 to 999999.999	A	0.001	F060	0
2358	Prefault Pos Seq Current	0 to 999999.999	A	0.001	F060	0
235A	Prefault Neg Seq Current	0 to 999999.999	A	0.001	F060	0
235C	Prefault Phase A Voltage	0 to 999999.999	V	0.001	F060	0
235E	Prefault Phase B Voltage	0 to 999999.999	V	0.001	F060	0
2360	Prefault Phase C Voltage	0 to 999999.999	V	0.001	F060	0
2362	Last Fault Location in Line length units (km or miles)	-3276.7 to 3276.7	---	0.1	F002	0
Expanded FlexStates (Read Only)						
2B00	FlexStates, one per register (256 items)	0 to 1	---	1	F108	0 (Off)
Expanded Digital I/O states (Read Only)						
2D00	Contact Input States, one per register (96 items)	0 to 1	---	1	F108	0 (Off)
2D80	Contact Output States, one per register (64 items)	0 to 1	---	1	F108	0 (Off)
2E00	Virtual Output States, one per register (64 items)	0 to 1	---	1	F108	0 (Off)
Expanded Remote I/O Status (Read Only)						
2F00	Remote Device States, one per register (16 items)	0 to 1	---	1	F155	0 (Offline)
2F80	Remote Input States, one per register (32 items)	0 to 1	---	1	F108	0 (Off)
Oscillography Values (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	F050	0
3004	Oscillography Number Of Cycles Per Record	0 to 65535	---	1	F001	0
Oscillography Commands (Read/Write Command)						
3005	Oscillography Force Trigger	0 to 1	---	1	F126	0 (No)
3011	Oscillography Clear Data	0 to 1	---	1	F126	0 (No)

Table B–9: MODBUS MEMORY MAP (Sheet 4 of 26)

ADDR	REGISTER NAME	RANGE	UNITS	STEP	FORMAT	DEFAULT
Modbus File Transfer (Read/Write)						
3100	Name of file to read	---	---	---	F204	(none)
Modbus File Transfer (Read Only)						
3200	Character position of current block within file	0 to 4294967295	---	1	F003	0
3202	Size of currently-available data block	0 to 65535	---	1	F001	0
3203	Block of data from requested file (122 items)	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	0 to 4294967295	---	1	F050	0
Event Recorder (Read/Write Command)						
3406	Event Recorder Clear Command	0 to 1	---	1	F126	0 (No)
DCMA Input Values (Read Only) (24 modules)						
34C0	DCMA Inputs x Value	-9999.999 to 9999.999	---	0.001	F004	0
34C2	...Repeated for module number 2					
34C4	...Repeated for module number 3					
34C6	...Repeated for module number 4					
34C8	...Repeated for module number 5					
34CA	...Repeated for module number 6					
34CC	...Repeated for module number 7					
34CE	...Repeated for module number 8					
34D0	...Repeated for module number 9					
34D2	...Repeated for module number 10					
34D4	...Repeated for module number 11					
34D6	...Repeated for module number 12					
34D8	...Repeated for module number 13					
34DA	...Repeated for module number 14					
34DC	...Repeated for module number 15					
34DE	...Repeated for module number 16					
34E0	...Repeated for module number 17					
34E2	...Repeated for module number 18					
34E4	...Repeated for module number 19					
34E6	...Repeated for module number 20					
34E8	...Repeated for module number 21					
34EA	...Repeated for module number 22					
34EC	...Repeated for module number 23					
34EE	...Repeated for module number 24					
RTD Input Values (Read Only) (48 modules)						
34F0	RTD Inputs x Value	-32768 to 32767	°C	1	F002	0
34F1	...Repeated for module number 2					
34F2	...Repeated for module number 3					
34F3	...Repeated for module number 4					
34F4	...Repeated for module number 5					
34F5	...Repeated for module number 6					
34F6	...Repeated for module number 7					
34F7	...Repeated for module number 8					
34F8	...Repeated for module number 9					
34F9	...Repeated for module number 10					
34FA	...Repeated for module number 11					
34FB	...Repeated for module number 12					
34FC	...Repeated for module number 13					
34FD	...Repeated for module number 14					
34FE	...Repeated for module number 15					
34FF	...Repeated for module number 16					

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Table B–9: MODBUS MEMORY MAP (Sheet 5 of 26)

ADDR	REGISTER NAME	RANGE	UNITS	STEP	FORMAT	DEFAULT
3500	...Repeated for module number 17					
3501	...Repeated for module number 18					
3502	...Repeated for module number 19					
3503	...Repeated for module number 20					
3504	...Repeated for module number 21					
3505	...Repeated for module number 22					
3506	...Repeated for module number 23					
3507	...Repeated for module number 24					
3508	...Repeated for module number 25					
3509	...Repeated for module number 26					
350A	...Repeated for module number 27					
350B	...Repeated for module number 28					
350C	...Repeated for module number 29					
350D	...Repeated for module number 30					
350E	...Repeated for module number 31					
350F	...Repeated for module number 32					
3510	...Repeated for module number 33					
3511	...Repeated for module number 34					
3512	...Repeated for module number 35					
3513	...Repeated for module number 36					
3514	...Repeated for module number 37					
3515	...Repeated for module number 38					
3516	...Repeated for module number 39					
3517	...Repeated for module number 40					
3518	...Repeated for module number 41					
3519	...Repeated for module number 42					
351A	...Repeated for module number 43					
351B	...Repeated for module number 44					
351C	...Repeated for module number 45					
351D	...Repeated for module number 46					
351E	...Repeated for module number 47					
351F	...Repeated for module number 48					
Ohm Input Values (Read Only) (2 modules)						
3520	Ohm Inputs x Value	0 to 65535		1	F001	0
3521	...Repeated for module number 2					
Expanded Platform Direct I/O Status (Read Only)						
3560	Direct Device States, one per register (8 items)	0 to 1	---	1	F155	0 (Offline)
3570	Direct Input States, one per register (96 items)	0 to 1	---	1	F108	0 (Off)
Passwords (Read/Write Command)						
4000	Command Password Setting	0 to 4294967295	---	1	F003	0
Passwords (Read/Write Setting)						
4002	Setting Password Setting	0 to 4294967295	---	1	F003	0
Passwords (Read/Write)						
4008	Command Password Entry	0 to 4294967295	---	1	F003	0
400A	Setting Password Entry	0 to 4294967295	---	1	F003	0
Passwords (Read Only)						
4010	Command Password Status	0 to 1	---	1	F102	0 (Disabled)
4011	Setting Password Status	0 to 1	---	1	F102	0 (Disabled)
Preferences (Read/Write Setting)						
4050	Flash Message Time	0.5 to 10	s	0.1	F001	10
4051	Default Message Timeout	10 to 900	s	1	F001	300
4052	Default Message Intensity	0 to 3	---	1	F101	0 (25%)
4053	Screen Saver Feature	0 to 1	---	1	F102	0 (Disabled)
4054	Screen Saver Wait Time	1 to 65535	min	1	F001	30

Table B–9: MODBUS MEMORY MAP (Sheet 6 of 26)

ADDR	REGISTER NAME	RANGE	UNITS	STEP	FORMAT	DEFAULT
4055	Current Cutoff Level	0.002 to 0.02	pu	0.001	F001	20
4056	Voltage Cutoff Level	0.1 to 1	V	0.1	F001	10
Communications (Read/Write Setting)						
407E	COM1 minimum response time	0 to 1000	ms	10	F001	0
407F	COM2 minimum response time	0 to 1000	ms	10	F001	0
4080	Modbus Slave Address	1 to 254	---	1	F001	254
4083	RS485 Com1 Baud Rate	0 to 11	---	1	F112	8 (115200)
4084	RS485 Com1 Parity	0 to 2	---	1	F113	0 (None)
4085	RS485 Com2 Baud Rate	0 to 11	---	1	F112	8 (115200)
4086	RS485 Com2 Parity	0 to 2	---	1	F113	0 (None)
4087	IP Address	0 to 4294967295	---	1	F003	56554706
4089	IP Subnet Mask	0 to 4294967295	---	1	F003	4294966272
408B	Gateway IP Address	0 to 4294967295	---	1	F003	56554497
408D	Network Address NSAP	---	---	---	F074	0
4097	Default GOOSE Update Time	1 to 60	s	1	F001	60
409A	DNP Port	0 to 4	---	1	F177	0 (NONE)
409B	DNP Address	0 to 65519	---	1	F001	1
409C	DNP Client Addresses (2 items)	0 to 4294967295	---	1	F003	0
40A0	TCP Port Number for the Modbus protocol	1 to 65535	---	1	F001	502
40A1	TCP/UDP Port Number for the DNP Protocol	1 to 65535	---	1	F001	20000
40A2	TCP Port Number for the UCA/MMS Protocol	1 to 65535	---	1	F001	102
40A3	TCP Port Number for the HTTP (Web Server) Protocol	1 to 65535	---	1	F001	80
40A4	Main UDP Port Number for the TFTP Protocol	1 to 65535	---	1	F001	69
40A5	Data Transfer UDP Port Numbers for the TFTP Protocol (zero means “automatic”) (2 items)	0 to 65535	---	1	F001	0
40A7	DNP Unsolicited Responses Function	0 to 1	---	1	F102	0 (Disabled)
40A8	DNP Unsolicited Responses Timeout	0 to 60	s	1	F001	5
40A9	DNP Unsolicited Responses Max Retries	1 to 255	---	1	F001	10
40AA	DNP Unsolicited Responses Destination Address	0 to 65519	---	1	F001	1
40AB	Ethernet Operation Mode	0 to 1	---	1	F192	0 (Half-Duplex)
40AC	DNP User Map Function	0 to 1	---	1	F102	0 (Disabled)
40AD	DNP Number of Sources used in Analog points list	1 to 6	---	1	F001	1
40AE	DNP Current Scale Factor	0 to 8	---	1	F194	2 (1)
40AF	DNP Voltage Scale Factor	0 to 8	---	1	F194	2 (1)
40B0	DNP Power Scale Factor	0 to 8	---	1	F194	2 (1)
40B1	DNP Energy Scale Factor	0 to 8	---	1	F194	2 (1)
40B2	DNP Other Scale Factor	0 to 8	---	1	F194	2 (1)
40B3	DNP Current Default Deadband	0 to 65535	---	1	F001	30000
40B4	DNP Voltage Default Deadband	0 to 65535	---	1	F001	30000
40B5	DNP Power Default Deadband	0 to 65535	---	1	F001	30000
40B6	DNP Energy Default Deadband	0 to 65535	---	1	F001	30000
40B7	DNP Other Default Deadband	0 to 65535	---	1	F001	30000
40B8	DNP IIN Time Sync Bit Period	1 to 10080	min	1	F001	1440
40B9	DNP Message Fragment Size	30 to 2048	---	1	F001	240
40BA	DNP Client Address 3	0 to 4294967295	---	1	F003	0
40BC	DNP Client Address 4	0 to 4294967295	---	1	F003	0
40BE	DNP Client Address 5	0 to 4294967295	---	1	F003	0
40C0	DNP Communications Reserved (8 items)	0 to 1	---	1	F001	0
40C8	UCA Logical Device Name	---	---	---	F203	“UCADevice”
40D0	GOOSE Function	0 to 1	---	1	F102	1 (Enabled)
40D1	UCA GLOBE.ST.LocRemDS Flexlogic Operand	0 to 65535	---	1	F300	0
40D2	UCA Communications Reserved (14 items)	0 to 1	---	1	F001	0
40E0	TCP Port Number for the IEC 60870-5-104 Protocol	1 to 65535	---	1	F001	2404
40E1	IEC 60870-5-104 Protocol Function	0 to 1	---	1	F102	0 (Disabled)

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Table B–9: MODBUS MEMORY MAP (Sheet 7 of 26)

ADDR	REGISTER NAME	RANGE	UNITS	STEP	FORMAT	DEFAULT
40E2	IEC 60870-5-104 Protocol Common Address of ASDU	0 to 65535	---	1	F001	0
40E3	IEC 60870-5-104 Protocol Cyclic Data Tx Period	1 to 65535	s	1	F001	60
40E4	IEC Number of Sources used in M_ME_NC_1 point list	1 to 6	---	1	F001	1
40E5	IEC Current Default Threshold	0 to 65535	---	1	F001	30000
40E6	IEC Voltage Default Threshold	0 to 65535	---	1	F001	30000
40E7	IEC Power Default Threshold	0 to 65535	---	1	F001	30000
40E8	IEC Energy Default Threshold	0 to 65535	---	1	F001	30000
40E9	IEC Other Default Threshold	0 to 65535	---	1	F001	30000
40EA	IEC Communications Reserved (22 items)	0 to 1	---	1	F001	0
4100	DNP Binary Input Block of 16 Points (58 items)	0 to 58	---	1	F197	0 (Not Used)
Simple Network Time Protocol (Read/Write Setting)						
4168	Simple Network Time Protocol (SNTP) Function	0 to 1	---	1	F102	0 (Disabled)
4169	Simple Network Time Protocol (SNTP) Server IP Addr	0 to 4294967295	---	1	F003	0
416B	Simple Network Time Protocol (SNTP) UDP Port No.	1 to 65535	---	1	F001	123
Data Logger Commands (Read/Write Command)						
4170	Clear Data Logger	0 to 1	---	1	F126	0 (No)
Data Logger (Read/Write Setting)						
4180	Data Logger Rate	0 to 7	---	1	F178	1 (1 min)
4181	Data Logger Channel Settings (16 items)	---	---	---	F600	0
Clock (Read/Write Command)						
41A0	RTC Set Time	0 to 235959	---	1	F050	0
Clock (Read/Write Setting)						
41A2	SR Date Format	0 to 4294967295	---	1	F051	0
41A4	SR Time Format	0 to 4294967295	---	1	F052	0
41A6	IRIG-B Signal Type	0 to 2	---	1	F114	0 (None)
Fault Report Settings and Commands (Read/Write Setting)						
41B0	Fault Report Source	0 to 5	---	1	F167	0 (SRC 1)
41B1	Fault Report Trigger	0 to 65535	---	1	F300	0
Fault Report Settings and Commands (Read/Write Command)						
41B2	Fault Reports Clear Data Command	0 to 1	---	1	F126	0 (No)
Oscillography (Read/Write Setting)						
41C0	Oscillography Number of Records	1 to 64	---	1	F001	15
41C1	Oscillography Trigger Mode	0 to 1	---	1	F118	0 (Auto Overwrite)
41C2	Oscillography Trigger Position	0 to 100	%	1	F001	50
41C3	Oscillography Trigger Source	0 to 65535	---	1	F300	0
41C4	Oscillography AC Input Waveforms	0 to 4	---	1	F183	2 (16 samples/cycle)
41D0	Oscillography Analog Channel X (16 items)	0 to 65535	---	1	F600	0
4200	Oscillography Digital Channel X (63 items)	0 to 65535	---	1	F300	0
Trip and Alarm LEDs (Read/Write Setting)						
4260	Trip LED Input FlexLogic Operand	0 to 65535	---	1	F300	0
4261	Alarm LED Input FlexLogic Operand	0 to 65535	---	1	F300	0
User Programmable LEDs (Read/Write Setting) (48 modules)						
4280	FlexLogic Operand to Activate LED	0 to 65535	---	1	F300	0
4281	User LED type (latched or self-resetting)	0 to 1	---	1	F127	1 (Self-Reset)
4282	...Repeated for module number 2					
4284	...Repeated for module number 3					
4286	...Repeated for module number 4					
4288	...Repeated for module number 5					
428A	...Repeated for module number 6					
428C	...Repeated for module number 7					
428E	...Repeated for module number 8					
4290	...Repeated for module number 9					
4292	...Repeated for module number 10					
4294	...Repeated for module number 11					

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Table B–9: MODBUS MEMORY MAP (Sheet 8 of 26)

ADDR	REGISTER NAME	RANGE	UNITS	STEP	FORMAT	DEFAULT
4296	...Repeated for module number 12					
4298	...Repeated for module number 13					
429A	...Repeated for module number 14					
429C	...Repeated for module number 15					
429E	...Repeated for module number 16					
42A0	...Repeated for module number 17					
42A2	...Repeated for module number 18					
42A4	...Repeated for module number 19					
42A6	...Repeated for module number 20					
42A8	...Repeated for module number 21					
42AA	...Repeated for module number 22					
42AC	...Repeated for module number 23					
42AE	...Repeated for module number 24					
42B0	...Repeated for module number 25					
42B2	...Repeated for module number 26					
42B4	...Repeated for module number 27					
42B6	...Repeated for module number 28					
42B8	...Repeated for module number 29					
42BA	...Repeated for module number 30					
42BC	...Repeated for module number 31					
42BE	...Repeated for module number 32					
42C0	...Repeated for module number 33					
42C2	...Repeated for module number 34					
42C4	...Repeated for module number 35					
42C6	...Repeated for module number 36					
42C8	...Repeated for module number 37					
42CA	...Repeated for module number 38					
42CC	...Repeated for module number 39					
42CE	...Repeated for module number 40					
42D0	...Repeated for module number 41					
42D2	...Repeated for module number 42					
42D4	...Repeated for module number 43					
42D6	...Repeated for module number 44					
42D8	...Repeated for module number 45					
42DA	...Repeated for module number 46					
42DC	...Repeated for module number 47					
42DE	...Repeated for module number 48					
Installation (Read/Write Setting)						
43E0	Relay Programmed State	0 to 1	---	1	F133	0 (Not Programmed)
43E1	Relay Name	---	---	---	F202	“Relay-1”
User Programmable Self Tests (Read/Write Setting)						
4441	User Programmable Detect Ring Break Function	0 to 1	---	1	F102	1 (Enabled)
4442	User Programmable Direct Device Off Function	0 to 1	---	1	F102	1 (Enabled)
4443	User Programmable Remote Device Off Function	0 to 1	---	1	F102	1 (Enabled)
4444	User Programmable Primary Ethernet Fail Function	0 to 1	---	1	F102	0 (Disabled)
4445	User Programmable Secondary Ethernet Fail Function	0 to 1	---	1	F102	0 (Disabled)
4446	User Programmable Battery Fail Function	0 to 1	---	1	F102	1 (Enabled)
4447	User Programmable SNTP Fail Function	0 to 1	---	1	F102	1 (Enabled)
4448	User Programmable IRIG-B Fail Function	0 to 1	---	1	F102	1 (Enabled)
Modbus User Map (Read/Write Setting)						
4A00	Modbus Address Settings for User Map (256 items)	0 to 65535	---	1	F001	0
User Displays Settings (Read/Write Setting) (8 modules)						
4C00	User display top line text	---	---	---	F202	“ “
4C0A	User display bottom line text	---	---	---	F202	“ “

B

Table B–9: MODBUS MEMORY MAP (Sheet 9 of 26)

ADDR	REGISTER NAME	RANGE	UNITS	STEP	FORMAT	DEFAULT
4C14	Modbus addresses of displayed items (5 items)	0 to 65535	---	1	F001	0
4C19	Reserved (7 items)	---	---	---	F001	0
4C20	...Repeated for module number 2					
4C40	...Repeated for module number 3					
4C60	...Repeated for module number 4					
4C80	...Repeated for module number 5					
4CA0	...Repeated for module number 6					
4CC0	...Repeated for module number 7					
4CE0	...Repeated for module number 8					
User Programmable Pushbuttons (Read/Write Setting) (12 modules)						
4E00	User Programmable Pushbutton Function	0 to 2	---	1	F109	2 (Disabled)
4E01	Programmable Pushbutton Top Line	---	---	---	F202	(none)
4E0B	Prog Pushbutton On Text	---	---	---	F202	(none)
4E15	Prog Pushbutton Off Text	---	---	---	F202	(none)
4E1F	Programmable Pushbutton Drop-Out Time	0 to 60	s	0.05	F001	0
4E20	Programmable Pushbutton Target	0 to 2	---	1	F109	0 (Self-reset)
4E21	User Programmable Pushbutton Events	0 to 1	---	1	F102	0 (Disabled)
4E22	Programmable Pushbutton Reserved (2 items)	0 to 65535	---	1	F001	0
4E24	...Repeated for module number 2					
4E48	...Repeated for module number 3					
4E6C	...Repeated for module number 4					
4E90	...Repeated for module number 5					
4EB4	...Repeated for module number 6					
4ED8	...Repeated for module number 7					
4EFC	...Repeated for module number 8					
4F20	...Repeated for module number 9					
4F44	...Repeated for module number 10					
4F68	...Repeated for module number 11					
4F8C	...Repeated for module number 12					
Flexlogic (Read/Write Setting)						
5000	FlexLogic Entry (512 items)	0 to 65535	---	1	F300	16384
Flexlogic Timers (Read/Write Setting) (32 modules)						
5800	Timer x Type	0 to 2	---	1	F129	0 (millisecond)
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 items)	0 to 65535	---	1	F001	0
5808	...Repeated for module number 2					
5810	...Repeated for module number 3					
5818	...Repeated for module number 4					
5820	...Repeated for module number 5					
5828	...Repeated for module number 6					
5830	...Repeated for module number 7					
5838	...Repeated for module number 8					
5840	...Repeated for module number 9					
5848	...Repeated for module number 10					
5850	...Repeated for module number 11					
5858	...Repeated for module number 12					
5860	...Repeated for module number 13					
5868	...Repeated for module number 14					
5870	...Repeated for module number 15					
5878	...Repeated for module number 16					
5880	...Repeated for module number 17					
5888	...Repeated for module number 18					
5890	...Repeated for module number 19					

B

Table B–9: MODBUS MEMORY MAP (Sheet 10 of 26)

ADDR	REGISTER NAME	RANGE	UNITS	STEP	FORMAT	DEFAULT
5898	...Repeated for module number 20					
58A0	...Repeated for module number 21					
58A8	...Repeated for module number 22					
58B0	...Repeated for module number 23					
58B8	...Repeated for module number 24					
58C0	...Repeated for module number 25					
58C8	...Repeated for module number 26					
58D0	...Repeated for module number 27					
58D8	...Repeated for module number 28					
58E0	...Repeated for module number 29					
58E8	...Repeated for module number 30					
58F0	...Repeated for module number 31					
58F8	...Repeated for module number 32					
DCMA Inputs (Read/Write Setting) (24 modules)						
7300	DCMA Inputs x Function	0 to 1	---	1	F102	0 (Disabled)
7301	DCMA Inputs x ID	---	---	---	F205	“DCMA Ip 1 “
7307	DCMA Inputs x Reserved 1 (4 items)	0 to 65535	---	1	F001	0
730B	DCMA Inputs x Units	---	---	---	F206	“mA”
730E	DCMA Inputs x Range	0 to 6	---	1	F173	6 (4 to 20 mA)
730F	DCMA Inputs x Minimum Value	-9999.999 to 9999.999	---	0.001	F004	4000
7311	DCMA Inputs x Maximum Value	-9999.999 to 9999.999	---	0.001	F004	20000
7313	DCMA Inputs x Reserved (5 items)	0 to 65535	---	1	F001	0
7318	...Repeated for module number 2					
7330	...Repeated for module number 3					
7348	...Repeated for module number 4					
7360	...Repeated for module number 5					
7378	...Repeated for module number 6					
7390	...Repeated for module number 7					
73A8	...Repeated for module number 8					
73C0	...Repeated for module number 9					
73D8	...Repeated for module number 10					
73F0	...Repeated for module number 11					
7408	...Repeated for module number 12					
7420	...Repeated for module number 13					
7438	...Repeated for module number 14					
7450	...Repeated for module number 15					
7468	...Repeated for module number 16					
7480	...Repeated for module number 17					
7498	...Repeated for module number 18					
74B0	...Repeated for module number 19					
74C8	...Repeated for module number 20					
74E0	...Repeated for module number 21					
74F8	...Repeated for module number 22					
7510	...Repeated for module number 23					
7528	...Repeated for module number 24					
RTD Inputs (Read/Write Setting) (48 modules)						
7540	RTD Inputs x Function	0 to 1	---	1	F102	0 (Disabled)
7541	RTD Inputs x ID	---	---	---	F205	“RTD Ip 1 “
7547	RTD Inputs x Reserved 1 (4 items)	0 to 65535	---	1	F001	0
754B	RTD Inputs x Type	0 to 3	---	1	F174	0 (100 Ω Platinum)
754C	RTD Inputs x Reserved 2 (4 items)	0 to 65535	---	1	F001	0
7550	...Repeated for module number 2					
7560	...Repeated for module number 3					
7570	...Repeated for module number 4					

