

# **SEL-487B-2**

## **Bus Protection Relay With Sampled Values or TiDL Technology**

# Instruction Manual



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PM487B-06

# Table of Contents

<b>List of Tables .....</b>	v
<b>List of Figures .....</b>	ix
<b>Preface .....</b>	xv
Differentiating Between Relay Versions .....	xv
Manual Overview .....	xvi
Safety Information .....	xix
General Information .....	xxi
<b>Section 1: Introduction and Specifications</b>	
Features .....	1.2
Models and Options .....	1.4
Applications .....	1.5
Product Characteristics .....	1.17
Specifications .....	1.19
<b>Section 2: Installation</b>	
Shared Configuration Attributes .....	2.1
Plug-In Boards .....	2.8
Jumpers .....	2.10
Relay Placement .....	2.14
Connection .....	2.15
Merging Unit AC/DC Connections .....	2.27
<b>Section 3: Testing</b>	
Relay Test Connections .....	3.1
Checking Relay Operation .....	3.3
Technical Support .....	3.20
<b>Section 4: Front-Panel Operations</b>	
Front-Panel LCD Default Displays .....	4.1
Front-Panel Menus and Screens .....	4.5
Target LEDs .....	4.7
Front-Panel Operator Control Pushbuttons .....	4.9
<b>Section 5: Protection Functions</b>	
Analog Channel Statuses .....	5.1
Sampled Values Alarm Logic (SEL-487B-2 SV Subscriber Relay) .....	5.3
TiDL Alarm Logic (SEL-487B-2 TiDL Relay) .....	5.4
Application Setting SVBLK and Relay Word Bit SVBK_EX .....	5.4
Selective Protection Disabling .....	5.5
Differential Zone and Check Zone Logic .....	5.6
Busbar Protection Elements .....	5.7
Check-Zone Protection Elements .....	5.16
Sensitive Differential Element .....	5.18
Zone Supervision Logic .....	5.20
Dynamic Zone Selection Logic .....	5.20
Check-Zone Selection .....	5.22
Instantaneous/Delayed Overcurrent Elements .....	5.23
Selectable Time-Overcurrent Elements (51) .....	5.24
Over- and Undervoltage Elements .....	5.31
Open-Phase Detection Logic .....	5.34
Open CT Detection Logic .....	5.35

Circuit Breaker Failure Protection .....	5.36
Circuit Breaker Failure Trip Logic .....	5.40
Bus Coupler/Bus Sectionalizer Configurations .....	5.42
Coupler Security Logic .....	5.43
Disconnect Monitor .....	5.49
Zone-Switching Supervision Logic .....	5.51
Differential Trip Logic.....	5.52
Breaker Trip Logic.....	5.54
Circuit Breaker Status Logic.....	5.55

## Section 6: Protection Application Examples

Input, Logic, and Output Assigning Process .....	6.1
Relay Differential Element Composition .....	6.2
CT Requirements .....	6.8
Disconnect Requirements .....	6.11
Alias Names .....	6.14
Bus-Zone Configurations.....	6.14
Bus-Zone-to-Bus-Zone Connections .....	6.28
Zone Supervision .....	6.31
Trip Logic .....	6.32
Output Assignments.....	6.32
Summary .....	6.33
Single Bus and Tie Breaker (Three Relays) Application .....	6.35

## Section 7: Metering, Monitoring, and Reporting

Metering .....	7.1
Station DC Battery System Monitor.....	7.7
Reporting .....	7.8

## Section 8: Settings

Alias Settings .....	8.1
Global Settings.....	8.3
Zone Configuration Settings .....	8.7
Group Settings .....	8.12
Protection Freeform SELOGIC Control Equations .....	8.20
Automation Freeform SELOGIC Control Equations .....	8.20
Notes Settings .....	8.20
Output Settings .....	8.21
Front-Panel Settings.....	8.21
Report Settings.....	8.24
Port Settings .....	8.25
DNP3 Settings—Custom Maps .....	8.26

## Section 9: ASCII Command Reference

Description of Commands .....	9.1
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## Section 10: Communications Interfaces

Communications Database .....	10.1
DNP3 Communication.....	10.6
IEC 61850 Communication .....	10.13

## Section 11: Relay Word Bits

Alphabetical List.....	11.1
Row List.....	11.79

## Section 12: Analog Quantities

## Appendix A: Firmware, ICD File, and Manual Versions

Firmware.....	A.1
SELBOOT.....	A.6
ICD File .....	A.6
Instruction Manual.....	A.9

## SEL-487B-2 Relay Command Summary

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# List of Tables

Table 1.1	Interface Board Information .....	1.5
Table 1.2	SEL-487B-2 SV Subscriber Relay IEC 61850 Subscriptions, Single Bus With Tie Breaker Application.....	1.7
Table 1.3	SEL-487B-2 SV Subscriber Relay IEC 61850 Publications, Single Bus With Tie Breaker Application.....	1.7
Table 1.4	SEL-487B-2 TiDL System Mapping, Single Bus With Tie Breaker Application .....	1.8
Table 1.5	SEL-487B-2 SV Subscriber Relay IEC 61850 Subscriptions, Single Bus Application.....	1.11
Table 1.6	SEL-487B-2 SV Subscriber Relay IEC 61850 Publications, Single Bus Application.....	1.12
Table 1.7	SEL-487B-2 SV Subscriber Relay IEC 61850 Subscriptions, Double-Bus Double-Breaker Application.....	1.14
Table 1.8	SEL-487B-2 SV Subscriber Relay IEC 61850 Publications, Double-Bus Double-Breaker Application .....	1.15
Table 1.9	Application Highlights .....	1.16
Table 1.10	SEL-487B Relay Characteristics .....	1.17
Table 2.1	Required Settings for Use With AC Control Signals .....	2.5
Table 2.2	I/O Interface Boards Control Inputs .....	2.9
Table 2.3	I/O Interface Boards Control Outputs .....	2.10
Table 2.4	Main Board Jumpers.....	2.11
Table 2.5	Serial Port Jumpers .....	2.13
Table 2.6	Fuse Requirements for the Power Supply .....	2.21
Table 3.1	Pushbutton Assignments to Simulate Disconnect Auxiliary Contacts .....	3.5
Table 3.2	Current for Testing the Threshold Point, O87P .....	3.11
Table 3.3	Current for Testing the Second Point on the Relay Characteristic .....	3.15
Table 3.4	Current Values for Testing the Threshold Value of the Directional Element .....	3.17
Table 3.5	Current Values for Testing the Boundary Values of the Directional Element .....	3.17
Table 3.6	Injected Voltage Values for Testing the Overvoltage Elements .....	3.19
Table 4.1	Metering Screens Enable Settings .....	4.1
Table 4.2	Front-Panel Target LEDs.....	4.7
Table 4.3	Operator Control Pushbuttons and LEDs—Factory Defaults .....	4.10
Table 5.1	Restrained Differential Element (87R) Operating Times (Cycles) .....	5.15
Table 5.2	Current Values Assigned to the Differential Element as a Function of the Disconnect Status .....	5.21
Table 5.3	Relay Word Bits in the Zone Selection Logic .....	5.22
Table 5.4	U.S. Time-Overcurrent Equations .....	5.24
Table 5.5	IEC Time-Overcurrent Equations.....	5.25
Table 5.6	Time-Overcurrent Operating Quantity List .....	5.29
Table 5.7	Undervoltage Operating Quantity List .....	5.32
Table 5.8	Overvoltage Operating Quantity List .....	5.33
Table 5.9	Relay Word Bits in the Open CT Detection Logic .....	5.36
Table 5.10	Breaker Failure Relay Word Bits Frozen During Loss of Breaker Current Data.....	5.38
Table 5.11	Station Breaker Failure Trips .....	5.41
Table 5.12	Summary of the Network Conditions Shown in Figure 5.45 .....	5.44
Table 5.13	Summary of the Event for Fault F1 Shown in Figure 5.45 .....	5.44
Table 5.14	Summary of the Events for Fault F2 Shown in Figure 5.46.....	5.45
Table 5.15	Summary of the Event for Fault F2 Shown in Figure 5.46 .....	5.45
Table 5.16	Summary of the Event for Fault F3 Shown in Figure 5.48 .....	5.47
Table 5.17	Summary of the Event for Fault F3 Using the Accelerated Trip Function .....	5.48
Table 5.18	Disconnect 89A and 89B Auxiliary Contact Status Interpretation .....	5.49
Table 5.19	Disconnect Auxiliary Contact Requirements to Ensure Correct Differential Element Operation .....	5.51
Table 5.20	Differential Trips .....	5.53
Table 5.21	Conditions and Results for the Circuit Breaker Status Logic.....	5.56

Table 6.1	Complete Station Configuration, Using Two Three-Phase Bus-Zones and All 21 Current Inputs in a Single-Relay Application .....	6.5
Table 6.2	Analog Mapping for A-Phase Relay, With All A-Phase Inputs of the Station and Two Bus-Zones Assigned.....	6.7
Table 6.3	Disconnect Auxiliary Contact Requirements to Ensure Correct Differential Element Operation .....	6.11
Table 6.4	Disconnect A and B Auxiliary Contact Status Interpretation.....	6.11
Table 6.5	Disconnect Auxiliary Contact Status Interpretation When Only Auxiliary Contact B Is Available.....	6.14
Table 6.6	Discussion of the Advanced Check Zone Settings .....	6.21
Table 6.7	Advance Check Zone Settings.....	6.21
Table 6.8	Primary Plant Data.....	6.33
Table 6.9	Data for Bus Coupler 1 and Bus Coupler 2 .....	6.34
Table 6.10	Data for Bus Coupler 3 and Bus Coupler 4 .....	6.34
Table 6.11	Disconnect, Breaker, and Input Data .....	6.34
Table 6.12	Breaker Failure Data.....	6.34
Table 6.13	End-Zone Protection .....	6.34
Table 6.14	Selection of the Standard Protection Functions.....	6.36
Table 6.15	Number of Input Contacts Required.....	6.39
Table 6.16	Breakdown and the Total Number of Outputs Required .....	6.39
Table 6.17	CTs-to-Analog Channel Allocations and Alias Assignments .....	6.40
Table 6.18	Alias Names for the Two Bus-Zones .....	6.41
Table 6.19	Alias Name for the Check Zone .....	6.41
Table 6.20	Alias Names for the Breaker Status Logic Output Relay Word Bits .....	6.41
Table 6.21	Alias Names for the Disconnect Auxiliary Contact Relay Word Bits.....	6.42
Table 6.22	Alias Names for the Disconnect Monitor Logic Output Relay Word Bits.....	6.43
Table 6.23	Alias Names for the Zone Differential Protection Output Relay Word Bits .....	6.43
Table 6.24	Primitive Differential Trip Bit Names, Alias Names for the Differential Trip Bits, and Associated Terminals.....	6.44
Table 6.25	Primitive and Alias Names for the Trip Logic of Each Terminal .....	6.44
Table 6.26	Alias Assignment for Trip Logic Outputs With TEST MODE Security .....	6.45
Table 6.27	Trip Logic Mapping to Merging Units .....	6.45
Table 6.28	Alias Names for Merging-Unit Output Contact .....	6.45
Table 7.1	Instantaneous Metering Quantities—Voltages and Currents .....	7.1
Table 7.2	MET Command—Metering Only .....	7.1
Table 7.3	Information Available With the MET Command.....	7.2
Table 7.4	Information Available With the MET CZq Command .....	7.3
Table 7.5	Information Available With the MET Zn Command .....	7.3
Table 7.6	Information Available With the MET SEC Command .....	7.4
Table 7.7	Information Available With the MET SEC CZq Command .....	7.5
Table 7.8	Information Available With the MET SEC Zn Command .....	7.6
Table 7.9	Information Available With the MET DIF Command .....	7.6
Table 7.10	Protection Element Analog Quantities and Processing Rates .....	7.8
Table 7.11	Processing Rates of Digital Inputs.....	7.8
Table 7.12	Event Report Nonvolatile Storage Capability When ERDIG = S .....	7.9
Table 7.13	Event Report Nonvolatile Storage Capability When ERDIG = A .....	7.9
Table 7.14	Event Report Metered Analog Quantities .....	7.11
Table 7.15	Event Types .....	7.15
Table 8.1	Default Alias Settings .....	8.1
Table 8.2	Global Settings Categories .....	8.3
Table 8.3	General Global Settings .....	8.4
Table 8.4	Global Enables.....	8.4
Table 8.5	Station DC Monitor .....	8.4
Table 8.6	Control Inputs (Global) .....	8.4
Table 8.7	Interface Board #1 Control Inputs .....	8.5
Table 8.8	Interface Board #n Control Inputs .....	8.5
Table 8.9	Settings Group Selection .....	8.5
Table 8.10	Time and Date Management.....	8.5

Table 8.11	Data Reset Control.....	8.6
Table 8.12	Breaker Inputs.....	8.6
Table 8.13	Disconnect Inputs .....	8.6
Table 8.14	Access Control.....	8.6
Table 8.15	DNP .....	8.7
Table 8.16	SV and TiDL Application Settings.....	8.7
Table 8.17	Zone Configuration Settings Categories.....	8.7
Table 8.18	Potential Transformer Ratios .....	8.7
Table 8.19	Current Transformer Ratios .....	8.8
Table 8.20	Terminal-to-Bus-Zone Connections, Terminal Emulation Program View .....	8.8
Table 8.21	Terminal-to-Bus-Zone Connections, SEL Grid Configurator View .....	8.8
Table 8.22	Bus-Zone-to-Bus-Zone Connections, Terminal Emulation Program View .....	8.9
Table 8.23	Bus-Zone-to-Bus-Zone Connections, SEL Grid Configurator View .....	8.9
Table 8.24	Zone Supervision .....	8.10
Table 8.25	Zone Switching Supervision.....	8.10
Table 8.26	Zone Open CT Detection.....	8.11
Table 8.27	Check Zone Configuration and Terminal-to-Check-Zone Connections, Terminal Emulation Program View .....	8.11
Table 8.28	Check Zone Configuration and Terminal-to-Check-Zone Connections, SEL Grid Configurator View.....	8.11
Table 8.29	Check Zone Supervision.....	8.12
Table 8.30	Group Settings Categories .....	8.12
Table 8.31	Relay Configuration .....	8.12
Table 8.32	Sensitive Differential Elements .....	8.13
Table 8.33	Check Zone Sensitive Differential Elements.....	8.13
Table 8.34	Restrained Differential Elements.....	8.13
Table 8.35	Check Zone Restrained Differential Elements .....	8.13
Table 8.36	Phase Directional Element.....	8.13
Table 8.37	Coupler Security Logic (1–4).....	8.14
Table 8.38	Terminal Out of Service (1–21).....	8.14
Table 8.39	Breaker Failure Logic (1–21) .....	8.14
Table 8.40	Definite-Time Overcurrent Elements .....	8.17
Table 8.41	Inverse-Time Overcurrent Elements.....	8.18
Table 8.42	Undervoltage Elements.....	8.18
Table 8.43	Oversupply Elements.....	8.18
Table 8.44	Trip Logic .....	8.19
Table 8.45	Protection Freeform SELOGIC Control Equations.....	8.20
Table 8.46	Main Board .....	8.21
Table 8.47	Front-Panel Settings .....	8.21
Table 8.48	Default Event Report Settings .....	8.24
Table 8.49	MIRRORED BITS Protocol Default Settings.....	8.25
Table 9.1	SEL-487B List of Commands .....	9.2
Table 9.2	MET Command .....	9.4
Table 9.3	MET CZq Command .....	9.4
Table 9.4	MET DIF Command.....	9.4
Table 9.5	MET SEC Command.....	9.5
Table 9.6	MET SEC CZq Command.....	9.5
Table 9.7	MET SEC Zn Command .....	9.5
Table 9.8	MET Zn Command.....	9.6
Table 9.9	SET Command Overview .....	9.6
Table 9.10	SHO Command Overview .....	9.7
Table 9.11	ZON Command .....	9.7
Table 9.12	ZON T Command .....	9.8
Table 9.13	ZON k Command .....	9.8
Table 10.1	SEL-487B Database Regions .....	10.1
Table 10.2	SEL-487B Database Structure—LOCAL Region .....	10.2
Table 10.3	SEL-487B Database Structure—METER Region .....	10.2
Table 10.4	SEL-487B Database Structure—TARGET Region .....	10.4

Table 10.5	SEL-487B Database Structure—HISTORY Region .....	10.4
Table 10.6	SEL-487B Database Structure—STATUS Region .....	10.5
Table 10.7	SEL-487B Database Structure—ANALOGS Region .....	10.5
Table 10.8	SEL-487B DNP3 Reference Data Map .....	10.7
Table 10.9	SEL-487B Object 12 Control Operations.....	10.9
Table 10.10	Object 30, 32, FTYPE Upper Byte-Event Cause .....	10.10
Table 10.11	SEL-487B DNP3 Default Data Map .....	10.10
Table 10.12	Logical Device: PRO (Protection).....	10.14
Table 10.13	Logical Device: MET (Metering).....	10.23
Table 10.14	FLTYPE—Fault Type .....	10.25
Table 10.15	FLTCAUS—Fault Cause .....	10.25
Table 11.1	Alphabetic List of Relay Word Bits .....	11.1
Table 11.2	Row List of Relay Word Bits .....	11.79
Table 12.1	Analog Quantities Sorted Alphabetically .....	12.1
Table 12.2	Analog Quantities Sorted by Function .....	12.3
Table A.1	Firmware Revision History .....	A.2
Table A.2	SELBOOT Revision History .....	A.6
Table A.3	SEL-487B-2 SV Subscriber Relay ICD File Revision History .....	A.7
Table A.4	SEL-487B-2 TiDL ICD File Revision History.....	A.8
Table A.5	Instruction Manual Revision History .....	A.9

# List of Figures

Figure 1.1	SEL-487B Relay Basic Functions in a Double-Bus Application .....	1.2
Figure 1.2	Single Bus With Bus-Tie Breaker Application (SV Subscriber) .....	1.6
Figure 1.3	Single Bus With Bus-Tie Breaker Application (TiDL).....	1.8
Figure 1.4	Single Bus Application (SV Subscriber) .....	1.11
Figure 1.5	Single Bus Application (TiDL) .....	1.13
Figure 1.6	Double-Breaker Double-Bus Application (SV Subscriber) .....	1.14
Figure 1.7	Double-Breaker Double-Bus Application (TiDL).....	1.16
Figure 2.1	Horizontal Front-Panel Template .....	2.2
Figure 2.2	Vertical Front-Panel Template .....	2.3
Figure 2.3	SEL-487B-2 SV Subscriber Relay Rear Panel.....	2.4
Figure 2.4	SEL-487B-2 TiDL Relay Rear Panel .....	2.4
Figure 2.5	Standard Control Output Connection .....	2.6
Figure 2.6	High-Speed, High-Current Interrupting Control Output Connection, INT4 .....	2.7
Figure 2.7	Precharging Internal Capacitance of High-Speed, High-Current Interrupting Output Contacts, INT4 .....	2.7
Figure 2.8	INT2 I/O Interface Board .....	2.9
Figure 2.9	INT4 I/O Interface Board (High-Speed).....	2.9
Figure 2.10	Jumper Location on the Main Board .....	2.11
Figure 2.11	Major Component Locations on the SEL-487B Main Board.....	2.12
Figure 2.12	Main Components of the EIA-232 Board, Showing the Location of Serial Port Jumpers JMP1 and JMP2 .....	2.13
Figure 2.13	SEL-487B Chassis Dimensions .....	2.15
Figure 2.14	SEL-487B-2 SV Subscriber Relay Rear Panel.....	2.16
Figure 2.15	SEL-487B-2 TiDL Relay, 4U Rear Panel .....	2.16
Figure 2.16	Rear-Panel Symbols .....	2.17
Figure 2.17	Screw-Terminal Connector Keying.....	2.18
Figure 2.18	Rear-Panel Receptacle Keying .....	2.19
Figure 2.19	Power Connection Area of the Rear Panel .....	2.20
Figure 2.20	Control Output OUT215.....	2.23
Figure 2.21	SEL-487B to Computer—D-Subminiature 9-Pin Connector .....	2.25
Figure 2.22	Four 100BASE-FX Port Configuration .....	2.26
Figure 2.23	Four 10/100BASE-T Port Configuration .....	2.26
Figure 2.24	100BASE-FX and 10/100BASE-T Port Configuration.....	2.26
Figure 2.25	Two 100/1000BASE and Three 100BASE SFP Ports .....	2.26
Figure 3.1	Test Network Topology and Mapping.....	3.2
Figure 3.2	Test Connections for Balanced Load With Three-Phase Current Sources .....	3.2
Figure 3.3	Voltage Test Connections .....	3.2
Figure 3.4	Station Layout, Comprising a Tie Breaker, Two Feeders and Two Busbars .....	3.4
Figure 3.5	Front-Panel Operator Pushbuttons.....	3.5
Figure 3.6	Alias Names for the Four Analog Channels .....	3.6
Figure 3.7	Zone Configuration Settings.....	3.7
Figure 3.8	Steps to Disable the Sensitive Differential Elements .....	3.7
Figure 3.9	Steps to Program Protection Latch Bits.....	3.8
Figure 3.10	Steps to Program the LEDs .....	3.9
Figure 3.11	Selected Information From the Relay Response to the SHO Z Command .....	3.10
Figure 3.12	Relay Response to the MET Z1 Command .....	3.11
Figure 3.13	Test Connections Using Two Current Sources.....	3.11
Figure 3.14	Differential Element Characteristic .....	3.12
Figure 3.15	Example Values Below the 8701 Element Pickup Value in Response to the MET DIF Command.....	3.13

Figure 3.16	Example Values Above the 8701 Element Pickup Value in Response to the MET DIF Command.....	3.13
Figure 3.17	Example Values in Response to the MET DIF Command With Two Active Zones .....	3.15
Figure 3.18	Example Values in Response to the MET DIF Command With Two Differential Elements Asserted.....	3.16
Figure 3.19	Test Connections for Testing the Directional Element .....	3.16
Figure 3.20	Directional Element Characteristic.....	3.16
Figure 3.21	Relay Response to the TAR 50DS01 Command.....	3.17
Figure 3.22	Relay Response to the TAR DE1F Command .....	3.17
Figure 3.23	Over- and Undervoltage Element Settings .....	3.18
Figure 3.24	Test Connections for Testing the Voltage Elements .....	3.19
Figure 4.1	ROTATING DISPLAY .....	4.2
Figure 4.2	Differential Screens .....	4.3
Figure 4.3	Terminals in Zone Screen.....	4.3
Figure 4.4	Fundamental Primary Current Screens.....	4.4
Figure 4.5	Fundamental Primary Voltage Screen .....	4.4
Figure 4.6	Station Battery Screen .....	4.5
Figure 4.7	EVENT SUMMARY Screen.....	4.5
Figure 4.8	VIEW CONFIGURATION Sample Screens.....	4.6
Figure 4.9	Factory-Default Front-Panel Target Areas .....	4.7
Figure 4.10	Operator Control Pushbuttons and LEDs .....	4.9
Figure 4.11	Factory-Default Operator Control Pushbuttons.....	4.11
Figure 5.1	I01 Channel Status Processing (Similar for Other Channels) .....	5.2
Figure 5.2	Current Channel Freeze Logic for Channel 01 (Similar for Other Current Channels) .....	5.3
Figure 5.3	General SV Alarm Logic (SVSALM) .....	5.4
Figure 5.4	General TiDL Alarm Logic (TIDLALM).....	5.4
Figure 5.5	Extended Application Blocking Logic (SVBK_EX).....	5.4
Figure 5.6	Selective Protection Disabling Overview .....	5.5
Figure 5.7	Differential Zone 1 Blocking Logic (Zones 2–6 Are Similar) .....	5.6
Figure 5.8	Check Zone 1 Blocking Logic (Check Zones 2 and 3 Are Similar).....	5.7
Figure 5.9	Block Diagram Showing the Logic for Busbar Protection Element 1 .....	5.9
Figure 5.10	Filtered Differential Element 1.....	5.10
Figure 5.11	Filtered Differential Element Characteristic.....	5.11
Figure 5.12	Torque Calculation Used in the Directional Element to Determine Fault Direction .....	5.11
Figure 5.13	Directional Element Characteristic, the Shaded Area Indicating an Internal Fault.....	5.12
Figure 5.14	Directional Element Logic.....	5.12
Figure 5.15	Fault Detection Logic That Distinguishes Between External and Internal Faults.....	5.13
Figure 5.16	Fault Detection Logic Obtaining Restraint and Operating Quantities .....	5.13
Figure 5.17	External Fault Detection Logic.....	5.14
Figure 5.18	Internal Fault Detection, Instantaneous Differential Element, Consecutive Measurement Fault Detection, and Fast Fault Detection Logics .....	5.14
Figure 5.19	Differential Element Output: Final Conditions and Adaptive Security Timer.....	5.15
Figure 5.20	Average 87R Operating Times .....	5.16
Figure 5.21	Block Diagram Showing Logic for Check-Zone Protection Element 1 .....	5.16
Figure 5.22	Check Zone Filtered Differential Element 1 .....	5.17
Figure 5.23	Check Zone External Fault Detection Logic .....	5.17
Figure 5.24	Check Zone Internal Fault Detection, Instantaneous Differential Element, Consecutive Measurements Fault Detection, and Fast Fault Detection Logics .....	5.18
Figure 5.25	Check Zone Differential Element Output: Final Conditions and Adaptive Security Timer .....	5.18
Figure 5.26	Sensitive Differential Element (87S).....	5.19
Figure 5.27	Check Zone Sensitive Differential Element (87S) .....	5.19
Figure 5.28	Zone and Check Zone Supervision Logic .....	5.20
Figure 5.29	Phase Instantaneous and Time-Delayed Overcurrent Elements.....	5.23
Figure 5.30	U.S. Curves U1, U2, U3, and U4 .....	5.26
Figure 5.31	U.S. Curve U5 and IEC Curves C1, C2, and C3 .....	5.27

Figure 5.32	IEC Curves C4 and C5 .....	5.28
Figure 5.33	Time-Overcurrent Logic .....	5.29
Figure 5.34	Over- and Undervoltage Logic .....	5.32
Figure 5.35	Open-Phase Detection .....	5.35
Figure 5.36	Zone n Open CT Detector .....	5.36
Figure 5.37	Breaker Failure Logic .....	5.37
Figure 5.38	Circuit Breaker Failure Initiation Extension and Seal In .....	5.38
Figure 5.39	Breaker Failure Logic for External Breaker Failure .....	5.39
Figure 5.40	Breaker Failure Clearing Times .....	5.40
Figure 5.41	Station Breaker Failure Trip Logic .....	5.41
Figure 5.42	Two CTs With the Busbar Protection Configured in Overlap .....	5.42
Figure 5.43	Two CTs With the Busbar Protection Configured as Breaker Differential .....	5.43
Figure 5.44	Single CT With the Busbar Protection Configured in Overlap .....	5.43
Figure 5.45	Fault F1 Between Bus Sectionalizer and CT With the Bus Sectionalizer Circuit Breaker Open .....	5.44
Figure 5.46	Closing the Bus Sectionalizing Circuit Breaker Onto a Faulted Busbar .....	5.45
Figure 5.47	Coupler Security Logic for Accelerated Tripping and Busbar Protection Security for Circuit Breaker Auxiliary Contact Misalignment .....	5.46
Figure 5.48	CTs on Either Side of the Sectionalizer Circuit Breaker With Breaker Differential Across Breaker Z .....	5.47
Figure 5.49	Single CT Application With Fault F4 Between the Bus Sectionalizer Circuit Breaker and CT .....	5.48
Figure 5.50	Disconnecting Switch Status Logic .....	5.50
Figure 5.51	Disconnecting Switch Main Contact, 89a, and 89b Status for Open-to-Close and Close-to-Open Conditions .....	5.51
Figure 5.52	Zone-Switching Supervision Logic .....	5.52
Figure 5.53	External Wiring and Initiation Input for Zone-Switching Supervision .....	5.52
Figure 5.54	Differential Element Zone Supervision for Zone 1 .....	5.53
Figure 5.55	Bus Differential Trip Logic .....	5.53
Figure 5.56	Differential Element Zone Supervision for Check Zone .....	5.54
Figure 5.57	Trip Logic for Breaker 1 .....	5.54
Figure 5.58	Breaker Status and Alarm Logic .....	5.55
Figure 6.1	Block Diagram of the Input, Logic, and Output Assigning Process for System Configuration Protection Element Settings .....	6.2
Figure 6.2	Block Diagram Showing Six Differential Elements .....	6.2
Figure 6.3	Single-Line Diagram of a Station With Two Busbars and a Tie Breaker .....	6.3
Figure 6.4	CT Wiring in a Single-Relay Application .....	6.4
Figure 6.5	Disconnect and Circuit Breaker Wiring for Terminal TD .....	6.5
Figure 6.6	CT Wiring in a Three-Relay Application .....	6.6
Figure 6.7	Digital Inputs 52 and 89 Connections .....	6.8
Figure 6.8	Polarity Marks .....	6.9
Figure 6.9	Polarity Marks Above the Odd-Numbered CT Terminals at the Rear of the SEL-401 Merging Unit .....	6.10
Figure 6.10	Declare Positive Polarity in Software (Preferred) .....	6.10
Figure 6.11	Declare Negative Polarity in Software .....	6.10
Figure 6.12	Disconnect Auxiliary Contact Requirements With Respect to the Arcing Point for an Open-to-Close Disconnect Operation .....	6.11
Figure 6.13	Disconnect Main Contacts and Auxiliary Contact A Open, Auxiliary Contact B Closed; Disconnect Is Considered Open .....	6.12
Figure 6.14	Intermediate Position With Both Auxiliary Contacts Open; the Disconnect Is Considered Closed .....	6.13
Figure 6.15	The Main Contact Has Completed 95% of Travel; Contact A Is Closed, Contact B Is Open, and the Disconnect Is Considered Closed .....	6.13
Figure 6.16	Both Differential Elements Balanced .....	6.16
Figure 6.17	Both Differential Elements Unbalanced .....	6.17
Figure 6.18	Outboard CT .....	6.18

Figure 6.19	Inboard CT.....	6.18
Figure 6.20	Normal Operating Conditions .....	6.19
Figure 6.21	Feeder With Inboard CTs .....	6.20
Figure 6.22	Terminal NEW_YRK Disconnects NEW892 and NEW891 and Bus-Zone NORTH .....	6.22
Figure 6.23	Positive CT Polarity for Terminal NEW_YRK.....	6.23
Figure 6.24	Three Typical Cases of Bus Coupler Configurations .....	6.24
Figure 6.25	General Information Regarding the Three Typical Bus Coupler Configurations .....	6.24
Figure 6.26	Negative CT Polarity for Terminal CPL1 .....	6.25
Figure 6.27	Positive CT Polarity for Terminal CPL2 .....	6.25
Figure 6.28	Using the SET Z 1 Command to Determine Terminal-to-Bus-Zone Settings .....	6.26
Figure 6.29	Positive CT Polarity for Both Terminals CPL1 and CPL2 .....	6.26
Figure 6.30	Using the SET Z 1 Command to Set the Terminal-to-Bus-Zone Settings .....	6.27
Figure 6.31	Negative CT Polarities for Both Terminals CPL1 and CPL2 When Balancing SOUTH and NORTH .....	6.27
Figure 6.32	Positive CT Polarities for Both Terminals CPL1 and CPL2 for the Breaker Differential.....	6.28
Figure 6.33	Entries for Terminals CPL1 and CPL2.....	6.28
Figure 6.34	Forming Bus-Zone-to-Bus-Zone Connections With and Without a Circuit Breaker.....	6.29
Figure 6.35	Bus-Zone to Bus-Zone Blocks 1–5 .....	6.31
Figure 6.36	Zone Supervision Logic.....	6.31
Figure 6.37	Assign the Protection Functions to the Trip Logic .....	6.32
Figure 6.38	Assigning the Output From the Trip Logic to an Output Contact.....	6.32
Figure 6.39	Information Flow Diagram .....	6.33
Figure 6.40	Single Bus With Bus Sectionalizer (Tie Breaker) .....	6.35
Figure 6.41	Station With Two Zone-Specific Bus-Zones and an Overall Check Zone.....	6.37
Figure 6.42	Zone Supervision Logic.....	6.38
Figure 6.43	One of the Disconnect Monitoring Logic Circuits Available in the Relay .....	6.42
Figure 6.44	Differential Trip Logic for Differential Element 1 .....	6.44
Figure 6.45	Breaker Trip Logic .....	6.44
Figure 6.46	Substation Layout With Specific Terminal Information .....	6.46
Figure 6.47	List of Default Primitive Names and Associated Alias Names.....	6.47
Figure 6.48	Deletion of the First 43 Alias Names .....	6.47
Figure 6.49	Analog Quantities and Relay Word Bit Alias Names .....	6.48
Figure 6.50	Global Settings .....	6.49
Figure 6.51	Bus Differential Trip Logic .....	6.51
Figure 6.52	Check-Zone Supervision Logic .....	6.51
Figure 6.53	Zone Supervision for Zone 1 (a) and Zone 2 (b).....	6.51
Figure 6.54	Zone Configuration Group Settings .....	6.52
Figure 6.55	Protection Group Settings.....	6.54
Figure 6.56	SEL-487B Protection SELOGIC Settings .....	6.55
Figure 6.57	Merging-Unit Output Settings .....	6.56
Figure 7.1	Relay Response to the MET Command .....	7.2
Figure 7.2	Response to MET CZ1 Command When All Terminals Are Inactive.....	7.3
Figure 7.3	Response to the MET CZ1 Command of One Phase in a Three-Relay Application.....	7.3
Figure 7.4	Response to MET Z1 Command When All Terminals Are Inactive.....	7.4
Figure 7.5	Response to the MET Z1 Command of One Phase in a Three-Relay Application .....	7.4
Figure 7.6	Relay Response to the MET SEC Command of One Phase of a Three-Relay Application.....	7.5
Figure 7.7	Response to the MET SEC CZ1 Command of One Phase in a Three-Relay Application.....	7.5
Figure 7.8	Relay Response to the MET SEC Z1 Command of One Phase in a Three-Relay Application.....	7.6
Figure 7.9	Relay Response to the MET DIF Command of One Phase in a Three-Relay Application.....	7.7
Figure 7.10	Typical Station DC Battery System.....	7.7
Figure 7.11	Analog Section of the Event Report .....	7.11

Figure 7.12	Differential Report.....	7.12
Figure 7.13	Digital Section of the Event Report.....	7.13
Figure 7.14	Summary Section of the Event Report .....	7.14
Figure 7.15	Sample Event Summary Report .....	7.14
Figure 7.16	Sample Event History .....	7.16
Figure 10.1	MAP 1: METER Command Example .....	10.6

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# Preface

This manual provides information and instructions for installing, setting, configuring, and operating the SEL-487B-2 Relay. The manual is for use by power engineers and others experienced in protective relaying applications. Included are detailed technical descriptions of the relay and application examples.