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Table B–9: MODBUS MEMORY MAP (Sheet 11 of 26)

ADDR	REGISTER NAME	RANGE	UNITS	STEP	FORMAT	DEFAULT
7580	...Repeated for module number 5					
7590	...Repeated for module number 6					
75A0	...Repeated for module number 7					
75B0	...Repeated for module number 8					
75C0	...Repeated for module number 9					
75D0	...Repeated for module number 10					
75E0	...Repeated for module number 11					
75F0	...Repeated for module number 12					
7600	...Repeated for module number 13					
7610	...Repeated for module number 14					
7620	...Repeated for module number 15					
7630	...Repeated for module number 16					
7640	...Repeated for module number 17					
7650	...Repeated for module number 18					
7660	...Repeated for module number 19					
7670	...Repeated for module number 20					
7680	...Repeated for module number 21					
7690	...Repeated for module number 22					
76A0	...Repeated for module number 23					
76B0	...Repeated for module number 24					
76C0	...Repeated for module number 25					
76D0	...Repeated for module number 26					
76E0	...Repeated for module number 27					
76F0	...Repeated for module number 28					
7700	...Repeated for module number 29					
7710	...Repeated for module number 30					
7720	...Repeated for module number 31					
7730	...Repeated for module number 32					
7740	...Repeated for module number 33					
7750	...Repeated for module number 34					
7760	...Repeated for module number 35					
7770	...Repeated for module number 36					
7780	...Repeated for module number 37					
7790	...Repeated for module number 38					
77A0	...Repeated for module number 39					
77B0	...Repeated for module number 40					
77C0	...Repeated for module number 41					
77D0	...Repeated for module number 42					
77E0	...Repeated for module number 43					
77F0	...Repeated for module number 44					
7800	...Repeated for module number 45					
7810	...Repeated for module number 46					
7820	...Repeated for module number 47					
7830	...Repeated for module number 48					
Ohm Inputs (Read/Write Setting) (2 modules)						
7840	Ohm Inputs x Function	0 to 1	---	1	F102	0 (Disabled)
7841	Ohm Inputs x ID	---	---	---	F205	“Ohm Ip 1 “
7847	Ohm Inputs x Reserved (9 items)	0 to 65535	---	1	F001	0
7850	...Repeated for module number 2					
FlexState Settings (Read/Write Setting)						
8800	FlexState Parameters (256 items)	---	---	---	F300	0
FlexElement (Read/Write Setting) (16 modules)						
9000	FlexElement Function	0 to 1	---	1	F102	0 (Disabled)
9001	FlexElement Name	---	---	---	F206	“FxE 1 “

Table B–9: MODBUS MEMORY MAP (Sheet 12 of 26)

ADDR	REGISTER NAME	RANGE	UNITS	STEP	FORMAT	DEFAULT
9004	FlexElement InputP	0 to 65535	---	1	F600	0
9005	FlexElement InputM	0 to 65535	---	1	F600	0
9006	FlexElement Compare	0 to 1	---	1	F516	0 (LEVEL)
9007	FlexElement Input	0 to 1	---	1	F515	0 (SIGNED)
9008	FlexElement Direction	0 to 1	---	1	F517	0 (OVER)
9009	FlexElement Hysteresis	0.1 to 50	%	0.1	F001	30
900A	FlexElement Pickup	-90 to 90	pu	0.001	F004	1000
900C	FlexElement DeltaT Units	0 to 2	---	1	F518	0 (Milliseconds)
900D	FlexElement DeltaT	20 to 86400	---	1	F003	20
900F	FlexElement Pkp Delay	0 to 65.535	s	0.001	F001	0
9010	FlexElement Rst Delay	0 to 65.535	s	0.001	F001	0
9011	FlexElement Block	0 to 65535	---	1	F300	0
9012	FlexElement Target	0 to 2	---	1	F109	0 (Self-reset)
9013	FlexElement Events	0 to 1	---	1	F102	0 (Disabled)
9014	...Repeated for module number 2					
9028	...Repeated for module number 3					
903C	...Repeated for module number 4					
9050	...Repeated for module number 5					
9064	...Repeated for module number 6					
9078	...Repeated for module number 7					
908C	...Repeated for module number 8					
90A0	...Repeated for module number 9					
90B4	...Repeated for module number 10					
90C8	...Repeated for module number 11					
90DC	...Repeated for module number 12					
90F0	...Repeated for module number 13					
9104	...Repeated for module number 14					
9118	...Repeated for module number 15					
912C	...Repeated for module number 16					
FlexElement Actuals (Read Only) (16 modules)						
9A01	FlexElement Actual	-2147483.647 to 2147483.647	---	0.001	F004	0
9A03	...Repeated for module number 2					
9A05	...Repeated for module number 3					
9A07	...Repeated for module number 4					
9A09	...Repeated for module number 5					
9A0B	...Repeated for module number 6					
9A0D	...Repeated for module number 7					
9A0F	...Repeated for module number 8					
9A11	...Repeated for module number 9					
9A13	...Repeated for module number 10					
9A15	...Repeated for module number 11					
9A17	...Repeated for module number 12					
9A19	...Repeated for module number 13					
9A1B	...Repeated for module number 14					
9A1D	...Repeated for module number 15					
9A1F	...Repeated for module number 16					
Setting Groups (Read/Write Setting)						
A000	Setting Group for Modbus Comms (0 means group 1)	0 to 5	---	1	F001	0
A001	Setting Groups Block	0 to 65535	---	1	F300	0
A002	FlexLogic Operands to Activate Groups 2 to 8 (5 items)	0 to 65535	---	1	F300	0
A009	Setting Group Function	0 to 1	---	1	F102	0 (Disabled)
A00A	Setting Group Events	0 to 1	---	1	F102	0 (Disabled)

B

Table B–9: MODBUS MEMORY MAP (Sheet 13 of 26)

ADDR	REGISTER NAME	RANGE	UNITS	STEP	FORMAT	DEFAULT
Setting Groups (Read Only)						
A00B	Current Setting Group	0 to 5	---	1	F001	0
Selector Switch Actuals (Read Only)						
A400	Selector 1 Position	1 to 7	---	1	F001	0
A401	Selector 2 Position	1 to 7	---	1	F001	1
Selector Switch (Read/Write Grouped Setting) (2 modules)						
A410	Selector x Function	0 to 1	---	1	F102	0 (Disabled)
A411	Selector x Range	1 to 7	---	1	F001	7
A412	Selector x Timeout	3 to 60	s	0.1	F001	50
A413	Selector x Step Up	0 to 65535	---	1	F300	0
A414	Selector x Step Mode	0 to 1	---	1	F083	0 (Time-out)
A415	Selector x Ack	0 to 65535	---	1	F300	0
A416	Selector x Bit0	0 to 65535	---	1	F300	0
A417	Selector x Bit1	0 to 65535	---	1	F300	0
A418	Selector x Bit2	0 to 65535	---	1	F300	0
A419	Selector x Bit Mode	0 to 1	---	1	F083	0 (Time-out)
A41A	Selector x Bit Ack	0 to 65535	---	1	F300	0
A41B	Power Up Mode	0 to 1	---	1	F084	0 (Restore)
A41C	Selector x Target	0 to 2	---	1	F109	0 (Self-reset)
A41D	Selector x Events	0 to 1	---	1	F102	0 (Disabled)
A41E	Selector x Reserved (10 items)	---	---	---	---	---
A428	...Repeated for module number 2					
Non Volatile Latches (Read/Write Setting) (16 modules)						
AD00	Latch x Function	0 to 1	---	1	F102	0 (Disabled)
AD01	Latch x Type	0 to 1	---	1	F519	0 (Reset Dominant)
AD02	Latch x Set	0 to 65535	---	1	F300	0
AD03	Latch x Reset	0 to 65535	---	1	F300	0
AD04	Latch x Target	0 to 2	---	1	F109	0 (Self-reset)
AD05	Latch x Events	0 to 1	---	1	F102	0 (Disabled)
AD06	Latch x Reserved (4 items)	---	---	---	F001	0
AD0A	...Repeated for module number 2					
AD14	...Repeated for module number 3					
AD1E	...Repeated for module number 4					
AD28	...Repeated for module number 5					
AD32	...Repeated for module number 6					
AD3C	...Repeated for module number 7					
AD46	...Repeated for module number 8					
AD50	...Repeated for module number 9					
AD5A	...Repeated for module number 10					
AD64	...Repeated for module number 11					
AD6E	...Repeated for module number 12					
AD78	...Repeated for module number 13					
AD82	...Repeated for module number 14					
AD8C	...Repeated for module number 15					
AD96	...Repeated for module number 16					
Digital Elements (Read/Write Setting) (16 modules)						
B000	Digital Element x Function	0 to 1	---	1	F102	0 (Disabled)
B001	Digital Element x Name	---	---	---	F203	"Dig Element 1 "
B015	Digital Element x Input	0 to 65535	---	1	F300	0
B016	Digital Element x Pickup Delay	0 to 999999.999	s	0.001	F003	0
B018	Digital Element x Reset Delay	0 to 999999.999	s	0.001	F003	0
B01A	Digital Element x Block	0 to 65535	---	1	F300	0
B01B	Digital Element x Target	0 to 2	---	1	F109	0 (Self-reset)
B01C	Digital Element x Events	0 to 1	---	1	F102	0 (Disabled)

Table B–9: MODBUS MEMORY MAP (Sheet 14 of 26)

ADDR	REGISTER NAME	RANGE	UNITS	STEP	FORMAT	DEFAULT
B01D	Digital Element x Reserved (3 items)	---	---	---	F001	0
B020	...Repeated for module number 2					
B040	...Repeated for module number 3					
B060	...Repeated for module number 4					
B080	...Repeated for module number 5					
B0A0	...Repeated for module number 6					
B0C0	...Repeated for module number 7					
B0E0	...Repeated for module number 8					
B100	...Repeated for module number 9					
B120	...Repeated for module number 10					
B140	...Repeated for module number 11					
B160	...Repeated for module number 12					
B180	...Repeated for module number 13					
B1A0	...Repeated for module number 14					
B1C0	...Repeated for module number 15					
B1E0	...Repeated for module number 16					
Digital Counter (Read/Write Setting) (8 modules)						
B300	Digital Counter x Function	0 to 1	---	1	F102	0 (Disabled)
B301	Digital Counter x Name	---	---	---	F205	“Counter 1 “
B307	Digital Counter x Units	---	---	---	F206	(none)
B30A	Digital Counter x Block	0 to 65535	---	1	F300	0
B30B	Digital Counter x Up	0 to 65535	---	1	F300	0
B30C	Digital Counter x Down	0 to 65535	---	1	F300	0
B30D	Digital Counter x Preset	-2147483647 to 2147483647	---	1	F004	0
B30F	Digital Counter x Compare	-2147483647 to 2147483647	---	1	F004	0
B311	Digital Counter x Reset	0 to 65535	---	1	F300	0
B312	Digital Counter x Freeze/Reset	0 to 65535	---	1	F300	0
B313	Digital Counter x Freeze/Count	0 to 65535	---	1	F300	0
B314	Digital Counter Set To Preset	0 to 65535	---	1	F300	0
B315	Digital Counter x Reserved (11 items)	---	---	---	F001	0
B320	...Repeated for module number 2					
B340	...Repeated for module number 3					
B360	...Repeated for module number 4					
B380	...Repeated for module number 5					
B3A0	...Repeated for module number 6					
B3C0	...Repeated for module number 7					
B3E0	...Repeated for module number 8					
Contact Inputs (Read/Write Setting) (96 modules)						
C000	Contact Input x Name	---	---	---	F205	“Cont Ip 1 “
C006	Contact Input x Events	0 to 1	---	1	F102	0 (Disabled)
C007	Contact Input x Debounce Time	0 to 16	ms	0.5	F001	20
C008	...Repeated for module number 2					
C010	...Repeated for module number 3					
C018	...Repeated for module number 4					
C020	...Repeated for module number 5					
C028	...Repeated for module number 6					
C030	...Repeated for module number 7					
C038	...Repeated for module number 8					
C040	...Repeated for module number 9					
C048	...Repeated for module number 10					
C050	...Repeated for module number 11					
C058	...Repeated for module number 12					
C060	...Repeated for module number 13					

B

Table B–9: MODBUS MEMORY MAP (Sheet 15 of 26)

ADDR	REGISTER NAME	RANGE	UNITS	STEP	FORMAT	DEFAULT
C068	...Repeated for module number 14					
C070	...Repeated for module number 15					
C078	...Repeated for module number 16					
C080	...Repeated for module number 17					
C088	...Repeated for module number 18					
C090	...Repeated for module number 19					
C098	...Repeated for module number 20					
C0A0	...Repeated for module number 21					
C0A8	...Repeated for module number 22					
C0B0	...Repeated for module number 23					
C0B8	...Repeated for module number 24					
C0C0	...Repeated for module number 25					
C0C8	...Repeated for module number 26					
C0D0	...Repeated for module number 27					
C0D8	...Repeated for module number 28					
C0E0	...Repeated for module number 29					
C0E8	...Repeated for module number 30					
C0F0	...Repeated for module number 31					
C0F8	...Repeated for module number 32					
C100	...Repeated for module number 33					
C108	...Repeated for module number 34					
C110	...Repeated for module number 35					
C118	...Repeated for module number 36					
C120	...Repeated for module number 37					
C128	...Repeated for module number 38					
C130	...Repeated for module number 39					
C138	...Repeated for module number 40					
C140	...Repeated for module number 41					
C148	...Repeated for module number 42					
C150	...Repeated for module number 43					
C158	...Repeated for module number 44					
C160	...Repeated for module number 45					
C168	...Repeated for module number 46					
C170	...Repeated for module number 47					
C178	...Repeated for module number 48					
C180	...Repeated for module number 49					
C188	...Repeated for module number 50					
C190	...Repeated for module number 51					
C198	...Repeated for module number 52					
C1A0	...Repeated for module number 53					
C1A8	...Repeated for module number 54					
C1B0	...Repeated for module number 55					
C1B8	...Repeated for module number 56					
C1C0	...Repeated for module number 57					
C1C8	...Repeated for module number 58					
C1D0	...Repeated for module number 59					
C1D8	...Repeated for module number 60					
C1E0	...Repeated for module number 61					
C1E8	...Repeated for module number 62					
C1F0	...Repeated for module number 63					
C1F8	...Repeated for module number 64					
C200	...Repeated for module number 65					
C208	...Repeated for module number 66					
C210	...Repeated for module number 67					

Table B–9: MODBUS MEMORY MAP (Sheet 16 of 26)

ADDR	REGISTER NAME	RANGE	UNITS	STEP	FORMAT	DEFAULT
C218	...Repeated for module number 68					
C220	...Repeated for module number 69					
C228	...Repeated for module number 70					
C230	...Repeated for module number 71					
C238	...Repeated for module number 72					
C240	...Repeated for module number 73					
C248	...Repeated for module number 74					
C250	...Repeated for module number 75					
C258	...Repeated for module number 76					
C260	...Repeated for module number 77					
C268	...Repeated for module number 78					
C270	...Repeated for module number 79					
C278	...Repeated for module number 80					
C280	...Repeated for module number 81					
C288	...Repeated for module number 82					
C290	...Repeated for module number 83					
C298	...Repeated for module number 84					
C2A0	...Repeated for module number 85					
C2A8	...Repeated for module number 86					
C2B0	...Repeated for module number 87					
C2B8	...Repeated for module number 88					
C2C0	...Repeated for module number 89					
C2C8	...Repeated for module number 90					
C2D0	...Repeated for module number 91					
C2D8	...Repeated for module number 92					
C2E0	...Repeated for module number 93					
C2E8	...Repeated for module number 94					
C2F0	...Repeated for module number 95					
C2F8	...Repeated for module number 96					
Contact Input Thresholds (Read/Write Setting)						
C600	Contact Input x Threshold (24 items)	0 to 3	---	1	F128	1 (33 Vdc)
Virtual Inputs Global Settings (Read/Write Setting)						
C680	Virtual Inputs SBO Timeout	1 to 60	s	1	F001	30
Virtual Inputs (Read/Write Setting) (32 modules)						
C690	Virtual Input x Function	0 to 1	---	1	F102	0 (Disabled)
C691	Virtual Input x Name	---	---	---	F205	“Virt Ip 1 “
C69B	Virtual Input x Programmed Type	0 to 1	---	1	F127	0 (Latched)
C69C	Virtual Input x Events	0 to 1	---	1	F102	0 (Disabled)
C69D	Virtual Input x UCA SBOClass	1 to 2	---	1	F001	1
C69E	Virtual Input x UCA SBOEna	0 to 1	---	1	F102	0 (Disabled)
C69F	Virtual Input x Reserved	---	---	---	F001	0
C6A0	...Repeated for module number 2					
C6B0	...Repeated for module number 3					
C6C0	...Repeated for module number 4					
C6D0	...Repeated for module number 5					
C6E0	...Repeated for module number 6					
C6F0	...Repeated for module number 7					
C700	...Repeated for module number 8					
C710	...Repeated for module number 9					
C720	...Repeated for module number 10					
C730	...Repeated for module number 11					
C740	...Repeated for module number 12					
C750	...Repeated for module number 13					
C760	...Repeated for module number 14					

B

Table B–9: MODBUS MEMORY MAP (Sheet 17 of 26)

ADDR	REGISTER NAME	RANGE	UNITS	STEP	FORMAT	DEFAULT
C770	...Repeated for module number 15					
C780	...Repeated for module number 16					
C790	...Repeated for module number 17					
C7A0	...Repeated for module number 18					
C7B0	...Repeated for module number 19					
C7C0	...Repeated for module number 20					
C7D0	...Repeated for module number 21					
C7E0	...Repeated for module number 22					
C7F0	...Repeated for module number 23					
C800	...Repeated for module number 24					
C810	...Repeated for module number 25					
C820	...Repeated for module number 26					
C830	...Repeated for module number 27					
C840	...Repeated for module number 28					
C850	...Repeated for module number 29					
C860	...Repeated for module number 30					
C870	...Repeated for module number 31					
C880	...Repeated for module number 32					
Virtual Outputs (Read/Write Setting) (64 modules)						
CC90	Virtual Output x Name	---	---	---	F205	“Virt Op 1 “
CC9A	Virtual Output x Events	0 to 1	---	1	F102	0 (Disabled)
CC9B	Virtual Output x Reserved (5 items)	---	---	---	F001	0
CCA0	...Repeated for module number 2					
CCB0	...Repeated for module number 3					
CCC0	...Repeated for module number 4					
CCD0	...Repeated for module number 5					
CCE0	...Repeated for module number 6					
CCF0	...Repeated for module number 7					
CD00	...Repeated for module number 8					
CD10	...Repeated for module number 9					
CD20	...Repeated for module number 10					
CD30	...Repeated for module number 11					
CD40	...Repeated for module number 12					
CD50	...Repeated for module number 13					
CD60	...Repeated for module number 14					
CD70	...Repeated for module number 15					
CD80	...Repeated for module number 16					
CD90	...Repeated for module number 17					
CDA0	...Repeated for module number 18					
CDB0	...Repeated for module number 19					
CDC0	...Repeated for module number 20					
CDD0	...Repeated for module number 21					
CDE0	...Repeated for module number 22					
CDF0	...Repeated for module number 23					
CE00	...Repeated for module number 24					
CE10	...Repeated for module number 25					
CE20	...Repeated for module number 26					
CE30	...Repeated for module number 27					
CE40	...Repeated for module number 28					
CE50	...Repeated for module number 29					
CE60	...Repeated for module number 30					
CE70	...Repeated for module number 31					
CE80	...Repeated for module number 32					
CE90	...Repeated for module number 33					

Table B–9: MODBUS MEMORY MAP (Sheet 18 of 26)

ADDR	REGISTER NAME	RANGE	UNITS	STEP	FORMAT	DEFAULT
CEA0	...Repeated for module number 34					
CEB0	...Repeated for module number 35					
CEC0	...Repeated for module number 36					
CED0	...Repeated for module number 37					
CEE0	...Repeated for module number 38					
CEF0	...Repeated for module number 39					
CF00	...Repeated for module number 40					
CF10	...Repeated for module number 41					
CF20	...Repeated for module number 42					
CF30	...Repeated for module number 43					
CF40	...Repeated for module number 44					
CF50	...Repeated for module number 45					
CF60	...Repeated for module number 46					
CF70	...Repeated for module number 47					
CF80	...Repeated for module number 48					
CF90	...Repeated for module number 49					
CFA0	...Repeated for module number 50					
CFB0	...Repeated for module number 51					
CFC0	...Repeated for module number 52					
CFD0	...Repeated for module number 53					
CFE0	...Repeated for module number 54					
CFF0	...Repeated for module number 55					
D000	...Repeated for module number 56					
D010	...Repeated for module number 57					
D020	...Repeated for module number 58					
D030	...Repeated for module number 59					
D040	...Repeated for module number 60					
D050	...Repeated for module number 61					
D060	...Repeated for module number 62					
D070	...Repeated for module number 63					
D080	...Repeated for module number 64					
Mandatory (Read/Write)						
D280	Test Mode Function	0 to 1	---	1	F102	0 (Disabled)
D281	Force VFD and LED	0 to 1	---	1	F126	0 (No)
Contact Outputs (Read/Write Setting) (64 modules)						
D290	Contact Output x Name	---	---	---	F205	“Cont Op 1 “
D29A	Contact Output x Operation	0 to 65535	---	1	F300	0
D29B	Contact Output x Seal In	0 to 65535	---	1	F300	0
D29C	Reserved	---	---	1	F001	0
D29D	Contact Output x Events	0 to 1	---	1	F102	1 (Enabled)
D29E	Reserved (2 items)	---	---	---	F001	0
D2A0	...Repeated for module number 2					
D2B0	...Repeated for module number 3					
D2C0	...Repeated for module number 4					
D2D0	...Repeated for module number 5					
D2E0	...Repeated for module number 6					
D2F0	...Repeated for module number 7					
D300	...Repeated for module number 8					
D310	...Repeated for module number 9					
D320	...Repeated for module number 10					
D330	...Repeated for module number 11					
D340	...Repeated for module number 12					
D350	...Repeated for module number 13					
D360	...Repeated for module number 14					

B

Table B–9: MODBUS MEMORY MAP (Sheet 19 of 26)

ADDR	REGISTER NAME	RANGE	UNITS	STEP	FORMAT	DEFAULT
D370	...Repeated for module number 15					
D380	...Repeated for module number 16					
D390	...Repeated for module number 17					
D3A0	...Repeated for module number 18					
D3B0	...Repeated for module number 19					
D3C0	...Repeated for module number 20					
D3D0	...Repeated for module number 21					
D3E0	...Repeated for module number 22					
D3F0	...Repeated for module number 23					
D400	...Repeated for module number 24					
D410	...Repeated for module number 25					
D420	...Repeated for module number 26					
D430	...Repeated for module number 27					
D440	...Repeated for module number 28					
D450	...Repeated for module number 29					
D460	...Repeated for module number 30					
D470	...Repeated for module number 31					
D480	...Repeated for module number 32					
D490	...Repeated for module number 33					
D4A0	...Repeated for module number 34					
D4B0	...Repeated for module number 35					
D4C0	...Repeated for module number 36					
D4D0	...Repeated for module number 37					
D4E0	...Repeated for module number 38					
D4F0	...Repeated for module number 39					
D500	...Repeated for module number 40					
D510	...Repeated for module number 41					
D520	...Repeated for module number 42					
D530	...Repeated for module number 43					
D540	...Repeated for module number 44					
D550	...Repeated for module number 45					
D560	...Repeated for module number 46					
D570	...Repeated for module number 47					
D580	...Repeated for module number 48					
D590	...Repeated for module number 49					
D5A0	...Repeated for module number 50					
D5B0	...Repeated for module number 51					
D5C0	...Repeated for module number 52					
D5D0	...Repeated for module number 53					
D5E0	...Repeated for module number 54					
D5F0	...Repeated for module number 55					
D600	...Repeated for module number 56					
D610	...Repeated for module number 57					
D620	...Repeated for module number 58					
D630	...Repeated for module number 59					
D640	...Repeated for module number 60					
D650	...Repeated for module number 61					
D660	...Repeated for module number 62					
D670	...Repeated for module number 63					
D680	...Repeated for module number 64					
Reset (Read/Write Setting)						
D800	FlexLogic operand which initiates a reset	0 to 65535	---	1	F300	0
Control Pushbuttons (Read/Write Setting) (3 modules)						
D810	Control Pushbutton x Function	0 to 1	---	1	F102	0 (Disabled)

Table B–9: MODBUS MEMORY MAP (Sheet 20 of 26)

ADDR	REGISTER NAME	RANGE	UNITS	STEP	FORMAT	DEFAULT
D811	Control Pushbutton x Events	0 to 1	---	1	F102	0 (Disabled)
D812	Control Pushbutton x Reserved	0 to 1	---	1	F001	0
D814	...Repeated for module number 2					
D818	...Repeated for module number 3					
Clear Relay Records (Read/Write Setting)						
D822	Clear Event Records Operand	0 to 65535	---	1	F300	0
D823	Clear Oscillography Operand	0 to 65535	---	1	F300	0
D824	Clear Data Logger Operand	0 to 65535	---	1	F300	0
D82B	Clear Unauthorized Access Operand	0 to 65535	---	1	F300	0
D82D	Clear Platform Direct I/O Stats Operand	0 to 65535	---	1	F300	0
D82E	Clear Relay Records Reserved					
Force Contact Inputs (Read/Write Setting)						
D8B0	Force Contact Input x State (96 items)	0 to 2	---	1	F144	0 (Disabled)
Force Contact Outputs (Read/Write Setting)						
D910	Force Contact Output x State (64 items)	0 to 3	---	1	F131	0 (Disabled)
Platform Direct I/O (Read/Write Setting)						
DB40	Direct Device ID	1 to 8	---	1	F001	1
DB41	Platform Direct I/O Ring Ch 1 Configuration Function	0 to 1	---	1	F126	0 (No)
DB42	Platform Direct I/O Data Rate	64 to 128	kbps	64	F001	64
DB41	Platform Direct I/O Ring Ch 2Configuration Function	0 to 1	---	1	F126	0 (No)
DB42	Platform Direct I/O Crossover Function	0 to 1	---	1	F102	0 (Disabled)
Platform Direct Inputs (Read/Write Setting) (96 modules)						
DB50	Direct Input x Device Number	0 to 8	---	1	F001	0
DB51	Direct Input x Number	0 to 96	---	1	F001	0
DB52	Direct Input x Default State	0 to 1	---	1	F108	0 (Off)
DB53	Direct Input x Events	0 to 1	---	1	F102	0 (Disabled)
DB54	...Repeated for module number 2					
DB58	...Repeated for module number 3					
DB5C	...Repeated for module number 4					
DB60	...Repeated for module number 5					
DB64	...Repeated for module number 6					
DB68	...Repeated for module number 7					
DB6C	...Repeated for module number 8					
DB70	...Repeated for module number 9					
DB74	...Repeated for module number 10					
DB78	...Repeated for module number 11					
DB7C	...Repeated for module number 12					
DB80	...Repeated for module number 13					
DB84	...Repeated for module number 14					
DB88	...Repeated for module number 15					
DB8C	...Repeated for module number 16					
DB90	...Repeated for module number 17					
DB94	...Repeated for module number 18					
DB98	...Repeated for module number 19					
DB9C	...Repeated for module number 20					
DBA0	...Repeated for module number 21					
DBA4	...Repeated for module number 22					
DBA8	...Repeated for module number 23					
DBAC	...Repeated for module number 24					
DBB0	...Repeated for module number 25					
DBB4	...Repeated for module number 26					
DBB8	...Repeated for module number 27					
DBBC	...Repeated for module number 28					
DBC0	...Repeated for module number 29					

Table B–9: MODBUS MEMORY MAP (Sheet 21 of 26)

ADDR	REGISTER NAME	RANGE	UNITS	STEP	FORMAT	DEFAULT
DBC4	...Repeated for module number 30					
DBC8	...Repeated for module number 31					
DBCC	...Repeated for module number 32					
DBD0	...Repeated for module number 33					
DBD4	...Repeated for module number 34					
DBD8	...Repeated for module number 35					
DBDC	...Repeated for module number 36					
DBE0	...Repeated for module number 37					
DBE4	...Repeated for module number 38					
DBE8	...Repeated for module number 39					
DBEC	...Repeated for module number 40					
DBF0	...Repeated for module number 41					
DBF4	...Repeated for module number 42					
DBF8	...Repeated for module number 43					
DBFC	...Repeated for module number 44					
DC00	...Repeated for module number 45					
DC04	...Repeated for module number 46					
DC08	...Repeated for module number 47					
DC0C	...Repeated for module number 48					
DC10	...Repeated for module number 49					
DC14	...Repeated for module number 50					
DC18	...Repeated for module number 51					
DC1C	...Repeated for module number 52					
DC20	...Repeated for module number 53					
DC24	...Repeated for module number 54					
DC28	...Repeated for module number 55					
DC2C	...Repeated for module number 56					
DC30	...Repeated for module number 57					
DC34	...Repeated for module number 58					
DC38	...Repeated for module number 59					
DC3C	...Repeated for module number 60					
DC40	...Repeated for module number 61					
DC44	...Repeated for module number 62					
DC48	...Repeated for module number 63					
DC4C	...Repeated for module number 64					
DC50	...Repeated for module number 65					
DC54	...Repeated for module number 66					
DC58	...Repeated for module number 67					
DC5C	...Repeated for module number 68					
DC60	...Repeated for module number 69					
DC64	...Repeated for module number 70					
DC68	...Repeated for module number 71					
DC6C	...Repeated for module number 72					
DC70	...Repeated for module number 73					
DC74	...Repeated for module number 74					
DC78	...Repeated for module number 75					
DC7C	...Repeated for module number 76					
DC80	...Repeated for module number 77					
DC84	...Repeated for module number 78					
DC88	...Repeated for module number 79					
DC8C	...Repeated for module number 80					
DC90	...Repeated for module number 81					
DC94	...Repeated for module number 82					
DC98	...Repeated for module number 83					

Table B–9: MODBUS MEMORY MAP (Sheet 22 of 26)

ADDR	REGISTER NAME	RANGE	UNITS	STEP	FORMAT	DEFAULT
DC9C	...Repeated for module number 84					
DCA0	...Repeated for module number 85					
DCA4	...Repeated for module number 86					
DCA8	...Repeated for module number 87					
DCAC	...Repeated for module number 88					
DCB0	...Repeated for module number 89					
DCB4	...Repeated for module number 90					
DCB8	...Repeated for module number 91					
DCBC	...Repeated for module number 92					
DCC0	...Repeated for module number 93					
DCC4	...Repeated for module number 94					
DCC8	...Repeated for module number 95					
DCCC	...Repeated for module number 96					
Platform Direct Outputs (Read/Write Setting) (96 modules)						
DD00	Direct Output x Operand	0 to 65535	---	1	F300	0
DD01	Direct Output x Events	0 to 1	---	1	F102	0 (Disabled)
DD02	...Repeated for module number 2					
DD04	...Repeated for module number 3					
DD06	...Repeated for module number 4					
DD08	...Repeated for module number 5					
DD0A	...Repeated for module number 6					
DD0C	...Repeated for module number 7					
DD0E	...Repeated for module number 8					
DD10	...Repeated for module number 9					
DD12	...Repeated for module number 10					
DD14	...Repeated for module number 11					
DD16	...Repeated for module number 12					
DD18	...Repeated for module number 13					
DD1A	...Repeated for module number 14					
DD1C	...Repeated for module number 15					
DD1E	...Repeated for module number 16					
DD20	...Repeated for module number 17					
DD22	...Repeated for module number 18					
DD24	...Repeated for module number 19					
DD26	...Repeated for module number 20					
DD28	...Repeated for module number 21					
DD2A	...Repeated for module number 22					
DD2C	...Repeated for module number 23					
DD2E	...Repeated for module number 24					
DD30	...Repeated for module number 25					
DD32	...Repeated for module number 26					
DD34	...Repeated for module number 27					
DD36	...Repeated for module number 28					
DD38	...Repeated for module number 29					
DD3A	...Repeated for module number 30					
DD3C	...Repeated for module number 31					
DD3E	...Repeated for module number 32					
DD40	...Repeated for module number 33					
DD42	...Repeated for module number 34					
DD44	...Repeated for module number 35					
DD46	...Repeated for module number 36					
DD48	...Repeated for module number 37					
DD4A	...Repeated for module number 38					
DD4C	...Repeated for module number 39					

B

Table B–9: MODBUS MEMORY MAP (Sheet 23 of 26)

ADDR	REGISTER NAME	RANGE	UNITS	STEP	FORMAT	DEFAULT
DD4E	...Repeated for module number 40					
DD50	...Repeated for module number 41					
DD52	...Repeated for module number 42					
DD54	...Repeated for module number 43					
DD56	...Repeated for module number 44					
DD58	...Repeated for module number 45					
DD5A	...Repeated for module number 46					
DD5C	...Repeated for module number 47					
DD5E	...Repeated for module number 48					
DD60	...Repeated for module number 49					
DD62	...Repeated for module number 50					
DD64	...Repeated for module number 51					
DD66	...Repeated for module number 52					
DD68	...Repeated for module number 53					
DD6A	...Repeated for module number 54					
DD6C	...Repeated for module number 55					
DD6E	...Repeated for module number 56					
DD70	...Repeated for module number 57					
DD72	...Repeated for module number 58					
DD74	...Repeated for module number 59					
DD76	...Repeated for module number 60					
DD78	...Repeated for module number 61					
DD7A	...Repeated for module number 62					
DD7C	...Repeated for module number 63					
DD7E	...Repeated for module number 64					
DD80	...Repeated for module number 65					
DD82	...Repeated for module number 66					
DD84	...Repeated for module number 67					
DD86	...Repeated for module number 68					
DD88	...Repeated for module number 69					
DD8A	...Repeated for module number 70					
DD8C	...Repeated for module number 71					
DD8E	...Repeated for module number 72					
DD90	...Repeated for module number 73					
DD92	...Repeated for module number 74					
DD94	...Repeated for module number 75					
DD96	...Repeated for module number 76					
DD98	...Repeated for module number 77					
DD9A	...Repeated for module number 78					
DD9C	...Repeated for module number 79					
DD9E	...Repeated for module number 80					
DDA0	...Repeated for module number 81					
DDA2	...Repeated for module number 82					
DDA4	...Repeated for module number 83					
DDA6	...Repeated for module number 84					
DDA8	...Repeated for module number 85					
DDAA	...Repeated for module number 86					
DDAC	...Repeated for module number 87					
DDAE	...Repeated for module number 88					
DDB0	...Repeated for module number 89					
DDB2	...Repeated for module number 90					
DDB4	...Repeated for module number 91					
DDB6	...Repeated for module number 92					
DDB8	...Repeated for module number 93					

Table B–9: MODBUS MEMORY MAP (Sheet 24 of 26)

ADDR	REGISTER NAME	RANGE	UNITS	STEP	FORMAT	DEFAULT
DDBA	...Repeated for module number 94					
DDBC	...Repeated for module number 95					
DDBE	...Repeated for module number 96					
Remote Devices (Read/Write Setting) (16 modules)						
E000	Remote Device x ID	---	---	---	F202	“Remote Device 1 “
E00A	...Repeated for module number 2					
E014	...Repeated for module number 3					
E01E	...Repeated for module number 4					
E028	...Repeated for module number 5					
E032	...Repeated for module number 6					
E03C	...Repeated for module number 7					
E046	...Repeated for module number 8					
E050	...Repeated for module number 9					
E05A	...Repeated for module number 10					
E064	...Repeated for module number 11					
E06E	...Repeated for module number 12					
E078	...Repeated for module number 13					
E082	...Repeated for module number 14					
E08C	...Repeated for module number 15					
E096	...Repeated for module number 16					
Remote Inputs (Read/Write Setting) (32 modules)						
E100	Remote Input x Device	1 to 16	---	1	F001	1
E101	Remote Input x Bit Pair	0 to 64	---	1	F156	0 (None)
E102	Remote Input x Default State	0 to 1	---	1	F108	0 (Off)
E103	Remote Input x Events	0 to 1	---	1	F102	0 (Disabled)
E104	...Repeated for module number 2					
E108	...Repeated for module number 3					
E10C	...Repeated for module number 4					
E110	...Repeated for module number 5					
E114	...Repeated for module number 6					
E118	...Repeated for module number 7					
E11C	...Repeated for module number 8					
E120	...Repeated for module number 9					
E124	...Repeated for module number 10					
E128	...Repeated for module number 11					
E12C	...Repeated for module number 12					
E130	...Repeated for module number 13					
E134	...Repeated for module number 14					
E138	...Repeated for module number 15					
E13C	...Repeated for module number 16					
E140	...Repeated for module number 17					
E144	...Repeated for module number 18					
E148	...Repeated for module number 19					
E14C	...Repeated for module number 20					
E150	...Repeated for module number 21					
E154	...Repeated for module number 22					
E158	...Repeated for module number 23					
E15C	...Repeated for module number 24					
E160	...Repeated for module number 25					
E164	...Repeated for module number 26					
E168	...Repeated for module number 27					
E16C	...Repeated for module number 28					
E170	...Repeated for module number 29					
E174	...Repeated for module number 30					

B

Table B–9: MODBUS MEMORY MAP (Sheet 25 of 26)

ADDR	REGISTER NAME	RANGE	UNITS	STEP	FORMAT	DEFAULT
E178	...Repeated for module number 31					
E17C	...Repeated for module number 32					
Remote Output DNA Pairs (Read/Write Setting) (32 modules)						
E600	Remote Output DNA x Operand	0 to 65535	---	1	F300	0
E601	Remote Output DNA x Events	0 to 1	---	1	F102	0 (Disabled)
E602	Remote Output DNA x Reserved (2 items)	0 to 1	---	1	F001	0
E604	...Repeated for module number 2					
E608	...Repeated for module number 3					
E60C	...Repeated for module number 4					
E610	...Repeated for module number 5					
E614	...Repeated for module number 6					
E618	...Repeated for module number 7					
E61C	...Repeated for module number 8					
E620	...Repeated for module number 9					
E624	...Repeated for module number 10					
E628	...Repeated for module number 11					
E62C	...Repeated for module number 12					
E630	...Repeated for module number 13					
E634	...Repeated for module number 14					
E638	...Repeated for module number 15					
E63C	...Repeated for module number 16					
E640	...Repeated for module number 17					
E644	...Repeated for module number 18					
E648	...Repeated for module number 19					
E64C	...Repeated for module number 20					
E650	...Repeated for module number 21					
E654	...Repeated for module number 22					
E658	...Repeated for module number 23					
E65C	...Repeated for module number 24					
E660	...Repeated for module number 25					
E664	...Repeated for module number 26					
E668	...Repeated for module number 27					
E66C	...Repeated for module number 28					
E670	...Repeated for module number 29					
E674	...Repeated for module number 30					
E678	...Repeated for module number 31					
E67C	...Repeated for module number 32					
Remote Output UserSt Pairs (Read/Write Setting) (32 modules)						
E680	Remote Output UserSt x Operand	0 to 65535	---	1	F300	0
E681	Remote Output UserSt x Events	0 to 1	---	1	F102	0 (Disabled)
E682	Remote Output UserSt x Reserved (2 items)	0 to 1	---	1	F001	0
E684	...Repeated for module number 2					
E688	...Repeated for module number 3					
E68C	...Repeated for module number 4					
E690	...Repeated for module number 5					
E694	...Repeated for module number 6					
E698	...Repeated for module number 7					
E69C	...Repeated for module number 8					
E6A0	...Repeated for module number 9					
E6A4	...Repeated for module number 10					
E6A8	...Repeated for module number 11					
E6AC	...Repeated for module number 12					
E6B0	...Repeated for module number 13					
E6B4	...Repeated for module number 14					

Table B–9: MODBUS MEMORY MAP (Sheet 26 of 26)

ADDR	REGISTER NAME	RANGE	UNITS	STEP	FORMAT	DEFAULT
E6B8	...Repeated for module number 15					
E6BC	...Repeated for module number 16					
E6C0	...Repeated for module number 17					
E6C4	...Repeated for module number 18					
E6C8	...Repeated for module number 19					
E6CC	...Repeated for module number 20					
E6D0	...Repeated for module number 21					
E6D4	...Repeated for module number 22					
E6D8	...Repeated for module number 23					
E6DC	...Repeated for module number 24					
E6E0	...Repeated for module number 25					
E6E4	...Repeated for module number 26					
E6E8	...Repeated for module number 27					
E6EC	...Repeated for module number 28					
E6F0	...Repeated for module number 29					
E6F4	...Repeated for module number 30					
E6F8	...Repeated for module number 31					
E6FC	...Repeated for module number 32					

B

B.4.2 DATA FORMATS

F001
UR_UINT16 UNSIGNED 16 BIT INTEGER

F002
UR_SINT16 SIGNED 16 BIT INTEGER

F003
UR_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
UR_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.

F005
UR_UINT8 UNSIGNED 8 BIT INTEGER

F006
UR_SINT8 SIGNED 8 BIT INTEGER

F011
UR_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.

F012
DISPLAY_SCALE DISPLAY SCALING
(unsigned 16-bit integer)

MSB indicates the SI units as a power of ten. LSB indicates the number of decimal points to display.

Example: Current values are stored as 32 bit numbers with three decimal places and base units in Amps. If the retrieved value is 12345.678 A and the display scale equals 0x0302 then the displayed value on the unit is 12.35 kA.

F040
UR_UINT48 48-BIT UNSIGNED INTEGER

F050
UR_UINT32 TIME and DATE (UNSIGNED 32 BIT INTEGER)

Gives the current time in seconds elapsed since 00:00:00 January 1, 1970.

F051
UR_UINT32 DATE in SR format (alternate format for F050)

First 16 bits are Month/Day (MM/DD/xxxx). Month: 1=January, 2=February,...,12=December; Day: 1 to 31 in steps of 1
Last 16 bits are Year (xx/xx/YYYY): 1970 to 2106 in steps of 1

F052
UR_UINT32 TIME in SR format (alternate format for F050)

First 16 bits are Hours/Minutes (HH:MM:xx.xxx).
Hours: 0=12am, 1=1am,...,12=12pm,...23=11pm;
Minutes: 0 to 59 in steps of 1

Last 16 bits are Seconds (xx:xx:.SS.SSS): 0=00.000s, 1=00.001,...,59999=59.999s)

F060
FLOATING_POINT IEE FLOATING POINT (32 bits)

F070
HEX2 2 BYTES - 4 ASCII DIGITS

F071
HEX4 4 BYTES - 8 ASCII DIGITS

F072
HEX6 6 BYTES - 12 ASCII DIGITS

F073
HEX8 8 BYTES - 16 ASCII DIGITS

F074
HEX20 20 BYTES - 40 ASCII DIGITS

F100
ENUMERATION: VT CONNECTION TYPE

0 = Wye; 1 = 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

bitmask	curve shape
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

bitmask	curve shape
9	IAC Inverse
10	IAC Short Inv
11	I2t
12	Definite Time
13	FlexCurve™ A
14	FlexCurve™ B
15	FlexCurve™ C
16	FlexCurve™ D

F104
ENUMERATION: RESET TYPE

0 = Instantaneous, 1 = Timed, 2 = Linear

F105
ENUMERATION: LOGIC INPUT

0 = Disabled, 1 = Input 1, 2 = Input 2

F106
ENUMERATION: PHASE ROTATION

0 = ABC, 1 = ACB

F108
ENUMERATION: OFF/ON

0 = Off, 1 = On

F109
ENUMERATION: CONTACT OUTPUT OPERATION

0 = Self-reset, 1 = Latched, 2 = Disabled

F110
ENUMERATION: CONTACT OUTPUT LED CONTROL

0 = Trip, 1 = Alarm, 2 = None

F112
ENUMERATION: RS485 BAUD RATES

bitmask	value
0	300
1	1200
2	2400
3	4800

bitmask	value
4	9600
5	19200
6	38400
7	57600

bitmask	value
8	115200
9	14400
10	28800
11	33600

F113
ENUMERATION: PARITY

0 = None, 1 = Odd, 2 = Even

F114
ENUMERATION: IRIG-B SIGNAL TYPE

0 = None, 1 = DC Shift, 2 = Amplitude Modulated

F117
ENUMERATION: NUMBER OF OSCILLOGRAPHY RECORDS

0 = 1×72 cycles, 1 = 3×36 cycles, 2 = 7×18 cycles, 3 = 15×9 cycles

F118
ENUMERATION: OSCILLOGRAPHY MODE

0 = Automatic Overwrite, 1 = Protected

F119
ENUMERATION: FLEXCURVE™ PICKUP RATIOS

mask	value	mask	value	mask	value	mask	value
0	0.00	30	0.88	60	2.90	90	5.90
1	0.05	31	0.90	61	3.00	91	6.00
2	0.10	32	0.91	62	3.10	92	6.50
3	0.15	33	0.92	63	3.20	93	7.00
4	0.20	34	0.93	64	3.30	94	7.50
5	0.25	35	0.94	65	3.40	95	8.00
6	0.30	36	0.95	66	3.50	96	8.50
7	0.35	37	0.96	67	3.60	97	9.00
8	0.40	38	0.97	68	3.70	98	9.50
9	0.45	39	0.98	69	3.80	99	10.00
10	0.48	40	1.03	70	3.90	100	10.50
11	0.50	41	1.05	71	4.00	101	11.00
12	0.52	42	1.10	72	4.10	102	11.50
13	0.54	43	1.20	73	4.20	103	12.00
14	0.56	44	1.30	74	4.30	104	12.50
15	0.58	45	1.40	75	4.40	105	13.00
16	0.60	46	1.50	76	4.50	106	13.50
17	0.62	47	1.60	77	4.60	107	14.00
18	0.64	48	1.70	78	4.70	108	14.50
19	0.66	49	1.80	79	4.80	109	15.00
20	0.68	50	1.90	80	4.90	110	15.50
21	0.70	51	2.00	81	5.00	111	16.00
22	0.72	52	2.10	82	5.10	112	16.50
23	0.74	53	2.20	83	5.20	113	17.00
24	0.76	54	2.30	84	5.30	114	17.50
25	0.78	55	2.40	85	5.40	115	18.00
26	0.80	56	2.50	86	5.50	116	18.50
27	0.82	57	2.60	87	5.60	117	19.00
28	0.84	58	2.70	88	5.70	118	19.50
29	0.86	59	2.80	89	5.80	119	20.00