## Differentiating Between Relay Versions

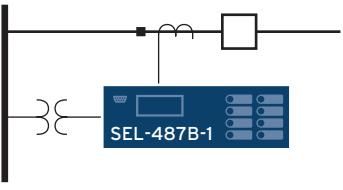
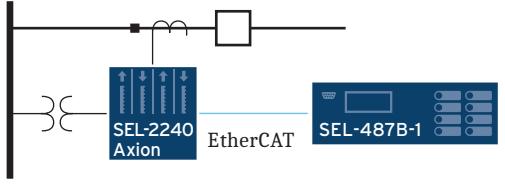
Unless otherwise indicated, the functionality of the SEL-487B discussed in this manual is common in both the traditional hardwired model (SEL-487B-1) and the model that exclusively supports digital secondary system (DSS) technology (SEL-487B-2).

The SEL-487B-2 only supports DSS and can be ordered as either a Sampled Values (SV) subscriber relay or an SEL TiDL relay. The supported DSS technology of the relay is locked at the time of order, and you cannot change the relay to support a DSS technology other than the one it was explicitly manufactured for; you can only use the SV subscriber relay version in networks that conform to IEC 61850-9-2LE, and you can only use the TiDL relay in an SEL TiDL system where it communicates with SEL TiDL Merging Units (TMUs).

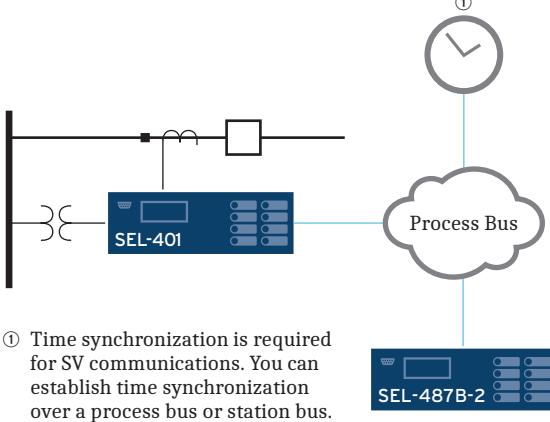
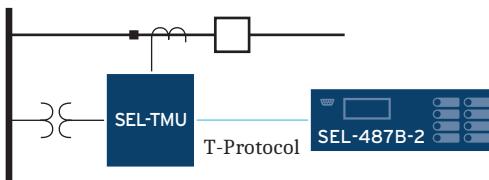
Most functionality that is impacted by the use of a DSS technology is common between the two relay versions of the SEL-487B-2, and, where there is common functionality, the relay is referred to as simply the SEL-487B-2 to indicate the common functionality. Should there be differences or logic that is specific to one version of the SEL-487B-2, the section indicates it is only for the specific version identified (for example, *Sampled Values Alarm Logic (SEL-487B-2 SV Subscriber Relay) on page 5.3* is specific logic for the SV subscriber version of the SEL-487B-2).

The following table highlights the currently available relays for order and their corresponding instruction manuals.

**SEL-487B Relay Versions (Sheet 1 of 2)**

Relay Model	High-Level Overview	Instruction Manual
SEL-487B-1 Traditional Relay		See <i>SEL-487B-1 Instruction Manual</i>
SEL-487B-1 TiDL Relay With Axion <sup>a</sup>		See <i>SEL-487B-1 Instruction Manual</i>

### SEL-487B Relay Versions (Sheet 2 of 2)

Relay Model	High-Level Overview	Instruction Manual
SEL-487B-2 SV Subscriber Relay	 <p>① Time synchronization is required for SV communications. You can establish time synchronization over a process bus or station bus.</p>	Use this manual
SEL-487B-2 TiDL Relay With the SEL-TMU		Use this manual

<sup>a</sup> TiDL (EtherCAT) technology is no longer offered in the SEL-487B-1. TiDL (T-Protocol) is available in the SEL-487B-2.

## Manual Overview

The SEL-487B-2 Instruction Manual set consists of two volumes:

- SEL-487B-2 Instruction Manual
- SEL-400 Series Relays Instruction Manual

The SEL-487B-2 manual set is a comprehensive work covering all aspects of relay application and use. Read the sections that pertain to your application to gain valuable information about using the SEL-487B-2. An overview of each manual section and section topics follows.

## SEL-487B-2 Instruction Manual

Preface. Describes manual organization and conventions used to present information, as well as safety information.

Section 1: Introduction and Specifications. Introduces the SEL-487B-2 features, summarizes relay functions and applications, and lists relay specifications, type tests, and ratings.

Section 2: Installation. Discusses the ordering configurations and interface features (control inputs, control outputs, and analog inputs, for example). Provides information about how to design a new physical installation and secure the relay in a panel or rack. Details how to set relay board jumpers and make proper rear-panel connections (including connecting to merging units and a GPS receiver). Explains the basic connections for the relay communications ports.

Section 3: Testing. Describes techniques for testing the relay.

**Section 4: Front-Panel Operations.** Describes the LCD display messages and menu screens that are unique to the SEL-487B.

**Section 5: Protection Functions.** Describes the function of various relay protection elements. Describes how the relay processes these elements. Gives detailed specifics on protection scheme logic for the differential elements. Provides trip logic diagrams and current and voltage source selection details.

**Section 6: Protection Application Examples.** Provides examples of configuring the SEL-487B-2 for some common applications.

**Section 7: Metering, Monitoring, and Reporting.** Describes SEL-487B-specific metering, monitoring, and reporting features.

**Section 8: Settings.** Provides a list of all relay settings and defaults. The settings list is organized in the same order as in the relay and in the SEL Grid Configurator Software.

**Section 9: ASCII Command Reference.** Provides an alphabetical listing of all ASCII commands with examples for each ASCII command option.

**Section 10: Communications Interfaces.** Describes the SEL-487B specific communications characteristics.

**Section 11: Relay Word Bits.** Contains a summary of Relay Word bits.

**Section 12: Analog Quantities.** Contains a summary of analog quantities.

**Appendix A: Firmware, ICD File, and Manual Versions.** Lists the current firmware and manual versions and details differences between the current and previous versions.

## SEL-400 Series Relays Instruction Manual

**Preface.** Describes manual organization and conventions used to present information, as well as safety information.

**Section 1: Introduction.** Introduces SEL-400 Series Relay common features.

**Section 2: PC Software.** Explains how to use SEL Grid Configurator and ACCELERATOR QuickSet SEL-5030 Software.

**Section 3: Basic Relay Operations.** Describes how to perform fundamental operations such as applying power and communicating with the relay, setting and viewing passwords, checking relay status, viewing metering data, reading event reports and Sequential Events Recorder (SER) records, operating relay control outputs and control inputs, and using relay features to make relay commissioning easier.

**Section 4: Front-Panel Operations.** Describes the LCD display messages and menu screens. Shows you how to use front-panel pushbuttons and read targets. Provides information about local substation control and how to make relay settings via the front panel.

**Section 5: Control.** Describes various control features of the relay, including circuit breaker operation, disconnect operation, remote bits, and one-line diagrams.

**Section 6: Autoreclosing.** Explains how to operate the two-circuit breaker multishot recloser. Describes how to set the relay for single-pole reclosing, three-pole reclosing, or both. Shows selection of the lead and follow circuit breakers.

**Section 7: Metering.** Provides information on viewing current, voltage, power, and energy quantities. Describes how to view other common internal operating quantities.

**Section 8: Monitoring.** Describes how to use the circuit breaker monitors and the substation dc battery monitors.

**Section 9: Reporting.** Explains how to obtain and interpret high-resolution raw data oscillograms, filtered event reports, event summaries, history reports, and SER reports. Discusses how to enter SER trigger settings.

**Section 10: Testing, Troubleshooting, and Maintenance.** Describes techniques for testing, troubleshooting, and maintaining the relay. Includes the list of status notification messages and a troubleshooting chart.

**Section 11: Time and Date Management.** Explains timekeeping principles, synchronized phasor measurements, and estimation of power system states using the high-accuracy time-stamping capability. Presents real-time load flow/power flow application ideas.

**Section 12: Settings.** Provides a list of all common SEL-400 Series Relay settings and defaults.

**Section 13: SELogic Control Equation Programming.** Describes multiple setting groups and SELOGIC control equations and how to apply these equations. Discusses expanded SELOGIC control equation features such as PLC-style commands, math functions, counters, and conditioning timers. Provides a tutorial for converting older format SELOGIC control equations to new freeform equations.

**Section 14: ASCII Command Reference.** Provides an alphabetical listing of all ASCII commands with examples for each ASCII command option.

**Section 15: Communications Interfaces.** Explains the physical connection of the relay to various communications network topologies. Describes the various software protocols and how to apply these protocols to substation integration and automation. Includes details about Ethernet IP protocols, SEL ASCII, SEL Compressed ASCII, SEL Fast Meter, SEL Fast Operate, SEL Fast SER, and enhanced MIRRORED BITS communications.

**Section 16: DNP3 Communication.** Describes the DNP3 communications protocol and how to apply this protocol to substation integration and automation. Provides a Job Done example for implementing DNP3 in a substation.

**Section 17: IEC 61850 Communication.** Describes the IEC 61850 protocol and how to apply this protocol to substation automation and integration. Includes IEC 61850 protocol compliance statements.

**Section 18: Synchrophasors.** Describes the phasor measurement unit (PMU) functions of the relay. Provides details on synchrophasor measurement and real-time control. Describes the IEEE C37.118 synchrophasor protocol settings. Describes the SEL Fast Message synchrophasor protocol settings.

**Section 19: Digital Secondary Systems.** Describes the basic concepts of digital secondary systems (DSS). This includes both the Time-Domain Link (TiDL) system and UCA 61850-9-2LE Sampled Values.

**Appendix A: Manual Versions.** Lists the current manual version and details differences between the current and previous versions.

Appendix B: Firmware Upgrade Instructions. Describes the procedure to update the firmware stored in Flash memory.

Appendix C: Cybersecurity Features. Describes the various features of the relay that impact cybersecurity.

Glossary. Defines various technical terms used in the SEL-400 Series Relays instruction manuals.

## Safety Information

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### Dangers, Warnings, and Cautions

This manual uses three kinds of hazard statements, defined as follows:

#### DANGER

Indicates an imminently hazardous situation that, if not avoided, **will** result in death or serious injury.

#### WARNING

Indicates a potentially hazardous situation that, if not avoided, **could** result in death or serious injury.

#### CAUTION

Indicates a potentially hazardous situation that, if not avoided, **may** result in minor or moderate injury or equipment damage.

## Safety Symbols

The following symbols are often marked on SEL products.

	<b>CAUTION</b> Refer to accompanying documents.	<b>ATTENTION</b> Se reporter à la documentation.
	Earth (ground)	Terre
	Protective earth (ground)	Terre de protection
	Direct current	Courant continu
	Alternating current	Courant alternatif
	Both direct and alternating current	Courant continu et alternatif
	Instruction manual	Manuel d'instructions

# Safety Marks

The following statements apply to this device.

## General Safety Marks

<b>!CAUTION</b> There is danger of explosion if the battery is incorrectly replaced. Replace only with Ray-O-Vac no. BR2335 or equivalent recommended by manufacturer. See Owner's Manual for safety instructions. The battery used in this device may present a fire or chemical burn hazard if mis-treated. Do not recharge, disassemble, heat above 100°C or incinerate. Dispose of used batteries according to the manufacturer's instructions. Keep battery out of reach of children.	<b>!ATTENTION</b> Une pile remplacée incorrectement pose des risques d'explosion. Remplacez seulement avec un Ray-O-Vac no BR2335 ou un produit équivalent recommandé par le fabricant. Voir le guide d'utilisateur pour les instructions de sécurité. La pile utilisée dans cet appareil peut présenter un risque d'incendie ou de brûlure chimique si vous en faites mauvais usage. Ne pas recharger, démonter, chauffer à plus de 100°C ou incinérer. Éliminez les vieilles piles suivant les instructions du fabricant. Gardez la pile hors de la portée des enfants.
<b>!CAUTION</b> To ensure proper safety and operation, the equipment ratings, installation instructions, and operating instructions must be checked before commissioning or maintenance of the equipment. The integrity of any protective conductor connection must be checked before carrying out any other actions. It is the responsibility of the user to ensure that the equipment is installed, operated, and used for its intended function in the manner specified in this manual. If misused, any safety protection provided by the equipment may be impaired.	<b>!ATTENTION</b> Pour assurer la sécurité et le bon fonctionnement, il faut vérifier les classements d'équipement ainsi que les instructions d'installation et d'opération avant la mise en service ou l'entretien de l'équipement. Il faut vérifier l'intégrité de toute connexion de conducteur de protection avant de réaliser d'autres actions. L'utilisateur est responsable d'assurer l'installation, l'opération et l'utilisation de l'équipement pour la fonction prévue et de la manière indiquée dans ce manuel. Une mauvaise utilisation pourrait diminuer toute protection de sécurité fournie par l'équipement.
For use in Pollution Degree 2 environment.	Pour l'utilisation dans un environnement de Degré de Pollution 2.

## Other Safety Marks (Sheet 1 of 2)

<b>!DANGER</b> Disconnect or de-energize all external connections before opening this device. Contact with hazardous voltages and currents inside this device can cause electrical shock resulting in injury or death.	<b>!DANGER</b> Débrancher tous les raccordements externes avant d'ouvrir cet appareil. Tout contact avec des tensions ou courants internes à l'appareil peut causer un choc électrique pouvant entraîner des blessures ou la mort.
<b>!DANGER</b> Contact with instrument terminals can cause electrical shock that can result in injury or death.	<b>!DANGER</b> Tout contact avec les bornes de l'appareil peut causer un choc électrique pouvant entraîner des blessures ou la mort.
<b>!WARNING</b> Use of this equipment in a manner other than specified in this manual can impair operator safety safeguards provided by this equipment.	<b>!AVERTISSEMENT</b> L'utilisation de cet appareil suivant des procédures différentes de celles indiquées dans ce manuel peut désarmer les dispositifs de protection d'opérateur normalement actifs sur cet équipement.
<b>!WARNING</b> Have only qualified personnel service this equipment. If you are not qualified to service this equipment, you can injure yourself or others, or cause equipment damage.	<b>!AVERTISSEMENT</b> Seules des personnes qualifiées peuvent travailler sur cet appareil. Si vous n'êtes pas qualifiés pour ce travail, vous pourriez vous blesser avec d'autres personnes ou endommager l'équipement.
<b>!WARNING</b> This device is shipped with default passwords. Default passwords should be changed to private passwords at installation. Failure to change each default password to a private password may allow unauthorized access. SEL shall not be responsible for any damage resulting from unauthorized access.	<b>!AVERTISSEMENT</b> Cet appareil est expédié avec des mots de passe par défaut. A l'installation, les mots de passe par défaut devront être changés pour des mots de passe confidentiels. Dans le cas contraire, un accès non-autorisé à l'équipement peut être possible. SEL décline toute responsabilité pour tout dommage résultant de cet accès non-autorisé.
<b>!WARNING</b> Do not look into the fiber ports/connectors.	<b>!AVERTISSEMENT</b> Ne pas regarder vers les ports ou connecteurs de fibres optiques.
<b>!WARNING</b> Do not look into the end of an optical cable connected to an optical output.	<b>!AVERTISSEMENT</b> Ne pas regarder vers l'extrémité d'un câble optique raccordé à une sortie optique.
<b>!WARNING</b> Do not perform any procedures or adjustments that this instruction manual does not describe.	<b>!AVERTISSEMENT</b> Ne pas appliquer une procédure ou un ajustement qui n'est pas décrit explicitement dans ce manuel d'instruction.
<b>!WARNING</b> During installation, maintenance, or testing of the optical ports, use only test equipment qualified for Class 1 laser products.	<b>!AVERTISSEMENT</b> Durant l'installation, la maintenance ou le test des ports optiques, utilisez exclusivement des équipements de test homologués comme produits de type laser de Classe 1.

**Other Safety Marks (Sheet 2 of 2)**

<b>⚠️ WARNING</b> Incorporated components, such as LEDs and transceivers are not user serviceable. Return units to SEL for repair or replacement.	<b>⚠️ AVERTISSEMENT</b> Les composants internes tels que les leds (diodes électroluminescentes) et émetteurs-récepteurs ne peuvent pas être entretenus par l'utilisateur. Retourner les unités à SEL pour réparation ou remplacement.
<b>⚠️ CAUTION</b> Equipment components are sensitive to electrostatic discharge (ESD). Undetectable permanent damage can result if you do not use proper ESD procedures. Ground yourself, your work surface, and this equipment before removing any cover from this equipment. If your facility is not equipped to work with these components, contact SEL about returning this device and related SEL equipment for service.	<b>⚠️ ATTENTION</b> Les composants de cet équipement sont sensibles aux décharges électrostatiques (DES). Des dommages permanents non-détectables peuvent résulter de l'absence de précautions contre les DES. Raccordez-vous correctement à la terre, ainsi que la surface de travail et l'appareil avant d'en retirer un panneau. Si vous n'êtes pas équipés pour travailler avec ce type de composants, contacter SEL afin de retourner l'appareil pour un service en usine.
<b>⚠️ CAUTION</b> Equipment damage can result from connecting ac circuits to Hybrid (high-current interrupting) control outputs. Do not connect ac circuits to Hybrid control outputs. Use only dc circuits with Hybrid control outputs.	<b>⚠️ ATTENTION</b> Des dommages à l'appareil pourraient survenir si un circuit CA était raccordé aux contacts de sortie à haut pouvoir de coupure de type "Hybrid." Ne pas raccorder de circuit CA aux contacts de sortie de type "Hybrid." Utiliser uniquement du CC avec les contacts de sortie de type "Hybrid."
<b>⚠️ CAUTION</b> Substation battery systems that have either a high resistance to ground (greater than 10 kΩ) or are ungrounded when used in conjunction with many direct-coupled inputs can reflect a dc voltage offset between battery rails. Similar conditions can exist for battery monitoring systems that have high-resistance balancing circuits or floating grounds. For these applications, SEL provides optional ground-isolated (optoisolated) contact inputs. In addition, SEL has published an application advisory on this issue. Contact the factory for more information.	<b>⚠️ ATTENTION</b> Les circuits de batterie de postes qui présentent une haute résistance à la terre (plus grande que 10 kΩ) ou sont isolés peuvent présenter un biais de tension CC entre les deux polarités de la batterie quand utilisés avec plusieurs entrées à couplage direct. Des conditions similaires peuvent exister pour des systèmes de surveillance de batterie qui utilisent des circuits d'équilibrage à haute résistance ou des masses flottantes. Pour ce type d'applications, SEL peut fournir en option des contacts d'entrée isolés (par couplage optoélectronique). De surcroît, SEL a publié des recommandations relatives à cette application. Contacter l'usine pour plus d'informations.
<b>⚠️ CAUTION</b> Do not install a jumper on positions A or D of the main board J21 header. Relay misoperation can result if you install jumpers on positions J21A and J21D.	<b>⚠️ ATTENTION</b> Ne pas installer de cavalier sur les positions A ou D sur le connecteur J21 de la carte principale. Une opération intempestive du relais pourrait résulter suite à l'installation d'un cavalier entre les positions J21A et J21D.
<b>⚠️ CAUTION</b> Insufficiently rated insulation can deteriorate under abnormal operating conditions and cause equipment damage. For external circuits, use wiring of sufficiently rated insulation that will not break down under abnormal operating conditions.	<b>⚠️ ATTENTION</b> Un niveau d'isolation insuffisant peut entraîner une détérioration sous des conditions anormales et causer des dommages à l'équipement. Pour les circuits externes, utiliser des conducteurs avec une isolation suffisante de façon à éviter les claquages durant les conditions anormales d'opération.
<b>⚠️ CAUTION</b> Severe power and ground problems can occur on the communications ports of this equipment as a result of using non-SEL cables. Never use standard null-modem cables with this equipment.	<b>⚠️ ATTENTION</b> Des problèmes graves d'alimentation et de terre peuvent survenir sur les ports de communication de cet appareil si des câbles d'origine autre que SEL sont utilisés. Ne jamais utiliser de câble de modem nul avec cet équipement.
<b>⚠️ CAUTION</b> Do not connect power to the relay until you have completed these procedures and receive instruction to apply power. Equipment damage can result otherwise.	<b>⚠️ ATTENTION</b> Ne pas mettre le relais sous tension avant d'avoir complété ces procédures et d'avoir reçu l'instruction de brancher l'alimentation. Des dommages à l'équipement pourraient survenir autrement.
<b>⚠️ CAUTION</b> Use of controls or adjustments, or performance of procedures other than those specified herein, may result in hazardous radiation exposure.	<b>⚠️ ATTENTION</b> L'utilisation de commandes ou de réglages, ou l'application de tests de fonctionnement différents de ceux décrits ci-après peuvent entraîner l'exposition à des radiations dangereuses.

## General Information

The SEL-487B Instruction Manual uses certain conventions that identify particular terms and help you find information. To benefit fully from reading this manual, take a moment to familiarize yourself with these conventions.

# Typographic Conventions

There are three ways to communicate with the SEL-487B-2:

- Using a command line interface on a PC terminal emulation window, such as Microsoft HyperTerminal
- Using the front-panel menus and pushbuttons
- Using QuickSet or SEL Grid Configurator

The instructions in this manual indicate these options with specific font and formatting attributes. The following table lists these conventions:

Example	Description
<b>STATUS</b>	Commands, command options, and command variables typed at a command line interface on a PC.
<i>n</i> <b>SUM n</b>	Variables determined based on an application (in bold if part of a command).
<b>&lt;Enter&gt;</b>	Single keystroke on a PC keyboard.
<b>&lt;Ctrl+D&gt;</b>	Multiple/combination keystroke on a PC keyboard.
<b>Start &gt; Settings</b>	PC software dialog boxes and menu selections. The > character indicates submenus.
<b>ENABLE</b>	Relay front- or rear-panel labels and pushbuttons.
<b>MAIN &gt; METER</b>	Relay front-panel LCD menus and relay responses visible on the PC screen. The > character indicates submenus.

# Logic Diagrams

Logic diagrams in this manual follow the conventions and definitions shown below.

<u>NAME</u>	<u>SYMBOL</u>	<u>FUNCTION</u>
Comparator	A → B → C	Input A is compared to Input B. Output C asserts if Input A is greater than Input B.
Input Flag	A ←	Input A comes from other logic.
OR	A → B → C	If either Input A or Input B asserts, Output C asserts.
Exclusive OR	A → B → C	If either Input A or Input B asserts, Output C asserts. If Input A and Input B are of the same state, Output C deasserts.
NOR	A → B → C	If neither Input A nor Input B asserts, Output C asserts.
AND	A → B → C	If Input A and Input B assert, Output C asserts.
AND w/ Inverted Input	A → B → C	If Input A asserts and Input B deasserts, Output C asserts. Inverter "O" inverts any input or output on any gate.
NAND	A → B → C	If Input A and/or Input B deassert, Output C asserts.
Time-Delayed Pick Up and/or Time-Delayed Drop Out	A → X → Y → B	X is a time-delay-pickup value; Y is a time-delay-dropout value. Output B asserts Time X after Input A asserts; Output B does not assert if Input A does not remain asserted for Time X. If Time X is zero, Output B asserts when Input A asserts. If Time Y is zero, Input B deasserts when Input A deasserts.
Edge Trigger Timer	A → X → Y → B	Rising edge of Input A starts timers. Output B asserts Time X after the rising edge of Input A. Output B remains asserted for Time Y. If Time Y is zero, Output B asserts for a single processing interval. Input A is ignored while the timers are running.
Set-Reset/Flip-Flop	S → Q → R	Input S asserts Output Q until Input R asserts. Output Q deasserts or resets when Input R asserts.
Falling Edge	A ↘ B	Output B asserts at the falling edge of Input A.
Rising Edge	A ↗ B	Output B asserts at the rising edge of Input A.

# Trademarks

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SEL trademarks appearing in this manual are shown in the following table.

ACSELERATOR Architect®	SELBOOT®
ACSELERATOR QuickSet®	SELOGIC®
MIRRORED BITS®	SYNCHROWAVE®
SEL-2240 Axion®	

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## Technical Support

We appreciate your interest in SEL products and services. If you have questions or comments, contact us at:

Schweitzer Engineering Laboratories, Inc.  
2350 NE Hopkins Court  
Pullman, WA 99163-5603 U.S.A.  
Tel: +1.509.338.3838  
Fax: +1.509.332.7990  
Internet: [selinc.com/support](http://selinc.com/support)  
Email: [info@selinc.com](mailto:info@selinc.com)

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## S E C T I O N   1

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# Introduction and Specifications

The SEL-487B-2 Relay provides bus current differential protection, circuit breaker failure protection, and backup overcurrent protection. Equipped with an interface board, the relay supports as many as 24 inputs and as many as 13 outputs in addition to communicating high-speed digital statuses with configured merging units. It is configurable in either a three-relay or a single-relay application. The relay has 21 analog current inputs and 3 analog voltage inputs. For buses with no more than seven terminals, use one SEL-487B in a single-relay application. For buses with as many as 21 terminals, use three SEL-487B Relays in a three-relay application; each relay provides as many as six dedicated zones of protection.

The SEL-487B-2 supports only digital secondary systems (DSS); the relay does not support local line current or voltage data acquisition. There are two versions of the SEL-487B-2 available: a Sampled Values (SV) subscriber relay or an SEL Time-Domain Link (TiDL) relay.

The SEL-487B-2 SV Subscriber Relay profile is compliant with UCA International Users Group’s “Implementation Guideline for Digital Interface to Instrument Transformers Using IEC 61850-9-2,” also known as UCA 61850-9-2LE or 9-2LE. The SV subscriber relay supports subscriptions for as many as seven SV merging units. See *Section 2: Installation* for more details about SV applications.

The SEL-487B-2 TiDL Relay is designed exclusively for SEL TiDL systems. SEL TiDL relays communicate with as many as eight SEL TiDL Merging Units (TMUs) over direct, point-to-point fiber-optic connections. See *Section 2: Installation* for more details about TiDL applications.

The SEL-487B has separate protection and automation SELOGIC control equation programming areas with extensive protection and automation programming capabilities. You can organize automation SELOGIC control equation programming into 10 blocks of 100 program lines each, for a total of 1000 lines of automation programming. Use as many as 100 lines in the separate protection programming area to program custom protection functions. With the flexibility of the expanded SELOGIC control equations, the relay is suitable for custom protection and control schemes.

Communications interfaces include standard SEL ASCII and enhanced MIRRORED BITS communications protocols. With the Ethernet card, you can employ common industry communications tools, including Telnet, FTP, IEC 61850, and DNP3 LAN/WAN protocols.

Purchase of an SEL-487B-2 includes the SEL Grid Configurator Software. SEL Grid is SEL’s relay configuration software package. SEL Grid Configurator assists you in setting, controlling, and acquiring data from the relay. For the SEL TiDL relays, use SEL Grid Configurator to configure and then commission your TiDL system. ACCELERATOR Architect SEL-5032 Software is included as well. Architect enables you to view and configure IEC 61850 GOOSE and MMS settings via a graphical user interface (GUI). In SV relays, you can set your SV mapping settings in Architect or SEL Grid Configurator.

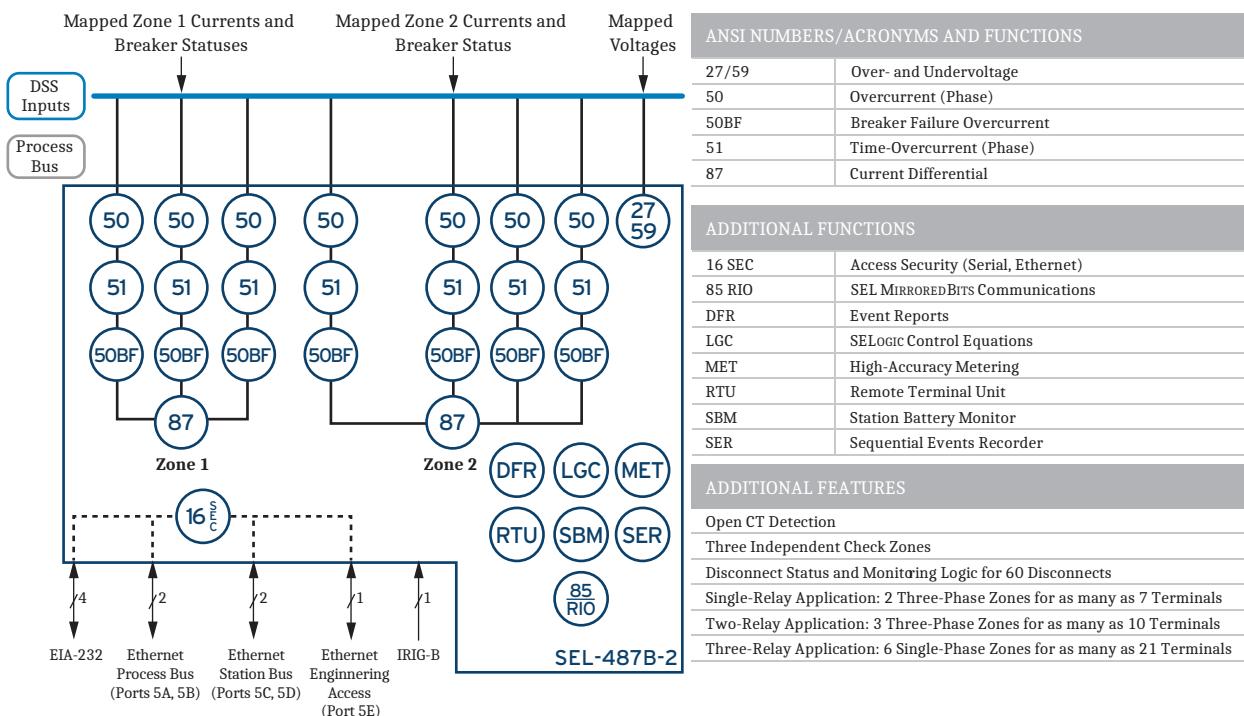
Combining the simple and robust hardware design with extensive self-testing provides relay reliability and enhances relay availability.

This section introduces the SEL-487B and provides information on the following topics:

- *Features on page 1.2*
- *Models and Options on page 1.4*
- *Applications on page 1.5*
- *Product Characteristics on page 1.17*
- *Specifications on page 1.19*

## Features

The SEL-487B contains many protection, automation, and control features. *Figure 1.1* presents a simplified functional overview of the relay.



Five-port Ethernet card ordering option depicted.

**Figure 1.1 SEL-487B Relay Basic Functions in a Double-Bus Application**

The SEL-487B features include the following:

**Digital Current Summation.** The relay can combine incoming current data digitally for mapped terminal inputs to simplify external wiring.

**IEC 61850 Sampled Values Subscription (SEL-487B-2 SV Subscriber Relay Only).**

The SEL-487B-2 SV Subscriber Relay supports as many as seven SV subscriptions. SV message subscription complies with UCA 9-2LE guidelines. These guidelines include four current and four voltage channels per frame at a sampling rate of 4.8 kHz for a 60 Hz system or 4.0 kHz for a 50 Hz system.

**SEL TiDL Technology (SEL-487B-2 TiDL Relay Only).** The SEL-487B-2 TiDL Relay supports communicating with as many as eight SEL-TMU over direct, point-to-point fiber-optic connections.

**Selective Protection Disabling.** The SEL-487B-2 provides selective disabling of protection functions by using hard-coded logic or available torque-control equations in case of a loss of communication between your merging unit and relay that results in the loss of relevant analog data.

**IEC 61850 Operating Modes.** The relay supports IEC 61850 standard operating modes such as Test, Blocked, On, and Off, in addition to the separate IEC 61850 simulation mode.

**Bus Protection.** The SEL-487B provides differential protection for the following: single bus, double bus, double bus with transfer, breaker-and-a-half, triple bus arrangements, generators and motors, shunt capacitor banks, autotransformers and reactors.

**Second Trip Criterion.** Each of the six elements includes a second trip criterion. This criterion consists of the OR combination of a directional element in parallel with a fault detection element.

**Check Zone Capability.** If your protection philosophy calls for an overall check zone, use as many as three independent check zones available in the relay.

**Voltage Elements.** Phase, negative-, and/or zero-sequence elements are available as additional trip criteria for trip supervision.

**Breaker Failure.** Select the type of breaker failure protection (internal or external) on a terminal-by-terminal basis. Internal breaker failure protection provides breaker failure trip and breaker retrip for 21 terminals. Open-phase detection ensures current-element reset in less than one cycle. For the external breaker failure protection, select the external breaker failure option. With this option, the relay accepts inputs from breaker failure relays installed in the feeder protection panels.

**Differential Protection.** Innovative algorithms switch the relay to a high-security mode during through-fault conditions. While in the high-security mode, the algorithm does not block the differential elements, thus avoiding unnecessary time delays for clearing faults evolving from external to internal faults.

**Overcurrent Elements.** Each of the 21 terminals provides one level of phase instantaneous (50) and one level of time-overcurrent (51) protection.

**CT Open-Circuit Detection.** Use the independent sensitive differential element in each zone to detect CT open circuit, short circuit, or incorrect CT polarity.

**Minimum CT Requirement.** The relay requires primary CTs that shall reproduce the primary current without saturation for at least 2 ms after external fault inception.

**Dynamic Station Configuration.** Wire the disconnect (89) auxiliary contacts to the relay to assign the current inputs dynamically to the correct differential measuring element. Instead of disabling bus protection during disconnect switching, use this feature to provide bus protection during switching operations, when the safety of personnel is at high risk.

**CT Ratio Mismatch.** Mismatched CTs of ratios as high as 10:1 can be installed. For example, this means you can install the new feeder with a CT ratio of 2000/5 to existing bus systems that all have CT ratios of 200/5.

Parallel Redundancy Protocol (PRP). Provide seamless recovery from any single Ethernet network failure with this protocol, in accordance with IEC 62439-3. The station bus and process bus Ethernet networks support PRP.<sup>1</sup>

Expanded SELogic Control Equations. Modify and set custom relay applications with PLC-style (programmable logic controller, IEC 61131-3) SELogic control equation programming that includes math and comparison functions. Use counters and multifunction timers for greater application flexibility, i.e., perform advanced PLC functions within the relay. The SEL-487B has separate protection and automation SELogic control equation programming areas. These programming areas provide ample protection programming capability and 10 blocks of 100-line automation programming capability (1000 lines).

Alias Settings. Use as many as 200 aliases to rename any digital or analog quantity in the relay. The aliases are available for use in customized programming, making the initial programming and maintenance much easier.

Metering. View metering primary or secondary information for phase currents and angles of all 21 terminals, phase voltages and angles, CT polarities, as well as the operating and restraint values from all protection zones.

Oscillography and Event Reporting. Record voltages, currents, and internal logic points at as high as an 8 kHz sampling rate. Phasor and harmonic analysis features allow investigation of relay and system performance.

Sequential Events Recorder (SER). Record 1000 system entries from 250 monitoring points, including settings changes, power ups, and Relay Word bit elements that you select. Set element names to easily understood aliases.