B

F122
ENUMERATION: ELEMENT INPUT SIGNAL TYPE

0 = Phasor, 1 = RMS

F123
ENUMERATION: CT SECONDARY

0 = 1 A, 1 = 5 A

F124
ENUMERATION: LIST OF ELEMENTS

bitmask	element
16	PHASE TOC1
17	PHASE TOC2
18	PHASE TOC3
19	PHASE TOC4
20	PHASE TOC5
21	PHASE TOC6
24	PH DIR1
25	PH DIR2
32	NEUTRAL IOC1
33	NEUTRAL IOC2
34	NEUTRAL IOC3
35	NEUTRAL IOC4
36	NEUTRAL IOC5
37	NEUTRAL IOC6
38	NEUTRAL IOC7
39	NEUTRAL IOC8
40	NEUTRAL IOC9
41	NEUTRAL IOC10
42	NEUTRAL IOC11
43	NEUTRAL IOC12
48	NEUTRAL TOC1
49	NEUTRAL TOC2
50	NEUTRAL TOC3
51	NEUTRAL TOC4
52	NEUTRAL TOC5
53	NEUTRAL TOC6
56	NTRL DIR OC1
57	NTRL DIR OC2
60	NEG SEQ DIR OC1
61	NEG SEQ DIR OC2
64	GROUND IOC1
65	GROUND IOC2
66	GROUND IOC3
67	GROUND IOC4
68	GROUND IOC5
69	GROUND IOC6
70	GROUND IOC7
71	GROUND IOC8
72	GROUND IOC9
73	GROUND IOC10
74	GROUND IOC11
75	GROUND IOC12
80	GROUND TOC1
81	GROUND TOC2
82	GROUND TOC3
83	GROUND TOC4
84	GROUND TOC5
85	GROUND TOC6
96	NEG SEQ IOC1
97	NEG SEQ IOC2
112	NEG SEQ TOC1
113	NEG SEQ TOC2
120	NEG SEQ OV
144	PHASE UV1
145	PHASE UV2
148	AUX OV1
152	PHASE OV1
156	NEUTRAL OV1
180	LOAD ENCHR
190	POWER SWING
244	50DD
245	CONT MONITOR
246	CT FAIL
265	STATOR DIFF
272	BREAKER 1
273	BREAKER 2
280	BKR FAIL
281	BKR FAIL
288	BKR ARC
289	BKR ARC
296	ACCDNT ENRG
300	LOSS EXCIT
312	SYNC 1
313	SYNC 2
320	COLD LOAD 1
321	COLD LOAD 2
324	AMP UNBALANCE 1
325	AMP UNBALANCE 2
330	3RD HARM
336	SETTING GROUP
337	RESET
344	OVERFREQ 1
345	OVERFREQ 2
346	OVERFREQ 3
347	OVERFREQ 4
352	UNDERFREQ 1
353	UNDERFREQ 2
354	UNDERFREQ 3
355	UNDERFREQ 4
356	UNDERFREQ 5
357	UNDERFREQ 6
376	AR
377	STARTS-PER-HOUR

bitmask	element
378	TIME-BTWN-STARTS
379	RESTART DELAY
380	MECHANICAL JAM
400	FLEX ELEMENT 1
401	FLEX ELEMENT 2
402	FLEX ELEMENT 3
403	FLEX ELEMENT 4
404	FLEX ELEMENT 5
405	FLEX ELEMENT 6
406	FLEX ELEMENT 7
407	FLEX ELEMENT 8
408	FLEX ELEMENT 9
409	FLEX ELEMENT 10
410	FLEX ELEMENT 11
411	FLEX ELEMENT 12
412	FLEX ELEMENT 13
413	FLEX ELEMENT 14
414	FLEX ELEMENT 15
415	FLEX ELEMENT 16
420	LATCH 1
421	LATCH 2
422	LATCH 3
423	LATCH 4
424	LATCH 5
425	LATCH 6
426	LATCH 7
427	LATCH 8
428	LATCH 9
429	LATCH 10
430	LATCH 11
431	LATCH 12
432	LATCH 13
433	LATCH 14
434	LATCH 15
435	LATCH 16
512	DIG ELEM 1
513	DIG ELEM 2
514	DIG ELEM 3
515	DIG ELEM 4
516	DIG ELEM 5
517	DIG ELEM 6
518	DIG ELEM 7
519	DIG ELEM 8
520	DIG ELEM 9
521	DIG ELEM 10
522	DIG ELEM 11
523	DIG ELEM 12
524	DIG ELEM 13
525	DIG ELEM 14
526	DIG ELEM 15
527	DIG ELEM 16
544	COUNTER 1
545	COUNTER 2
546	COUNTER 3
547	COUNTER 4
548	COUNTER 5
549	COUNTER 6
550	COUNTER 7
551	COUNTER 8
680	PUSHBUTTON 1
681	PUSHBUTTON 2
682	PUSHBUTTON 3
683	PUSHBUTTON 4
684	PUSHBUTTON 5
685	PUSHBUTTON 6
686	PUSHBUTTON 7
687	PUSHBUTTON 8
688	PUSHBUTTON 9
689	PUSHBUTTON 10
690	PUSHBUTTON 11
691	PUSHBUTTON 12

F125
ENUMERATION: ACCESS LEVEL

0 = Restricted; 1 = Command, 2 = Setting, 3 = Factory Service

F126
ENUMERATION: NO/YES CHOICE

0 = No, 1 = Yes

F127
ENUMERATION: LATCHED OR SELF-RESETTING

0 = Latched, 1 = Self-Reset

F128
ENUMERATION: CONTACT INPUT THRESHOLD

0 = 17 V DC, 1 = 33 V DC, 2 = 84 V DC, 3 = 166 V DC

F129
ENUMERATION: FLEXLOGIC TIMER TYPE

0 = millisecond, 1 = second, 2 = minute

F130
ENUMERATION: SIMULATION MODE

0 = Off. 1 = Pre-Fault, 2 = Fault, 3 = Post-Fault

F131
ENUMERATION: FORCED CONTACT OUTPUT STATE

0 = Disabled, 1 = Energized, 2 = De-energized, 3 = Freeze

B

F133
ENUMERATION: PROGRAM STATE

0 = Not Programmed, 1 = Programmed

F134
ENUMERATION: PASS/FAIL

0 = Fail, 1 = OK, 2 = n/a

F135
ENUMERATION: GAIN CALIBRATION

0 = 0x1, 1 = 1x16

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 46 A, 2 = Voltage 280 V, 3 = Current 4.6 A, 4 = Current 2 A, 5 = Notched 4.6 A, 6 = Notched 2 A

F141
ENUMERATION: SELF TEST ERROR

bitmask	error
0	ANY SELF TESTS
1	IRIG-B FAILURE
2	DSP ERROR
4	NO DSP INTERRUPTS
5	UNIT NOT CALIBRATED
9	PROTOTYPE FIRMWARE
10	FLEXLOGIC ERR TOKEN
11	EQUIPMENT MISMATCH
13	UNIT NOT PROGRAMMED
14	SYSTEM EXCEPTION
19	BATTERY FAIL
20	PRI ETHERNET FAIL
21	SEC ETHERNET FAIL
22	EEPROM DATA ERROR
23	SRAM DATA ERROR
24	PROGRAM MEMORY
25	WATCHDOG ERROR
26	LOW ON MEMORY
27	REMOTE DEVICE OFF
30	ANY MINOR ERROR
31	ANY MAJOR ERROR

F142
ENUMERATION: EVENT RECORDER ACCESS FILE TYPE

0 = All Record Data, 1 = Headers Only, 2 = Numeric Event Cause

F143
UR_UINT32: 32 BIT ERROR CODE (F141 specifies bit number)

A bit value of 0 = no error, 1 = error

F144
ENUMERATION: FORCED CONTACT INPUT STATE

0 = Disabled, 1 = Open, 2 = Closed

F145
ENUMERATION: ALPHABET LETTER

bitmask	type	bitmask	type	bitmask	type	bitmask	type
0	null	7	G	14	N	21	U
1	A	8	H	15	O	22	V
2	B	9	I	16	P	23	W
3	C	10	J	17	Q	24	X
4	D	11	K	18	R	25	Y
5	E	12	L	19	S	26	Z
6	F	13	M	20	T		

F146
ENUMERATION: MISC. EVENT CAUSES

bitmask	definition
0	EVENTS CLEARED
1	OSCILLOGRAPHY TRIGGERED
2	DATE/TIME CHANGED
3	DEF SETTINGS LOADED
4	TEST MODE ON
5	TEST MODE OFF
6	POWER ON
7	POWER OFF
8	RELAY IN SERVICE
9	RELAY OUT OF SERVICE
10	WATCHDOG RESET
11	OSCILLOGRAPHY CLEAR
12	REBOOT COMMAND

F151
ENUMERATION: RTD SELECTION

bitmask	RTD#	bitmask	RTD#	bitmask	RTD#
0	NONE	17	RTD 17	33	RTD 33
1	RTD 1	18	RTD 18	34	RTD 34
2	RTD 2	19	RTD 19	35	RTD 35
3	RTD 3	20	RTD 20	36	RTD 36
4	RTD 4	21	RTD 21	37	RTD 37
5	RTD 5	22	RTD 22	38	RTD 38
6	RTD 6	23	RTD 23	39	RTD 39
7	RTD 7	24	RTD 24	40	RTD 40
8	RTD 8	25	RTD 25	41	RTD 41
9	RTD 9	26	RTD 26	42	RTD 42
10	RTD 10	27	RTD 27	43	RTD 43
11	RTD 11	28	RTD 28	44	RTD 44
12	RTD 12	29	RTD 29	45	RTD 45
13	RTD 13	30	RTD 30	46	RTD 46
14	RTD 14	31	RTD 31	47	RTD 47
15	RTD 15	32	RTD 32	48	RTD 48
16	RTD 16				

F152
ENUMERATION: SETTING GROUP

0 = Active Group, 1 = Group 1, 2 = Group 2, 3 = Group 3
4 = Group 4, 5 = Group 5, 6 = Group 6

F155
ENUMERATION: REMOTE DEVICE STATE

0 = Offline, 1 = Online

F156
ENUMERATION: REMOTE INPUT BIT PAIRS

bitmask	RTD#	bitmask	RTD#	bitmask	RTD#
0	NONE	22	DNA-22	44	UserSt-12
1	DNA-1	23	DNA-23	45	UserSt-13
2	DNA-2	24	DNA-24	46	UserSt-14
3	DNA-3	25	DNA-25	47	UserSt-15
4	DNA-4	26	DNA-26	48	UserSt-16
5	DNA-5	27	DNA-27	49	UserSt-17
6	DNA-6	28	DNA-28	50	UserSt-18
7	DNA-7	29	DNA-29	51	UserSt-19
8	DNA-8	30	DNA-30	52	UserSt-20
9	DNA-9	31	DNA-31	53	UserSt-21
10	DNA-10	32	DNA-32	54	UserSt-22
11	DNA-11	33	UserSt-1	55	UserSt-23
12	DNA-12	34	UserSt-2	56	UserSt-24
13	DNA-13	35	UserSt-3	57	UserSt-25
14	DNA-14	36	UserSt-4	58	UserSt-26
15	DNA-15	37	UserSt-5	59	UserSt-27
16	DNA-16	38	UserSt-6	60	UserSt-28
17	DNA-17	39	UserSt-7	61	UserSt-29
18	DNA-18	40	UserSt-8	62	UserSt-30
19	DNA-19	41	UserSt-9	63	UserSt-31
20	DNA-20	42	UserSt-10	64	UserSt-32
21	DNA-21	43	UserSt-11		

F166
ENUMERATION: AUXILIARY VT CONNECTION TYPE

0 = Vn, 1 = Vag, 2 = Vbg, 3 = Vcg, 4 = Vab, 5 = Vbc, 6 = Vca

F167
ENUMERATION: SIGNAL SOURCE

0 = SRC 1, 1 = SRC 2, 2 = SRC 3, 3 = SRC 4,
4 = SRC 5, 5 = SRC 6

F168
ENUMERATION: INRUSH INHIBIT FUNCTION

0 = Disabled, 1 = 2nd

F169
ENUMERATION: OVEREXCITATION INHIBIT FUNCTION

0 = Disabled, 1 = 5th

F170
ENUMERATION: LOW/HIGH OFFSET & GAIN TRANSDUCER I/O SELECTION

0 = LOW, 1 = HIGH

B

F171
ENUMERATION: TRANSDUCER CHANNEL INPUT TYPE

0 = dcmA IN, 1 = OHMS IN, 2 = RTD IN, 3 = dcmA OUT

F172
ENUMERATION: SLOT LETTERS

bitmask	slot	bitmask	slot	bitmask	slot	bitmask	slot
0	F	4	K	8	P	12	U
1	G	5	L	9	R	13	V
2	H	6	M	10	S	14	W
3	J	7	N	11	T	15	X

F173
ENUMERATION: TRANSDUCER DCMA I/O RANGE

bitmask	dcmA I/O range
0	0 to –1 mA
1	0 to 1 mA
2	–1 to 1 mA
3	0 to 5 mA
4	0 to 10 mA
5	0 to 20 mA
6	4 to 20 mA

F174
ENUMERATION: TRANSDUCER RTD INPUT TYPE

0 = 100 Ohm Platinum, 1 = 120 Ohm Nickel,
2 = 100 Ohm Nickel, 3 = 10 Ohm Copper

F175
ENUMERATION: PHASE LETTERS

0 = A, 1 = B, 2 = C

F177
ENUMERATION: COMMUNICATION PORT

0 = NONE, 1 = COM1-RS485, 2 = COM2-RS485,
3 = FRONT PANEL-RS232, 4 = NETWORK

F178
ENUMERATION: DATA LOGGER RATES

0 = 1 sec, 1 = 1 min, 2 = 5 min, 3 = 10 min, 4 = 15 min,
5 = 20 min, 6 = 30 min, 7 = 60 min

F180
ENUMERATION: PHASE/GROUND

0 = PHASE, 1 = GROUND

F181
ENUMERATION: ODD/EVEN/NONE

0 = ODD, 1 = EVEN, 2 = NONE

F183
ENUMERATION AC INPUT WAVEFORMS

bitmask	definition
0	Off
1	8 samples/cycle
2	16 samples/cycle
3	32 samples/cycle
4	64 samples/cycle

F185
ENUMERATION PHASE A,B,C, GROUND SELECTOR

0 = A, 1 = B, 2 = C, 3 = G

F186
ENUMERATION MEASUREMENT MODE

0 = Phase to Ground, 1 = Phase to Phase

F190
ENUMERATION Simulated Keypress

bitmask	keypress	bitmask	keypress
0	--- use between real keys	13	Value Up
		14	Value Down
1	1	15	Message Up
2	2	16	Message Down
3	3	17	Message Left
4	4	18	Message Right
5	5	19	Menu
6	6	20	Help
7	7	21	Escape
8	8	22	Enter
9	9	23	Reset
10	0	24	User 1
11	Decimal Pt	25	User 2
12	Plus/Minus	26	User 3

F192
ENUMERATION ETHERNET OPERATION MODE

0 = Half-Duplex, 1 = Full-Duplex

F194
ENUMERATION DNP SCALE

A bitmask of 0 = 0.01, 1 = 0.1, 2 = 1, 3 = 10, 4 = 100, 5 = 1000

F197
ENUMERATION DNP BINARY INPUT POINT BLOCK

bitmask	Input Point Block
0	Not Used
1	Virtual Inputs 1 to 16
2	Virtual Inputs 17 to 32
3	Virtual Outputs 1 to 16
4	Virtual Outputs 17 to 32
5	Virtual Outputs 33 to 48
6	Virtual Outputs 49 to 64
7	Contact Inputs 1 to 16
8	Contact Inputs 17 to 32
9	Contact Inputs 33 to 48
10	Contact Inputs 49 to 64
11	Contact Inputs 65 to 80
12	Contact Inputs 81 to 96
13	Contact Outputs 1 to 16
14	Contact Outputs 17 to 32
15	Contact Outputs 33 to 48
16	Contact Outputs 49 to 64
17	Remote Inputs 1 to 16
18	Remote Inputs 17 to 32
19	Remote Devs 1 to 16
20	Elements 1 to 16
21	Elements 17 to 32
22	Elements 33 to 48
23	Elements 49 to 64
24	Elements 65 to 80
25	Elements 81 to 96
26	Elements 97 to 112
27	Elements 113 to 128
28	Elements 129 to 144
29	Elements 145 to 160
30	Elements 161 to 176
31	Elements 177 to 192
32	Elements 193 to 208
33	Elements 209 to 224
34	Elements 225 to 240
35	Elements 241 to 256
36	Elements 257 to 272
37	Elements 273 to 288
38	Elements 289 to 304
39	Elements 305 to 320
40	Elements 321 to 336
41	Elements 337 to 352
42	Elements 353 to 368
43	Elements 369 to 384
44	Elements 385 to 400
45	Elements 401 to 406
46	Elements 417 to 432
47	Elements 433 to 448
48	Elements 449 to 464
49	Elements 465 to 480
50	Elements 481 to 496
51	Elements 497 to 512
52	Elements 513 to 528
53	Elements 529 to 544
54	Elements 545 to 560
55	LED States 1 to 16
56	LED States 17 to 32
57	Self Tests 1 to 16
58	Self Tests 17 to 32

B

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

F205
TEXT12 12 CHARACTER ASCII TEXT

F206
TEXT6 6 CHARACTER ASCII TEXT

F207
TEXT4 4 CHARACTER ASCII TEXT

F208
TEXT2 2 CHARACTER ASCII TEXT

F222
ENUMERATION TEST ENUMERATION

0 = Test Enumeration 0, 1 = Test Enumeration 1

B

F300
UR_UINT16 FLEXLOGIC™ BASE TYPE (6 bit type)

The FlexLogic™ BASE type is 6 bits and is combined with a 9 bit descriptor and 1 bit for protection element to form a 16 bit value. The combined bits are of the form: PTTTTTTDDDDDDDDD, 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 with P prefix [PTTTTTT] and the values in round brackets indicate the descriptor range.

[0] Off(0) this is boolean FALSE value
[0] On (1)This is boolean TRUE value
[2] CONTACT INPUTS (1 - 96)
[3] CONTACT INPUTS OFF (1-96)
[4] VIRTUAL INPUTS (1-64)
[6] VIRTUAL OUTPUTS (1-64)
[10] CONTACT OUTPUTS VOLTAGE DETECTED (1-64)
[11] CONTACT OUTPUTS VOLTAGE OFF DETECTED (1-64)
[12] CONTACT OUTPUTS CURRENT DETECTED (1-64)
[13] CONTACT OUTPUTS CURRENT OFF DETECTED (1-64)
[14] REMOTE INPUTS (1-32)
[28] INSERT (Via Keypad only)
[32] END
[34] NOT (1 INPUT)
[36] 2 INPUT XOR (0)
[38] LATCH SET/RESET (2 inputs)
[40] OR (2 to 16 inputs)
[42] AND (2 to 16 inputs)
[44] NOR (2 to 16 inputs)
[46] NAND (2 to 16 inputs)
[48] TIMER (1 to 32)
[50] ASSIGN VIRTUAL OUTPUT (1 to 64)
[52] SELF-TEST ERROR (see F141 for range)
[56] ACTIVE SETTING GROUP (1 to 6)
[62] MISCELLANEOUS EVENTS (see F146 for range)
[64 to 127] ELEMENT STATES

F400
UR_UINT16 CT/VT BANK SELECTION

bitmask	bank selection
0	Card 1 Contact 1 to 4
1	Card 1 Contact 5 to 8
2	Card 2 Contact 1 to 4
3	Card 2 Contact 5 to 8
4	Card 3 Contact 1 to 4
5	Card 3 Contact 5 to 8

F500
UR_UINT16 PACKED BITFIELD

First register indicates I/O state with bits 0(MSB)-15(LSB) corresponding to I/0 state 1-16. The second register indicates I/O state with bits 0-15 corresponding to I/0 state 17-32 (if required) The third register indicates I/O state with bits 0-15 corresponding to I/0 state 33-48 (if required). The fourth register indicates I/O state with bits 0-15 corresponding to I/0 state 49-64 (if required).

The number of registers required is determined by the specific data item. A bit value of 0 = Off, 1 = On

F501
UR_UINT16 LED STATUS

Low byte of register indicates LED status with bit 0 representing the top LED and bit 7 the bottom LED. A bit value of 1 indicates the LED is on, 0 indicates the LED is off.

F502
BITFIELD ELEMENT OPERATE STATES

Each bit contains the operate state for an element. See the F124 format code for a list of element IDs. The operate bit for element ID X is bit [X mod 16] in register [X/16].

F504
BITFIELD 3 PHASE ELEMENT STATE

bitmask	element state
0	Pickup
1	Operate
2	Pickup Phase A
3	Pickup Phase B
4	Pickup Phase C
5	Operate Phase A
6	Operate Phase B
7	Operate Phase C

F505
BITFIELD CONTACT OUTPUT STATE

0 = Contact State, 1 = Voltage Detected, 2 = Current Detected

F506|
BITFIELD 1 PHASE ELEMENT STATE

0 = Pickup, 1 = Operate

F507
BITFIELD COUNTER ELEMENT STATE

0 = Count Greater Than, 1 = Count Equal To, 2 = Count Less Than

F509
BITFIELD SIMPLE ELEMENT STATE

0 = Operate

F511
BITFIELD 3 PHASE SIMPLE ELEMENT STATE

0 = Operate, 1 = Operate A, 2 = Operate B, 3 = Operate C

F515
ENUMERATION ELEMENT INPUT MODE

0 = SIGNED, 1 = ABSOLUTE

F516
ENUMERATION ELEMENT COMPARE MODE

0 = LEVEL, 1 = DELTA

F518
ENUMERATION FlexElement Units

0 = Milliseconds, 1 = Seconds, 2 = Minutes

F600
UR_UINT16 FlexAnalog Parameter

The 16-bit value corresponds to the modbus address of the value to be used when this parameter is selected. Only certain values may be used as FlexAnalogs (basically all the metering quantities used in protection)

MMI_FLASH ENUMERATION
Flash message definitions for Front-panel MMI

bitmask	Flash Message
1	ADJUSTED VALUE HAS BEEN STORED
2	ENTERED PASSCODE IS INVALID
3	COMMAND EXECUTED
4	DEFAULT MESSAGE HAS BEEN ADDED
5	DEFAULT MESSAGE HAS BEEN REMOVED
6	INPUT FUNCTION IS ALREADY ASSIGNED
7	PRESS [ENTER] TO ADD AS DEFAULT
8	PRESS [ENTER] TO REMOVE MESSAGE
9	PRESS [ENTER] TO BEGIN TEXT EDIT
10	ENTRY MISMATCH - CODE NOT STORED
11	PRESSED KEY IS INVALID HERE
12	INVALID KEY: MUST BE IN LOCAL MODE
13	NEW PASSWORD HAS BEEN STORED
14	PLEASE ENTER A NON-ZERO PASSCODE
15	NO ACTIVE TARGETS (TESTING LEDS)
16	OUT OF RANGE - VALUE NOT STORED
17	RESETTING LATCHED CONDITIONS
18	SETPOINT ACCESS IS NOW ALLOWED
19	SETPOINT ACCESS DENIED (PASSCODE)
20	SETPOINT ACCESS IS NOW RESTRICTED
21	NEW SETTING HAS BEEN STORED
22	SETPOINT ACCESS DENIED (SWITCH)
23	DATA NOT ACCEPTED
24	NOT ALL CONDITIONS HAVE BEEN RESET
25	DATE NOT ACCEPTED IRIGB IS ENABLED
26	NOT EXECUTED
27	DISPLAY ADDED TO USER DISPLAY LIST
28	DISPLAY NOT ADDED TO USER DISPLAY LIST
29	DISPLAY REMOVED FROM USER DISPLAY LIST

MMI_PASSWORD_TYPE ENUMERATION
Password types for display in password prompts

bitmask	password type
0	No
1	MASTER
2	SETTING
3	COMMAND
4	FACTORY

MMI_SETTING_TYPE ENUMERATION
Setting types for display in web pages

bitmask	Setting Type
0	Unrestricted Setting
1	Master-accessed Setting
2	Setting
3	Command
4	Factory Setting

B

C.1.1 UCA

The **Utility Communications Architecture** (UCA) Version 2 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 describe the complete capabilities of the UCA. Following, is a description of the subset of UCA/MMS features that are supported by the UR relay. The reference document set includes:

- Introduction to UCA version 2
- Generic Object Models for Substation and Feeder Equipment (GOMSFE)
- Common Application Service Models (CASM) and Mapping to MMS
- UCA Version 2 Profiles

These documents can be obtained from the UCA User's Group at http://www.ucausersgroup.org. It is strongly recommended that all those involved with any UCA implementation obtain this document set.

COMMUNICATION PROFILES:

The UCA specifies a number of possibilities for communicating with electronic devices based on the OSI Reference Model. The UR relay uses the seven layer OSI stack (TP4/CLNP and TCP/IP profiles). Refer to the "UCA Version 2 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. The TCP/IP profile requires the UR relay to have an IP address in order to establish a communication link. These addresses are set in the SETTINGS ⇨ PRODUCT SETUP ⇨⇩ COMMUNICATIONS ⇨⇩ NETWORK menu. Note that the UR relay supports UCA operation over the TP4/CLNP or the TCP/IP stacks and also supports operation over both stacks simultaneously. It is possible to have up to two simultaneous connections. This is in addition to DNP and Modbus/TCP (non-UCA) connections.

C.1.2 MMS

a) DESCRIPTION

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 the transfer of data within a substation LAN environment. Data can be grouped to form objects and be mapped to MMS services. Refer to the "GOMSFE" and "CASM" reference documents for details.

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:

• DI (device identity)	• PHIZ (high impedance ground detector)
• GCTL (generic control)	• PIOC (instantaneous overcurrent relay)
• GIND (generic indicator)	• POVR (overvoltage relay)
• GLOBE (global data)	• PTOC (time overcurrent relay)
• MMXU (polyphase measurement unit)	• PUVR (under voltage relay)
• PBRL (phase balance current relay)	• PVPH (volts per hertz relay)
• PBRO (basic relay object)	• ctRATO (CT ratio information)
• PDIF (differential relay)	• vtRATO (VT ratio information)
• PDIS (distance)	• RREC (reclosing relay)
• PDOC (directional overcurrent)	• RSYN (synchronizing or synchronism-check relay)
• PDPR (directional power relay)	• XCBR (circuit breaker)
• PFRQ (frequency relay)	

UCA data can be accessed through the "UCADevice" MMS domain.

PEER-TO-PEER COMMUNICATION:

Peer-to-peer communication of digital state information, using the UCA GOOSE data object, is supported via the use of the UR Remote Inputs/Outputs feature. This feature allows digital points to be transferred between any UCA conforming devices.

FILE SERVICES:

MMS file services are supported to allow transfer of Oscillography, Event Record, or other files from a UR relay.

COMMUNICATION SOFTWARE UTILITIES:

The exact structure and values of the implemented objects can be seen by connecting to a UR relay with an MMS browser, such as the “MMS Object Explorer and AXS4-MMS DDE/OPC” server from Sisco Inc.

NON-UCA DATA:

The UR relay makes available a number of non-UCA data items. These data items can be accessed through the "UR" MMS domain. UCA data can be accessed through the "UCADevice" MMS domain.

b) PROTOCOL IMPLEMENTATION AND CONFORMANCE STATEMENT (PICS)

NOTE

The UR relay functions as a server only; a UR relay cannot be configured as a client. Thus, the following list of supported services is for server operation only:

The MMS supported services are as follows:

CONNECTION MANAGEMENT SERVICES:

- Initiate
- Conclude
- Cancel
- Abort
- Reject

VMD SUPPORT SERVICES:

- Status
- GetNameList
- Identify

VARIABLE ACCESS SERVICES:

- Read
- Write
- InformationReport
- GetVariableAccessAttributes
- GetNamedVariableListAttributes

OPERATOR COMMUNICATION SERVICES:

(none)

SEMAPHORE MANAGEMENT SERVICES:

(none)

DOMAIN MANAGEMENT SERVICES:

- GetDomainAttributes

PROGRAM INVOCATION MANAGEMENT SERVICES:

(none)

EVENT MANAGEMENT SERVICES:

(none)

JOURNAL MANAGEMENT SERVICES:

(none)

FILE MANAGEMENT SERVICES:

- ObtainFile
- FileOpen
- FileRead
- FileClose
- FileDirectory

The following MMS parameters are supported:

- STR1 (Arrays)
- STR2 (Structures)
- NEST (Nesting Levels of STR1 and STR2) - 1
- VNAM (Named Variables)
- VADR (Unnamed Variables)
- VALT (Alternate Access Variables)
- VLIS (Named Variable Lists)
- REAL (ASN.1 REAL Type)

c) MODEL IMPLEMENTATION CONFORMANCE (MIC)

This section provides details of the UCA object models supported by the UR series relays. Note that not all of the protective device functions are applicable to all the UR series relays.

Table C–1: DEVICE IDENTITY – DI

NAME	M/O	RWEC
Name	m	rw
Class	o	rw
d	o	rw
Own	o	rw
Loc	o	rw
VndID	m	r

Table C–2: GENERIC CONTROL – GCTL

FC	NAME	CLASS	RWECS	DESCRIPTION
ST	BO<n>	SI	rw	Generic Single Point Indication
CO	BO<n>	SI	rw	Generic Binary Output
CF	BO<n>	SBOCF	rw	SBO Configuration
DC	LN	d	rw	Description for brick
	BO<n>	d	rw	Description for each point

NOTE

Actual instantiation of GCTL objects is as follows:

GCTL1 = Virtual Inputs (32 total points – SI1 to SI32); includes SBO functionality.

Table C–3: GENERIC INDICATORS – GIND 1 TO 6

FC	NAME	CLASS	RWECS	DESCRIPTION
ST	SIG<n>	SIG	r	Generic Indication (block of 16)
DC	LN	d	rw	Description for brick
RP	BrcbST	BasRCB	rw	Controls reporting of STATUS

Table C–4: GENERIC INDICATOR – GIND7

FC	OBJECT NAME	CLASS	RWECS	DESCRIPTION
ST	SI<n>	SI	r	Generic single point indication
DC	LN	d	rw	Description for brick
	SI<n>	d	rw	Description for all included SI
RP	BrcbST	BasRCB	rw	Controls reporting of STATUS

NOTE

Actual instantiation of GIND objects is as follows:

GIND1 = Contact Inputs (96 total points – SIG1 to SIG6)
GIND2 = Contact Outputs (64 total points – SIG1 to SIG4)
GIND3 = Virtual Inputs (32 total points – SIG1 to SIG2)
GIND4 = Virtual Outputs (64 total points – SIG1 to SIG4)
GIND5 = Remote Inputs (32 total points – SIG1 to SIG2)
GIND6 = Flex States (16 total points – SIG1 representing Flex States 1 to 16)
GIND7 = Flex States (16 total points – SI1 to SI16 representing Flex States 1 to 16)

Table C–5: GLOBAL DATA – GLOBE

FC	OBJECT NAME	CLASS	RWECS	DESCRIPTION
ST	ModeDS	SIT	r	Device is: in test, off-line, available, or unhealthy
	LocRemDS	SIT	r	The mode of control, local or remote (DevST)
	ActSG	INT8U	r	Active Settings Group
	EditSG	INT8u	r	Settings Group selected for read/write operation
CO	CopySG	INT8U	w	Selects Settings Group for read/write operation
	IndRs	BOOL	w	Resets ALL targets
CF	ClockTOD	BTIME	rw	Date and time
RP	GOOSE	PACT	rw	Reports IED Inputs and Outputs

Table C–6: MEASUREMENT UNIT (POLYPHASE) – MMXU

FC	OBJECT NAME	CLASS	RWECS	DESCRIPTION
MX	V	WYE	rw	Voltage on phase A, B, C to G
	PPV	DELTA	rw	Voltage on AB, BC, CA
	A	WYE	rw	Current in phase A, B, C, and N
	W	WYE	rw	Watts in phase A, B, C
	TotW	AI	rw	Total watts in all three phases
	Var	WYE	rw	Vars in phase A, B, C
	TotVar	AI	rw	Total vars in all three phases
	VA	WYE	rw	VA in phase A, B, C
	TotVA	AI	rw	Total VA in all 3 phases
	PF	WYE	rw	Power Factor for phase A, B, C
	AvgPF	AI	rw	Average Power Factor for all three phases
	Hz	AI	rw	Power system frequency
CF	All MMXU.MX	ACF	rw	Configuration of ALL included MMXU.MX
DC	LN	d	rw	Description for brick
	All MMXU.MX	d	rw	Description of ALL included MMXU.MX
RP	BrcbMX	BasRCB	rw	Controls reporting of measurements

NOTE

Actual instantiation of MMXU objects is as follows:

1 MMXU per Source (as determined from the ‘product order code’)

Table C–7: PROTECTIVE ELEMENTS

FC	OBJECT NAME	CLASS	RWECS	DESCRIPTION
ST	Out	BOOL	r	1 = Element operated, 0 = Element not operated
	Tar	PhsTar	r	Targets since last reset
	FctDS	SIT	r	Function is enabled/disabled
	PuGrp	INT8U	r	Settings group selected for use
CO	EnaDisFct	DCO	w	1 = Element function enabled, 0 = disabled
	RsTar	BO	w	Reset ALL Elements/Targets
	RsLat	BO	w	Reset ALL Elements/Targets
DC	LN	d	rw	Description for brick
	ElementSt	d	r	Element state string

The following GOMSFE objects are defined by the object model described via the above table:

- PBRO (basic relay object)
- PDIF (differential relay)
- PDIS (distance)
- PDOC (directional overcurrent)
- PDPR (directional power relay)
- PFRQ (frequency relay)
- PHIZ (high impedance ground detector)
- PIOC (instantaneous overcurrent relay)
- POVR (over voltage relay)
- PTOC (time overcurrent relay)
- PUVR (under voltage relay)
- RSYN (synchronizing or synchronism-check relay)
- POVR (overvoltage)
- PVPH (volts per hertz relay)
- PBRL (phase balance current relay)

NOTE

Actual instantiation of these objects is determined by the number of the corresponding elements present in the UR as per the ‘product order code’.

Table C–8: CT RATIO INFORMATION – ctRATO

OBJECT NAME	CLASS	RWECS	DESCRIPTION
PhsARat	RATIO	rw	Primary/secondary winding ratio
NeutARat	RATIO	rw	Primary/secondary winding ratio
LN	d	rw	Description for brick (current bank ID)

Table C–9: VT RATIO INFORMATION – vtRATO

OBJECT NAME	CLASS	RWECS	DESCRIPTION
PhsVRat	RATIO	rw	Primary/secondary winding ratio
LN	d	rw	Description for brick (current bank ID)

NOTE

Actual instantiation of ctRATO and vtRATO objects is as follows:

1 ctRATO per Source (as determined from the product order code).
1 vtRATO per Source (as determined from the product order code).

C

Table C–10: RECLOSING RELAY – RREC

FC	OBJECT NAME	CLASS	RWECS	DESCRIPTION
ST	Out	BOOL	r	1 = Element operated, 0 = Element not operated
	FctDS	SIT	r	Function is enabled/disabled
	PuGrp	INT8U	r	Settings group selected for use
SG	ReclSeq	SHOTS	rw	Reclosing Sequence
CO	EnaDisFct	DCO	w	1 = Element function enabled, 0 = disabled
	RsTar	BO	w	Reset ALL Elements/Targets
	RsLat	BO	w	Reset ALL Elements/Targets
CF	ReclSeq	ACF	rw	Configuration for RREC.SG
DC	LN	d	rw	Description for brick
	ElementSt	d	r	Element state string

NOTE

Actual instantiation of RREC objects is determined by the number of autoreclose elements present in the UR as per the product order code.

Also note that the Shots class data (i.e. Tmr1, Tmr2, Tmr3, Tmr4, RsTmr) is specified to be of type INT16S (16 bit signed integer); this data type is not large enough to properly display the full range of these settings from the UR. Numbers larger than 32768 will be displayed incorrectly.

Table C–11: CIRCUIT BREAKER – XCBR

FC	OBJECT NAME	CLASS	RWECS	DESCRIPTION
ST	SwDS	SIT	rw	Switch Device Status
	SwPoleDS	BSTR8	rw	Switch Pole Device Status
	PwrSupSt	SIG	rw	Health of the power supply
	PresSt	SIT	rw	The condition of the insulating medium pressure
	PoleDiscSt	SI	rw	All CB poles did not operate within time interval
	TrpCoil	SI	rw	Trip coil supervision
CO	ODSw	DCO	rw	The command to open/close the switch
CF	ODSwSBO	SBOCF	rw	Configuration for all included XCBR.CO
DC	LN	d	rw	Description for brick
RP	brcbST	BasRCB	rw	Controls reporting of Status Points

NOTE

Actual instantiation of XCBR objects is determined by the number of breaker control elements present in the UR as per the product order code.

C.1.3 UCA REPORTING

A built-in TCP/IP connection timeout of two minutes is employed by the UR to detect "dead" connections. If there is no data traffic on a TCP connection for greater than two minutes, the connection will be aborted by the UR. This frees up the connection to be used by other clients. Therefore, when using UCA reporting, clients should configure BasRCB objects such that an integrity report will be issued at least every 2 minutes (120000 ms). This ensures that the UR will not abort the connection. If other MMS data is being polled on the same connection at least once every 2 minutes, this timeout will not apply.

D.1.1 INTEROPERABILITY DOCUMENT

This document is adapted from the IEC 60870-5-104 standard. For ths section the boxes indicate the following: ☒ – used in standard direction; ☐ – not used; ■ – cannot be selected in IEC 60870-5-104 standard.

1. SYSTEM OR DEVICE:

☐ System Definition

☐ Controlling Station Definition (Master)

☒ **Controlled Station Definition (Slave)**

2. NETWORK CONFIGURATION:

■ ~~Point-to-Point~~ ■ ~~Multipoint~~

■ ~~Multiple Point-to-Point~~ ■ ~~Multipoint Star~~

3. PHYSICAL LAYER

Transmission Speed (control direction):

Unbalanced Interchange Circuit V.24/V.28 Standard:	Unbalanced Interchange Circuit V.24/V.28 Recommended if >1200 bits/s:	Balanced Interchange Circuit X.24/X.27:
■ ~~100 bits/sec.~~	■ ~~2400 bits/sec.~~	■ ~~2400 bits/sec.~~
■ ~~200 bits/sec.~~	■ ~~4800 bits/sec.~~	■ ~~4800 bits/sec.~~
■ ~~300 bits/sec.~~	■ ~~9600 bits/sec.~~	■ ~~9600 bits/sec.~~
■ ~~600 bits/sec.~~		■ ~~19200 bits/sec.~~
■ ~~1200 bits/sec.~~		■ ~~38400 bits/sec.~~
		■ ~~56000 bits/sec.~~
		■ ~~64000 bits/sec.~~

Transmission Speed (monitor direction):

Unbalanced Interchange Circuit V.24/V.28 Standard:	Unbalanced Interchange Circuit V.24/V.28 Recommended if >1200 bits/s:	Balanced Interchange Circuit X.24/X.27:
■ ~~100 bits/sec.~~	■ ~~2400 bits/sec.~~	■ ~~2400 bits/sec.~~
■ ~~200 bits/sec.~~	■ ~~4800 bits/sec.~~	■ ~~4800 bits/sec.~~
■ ~~300 bits/sec.~~	■ ~~9600 bits/sec.~~	■ ~~9600 bits/sec.~~
■ ~~600 bits/sec.~~		■ ~~19200 bits/sec.~~
■ ~~1200 bits/sec.~~		■ ~~38400 bits/sec.~~
		■ ~~56000 bits/sec.~~
		■ ~~64000 bits/sec.~~

4. LINK LAYER

Link Transmission Procedure:	Address Field of the Link:
■ ~~Balanced Transmision~~	■ ~~Not Present (Balanced Transmission Only)~~
■ ~~Unbalanced Transmission~~	■ ~~One Octet~~
	■ ~~Two Octets~~
	■ ~~Structured~~
	■ ~~Unstructured~~
Frame Length (maximum length, number of octets): Not selectable in companion IEC 60870-5-104 standard	

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When using an unbalanced link layer, the following ADSU types are returned in class 2 messages (low priority) with the indicated causes of transmission:

■ ~~The standard assignment of ADSUs to class 2 messages is used as follows~~:

■ ~~A special assignment of ADSUs to class 2 messages is used as follows~~:

5. APPLICATION LAYER

Transmission Mode for Application Data:
Mode 1 (least significant octet first), as defined in Clause 4.10 of IEC 60870-5-4, is used exclusively in this companion stanadard.

Common Address of ADSU:

■ ~~One Octet~~

☒ Two Octets

Information Object Address:

■ ~~One Octet~~

■ ~~Two Octets~~

☒ Three Octets

☒ Structured

☒ Unstructured

Cause of Transmission:

■ ~~One Octet~~

☒ Two Octets (with originator address). Originator address is set to zero if not used.

Maximum Length of APDU: 253 (the maximum length may be reduced by the system.

Selection of standard ASDUs:

For the following lists, the boxes indicate the following: ☒ – used in standard direction; ❐ – not used; ■ – cannot be selected in IEC 60870-5-104 standard.

Process information in monitor direction

☒ <1> := Single-point information	M_SP_NA_1
■ ~~<2> := Single-point information with time tag~~	~~M_SP_TA_1~~
❐ <3> := Double-point information	M_DP_NA_1
■ ~~<4> := Double-point information with time tag~~	~~M_DP_TA_1~~
❐ <5> := Step position information	M_ST_NA_1
■ ~~<6> := Step position information with time tag~~	~~M_ST_TA_1~~
❐ <7> := Bitstring of 32 bits	M_BO_NA_1
■ ~~<8> := Bitstring of 32 bits with time tag~~	~~M_BO_TA_1~~
❐ <9> := Measured value, normalized value	M_ME_NA_1
■ ~~<10> := Measured value, normalized value with time tag~~	~~M_NE_TA_1~~
❐ <11> := Measured value, scaled value	M_ME_NB_1
■ ~~<12> := Measured value, scaled value with time tag~~	~~M_NE_TB_1~~
☒ <13> := Measured value, short floating point value	M_ME_NC_1
■ ~~<14> := Measured value, short floating point value with time tag~~	~~M_NE_TC_1~~
☒ <15> := Integrated totals	M_IT_NA_1
■ ~~<16> := Integrated totals with time tag~~	~~M_IT_TA_1~~
■ ~~<17> := Event of protection equipment with time tag~~	~~M_EP_TA_1~~
■ ~~<18> := Packed start events of protection equipment with time tag~~	~~M_EP_TB_1~~
■ ~~<19> := Packed output circuit information of protection equipment with time tag~~	~~M_EP_TC_1~~
❐ <20> := Packed single-point information with status change detection	M_SP_NA_1

D

☐ <21> := Measured value, normalized value without quantity descriptor	M_ME_ND_1
☒ <30> := Single-point information with time tag CP56Time2a	M_SP_TB_1
☐ <31> := Double-point information wiht time tag CP56Time2a	M_DP_TB_1
☐ <32> := Step position information with time tag CP56Time2a	M_ST_TB_1
☐ <33> := Bitstring of 32 bits with time tag CP56Time2a	M_BO_TB_1
☐ <34> := Measured value, normalized value with time tag CP56Time2a	M_ME_TD_1
☐ <35> := Measured value, scaled value with time tag CP56Time2a	M_ME_TE_1
☐ <36> := Measured value, short floating point value with time tag CP56Time2a	M_ME_TF_1
☒ <37> := Integrated totals with time tag CP56Time2a	M_IT_TB_1
☐ <38> := Event of protection equipment with time tag CP56Time2a	M_EP_TD_1
☐ <39> := Packed start events of protection equipment with time tag CP56Time2a	M_EP_TE_1
☐ <40> := Packed output circuit information of protection equipment with time tag CP56Time2a	M_EP_TF_1

Either the ASDUs of the set <2>, <4>, <6>, <8>, <10>, <12>, <14>, <16>, <17>, <18>, and <19> or of the set <30> to <40> are used.

Process information in control direction

☒ <45> := Single command	C_SC_NA_1
☐ <46> := Double command	C_DC_NA_1
☐ <47> := Regulating step command	C_RC_NA_1
☐ <48> := Set point command, normalized value	C_SE_NA_1
☐ <49> := Set point command, scaled value	C_SE_NB_1
☐ <50> := Set point command, short floating point value	C_SE_NC_1
☐ <51> := Bitstring of 32 bits	C_BO_NA_1
☒ <58> := Single command with time tag CP56Time2a	C_SC_TA_1
☐ <59> := Double command with time tag CP56Time2a	C_DC_TA_1
☐ <60> := Regulating step command with time tag CP56Time2a	C_RC_TA_1
☐ <61> := Set point command, normalized value with time tag CP56Time2a	C_SE_TA_1
☐ <62> := Set point command, scaled value with time tag CP56Time2a	C_SE_TB_1
☐ <63> := Set point command, short floating point value with time tag CP56Time2a	C_SE_TC_1
☐ <64> := Bitstring of 32 bits with time tag CP56Time2a	C_BO_TA_1

Either the ASDUs of the set <45> to <51> or of the set <58> to <64> are used.