Digital Relay-to-Relay Communication. Use MIRRORED BITS communications to monitor internal element conditions between relays within a substation and between substations using communication channels (SEL fiber-optic transceivers to send a direct transfer trip, for example).

Ethernet Communications Capability. Implement control and data gathering capabilities via substation LANs and company WANs with the Ethernet card. Employ the FTP protocol for system data acquisition. Use Telnet for remote terminal interface. Use DNP3 and IEC 61850 for SCADA. Employ SNTP or Precision Time Protocol (PTP) for time synchronization.

Rules-Based Settings Editor. Communicate with and set the relay by using an ASCII terminal, or use the PC-based SEL Grid Configurator to configure the SEL-487B-2.

## Models and Options

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Consider the following options when ordering and configuring the SEL-487B.

- DSS connector type
- IEC 61850-9-2LE-compliant SV subscriber relay
- SEL TiDL relay with T-Protocol

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<sup>1</sup> Only the five-port Ethernet card ordering option supports PRP on both the station bus and the process bus.

- Chassis size
  - 4U (U is one rack unit—1.75 inches or 44.45 mm)

**Table 1.1 Interface Board Information**

<b>Board Name</b>	<b>Inputs</b>	<b>Description</b>	<b>Outputs</b>	<b>Description</b>
INT2	8	Optoisolated, independent, level-sensitive	13	Standard Form A
			2	Standard Form C
INT4	18	Two sets of 9 common optoisolated, level-sensitive	6	High-speed, high-current interrupting, Form A
			2	Standard Form A

- Chassis orientation and type
  - Horizontal rack mount
  - Horizontal panel mount
  - Vertical rack mount
  - Vertical panel mount
- Power supply
  - 24–48 Vdc
  - 48–125 Vdc or 110–120 Vac
  - 125–250 Vdc or 110–240 Vac
- Ethernet card options
  - Four-port Ethernet card with port combinations of:
    - Four copper (10BASE-T/100BASE-TX)
    - Four fiber (100BASE-FX)
    - Two copper (10BASE-T/100BASE-TX) and two fiber (100BASE-FX)
  - Five-port Ethernet card with small form-factor pluggable (SFP) ports (100BASE-FX and 1000BASE-X)<sup>2</sup>
- Communications protocols
  - Complete group of protocols (SEL ASCII, SEL Compressed ASCII, SEL Settings File Transfer, SEL Fast Meter, SEL Fast Operate, SEL Fast SER, MIRRORED BITS Communications), and DNP3
  - Above protocols plus IEC 61850 Edition 2

Contact the SEL factory or your local Technical Service Center for ordering information (see *Technical Support on page 3.20*). You can also view the latest ordering information on the SEL website at [selinc.com](http://selinc.com).

## Applications

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Use the SEL-487B for most bus protection applications. For information on connecting the relay, see *Section 2: Installation*. See *Section 6: Protection Application Examples* for discussions of protection and automation applications using

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<sup>2</sup> All ports support 100 Mbps speeds. PORT 5A and PORT 5B also support 1 Gbps speeds.

**NOTE:** Use caution if summing current data external to the SEL-487B. For percent-restraint differential applications, external current summation could cause an unexpected reduction in restraint current if misapplied.

the SEL-487B. The figures in this section illustrate common sampled value relay applications. Transformer and line relays can also make use of the same merging units as the SEL-487B, as shown in several of the following examples.

The SEL-487B-2 has 21 mapped analog current inputs (I01–I21) and 3 mapped analog voltage inputs (V01–V03). The examples that follow show possible user mapping of analog and digital data between the SEL-487B-2 and several merging units.

The figures in this section illustrate common DSS applications.

## Single Bus With Tie Breaker Application

In the SV version of this application, the SEL-487B-2 SV Subscriber Relay subscribes to seven IEC 61850 9-2 SV streams. The SV publishers and subscribers for this application connect through a process bus network switch. The same network switch is used to communicate GOOSE messages, and time synchronize the system using a PTP time source. SV and GOOSE mapping between SEL-401 Merging Units and the SEL-487B SV Subscriber Relay are described in *Table 1.2* and *Table 1.3*.

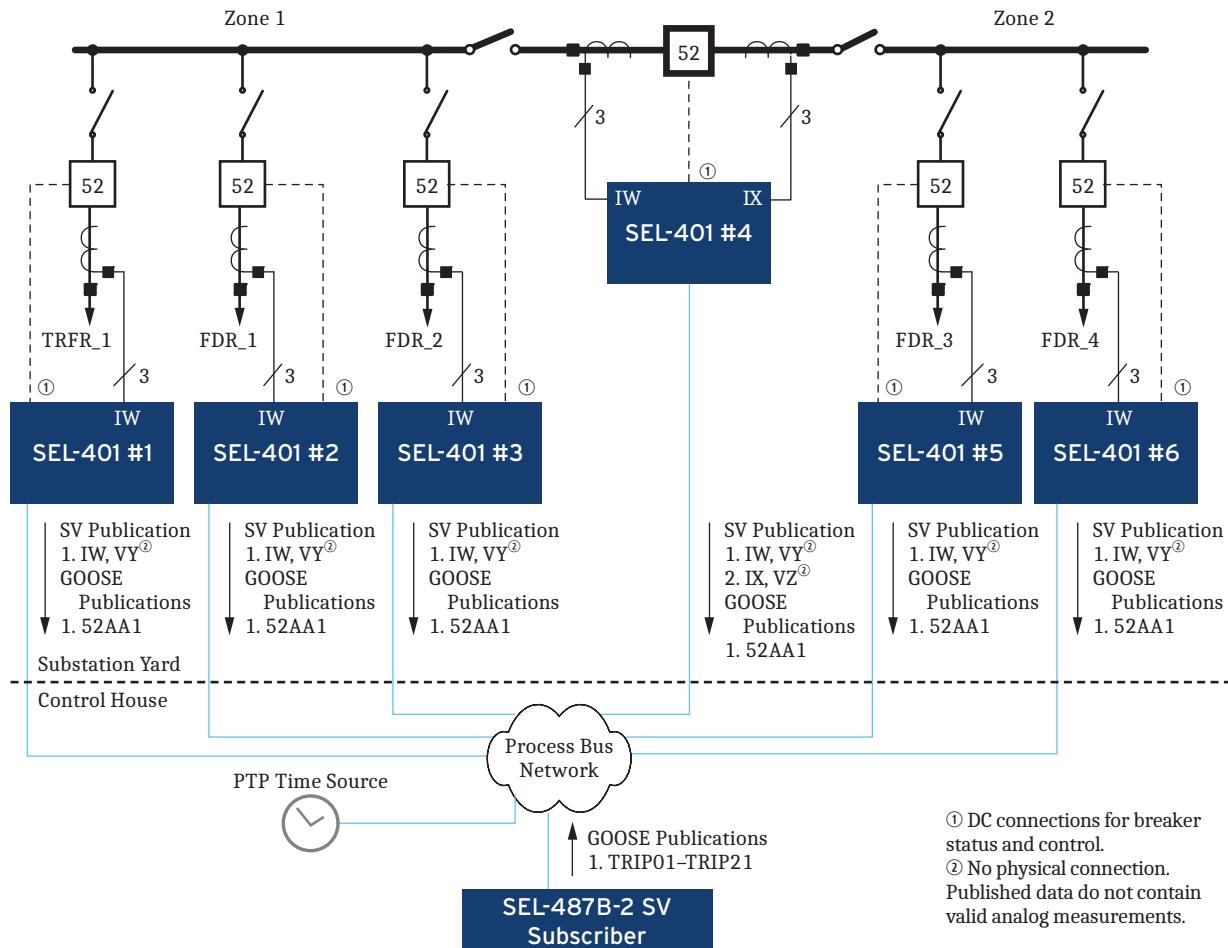


Figure 1.2 Single Bus With Bus-Tie Breaker Application (SV Subscriber)

In *Figure 1.2*, all SEL-401 Merging Units have been configured to publish their three phase current measurements to the SEL-487B-2 SV Subscriber Relay. SEL-401 #1 receives Relay Word bits VB001–VB003 from the SEL-487B-2 and

is set to trip the breaker associated with TRFR\_1. The SEL-487B-2 receives VB001 from SEL-401 #1 and uses that bit to monitor the status of the breaker on line TRFR\_1. The other merging units have their analog and digital mapping configured similarly to form two zones of differential protection with the SEL-487B-2 SV Subscriber Relay consisting of six independent differential elements.

**Table 1.2 SEL-487B-2 SV Subscriber Relay IEC 61850 Subscriptions, Single Bus With Tie Breaker Application**

Merging Unit Publications	SEL-487B Subscriptions
<b>SEL-401 #1</b>	
IAW, IBW, ICW	I01, I02, I03
52AA1	VB001
<b>SEL-401 #2</b>	
IAW, IBW, ICW	I04, I05, I06
52AA1	VB002
<b>SEL-401 #3</b>	
IAW, IBW, ICW	I07, I08, I09
52AA1	VB003
<b>SEL-401 #4</b>	
IAW, IBW, ICW	I10, I11, I12
IAX, IBX, ICX	I13, I14, I15
52AA1	VB004
<b>SEL-401 #5</b>	
IAW, IBW, ICW	I16, I17, I18
52AA1	VB005
<b>SEL-401 #6</b>	
IAW, IBW, ICW	I19, I20, I21
52AA1	VB006

The SEL-487B-2 SV Subscriber Relay receives GOOSE messages VB001–VB006 to monitor the status of all three-phase breakers within each bus-zone of protection. The SEL-487B-2 SV Subscriber Relay is configured to send individual trip signals to each respective breaker by using GOOSE messaging. These GOOSE messages are logically combined within the merging unit to issue a physical, three-phase trip signal to the associated breaker.

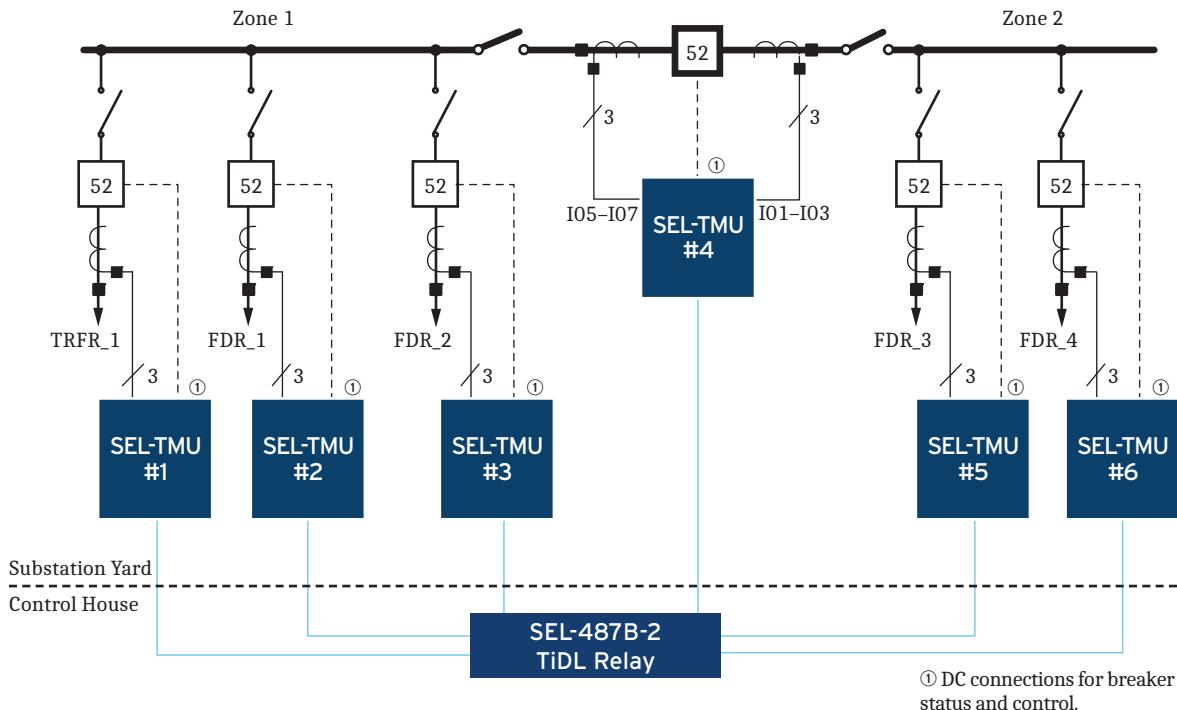
**Table 1.3 SEL-487B-2 SV Subscriber Relay IEC 61850 Publications, Single Bus With Tie Breaker Application (Sheet 1 of 2)**

Merging Unit Subscriptions	SEL-487B Publications
<b>SEL-401 #1</b>	
VB001, VB002, VB003	TRIP01, TRIP02, TRIP03
<b>SEL-401 #2</b>	
VB001, VB002, VB003	TRIP04, TRIP05, TRIP06
<b>SEL-401 #3</b>	
VB001, VB002, VB003	TRIP07, TRIP08, TRIP09

**Table 1.3 SEL-487B-2 SV Subscriber Relay IEC 61850 Publications, Single Bus With Tie Breaker Application (Sheet 2 of 2)**

Merging Unit Subscriptions	SEL-487B Publications
<b>SEL-401 #4</b>	
VB001, VB002, VB003, VB004, VB005, VB006	TRIP10, TRIP11, TRIP12, TRIP13, TRIP14, TRIP15
<b>SEL-401 #5</b>	
VB001, VB002, VB003	TRIP16, TRIP17, TRIP18
<b>SEL-401 #6</b>	
VB001, VB002, VB003	TRIP19, TRIP20, TRIP21

In the TiDL version of this application, the SEL-487B-2 TiDL Relay is connected to six SEL-TMU. The SEL-TMU inputs and outputs are mapped locally within the relay as shown in *Table 1.4*.



**Figure 1.3 Single Bus With Bus-Tie Breaker Application (TiDL)**

**Table 1.4 SEL-487B-2 TiDL System Mapping, Single Bus With Tie Breaker Application (Sheet 1 of 3)**

SEL-TMU Input	Signal/Control	SEL-487B-2 Local I/O Mapping
<b>SEL-TMU #1</b>		
I1	TRFR_1 Current IA	I01
I2	TRFR_1 Current IB	I02
I3	TRFR_1 Current IC	I03
I4	None	None
I5	None	None
I6	None	None
I7	None	None

**Table 1.4 SEL-487B-2 TiDL System Mapping, Single Bus With Tie Breaker Application (Sheet 2 of 3)**

<b>SEL-TMU Input</b>	<b>Signal/Control</b>	<b>SEL-487B-2 Local I/O Mapping</b>
I8	None	None
IN01	52AA1	IN301
OUT01	BK Close	OUT301
OUT05	BK Trip	OUT302
<b>SEL-TMU #2</b>		
I1	FDR_1 Current IA	I04
I2	FDR_1 Current IB	I05
I3	FDR_1 Current IC	I06
I4	None	None
I5	None	None
I6	None	None
I7	None	None
I8	None	None
IN01	52AA1	IN302
OUT01	BK Close	OUT303
OUT05	BK Trip	OUT304
<b>SEL-TMU #3</b>		
I1	FDR_2 Current IA	I07
I2	FDR_2 Current IB	I08
I3	FDR_2 Current IC	I09
I4	None	None
I5	None	None
I6	None	None
I7	None	None
I8	None	None
IN01	52AA1	IN303
OUT01	BK Close	OUT305
OUT05	BK Trip	OUT306
<b>SEL-TMU #4</b>		
I1	Zone 1 Current IA	I10
I2	Zone 1 Current IB	I11
I3	Zone 1 Current IC	I12
I4	None	None
I5	Zone 2 Current IA	I13
I6	Zone 2 Current IB	I14
I7	Zone 2 Current IC	I15
I8	None	None
IN01	52AA1	IN304
OUT01	BK Close	OUT307
OUT05	BK Trip	OUT308

**Table 1.4 SEL-487B-2 TiDL System Mapping, Single Bus With Tie Breaker Application (Sheet 3 of 3)**

<b>SEL-TMU Input</b>	<b>Signal/Control</b>	<b>SEL-487B-2 Local I/O Mapping</b>
<b>SEL-TMU #5</b>		
I1	FDR_3 Current IA	I16
I2	FDR_3 Current IB	I17
I3	FDR_3 Current IC	I18
I4	None	None
I5	None	None
I6	None	None
I7	None	None
I8	None	None
IN01	52AA1	IN305
OUT01	BK Close	OUT309
OUT05	BK Trip	OUT310
<b>SEL-TMU #6</b>		
I1	FDR_4 Current IA	I19
I2	FDR_4 Current IB	I20
I3	FDR_4 Current IC	I21
I4	None	None
I5	None	None
I6	None	None
I7	None	None
I8	None	None
IN01	52AA1	IN306
OUT01	BK Close	OUT311
OUT05	BK Trip	OUT312

## Single Bus Application

In the SV version of this application, the SEL-487B-2 SV Subscriber Relay subscribes to four IEC 61850 9-2 SV streams. The SV publishers and subscribers for this application connect through a process bus network switch. The same network switch is used to communicate GOOSE messages, and time synchronize the system by using a PTP time source. SV and GOOSE mapping between SEL-401 Merging Units and the SEL-487B-2 SV Subscriber Relay are described in *Table 1.5* and *Table 1.6*.

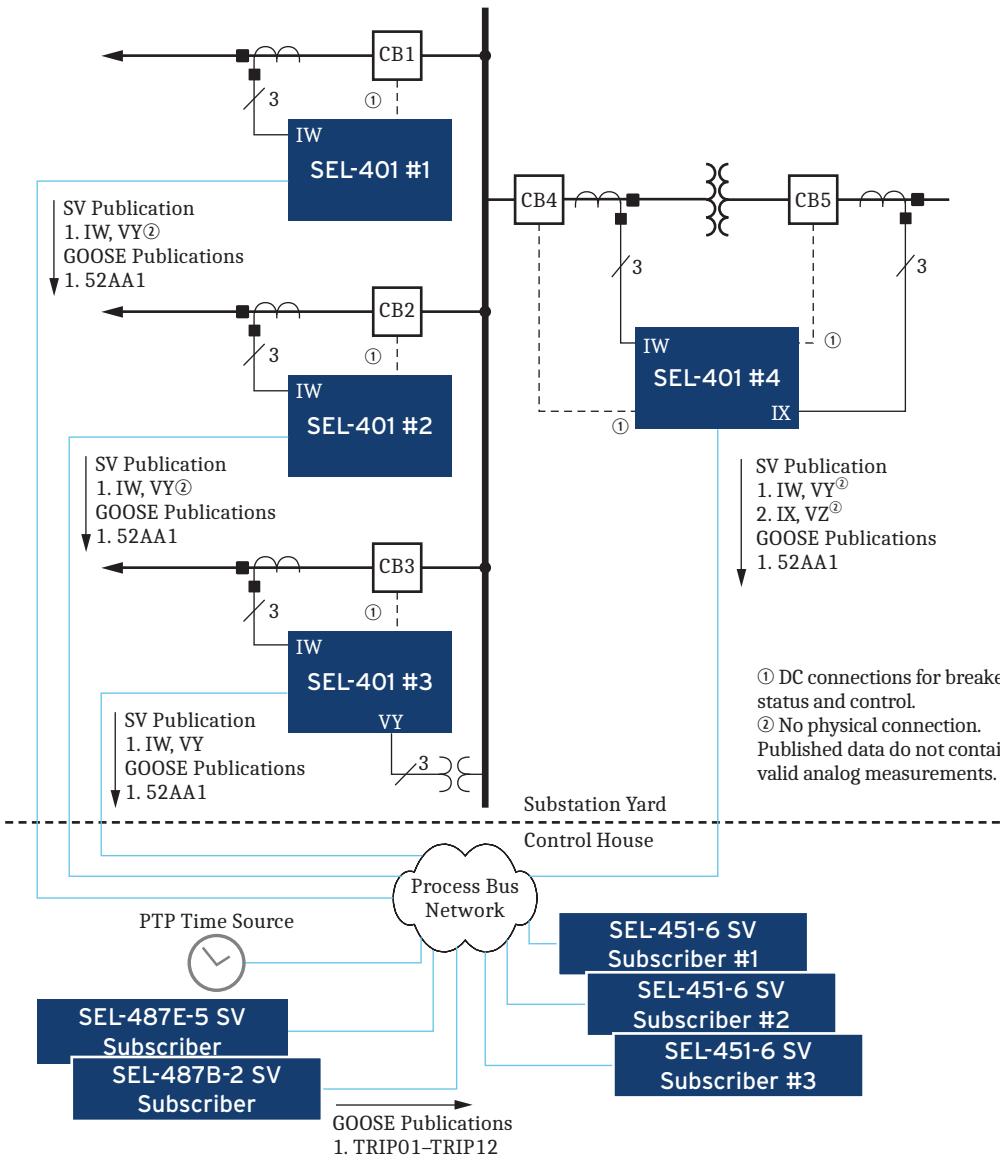


Figure 1.4 Single Bus Application (SV Subscriber)

In *Figure 1.4*, all SEL-401 Merging Units are configured to publish their three phase current measurements to the SEL-487B-2 SV Subscriber Relay. The SEL-487B in this application receives the station bus voltage, measured by SEL-401 #3. Each SEL-401 Merging Unit publishes the breaker status associated with their feeder and receives the corresponding feeder trip signal from the SEL-487B-2 SV Subscriber Relay.

Table 1.5 SEL-487B-2 SV Subscriber Relay IEC 61850 Subscriptions, Single Bus Application (Sheet 1 of 2)

Merging Unit Publications	SEL-487B Subscriptions
SEL-401 #1	
IAW, IBW, ICW	I01, I02, I03
52AA1	VB001

**Table 1.5 SEL-487B-2 SV Subscriber Relay IEC 61850 Subscriptions, Single Bus Application (Sheet 2 of 2)**

Merging Unit Publications	SEL-487B Subscriptions
<b>SEL-401 #2</b>	
IAW, IBW, ICW	I04, I05, I06
52AA1	VB002
<b>SEL-401 #3</b>	
IAW, IBW, ICW, VAY, VBY, VCY	I07, I08, I09 V01, V02, V03
52AA1	VB003
<b>SEL-401 #4</b>	
IAW, IBW, ICW	I10, I11, I12
52AA1	VB004

The SEL-487B-2 SV Subscriber Relay receives GOOSE messages VB001–VB004 to monitor the status of all three-phase breakers within the zone of protection. The SEL-487B-2 SV Subscriber Relay is configured to send individual trip signals to each respective breaker by using GOOSE messaging. These GOOSE messages are logically combined within the merging unit to issue a physical three-phase trip signals to the associated breaker.

**Table 1.6 SEL-487B-2 SV Subscriber Relay IEC 61850 Publications, Single Bus Application**

Merging Unit Subscriptions	SEL-487B Publications
<b>SEL-401 #1</b>	
VB001, VB002, VB003	TRIP01, TRIP02, TRIP03
<b>SEL-401 #2</b>	
VB001, VB002, VB003	TRIP04, TRIP05, TRIP06
<b>SEL-401 #3</b>	
VB001, VB002, VB003	TRIP07, TRIP08, TRIP09
<b>SEL-401 #4</b>	
VB001, VB002, VB003	TRIP10, TRIP11, TRIP12

In the TiDL version of this application, the SEL-487B-2 TiDL Relay is connected to four SEL-TMU. The SEL TiDL multiple point-to-point feature is highlighted in this application to include feeder and transformer protection sharing similar merging units.

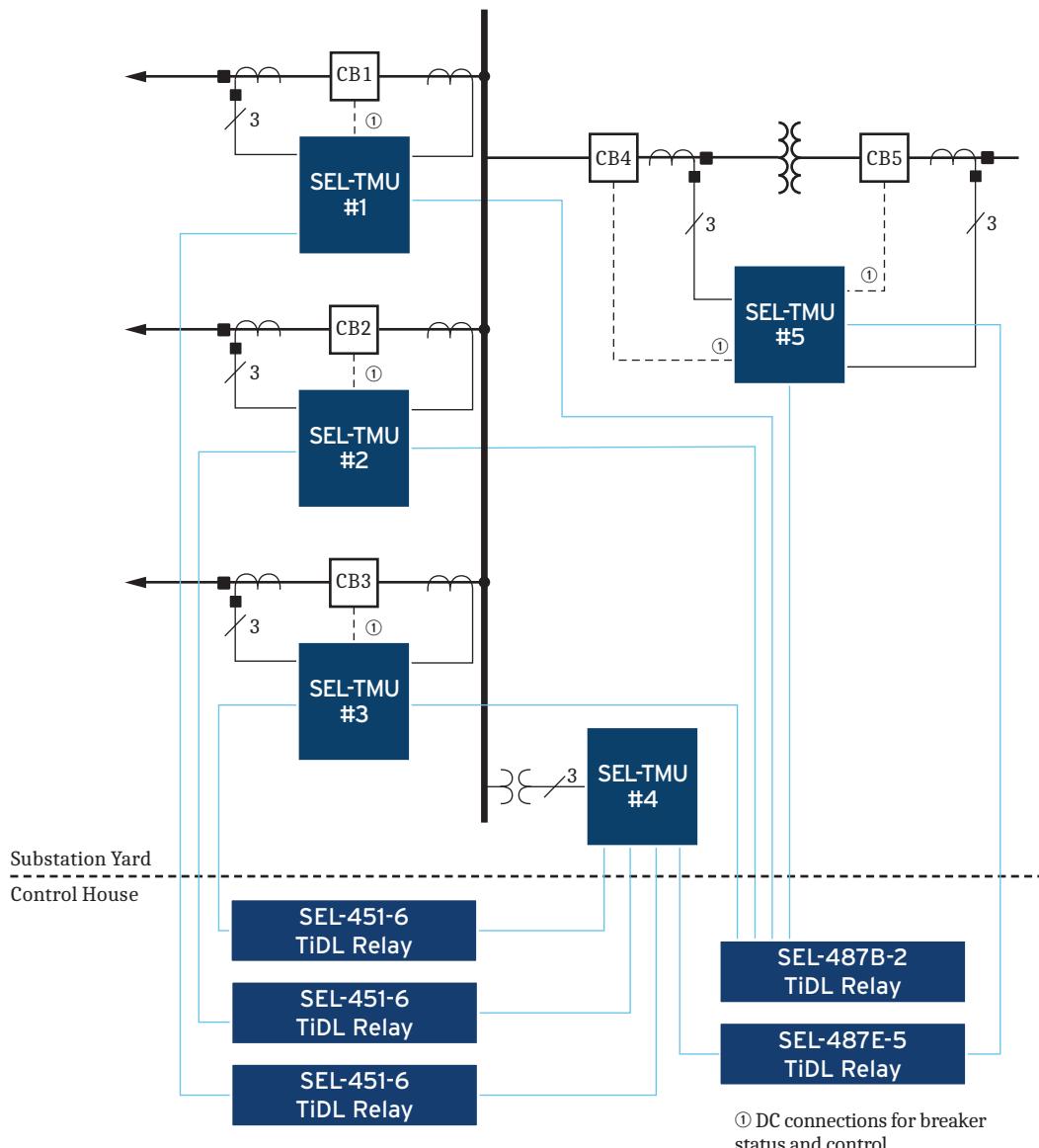
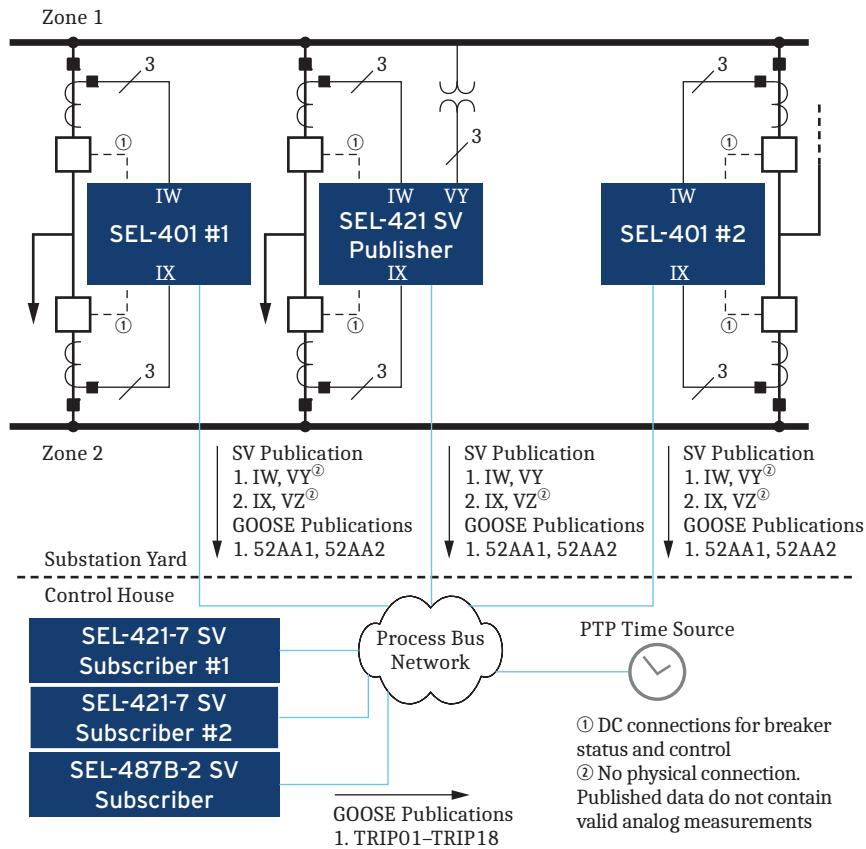


Figure 1.5 Single Bus Application (TiDL)

## Double-Breaker Double-Bus Application

In the SV version of this application, the SEL-487B-2 SV Subscriber Relay subscribes to a total of six IEC 61850 9-2 SV streams from three different merging units. The SV publishers and subscribers for this application are connected through a process bus network switch. The same network switch is used to communicate GOOSE messages and time-synchronize the system by using a PTP time source. SV and GOOSE mapping between the merging units and sampled value subscribers are described in *Table 1.7* and *Table 1.8*.



**Figure 1.6 Double-Breaker Double-Bus Application (SV Subscriber)**

In *Figure 1.6*, all SEL-401 Merging Units are configured to publish two sets of three phase current measurements to the SEL-487B-2 SV Subscriber Relay for each line leaving the bus. The differential protection in this example is phase segregated and split into two zones, requiring six independent differential elements. The SEL-487B in this application receives the station bus voltage, measured by the SEL-421-7 SV Publisher Relay. Each merging unit publishes both breaker statuses associated with their line and receives the trip signals of the same line from the SEL-487B-2 SV Subscriber Relay.

**Table 1.7 SEL-487B-2 SV Subscriber Relay IEC 61850 Subscriptions, Double-Bus Double-Breaker Application (Sheet 1 of 2)**

Merging Unit Publications	SEL-487B Subscriptions
<b>SEL-401 #1</b>	
IAW, IBW, ICW	I01, I02, I03
IAX, IBX, ICX	I04, I05, I06
52AA1, 52AA2	VB001, VB002
<b>SEL-421-7 SV Publisher Relay</b>	
IAW, IBW, ICW	I07, I08, I09
IAX, IBX, ICX	I10, I11, I12
VAY, VBY, VCY	V01, V02, V03
52AA1, 52AA2	VB003, VB004

**Table 1.7 SEL-487B-2 SV Subscriber Relay IEC 61850 Subscriptions, Double-Bus Double-Breaker Application (Sheet 2 of 2)**

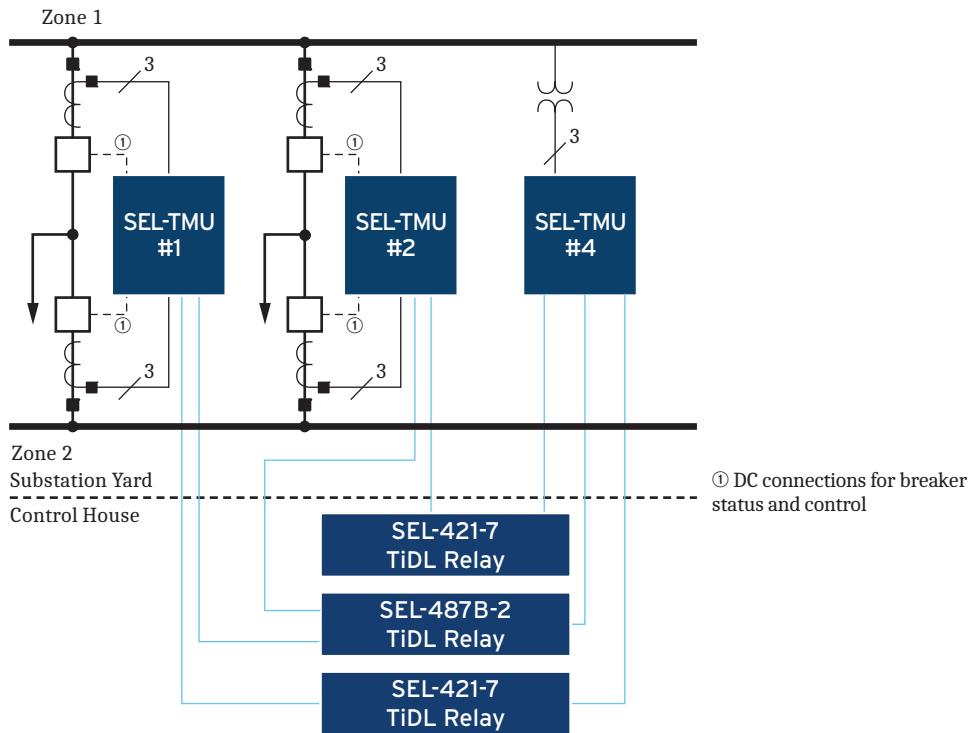
Merging Unit Publications	SEL-487B Subscriptions
SEL-401 #2	
IAW, IBW, ICW	I13, I14, I15
IAX, IBX, ICX	I16, I17, I18
52AA1, 52AA2	VB005, VB006

The SEL-487B-2 receives GOOSE messages VB001–VB006 to monitor the status of all three phase breakers within each bus-zone of protection. The SEL-487B-2 SV Subscriber Relay is configured to send individual trip signals to each respective breaker using GOOSE messaging. These GOOSE messages are logically combined within the merging unit to issue a physical three-phase trip signals to the associated breaker.

**Table 1.8 SEL-487B-2 SV Subscriber Relay IEC 61850 Publications, Double-Bus Double-Breaker Application**

Merging Unit Subscriptions	SEL-487B Publications
SEL-401 #1	
VB001, VB002, VB003, VB004, VB005, VB006	TRIP01, TRIP02, TRIP03, TRIP04, TRIP05, TRIP06
SEL-421-7 SV Publisher	
VB001, VB002, VB003, VB004, VB005, VB006	TRIP07, TRIP08, TRIP09, TRIP10, TRIP11, TRIP12
SEL-401 #2	
VB001, VB002, VB003, VB004, VB005, VB006	TRIP13, TRIP14, TRIP15, TRIP16, TRIP17, TRIP18

In the TiDL version of this application, the SEL-487B-2 TiDL Relay is connected to four SEL-TMU. The SEL TiDL multiple point-to-point feature is highlighted in this application to include line protection.