System information in monitor direction

☒ <70> := End of initialization	M_EI_NA_1

System information in control direction

☒ <100> := Interrogation command	C_IC_NA_1
☒ <101> := Counter interrogation command	C_CI_NA_1
☒ <102> := Read command	C_RD_NA_1
☒ <103> := Clock synchronization command (see Clause 7.6 in standard)	C_CS_NA_1
■ ~~<104> := Test command~~	~~C_TS_NA_1~~
☒ <105> := Reset process command	C_RP_NA_1
■ <106> := Delay acquisition command	C_CD_NA_1
☒ <107> := Test command with time tag CP56Time2a	C_TS_TA_1

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Parameter in control direction

- ☐ <110> := Parameter of measured value, normalized value PE_ME_NA_1
- ☐ <111> := Parameter of measured value, scaled value PE_ME_NB_1
- ☒ <112> := Parameter of measured value, short floating point value PE_ME_NC_1
- ☐ <113> := Parameter activation PE_AC_NA_1

File transfer

- ☐ <120> := File Ready F_FR_NA_1
- ☐ <121> := Section Ready F_SR_NA_1
- ☐ <122> := Call directory, select file, call file, call section F_SC_NA_1
- ☐ <123> := Last section, last segment F_LS_NA_1
- ☐ <124> := Ack file, ack section F_AF_NA_1
- ☐ <125> := Segment F_SG_NA_1
- ☐ <126> := Directory (blank or X, available only in monitor [standard] direction) C_CD_NA_1

D

Type identifier and cause of transmission assignments
(station-specific parameters)

In the following table:

- Shaded boxes are not required.
- Black boxes are not permitted in this companion standard.
- Blank boxes indicate functions or ASDU not used.
- '**X**' if only used in the standard direction

TYPE IDENTIFICATION		CAUSE OF TRANSMISSION																
		PERIODIC, CYCLIC	BACKGROUND SCAN	SPONTANEOUS	INITIALIZED	REQUEST OR REQUESTED	ACTIVATION	ACTIVATION CONFIRMATION	DEACTIVATION	DEACTIVATION CONFIRMATION	ACTIVATION TERMINATION	RETURN INFO CAUSED BY LOCAL CMD	FILE TRANSFER	INTERROGATED BY GROUP <NUMBER>	REQUEST BY GROUP <N> COUNTER REQ	UNKNOWN TYPE IDENTIFICATION	UNKNOWN CAUSE OF TRANSMISSION	UNKNOWN COMMON ADDRESS OF ADSU	UNKNOWN INFORMATION OBJECT ADDR	UNKNOWN INFORMATION OBJECT ADDR
NO.	MNEMONIC	1	2	3	4	5	6	7	8	9	10	11	12	13	20 to 36	37 to 41	44	45	46	47
<1>	M_SP_NA_1			X		X						X	X		X					
<2>	M_SP_TA_1																			
<3>	M_DP_NA_1																			
<4>	M_DP_TA_1																			
<5>	M_ST_NA_1																			
<6>	M_ST_TA_1																			
<7>	M_BO_NA_1																			
<8>	M_BO_TA_1																			

TYPE IDENTIFICATION		CAUSE OF TRANSMISSION																		
		PERIODIC, CYCLIC	BACKGROUND SCAN	SPONTANEOUS	INITIALIZED	REQUEST OR REQUESTED	ACTIVATION	ACTIVATION CONFIRMATION	DEACTIVATION	DEACTIVATION CONFIRMATION	ACTIVATION TERMINATION	RETURN INFO CAUSED BY LOCAL CMD	FILE TRANSFER	INTERROGATED BY GROUP <NUMBER>	REQUEST BY GROUP <N> COUNTER REQ	UNKNOWN TYPE IDENTIFICATION	UNKNOWN CAUSE OF TRANSMISSION	UNKNOWN COMMON ADDRESS OF ADSU	UNKNOWN INFORMATION OBJECT ADDR	UNKNOWN INFORMATION OBJECT ADDR
NO.	MNEMONIC	1	2	3	4	5	6	7	8	9	10	11	12	13	20 to 36	37 to 41	44	45	46	47
<9>	M_ME_NA_1																			
<10>	M_ME_TA_1																			
<11>	M_ME_NB_1																			
<12>	M_ME_TB_1																			
<13>	M_ME_NC_1	X		X		X									X					
<14>	M_ME_TC_1																			
<15>	M_IT_NA_1			X												X				
<16>	M_IT_TA_1																			
<17>	M_EP_TA_1																			
<18>	M_EP_TB_1																			
<19>	M_EP_TC_1																			
<20>	M_PS_NA_1																			
<21>	M_ME_ND_1																			
<30>	M_SP_TB_1			X								X	X							
<31>	M_DP_TB_1																			
<32>	M_ST_TB_1																			
<33>	M_BO_TB_1																			
<34>	M_ME_TD_1																			
<35>	M_ME_TE_1																			
<36>	M_ME_TF_1																			
<37>	M_IT_TB_1			X												X				
<38>	M_EP_TD_1																			
<39>	M_EP_TE_1																			
<40>	M_EP_TF_1																			
<45>	C_SC_NA_1						X	X	X	X	X									
<46>	C_DC_NA_1																			
<47>	C_RC_NA_1																			
<48>	C_SE_NA_1																			
<49>	C_SE_NB_1																			

D

D

TYPE IDENTIFICATION		CAUSE OF TRANSMISSION																		
		PERIODIC, CYCLIC	BACKGROUND SCAN	SPONTANEOUS	INITIALIZED	REQUEST OR REQUESTED	ACTIVATION	ACTIVATION CONFIRMATION	DEACTIVATION	DEACTIVATION CONFIRMATION	ACTIVATION TERMINATION	RETURN INFO CAUSED BY LOCAL CMD	FILE TRANSFER	INTERROGATED BY GROUP <NUMBER>	REQUEST BY GROUP <N> COUNTER REQ	UNKNOWN TYPE IDENTIFICATION	UNKNOWN CAUSE OF TRANSMISSION	UNKNOWN COMMON ADDRESS OF ADSU	UNKNOWN INFORMATION OBJECT ADDR	UNKNOWN INFORMATION OBJECT ADDR
NO.	MNEMONIC	1	2	3	4	5	6	7	8	9	10	11	12	13	20 to 36	37 to 41	44	45	46	47
<50>	C_SE_NC_1																			
<51>	C_BO_NA_1																			
<58>	C_SC_TA_1						X	X	X	X	X									
<59>	C_DC_TA_1																			
<60>	C_RC_TA_1																			
<61>	C_SE_TA_1																			
<62>	C_SE_TB_1																			
<63>	C_SE_TC_1																			
<64>	C_BO_TA_1																			
<70>	M_EI_NA_1*)				X															
<100>	C_IC_NA_1						X	X	X	X	X									
<101>	C_CI_NA_1						X	X			X									
<102>	C_RD_NA_1					X														
<103>	C_CS_NA_1			X			X	X												
<104>	C_TS_NA_1																			
<105>	C_RP_NA_1						X	X												
<106>	C_CD_NA_1																			
<107>	C_TS_TA_1																			
<110>	P_ME_NA_1																			
<111>	P_ME_NB_1																			
<112>	P_ME_NC_1						X	X							X					
<113>	P_AC_NA_1																			
<120>	F_FR_NA_1																			
<121>	F_SR_NA_1																			
<122>	F_SC_NA_1																			
<123>	F_LS_NA_1																			
<124>	F_AF_NA_1																			
<125>	F_SG_NA_1																			
<126>	F_DR_TA_1*)																			

6. BASIC APPLICATION FUNCTIONS

Station Initialization:

☒ Remote initialization

Cyclic Data Transmission:

☒ Cyclic data transmission

Read Procedure:

☒ Read procedure

Spontaneous Transmission:

☒ Spontaneous transmission

Double transmission of information objects with cause of transmission spontaneous:

The following type identifications may be transmitted in succession caused by a single status change of an information object. The particular information object addresses for which double transmission is enabled are defined in a project-specific list.

☐ Single point information: M_SP_NA_1, M_SP_TA_1, M_SP_TB_1, and M_PS_NA_1

☐ Double point information: M_DP_NA_1, M_DP_TA_1, and M_DP_TB_1

☐ Step position information: M_ST_NA_1, M_ST_TA_1, and M_ST_TB_1

☐ Bitstring of 32 bits: M_BO_NA_1, M_BO_TA_1, and M_BO_TB_1 (if defined for a specific project)

☐ Measured value, normalized value: M_ME_NA_1, M_ME_TA_1, M_ME_ND_1, and M_ME_TD_1

☐ Measured value, scaled value: M_ME_NB_1, M_ME_TB_1, and M_ME_TE_1

☐ Measured value, short floating point number: M_ME_NC_1, M_ME_TC_1, and M_ME_TF_1

Station interrogation:

☒ Global

☒ Group 1	☒ Group 5	☒ Group 9	☒ Group 13
☒ Group 2	☒ Group 6	☒ Group 10	☒ Group 14
☒ Group 3	☒ Group 7	☒ Group 11	☒ Group 15
☒ Group 4	☒ Group 8	☒ Group 12	☒ Group 16

Clock synchronization:

☒ Clock synchronization (optional, see Clause 7.6)

Command transmission:

☒ Direct command transmission

☐ Direct setpoint command transmission

☒ Select and execute command

☐ Select and execute setpoint command

☒ C_SE ACTTERM used

☒ No additional definition

☒ Short pulse duration (duration determined by a system parameter in the outstation)

☒ Long pulse duration (duration determined by a system parameter in the outstation)

☒ Persistent output

☒ Supervision of maximum delay in command direction of commands and setpoint commands

Maximum allowable delay of commands and setpoint commands: **10 s**

Transmission of integrated totals:

- ☒ Mode A: Local freeze with spontaneous transmission
- ☒ Mode B: Local freeze with counter interrogation
- ☒ Mode C: Freeze and transmit by counter-interrogation commands
- ☒ Mode D: Freeze by counter-interrogation command, frozen values reported simultaneously

- ☒ Counter read
- ☒ Counter freeze without reset
- ☒ Counter freeze with reset
- ☒ Counter reset

- ☒ General request counter
- ☒ Request counter group 1
- ☒ Request counter group 2
- ☒ Request counter group 3
- ☒ Request counter group 4

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Parameter loading:

- ☒ Threshold value
- ☐ Smoothing factor
- ☐ Low limit for transmission of measured values
- ☐ High limit for transmission of measured values

Parameter activation:

- ☐ Activation/deactivation of persistent cyclic or periodic transmission of the addressed object

Test procedure:

- ☐ Test procedure

File transfer:

File transfer in monitor direction:

- ☐ Transparent file
- ☐ Transmission of disturbance data of protection equipment
- ☐ Transmission of sequences of events
- ☐ Transmission of sequences of recorded analog values

File transfer in control direction:

- ☐ Transparent file

Background scan:

- ☐ Background scan

Acquisition of transmission delay:

- ■ ~~Acquisition of transmission delay~~

Definition of time outs:

PARAMETER	DEFAULT VALUE	REMARKS	SELECTED VALUE
t_0	30 s	Timeout of connection establishment	120 s
t_1	15 s	Timeout of send or test APDUs	15 s
t_2	10 s	Timeout for acknowlegements in case of no data messages $t_2 < t_1$	10 s
t_3	20 s	Timeout for sending test frames in case of a long idle state	20 s

Maximum range of values for all time outs: 1 to 255 s, accuracy 1 s

Maximum number of outstanding I-format APDUs *k* and latest acknowledge APDUs (*w*):

PARAMETER	DEFAULT VALUE	REMARKS	SELECTED VALUE
k	12 APDUs	Maximum difference receive sequence number to send state variable	12 APDUs
w	8 APDUs	Latest acknowledge after receiving *w* I-format APDUs	8 APDUs

Maximum range of values *k*: 1 to 32767 (2^{15} – 1) APDUs, accuracy 1 APDU

Maximum range of values *w*: 1 to 32767 APDUs, accuracy 1 APDU
Recommendation: *w* should not exceed two-thirds of *k*.

Portnumber:

PARAMETER	VALUE	REMARKS
Portnumber	2404	In all cases

RFC 2200 suite:

RFC 2200 is an official Internet Standard which describes the state of standardization of protocols used in the Internet as determined by the Internet Architecture Board (IAB). It offers a broad spectrum of actual standards used in the Internet. The suitable selection of documents from RFC 2200 defined in this standard for given projects has to be chosen by the user of this standard.

☒ Ethernet 802.3

☐ Serial X.21 interface

☐ Other selection(s) from RFC 2200 (list below if selected)

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D.1.2 POINT LIST

Table D–1: IEC 60870-5-104 POINT LIST (SHEET 1 OF 2)

POINT	DESCRIPTION
M_ME_NC_1 POINTS	
2000	FlexElement 1 Actual
2001	FlexElement 2 Actual
2002	FlexElement 3 Actual
2003	FlexElement 4 Actual
2004	FlexElement 5 Actual
2005	FlexElement 6 Actual
2006	FlexElement 7 Actual
2007	FlexElement 8 Actual
2016	Current Setting Group
P_ME_NC_1 POINTS	
5000 - 5016	Threshold values for M_ME_NC_1 points
M_SP_NA_1 POINTS	
100 - 115	Virtual Input States[0]
116 - 131	Virtual Input States[1]
132 - 147	Virtual Output States[0]
148 - 163	Virtual Output States[1]
164 - 179	Virtual Output States[2]
180 - 195	Virtual Output States[3]
196 - 211	Contact Input States[0]
212 - 227	Contact Input States[1]
228 - 243	Contact Input States[2]
244 - 259	Contact Input States[3]
260 - 275	Contact Input States[4]
276 - 291	Contact Input States[5]
292 - 307	Contact Output States[0]
308 - 323	Contact Output States[1]
324 - 339	Contact Output States[2]
340 - 355	Contact Output States[3]
356 - 371	Remote Input x States[0]
372 - 387	Remote Input x States[1]
388 - 403	Remote Device x States
404 - 419	LED Column x State[0]
420 - 435	LED Column x State[1]
C_SC_NA_1 POINTS	
1100 - 1115	Virtual Input States[0] - No Select Required
1116 - 1131	Virtual Input States[1] - Select Required

Table D–1: IEC 60870-5-104 POINT LIST (SHEET 2 OF 2)

POINT	DESCRIPTION
M_IT_NA_1 POINTS	
4000	Digital Counter 1 Value
4001	Digital Counter 2 Value
4002	Digital Counter 3 Value
4003	Digital Counter 4 Value
4004	Digital Counter 5 Value
4005	Digital Counter 6 Value
4006	Digital Counter 7 Value
4007	Digital Counter 8 Value

E.1.1 DEVICE PROFILE DOCUMENT

The following table provides a ‘Device Profile Document’ in the standard format defined in the DNP 3.0 Subset Definitions Document.

Table E–1: DNP V3.00 DEVICE PROFILE (Sheet 1 of 3)

(Also see the IMPLEMENTATION TABLE in the following section)	
Vendor Name: **General Electric Multilin**	
Device Name: **UR Series Relay**	
Highest DNP Level Supported: For Requests: **Level 2** For Responses: **Level 2**	**Device Function:** ☐ Master ☒ **Slave**
Notable objects, functions, and/or qualifiers supported in addition to the Highest DNP Levels Supported (the complete list is described in the attached table): **Binary Inputs (Object 1)** **Binary Input Changes (Object 2)** **Binary Outputs (Object 10)** **Binary Counters (Object 20)** **Frozen Counters (Object 21)** **Counter Change Event (Object 22)** **Frozen Counter Event (Object 23)** **Analog Inputs (Object 30)** **Analog Input Changes (Object 32)** **Analog Deadbands (Object 34)**	
Maximum Data Link Frame Size (octets): Transmitted: **292** Received: **292**	**Maximum Application Fragment Size (octets):** Transmitted: **240** Received: **2048**
Maximum Data Link Re-tries: ☐ **None** ☒ Fixed at 2 ☐ Configurable	**Maximum Application Layer Re-tries:** ☒ None ☐ Configurable
Requires Data Link Layer Confirmation: ☒ Never ☐ Always ☐ Sometimes ☐ Configurable	

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Table E–1: DNP V3.00 DEVICE PROFILE (Sheet 2 of 3)

Requires Application Layer Confirmation:

- ☐ Never
- ☐ Always
- ☒ When reporting Event Data
- ☒ When sending multi-fragment responses
- ☐ Sometimes
- ☐ Configurable

Timeouts while waiting for:

Data Link Confirm:	☐ None	☒ **Fixed at 3 s**	☐ Variable	☐ Configurable
Complete Appl. Fragment:	☒ **None**	☐ Fixed at ____	☐ Variable	☐ Configurable
Application Confirm:	☐ None	☒ **Fixed at 4 s**	☐ Variable	☐ Configurable
Complete Appl. Response:	☒ **None**	☐ Fixed at ____	☐ Variable	☐ Configurable

Others:

Transmission Delay:	**No intentional delay**
Inter-character Timeout:	**50 ms**
Need Time Delay:	**Configurable (default = 24 hrs.)**
Select/Operate Arm Timeout:	**10 s**
Binary input change scanning period:	**8 times per power system cycle**
Packed binary change process period:	**1 s**
Analog input change scanning period:	**500 ms**
Counter change scanning period:	**500 ms**
Frozen counter event scanning period:	**500 ms**
Unsolicited response notification delay:	**500 ms**
Unsolicited response retry delay	**configurable 0 to 60 sec.**

Sends/Executes Control Operations:

WRITE Binary Outputs	☒ **Never**	☐ Always	☐ Sometimes	☐ Configurable
SELECT/OPERATE	☐ Never	☒ **Always**	☐ Sometimes	☐ Configurable
DIRECT OPERATE	☐ Never	☒ **Always**	☐ Sometimes	☐ Configurable
DIRECT OPERATE – NO ACK	☐ Never	☒ **Always**	☐ Sometimes	☐ Configurable

Count > 1	☒ **Never**	☐ Always	☐ Sometimes	☐ Configurable
Pulse On	☐ Never	☐ Always	☒ **Sometimes**	☐ Configurable
Pulse Off	☐ Never	☐ Always	☒ **Sometimes**	☐ Configurable
Latch On	☐ Never	☐ Always	☒ **Sometimes**	☐ Configurable
Latch Off	☐ Never	☐ Always	☒ **Sometimes**	☐ Configurable

Queue	☒ **Never**	☐ Always	☐ Sometimes	☐ Configurable
Clear Queue	☒ **Never**	☐ Always	☐ Sometimes	☐ Configurable

Explanation of 'Sometimes': Object 12 points are mapped to UR Virtual Inputs. The persistence of Virtual Inputs is determined by the **VIRTUAL INPUT X TYPE** settings. Both "Pulse On" and "Latch On" operations perform the same function in the UR; that is, the appropriate Virtual Input is put into the "On" state. If the Virtual Input is set to "Self-Reset", it will reset after one pass of FlexLogic™. The On/Off times and Count value are ignored. "Pulse Off" and "Latch Off" operations put the appropriate Virtual Input into the "Off" state. "Trip" and "Close" operations both put the appropriate Virtual Input into the "On" state.

Table E–1: DNP V3.00 DEVICE PROFILE (Sheet 3 of 3)

Reports Binary Input Change Events when no specific variation requested: ☐ Never ☒ **Only time-tagged** ☐ Only non-time-tagged ☐ Configurable	**Reports time-tagged Binary Input Change Events when no specific variation requested:** ☐ Never ☒ Binary Input Change With Time ☐ Binary Input Change With Relative Time ☐ Configurable (attach explanation)
Sends Unsolicited Responses: ☐ **Never** ☒ Configurable ☐ Only certain objects ☐ Sometimes (attach explanation) ☒ ENABLE/DISABLE unsolicited Function codes supported	**Sends Static Data in Unsolicited Responses:** ☒ Never ☐ When Device Restarts ☐ When Status Flags Change No other options are permitted.
Default Counter Object/Variation: ☐ No Counters Reported ☐ Configurable (attach explanation) ☒ **Default Object: 20** **Default Variation: 1** ☒ **Point-by-point list attached**	**Counters Roll Over at:** ☐ No Counters Reported ☐ Configurable (attach explanation) ☒ **16 Bits (Counter 8)** ☒ **32 Bits (Counters 0 to 7, 9)** ☐ Other Value: _____ ☒ **Point-by-point list attached**
Sends Multi-Fragment Responses: ☒ **Yes** ☐ No	

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E.1.2 DNP IMPLEMENTATION

The following table identifies the variations, function codes, and qualifiers supported by the UR in both request messages and in response messages. For static (non-change-event) objects, requests sent with qualifiers 00, 01, 06, 07, or 08, will be responded with qualifiers 00 or 01. Static object requests sent with qualifiers 17 or 28 will be responded with qualifiers 17 or 28. For change-event objects, qualifiers 17 or 28 are always responded.

Table E–2: IMPLEMENTATION TABLE (Sheet 1 of 4)

OBJECT			REQUEST		RESPONSE	
OBJECT NO.	VARIATION NO.	DESCRIPTION	FUNCTION CODES (DEC)	QUALIFIER CODES (HEX)	FUNCTION CODES (DEC)	QUALIFIER CODES (HEX)
1	0	Binary Input (Variation 0 is used to request default variation)	1 (read) 22 (assign class)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited quantity) 17, 28 (index)		
	1	Binary Input	1 (read) 22 (assign class)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited quantity) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index) *(see Note 2)*
	2	Binary Input with Status *(default – see Note 1)*	1 (read) 22 (assign class)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited quantity) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index) *(see Note 2)*
2	0	Binary Input Change (Variation 0 is used to request default variation)	1 (read)	06 (no range, or all) 07, 08 (limited quantity)		
	1	Binary Input Change without Time	1 (read)	06 (no range, or all) 07, 08 (limited quantity)	129 (response) 130 (unsol. resp.)	17, 28 (index)
	2	Binary Input Change with Time *(default – see Note 1)*	1 (read)	06 (no range, or all) 07, 08 (limited quantity)	129 (response 130 (unsol. resp.)	17, 28 (index)
	3 (parse only)	Binary Input Change with Relative Time	1 (read)	06 (no range, or all) 07, 08 (limited quantity)		
10	0	Binary Output Status (Variation 0 is used to request default variation)	1 (read)	00, 01(start-stop) 06 (no range, or all) 07, 08 (limited quantity) 17, 28 (index)		
	2	Binary Output Status *(default – see Note 1)*	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited quantity) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index) *(see Note 2)*
12	1	Control Relay Output Block	3 (select) 4 (operate) 5 (direct op) 6 (dir. op, noack)	00, 01 (start-stop) 07, 08 (limited quantity) 17, 28 (index)	129 (response)	echo of request
20	0	Binary Counter (Variation 0 is used to request default variation)	1 (read) 7 (freeze) 8 (freeze noack) 9 (freeze clear) 10 (frz. cl. noack) 22 (assign class)	00, 01(start-stop) 06(no range, or all) 07, 08(limited quantity) 17, 28(index)		
	1	32-Bit Binary Counter *(default – see Note 1)*	1 (read) 7 (freeze) 8 (freeze noack) 9 (freeze clear) 10 (frz. cl. noack) 22 (assign class)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited quantity) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index) *(see Note 2)*

Note 1: A Default variation refers to the variation responded when variation 0 is requested and/or in class 0, 1, 2, or 3 scans. Type 30 (Analog Input) data is limited to data that is actually possible to be used in the UR, based on the product order code. For example, Signal Source data from source numbers that cannot be used is not included. This optimizes the class 0 poll data size.

Note 2: For static (non-change-event) objects, qualifiers 17 or 28 are only responded when a request is sent with qualifiers 17 or 28, respectively. Otherwise, static object requests sent with qualifiers 00, 01, 06, 07, or 08, will be responded with qualifiers 00 or 01 (for change-event objects, qualifiers 17 or 28 are always responded.)

Note 3: Cold restarts are implemented the same as warm restarts – the UR is not restarted, but the DNP process is restarted.

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Table E–2: IMPLEMENTATION TABLE (Sheet 2 of 4)

OBJECT			REQUEST		RESPONSE	
OBJECT NO.	VARIATION NO.	DESCRIPTION	FUNCTION CODES (DEC)	QUALIFIER CODES (HEX)	FUNCTION CODES (DEC)	QUALIFIER CODES (HEX)
20 cont'd	2	16-Bit Binary Counter	1 (read) 7 (freeze) 8 (freeze noack) 9 (freeze clear) 10 (frz. cl. noack) 22 (assign class)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited quantity) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index) *(see Note 2)*
	5	32-Bit Binary Counter without Flag	1 (read) 7 (freeze) 8 (freeze noack) 9 (freeze clear) 10 (frz. cl. noack) 22 (assign class)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited quantity) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index) *(see Note 2)*
	6	16-Bit Binary Counter without Flag	1 (read) 7 (freeze) 8 (freeze noack) 9 (freeze clear) 10 (frz. cl. noack) 22 (assign class)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited quantity) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index) *(see Note 2)*
21	0	Frozen Counter (Variation 0 is used to request default variation)	1 (read) 22 (assign class)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited quantity) 17, 28 (index)		
	1	32-Bit Frozen Counter *(default – see Note 1)*	1 (read) 22 (assign class)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited quantity) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index) *(see Note 2)*
	2	16-Bit Frozen Counter	1 (read) 22 (assign class)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited quantity) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index) *(see Note 2)*
	9	32-Bit Frozen Counter without Flag	1 (read) 22 (assign class)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited quantity) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index) *(see Note 2)*
	10	16-Bit Frozen Counter without Flag	1 (read) 22 (assign class)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited quantity) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index) *(see Note 2)*
22	0	Counter Change Event (Variation 0 is used to request default variation)	1 (read)	06 (no range, or all) 07, 08 (limited quantity)		
	1	32-Bit Counter Change Event *(default – see Note 1)*	1 (read)	06 (no range, or all) 07, 08 (limited quantity)	129 (response) 130 (unsol. resp.)	17, 28 (index)
	2	16-Bit Counter Change Event	1 (read)	06 (no range, or all) 07, 08 (limited quantity)	129 (response) 130 (unsol. resp.)	17, 28 (index)
	5	32-Bit Counter Change Event with Time	1 (read)	06 (no range, or all) 07, 08 (limited quantity)	129 (response) 130 (unsol. resp.)	17, 28 (index)
	6	16-Bit Counter Change Event with Time	1 (read)	06 (no range, or all) 07, 08 (limited quantity)	129 (response) 130 (unsol. resp.)	17, 28 (index)
23	0	Frozen Counter Event (Variation 0 is used to request default variation)	1 (read)	06 (no range, or all) 07, 08 (limited quantity)		
	1	32-Bit Frozen Counter Event *(default – see Note 1)*	1 (read)	06 (no range, or all) 07, 08 (limited quantity)	129 (response) 130 (unsol. resp.)	17, 28 (index)
	2	16-Bit Frozen Counter Event	1 (read)	06 (no range, or all) 07, 08 (limited quantity)	129 (response) 130 (unsol. resp.)	17, 28 (index)

Note 1: A Default variation refers to the variation responded when variation 0 is requested and/or in class 0, 1, 2, or 3 scans. Type 30 (Analog Input) data is limited to data that is actually possible to be used in the UR, based on the product order code. For example, Signal Source data from source numbers that cannot be used is not included. This optimizes the class 0 poll data size.

Note 2: For static (non-change-event) objects, qualifiers 17 or 28 are only responded when a request is sent with qualifiers 17 or 28, respectively. Otherwise, static object requests sent with qualifiers 00, 01, 06, 07, or 08, will be responded with qualifiers 00 or 01 (for change-event objects, qualifiers 17 or 28 are always responded.)

Note 3: Cold restarts are implemented the same as warm restarts – the UR is not restarted, but the DNP process is restarted.

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Table E–2: IMPLEMENTATION TABLE (Sheet 3 of 4)

OBJECT			REQUEST		RESPONSE	
OBJECT NO.	VARIATION NO.	DESCRIPTION	FUNCTION CODES (DEC)	QUALIFIER CODES (HEX)	FUNCTION CODES (DEC)	QUALIFIER CODES (HEX)
23 cont'd	5	32-Bit Frozen Counter Event with Time	1 (read)	06 (no range, or all) 07, 08 (limited quantity)	129 (response) 130 (unsol. resp.)	17, 28 (index)
	6	16-Bit Frozen Counter Event with Time	1 (read)	06 (no range, or all) 07, 08 (limited quantity)	129 (response) 130 (unsol. resp.)	17, 28 (index)
30	0	Analog Input (Variation 0 is used to request default variation)	1 (read) 22 (assign class)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited quantity) 17, 28 (index)		
	1	32-Bit Analog Input *(default – see Note 1)*	1 (read) 22 (assign class)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited quantity) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index) *(see Note 2)*
	2	16-Bit Analog Input	1 (read) 22 (assign class)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited quantity) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index) *(see Note 2)*
	3	32-Bit Analog Input without Flag	1 (read) 22 (assign class)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited quantity) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index) *(see Note 2)*
	4	16-Bit Analog Input without Flag	1 (read) 22 (assign class)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited quantity) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index) *(see Note 2)*
	5	short floating point	1 (read) 22 (assign class)	00, 01 (start-stop) 06(no range, or all) 07, 08(limited quantity) 17, 28(index)	129 (response)	00, 01 (start-stop) 17, 28 (index) *(see Note 2)*
32	0	Analog Change Event (Variation 0 is used to request default variation)	1 (read)	06 (no range, or all) 07, 08 (limited quantity)		
	1	32-Bit Analog Change Event without Time *(default – see Note 1)*	1 (read)	06 (no range, or all) 07, 08 (limited quantity)	129 (response) 130 (unsol. resp.)	17, 28 (index)
	2	16-Bit Analog Change Event without Time	1 (read)	06 (no range, or all) 07, 08 (limited quantity)	129 (response) 130 (unsol. resp.)	17, 28 (index)
	3	32-Bit Analog Change Event with Time	1 (read)	06 (no range, or all) 07, 08 (limited quantity)	129 (response) 130 (unsol. resp.)	17, 28 (index)
	4	16-Bit Analog Change Event with Time	1 (read)	06 (no range, or all) 07, 08 (limited quantity)	129 (response) 130 (unsol. resp.)	17, 28 (index)
	5	short floating point Analog Change Event without Time	1 (read)	06 (no range, or all) 07, 08 (limited quantity)	129 (response) 130 (unsol. resp.)	17, 28 (index)
	7	short floating point Analog Change Event with Time	1 (read)	06 (no range, or all) 07, 08 (limited quantity)	129 (response) 130 (unsol. resp.)	17, 28 (index)
34	0	Analog Input Reporting Deadband (Variation 0 is used to request default variation)	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited quantity) 17, 28 (index)		
	1	16-bit Analog Input Reporting Deadband (default – see Note 1)	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited quantity) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index) *(see Note 2)*
			2 (write)	00, 01 (start-stop) 07, 08 (limited quantity) 17, 28 (index)		

Note 1: A Default variation refers to the variation responded when variation 0 is requested and/or in class 0, 1, 2, or 3 scans. Type 30 (Analog Input) data is limited to data that is actually possible to be used in the UR, based on the product order code. For example, Signal Source data from source numbers that cannot be used is not included. This optimizes the class 0 poll data size.

Note 2: For static (non-change-event) objects, qualifiers 17 or 28 are only responded when a request is sent with qualifiers 17 or 28, respectively. Otherwise, static object requests sent with qualifiers 00, 01, 06, 07, or 08, will be responded with qualifiers 00 or 01 (for change-event objects, qualifiers 17 or 28 are always responded.)

Note 3: Cold restarts are implemented the same as warm restarts – the UR is not restarted, but the DNP process is restarted.

Table E–2: IMPLEMENTATION TABLE (Sheet 4 of 4)

OBJECT			REQUEST		RESPONSE	
OBJECT NO.	VARIATION NO.	DESCRIPTION	FUNCTION CODES (DEC)	QUALIFIER CODES (HEX)	FUNCTION CODES (DEC)	QUALIFIER CODES (HEX)
34 cont'd	2	32-bit Analog Input Reporting Deadband (default – see Note 1)	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited quantity) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index) *(see Note 2)*
			2 (write)	00, 01 (start-stop) 07, 08 (limited quantity) 17, 28 (index)		
	3	Short floating point Analog Input Reporting Deadband	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited quantity) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index) *(see Note 2)*
50	0	Time and Date	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited quantity) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index) *(see Note 2)*
	1	Time and Date (default – see Note 1)	1 (read) 2 (write)	00, 01 (start-stop) 06 (no range, or all) 07 (limited qty=1) 08 (limited quantity) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index) *(see Note 2)*
52	2	Time Delay Fine			129 (response)	07 (limited quantity) (quantity = 1)
60	0	Class 0, 1, 2, and 3 Data	1 (read) 20 (enable unsol) 21 (disable unsol) 22 (assign class)	06 (no range, or all)		
	1	Class 0 Data	1 (read) 22 (assign class)	06 (no range, or all)		
	2	Class 1 Data	1 (read) 20 (enable unsol) 21 (disable unsol) 22 (assign class)	06 (no range, or all) 07, 08 (limited quantity)		
	3	Class 2 Data	1 (read) 20 (enable unsol) 21 (disable unsol) 22 (assign class)	06 (no range, or all) 07, 08 (limited quantity)		
	4	Class 3 Data	1 (read) 20 (enable unsol) 21 (disable unsol) 22 (assign class)	06 (no range, or all) 07, 08 (limited quantity)		
80	1	Internal Indications	2 (write)	00 (start-stop) (index must =7)		
---		No Object (function code only) *see Note 3*	13 (cold restart)			
---		No Object (function code only)	14 (warm restart)			
---		No Object (function code only)	23 (delay meas.)			

Note 1: A Default variation refers to the variation responded when variation 0 is requested and/or in class 0, 1, 2, or 3 scans. Type 30 (Analog Input) data is limited to data that is actually possible to be used in the UR, based on the product order code. For example, Signal Source data from source numbers that cannot be used is not included. This optimizes the class 0 poll data size.

Note 2: For static (non-change-event) objects, qualifiers 17 or 28 are only responded when a request is sent with qualifiers 17 or 28, respectively. Otherwise, static object requests sent with qualifiers 00, 01, 06, 07, or 08, will be responded with qualifiers 00 or 01 (for change-event objects, qualifiers 17 or 28 are always responded.)

Note 3: Cold restarts are implemented the same as warm restarts – the UR is not restarted, but the DNP process is restarted.

E

E.2.1 BINARY INPUTS

The following table lists both Binary Counters (Object 20) and Frozen Counters (Object 21). When a freeze function is performed on a Binary Counter point, the frozen value is available in the corresponding Frozen Counter point.

BINARY INPUT POINTS

Static (Steady-State) Object Number: **1**

Change Event Object Number: **2**

Request Function Codes supported: **1 (read), 22 (assign class)**

Static Variation reported when variation 0 requested: **2 (Binary Input with status)**

Change Event Variation reported when variation 0 requested: **2 (Binary Input Change with Time)**

Change Event Scan Rate: **8 times per power system cycle**

Change Event Buffer Size: **1000**

Table E–3: BINARY INPUTS (Sheet 1 of 9)

POINT INDEX	NAME/DESCRIPTION	CHANGE EVENT CLASS (1/2/3/NONE)
0	Virtual Input 1	2
1	Virtual Input 2	2
2	Virtual Input 3	2
3	Virtual Input 4	2
4	Virtual Input 5	2
5	Virtual Input 6	2
6	Virtual Input 7	2
7	Virtual Input 8	2
8	Virtual Input 9	2
9	Virtual Input 10	2
10	Virtual Input 11	2
11	Virtual Input 12	2
12	Virtual Input 13	2
13	Virtual Input 14	2
14	Virtual Input 15	2
15	Virtual Input 16	2
16	Virtual Input 17	2
17	Virtual Input 18	2
18	Virtual Input 19	2
19	Virtual Input 20	2
20	Virtual Input 21	2
21	Virtual Input 22	2
22	Virtual Input 23	2
23	Virtual Input 24	2
24	Virtual Input 25	2
25	Virtual Input 26	2
26	Virtual Input 27	2
27	Virtual Input 28	2
28	Virtual Input 29	2
29	Virtual Input 30	2
30	Virtual Input 31	2
31	Virtual Input 32	2

Table E–3: BINARY INPUTS (Sheet 2 of 9)

POINT INDEX	NAME/DESCRIPTION	CHANGE EVENT CLASS (1/2/3/NONE)
32	Virtual Output 1	2
33	Virtual Output 2	2
34	Virtual Output 3	2
35	Virtual Output 4	2
36	Virtual Output 5	2
37	Virtual Output 6	2
38	Virtual Output 7	2
39	Virtual Output 8	2
40	Virtual Output 9	2
41	Virtual Output 10	2
42	Virtual Output 11	2
43	Virtual Output 12	2
44	Virtual Output 13	2
45	Virtual Output 14	2
46	Virtual Output 15	2
47	Virtual Output 16	2
48	Virtual Output 17	2
49	Virtual Output 18	2
50	Virtual Output 19	2
51	Virtual Output 20	2
52	Virtual Output 21	2
53	Virtual Output 22	2
54	Virtual Output 23	2
55	Virtual Output 24	2
56	Virtual Output 25	2
57	Virtual Output 26	2
58	Virtual Output 27	2
59	Virtual Output 28	2
60	Virtual Output 29	2
61	Virtual Output 30	2
62	Virtual Output 31	2
63	Virtual Output 32	2

Table E–3: BINARY INPUTS (Sheet 3 of 9)

POINT INDEX	NAME/DESCRIPTION	CHANGE EVENT CLASS (1/2/3/NONE)
64	Virtual Output 33	2
65	Virtual Output 34	2
66	Virtual Output 35	2
67	Virtual Output 36	2
68	Virtual Output 37	2
69	Virtual Output 38	2
70	Virtual Output 39	2
71	Virtual Output 40	2
72	Virtual Output 41	2
73	Virtual Output 42	2
74	Virtual Output 43	2
75	Virtual Output 44	2
76	Virtual Output 45	2
77	Virtual Output 46	2
78	Virtual Output 47	2
79	Virtual Output 48	2
80	Virtual Output 49	2
81	Virtual Output 50	2
82	Virtual Output 51	2
83	Virtual Output 52	2
84	Virtual Output 53	2
85	Virtual Output 54	2
86	Virtual Output 55	2
87	Virtual Output 56	2
88	Virtual Output 57	2
89	Virtual Output 58	2
90	Virtual Output 59	2
91	Virtual Output 60	2
92	Virtual Output 61	2
93	Virtual Output 62	2
94	Virtual Output 63	2
95	Virtual Output 64	2
96	Contact Input 1	1
97	Contact Input 2	1
98	Contact Input 3	1
99	Contact Input 4	1
100	Contact Input 5	1
101	Contact Input 6	1
102	Contact Input 7	1
103	Contact Input 8	1
104	Contact Input 9	1
105	Contact Input 10	1
106	Contact Input 11	1
107	Contact Input 12	1
108	Contact Input 13	1
109	Contact Input 14	1
110	Contact Input 15	1
111	Contact Input 16	1
112	Contact Input 17	1

Table E–3: BINARY INPUTS (Sheet 4 of 9)

POINT INDEX	NAME/DESCRIPTION	CHANGE EVENT CLASS (1/2/3/NONE)
113	Contact Input 18	1
114	Contact Input 19	1
115	Contact Input 20	1
116	Contact Input 21	1
117	Contact Input 22	1
118	Contact Input 23	1
119	Contact Input 24	1
120	Contact Input 25	1
121	Contact Input 26	1
122	Contact Input 27	1
123	Contact Input 28	1
124	Contact Input 29	1
125	Contact Input 30	1
126	Contact Input 31	1
127	Contact Input 32	1
128	Contact Input 33	1
129	Contact Input 34	1
130	Contact Input 35	1
131	Contact Input 36	1
132	Contact Input 37	1
133	Contact Input 38	1
134	Contact Input 39	1
135	Contact Input 40	1
136	Contact Input 41	1
137	Contact Input 42	1
138	Contact Input 43	1
139	Contact Input 44	1
140	Contact Input 45	1
141	Contact Input 46	1
142	Contact Input 47	1
143	Contact Input 48	1
144	Contact Input 49	1
145	Contact Input 50	1
146	Contact Input 51	1
147	Contact Input 52	1
148	Contact Input 53	1
149	Contact Input 54	1
150	Contact Input 55	1
151	Contact Input 56	1
152	Contact Input 57	1
153	Contact Input 58	1
154	Contact Input 59	1
155	Contact Input 60	1
156	Contact Input 61	1
157	Contact Input 62	1
158	Contact Input 63	1
159	Contact Input 64	1
160	Contact Input 65	1
161	Contact Input 66	1

Table E–3: BINARY INPUTS (Sheet 5 of 9)

POINT INDEX	NAME/DESCRIPTION	CHANGE EVENT CLASS (1/2/3/NONE)
162	Contact Input 67	1
163	Contact Input 68	1
164	Contact Input 69	1
165	Contact Input 70	1
166	Contact Input 71	1
167	Contact Input 72	1
168	Contact Input 73	1
169	Contact Input 74	1
170	Contact Input 75	1
171	Contact Input 76	1
172	Contact Input 77	1
173	Contact Input 78	1
174	Contact Input 79	1
175	Contact Input 80	1
176	Contact Input 81	1
177	Contact Input 82	1
178	Contact Input 83	1
179	Contact Input 84	1
180	Contact Input 85	1
181	Contact Input 86	1
182	Contact Input 87	1
183	Contact Input 88	1
184	Contact Input 89	1
185	Contact Input 90	1
186	Contact Input 91	1
187	Contact Input 92	1
188	Contact Input 93	1
189	Contact Input 94	1
190	Contact Input 95	1
191	Contact Input 96	1
192	Contact Output 1	1
193	Contact Output 2	1
194	Contact Output 3	1
195	Contact Output 4	1
196	Contact Output 5	1
197	Contact Output 6	1
198	Contact Output 7	1
199	Contact Output 8	1
200	Contact Output 9	1
201	Contact Output 10	1
202	Contact Output 11	1
203	Contact Output 12	1
204	Contact Output 13	1
205	Contact Output 14	1
206	Contact Output 15	1
207	Contact Output 16	1
208	Contact Output 17	1
209	Contact Output 18	1
210	Contact Output 19	1

Table E–3: BINARY INPUTS (Sheet 6 of 9)

POINT INDEX	NAME/DESCRIPTION	CHANGE EVENT CLASS (1/2/3/NONE)
211	Contact Output 20	1
212	Contact Output 21	1
213	Contact Output 22	1
214	Contact Output 23	1
215	Contact Output 24	1
216	Contact Output 25	1
217	Contact Output 26	1
218	Contact Output 27	1
219	Contact Output 28	1
220	Contact Output 29	1
221	Contact Output 30	1
222	Contact Output 31	1
223	Contact Output 32	1
224	Contact Output 33	1
225	Contact Output 34	1
226	Contact Output 35	1
227	Contact Output 36	1
228	Contact Output 37	1
229	Contact Output 38	1
230	Contact Output 39	1
231	Contact Output 40	1
232	Contact Output 41	1
233	Contact Output 42	1
234	Contact Output 43	1
235	Contact Output 44	1
236	Contact Output 45	1
237	Contact Output 46	1
238	Contact Output 47	1
239	Contact Output 48	1
240	Contact Output 49	1
241	Contact Output 50	1
242	Contact Output 51	1
243	Contact Output 52	1
244	Contact Output 53	1
245	Contact Output 54	1
246	Contact Output 55	1
247	Contact Output 56	1
248	Contact Output 57	1
249	Contact Output 58	1
250	Contact Output 59	1
251	Contact Output 60	1
252	Contact Output 61	1
253	Contact Output 62	1
254	Contact Output 63	1
255	Contact Output 64	1
256	Remote Input 1	1
257	Remote Input 2	1
258	Remote Input 3	1
259	Remote Input 4	1

Table E–3: BINARY INPUTS (Sheet 7 of 9)

POINT INDEX	NAME/DESCRIPTION	CHANGE EVENT CLASS (1/2/3/NONE)
260	Remote Input 5	1
261	Remote Input 6	1
262	Remote Input 7	1
263	Remote Input 8	1
264	Remote Input 9	1
265	Remote Input 10	1
266	Remote Input 11	1
267	Remote Input 12	1
268	Remote Input 13	1
269	Remote Input 14	1
270	Remote Input 15	1
271	Remote Input 16	1
272	Remote Input 17	1
273	Remote Input 18	1
274	Remote Input 19	1
275	Remote Input 20	1
276	Remote Input 21	1
277	Remote Input 22	1
278	Remote Input 23	1
279	Remote Input 24	1
280	Remote Input 25	1
281	Remote Input 26	1
282	Remote Input 27	1
283	Remote Input 28	1
284	Remote Input 29	1
285	Remote Input 30	1
286	Remote Input 31	1
287	Remote Input 32	1
288	Remote Device 1	1
289	Remote Device 2	1
290	Remote Device 3	1
291	Remote Device 4	1
292	Remote Device 5	1
293	Remote Device 6	1
294	Remote Device 7	1
295	Remote Device 8	1
296	Remote Device 9	1
297	Remote Device 10	1
298	Remote Device 11	1
299	Remote Device 12	1
300	Remote Device 13	1
301	Remote Device 14	1
302	Remote Device 15	1
303	Remote Device 16	1
640	SETTING GROUP Element OP	1
641	RESET Element OP	1
704	FLEXELEMENT 1 Element OP	1
705	FLEXELEMENT 2 Element OP	1
706	FLEXELEMENT 3 Element OP	1

Table E–3: BINARY INPUTS (Sheet 8 of 9)

POINT INDEX	NAME/DESCRIPTION	CHANGE EVENT CLASS (1/2/3/NONE)
707	FLEXELEMENT 4 Element OP	1
708	FLEXELEMENT 5 Element OP	1
709	FLEXELEMENT 6 Element OP	1
710	FLEXELEMENT 7 Element OP	1
711	FLEXELEMENT 8 Element OP	1
816	DIG ELEM 1 Element OP	1
817	DIG ELEM 2 Element OP	1
818	DIG ELEM 3 Element OP	1
819	DIG ELEM 4 Element OP	1
820	DIG ELEM 5 Element OP	1
821	DIG ELEM 6 Element OP	1
822	DIG ELEM 7 Element OP	1
823	DIG ELEM 8 Element OP	1
824	DIG ELEM 9 Element OP	1
825	DIG ELEM 10 Element OP	1
826	DIG ELEM 11 Element OP	1
827	DIG ELEM 12 Element OP	1
828	DIG ELEM 13 Element OP	1
829	DIG ELEM 14 Element OP	1
830	DIG ELEM 15 Element OP	1
831	DIG ELEM 16 Element OP	1
848	COUNTER 1 Element OP	1
849	COUNTER 2 Element OP	1
850	COUNTER 3 Element OP	1
851	COUNTER 4 Element OP	1
852	COUNTER 5 Element OP	1
853	COUNTER 6 Element OP	1
854	COUNTER 7 Element OP	1
855	COUNTER 8 Element OP	1
864	LED State 1 (IN SERVICE)	1
865	LED State 2 (TROUBLE)	1
866	LED State 3 (TEST MODE)	1
867	LED State 4 (TRIP)	1
868	LED State 5 (ALARM)	1
869	LED State 6(PICKUP)	1
880	LED State 9 (VOLTAGE)	1
881	LED State 10 (CURRENT)	1
882	LED State 11 (FREQUENCY)	1
883	LED State 12 (OTHER)	1
884	LED State 13 (PHASE A)	1
885	LED State 14 (PHASE B)	1
886	LED State 15 (PHASE C)	1
887	LED State 16 (NTL/GROUND)	1
898	SNTP FAILURE	1
899	BATTERY FAIL	1
900	PRI ETHERNET FAIL	1
901	SEC ETHERNET FAIL	1
902	EEPROM DATA ERROR	1
903	SRAM DATA ERROR	1

Table E–3: BINARY INPUTS (Sheet 9 of 9)

POINT INDEX	NAME/DESCRIPTION	CHANGE EVENT CLASS (1/2/3/NONE)
904	PROGRAM MEMORY	1
905	WATCHDOG ERROR	1
906	LOW ON MEMORY	1
907	REMOTE DEVICE OFF	1
908	DIRECT DEVICE OFF	
909	DIRECT RING BREAK	
910	ANY MINOR ERROR	1
911	ANY MAJOR ERROR	1
912	ANY SELF-TESTS	1
913	IRIG-B FAILURE	1
914	DSP ERROR	1
916	NO DSP INTERUPTS	1
917	UNIT NOT CALIBRATED	1
921	PROTOTYPE FIRMWARE	1
922	FLEXLOGIC ERR TOKEN	1
923	EQUIPMENT MISMATCH	1
925	UNIT NOT PROGRAMMED	1
926	SYSTEM EXCEPTION	1
927	LATCHING OUT ERROR	1

E.2.2 BINARY AND CONTROL RELAY OUTPUTS

Supported Control Relay Output Block fields: Pulse On, Pulse Off, Latch On, Latch Off, Paired Trip, Paired Close.