**Figure 1.7 Double-Breaker Double-Bus Application (TiDL)**

**Table 1.9 Application Highlights (Sheet 1 of 2)**

Application	Key Feature
Complex busbar arrangements	Flexible zone selection logic uses the disconnect auxiliary contacts to dynamically assign the currents to the correct zones.
Wide range of bus applications	A variety of bus applications are available: single bus, double bus, double bus with transfer, breaker-and-a-half, triple bus arrangements.
High-speed tripping	The SEL-487B features fast differential elements and fast closing trip outputs with total tripping times of less than one cycle.
Minimum CT requirements	The differential elements are secure when the CTs reproduce the primary current without saturating for at least 2 ms after external fault inception.
Open CT detection	The open CT detection elements use delta IOP/IRT to reliably detect failed CTs within each differential zone.
Terminals with different CT ratios	The SEL-487B accepts a CT mismatch of 10:1 in any one zone or combination of zones; for example, 250/5 to 2500/5.
Fast resetting internal breaker failure protection	The SEL-487B includes breaker failure protection with retrip for each terminal. Open-phase detection ensures current-element reset in less than one cycle.
External breaker failure relays	Set any terminal to “external breaker failure” to still use the trip logic in the relay, but the breaker failure initiation is from an external breaker failure relay.
Backup overcurrent protection	Each terminal has instantaneous and inverse time-overcurrent elements.
Check zone as trip criterion	Configure any of the six zones as an overall check zone or use any of the three the available independent check zones.
Voltage as trip supervision	Choose from phase, negative-, or zero-sequence voltage to supervise the differential elements.
End-zone protection	Use SELOGIC control equations to configure end-zone protection for faults between the feeder circuit breaker and the CT.

**Table 1.9 Application Highlights (Sheet 2 of 2)**

Application	Key Feature
Fault between tie breaker and CT	The SEL-487B includes logic to accelerate tripping for a fault between the tie breaker and CT. Further logic ensures the security of the healthy zone when the tie breaker is closed onto a fault.
Direct transfer trip	Use MIRRORED BITS communications to send a trip to the remote end of the line.
Auxiliary relays	The SEL-487B requires no auxiliary relays for zone selection.
SCADA applications analog and digital data acquisition for station-wide functions	The SEL-487B can acquire analog and digital data for station-wide functions.
Communications capability	These protocols are included in the relay: SEL Compressed ASCII, SEL Fast Messaging (SEL Fast Meter, SEL Fast Operate, SEL Fast SER), SEL ASCII, Enhanced MIRRORED BITS communications, Ymodem File Transfer, DNP3 Serial. Ethernet, IEC 61850, FTP, Telnet, DNP3 LAN/WAN.
Customized protection and automation schemes	The SEL-487B includes separate protection and automation SELOGIC control equation programming areas. Use timers and counters in expanded SELOGIC control equations for complete flexibility.
IEC 61850 Sampled Values <sup>a</sup>	<ul style="list-style-type: none"> <li>➤ Complies with UCA International Users Group's "Implementation Guideline for Digital Interface to Instrument Transformers Using IEC 61850-9-2"</li> <li>➤ Supports one Application Data Service Unit (ASDU).</li> <li>➤ Supports as many as seven SV subscriptions.</li> </ul>
TiDL <sup>a</sup>	<ul style="list-style-type: none"> <li>➤ Allows you to communicate with as many as eight SEL-TMU over a direct, point-to-point fiber-optic connection via T-Protocol.</li> </ul>

<sup>a</sup> Because the SEL-487B-2 uses DSS, the relay operating times are delayed. For SV applications, operating times are delayed by the configured channel delay, CH\_DLY. See SV Network Delays on page 17.25 in the SEL-400 Series Relays Instruction Manual for more details. For TiDL applications, the operating times are delayed by a fixed 1 ms. Use caution when setting relay coordination to account for this added delay.

## Product Characteristics

Each SEL-400 series relay shares common features, but has unique characteristics. *Table 1.10* summarizes the unique characteristics of the SEL-487B Relay.

**Table 1.10 SEL-487B Relay Characteristics (Sheet 1 of 2)**

Characteristic	Value
Standard Processing Rate	12 times per cycle
Battery Monitor	One
Autorecloser	none
MBG Protocol	Not supported
<b>SELOGIC</b>	
Protection Free Form	100 lines
Automation Free Form	10 blocks of 100 lines each
SELOGIC Variables	64 protection 256 automation
SELOGIC Math Variables	64 protection 256 automation
Conditioning Timers	16 protection 32 automation
Sequencing Timers	32 protection 32 automation

**Table 1.10 SEL-487B Relay Characteristics (Sheet 2 of 2)**

Characteristic	Value
Counters	32 protection 32 automation
Latch Bits	32 automation 32 protection
<b>Control</b>	
Remote Bits	96
Local Bits	64
Breakers	21: 1–21 (open control only)
Disconnects	60 (status only)
Bay Control	Not supported
<b>Metering</b>	
Maximum/Minimum Metering	Not supported
Energy Metering	Not supported
Demand Metering	Not supported

Additionally, the SEL-487B does not support the following typical SEL-400 series features:

- Synchrophasors
- Frequency measurement and tracking
- One-line diagrams on the front panel
- Breaker close operations
- Circuit breaker monitor
- Communications with the SEL-2600A RTD Module

# Specifications

**Note:** Because the SEL-487B-2 uses DSS, the relay operating times are delayed. For SV applications, operating times are delayed by the configured channel delay, CH\_DLY. See *SV Network Delays on page 17.25 in the SEL-400 Series Relays Instruction Manual* for more details. For TiDL applications, the operating times are delayed by a fixed 1 ms. Use caution when setting relay coordination to account for this added delay.

**Note:** The metering and protection element accuracies specified for the SEL-487B SV Subscriber Relay are valid only when using SEL merging units. For SV applications, third-party SV publisher devices are supported, but hardware accuracies and analog filtering need to be considered to determine the effect on SEL-487B-2 SV Subscriber performance.

## Compliance

Designed and manufactured under an ISO 9001 certified quality management system

### FCC Compliance Statement

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference in which case the user will be required to correct the interference at his own expense.

UL Listed to U.S. and Canadian safety standards  
(File E212775; NRGU, NRGU7)

CE Mark

RCM Mark

## General

### Frequency and Rotation

System Frequency: 50/60 Hz  
Phase Rotation: ABC

### Power Supply

#### 24–48 Vdc

Rated Voltage: 24–48 Vdc  
Operational Voltage Range: 18–60 Vdc  
Vdc Input Ripple: 15% per IEC 60255-26:2013  
Interruption: 20 ms at 24 Vdc, 100 ms at 48 Vdc  
per IEC 60255-26:2013

#### Burden

SV Relay: <35 W  
TiDL Relay: <40 W

#### 48–125 Vdc or 110–120 Vac

Rated Voltage: 48–125 Vdc, 110–120 Vac  
Operational Voltage Range: 38–140 Vdc  
Rated Frequency: 50/60 Hz  
Operational Frequency Range: 30–120 Hz  
Vdc Input Ripple: 15% per IEC 60255-26:2013  
Interruption: 14 ms @ 48 Vdc, 160 ms @ 125 Vdc  
per IEC 60255-26:2013

#### Burden

SV Relay: <35 W, <90 VA  
TiDL Relay: <40 W, <90 VA

125–250 Vdc or 110–240 Vac

Rated Voltage:	125–250 Vdc, 110–240 Vac
Operational Voltage Range:	85–300 Vdc 85–264 Vac
Rated Frequency:	50/60 Hz
Operational Frequency Range:	30–120 Hz
Vdc Input Ripple:	15% per IEC 60255-26:2013
Interruption:	46 ms @ 125 Vdc, 250 ms @ 250 Vdc per IEC 60255-26:2013
<b>Burden</b>	
SV Relay:	<35 W, <90 VA
TiDL Relay:	<40 W, <90 VA

### Control Outputs

**Note:** IEEE C37.90-2005 and IEC 60255-27:2013

Update Rate:	1/8 cycle
Make (Short Duration Contact Current):	30 Adc 1,000 operations at 250 Vdc 2,000 operations at 125 Vdc
Limiting Making Capacity:	1000 W at 250 Vdc (L/R = 40 ms)
Mechanical Endurance:	10,000 operations

### Standard

Rated Voltage:	24–250 Vdc 110–240 Vrms
Operational Voltage Range:	0–300 Vdc 0–264 Vrms
Operating Time:	Pickup ≤6 ms (resistive load) Dropout ≤6 ms (resistive load)
Short-Time Thermal Withstand:	50 A for 1 s
Continuous Contact Current:	6 A at 70°C 4 A at 85°C
Contact Protection:	MOV protection across open contacts 264 Vrms continuous voltage 300 Vdc continuous voltage
Limiting Breaking Capacity/Electrical Endurance:	10,000 operations 10 operations in 4 seconds, followed by 2 minutes idle

Rated Voltage	Resistive Break	Inductive Break L/R = 40 ms (DC) PF = 0.4 (AC)
24 Vdc	0.75 Adc	0.75 Adc
48 Vdc	0.63 Adc	0.63 Adc
125 Vdc	0.30 Adc	0.30 Adc
250 Vdc	0.20 Adc	0.20 Adc
110 Vrms	0.30 Arms	0.30 Arms
240 Vrms	0.20 Arms	0.20 Arms

### Fast Hybrid (High-Speed High-Current Interrupting)

Rated Voltage:	48–250 Vdc
Operational Voltage Range:	0–300 Vdc
Operating Time:	Pickup ≤10 µs (resistive load) Dropout ≤8 ms (resistive load)
Short-Time Thermal Withstand:	50 Adc for 1 s

## 1.20 | Introduction and Specifications

### Specifications

Continuous Contact Current:	6 Adc at 70°C 4 Adc at 85°C
Contact Protection:	MOV protection across open contacts 300 Vdc continuous voltage
Limiting Breaking Capacity/Electrical Endurance:	10,000 operations 4 operations in 1 second, followed by 2 minutes idle

Rated Voltage	Resistive Break	Inductive Break
24 Vdc	10 Adc	10 Adc (L/R = 40 ms)
48 Vdc	10 Adc	10 Adc (L/R = 40 ms)
125 Vdc	10 Adc	10 Adc (L/R = 40 ms)
250 Vdc	10 Adc	10 Adc (L/R = 20 ms)

**Note:** Do not use hybrid control outputs to switch ac control signals.

#### Control Inputs

##### Optoisolated (For Use With AC or DC Signals)

INT2 Interface Board:	8 inputs with no shared terminals
INT4 Interface Board:	6 inputs with no shared terminals 18 inputs with shared terminals (2 groups of 9 inputs with each group sharing one terminal)
Voltage Options:	24, 48, 110, 125, 220, 250 V
Current Draw:	<5 mA at nominal voltage <8 mA for 110 V option
Sampling Rate:	2 kHz

##### DC Thresholds (Dropout thresholds indicate level-sensitive option)

24 Vdc:	Pickup 19.2–30.0 Vdc; Dropout <14.4 Vdc
48 Vdc:	Pickup 38.4–60.0 Vdc; Dropout <28.8 Vdc
110 Vdc:	Pickup 88.0–132.0 Vdc; Dropout <66.0 Vdc
125 Vdc:	Pickup 105–150 Vdc; Dropout <75 Vdc
220 Vdc:	Pickup 176–264 Vdc; Dropout <132 Vdc
250 Vdc:	Pickup 200–300 Vdc; Dropout <150 Vdc

##### AC Thresholds (Ratings met only when recommended control input settings are used)

24 Vac:	Pickup 16.4–30.0 Vac rms; Dropout <10.1 Vac rms
48 Vac:	Pickup 32.8–60.0 Vac rms; Dropout <20.3 Vac rms
110 Vac:	Pickup 75.1–132.0 Vac rms; Dropout <46.6 Vac rms
125 Vac:	Pickup 89.6–150.0 Vac rms; Dropout <53.0 Vac rms
220 Vac:	Pickup 150.3–264.0 Vac rms; Dropout <93.2 Vac rms
250 Vac:	Pickup 170.6–264.0 Vac rms; Dropout <106 Vac rms

Current Drawn:	<5 mA at nominal voltage <8 mA for 110 V option
Sampling Rate:	2 kHz

#### Communications Ports

EIA-232:	1 Front and 3 Rear
Serial Data Speed:	300–57600 bps

#### Ethernet Card Slot for Four-Port Ethernet Card

Ordering Option:	10/100BASE-T
Connector Type:	RJ45
Ordering Option:	100BASE-FX fiber-optic Ethernet
Mode:	Multi
Wavelength (nm):	1300
Source:	LED
Connector Type:	LC
Min. TX Pwr. (dBm):	-19
Max. TX Pwr. (dBm):	-14
RX Sens. (dBm):	-32
Sys. Gain (dB):	13

#### Ethernet Card Slot for the Five-Port Ethernet Card

Ordering Option:	100BASE-FX fiber-optic Ethernet SFP transceiver
Part Number:	8103-01 or 8109-01
Mode:	Multi
Wavelength (nm):	1310
Source:	LED
Connector Type:	LC
Min. TX Pwr. (dBm):	-24
Max. TX Pwr. (dBm):	-14
Min. RX Sens. (dBm):	-31
Max. RX Sens. (dBm):	-12
Approximate Range:	2 km
Transceiver Internal Temperature Accuracy:	±3.0°C
Transmitter Average Optical Power Accuracy:	±3.0 dB
Received Average Optical Input Power Accuracy:	±3.0 dB
Ordering Option:	1000BASE-LX fiber-optic Ethernet SFP transceiver
Part Number:	8130-01, 8130-02, 8130-03, or 8130-04
Mode:	Single
Wavelength (nm):	1310
Source:	LED
Connector Type:	LC

	Part Number			
	8130-01	8130-02	8130-03	8130-04
Min. TX Pwr. (dBm)	-9.5	-6	-5	-2
Max. TX Pwr. (dBm)	-3	-1	0	3
Min. RX Sens. (dBm)	-21	-22	-24	-24
Max. RX Sens. (dBm)	-3	-3	-3	-3
Approximate Range (km)	10	20	30	40

Transceiver Internal Temperature Accuracy:	$\pm 3.0^{\circ}\text{C}$	Approximate Range:	300 m for 62.5/125 $\mu\text{m}$ ; 550 m for 50/125 $\mu\text{m}$
Transmitter Average Optical Power Accuracy:	$\pm 3.0 \text{ dB}$	Transceiver Internal Temperature Accuracy:	$\pm 3.0^{\circ}\text{C}$
Received Average Optical Input Power Accuracy:	$\pm 3.0 \text{ dB}$	Transmitter Average Optical Power Accuracy:	$\pm 3.0 \text{ dB}$
Ordering Option:	1000BASE-XD fiber-optic Ethernet SFP transceiver	Received Average Optical Input Power Accuracy:	$\pm 3.0 \text{ dB}$
Part Number:	8130-05	<b>Optional TiDL Communication Ports</b>	
Mode:	Single	Number of Ports:	8
Wavelength (nm):	1550	Protocol:	T-Protocol
Source:	LED	Supported SFP Transceivers:	8103-01 or 8109-01
Connector Type:	LC	<b>Note:</b> For SFP Transceiver specification, see <i>Ethernet Card Slot for the Five-Port Ethernet Card</i> on page 1.20.	
Min. TX Pwr. (dBm):	-5	<b>Time Inputs</b>	
Max. TX Pwr. (dBm):	0	<b>IRIG Time Input—Serial PORT 1</b>	
Min. RX Sens. (dBm):	-24	Input:	Demodulated IRIG-B
Max. RX Sens. (dBm):	-3	Rated I/O Voltage:	5 Vdc
Approximate Range:	50 km	Operational Voltage Range:	0–8 Vdc
Transceiver Internal Temperature Accuracy:	$\pm 3.0^{\circ}\text{C}$	Logic High Threshold:	$\geq 2.8 \text{ Vdc}$
Transmitter Average Optical Power Accuracy:	$\pm 3.0 \text{ dB}$	Logic Low Threshold:	$\leq 0.8 \text{ Vdc}$
Received Average Optical Input Power Accuracy:	$\pm 3.0 \text{ dB}$	Input Impedance:	2.5 k $\Omega$
Ordering Option:	1000BASE-ZX fiber-optic Ethernet SFP transceiver	<b>IRIG-B Input—BNC Connector</b>	
Part Number:	8130-06, 8130-08, or 8130-10	Input:	Demodulated IRIG-B
Mode:	Single	Rated I/O Voltage:	5 Vdc
Wavelength (nm):	1550	Operational Voltage Range:	0–8 Vdc
Source:	LED	Logic High Threshold:	$\geq 2.2 \text{ Vdc}$
Connector Type:	LC	Logic Low Threshold:	$\leq 0.8 \text{ Vdc}$

	Part Number		
	8130-06	8130-08	8130-10
Min. TX Pwr. (dBm)	0	1	5
Max. TX Pwr. (dBm)	5	5	8
Min. RX Sens. (dBm)	-24	-36	-36
Max. RX Sens. (dBm)	-3	-10	-10
Approximate Range (km)	80	160	200

Transceiver Internal Temperature Accuracy:	$\pm 3.0^{\circ}\text{C}$	Operating Temperature	-40° to +85°C (-40° to +185°F)
Transmitter Average Optical Power Accuracy:	$\pm 3.0 \text{ dB}$	<b>Note:</b> LCD contrast impaired for temperatures below -20° and above +70°C.	
Received Average Optical Input Power Accuracy:	$\pm 3.0 \text{ dB}$	<b>Humidity</b>	5% to 95% without condensation
Ordering Option:	1000BASE-SX fiber-optic Ethernet SFP transceiver	<b>Weight (Maximum)</b>	
Part Number:	8131-01	TiDL Relay:	6.74 kg (14.87 lb)
Mode:	Multi	SV Relay:	6.57 kg (14.47 lb)
Wavelength (nm):	850	<b>Terminal Connections</b>	
Source:	LED	Rear Screw-Terminal Tightening Torque, #8 Ring Lug	
Connector Type:	LC	Minimum:	1.0 Nm (9 in-lb)
Min. TX Pwr. (dBm):	-9	Maximum:	2.0 Nm (18 in-lb)
Max. TX Pwr. (dBm):	-2.5	User terminals and stranded copper wire should have a minimum temperature rating of 105°C. Ring terminals are recommended.	
Min. RX Sens. (dBm):	-18		
Max. RX Sens. (dBm):	0		

### Wire Sizes and Insulation

Wire sizes for grounding (earthing) and contact connections are dictated by the terminal blocks and expected load currents. You can use the following table as a guide in selecting wire sizes:

Connection Type	Min. Wire Size	Max. Wire Size
Grounding (Earthing) Connection	14 AWG (2.5 mm <sup>2</sup> )	N/A
Contact I/O	18 AWG (0.8 mm <sup>2</sup> )	10 AWG (5.3 mm <sup>2</sup> )
Other Connection	18 AWG (0.8 mm <sup>2</sup> )	10 AWG (5.3 mm <sup>2</sup> )

### Type Tests

#### Installation Requirements

Overvoltage Category: 2

Pollution Degree: 2

#### Safety

Product Standards: IEC 60255-27:2013  
IEEE C37.90-2005  
21 CFR 1040.10

Dielectric Strength: IEC 60255-27:2013, Section 10.6.4.3  
2.5 kVAC, 50/60 Hz for 1 min: Analog Inputs, Contact Outputs, Digital Inputs  
3.6 kVDC for 1 min: Power Supply, Battery Monitors  
2.5 kVDC for 1 min: IRIG-B  
1.1 kVDC for 1 min: Ethernet

Impulse Withstand: IEC 60255-27:2013, Section 10.6.4.2  
IEEE C37.90-2005  
Common Mode:  
±1.0 kV: Ethernet  
±2.5 kV: IRIG-B  
±5.0 kV: All other ports  
Differential Mode:  
0 kV: Analog Inputs, Ethernet, IRIG-B, Digital Inputs  
±5.0 kV: Standard Contact Outputs, Power Supply Battery Monitors  
+5.0 kV: Hybrid Contact Outputs

Insulation Resistance: IEC 60255-27:2013, Section 10.6.4.4  
>100 MΩ @ 500 VDC

Protective Bonding: IEC 60255-27:2013, Section 10.6.4.5.2  
<0.1 Ω @ 12 VDC, 30 A for 1 min

Ingress Protection: IEC 60529:2001 + CRGD:2003  
IEC 60255-27:2013  
IP30 for front and rear panel  
IP10 for rear terminals with installation of ring lug  
IP40 for front panel with installation of serial port cover

Max Temperature of Parts and Materials: IEC 60255-27:2013, Section 7.3

Flammability of Insulating Materials: IEC 60255-27:2013, Section 7.6 Compliant

#### Electromagnetic (EMC) Immunity

Product Standards: IEC 60255-26:2013  
IEC 60255-27:2013  
IEEE C37.90-2005

Surge Withstand Capability (SWC): IEC 61000-4-18:2006 + A:2010  
IEEE C37.90.1-2012  
Slow Damped Oscillatory, Common and Differential Mode:  
±1.0 kV  
±2.5 kV  
Fast Transient, Common and Differential Mode:  
±4.0 kV

Electrostatic Discharge (ESD): IEC 61000-4-2:2008  
IEEE C37.90.3-2001  
Contact:  
±8 kV  
Air Discharge:  
±15 kV

Radiated RF Immunity: IEEE C37.90.2-2004  
IEC 61000-4-3:2006 + A1:2007 + A2:2010  
20 V/m (>35 V/m, 80% AM, 1 kHz)  
Sweep: 80 MHz to 1 GHz  
Spot: 80, 160, 450, 900 MHz  
10 V/m (>15 V/m, 80% AM, 1 kHz)  
Sweep: 80 MHz to 1 GHz  
Sweep: 1.4 GHz to 2.7 GHz  
Spot: 80, 160, 380, 450, 900, 1850, 2150 MHz

Electrical Fast Transient Burst (EFTB): IEC 61000-4-4:2012  
Zone A:  
±2 kV: Communication ports  
±4 kV: All other ports

Surge Immunity: IEC 61000-4-5:2005  
Zone A:  
±2 kV<sub>L-L</sub>  
±4 kV<sub>L-E</sub>  
±4 kV: Communication Ports  
**Note:** Cables connected to IRIG-B ports shall be less than 10 m in length for Zone A compliance.

Zone B:  
±2 kV: Communication Ports

Conducted Immunity: IEC 61000-4-6:2013  
20 V/m; (>35 V/m, 80% AM, 1 kHz)  
Sweep: 150 kHz–80 MHz  
Spot: 27, 68 MHz

Power Frequency Immunity (DC Inputs): IEC 61000-4-16:2015  
Zone A:  
Differential: 150 V<sub>RMS</sub>  
Common Mode: 300 V<sub>RMS</sub>

Power Frequency Magnetic Field: IEC 61000-4-8:2009  
Level 5:  
100 A/m; ≥60 Seconds; 50/60 Hz  
1000 A/m 1 to 3 Seconds; 50/60 Hz  
**Note:** 50G1P ≥0.05 (ESS = N, 1, 2)  
50G1P ≥0.1 (ESS = 3, 4)

Power Supply Immunity: IEC 61000-4-11:2004  
IEC 61000-4-17:1999/A1:2001/A2:2008  
IEC 61000-4-29:2000  
AC Dips & Interruptions  
Ripple on DC Power Input  
DC Dips & Interruptions  
Gradual Shutdown/Startup (DC only)  
Discharge of Capacitors  
Slow Ramp Down/Up  
Reverse Polarity (DC only)

Damped Oscillatory Magnetic Field: IEC 61000-4-10:2016  
Level 5:  
100 A/m

#### EMC Compatibility

Product Standards: IEC 60255-26:2013  
Emissions: IEC 60255-26:2013, Section 7.1  
Class A  
47 CFR Part 15B  
Class A  
Canada ICES-001 (A) / NMB-001 (A)

#### Environmental

Product Standards: IEC 60255-27:2013  
Cold, Operational:  
Test Ad: 16 hours at -40°C

Cold, Storage:	IEC 60068-2-1:2007 Test Ad: 16 hours at $-40^{\circ}\text{C}$
Dry Heat, Operational:	IEC 60068-2-2:2007 Test Bd: 16 hours at $+85^{\circ}\text{C}$
Dry Heat, Storage:	IEC 60068-2-2:2007 Test Bd: 16 hours at $+85^{\circ}\text{C}$
Damp Heat, Cyclic:	IEC 60068-2-30:2005 Test Db: $+25^{\circ}\text{C}$ to $+55^{\circ}\text{C}$ , 6 cycles (12 + 12-hour cycle), 95% RH
Damp Heat, Steady State:	IEC 60068-2-78:2013 Severity: 93% RH, $+40^{\circ}\text{C}$ , 10 days
Vibration Resistance:	EC 60255-21-1:1988 Class 2 Endurance, Class 2 Response
Shock Resistance:	IEC 60255-21-2:1988 Class 1 Shock Withstand, Class 1 Bump Withstand, Class 2 Shock Response
Seismic:	IEC 60255-21-3:1993 Class 2 Quake Response

## Reporting Functions

### High-Resolution Data

Rate:	8000 samples/second
	4000 samples/second
	2000 samples/second
	1000 samples/second

Output Format:	Binary COMTRADE
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**Note:** Per IEEE C37.111-1999 and IEEE C37.111-2013, *Common Format for Transient Data Exchange (COMTRADE) for Power Systems*.

### Event Reports

Length:	0.25–24 seconds (depending on LER setting)
Volatile Memory:	3 seconds of back-to-back event reports sampled at 8 kHz
Nonvolatile Memory:	At least 4 event reports of a 3-second duration sampled at 8 kHz
Resolution:	4 and 12 samples/cycle

### Event Summary

Storage:	100 summaries
----------	---------------

### Sequential Events Recorder

Storage:	1000 entries
Trigger Elements:	250 relay elements
Resolution:	0.5 ms for contact inputs
Resolution:	1/12 cycle for all elements

## Processing Specifications

### AC Voltage and Current Inputs

8000 samples per second  
Full-cycle cosine filtering

### Protection and Control Processing

12 times per power system cycle

### Control Points

96 remote bits  
64 local control bits  
32 latch bits in protection logic  
32 latch bits in automation logic

## Relay Element Pickup Ranges and Accuracies

### Differential Elements

Number of Zones:	6
Number of Check Zones:	3

### Number of Terminals

Three-Relay Application:	21
Single-Relay Application:	7
Pickup Range:	0.10–4.00 pu
Pickup Accuracy:	1 A nominal: $\pm 5\% \pm 0.02$ A 5 A nominal: $\pm 5\% \pm 0.10$ A

### Slope 1

Setting Range:	15%–90%
Setting Range:	50%–90%

### Supervising Differential Element

Quantity:	9 total, 1 per zone (6 standard zones, 3 check zones)
Setting Range:	0.05–3.00 pu
Accuracy:	$\pm 5\% \pm 0.02 \cdot I_{NOM}$

### Incremental Restraint and Operating Threshold Current Supervision

Setting Range:	0.1–10.0 pu
Accuracy:	$\pm 5\% \pm 0.02 \cdot I_{NOM}$

### Sensitive Differential Current Alarm

Quantity:	9 total, 1 per zone (6 standard zones, 3 check zones)
Setting Range:	0.05–1.00 pu
Accuracy:	$\pm 5\% \pm 0.02 \cdot I_{NOM}$
Timer Setting Range:	50–6000 cycles

### Instantaneous/Definite-Time Overcurrent Elements

Phase Current Setting Range	
5 A Model:	OFF, 0.25–100.00 A secondary, 0.01 A steps
1 A Model:	OFF, 0.05–20.00 A secondary, 0.01 A steps
Accuracy (Steady State)	
5 A Model:	$\pm 0.05$ A, $\pm 3\%$ of setting
1 A Model:	$\pm 0.01$ A, $\pm 3\%$ of setting
Transient Overreach:	<5% of setting
Timer Setting Range:	0.00–99999.00 cycles, 1/6-cycle steps
Timer Accuracy:	$\pm 0.1\%$ of settings $\pm 1/6$ cycle
Maximum Operating Time:	1.5 cycles

### Time-Overcurrent Elements

Pickup Range	
5 A Model:	0.25–16.00 A secondary, 0.01 A steps
1 A Model:	0.05–3.20 A secondary, 0.01 A steps
Accuracy (Steady State)	
5 A Model:	$\pm 0.05$ A, $\pm 3\%$ of setting
1 A Model:	$\pm 0.01$ A, $\pm 3\%$ of setting
Time Dial Range	
US:	0.50–15.00, 0.01 steps
IEC:	0.05–1.00, 0.01 steps
Curve Timing Accuracy:	$\pm 1.50$ cycles, $\pm 4\%$ of curve time (for current between 2 and 30 multiples of pickup)
Reset:	1 power cycle or Electromechanical Reset Emulation time

### Under- and Overvoltage Elements (27, 59)

Processing Rate:	1/6 cycle
Phase Under- and Overvoltage (2 Level/Phase)	
Setting Range:	2.00–300 V <sub>L-N</sub> in 0.01 steps
Accuracy:	±3% of setting, ±0.5 V
Transient Overreach:	<5% of pickup
Maximum Delay:	1.5 cycles
Zero- and Negative-Sequence Overvoltage Elements	
Setting Range:	2.00–300 V <sub>L-N</sub> in 0.01 steps
Accuracy:	±5% of setting, ±1 V
Transient Overreach:	<5% of setting
Maximum Delay:	1.5 cycles

### Breaker Failure Instantaneous Overcurrent

Setting Range	
5 A Model:	0.50–50 A, 0.01 A steps
1 A Model:	0.10–10.0 A, 0.01 A steps
Accuracy	
5 A Model:	±0.05 A, ±3% of setting
1 A Model:	±0.01 A, ±3% of setting
Transient Overreach:	<5% of setting
Maximum Pickup Time:	1.5 cycles
Maximum Reset Time:	<1 cycle
Timers Setting Range:	0–6000 cycles, 1/12-cycle steps (BFPU <sub>nn</sub> , RTPU <sub>nn</sub> ) 0–1000 cycles, 1/12-cycle steps (BFISP <sub>nn</sub> , BFIDOn <sub>n</sub> )
Time Delay Accuracy:	1/12 cycle, ±0.1% of setting

### Disconnect Monitor

Number:	60
Timer Setting Range:	0–99999 cycles, 1 cycle step

### Breaker Status Monitor

Number:	21
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### Coupler Security Logic

Number:	4
Timer Setting Range:	0–1000 cycles, 1/12 cycle step

### Control Input Timers

Setting Range	
Pickup:	0.00–30 ms
Dropout:	0.00–30 ms

### Station DC Battery System Monitor Specifications

Rated Voltage:	24–250 Vdc
Operational Voltage Range:	0–300 Vdc
Sampling Rate:	2 kHz
Processing Rate:	1/8 cycle
Operating Time:	Less than 1.5 cycles (all elements except ac ripple) Less than 1.5 seconds (ac ripple element)
Setting Range	
15–300 Vdc, 1 Vdc steps (all elements except ac ripple)	
1–300 Vac, 1 Vac steps (ac ripple element)	
Accuracy	
Pickup Accuracy:	±3% ± 2 Vdc (all elements except ac ripple) ±10% ± 2 Vac (ac ripple element)

### Metering Accuracy

All metering accuracies are based on an ambient temperature of 20°C and nominal frequency.

#### Currents

##### Phase Current Magnitude

5 A Model:	±0.2% plus ± 4 mA (2.5–15 A sec)
1 A Model:	±0.2% plus ± 0.8 mA (0.5–3.0 A sec)

##### Phase Current Angle

All Models:	±0.2° in the current range (0.5–3.0) • I <sub>NOM</sub>
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##### Differential Currents per Zone (Steady State)

IOP, IRT:	±5.0% ± 0.02 • I <sub>NOM</sub>
IOPCZ, IRTCA:	±5.0% ± 0.02 • I <sub>NOM</sub>

#### Voltages

##### Phase Voltage Magnitude

300 V Maximum Inputs:	±2.5% ± 1 V (5–33.5 V) ±0.1% (33.5–300 V)
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##### Phase Angle

300 V Maximum Inputs:	±1.0° (5–33.5 V) ±0.5° (33.5–300 V)
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## S E C T I O N   2

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# Installation

The first steps in applying the SEL-487B-2 Relay are installing and connecting the relay. This section describes common installation features and particular installation requirements for the physical configurations of the SEL-487B. You can order the relay in horizontal and vertical orientations, and in panel-mount and rack-mount versions. SEL also provides various expansion I/O interface boards to tailor the relay to your specific needs.

To install and connect the relay safely and effectively, you must be familiar with relay configuration features and options and relay jumper configuration. You should carefully plan relay placement, cable connection, and relay communications.

Consider the following when installing the SEL-487B:

- *Shared Configuration Attributes on page 2.1*
- *Plug-In Boards on page 2.8*
- *Jumpers on page 2.10*
- *Relay Placement on page 2.14*
- *Connection on page 2.15*
- *Merging Unit AC/DC Connections on page 2.27*

It is also very important to limit access to the SEL-487B settings and control functions by using passwords. For information on relay access levels and passwords, see *Access Levels and Passwords on page 3.7 in the SEL-400 Series Relays Instruction Manual*.

For more introductory information on using the SEL-487B, see *Section 2: PC Software* and *Section 3: Basic Relay Operations in the SEL-400 Series Relays Instruction Manual*.

## Shared Configuration Attributes

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There are common or shared attributes among the many possible configurations of SEL-487B-2 Relays. This section discusses the main shared features of the relay.

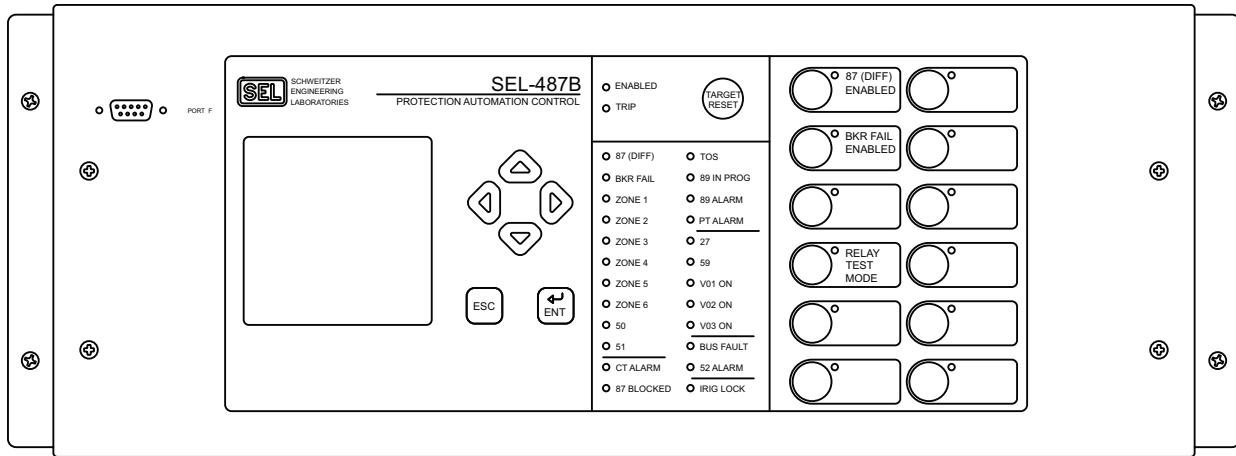
## Relay Sizes

SEL produces the SEL-487B in horizontal and vertical rack-mount versions and horizontal and vertical panel-mount versions. Relay sizes correspond to height in rack units, U, where U is approximately 1.75 inches or 44.45 mm. The SEL-487B-2 is only available in a 4U chassis and as either a Sampled Values (SV) subscriber relay or an SEL Time-Domain Link (TiDL) relay.

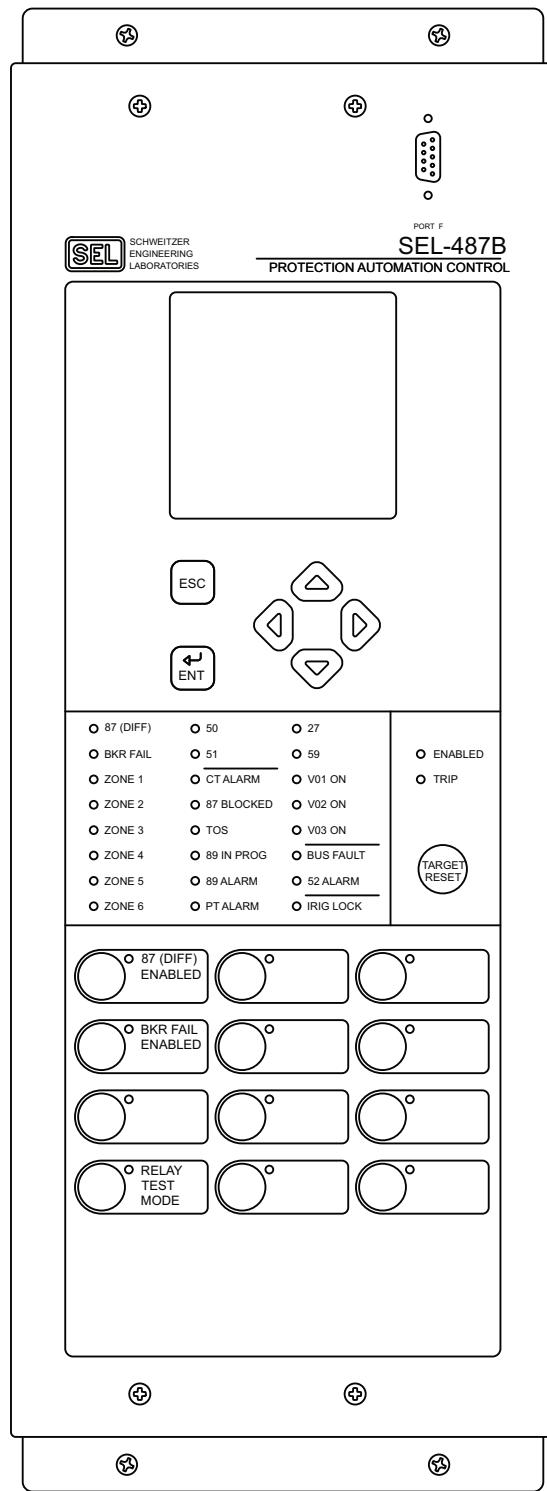
## Front-Panel Templates

The horizontal front-panel template for the SEL-487B-2 is shown in *Figure 2.1*. The vertical front-panel template is shown in *Figure 2.2*.

The SEL-487B front panel has three pockets for slide-in labels: one pocket for the target LED label, and two pockets for the operator control labels. *Figure 2.1* shows the front-panel pocket areas and openings for typical horizontal and vertical relay orientations; dashed lines denote the pocket areas. Refer to the instructions included in the Configurable Label kit for information on reconfiguring front-panel LED and pushbutton labels.



**Figure 2.1** Horizontal Front-Panel Template

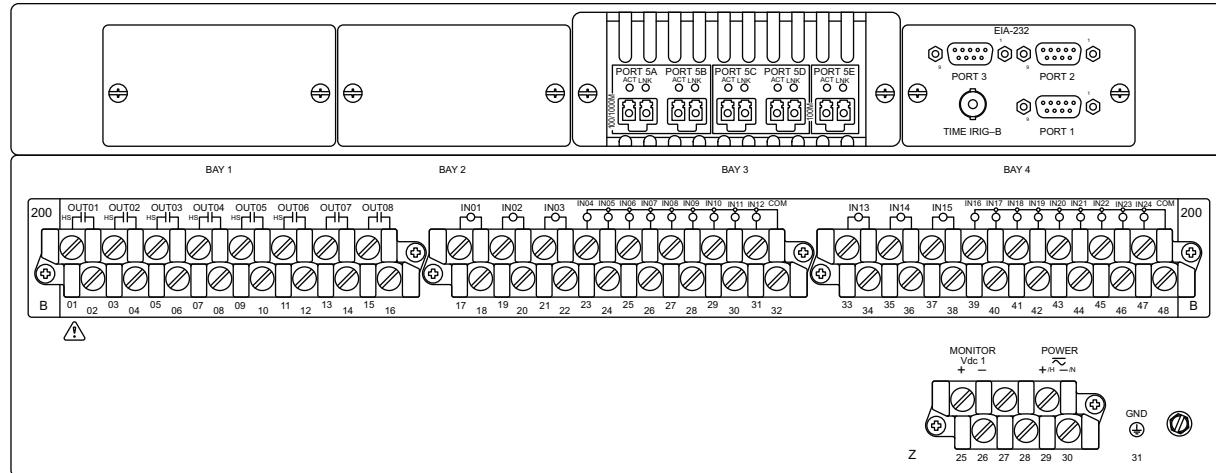


i7290a

**Figure 2.2 Vertical Front-Panel Template**

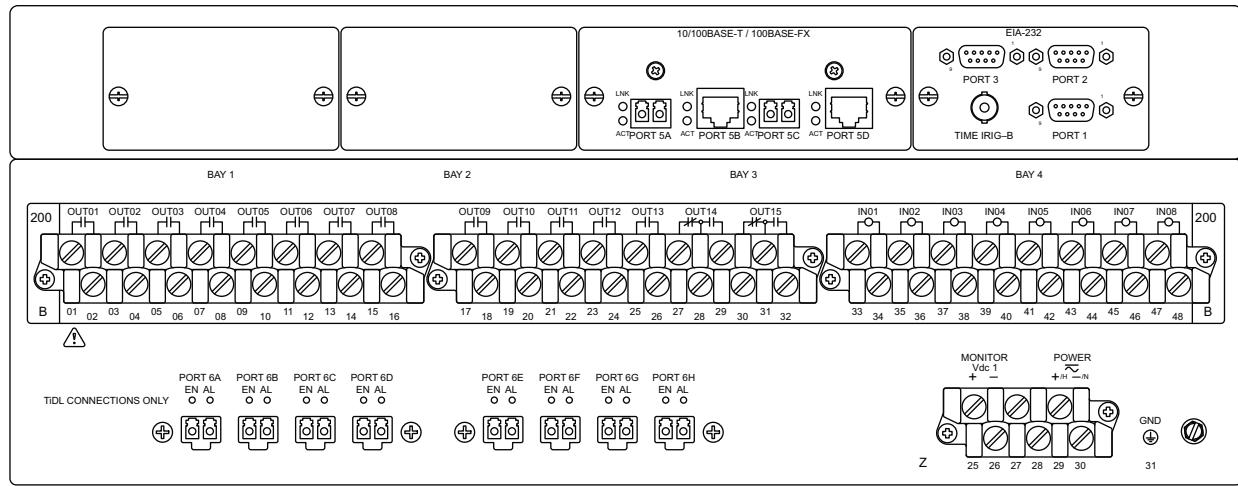
## Rear Panels

Rear panels are identical for the horizontal and the vertical configurations of the relay. See *Figure 2.3* for a rear-panel representation of the SEL-487B-2 SV Subscriber Relay and *Figure 2.4* for a rear-panel representation of the SEL-487B-2 TiDL Relay.



Five-port Ethernet card ordering option depicted.

**Figure 2.3 SEL-487B-2 SV Subscriber Relay Rear Panel**



Four-port Ethernet card ordering option depicted.

**Figure 2.4 SEL-487B-2 TiDL Relay Rear Panel**

## Secondary Circuits SV Subscriber Relays and TiDL Relays

The SEL-487B-2 Relays that subscribe to data (through SV or TiDL communications) do not contain secondary circuits on the relay. The relay uses a merging unit to supply the voltages and currents through a networked connection (for the SV subscriber relay) or a direct point-to-point connection (for the TiDL relay). Both the SV subscriber relay version and the TiDL relay version must be configured to match the nominal secondary current of the mapped current inputs of the connected merging units. The SV subscriber relay and TiDL relay both, by

default, assume 5 A as the nominal current selection. For 1 A scaling, use the **CFG CTNOM** command (see *Table 14.28* in the *SEL-400 Series Relays Instruction Manual* for more information).

## Control Inputs

### Optoisolated

The SEL-487B inputs on the optional I/O interface boards (INT2 or INT4 I/O boards—see *Models and Options on page 1.4*), are fixed pickup threshold, optoisolated, control inputs. The pickup voltage level is determined for each board at ordering time.

Inputs can be independent or common. Independent inputs have two separate ground-isolated connections, with no internal connections among inputs. Common inputs share one input leg in common; all input legs of common inputs are ground-isolated. Each group of common inputs is isolated from all other groups.

Nominal current drawn by these inputs is 8 mA or less with six voltage options covering a wide range of voltages, as listed in *Control Inputs on page 1.20*. You can debounce the control input pickup delay and dropout delay separately for each input, or you can use a single debounce setting that applies to all the contact input pickup and dropout times (see *Global Settings on page 8.3*).

### AC Control Signals

Optoisolated control inputs can be used with ac control signals, within the ratings shown in *Control Inputs on page 1.20*. Specific pickup and dropout time-delay settings are required to achieve the specified ac thresholds, as shown in *Table 2.1*.

It is possible to mix ac and dc control signal detection on the same interface board with optoisolated contact inputs, provided that the two signal types are not present on the same set of combined inputs. Use standard debounce time settings (usually the same value in both the pickup and dropout settings) for the inputs being used with dc control voltages.

**Table 2.1 Required Settings for Use With AC Control Signals**

Global Settings <sup>a</sup>	Prompt	Entry <sup>b</sup>	Relay Recognition Time for AC Control Signal state change
IN2mmPU <sup>c</sup>	Pickup Delay	2 ms	0.625 cycles maximum (assertion)
IN2mmDO <sup>c</sup>	Dropout Delay	16 ms	1.1875 cycles maximum (deassertion)

<sup>a</sup> First set Global setting EICIS := Y to gain access to the individual input pickup and dropout timer settings.

<sup>b</sup> These are the only setting values that SEL recommends for detecting ac control signals. Other values may result in inconsistent operation.

<sup>c</sup> Where mm = number of available contact inputs depending on the type of board.

The recognition times listed in *Table 2.1* are only valid when:

- The ac signal applied is at the same frequency as the power system.
- The signal is within the ac threshold pickup ranges defined in *Optoisolated (For Use With AC or DC Signals) on page 1.20*.
- The signal contains no dc offset.

The SEL-487B samples the optoisolated inputs at 2 kHz (see *Data Processing on page 9.1* in the *SEL-400 Series Relays Instruction Manual*).

## Control Outputs

I/O control outputs from the relay include standard outputs and high-speed, high-current interrupting outputs. High-speed, high-current interrupting outputs are available only on the optional INT4 I/O interface board. A metal oxide varistor (MOV) protects against excess voltage transients for each contact. Each output is individually isolated, except Form C outputs, which share a common connection between the NC (normally closed) and NO (normally open) contacts.

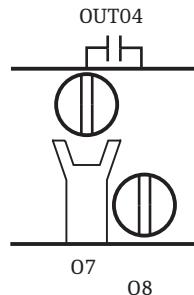
The relay updates control outputs 12 times per cycle. Updating of relay control outputs does not occur when the relay is disabled. When the relay is reenabled, the control outputs assume the state that reflects the present protection processing.

For the SEL-487B-2 TiDL Relay, the control outputs of the connected SEL-TMU map to local I/O of the relay (in the 300, 400, and 500 level of I/O) based on your configured TiDL topology in SEL Grid Configurator. Because any control output on the SEL-TMU can be shared across the connected SEL TiDL relays, the SEL-TMU provides the state (asserted/deasserted) of each output to all connected SEL TiDL relays. The SEL TiDL relays then map the SEL-TMU output states to local output states based on the configured TiDL topology.

### Standard Control Outputs

**NOTE:** You can use ac or dc circuits with standard control outputs.

The standard control outputs are “dry” Form A contacts rated for tripping duty. Ratings for standard outputs are 30 A make, 6 A continuous, and 0.75 A or less break (depending on circuit voltage). Standard contact outputs have a maximum voltage rating of 250 Vac/330 Vdc. Maximum break time is 6 ms (milliseconds) with a resistive load. The maximum pickup time for the standard control outputs is 6 ms (see *Figure 2.5*).



**Figure 2.5 Standard Control Output Connection**

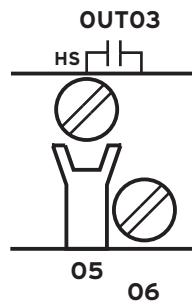
See *Control Outputs* on page 1.19 for complete standard control output specifications.

### High-Speed, High-Current Interrupting Control Outputs

**NOTE:** You can use only dc circuits with high-speed, high-current interrupting outputs.

In addition to the standard control outputs, the INT4 I/O interface board offers high-speed, high-current interrupting control outputs. These control outputs have a resistive load pickup time of 10 µs, which is much faster than the 6 ms pickup time of the standard and hybrid control outputs. The high-speed, high-current interrupting control outputs drop out at a maximum time of 8 ms. The maximum voltage rating is 330 Vdc. See *Control Outputs* on page 2.6 for complete high-speed, high-current interrupting control output specifications.

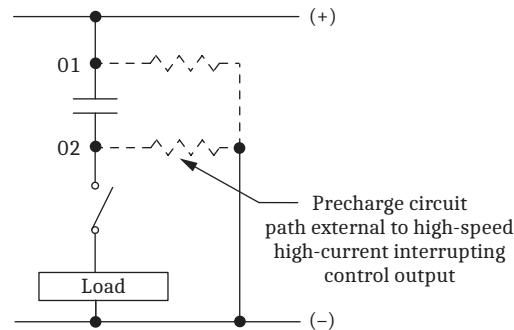
*Figure 2.6* shows a representative connection for a Form A high-speed, high-current interrupting control output on the INT4 I/O interface terminals. The HS marks are included to indicate that this is a high-speed control output.



**Figure 2.6 High-Speed, High-Current Interrupting Control Output Connection, INT4**

Short transient inrush current can flow at the closing of an external switch in series with open high-speed, high-current interrupting contacts. This transient will not energize the circuits in typical relay-coil control applications (trip coils and close coils), and standard auxiliary relays will not pick up. However, an extremely sensitive digital input or light-duty, high-speed auxiliary relay can pick up for this condition. This false pickup transient occurs when the capacitance of the high-speed, high-current interrupting output circuitry charges (creating a momentary short circuit that a fast, sensitive device sees as a contact closure).

Figure 2.7 shows some possible connections for external resistors that will eliminate the false pickup transients when closing an external switch. In general, you must connect external resistors to the dc rail (positive or negative) that is on the same side as the open external switch condition. If an open switch exists on either side of the output contact, then you can accommodate only one condition because two open switches (one on each side of the contact) defeat the precharge circuit.



**Figure 2.7 Precharging Internal Capacitance of High-Speed, High-Current Interrupting Output Contacts, INT4**

## IRIG-B Inputs

The SEL-487B has a regular IRIG-B timekeeping mode, and a high-accuracy IRIG-B (HIRIG) timekeeping mode. The IRIG-B serial data format consists of a 1-second frame containing 100 pulses divided into fields, from which the relay decodes the second, minute, hour, and day fields and sets the internal time clock upon detecting valid time data in the IRIG time mode. There is one IRIG-B input on the SEL-487B rear panel, capable of supporting the HIRIG mode.

### IRIG-B Pins of Serial PORT 1

This IRIG-B input is capable of regular IRIG mode timekeeping only. Timing accuracy for the IRIG time mode is 500  $\mu$ s.

## IRIG-B BNC Connector

This IRIG-B input is capable of both modes of timekeeping. If the connected time-keeping source is qualified as high-accuracy, the relay enters the HIRIG mode, which has a timing accuracy of 1  $\mu$ s. If both inputs are connected, the SEL-487B uses the IRIG-B signal from the BNC connection (if a signal is available).

## Battery-Backed Clock

If relay input power is lost or removed, a lithium battery powers the relay clock, providing date and time backup. The battery is a 3 V lithium coin cell, Rayovac No. BR2335 or equivalent. If power is lost or disconnected, the battery discharges to power the clock. At room temperature (25°C), the battery will operate for approximately 10 years at rated load.

When the SEL-487B is operating with power from an external source, the self-discharge rate of the battery only is very small. Thus, battery life can extend well beyond the nominal 10-year period because the battery rarely discharges after the relay is installed. The battery cannot be recharged. *Figure 2.11* shows the clock battery location (at the front of the main board).

If the relay does not maintain the date and time after power loss, replace the battery (see *Replacing the Lithium Battery on page 10.27 in the SEL-400 Series Relays Instruction Manual*).

## Communications Interfaces

The SEL-487B has several communications interfaces you can use to communicate with other IEDs via EIA-232 ports: **PORT 1**, **PORT 2**, **PORT 3**, and **PORT F**. See *Section 10: Testing, Troubleshooting, and Maintenance* for more information and options for connecting your relay to the communications interfaces.

The Ethernet card gives the relay access to popular Ethernet networking standards including TCP/IP, FTP, Telnet, DNP3, IEEE C37.118, and IEC 61850 over local area and wide area networks. For information on DNP3 applications, see *Section 16: DNP3 Communication in the SEL-400 Series Relays Instruction Manual*. For more information on IEC 61850 applications, see *Section 17: IEC 61850 Communication in the SEL-400 Series Relays Instruction Manual*.

## Plug-In Boards

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The relay is available with two I/O configuration options. The relay is a 4U chassis with one I/O board (there are no I/O on the main board) and screw-terminal connector connections (see *Figure 2.3*).

## I/O Interface Boards

You must choose between the INT2 or INT4 interface boards for the I/O slot of the 4U chassis. *Figure 2.8–Figure 2.9* show the rear screw-terminal connectors associated with these interface boards.

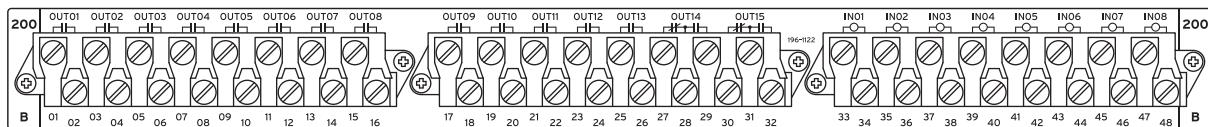


Figure 2.8 INT2 I/O Interface Board

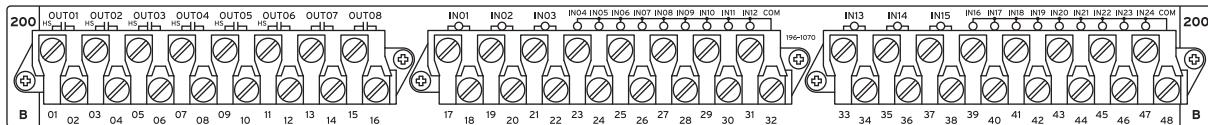


Figure 2.9 INT4 I/O Interface Board (High-Speed)

The I/O interface boards carry jumpers that identify the board location (see *Jumpers on page 2.10*).

## I/O Interface Board Inputs

The INT4 I/O interface board has two groups of 9 common contacts (18 total) and 6 independent control inputs. The INT2 I/O interface board has eight independent control inputs. All independent inputs are isolated from other inputs. These control inputs are optoisolated and hence are not polarity sensitive, i.e., the relay will detect input changes with voltage applied at either polarity, or ac signals when properly configured, (see *Optoisolated on page 2.22*).

*Table 2.2* is a comparison of the I/O board input capacities; the table also shows the absence of I/O inputs on the Main Board. See *Control Inputs on page 1.20* for complete control input specifications.

Table 2.2 I/O Interface Boards Control Inputs

Board	Independent Contact Pairs	Common Contacts
INT2 <sup>a</sup>	8	0
INT4 <sup>a</sup>	6	Two sets of 9

<sup>a</sup> The INT2 and INT4 control inputs are optoisolated and are not polarity sensitive.

## I/O Interface Board Outputs

**NOTE:** Form A control outputs cannot be jumpered to Form B.

The I/O interface boards vary by the type and amount of output capabilities. *Table 2.3* lists the outputs of the I/O interface boards. Information about the standard and high-speed, high-current interrupting control outputs is in *Control Outputs on page 2.22*.

**Table 2.3 I/O Interface Boards Control Outputs**

Board	Standard		High-Speed, High-Current Interrupting
	Form A	Form C	Form A
INT2	13	2	0
INT4 <sup>a</sup>	2	0	6
Main Board	0	0	0

<sup>a</sup> High-Speed, High-Current Interrupting.

## Ethernet Card

Factory-installed in the rear relay PORT 5, the Ethernet card provides Ethernet ports for industrial applications that process data traffic between the relay and a LAN.

## Jumpers

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The SEL-487B contains jumpers that configure the relay for certain operating modes. The jumpers are located on the main board (the top board) and the I/O interface boards (one or two boards located immediately below the main board).

### Main Board Jumpers

The jumpers on the main board of the SEL-487B perform these functions:

- ▶ Temporary/emergency password disable
- ▶ Circuit breaker and disconnect control enable

*Figure 2.11* shows the positions of the main board jumpers. The main board jumpers are in two locations. The password disable jumper and circuit breaker control jumper are at the front of the main board. The serial port jumpers are on the EIA-232 card.

### Password and Circuit Breaker Jumpers

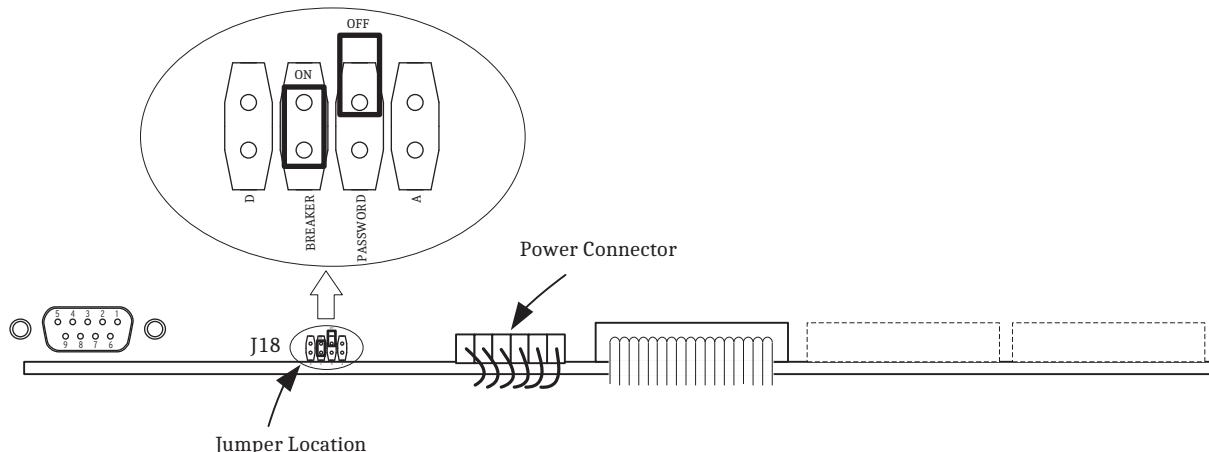
You can access the password disable jumper and circuit breaker control jumper without removing the main board from the relay cabinet. Remove the SEL-487B front cover to view these jumpers (use appropriate ESD precautions). The password and circuit breaker jumpers are located on the front of the main board, immediately left of the power connector (see *Figure 2.10*).

There are four jumpers, denoted D, BREAKER, PASSWORD, and A from left to right (position D is on the left). Position PASSWORD is the password disable jumper; position BREAKER is the circuit breaker control enable jumper. Positions D and A are for SEL use. *Figure 2.10* shows the jumper header with the circuit breaker/control jumper in the ON position and the password jumper in the OFF position; these are the normal jumper positions for an in-service relay.

*Table 2.4* lists the jumper positions and functions.

#### ⚠ CAUTION

Do not install a jumper on positions A or D of the main board J18 header. Relay misoperation can result if you install jumpers on positions J18A and J18D.



**Figure 2.10 Jumper Location on the Main Board**

**Table 2.4 Main Board Jumpers**

Jumper	Jumper Location	Jumper Position <sup>a</sup>	Function
A	Front	OFF	For SEL use only
PASSWORD	Front	OFF	Enable password protection (normal and shipped position)
		ON	Disable password protection (temporary or emergency only)
BREAKER	Front	OFF	Disable circuit breaker commands <sup>b</sup> (shipped position)
		ON	Enable circuit breaker commands <sup>b</sup>
D	Front	OFF	For SEL use only

<sup>a</sup> ON is the jumper shorting both pins of the jumper. Place the jumper over one pin only for OFF.

<sup>b</sup> Affects the availability of breaker control via the following methods: OPEN and PULSE commands, DNP and IEC 61850 communications, Fast Operate breaker control messages, and the front-panel LOCAL CONTROL > BREAKER CONTROL and LOCAL CONTROL > OUTPUT TESTING screens.

The password disable jumper, PASSWORD, is for temporary or emergency suspension of the relay password protection mechanisms. Under no circumstance should you install PASSWORD on a long-term basis. The SEL-487B ships with password disable jumper PASSWORD OFF (passwords enabled).

The circuit breaker control enable jumper, BREAKER, supervises breaker control. When the BREAKER jumper is in position OFF, you cannot control the breaker via the OPEN and PULSE commands, DNP and IEC 61850 communications, Fast Operate breaker control messages, and the front-panel LOCAL CONTROL > BREAKER CONTROL and LOCAL CONTROL > OUTPUT TESTING screens.

When the BREAKER jumper is in position ON, you can control the breaker via the terminal line commands, SCADA communications, and the relay front-panel control screens referenced previously.

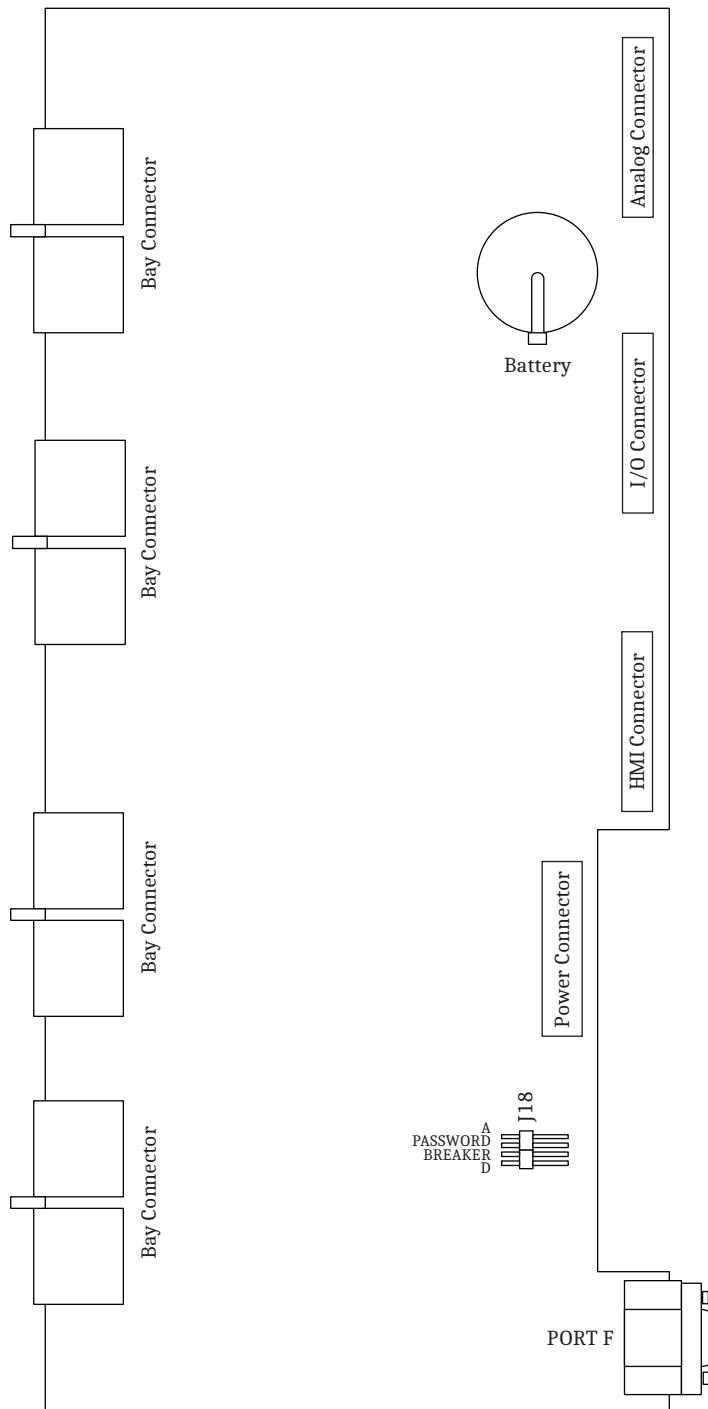


Figure 2.11 Major Component Locations on the SEL-487B Main Board

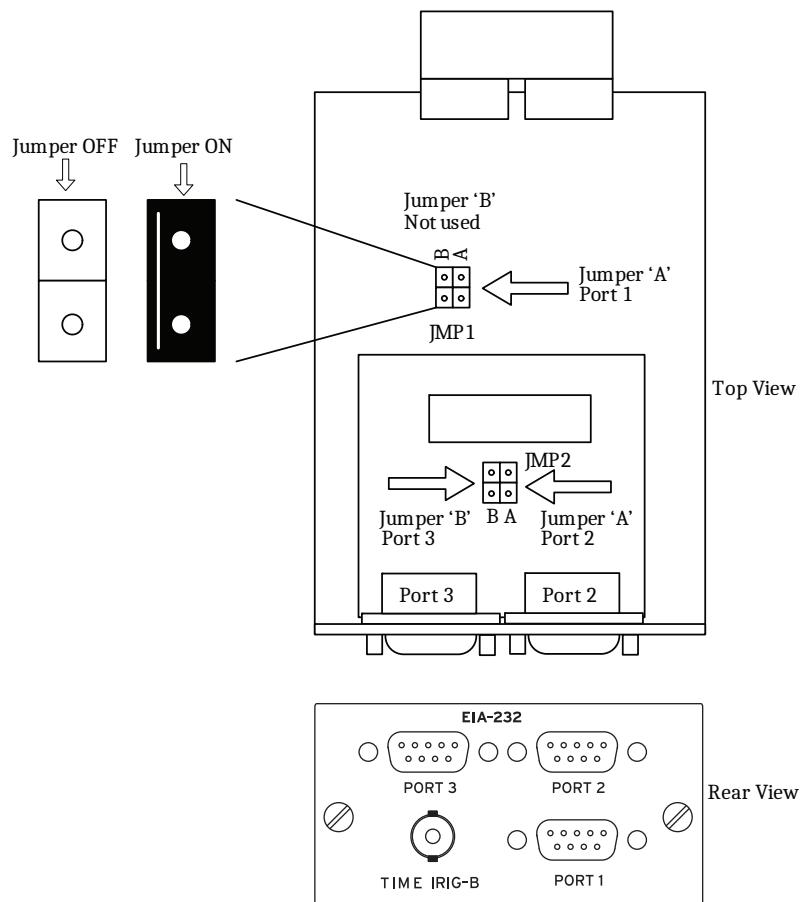
## Serial Port Jumpers

Place jumpers on the EIA-232 board to connect +5 Vdc to Pin 1 of each of the three rear-panel EIA-232 serial ports. The maximum current available from this Pin 1 source is 0.5 A. The Pin 1 source is useful for powering an external modem. *Table 2.5* describes the JMP1 and JMP2 positions. Refer to *Figure 2.11* for the locations of these jumpers. The SEL-487B ships with JMP1A, JMP2A, and JMP2B OFF (no +5 Vdc on Pin 1).

**Table 2.5 Serial Port Jumpers**

Jumper	Jumper Location	Jumper Position <sup>a</sup>	Function
JMP1	A	OFF	Serial PORT 1, Pin 1 = not connected
		ON	Serial PORT 1, Pin 1 = +5 Vdc
JMP2	A	—	Not used
		OFF	Serial PORT 2, Pin 1 = not connected
	B	ON	Serial PORT 2, Pin 1 = +5 Vdc
		OFF	Serial PORT 3, Pin 1 = not connected
		ON	Serial PORT 3, Pin 1 = +5 Vdc

<sup>a</sup> ON is the jumper shorting both pins of the jumper. Place the jumper over one pin only for OFF.

**Figure 2.12 Main Components of the EIA-232 Board, Showing the Location of Serial Port Jumpers JMP1 and JMP2**

## Changing Serial Port Jumpers

### DANGER

Contact with instrument terminals can cause electrical shock that can result in injury or death.

### WARNING

Have only qualified personnel service this equipment. If you are not qualified to service this equipment, you can injure yourself or others, or cause equipment damage.

You must remove the EIA-232 board to access the serial port jumpers. Perform the following steps to change the JMP1A, JMP2A, and JMP2B jumpers in an SEL-487B:

- Step 1. Follow your company standard to remove the merging unit from service.
- Step 2. Disconnect power from the merging unit.
- Step 3. Retain the GND connection, if possible, and ground the equipment to an ESD mat.

**CAUTION**

Equipment components are sensitive ESD. Undetectable permanent damage can result if you do not use proper ESD procedures. Ground yourself, your work surface, and this equipment before removing any cover from this equipment. If your facility is not equipped to work with these components, contact SEL about returning this device and related SEL equipment for service.

- Step 4. Unscrew the keeper screws and disconnect any serial cables connected to the **PORT 1**, **PORT 2**, and **PORT 3** rear-panel receptacles. Disconnect the IRIG-B cable from the BNC connector.
- Step 5. Loosen the screws retaining the serial port plug-in card and remove the card.
- Step 6. Locate the jumper you want to change (see *Figure 2.12*).
- Step 7. Install or remove the jumper as needed (see *Table 2.5* for jumper position descriptions).
- Step 8. Reinstall the relay EIA-232 board and tighten the keeper screws.
- Step 9. Reconnect any serial cables that you removed from the EIA-232 ports in the disassembly process.
- Step 10. Follow your company standard procedure to return the merging unit to service.