BINARY OUTPUT STATUS POINTS
Object Number: **10**
Request Function Codes supported: **1 (read)**
Default Variation reported when Variation 0 requested: **2 (Binary Output Status)**
CONTROL RELAY OUTPUT BLOCKS
Object Number: **12**
Request Function Codes supported: **3 (select), 4 (operate), 5 (direct operate), 6 (direct operate, noack)**

Table E–4: BINARY/CONTROL OUTPUTS

POINT	NAME/DESCRIPTION
0	Virtual Input 1
1	Virtual Input 2
2	Virtual Input 3
3	Virtual Input 4
4	Virtual Input 5
5	Virtual Input 6
6	Virtual Input 7
7	Virtual Input 8
8	Virtual Input 9
9	Virtual Input 10
10	Virtual Input 11
11	Virtual Input 12
12	Virtual Input 13
13	Virtual Input 14
14	Virtual Input 15
15	Virtual Input 16
16	Virtual Input 17
17	Virtual Input 18
18	Virtual Input 19
19	Virtual Input 20
20	Virtual Input 21
21	Virtual Input 22
22	Virtual Input 23
23	Virtual Input 24
24	Virtual Input 25
25	Virtual Input 26
26	Virtual Input 27
27	Virtual Input 28
28	Virtual Input 29
29	Virtual Input 30
30	Virtual Input 31
31	Virtual Input 32

E.2.3 COUNTERS

The following table lists both Binary Counters (Object 20) and Frozen Counters (Object 21). When a freeze function is performed on a Binary Counter point, the frozen value is available in the corresponding Frozen Counter point.

BINARY COUNTERS

Static (Steady-State) Object Number: **20**

Change Event Object Number: **22**

Request Function Codes supported: **1 (read), 7 (freeze), 8 (freeze noack), 9 (freeze and clear), 10 (freeze and clear, noack), 22 (assign class)**

Static Variation reported when variation 0 requested: **1 (32-Bit Binary Counter with Flag)**

Change Event Variation reported when variation 0 requested: **1 (32-Bit Counter Change Event without time)**

Change Event Buffer Size: **10**

Default Class for all points: **2**

FROZEN COUNTERS

Static (Steady-State) Object Number: **21**

Change Event Object Number: **23**

Request Function Codes supported: **1 (read)**

Static Variation reported when variation 0 requested: **1 (32-Bit Frozen Counter with Flag)**

Change Event Variation reported when variation 0 requested: **1 (32-Bit Frozen Counter Event without time)**

Change Event Buffer Size: **10**

Default Class for all points: **2**

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Table E–5: BINARY AND FROZEN COUNTERS

POINT INDEX	NAME/DESCRIPTION
0	Digital Counter 1
1	Digital Counter 2
2	Digital Counter 3
3	Digital Counter 4
4	Digital Counter 5
5	Digital Counter 6
6	Digital Counter 7
7	Digital Counter 8
8	Oscillography Trigger Count
9	Events Since Last Clear

A counter freeze command has no meaning for counters 8 and 9. C30 Digital Counter values are represented as 32-bit integers. The DNP 3.0 protocol defines counters to be unsigned integers. Care should be taken when interpreting negative counter values.

E.2.4 ANALOG INPUTS

The following table lists Analog Inputs (Object 30). It is important to note that 16-bit and 32-bit variations of analog inputs are transmitted through DNP as signed numbers. Even for analog input points that are not valid as negative values, the maximum positive representation is 32767 for 16-bit values and 2147483647 for 32-bit values. This is a DNP requirement.

The deadbands for all Analog Input points are in the same units as the Analog Input quantity. For example, an Analog Input quantity measured in volts has a corresponding deadband in units of volts. This is in conformance with DNP Technical Bulletin 9809-001 Analog Input Reporting Deadband. Relay settings are available to set default deadband values according to data type. Deadbands for individual Analog Input Points can be set using DNP Object 34.

When using the C30 in DNP systems with limited memory, the Analog Input Points below may be replaced with a user-definable list. This user-definable list uses the same settings as the Modbus User Map and can be configured with the Modbus User Map settings. When used with DNP, each entry in the Modbus User Map represents the starting Modbus address of a data item available as a DNP Analog Input point. To enable use of the Modbus User Map for DNP Analog Input points, set the **USER MAP FOR DNP ANALOGS** setting to Enabled (this setting is in the **PRODUCT SETUP ⇨⇩ COMMUNICATIONS ⇨⇩ DNP PROTOCOL** menu). The new DNP Analog points list can be checked via the “DNP Analog Input Points List” webpage, accessible from the “Device Information menu” webpage.

NOTE: After changing the **USER MAP FOR DNP ANALOGS** setting, the relay must be powered off and then back on for the setting to take effect.

Only Source 1 data points are shown in the following table. If the **NUMBER OF SOURCES IN ANALOG LIST** setting is increased, data points for subsequent sources will be added to the list immediately following the Source 1 data points.

Units for Analog Input points are as follows:

- Current: A (amps)
- Voltage: V (volts)
- Real Power: W (watts)
- Reactive Power: var (vars)
- Apparent Power: VA (volt-amps)
- Energy Wh, varh (watt-hours, var-hours)
- Frequency: Hz (hertz)
- Angle: degrees
- Ohm Input: ohms
- RTD Input: °C (degrees Celsius)

Static (Steady-State) Object Number: **30**
Change Event Object Number: **32**
Request Function Codes supported: **1 (read), 2 (write, deadbands only), 22 (assign class)**
Static Variation reported when variation 0 requested: **1 (32-Bit Analog Input)**
Change Event Variation reported when variation 0 requested: **1 (Analog Change Event without Time)**
Change Event Scan Rate: defaults to **500 ms**
Change Event Buffer Size: **800**
Default Class for all Points: **1**

Table E–6: ANALOG INPUT POINTS

POINT	DESCRIPTION
0	FlexElement 1 Actual
1	FlexElement 2 Actual
2	FlexElement 3 Actual
3	FlexElement 4 Actual
4	FlexElement 5 Actual
5	FlexElement 6 Actual
6	FlexElement 7 Actual
7	FlexElement 8 Actual
8	Current Setting Group

F.1.1 REVISION HISTORY

Table F–1: REVISION HISTORY

MANUAL P/N	REVISION	RELEASE DATE	ECO
1601-0088-A1	1.5x	19 February 1999	N/A
1601-0088-A2	1.6x	10 August 1999	URC-003
1601-0088-A3	1.8x	29 October 1999	URC-004
1601-0088-A4	1.8x	15 November 1999	URC-008
1601-0088-A5	2.0x	17 December 1999	URC-009
1601-0088-A6	2.2x	12 May 2000	URC-011
1601-0088-A7	2.2x	14 June 2000	URC-013
1601-0088-A7a	2.2x	28 June 2000	URC-013a
1601-0088-B1	2.4x	08 September 2000	URC-015
1601-0088-B2	2.4x	03 November 2000	URC-017
1601-0088-B3	2.6x	09 March 2001	URC-019
1601-0088-B4	2.8x	26 September 2001	URC-022
1601-0088-B5	2.9x	03 December 2001	URC-024
1601-0088-C1	3.0x	02 July 2002	URC-026
1601-0088-C2	3.1x	30 August 2002	URC-028
1601-0088-C3	3.0x	18 November 2002	URC-030
1601-0088-C4	3.1x	18 November 2002	URC-031
1601-0088-C5	3.0x	11 February 2003	URC-034
1601-0088-C6	3.1x	11 February 2003	URC-035
1601-0088-D1	3.2x	11 February 2003	URC-038
1601-0088-E1	3.3x	01 May 2003	URX-080
1601-0088-E2	3.3x	29 May 2003	URX-089

F.1.2 CHANGES TO THE C30 MANUAL

Table F–2: MAJOR UPDATES FOR C30 MANUAL REVISION E2

PAGE (E1)	PAGE (E2)	CHANGE	DESCRIPTION
Title	Title	Update	Manual part number to 1601-0088-E2.
4-4	4-4	Update	Updated UR VERTICAL FACEPLATE PANELS figure to remove incorrect reference to User-Programmable Pushbuttons.

Table F–3: MAJOR UPDATES FOR C30 MANUAL REVISION E1

PAGE (D1)	PAGE (E1)	CHANGE	DESCRIPTION
Title	Title	Update	Manual part number to 1601-0088-E1.
2-4	2-4	Update	Added specifications for SELECTOR SWITCH, CONTROL PUSHBUTTONS, USER-DEFINABLE DISPLAYS, DIRECT INPUTS, DIRECT OUTPUTS, LATCHING OUTPUTS, and LED TEST.
3-10	3-10	Update	Updated DIGITAL I/O MODULE ASSIGNMENTS table to add the 4A, 4B, 4C, and 4L modules.
3-12	3-12	Update	Updated the DIGITAL I/O MODULE WIRING diagram to 827719CX.
3-28	3-28	Add	Added section for IEEE C37.94 Direct I/O communications.
5-6	5-6	Add	Added CLEAR RELAY RECORDS section.
5-16	5-17	Update	Updated USER-PROGRAMMABLE LEDs section to include LED Test feature.
5-17	5-20	Add	Added CONTROL PUSHBUTTONS section.
5-19	5-23	Update	Updated USER-DEFINABLE DISPLAYS section.
5-20	5-25	Update	Updated DIRECT I/O section to include CRC Alarm and Unreturned Messages Alarm features.
5-40	5-47	Add	Added SELECTOR SWITCH section.
5-49	5-61	Add	Added LATCHING OUTPUTS section.
5-59	5-73	Update	Updated TESTING section.
7-3	7-3	Update	Updated RELAY SELF-TESTS section.
B-8	B-8	Update	Updated MODBUS MEMORY MAP to reflect new firmware 3.3x features.

Table F–4: MAJOR UPDATES FOR C30 MANUAL REVISION D1

PAGE (C6)	PAGE (D1)	CHANGE	DESCRIPTION
Title	Title	Update	Manual part number to 1601-0088-D1.
1-6	1-6	Update	Updated CONNECTING URPC WITH THE C30 section to reflect new URPC software.
2-2	2-2	Update	Updated DEVICE FUNCTIONS table to include User-Programmable Self Tests.
5-10	5-10	Update	Updated UCA/MMS PROTOCOL sub-section to include two new settings.
5-17	5-17	Add	Added USER-PROGRAMMABLE SELF-TESTS section.
5-29	5-27	Update	Updated FLEXLOGIC™ OPERANDS table to include firmware revision 3.2x features.
7-3	7-3	Update	Updated RELAY SELF-TESTS section.
B-9	B-8	Update	Updated MODBUS MEMORY MAP to reflect new firmware 3.2x features.

Table F–5: MAJOR UPDATES FOR C30 MANUAL REVISION C6

PAGE (C4)	PAGE (C6)	CHANGE	DESCRIPTION
Title	Title	Update	Manual part number to 1601-0088-C6.
2-2	2-2	Update	Updated ORDER CODES table to add the 67 Digital I/O option.
2-3	2-3	Update	Updated ORDER CODES FOR REPLACEMENT MODULES table to add the 67 Module option.
3-10	3-10	Update	Updated DIGITAL I/O MODULE ASSIGNMENTS table to add the 67 module.
3-12	3-12	Update	Updated the DIGITAL I/O MODULE WIRING diagram to 827719CV.

Table F–6: MAJOR UPDATES FOR C30 MANUAL REVISION C5

PAGE (C3)	PAGE (C5)	CHANGE	DESCRIPTION
Title	Title	Update	Manual part number to 1601-0088-C5.
2-2	2-2	Update	Updated ORDER CODES table to add the 67 Digital I/O option.
2-3	2-3	Update	Updated ORDER CODES FOR REPLACEMENT MODULES table to add the 67 Module option.
3-10	3-10	Update	Updated DIGITAL I/O MODULE ASSIGNMENTS table to add the 67 module.
3-12	3-12	Update	Updated the DIGITAL I/O MODULE WIRING diagram to 827719CV

Table F–7: MAJOR UPDATES FOR C30 MANUAL REVISION C4

PAGE (C2)	PAGE (C4)	CHANGE	DESCRIPTION
Title	Title	Update	Manual part number to 1601-0088-C4
2-2	2-2	Update	Updated ORDER CODES table to remove the 63 and 64 Digital I/O options
2-3	2-3	Update	Updated ORDER CODES FOR REPLACEMENT MODULES table to remove the 63 and 64 Digital I/O options
3-10	3-10	Update	Updated DIGITAL I/O MODULE ASSIGNMENTS table to remove the 63 and 64 modules
3-12	3-12	Update	Updated the DIGITAL I/O MODULE WIRING diagram to 827719CT
F-2	---	Remove	Removed List of Tables and List of Figures sections.

Table F–8: MAJOR UPDATES FOR C30 MANUAL REVISION C3

PAGE (C1)	PAGE (C3)	CHANGE	DESCRIPTION
Title	Title	Update	Manual part number to 1601-0088-C3.
2-2	2-2	Update	Updated ORDER CODES table to remove the 63 and 64 Digital I/O options
2-3	2-3	Update	Updated ORDER CODES FOR REPLACEMENT MODULES table to remove the 63 and 64 Digital I/O options.
3-10	3-10	Update	Updated DIGITAL I/O MODULE ASSIGNMENTS table to remove the 63 and 64 modules.
3-12	3-12	Update	Updated the DIGITAL I/O MODULE WIRING diagram to 827719CT.
10-1	---	Remove	Removed COMMISSIONING chapter; setpoints tables are available from URPC or can be downloaded from the GE Multilin website.

Table F–9: MAJOR UPDATES FOR C30 MANUAL REVISION C2

PAGE (C1)	PAGE (C2)	CHANGE	DESCRIPTION
Title	Title	Update	Manual part number from C1 to C2
10-	---	Remove	Removed COMMISSIONING setpoints tables; will be available online only

F.2.1 STANDARD ABBREVIATIONS

A..................... Ampere
AC .... Alternating Current
A/D .... Analog to Digital
AE .... Accidental Energization, Application Entity
AMP .... Ampere
ANG .... Angle
ANSI............... American National Standards Institute
AR .... Automatic Reclosure
ASDU .... Application-layer Service Data Unit
ASYM .... Asymmetry
AUTO .... Automatic
AUX................ Auxiliary
AVG................ Average

BER................ Bit Error Rate
BF................... Breaker Fail
BFI.................. Breaker Failure Initiate
BKR................ Breaker
BLK .... Block
BLKG.............. Blocking
BPNT.............. Breakpoint of a characteristic
BRKR .... Breaker

CAP................ Capacitor
CC.................. Coupling Capacitor
CCVT .... Coupling Capacitor Voltage Transformer
CFG................ Configure / Configurable
.CFG............... Filename extension for oscillography files
CHK................ Check
CHNL .... Channel
CLS .... Close
CLSD.............. Closed
CMND .... Command
CMPRSN........ Comparison
CO.................. Contact Output
COM............... Communication
COMM............ Communications
COMP .... Compensated, Comparison
CONN............. Connection
CONT .... Continuous, Contact
CO-ORD......... Coordination
CPU................ Central Processing Unit
CRC .... Cyclic Redundancy Code
CRT, CRNT .... Current
CSA................ Canadian Standards Association
CT .... Current Transformer
CVT .... Capacitive Voltage Transformer

D/A .... Digital to Analog
DC (dc)........... Direct Current
DD .... Disturbance Detector
DFLT .... Default
DGNST........... Diagnostics
DI.................... Digital Input
DIFF .... Differential
DIR .... Directional
DISCREP .... Discrepancy
DIST .... Distance
DMD .... Demand
DNP................ Distributed Network Protocol
DPO .... Dropout
DSP................ Digital Signal Processor
dt .... Rate of Change
DTT .... Direct Transfer Trip
DUTT.............. Direct Under-reaching Transfer Trip

ENCRMNT ..... Encroachment
EPRI............... Electric Power Research Institute
.EVT .... Filename extension for event recorder files
EXT .... Extension, External

F..................... Field
FAIL................ Failure
FD .... Fault Detector
FDH................ Fault Detector high-set
FDL .... Fault Detector low-set
FLA................. Full Load Current
FO .... Fiber Optic

FREQ............. Frequency
FSK................ Frequency-Shift Keying
FTP .... File Transfer Protocol
FxE .... FlexElement™
FWD............... Forward

G .... Generator
GE.................. General Electric
GND............... Ground
GNTR............. Generator
GOOSE.......... General Object Oriented Substation Event
GPS .... Global Positioning System

HARM .... Harmonic / Harmonics
HCT .... High Current Time
HGF .... High-Impedance Ground Fault (CT)
HIZ .... High-Impedance and Arcing Ground
HMI .... Human-Machine Interface
HTTP .... Hyper Text Transfer Protocol
HYB .... Hybrid

I...................... Instantaneous
I_0.................. Zero Sequence current
I_1.................. Positive Sequence current
I_2.................. Negative Sequence current
IA .... Phase A current
IAB .... Phase A minus B current
IB .... Phase B current
IBC................. Phase B minus C current
IC .... Phase C current
ICA................. Phase C minus A current
ID .... Identification
IED................. Intelligent Electronic Device
IEC................. International Electrotechnical Commission
IEEE............... Institute of Electrical and Electronic Engineers
IG .... Ground (not residual) current
Igd.................. Differential Ground current
IN .... CT Residual Current (3Io) or Input
INC SEQ .... Incomplete Sequence
INIT .... Initiate
INST............... Instantaneous
INV................. Inverse
I/O .... Input/Output
IOC .... Instantaneous Overcurrent
IOV................. Instantaneous Overvoltage
IRIG .... Inter-Range Instrumentation Group
ISO................. International Standards Organization
IUV................. Instantaneous Undervoltage

K0 .... Zero Sequence Current Compensation
kA................... kiloAmpere
kV................... kiloVolt

LED................ Light Emitting Diode
LEO................ Line End Open
LFT BLD .... Left Blinder
LOOP............. Loopback
LPU................ Line Pickup
LRA................ Locked-Rotor Current
LTC .... Load Tap-Changer

M.................... Machine
mA .... MilliAmpere
MAG............... Magnitude
MAN............... Manual / Manually
MAX .... Maximum
MIC .... Model Implementation Conformance
MIN .... Minimum, Minutes
MMI................ Man Machine Interface
MMS .... Manufacturing Message Specification
MRT .... Minimum Response Time
MSG............... Message
MTA................ Maximum Torque Angle
MTR .... Motor
MVA .... MegaVolt-Ampere (total 3-phase)
MVA_A........... MegaVolt-Ampere (phase A)
MVA_B........... MegaVolt-Ampere (phase B)
MVA_C........... MegaVolt-Ampere (phase C)

F

MVAR .... MegaVar (total 3-phase)
MVAR_A......... MegaVar (phase A)
MVAR_B......... MegaVar (phase B)
MVAR_C .... MegaVar (phase C)
MVARH .... MegaVar-Hour
MW................. MegaWatt (total 3-phase)
MW_A .... MegaWatt (phase A)
MW_B .... MegaWatt (phase B)
MW_C .... MegaWatt (phase C)
MWH .... MegaWatt-Hour

N..................... Neutral
N/A, n/a .... Not Applicable
NEG .... Negative
NMPLT .... Nameplate
NOM............... Nominal
NSAP .... Network Service Access Protocol
NTR................ Neutral

O .... Over
OC, O/C .... Overcurrent
O/P, Op........... Output
OP .... Operate
OPER .... Operate
OPERATG...... Operating
O/S .... Operating System
OSI .... Open Systems Interconnect
OSB................ Out-of-Step Blocking
OUT................ Output
OV .... Overvoltage
OVERFREQ ... Overfrequency
OVLD .... Overload

P..................... Phase
PC .... Phase Comparison, Personal Computer
PCNT .... Percent
PF................... Power Factor (total 3-phase)
PF_A .... Power Factor (phase A)
PF_B .... Power Factor (phase B)
PF_C .... Power Factor (phase C)
PFLL............... Phase and Frequency Lock Loop
PHS................ Phase
PICS............... Protocol Implementation & Conformance Statement
PKP .... Pickup
PLC .... Power Line Carrier
POS................ Positive
POTT.............. Permissive Over-reaching Transfer Trip
PRESS........... Pressure
PRI .... Primary
PROT .... Protection
PSEL.............. Presentation Selector
pu .... Per Unit
PUIB............... Pickup Current Block
PUIT .... Pickup Current Trip
PUSHBTN...... Pushbutton
PUTT.............. Permissive Under-reaching Transfer Trip
PWM .... Pulse Width Modulated
PWR............... Power

QUAD............. Quadrilateral

R..................... Rate, Reverse
RCA................ Reach Characteristic Angle
REF .... Reference
REM .... Remote
REV................ Reverse
RI.................... Reclose Initiate
RIP .... Reclose In Progress
RGT BLD........ Right Blinder
ROD .... Remote Open Detector
RST................ Reset
RSTR .... Restrained
RTD................ Resistance Temperature Detector
RTU................ Remote Terminal Unit
RX (Rx) .... Receive, Receiver

s .... second
S..................... Sensitive

SAT ....CT Saturation
SBO ....Select Before Operate
SCADA ....Supervisory Control and Data Acquisition
SEC ....Secondary
SEL ....Select / Selector / Selection
SENS ....Sensitive
SEQ ....Sequence
SIR..................Source Impedance Ratio
SNTP ....Simple Network Time Protocol
SRC ....Source
SSB.................Single Side Band
SSEL...............Session Selector
STATS.............Statistics
SUPN..............Supervision
SUPV ....Supervise / Supervision
SV ....Supervision, Service
SYNC..............Synchrocheck
SYNCHCHK....Synchrocheck

T......................Time, transformer
TC ....Thermal Capacity
TCP.................Transmission Control Protocol
TCU ....Thermal Capacity Used
TD MULT ....Time Dial Multiplier
TEMP..............Temperature
TFTP...............Trivial File Transfer Protocol
THD ....Total Harmonic Distortion
TMR ....Timer
TOC ....Time Overcurrent
TOV ....Time Overvoltage
TRANS............Transient
TRANSF ....Transfer
TSEL...............Transport Selector
TUC ....Time Undercurrent
TUV.................Time Undervoltage
TX (Tx)............Transmit, Transmitter

U ....Under
UC...................Undercurrent
UCA ....Utility Communications Architecture
UDP ....User Datagram Protocol
UL ....Underwriters Laboratories
UNBAL............Unbalance
UR...................Universal Relay
URC................Universal Recloser Control
.URS ....Filename extension for settings files
UV...................Undervoltage

V/Hz ....Volts per Hertz
V_0 ....Zero Sequence voltage
V_1 ....Positive Sequence voltage
V_2 ....Negative Sequence voltage
VA ....Phase A voltage
VAB.................Phase A to B voltage
VAG ....Phase A to Ground voltage
VARH ....Var-hour voltage
VB ....Phase B voltage
VBA.................Phase B to A voltage
VBG ....Phase B to Ground voltage
VC...................Phase C voltage
VCA ....Phase C to A voltage
VCG ....Phase C to Ground voltage
VF ....Variable Frequency
VIBR ....Vibration
VT ....Voltage Transformer
VTFF...............Voltage Transformer Fuse Failure
VTLOS............Voltage Transformer Loss Of Signal

WDG ....Winding
WH..................Watt-hour
w/ opt ....With Option
WRT................With Respect To

X ....Reactance
XDUCER.........Transducer
XFMR..............Transformer

Z......................Impedance, Zone

F.3.1 GE MULTILIN WARRANTY

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.

Numerics

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