## Relay Placement

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Proper placement of the SEL-487B helps make certain that you receive years of trouble-free power system protection. Use the following guidelines for proper physical installation of the SEL-487B.

### Physical Location

You can mount the SEL-487B in a sheltered indoor environment (a building or an enclosed cabinet) that does not exceed the temperature and humidity ratings for the relay.

The relay is rated at Installation/Overvoltage Category II and Pollution Degree 2. This rating allows mounting the relay indoors or in an outdoor (extended) enclosure where the relay is protected against exposure to direct sunlight, precipitation, and full wind pressure, but neither temperature nor humidity are controlled.

You can place the relay in extreme temperature and humidity locations. The temperature range over which the relay operates is  $-40^{\circ}$  to  $+185^{\circ}\text{F}$  ( $-40^{\circ}$  to  $+85^{\circ}\text{C}$ , see *Operating Temperature on page 1.21*). The relay operates in a humidity range from 5 to 95 percent, no condensation, and is rated for installation at a maximum altitude of 2000 m (6560 ft) above mean sea level.

### Rack Mounting

When mounting the SEL-487B in a rack, use the reversible front flanges to either semiflush-mount or projection-mount the relay.

The semiflush mount gives a small panel protrusion from the relay rack rails of approximately 1.1 in or 27.9 mm. The projection mount places the front panel approximately 3.5 in or 88.9 mm in front of the relay rack rails.

See *Figure 2.13* for exact mounting dimensions for both the horizontal and vertical rack-mount relays. Use four screws of the appropriate size for your rack.

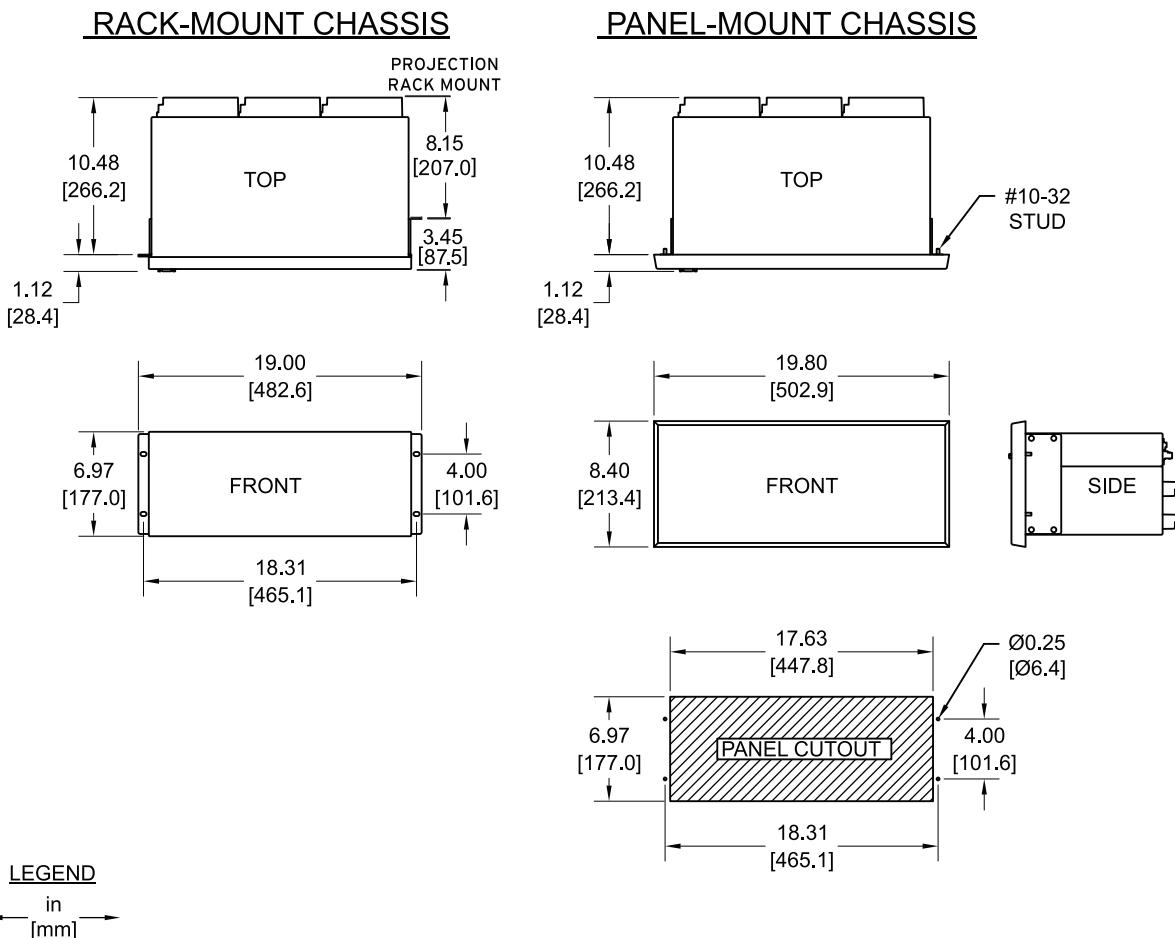


Figure 2.13 SEL-487B Chassis Dimensions

## Panel Mounting

Place the panel-mount versions of the SEL-487B in a switchboard panel. See the drawings in *Figure 2.13* for panel cut and drill dimensions (these dimensions apply to both the horizontal and vertical panel-mount relay versions). Use the supplied mounting hardware to attach the relay.

## Connection

### ⚠ CAUTION

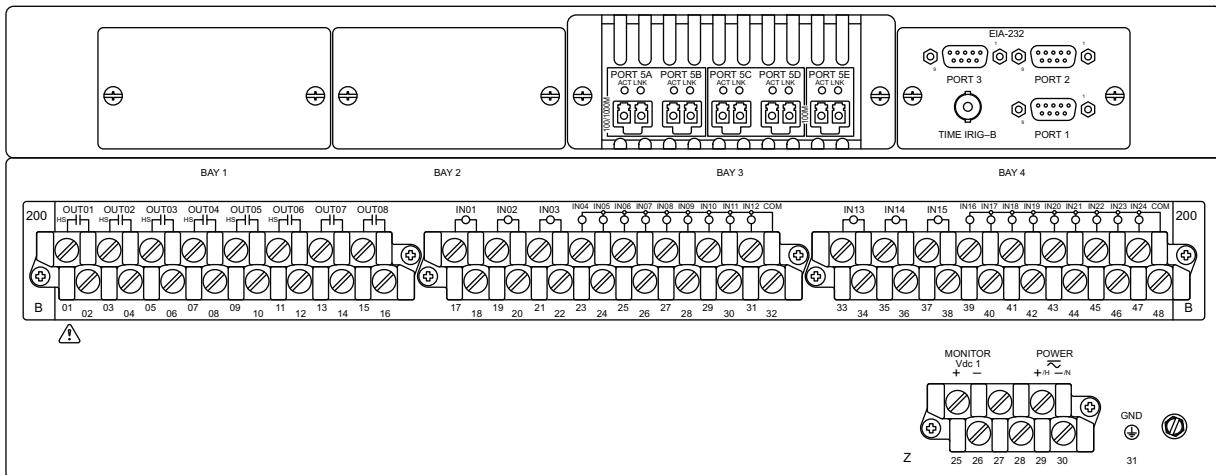
Insufficiently rated insulation can deteriorate under abnormal operating conditions and cause equipment damage. For external circuits, use wiring of sufficiently rated insulation that will not break down under abnormal operating conditions.

The SEL-487B-2 is available as an SV subscriber relay or a TiDL relay. This subsection presents a representative sample of relay rear-panel configurations and the connections to these rear panels. Only horizontal chassis are shown; rear panels of vertical chassis are identical to horizontal chassis rear panels.

When connecting the SEL-487B, refer to your company plan for wire routing and wire management. Be sure to use wire that is appropriate for your installation with an insulation rating of at least 90°C.

## Rear-Panel Layout

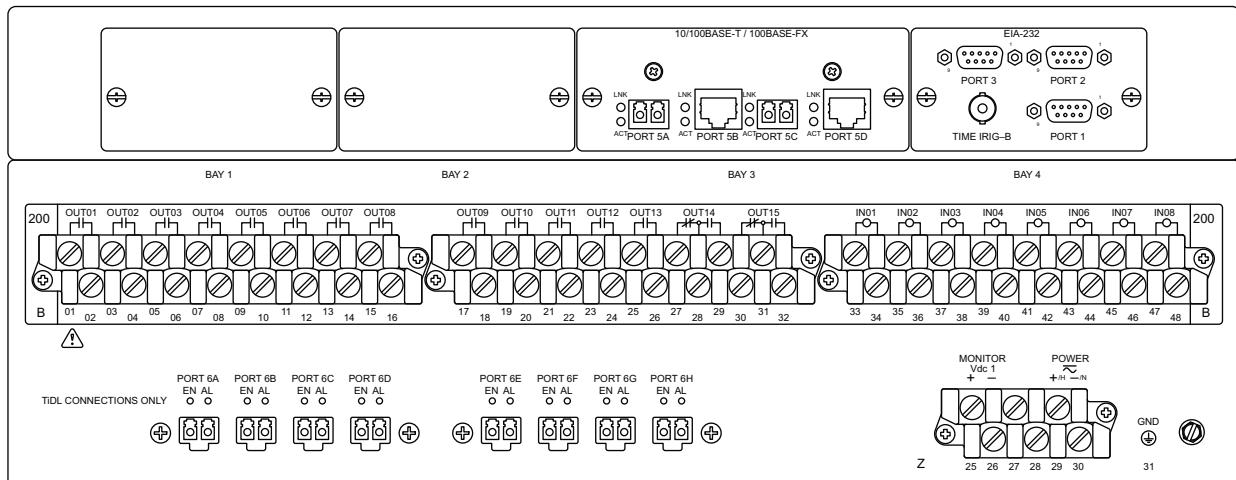
*Figure 2.14* shows the available SEL-487B-2 SV Subscriber rear panel, which includes screw-terminal connectors for I/O, power, and battery monitor.



Five-port Ethernet card ordering option depicted.

**Figure 2.14 SEL-487B-2 SV Subscriber Relay Rear Panel**

*Figure 2.15* shows the available SEL-487B-2 TiDL Relay rear panel, which includes screw-terminal connectors for I/O, power, and battery monitor.



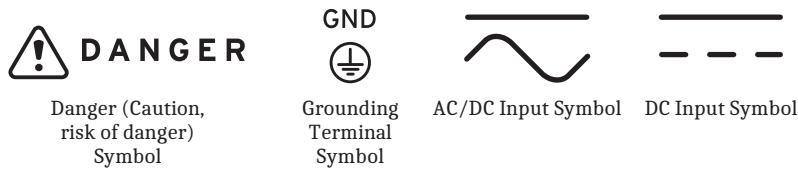
Four-port Ethernet card ordering option depicted.

**Figure 2.15 SEL-487B-2 TiDL Relay, 4U Rear Panel**

## Rear-Panel Symbols

There are important safety symbols on the rear of the SEL-487B (see *Figure 2.16*). Observe proper safety precautions when you connect the relay at terminals marked by these symbols. In particular, the danger symbol located on

the rear panel corresponds to the following: Contact with instrument terminals can cause electrical shock that can result in injury or death. Be careful to limit access to these terminals.



**Figure 2.16 Rear-Panel Symbols**

## Screw-Terminal Connectors

Terminate connections to the SEL-487B screw-terminal connectors with ring-type crimp lugs. Use a #8 ring lug with a maximum width of 9.1 mm (0.360 in.). The screws in the rear-panel screw-terminal connectors are #8-32 binding head, slotted, nickel-plated brass screws. Tightening torque for the terminal connector screws is 1.0 Nm to 2.0 Nm (9 in-lb to 18 in-lb).

You can remove the screw-terminal connectors from the rear of the SEL-487B by unscrewing the screws at each end of the connector block. Perform the following steps to remove a screw-terminal connector:

- Step 1. Remove the connector by pulling the connector block straight out. Note that the receptacle on the relay circuit board is keyed; you can insert each screw-terminal connector in only one location on the rear panel.
- Step 2. To replace the screw-terminal connector, confirm that you have the correct connector and push the connector firmly onto the circuit board receptacle.
- Step 3. Reattach the two screws at each end of the block.

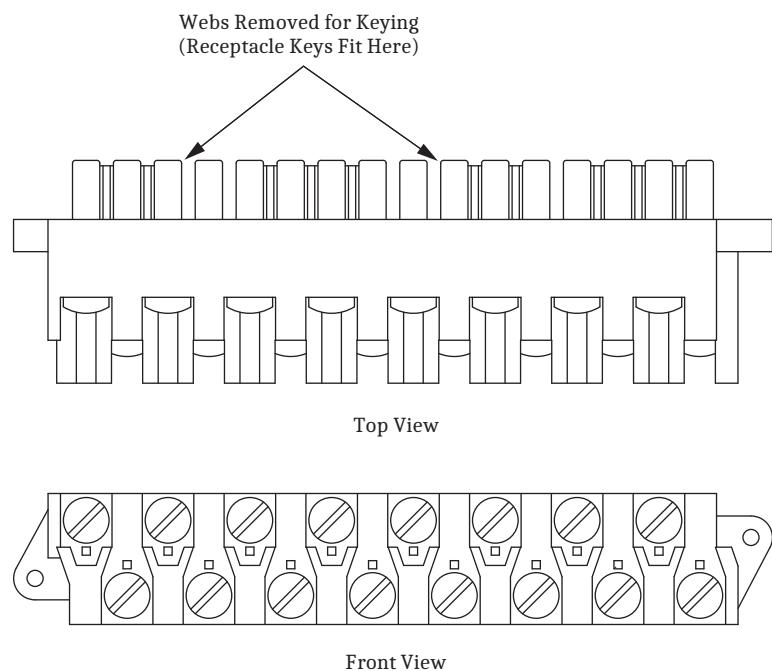
## Changing Screw-Terminal Connector Keying

You can rotate a screw-terminal connector so that the connector wire dress position is the reverse of the factory-installed position (for example, wires entering the relay panel from below instead of from above). In addition, you can move similar function screw-terminal connectors to other locations on the rear panel. To move these connectors to other locations, you must change the screw-terminal connector keying.

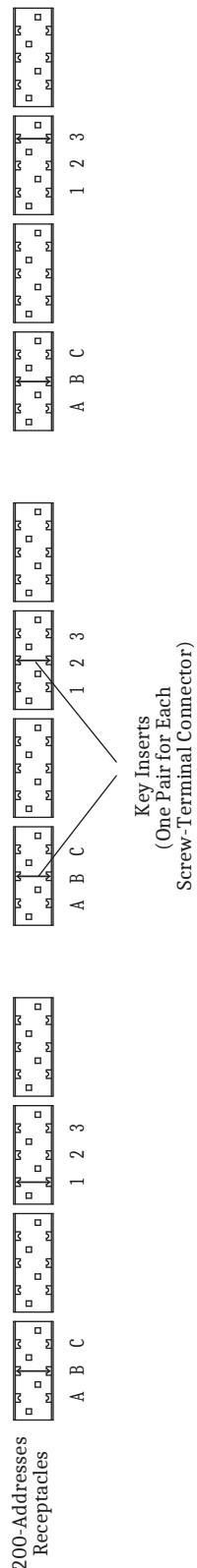
Inserts in the circuit board receptacles key the receptacles for only one screw-terminal connector in one orientation. Each screw-terminal connector has a missing web into which the key fits (see *Figure 2.17*).

If you want to move a screw-terminal connector to another circuit board receptacle or reverse the connector orientation, you must rearrange the receptacle keys to match the screw-terminal connector block. Use long-nosed pliers to move the keys.

*Figure 2.18* shows the factory-default key positions.



**Figure 2.17 Screw-Terminal Connector Keying**



**Figure 2.18 Rear-Panel Receptacle Keying**

## Grounding

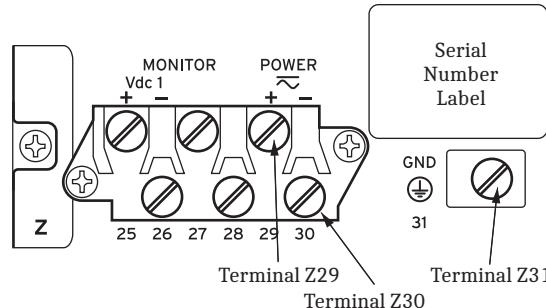
Connect the grounding terminal (#Z31) labeled **GND** on the rear panel to a rack frame ground or main station ground for proper safety and performance.

This protective earthing terminal is in the lower right side of the relay panel (see *Figure 2.14*). The symbol that indicates the grounding terminal is shown in *Figure 2.16*.

Use 2.5 mm<sup>2</sup> (14 AWG) or larger wire less than 2 m (6.6 ft) in length for this connection. This terminal connects directly to the internal chassis ground of the SEL-487B.

## Power Connections

The terminals labeled **POWER** on the rear panel (#Z29 and #Z30) must connect to a power source that matches the power supply characteristics that your SEL-487B specifies on the rear-panel serial number label. (See *Power Supply* on page 1.19, for complete power input specifications.) For the relay models that accept dc input, the serial number label specifies dc with the symbol shown in *Figure 2.16*.



**Figure 2.19 Power Connection Area of the Rear Panel**

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**NOTE:** The combined voltages applied to the **POWER** and **MONITOR** terminals must not exceed 600 V (rms or dc).

The **POWER** terminals are isolated from chassis ground. Use 0.8 mm<sup>2</sup> (18 AWG) or larger size wire to connect to the **POWER** terminals. Connection to external power must comply with IEC 60947-1 and IEC 60947-3 and must be identified as the disconnect device for the equipment.

Place an external disconnect device, switch/fuse combination, or circuit breaker in the **POWER** leads for the SEL-487B; this device must interrupt both the hot (**H/+**) and neutral (**N/-**) power leads. The current rating for the power disconnect circuit breaker or fuse must be 20 A maximum. Be sure to locate this device within 3.0 m (9.8 ft) of the relay.

Operational power is internally fused by power supply fuse F1. *Table 2.6* lists the SEL-487B power supply fuse requirements. Be sure to use fuses that comply with IEC 127-2.

You can order the SEL-487B with one of three operational power input ranges listed in *Table 2.6*. Each of the three supply voltage ranges represents a power supply ordering option. As noted in *Table 2.6*, model numbers for the relay with these power supplies begin with 0487B2XXXXn, where n is 2, 4, or 6, to indicate low, middle, and high-voltage input power supplies, respectively. Note that each power supply range covers two widely used nominal input voltages. The SEL-487B power supply operates from 30 Hz to 120 Hz when ac power is used for the **POWER** input.

**Table 2.6 Fuse Requirements for the Power Supply**

<b>Rated Voltage</b>	<b>Operational Voltage Range</b>	<b>Fuse F1</b>	<b>Fuse Description</b>
24-48 Vdc	18-60 Vdc	T5.0AH250V	5x20 mm, time-lag, 5.0 A, high break capacity, 250 V
48-125 V or 110-120 Vac	38-140 Vdc or 85-140 Vac (30-120 Hz)		
125-250 V or 110-240 Vac	85-300 Vdc or 85-264 Vac (30-120 Hz)	T3.15AH250V	5x20 mm, time-lag, 3.15 A, high break capacity, 250 V

The SEL-487B accepts dc power input for all three power supply models. The 48-125 Vdc supply also accepts 110-120 Vac; the 125-250 Vdc supply also accepts 110-240 Vac. When connecting a dc power source, you must connect the source with the proper polarity, as indicated by the + (Terminal #Z29) and - (Terminal #Z30) symbols on the power terminals. When connecting to an ac power source, the + Terminal #Z29 is hot (H), and the - Terminal #Z30 is neutral (N).

Each model of the SEL-487B internal power supply exhibits low power consumption and a wide input voltage tolerance. For more information on the power supplies, see *Power Supply on page 1.19*.

## Monitor Connections (DC Battery)

The SEL-487B monitors one dc battery system. For information on the battery monitoring function, see *Station DC Battery System Monitor Specifications on page 1.24*.

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**NOTE:** The combined voltages applied to the **POWER** and **MONITOR** terminals must not exceed 600 V (rms or dc).

Connect the positive lead of Battery System 1 to Terminal #Z25 and the negative lead of Battery System 1 to Terminal #Z26. (Usually Battery System 1 is also connected to the rear-panel **POWER** input terminals.) For Battery System 2, connect the positive lead to Terminal #Z27, and the negative lead to Terminal #Z28.

## Secondary Circuit Connections SV Subscriber Relays

The SEL-487B-2 SV Subscriber Relay does not have secondary circuit connections but rather relies on the Ethernet ports connected to an Ethernet network to subscribe to published voltage and current signals by a merging unit.

## TiDL Relays

The SEL-487B-2 TiDL Relay does not have secondary circuit connections but rather relies on direct, point-to-point fiber-optic cable connections with SEL-TMU. For supported fiber-optic cable types and connectors, see *Specifications on page 1.19*.

## Control Circuit Connections

You can configure the SEL-487B with two combinations of control inputs and control outputs. See and *I/O Interface Boards on page 2.8* for information about I/O configurations. This subsection provides details about connecting these control inputs and outputs. Refer to *Figure 2.3*, for representative rear-panel screw-terminal connector locations.

### Control Inputs

#### Optoisolated

**NOTE:** The combined voltages applied to the INnnn and OUTnnn terminals must not exceed 600 V (rms or dc).

Optoisolated control inputs are not polarity-sensitive. These inputs respond to voltage of either polarity and can be used with ac control signals when properly configured.

Note that INT4 I/O interface boards have two sets of nine inputs that share a common leg (see *Figure 2.9*).

#### Assigning

To assign the functions of the control inputs, see *Operating the Relay Inputs and Outputs on page 3.55* in the *SEL-400 Series Relays Instruction Manual* for more details. You can also use SEL Grid Configurator Software to set and verify operation of the inputs.

### Control Outputs

The SEL-487B has two types of outputs:

- Standard outputs
- High-speed, high-current interrupting outputs

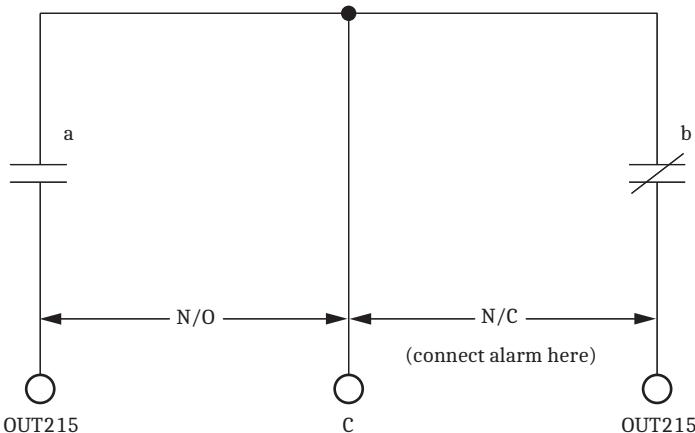
See *Control Outputs on page 2.6* for more information.

You can connect the standard outputs in either ac or dc circuits. Connect the high-speed, high-current interrupting outputs to dc circuits only. The screw-terminal connector legends alert you about this requirement by showing polarity marks on the hybrid (high-current interrupting) contacts and polarity and HS marks on the high-speed, high-current interrupting contacts.

### Alarm Output

The relay monitors internal processes and hardware in continual self-tests. Also see *Relay Self-Tests on page 10.19* in the *SEL-400 Series Relays Instruction Manual*. If the relay senses an out-of-tolerance condition, the relay declares a Status Warning or a Status Failure. The relay signals a Status Warning by pulsing the HALARM Relay Word bit (hardware alarm) to a logical 1 for five seconds. For a status failure, the relay latches the HALARM Relay Word bit at logical 1.

To provide remote alarm status indication, connect the b contact of an output contact to your control system remote alarm input. *Figure 2.20* shows the configuration of the a and b contacts of control output OUT215, using INT2 as an example.



**Figure 2.20 Control Output OUT215**

Program OUT215 to respond to NOT HALARM by entering the following SELOGIC control equation with a communications terminal, with SEL Grid Configurator.

**OUT215 := NOT HALARM**

When the relay is operating normally, the NOT HALARM signal is at logical 1 and the b contacts of control output OUT215 are open.

When a status warning condition occurs, the relay pulses the NOT HALARM signal to logical 0 and the b contacts of OUT215 close momentarily to indicate an alarm condition.

For a status failure, the relay disables all control outputs and the OUT215 b contacts close to trigger an alarm. Also, when relay power is off, the OUT215 b contacts close to generate a power-off alarm. See *Relay Self-Tests on page 10.19 in the SEL-400 Series Relays Instruction Manual* for information on relay self-tests.

The relay pulses the SALARM Relay Word bit for software programmed conditions; these conditions include settings changes, access level changes, alarming after three unsuccessful password entry attempts, and Ethernet firmware upgrade attempts.

The relay also pulses the BADPASS Relay Word bit after three unsuccessful password entry attempts.

You can add the software alarm SALARM to the alarm output by entering the following SELOGIC control equation.

**OUT215 := NOT (HALARM OR SALARM)**

## Tripping and Closing Outputs

To assign the control outputs for tripping and closing, see *Setting Outputs for Tripping and Closing on page 3.61 in the SEL-400 Series Relays Instruction Manual*. In addition, you can use the **SET O** command (see *Output Settings on page 8.21* for more details). You can also use the front panel to set and verify operation of the outputs (see *Set/Show on page 4.26* in the *SEL-400 Series Relays Instruction Manual*).

## IRIG-B Input Connections

The SEL-487B accepts a demodulated IRIG-B signal through two types of rear-panel connectors. These IRIG-B inputs are the BNC connector labeled **IRIG-B** and Pin 4 (+) and Pin 6 (-) of the DB-9 rear-panel serial port labeled **PORT1**. When you use the **PORT1** input, ensure that you connect Pins 4 and 6 with the proper polarity. See *Communications Ports Connections on page 2.24* for other DB-9 connector pinouts and additional details.

These inputs accept the dc shift time code generator output (demodulated) IRIG-B signal with positive edge on the time mark. For more information on IRIG-B and the SEL-487B, see *IRIG-B Inputs on page 2.7*.

The **PORT1** IRIG-B input connects to a  $2.5\text{ k}\Omega$  grounded resistor and goes through a single logic signal buffer. The **PORT1** IRIG-B is equipped with robust ESD and overvoltage protection but is not optically isolated. When you are using the **PORT1** input, ensure that you connect Pin 4 (+) and Pin 6 (-) with the proper polarity.

The IRIG network should be properly terminated with an external termination resistor (SEL 240-1802, BNC Tee, and SEL 240-1800, BNC terminator, 50 ohm) placed on the unit that is farthest from the source. This termination provides impedance matching of the cable for the best possible signal-to-noise ratio.

Where distance between the SEL-487B and the IRIG-B sending device exceeds the cable length recommended for conventional EIA-232 metallic conductor cables, you can use transceivers to provide isolation and to establish communication to remote locations.

Conventional fiber-optic and telephone modems do not support IRIG-B signal transmission. The SEL-2810 Fiber-Optic Transceiver/Modem includes a channel for the IRIG-B time code. These transceivers enable you to synchronize time precisely from IRIG-B time code generators (such as the SEL-2032 Communications Processor) over a fiber-optic communications link.

## Communications Ports Connections

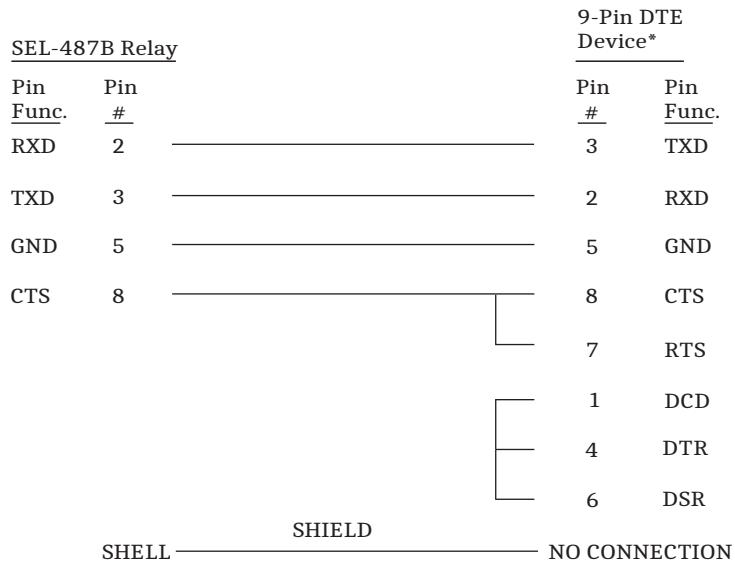
The SEL-487B has three rear-panel EIA-232 serial communications ports labeled **PORT1**, **PORT2**, and **PORT3** and one front-panel port, **PORTF**. For information on serial communication, see *Establishing Communication on page 3.3*, *Serial Communication on page 15.2*, and *Serial Port Hardware Protocol on page 15.4* in the *SEL-400 Series Relays Instruction Manual*.

In addition, the rear-panel features a **PORT5** for an Ethernet card. For additional information about communications topologies and standard protocols that are available in the SEL-487B, see *Section 15: Communications Interfaces*, *Section 16: DNP3 Communication*, and *Section 17: IEC 61850 Communication* in the *SEL-400 Series Relays Instruction Manual* and *Section 10: Communications Interfaces* in this manual.

## Serial Ports

The SEL-487B serial communications ports use EIA-232 standard signal levels in a D-subminiature 9-pin (DB-9) connector. To establish communication between the relay and a DTE device (a computer terminal, for example) with a DB-9 connector, use an SEL-C234A cable. Alternatively, you can use a SEL-C662 cable to connect to a USB port.

*Figure 2.21* shows the configuration of SEL-C234A cable that you can use for basic ASCII and binary communication with the relay. A properly configured ASCII terminal, terminal emulation program, or SEL Grid Configurator along with the SEL-C234A cable provide communication with the relay in most cases.



\*DTE = Data Terminal Equipment (Computer, Terminal, etc.)

**Figure 2.21 SEL-487B to Computer-D-Subminiature 9-Pin Connector**

## Serial Cables

### ⚠ CAUTION

Severe power and ground problems can occur on the communications ports of this equipment as a result of using non-SEL cables. Never use standard null-modem cables with this equipment.

Using an improper cable can cause numerous problems or failure to operate, so you must be sure to specify the proper cable for application of your SEL-487B. Several standard SEL communications cables are available for use with the relay.

The following list provides additional rules and practices you should follow for successful communication through the use of EIA-232 serial communications devices and cables:

- Route communications cables well away from power and control circuits. Switching spikes and surges in power and control circuits can cause noise in the communications circuits if power and control circuits are not adequately separated from communications cables.
- Keep the length of the communications cables as short as possible to minimize communications circuit interference and also to minimize the magnitude of hazardous ground potential differences that can develop during abnormal power system conditions.
- Ensure that EIA-232 communications cable lengths never exceed 50 ft, and always use shielded cables for communications circuit lengths greater than 10 feet.
- Modems provide communication over long distances and give isolation from ground potential differences that are present between device locations (examples are the SEL-2800-series transceivers).
- Lower data speed communication is less susceptible to interference and will transmit greater distances over the same medium than higher data speeds. Use the lowest data speed that provides an adequate data transfer rate.

## Ethernet Network Connections

### ! CAUTION

Use of controls or adjustments, or performance of procedures other than those specified herein, may result in hazardous radiation exposure.

### ! WARNING

Do not look into the fiber ports/connectors.

**NOTE:** The five-port Ethernet card uses SFP ports for its fiber-optic connections. SFP transceivers are not included with the card and must be ordered separately. See Table 15.7 in the SEL-400 Series Relays Instruction Manual or [selinc.com/products/sfp](http://selinc.com/products/sfp) for a list of compatible SFP transceivers.

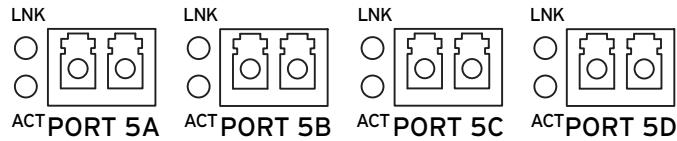
The Ethernet card for the SEL-487B is available with either four or five Ethernet ports. These ports can work together to provide a primary and backup interface. Other operating modes are also available. The following list describes the Ethernet card port options.

- **10/100BASE-T.** 10 Mbps or 100 Mbps communication through the use of Cat 5 cable (Category 5 twisted-pair) and an RJ45 connector (four-port Ethernet card only)
- **100BASE-FX.** 100 Mbps communication over multimode fiber-optic cable through the use of an LC connector
- **1000BASE-X.** 1 Gbps communication over fiber-optic cable through the use of an LC connector (**PORT 5A** and **PORT 5B** on the five-port Ethernet card only)

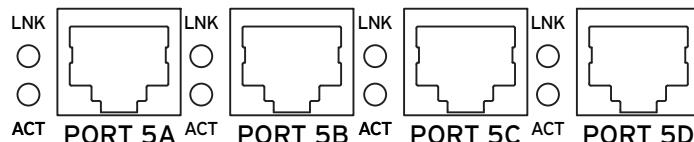
For SV applications, your process bus and station bus port designations depend on certain settings and which Ethernet card is installed. For more information, see *Section 17: IEC 61850 Communication in the SEL-400 Series Relays Instruction Manual*.

## Ethernet Card Rear-Panel Layout

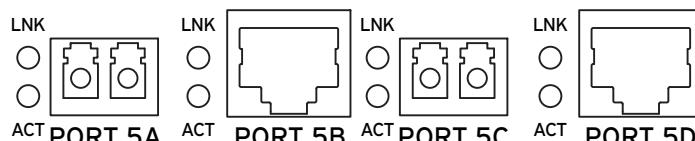
Rear-panel layouts for the Ethernet card port configurations are shown in *Figure 2.22–Figure 2.25*.



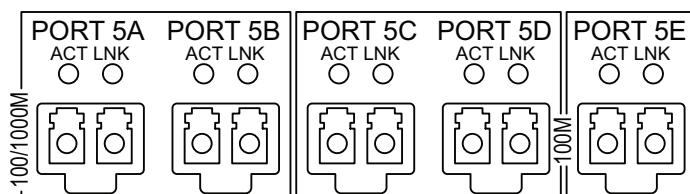
**Figure 2.22 Four 100BASE-FX Port Configuration**



**Figure 2.23 Four 10/100BASE-T Port Configuration**



**Figure 2.24 100BASE-FX and 10/100BASE-T Port Configuration**



**Figure 2.25 Two 100/1000BASE and Three 100BASE SFP Ports**

## Twisted-Pair Networks

**NOTE:** Use caution with UTP cables as these cables do not provide adequate immunity to interference in electrically noisy environments unless additional shielding measures are employed.

While Unshielded Twisted Pair (UTP) cables dominate office Ethernet networks, Shielded Twisted Pair (STP) cables are often used in industrial applications. The four-port Ethernet card is compatible with standard UTP cables for Ethernet networks as well as STP cables for Ethernet networks.

Typically, UTP cables are installed in relatively low-noise environments including offices, homes, and schools. Where noise levels are high, you must either use STP cable or shield UTP by using grounded ferrous raceways such as a steel conduit.

Several types of STP bulk cable and patch cables are available for use in Ethernet networks. If noise in your environment is severe, you should consider using fiber-optic cables. SEL strongly advises against using twisted-pair cables for segments that leave or enter the control house.

If you use twisted-pair cables, you should use care to isolate these cables from sources of noise to the maximum extent possible. Do not install twisted-pair cables in trenches, raceways, or wireways with unshielded power, instrumentation, or control cables. Do not install twisted-pair cables in parallel with power, instrumentation, or control wiring within panels, rather make them perpendicular to the other wiring.

You must use a cable and connector rated as Category 5 (Cat 5) to operate the twisted-pair interface (10/100BASE-T) at 100 Mbps. Because lower categories are becoming rare and because you may upgrade a 10 Mbps network to 100 Mbps, SEL recommends using all Cat 5 or better components.

Some industrial Ethernet network devices use 9-pin connectors for STP cables. The Ethernet card RJ45 connectors are grounded so you can ground the shielded cable by using a standard, externally shielded jack with cables terminating at the Ethernet card.

## Merging Unit AC/DC Connections

See *AC/DC Connection Diagrams* in *Section 2: Installation in the SEL-421-7, SEL-401, or SEL-TMU Instruction Manuals* for typical power system connections to the merging unit for a variety of schemes. See *Applications* on page 1.5 for a variety of schemes and corresponding example SV networks or TiDL systems.

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## S E C T I O N   3

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# Testing

This section contains guidelines for determining and establishing test routines for the SEL-487B-2 Relay. Follow the standard practices of your company in choosing testing philosophies, methods, and tools. *Section 10: Testing, Troubleshooting, and Maintenance in the SEL-400 Series Relays Instruction Manual* addresses the concepts related to testing. This section provides supplemental information specific to testing the SEL-487B.

This section includes the following topics:

- *Relay Test Connections on page 3.1*
- *Checking Relay Operation on page 3.3*
- *Technical Support on page 3.20*

## Relay Test Connections

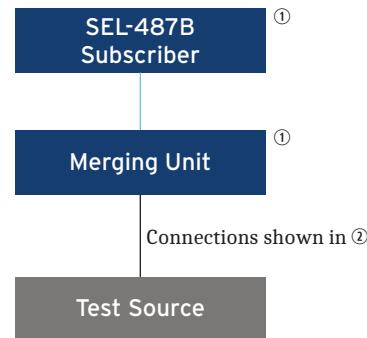
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The SEL-487B is a flexible tool that you can use to implement many protection and control schemes. Although you can connect the relay to the power system in many ways, connecting basic bench test sources helps you model and understand more complex relay field connection schemes.

For each relay element test, you must apply ac voltage and current signals to the merging unit. The text and figures in this subsection describe the test source connections you need for relay protection element checks. You can use these connections to test protective elements and simulate all fault types. These examples show subscriptions on I01, I02, and I03. You can make similar subscriptions to any of the current inputs: I01–I21.

Create a simple connection between your merging unit and the SEL-487B-2, as shown in *Figure 3.1*. See *IEC 61850-9-2 Sampled Values (SV) on page 19.23* in the *SEL-400 Series Relays Instruction Manual* for guidance on how to configure a Sampled Values (SV) network. See *Time-Domain Link (TiDL) on page 19.1* in the *SEL-400 Series Relays Instruction Manual* for guidance on configuring and commissioning an SEL Time-Domain Link (TiDL) system.

In the SEL-487B-2, use the **CFG CTNOM** command (see *Secondary Circuit Connections on page 2.21*) to match your CT nominal current.



① SV configurations require time synchronization; for more information, see IEC 61850-9-2 Sampled Values (SV) on page 19.23 in the SEL-400 Series Relays Instruction Manual.

② Figure 3.2 and Figure 3.3

**Figure 3.1 Test Network Topology and Mapping**

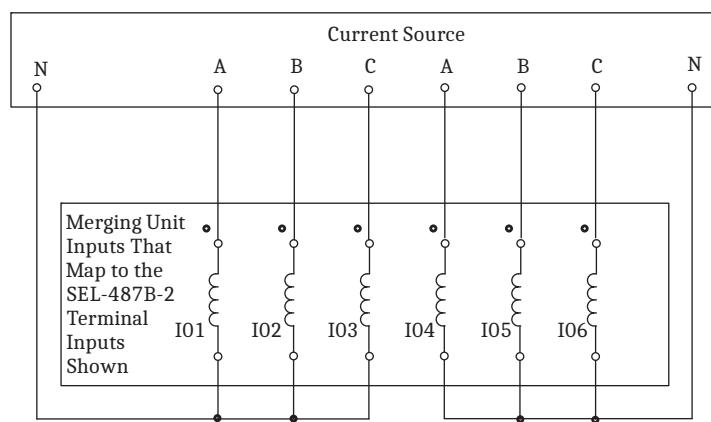
## Merging Unit Connections

**NOTE:** The procedures specified in this section are for initial relay testing only. Follow your company policy for connecting the relay to the power system.

### ⚠️ WARNING

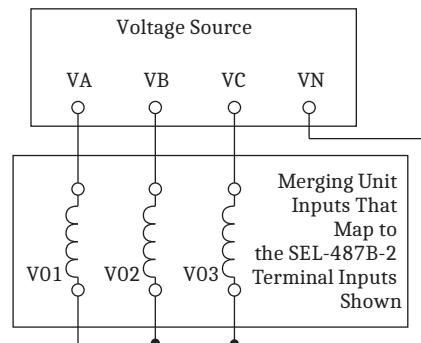
Before working on a CT circuit, first apply a short to the secondary winding of the CT.

Figure 3.2 shows the test set and merging unit connections for three-phase current injection. The terminal names shown are the local terminal names of the SEL-487B-2 to which the incoming signals are mapped.



**Figure 3.2 Test Connections for Balanced Load With Three-Phase Current Sources**

Figure 3.3 shows the test set and relay connections for three-phase voltage injection.



**Figure 3.3 Voltage Test Connections**

# Checking Relay Operation

Your SEL-487B comes with all functions fully checked and calibrated so that the relay operates correctly and accurately. You can test the relay to verify proper relay operation, but you do not need to test every relay element, timer, and function in this evaluation. The following checks are valuable for confirming proper SEL-487B connections and operation:

- AC connection check (metering)
- Commissioning tests
- Functional tests
- Element verification

**NOTE:** While in SEL test mode, SEL SV publishers, including the SEL-421 with SV publication capability and the SEL-401, substitute SV test data for the outgoing publications only. The local metering and protection functions continue to use the analog data from the terminal inputs.

An ac connection check uses relay metering to verify that the relay current and voltage inputs have the proper magnitude and phase angle (see *Examining Metering Quantities on page 3.34 in the SEL-400 Series Relays Instruction Manual*). Commissioning tests help you verify that you have properly connected the relay to the power system and all auxiliary equipment. These tests confirm proper connection of control inputs and control outputs as well (see *Operating the Relay Inputs and Outputs on page 3.55 in the SEL-400 Series Relays Instruction Manual*). Brief functional tests and element verification confirm correct internal relay processing.

This subsection discusses tests for the following:

- Alias settings
- Zone selection function
- Sensitive differential elements
- Differential elements
- Directional element
- Voltage elements

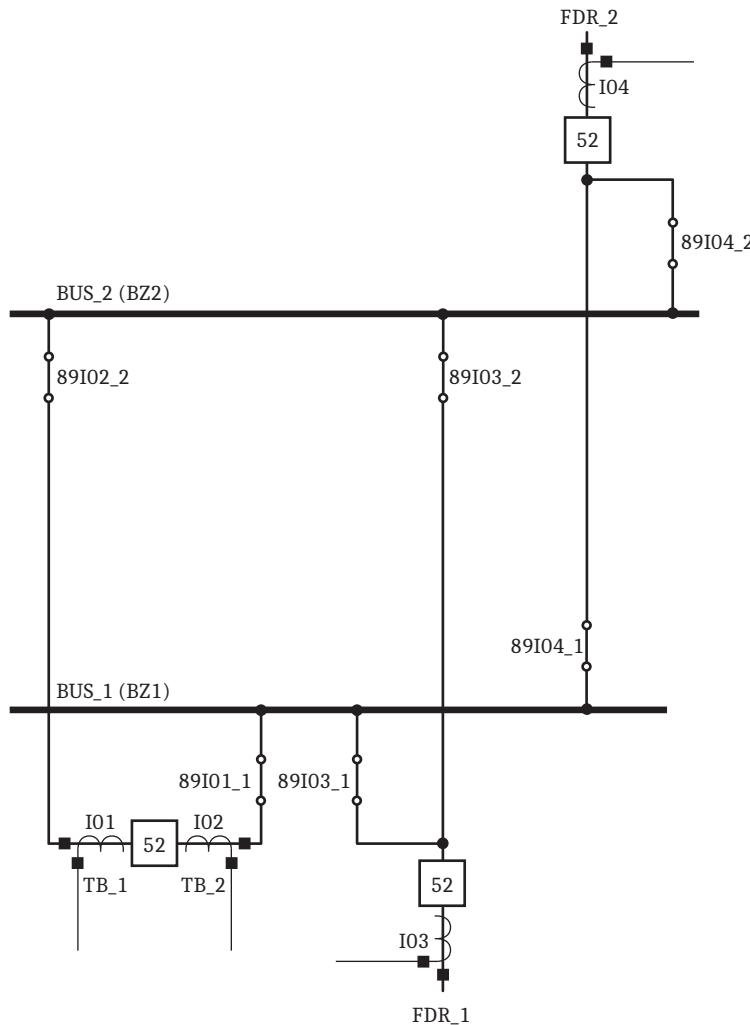
Before you perform element tests, however, you should be aware of your substation layout, and you should apply the appropriate settings to the relay.

The SEL-487B is the intended device for all commands and responses throughout this section. Merging units are specifically called out if any setting changes or response is required.

## Example Substation

*Figure 3.4* shows an example of a substation that requires two protection zones. The station layout consists of two busbars (BUS\_1 and BUS\_2), a tie breaker (TB\_1 and TB\_2), and two feeders (FDR\_1 and FDR\_2).

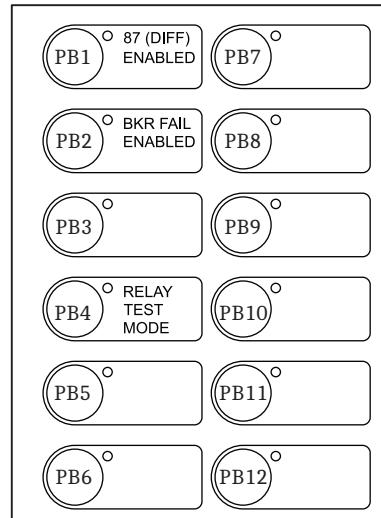
**3.4** Testing  
Checking Relay Operation



**Figure 3.4 Station Layout, Comprising a Tie Breaker, Two Feeders and Two Busbars**

Use front-panel pushbuttons to simulate the disconnect auxiliary contacts for the terminal-to-bus-zone SELOGIC control equations as shown in *Figure 3.4*. *Table 3.1* shows the SELOGIC control equation assignments.

**NOTE:** Pushbutton labels PB1-PB12 (shown in Figure 3.5) identify the pushbuttons for this test; these labels do not appear on the relay front panel.



**Figure 3.5 Front-Panel Operator Pushbuttons**

**Table 3.1 Pushbutton Assignments to Simulate Disconnect Auxiliary Contacts**

Pushbutton	Relay Word Bits	Description
PB5	I01BZ1V	Connects TB_1 to BUS_1 when closed
PB6	I02BZ2V	Connects TB_2 to BUS_2 when closed
PB7	I03BZ1V	Connects FDR_1 to BUS_1 when closed
PB8	I04BZ2V	Connects FDR_2 to BUS_2 when closed

## Relay Settings

Apply the appropriate settings to the relay. For the relay to match the station layout in *Figure 3.4*, change the following setting categories:

- Alias settings
- Zone configuration settings
- Protection group settings
- Protection logic settings
- Front-panel settings

## Alias Settings

Change the default alias names for the four analog channels to the names indicated in *Figure 3.4*. From Access Level 2, use the **SET T** command to rename the analog channels, as shown in *Figure 3.6*. Some of the alias names assigned in this example are default alias names in the relay. If an alias name is duplicated, type **Delete <Enter>** to clear the default alias names that are not relevant to this example.

```
=>>SET T <Enter>
Alias

Relay Aliases
(RW Bit,Analog Qty.,Terminal,Bus-Zone, or Check Zone, 7 Char. Alias [0-9 A-Z _])

1: I01,"FDR_1"
? I01,TB_1 <Enter>
2: I02,"FDR_2"
? I02,TB_2 <Enter>
3: I03,"FDR_3"
? I03,FDR_1 <Enter>
4: I04,"TRFR_1"
? I04,FDR_2 <Enter>
5: I05,"TB_1"
? BZ1, BUS_1 <Enter>
6: I06,"TB_2"
? BZ2, BUS_2 <Enter>
7: BZ1,"BUS_1"
? DELETE <Enter> (Note, this is to clear default alias settings for this
example)
7: BZ2,"BUS_2"
? DELETE <Enter>
7: FBF01,"F1_BF"
? END <Enter>
Alias
.
.
.
Save settings (Y,N) ? Y <Enter>
Saving Settings, Please Wait.....
Settings Saved
=>>
```

Figure 3.6 Alias Names for the Four Analog Channels

## Zone Configuration Settings

Set the terminal-to-bus-zone connections to determine when the input currents from the terminals are considered in the differential calculations. We use protection latch bits in the terminal-to-bus-zone connections to emulate disconnect auxiliary contacts (see *Protection Logic Settings on page 3.8*). *Figure 3.7* shows the steps to enter the zone configuration settings.

---

```
=>>SET Z <Enter>
Zone Config Group 1
Potential Transformer Ratio
Potential Transformer Ratio -V01 (1-10000) PTR1 := 2000 ?> <Enter>
Current Transformer Ratio
Current Transformer Ratio -I01 (1-15000) CTR01 := 600 ?> <Enter>
Zone Configuration: Terminal to Bus-Zone Connections

Terminal, Bus-Zone, Polarity (P,N)
I01BZ1C := TB_1, BUS_1, P
? TB_1, BUS_1, P <Enter>
TB_1 to BUS_1 Connection (SELogic Equation)
I01BZ1V := DIFF_EN AND NOT TOS01
? PLT07 <Enter>
Terminal, Bus-Zone, Polarity (P,N)
I02BZ1C := TB_2, BUS_1, P
? TB_2, BUS_1, P <Enter>
TB_2 to BUS_1 Connection (SELogic Equation)
I02BZ1V := DIFF_EN AND NOT TOS02
? PLT08 <Enter>
Terminal, Bus-Zone, Polarity (P,N)
I03BZ2C := FDR_1, BUS_2, P
? FDR_1,BUS_1,P <Enter>
FDR_1 to BUS_1 Connection (SELogic Equation)
I03BZ1V := NA
? PLT09 <Enter>
Terminal, Bus-Zone, Polarity (P,N)
I04BZ2C := FDR_2, BUS_2, P
? FDR_2,BUS_2,P <Enter>
FDR_2 to BUS_2 Connection (SELogic Equation)
I04BZ2V := DIFF_EN AND NOT TOS04
? PLT10 <Enter>
Terminal, Bus-Zone, Polarity (P,N)
I05BZ1C := I05, BUS_1, P
? DELETE <Enter>
Terminal, Bus-Zone, Polarity (P,N)
? END <Enter>
.

.

Save settings (Y,N) ?Y <Enter>
Saving Settings, Please Wait.....
Settings Saved

=>>
```

---

**Figure 3.7 Zone Configuration Settings**

## Protection Group Settings

The sensitive differential element default settings block the differential elements from operating during CT open-circuit conditions. Disable the sensitive differential elements to prevent these elements from blocking the differential elements when we inject unbalanced test values. *Figure 3.8* shows the steps to disable the sensitive differential elements.

---

```
=>>SET <Enter>
Relay Configuration
Sensitive Differential Element Supervision (Y,N) E87SSUP := Y ?N <Enter>
.
Save settings (Y,N) ?Y <Enter>
=>>
```

---

**Figure 3.8 Steps to Disable the Sensitive Differential Elements**

## Protection Logic Settings

We use four protection latch bits, operated from four front-panel pushbuttons to simulate disconnect auxiliary contacts. *Figure 3.9* shows the steps to program the protection latch bits.

```
=>>SET L <Enter>
1: PLT01S := NOT DIFF_EN AND PLT04 # DIFFERENTIAL ENABLED
? > <Enter>
21:
? PLT07S := PB5_PUL AND NOT PLT07 <Enter>
22:
? PLT07R := PB5_PUL AND PLT07 <Enter>
23:
? PLT08S := PB6_PUL AND NOT PLT08 <Enter>
24:
? PLT08R := PB6_PUL AND PLT08 <Enter>
25:
? PLT09S := PB7_PUL AND NOT PLT09 <Enter>
26:
? PLT09R := PB7_PUL AND PLT09 <Enter>
27:
? PLT10S := PB8_PUL AND NOT PLT10 <Enter>
28:
? PLT10R := PB8_PUL AND PLT10 <Enter>
29:
? END <Enter>
Protection 1

.
.
.

Save settings (Y,N) ? Y <Enter>
Saving Settings, Please Wait.....
Settings Saved
=>>
```

**Figure 3.9 Steps to Program Protection Latch Bits**

## Front-Panel Settings

We use four protection latch bits, operated from four front-panel pushbuttons to simulate disconnect auxiliary contacts. Each front-panel pushbutton has an LED in close proximity to the pushbutton. Program these LEDs to illuminate when the pushbuttons are in the closed position. Pushbutton assertion simulates closing disconnect auxiliary contacts, assigning the input currents to the appropriate differential elements. *Figure 3.10* shows the steps to program the LEDs.

---

```

=>>SET F <Enter>
Front Panel
Front Panel Settings
Front Panel Display Time-Out (OFF,1-60 mins)           FP_TO    := 15      ? <Enter>
Pushbutton LED 1 (SELogic Equation)
PB1_LED := DIFF_EN # DIFFERENTIAL PROTECTION ENABLED
? <Enter>
Pushbutton LED 2 (SELogic Equation)
PB2_LED := BF_EN # BREAKER FAILURE ENABLED
? <Enter>
Pushbutton LED 3 (SELogic Equation)
PB3_LED := NA
? <Enter>
Pushbutton LED 4 (SELogic Equation)
PB4_LED := TNS_SW # TEST NORMAL SWITCH ENABLED
? <Enter>
Pushbutton LED 5 (SELogic Equation)
PB5_LED := NA
? <Enter>
Pushbutton LED 6 (SELogic Equation)
PB6_LED := NA
? <Enter>
Pushbutton LED 7 (SELogic Equation)
PB7_LED := NA
? <Enter>
Pushbutton LED 8 (SELogic Equation)
PB8_LED := NA
? <Enter>
Target LED 1 (SELogic Equation)
T1_LED := 87BTR
? END <Enter>
.
.
.
Save settings (Y,N) ? Y <Enter>
Saving Settings, Please Wait.....
Settings Saved
=>>

```

---

**Figure 3.10 Steps to Program the LEDs**

## Verify Settings

- Step 1. Use the serial port **SHO Z** ASCII command to generate a report similar to that shown in *Figure 3.11*.  
Information shown in *Figure 3.11* is an extract of important settings, not the complete relay response.
- Step 2. Verify the following SEL-487B values:
- PTR1, PTR2, and PTR3 are all equal to 2000.
  - CTR01, CTR02, CTR03, and CTR04 are all equal to 600.
  - TAP01, TAP02, TAP03, and TAP04 are all equal to 5.
  - The terminal-to-bus-zone settings are as shown.
- Step 3. Verify the following merging unit (SEL-401) values.
- PTRY is equal to 2000.
  - CRTW and CRTX are equal to 600.

```
=>>SHO Z <Enter>
Zone Config Group 1

Potential Transformer Ratio
PTR1    := 2000    PTR2    := 2000    PTR3    := 2000

Current Transformer Ratio
CTR01   := 600     CTR02   := 600     CTR03   := 600     CTR04   := 600

Zone Configuration: Terminal to Bus-Zone Connections

Terminal, Bus-Zone, Polarity (P,N)
I01BZ1C := TB_1, BUS_1, P
TB_1 to BUS_1 Connection (SELogic Equation)
I01BZ1V := PLT07
Terminal, Bus-Zone, Polarity (P,N)
I02BZ1C := TB_2, BUS_1, P
TB_2 to BUS_1 Connection (SELogic Equation)
I02BZ1V := PLT08
Terminal, Bus-Zone, Polarity (P,N)
I03BZ1C := FDR_1, BUS_1, P
FDR_1 to BUS_1 Connection (SELogic Equation)
I03BZ1V := PLT09
Terminal, Bus-Zone, Polarity (P,N)
I04BZ2C := FDR_2, BUS_2, P
FDR_2 to BUS_2 Connection (SELogic Equation)
I04BZ2V := PLT10

.

.

.

Current Normalization Factor

TAP01    := 5.00    TAP02    := 5.00    TAP03    := 5.00    TAP04    := 5.00

=>>
```

**Figure 3.11 Selected Information From the Relay Response to the SHO Z Command**

## Selected Element Tests

### Zone Selection Function

Step 1. Test the zone selection logic (terminal-to-bus-zone connection).

- Press the **PB5** pushbutton to simulate the closing of disconnect 89I01\_1, assigning TB\_1 to BUS\_1.
- Confirm that the relay assigns Terminal TB\_1 to BUS\_1, and includes the bus-zone BUS\_1 in Protection Zone 1.
- Type **MET Z1 <Enter>** to generate a Zone 1 meter report.

*Figure 3.12* shows the relay response, confirming that Terminal TB\_1 is an active terminal in BUS\_1.

---

**NOTE:** When a terminal is active, the terminal name appears under the heading "Primary Currents." The heading "Bus-Zones in Protection Zone 1" shows the Bus-Zones in Protection Zone 1.

```
=>>MET Z1 <ENTER>

Relay 1                               Date: 09/10/2018 Time: 07:41:32.970
Station A                             Serial Number: 1180010001

Current Terminals in Protection Zone 1

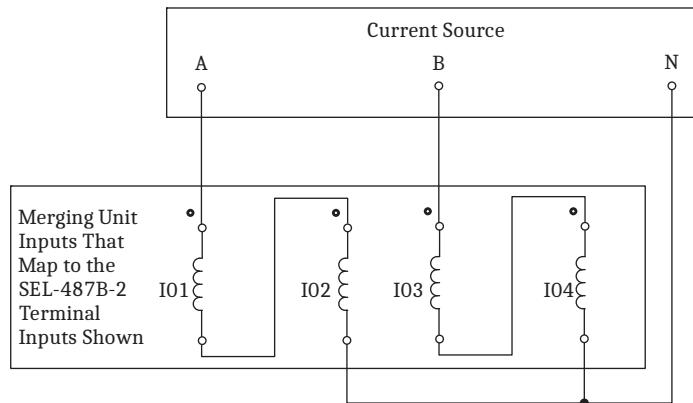
Primary Currents
Terminal MAG(A) ANG(DEG) POL
TB_1    0.291   -6.94   P

Primary Voltages
Terminal MAG(KV) ANG(DEG)
V01      0.002   -37.06
V02      0.003   -53.56
V03      0.001   -169.73

Bus-Zones in Protection Zone 1
BUS_1
```

**Figure 3.12 Relay Response to the MET Z1 Command**

## Sensitive Differential Element



**Figure 3.13 Test Connections Using Two Current Sources**

- Step 1. Use the test connections shown in *Figure 3.13* for this test.
- Step 2. Inject the current values listed in *Table 3.2* into the merging unit.

**Table 3.2 Current for Testing the Threshold Point, 087P**

Current	Value
IA	$4.8\angle 0^\circ$
IB	$4.8\angle 180^\circ$

Current is measured in all four terminals, but because only the PB5 pushbutton (*Step a on page 3.10*) is closed, the relay only considers the subscribed current from Terminal TB\_1 (merging unit current IAW).

The **CT ALARM** LED illuminates after approximately five seconds, and the relay triggers an event report. The relay does not trip, because the differential current is below the 087P threshold.

- Step 3. Stop the injection. The **CT ALARM** LED turns off.

## Differential Elements

The following test verifies the characteristics for two of the six differential elements in the SEL-487B. The test plots the relay characteristic at two points. The first point is at the pickup threshold (O87P); the second point is at three per-unit restraint current. Three per unit is an arbitrary value; you may use any other convenient restraint current value.

*Figure 3.14* shows the default O87P setting and the default Slope 1 setting.

Use the following equation to calculate IOP(IRT), the operating current value for any specified restraint current value:

$$IOP(IRT) = \frac{SLP1}{100} \cdot IRT$$

**Equation 3.1**

where:

IOP(IRT) = Operating current as a function of the restraint current

SLP1 = Differential element Slope 1 setting

IRT = Differential element restraint current



**Figure 3.14 Differential Element Characteristic**

Test the first point on the differential element characteristic.

- Step 1. Obtain the operate current value and restraint current value.
- Inject the current values in *Table 3.2* into the merging unit.
  - Type **MET DIF <Enter>**.

The current values should approximate those in *Figure 3.15*:

```
=>>MET DIF <Enter>
Relay 1                               Date: 09/10/2018 Time: 07:41:32.970
Station A                             Serial Number: 1180010001

Operate Currents      Restraint Currents
(Per Unit)           (Per Unit)
ZONE    IOP          IRT
1       0.96         0.96
2       0.00         0.00
Current Reference (A)
IREF
3000

=>>
```

**Figure 3.15 Example Values Below the 8701 Element Pickup Value in Response to the MET DIF Command**

- Step 2. Test the threshold point, O87P. (Pushbutton **PB5** is still asserted.)
- Type **TAR 8701 9999 <Enter>** to monitor the status of Relay Word bit 8701.
  - Increase current IA until the status of Relay Word bit 8701 changes from logical 0 to logical 1.  
When the bit changes state, the **TRIP**, **87 (DIFF)**, and **ZONE 1** LEDs illuminate.
  - Record the value of the injected current.  
This value should be  $5 \text{ A} \pm 5\%$  and  $\pm 0.02 \cdot I_{\text{NOM}}$ .
  - Type **<Ctrl+X>** to end the scrolling of Relay Word bit 8701 status values.
  - Type **MET DIF <Enter>** to obtain the differential operate current value and differential restraint current value.  
These values should approximate the differential operate current values and differential restraint current values in *Figure 3.16*.
  - Stop the injection.
  - Press the **TARGET RESET** pushbutton.

```
=>>MET DIF <Enter>
Relay 1                               Date: 09/10/2018 Time: 07:41:32.970
Station A                             Serial Number: 1180010001

Operate Currents      Restraint Currents
(Per Unit)           (Per Unit)
ZONE    IOP          IRT
1       1.02         1.02
2       0.00         0.00
Current Reference (A)
IREF
3000

=>>
```

**Figure 3.16 Example Values Above the 8701 Element Pickup Value in Response to the MET DIF Command**

Test the second point on Zone 1 and Zone 2 differential element characteristic.

Step 1. Use *Equation 3.1* to calculate the per-unit operating current for a restraint current of 3 per unit.

This operating current is for the second point on the differential characteristic.

$$\begin{aligned} \text{IOP(IRT)} &= \frac{\text{SLP1}}{100} \cdot \text{IRT} \\ &= (0.6 \cdot 3 \text{ per unit}) \\ &= 1.8 \text{ per unit} \end{aligned}$$

**Equation 3.2**

Step 2. Use *Equation 3.3* and *Equation 3.4* to calculate the two current values that result in an operating current of 1.8 per unit at a restraint current of 3 per unit.

$$\begin{aligned} \text{I1}_{\text{pu}} &= \frac{\text{IRT} + \text{IOP(IRT)}}{2} \text{ per unit} \\ &= \frac{3.0 + 1.8}{2} \text{ per unit} \\ &= 2.4 \text{ per unit} \end{aligned}$$

**Equation 3.3**

$$\begin{aligned} \text{I2}_{\text{pu}} &= \text{IRT} - \text{I1}_{\text{pu}} \text{ per unit} \\ &= 3.0 - 2.4 \text{ per unit} \\ &= 0.6 \text{ per unit} \end{aligned}$$

**Equation 3.4**

Step 3. Use *Equation 3.5* to convert the current values from per-unit values to current values in amperes:

$$\begin{aligned} \text{I1}_A &= \text{TAP}(01 \cdot \text{I1}_{\text{pu}} \text{ A}) \\ &= (5 \cdot 2.4 \text{ A}) \\ &= 12.0 \text{ A} \end{aligned}$$

$$\begin{aligned} \text{I2}_A &= \text{TAP}02 \cdot \text{I2}_{\text{pu}} \text{ A} \\ &= (5 \cdot 0.6 \text{ A}) \\ &= 3.0 \text{ A} \end{aligned}$$

**Equation 3.5**

where:

TAP01 = Terminal 01 normalization factor.

TAP02 = Terminal 02 normalization factor.

Step 4. Press pushbuttons PB6, PB7, and PB8.

Step 5. Inject the current values listed in *Table 3.3* into the merging unit.

**Table 3.3 Current for Testing the Second Point on the Relay Characteristic**

Current	Value
IA	$12.0\angle 0^\circ$
IB	$3.2\angle 180^\circ$

The **CT ALARM** LED illuminates after approximately five seconds, but the relay does not trip, because the differential current is below the operating value.

- Step 6. Type **MET DIF <Enter>** to obtain the operate current value and restraint current value.

These values should approximate the operate current values and restraint current values shown in *Figure 3.17*:

```
=>>MET DIF <Enter>
Relay 1                               Date: 09/10/2018 Time: 07:41:32.970
Station A                             Serial Number: 1180010001

Operate Currents      Restraint Currents
(Per Unit)           (Per Unit)
ZONE    IOP          IRT
1       1.76         3.04
2       1.76         3.04
Current Reference (A)
IREF
3000

=>>
```

**Figure 3.17 Example Values in Response to the MET DIF Command With Two Active Zones**

- Step 7. Type **TAR 87R1 9999 <Enter>** to monitor the status of Relay Word bit 87R1.

- Step 8. Decrease current IB until the status of Relay Word bit 87R1 changes from logical 0 to logical 1.

After this bit changes state, the **TRIP**, **87 (DIFF)**, **ZONE 1**, and **ZONE 2** LEDs illuminate.

- Step 9. Record the value of IB.

IB should be  $3 \text{ A} \pm 5\%$  and  $\pm 0.02 \cdot I_{\text{NOM}}$ .

- Step 10. Type **<Ctrl+X>** to end the scrolling of the status values of Relay Word bit 87R1.

- Step 11. Type **MET DIF <Enter>** to obtain the operate current value and restraint current value.

These values should approximate the operate current values and restraint current values shown in *Figure 3.18*.

```
=>>MET DIF <Enter>
Relay 1
Station A
Operate Currents      Restraint Currents
(Per Unit)            (Per Unit)
ZONE     IOP          IRT
1        1.80         3.00
2        1.80         3.00
Current Reference (A)
IREF
3000
=>>
```

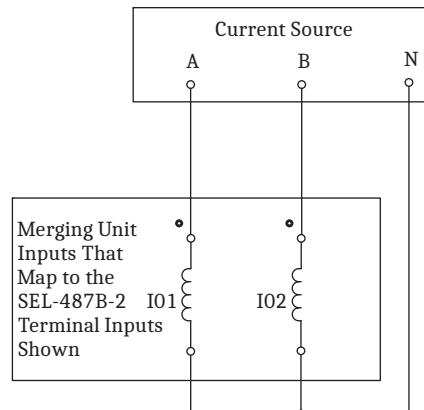
**Figure 3.18 Example Values in Response to the MET DIF Command With Two Differential Elements Asserted**

Step 12. Turn off the test set.

Step 13. Press pushbuttons PB5–PB8 and TARGET RESET.

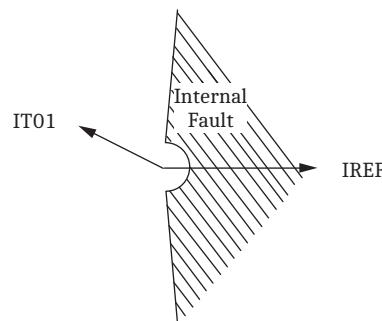
## Directional Element

Use the steps in the following example to test the directional element. Apply the same relay settings as when testing the differential element. To test the directional element characteristic, use the test connections as shown in *Figure 3.19*.



**Figure 3.19 Test Connections for Testing the Directional Element**

*Figure 3.20* shows the directional element characteristic, the shaded area indicating an internal fault.



**Figure 3.20 Directional Element Characteristic**

The test consists of two parts. In the first part, we test the threshold of the directional element. The directional element only considers terminals with current values exceeding the threshold value in the directional calculations. In the second part, we test the boundaries of the element characteristic.

- Step 1. Test the threshold value by injecting the current values shown in *Table 3.4* into the merging unit.

**Table 3.4 Current Values for Testing the Threshold Value of the Directional Element**

Current	Current Injected
IA	$0.2\angle 0^\circ$
IB	$2.0\angle 180^\circ$

- Type **TAR 50DS01 <Enter>** to obtain the relay response as shown in *Figure 3.21*.
- Verify that only Relay Word bit 50DS03 has a value of logical 1.

```
=>>TAR 50DS01 <ENTER>
50DS08 50DS07 50DS06 50DS05 50DS04 50DS03 50DS02 50DS01
0      0      0      0      0      1      0      0
```

=>>

**Figure 3.21 Relay Response to the TAR 50DS01 Command**

- Type **TAR 50DS01 9999 <Enter>** and slowly increase current IA. Relay Word bit 50DS01 asserts when IA reaches a value of approximately 0.26 A.
- Stop the injection.
- Type **<Ctrl+X>** to end the scrolling of the Relay Word bit 50DS01 status values.

- Step 2. Test the boundary values.

- Press pushbuttons PB5 and PB7.
- Inject the current values shown in *Table 3.5* into the merging unit.

**Table 3.5 Current Values for Testing the Boundary Values of the Directional Element**

Current	Current Injected
IA	$2.0\angle 0^\circ$
IB	$2.0\angle 90^\circ$

- Type **TAR DE1F <Enter>** to obtain a relay response similar to that shown in *Figure 3.22*.
- Verify that Relay Word bit DE1F is deasserted.

```
=>>TAR DE1F <Enter>
*      *      DE6F   DE5F   DE4F   DE3F   DE2F   DE1F
0      0      0      0      0      0      0      0
```

**Figure 3.22 Relay Response to the TAR DE1F Command**

- e. Type **TAR DE1F 9999 <Enter>** and slowly decrease the angle of current IB.  
Relay Word bit DE1F asserts when the angle reaches a value of approximately 74 degrees.
- f. Quickly move the angle of Current IB to -70 degrees and continue to slowly decrease the angle of current IB.  
Relay Word bit DE1F deasserts when the angle reaches a value of approximately -74 degrees.
- g. Type **<Ctrl+X>** to end the scrolling of the status values of Relay Word bit DE1F.
- h. Stop the injection.

## Voltage Elements

The SEL-487B includes six overvoltage and six undervoltage elements. Each element has two pickup level settings, with a definite-time delay assigned to Level 1. The operating quantity for the input to each voltage element is selectable, with phase, zero-sequence, and negative-sequence voltage quantities available for selection. We will test the phase voltage elements for the voltage inputs.

### Phase Over- and Undervoltage Elements

*Figure 3.23* shows the steps to apply settings to the over- and undervoltage elements to V01.

---

```
=>>SET E27 <Enter>
Group 1
Relay Configuration
Enable Under Voltage Elements (N,1-6)          E27      := N      ?1 <Enter>
Enable Over Voltage Elements (N,1-6)            E59      := N      ?1 <Enter>
Advanced Settings (Y,N)                         EADVS   := N      ? <Enter>
.
.
Under Voltage (27) Element 1
U/V Element 1 Operating Quantity                2701    := V01FIM ? <Enter>
U/V Element 1 Level 1 P/U (2.00-300 V,sec)     27P1P1  := 20.00 ?60 <Enter>
U/V Element 1 Torque Control (SELogic Eqn)
27TC1 := 1
? <Enter>
U/V Element 1 Level 1 Delay (0.00-16000 cyc)   27P1D1  := 10.00 ? <Enter>
U/V Element 1 Level 2 P/U (2.00-300 V,sec)     27P1P2  := 15.00 ?55 <Enter>
```

---

**Figure 3.23** Over- and Undervoltage Element Settings

```

Over Voltage (59) Element 1
O/V Element 1 Operating Quantity           5901   := V01FIM ? <Enter>
O/V Element 1 Level 1 P/U (2.00-300 V,sec) 59P1P1 := 76.00 ?70 <Enter>
O/V Element 1 Torque Control (SELogic Eqn)
59TC1 := 1
? <Enter>
O/V Element 1 Level 1 Delay (0.00-16000 cyc) 59P1D1 := 10.00 ? <Enter>
O/V Element 1 Level 2 P/U (2.00-300 V,sec)    59P1P2 := 80.00 ?75 <Enter>

Trip Logic
Trip 01 (SELogic Equation)
TR01 := 0
? END <Enter>
.
.
.

Save settings (Y,N) ? Y <Enter>
Saving Settings, Please Wait.....
Settings Saved

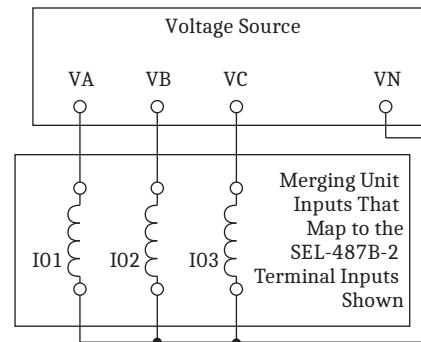
=>>

```

**Figure 3.23 Over- and Undervoltage Element Settings**

Verify the operation of the phase over- and undervoltage elements.

Step 1. Connect a source of variable three-phase voltage to the merging unit as shown in *Figure 3.24*.

**Figure 3.24 Test Connections for Testing the Voltage Elements**

Step 2. Test the overvoltage elements by applying the voltage values shown in *Table 3.6* to the merging unit.

**Table 3.6 Injected Voltage Values for Testing the Overvoltage Elements**

Channel	Voltage Value
VA	$67\angle 0^\circ$
VB	$67\angle -120^\circ$
VC	$67\angle 120^\circ$

The voltage elements are on a per-phase basis, with V01 (A-Phase) assigned to voltage Element 1. Similar steps can be followed to assign V02 (B-Phase) to voltage Element 2 and V03 (C-Phase) to voltage Element 3. Relay Word bits 591P1T, 591P2, 592P1T, and 592P2 are in the same row.

- Type **TAR 591P1T 999 <Enter>** to see the status of these Relay Word bits.
- Raise the A-Phase voltage (V01) until Relay Word bit 591P1 asserts. The voltage should equal  $70 \text{ V} \pm 0.5 \text{ V}$  and  $\pm 5\%$ .

- c. Continue to increase the A-Phase voltage until Relay Word bit 591P2 asserts.  
The voltage should equal  $75\text{ V} \pm 0.5\text{ V}$  and  $\pm 5\%$ .
- d. Type **<Ctrl+X> <Enter>** to end the scrolling of the Relay Word bits status values.
- e. Stop the injection.

Step 3. Test the undervoltage elements.

- a. Apply the voltage values shown in *Table 3.6* to the merging unit.
- b. Type **TAR 271P1T 999 <Enter>** to see the status of these Relay Word bits.
- c. Lower the A-Phase voltage (V01) until Relay Word bit 271P1 asserts.  
The voltage should equal  $60\text{ V} \pm 0.5\text{ V}$  and  $\pm 5\%$ .
- d. Continue to lower the A-Phase voltage until Relay Word bit 271P2 asserts.  
The voltage should equal  $55\text{ V} \pm 0.5\text{ V}$  and  $\pm 5\%$ .
- e. Type **<Ctrl+X> <Enter>** to end the scrolling of the Relay Word bits status values.
- f. Stop the injection.

## Technical Support

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We appreciate your interest in SEL products and services. If you have questions or comments, please contact us at:

Schweitzer Engineering Laboratories, Inc.  
2350 NE Hopkins Court  
Pullman, WA 99163-5603 U.S.A.  
Tel: +1.509.338.3838  
Fax: +1.509.332.7990  
Internet: [selinc.com/support](http://selinc.com/support)  
Email: [info@selinc.com](mailto:info@selinc.com)

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## S E C T I O N   4

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# Front-Panel Operations

The SEL-487B-2 Relay front panel makes power system data collection and system control quick and efficient. Using the front panel, you can examine power system operating information, view and change port, group, and Global settings, and perform relay control functions. The relay features a straightforward menu-driven control structure presented on the front-panel LCD. Front-panel targets and other LED indicators give a quick look at SEL-487B operation status. You can perform often-used control actions rapidly by using the large direct-action pushbuttons. All of these features help you operate the relay from the front panel and include the following:

- ▶ Reading metering
- ▶ Inspecting targets
- ▶ Accessing port, group, global, date, and time settings
- ▶ Controlling relay operations

General front-panel operations are described in *Section 4: Front-Panel Operations in the SEL-400 Series Relays Instruction Manual*. This section provides additional information that is unique to the SEL-487B. This section includes the following:

- ▶ *Front-Panel LCD Default Displays on page 4.1*
- ▶ *Front-Panel Menus and Screens on page 4.5*
- ▶ *Target LEDs on page 4.7*
- ▶ *Front-Panel Operator Control Pushbuttons on page 4.9*

## Front-Panel LCD Default Displays

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The SEL-487B has two screen scrolling modes: autoscrolling and manual scrolling. After the initial relay power up, or after front-panel time out, the LCD presents each of the display screens in this sequence:

- ▶ Any active (filled) alarm points screens
- ▶ Any active (filled) display points screens
- ▶ Enabled metering screens
- ▶ Zone configuration screens

If enabled, the relay displays the metering and zone configuration screens in the order listed in *Table 4.1* (see *Figure 4.4* for samples of the metering screens). This sequence comprises the ROTATING DISPLAY.

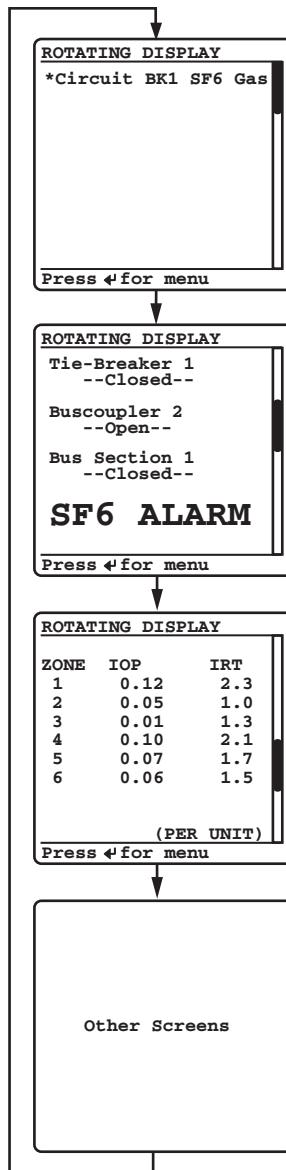
**Table 4.1 Metering Screens Enable Settings (Sheet 1 of 2)**

Name	Description	Range	Default
STA_BAT	Station Battery Screen	Y, N	N
FUND_VI	Fundamental Voltage and Current Screens	Y, N	Y

**Table 4.1 Metering Screens Enable Settings (Sheet 2 of 2)**

Name	Description	Range	Default
DIFF	Differential Metering	Y, N	Y
ZONECFG	Terminals Associated With Zones	Y, N	Y

Use the front-panel settings (the **SET F** command from a communications port or the **Front Panel** settings in SEL Grid Configurator Software) to access the metering screen enable settings. Entering a **Y** (Yes) for a metering screen enable setting results in the corresponding metering screen appearing in the **ROTATING DISPLAY**. Entering an **N** (No) hides the metering screen from presentation in the **ROTATING DISPLAY**. If all metering screen enable settings are set to **N** (No) and there are no configured display points screens, the **DIFF** screen appears by default in the **ROTATING DISPLAY**. *Figure 4.1* shows a **ROTATING DISPLAY** example consisting of an example alarm points screen, a display points screen, and one of the factory-default metering screens (the screen values in *Figure 4.1* are representative values).



**Figure 4.1 ROTATING DISPLAY**

The active alarm points are the first screens in the ROTATING DISPLAY (see *Alarm Points on page 4.7 in the SEL-400 Series Relays Instruction Manual*). Each alarm points screen shows as many as 11 alarm conditions. The SEL-487B can present a maximum of six alarm points screens.

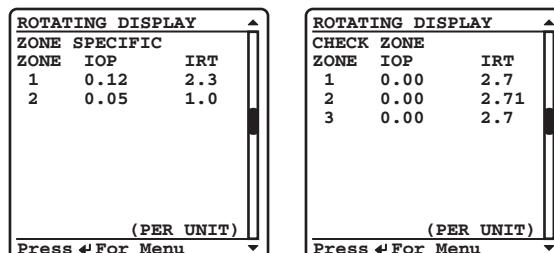
The active display points are the next screens in the ROTATING DISPLAY (see *Display Points on page 4.10 in the SEL-400 Series Relays Instruction Manual*). Each display points screen shows as many as 11 enabled display points. (With 192 display points, the SEL-487B can present a maximum of 18 display point screens.) If a display point does not have text to display, the screen space for that display point is maintained.

## METER

Factory-enabled metering screens scroll through the following metering screens:

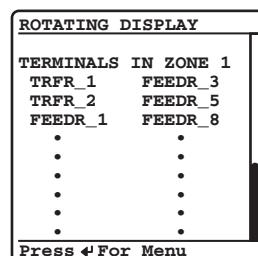
- Differential quantities
- Zone configuration (when active)
- Fundamental Current
- Fundamental Voltage

*Figure 4.2* shows the zone-specific and check-zone differential metering screens. The display shows the Bus-Zone number and the operating and restraint current for each active zone. An active zone is a zone with at least one terminal in the zone. Zones become inactive when there are no terminals connected to the zone or when the zone was merged with other zones. Inactive zones are not displayed. *Figure 4.2* shows an example with two zones active.



**Figure 4.2** Differential Screens

*Figure 4.3* shows the screen displaying the terminal(s) present in each active zone. For each active zone, the relay displays the terminals connected to that particular zone. When two zones merge, the new zone carries the zone number of the lower of the two zones. For example, when Zones 2 and 4 merge, the new combined zone becomes Zone 2.



**Figure 4.3** Terminals in Zone Screen

*Figure 4.4* shows the fundamental current screens, displaying the primary current and phase angle for each terminal.

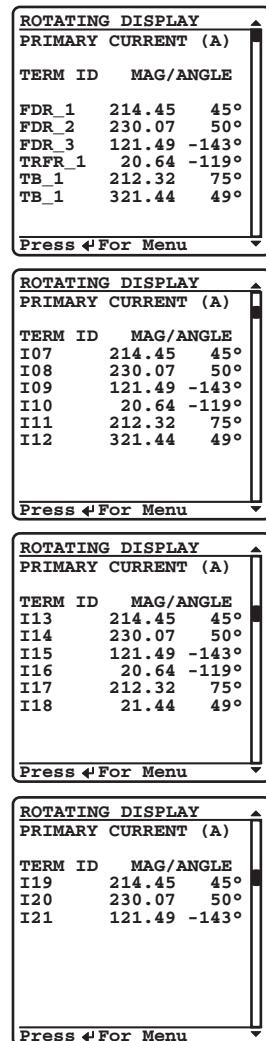


Figure 4.4 Fundamental Primary Current Screens

All angles are referenced to the voltage connected to voltage terminal V01. If the voltage at terminal V01 is not available, the relay selects V02, and then V03. In the absence of voltage inputs, the relay references the current input of I01, provided the current is above  $0.05 \cdot I_{NOM}$ . If I01 is not above this current level, the relay references the current from I02, if available. If I02 is not available, the relay continues to I03, I04, and so on until it finds a current input above  $0.05 \cdot I_{NOM}$ .

Figure 4.5 shows the primary voltage magnitudes and angles from the three voltage inputs in kV.

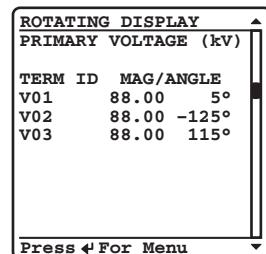
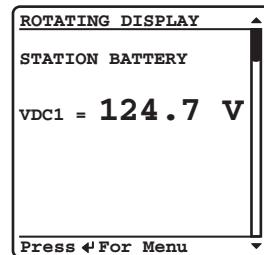


Figure 4.5 Fundamental Primary Voltage Screen

Use the **SET F** command and set STA\_BAT = Y to enable the station battery screen, as displayed in *Figure 4.6*.



**Figure 4.6** Station Battery Screen

## Front-Panel Menus and Screens

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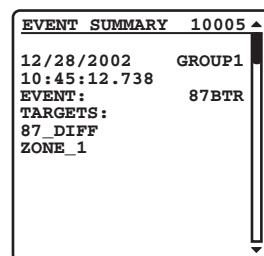
Operate the SEL-487B front panel through a sequence of menus that you view on the front-panel display. The **MAIN MENU** is the introductory menu for other front-panel menus. These additional menus allow you onsite access to control and port settings. Use the following menus and screens to set the relay and perform local control actions:

- Support Screens
  - Adjust Contrast
  - Password
- MAIN MENU
  - EVENTS
  - RELAY ELEMENTS
  - LOCAL CONTROL
  - SET/SHOW
  - RELAY STATUS
  - VIEW CONFIGURATION
  - DISPLAY TEST
  - RESET ACCESS LEVEL

See *Section 4: Front-Panel Operations in the SEL-400 Series Relays Instruction Manual* for information on most of these screens. The following screen descriptions are unique to the SEL-487B.

## Events

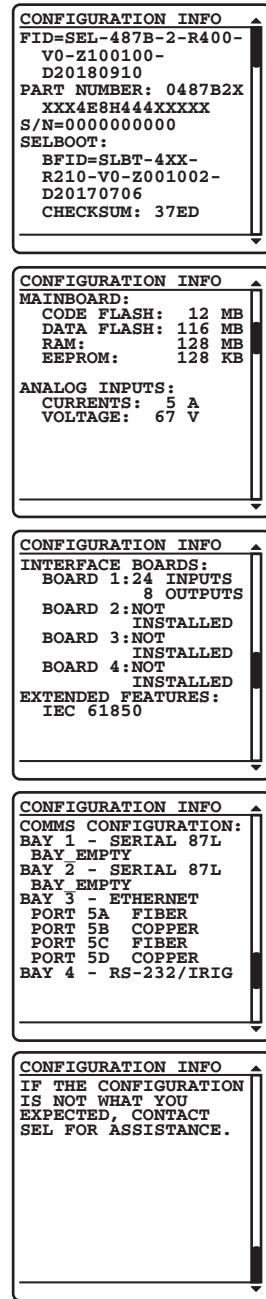
*Section 4: Front-Panel Operations in the SEL-400 Series Relays Instruction Manual* describes viewing summary events from the front panel. *Figure 4.7* illustrates what a summary event report looks like in a SEL-487B.



**Figure 4.7** EVENT SUMMARY Screen

## View Configuration

You can use the front panel to view detailed information about the configuration of the firmware and hardware components in the SEL-487B. In the **MAIN MENU**, highlight the **VIEW CONFIGURATION** option by using the navigation pushbuttons. The relay presents five screens in the order shown in *Figure 4.8*. Use the navigation pushbuttons to scroll through these screens. When finished viewing these screens, press **ESC** to return to the **MAIN MENU**.



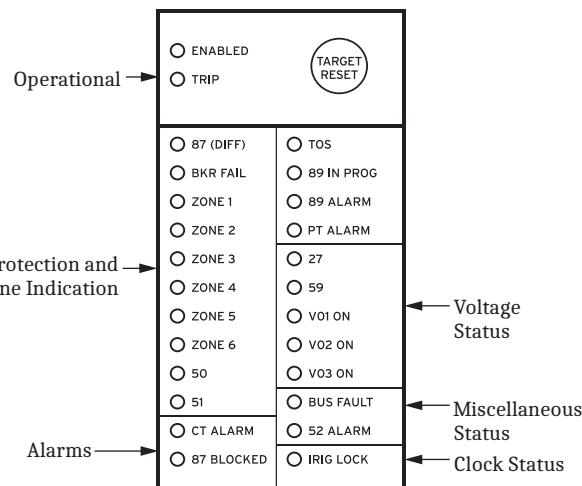
**Figure 4.8** VIEW CONFIGURATION Sample Screens

# Target LEDs

The SEL-487B gives you at-a-glance confirmation of relay conditions via operation and target LEDs. These LEDs are located in the middle of the relay front panel. The SEL-487B provides 24 LEDs.

The general operation and configuration of these LEDs is described in *Section 4: Front-Panel Operations in the SEL-400 Series Relays Instruction Manual*. Please note that the SEL-487B has the alternative behavior on the Tn\_LED bits: they latch independent of the trip condition. For a concise listing of the default programming on the front-panel LEDs, see *Front-Panel Settings on page 12.20 in the SEL-400 Series Relays Instruction Manual*.

Use the slide-in labels to mark the LEDs with custom names. Included on the SEL-400 Series Product Literature DVD are Customer Label Templates to print labels for the slide-in label carrier. *Figure 4.9* shows the arrangement of the operation and target LEDs region into several areas described in *Table 4.2*.



**Figure 4.9 Factory-Default Front-Panel Target Areas**

**Table 4.2 Front-Panel Target LEDs**

Label	Function
ENABLED, TRIP	Operational
87 (DIFF), BKR FAIL, ZONE 1, ZONE 2, ZONE 3, ZONE 4, ZONE 5, ZONE 6, 50, 51	Protection and Zone Indication
CT ALARM, 87 BLOCKED, TOS, 89 IN PROG, 89 ALARM, PT ALARM	Alarms
27, 59, V01 ON, V02 ON, V03 ON	Voltage Status
BUS FAULT, 52 ALARM	Miscellaneous Status
IRIG LOCK	Clock Status

## Protection and Zone Indication

The SEL-487B indicates essential information about the most recent relay trip event with the LEDs of the Protection and Zone Indication area. These trip types are **87 (DIFF)**, **BKR FAIL**, **ZONE 1-6, 50, 51**.

The **87 (DIFF)** target LED illuminates and latches the indication, indicating operation of any one of the six SEL-487B differential elements.

The **BKR FAIL** target LED illuminates and latches the indication, indicating operation of any one of the 21 SEL-487B breaker failure elements.

The **ZONE 1-6** target LEDs illuminate and latch the indication, indicating the zone(s) in which the fault occurred.

The **50** target LED illuminates and latches the indication, indicating operation of any one of the 21 nondirectional, instantaneous elements.

The **51** target LED illuminates and latches the indication, indicating operation of any one of the 21 nondirectional, time-delayed overcurrent elements.

## Alarms

The alarm area target indicators are the **CT ALARM**, **87 BLOCKED**, **TOS**, **89 IN PROG**, **89 ALARM**, **PT ALARM** LEDs.

The **CT ALARM** (current transformer) target illuminates but does not latch the indication when any one of the six sensitive differential elements times out.

The **87 BLOCKED** target illuminates and latches the indication when any one of the six Zone Supervision ( $Z_nS$ ) SELOGIC control equations becomes a logical 0.

The **TOS** (Terminal Out of Service) target illuminates but does not latch the indication when any one of the 21 terminals is out of service.

The **89 IN PROG** target illuminates but does not latch the indication when a disconnect operation is in progress on any one of the 60 disconnects.

The **89 ALARM** (Disconnect Alarm) target illuminates but does not latch the indication when the disconnect alarm 89AL asserts.

The **PT ALARM** (potential transformer) target illuminates and latches after a 240-cycle time delay, indicating the presence of a negative- or zero-sequence voltage. This function works on the assumption that all three phases from the PTs are available in the same relay with an ABC phase rotation. In a three-relay application, wire the three phases from the PTs to the same SEL-487B.

## Voltage Status

The **27** target LED illuminates when any one of the terminal undervoltage elements operates.

The **59** target LED illuminates when any one of the terminal overvoltage elements operates.

The **V01 ON**, **V02 ON**, and **V03 ON** LEDs illuminate when the terminal filtered instantaneous voltages are greater than 55 V. See *Table 8.47* for setting default values. The default setting of 55 V is 82 percent of the line-to-neutral nominal voltage of 67 V to coincide with the nominal line-to-line voltage of 115 V.

## Miscellaneous Status

The **BUS FAULT** target LED illuminates when a busbar fault is detected (Relay Word bit FAULT is asserted).

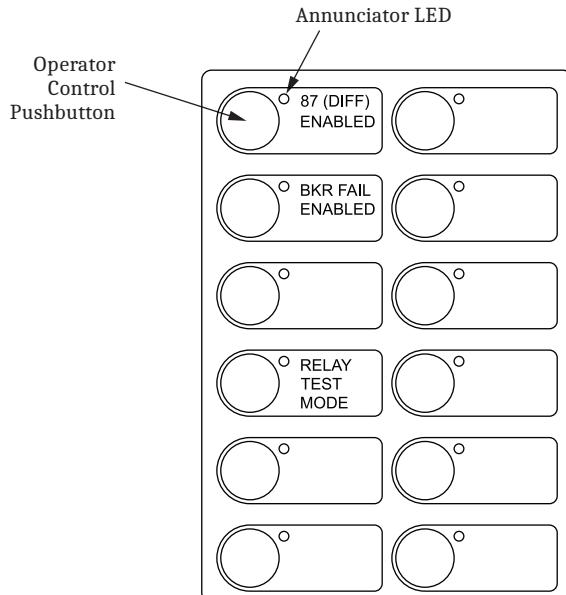
The **52 ALARM** target LED illuminates when the relay detects any circuit breaker alarm (Relay Word bit 52AL is asserted).

## Clock Status

The **IRIG LOCK** target LED illuminates in the SEL-487B when the relay detects synchronization to an external clock with less than 500 ns of jitter (Relay Word bit TIRIG is asserted). See *IRIG-B Timekeeping on page 11.1 in the SEL-400 Series Relays Instruction Manual* for complete details.

## Front-Panel Operator Control Pushbuttons

The SEL-487B front panel features large operator control pushbuttons coupled with amber annunciator LEDs for local control. *Figure 4.10* shows this region of the relay front panel with factory-default configurable front-panel label text. The SEL-487B provides 12 pushbuttons.



**Figure 4.10** Operator Control Pushbuttons and LEDs

Factory-default programming associates specific relay functions with the pushbuttons and LEDs. The SEL-487B default setting uses only three of the pushbuttons, as listed in *Table 4.3*. For a concise listing of the default programming for the front-panel pushbuttons and LEDs, see *Front-Panel Settings on page 8.21*.

**Table 4.3 Operator Control Pushbuttons and LEDs—Factory Defaults**

LED	Function
87 (DIFF) ENABLED	Enable the differential protection
BKR FAIL ENABLED	Enable the breaker failure protection
RELAY TEST MODE	Enable the differential and breaker failure protection, but inhibit trip outputs

Press the operator control pushbuttons momentarily to toggle on and off the functions listed adjacent to each LED/pushbutton combination. The operator control pushbuttons and LEDs are programmable. *Figure 4.11* describes the factory defaults for the three operator controls.

There are two ways to program the operator control pushbuttons. The first is through front-panel settings `PBn_HMI`. These settings allow any of the operator control pushbuttons to be programmed to display a particular HMI screen category. The HMI screen categories available are Alarm Points, Display Points, Event Summaries, and SER. All `PBn_HMI` settings are OFF by default. Front-panel setting `NUM_ER` allows the user to define the number of event summaries that are displayed via the operator control pushbutton; it has no effect on the event summaries automatically displayed or the event summaries available through the main menu. Each HMI screen category can be assigned to a single pushbutton. Attempting to program more than one pushbutton to a single HMI screen category will result in an error. After assigning a pushbutton to an HMI screen category, pressing the pushbutton will jump to the first available HMI screen in that particular category. If more than one screen is available, a navigation scroll bar will be displayed. Pressing the navigation arrows will scroll through the available screens. Subsequent pressing of the operator control pushbutton will advance through the available screens, behaving the same as the **Right Arrow** or the **Down Arrow** pushbutton. Pressing the **ESC** pushbutton will return the user to the ROTATING DISPLAY.

The second way to program the operator control pushbutton is through SELOGIC control equations, using the pushbutton output as a programming element. Using SELOGIC control equations, you can change the default pushbutton and LED functions. Use the slide-in labels to mark the pushbuttons and pushbutton LEDs with custom names to reflect any programming changes that you make. The labels are keyed; you can insert each Operator Control Label in only one position on the front of the relay. Word processor templates for printing slide-in labels are included on the SEL-400 Series Product Literature DVD. See *Front-Panel Templates on page 2.2* for more information on changing the slide-in labels.

The SEL-487B has two types of outputs for each of the front-panel pushbuttons. Relay Word bits represent the pushbutton presses. One set of Relay Word bits follows the pushbutton and another set pulses for one processing interval when the button is pressed. Relay Word bits `PB1–PB12` are the “follow” outputs of operator control pushbuttons. Relay Word bits `PB1_PUL–PB12PUL` are the “pulsed” outputs.

Annunciator LEDs for each operator control pushbutton are `PB1_LED–PB12LED`. The factory defaults programmed for three LEDs used are protection latches (`PLT01`, for example), settings groups, and Relay Word bits. The asserted and deasserted colors for the LED are determined with settings `PB1COL–PB12COL` (12-pushbutton version). Options include red, green, amber, or off. You can change the LED indications to fit your specific control and operational requirements. This programmability allows great flexibility and provides operator confidence and safety, especially in indicating the status of functions that are controlled both locally and remotely.

SELLOGIC Factory Setting	Operator Control Pushbutton Label	LED Label	Description
PB1_LED = DIFF_EN # Differential Protection Enabled		87 (DIFF) ENABLED	Press this operator control pushbutton enable differential protection. The corresponding 87 (DIFF) ENABLED LED is illuminated amber indicating that DIFF_EN=1. DIFF_EN is the default alias setting for the Relay Word bit PLT01. DIFF_EN is included in the Terminal to Bus Connection Logic setting for $IqqBZpV$ ( $qq = 00\text{--}21, p = 1\text{--}6$ ) and effectively supervises the terminal to bus-zone connection. Therefore, if PB1 is not pressed, DIFF_EN = 0 and the terminal $Iqq$ will not be connected to bus zone $BZp$ . To disable differential protection, press and hold this pushbutton for one second until the LED is no longer illuminated. If the LED is off, DIFF_EN = 0.
PB2_LED = BF_EN # Breaker Failure Enabled		BKR FAIL ENABLED	Press this operator control pushbutton enable breaker failure initiate settings. The corresponding BKR FAIL ENABLED LED is illuminated amber indicating that BF_EN = 1. BF_EN is the default alias setting for the Relay Word bit PLT02. BF_EN is included in the Breaker Failure Initiate setting for BFI01–BFI06. Therefore, if PB2 is not pressed, BF_EN = 0 and the breaker failure initiate equation cannot be true. To disable breaker failure protection, press and hold this pushbutton for one second until the LED is no longer illuminated. If the LED is off, BF_EN = 0.
PB3_LED = NA			
PB4_LED = TNS_SW # Test normal Switch Enabled		RELAY TEST MODE	Press this operator control pushbutton to disable outputs OUT201–OUT205 and close OUT207. The corresponding RELAY TEST MODE LED is illuminated amber indicating that TNS_SW = 1. TNS_SW is the default alias setting for the Relay Word bit PLT03. TNS_SW is included in the output equation for OUT201–OUT205. Therefore, if PB4 is pressed, TNS_SW = 1 and the output equations supervised by this Relay Word bit cannot be true and the associated outputs will not close. This is useful functionality for testing TRIP01–TRIP05 equations during commissioning, but preventing the output operation. To disable the test mode, press and hold this pushbutton for one second until the LED is no longer illuminated. If the LED is off, TNS_SW = 0.
PB5_LED = NA			
PB6_LED = NA			
PB7_LED = NA			
PB8_LED = NA			
PB9_LED = NA			
PB10LED = NA			
PB11LED = NA			
PB12LED = NA			

**Figure 4.11 Factory-Default Operator Control Pushbuttons**

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## S E C T I O N 5

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# Protection Functions

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**NOTE:** You can order the SEL-487B-2 as an SV subscriber relay or as a TIDL relay. For SV applications, operating times are delayed by the configured channel delay, CH\_DLY. See SV Network Delays on page 17.25 in the SEL-400 Series Relays Instruction Manual for more details. For TIDL applications, the operating times are delayed by a fixed 1 ms. Use caution when setting relay coordination to account for this added delay.

This section provides a detailed explanation of the SEL-487B-2 Relay protection functions. Each subsection provides an explanation of the function, along with a list of the corresponding settings and Relay Word bits. Logic diagrams and other figures are included.

Functions discussed in this section are listed below.

- *Analog Channel Statuses on page 5.1*
- *Sampled Values Alarm Logic (SEL-487B-2 SV Subscriber Relay) on page 5.3*
- *Application Setting SVBLK and Relay Word Bit SVBK\_EX on page 5.4*
- *Differential Zone and Check Zone Logic on page 5.6*
- *Busbar Protection Elements on page 5.7*
- *Check-Zone Protection Elements on page 5.16*
- *Sensitive Differential Element on page 5.18*
- *Zone Supervision Logic on page 5.20*
- *Dynamic Zone Selection Logic on page 5.20*
- *Check-Zone Selection on page 5.22*
- *Instantaneous/Delayed Overcurrent Elements on page 5.23*
- *Selectable Time-Overcurrent Elements (51) on page 5.24*
- *Over- and Undervoltage Elements on page 5.31*
- *Open-Phase Detection Logic on page 5.34*
- *Open CT Detection Logic on page 5.35*
- *Circuit Breaker Failure Protection on page 5.36*
- *Circuit Breaker Failure Trip Logic on page 5.40*
- *Bus Coupler/Bus Sectionalizer Configurations on page 5.42*
- *Coupler Security Logic on page 5.43*
- *Disconnect Monitor on page 5.49*
- *Zone-Switching Supervision Logic on page 5.51*
- *Differential Trip Logic on page 5.52*
- *Breaker Trip Logic on page 5.54*
- *Circuit Breaker Status Logic on page 5.55*

## Analog Channel Statuses

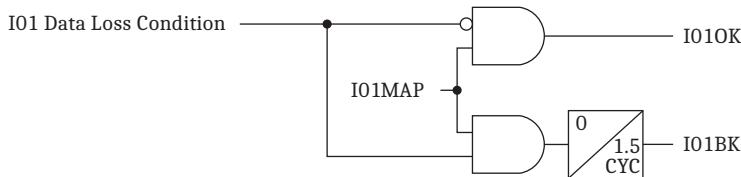
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The SEL-487B-2 provides Relay Word bits for monitoring the status of analog channel data received over a DSS connection. Relay Word bits I01MAP–I21-MAP assert to indicate that the relay is configured to receive data for the respec-

tive current channels from a merging unit. Relay Word bits V01MAP–V03MAP assert to indicate that the relay is configured to receive data for the respective voltage channels from a merging unit. For example, I01MAP = 1 and V01MAP = 1 if I01 and V01 are configured to receive data over a DSS connection. Otherwise, these Relay Word bits evaluate to zero.

The relay declares each analog channel to be either OK or Blocked depending on the following criteria (*Figure 5.1* illustrates the processing of I01OK and I01BK as an example):

- If an analog channel is mapped (such as I01MAP = 1), and if no more than three samples (for Sampled Values [SV] subscriber relays) or seven samples (for Time-Domain Link [TiDL] relays) are unusable or lost, the corresponding OK Relay Word bit asserts (such as I01OK = 1).
- If an analog channel is mapped (such as I01MAP = 1), and if more than three samples (for SV subscriber relays) or seven samples (for TiDL relays) are unusable or lost, the corresponding Blocked Relay Word bit asserts (such as I01BK = 1).
- The Blocked Relay Word bit has a 1.5-cycle dropout timer when the channel data becomes good and usable again to account for proper filtering of the incoming signal.
- If an analog channel is not mapped (such as I01MAP = 0), neither the OK nor the Blocked Relay Word bit asserts.
- A data loss condition occurs when a relay can no longer interpolate between data points to account for missed data. In the SV relay, the loss of more than three consecutive samples results in a data loss condition. In the TiDL relay, the loss of more than seven consecutive samples results in a data loss condition.

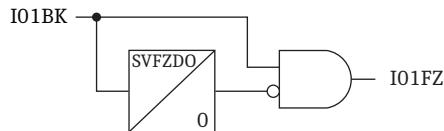


**Figure 5.1 I01 Channel Status Processing (Similar for Other Channels)**

Relay Word bits I01OK–I21OK assert to indicate good data for the respective current channels. Relay Word bits V01OK–V03OK assert to indicate good data for the respective voltage channels. You can use these Relay Word bits to monitor the health of the DSS.

*Figure 5.2* illustrates the freeze logic of analog current channels.

The freeze dropout delay setting, SVFZDO, allows users to reset the freeze logic for a permanent communications outage. If SVFZDO is set to the default value of OFF, the output of the timer is forced to always be deasserted and the freeze Relay Word bits follow the blocking Relay Word bits. When SVFZDO is set to 0, the freeze Relay Word bit is permanently blocked. Changing SVFZDO to a value other than OFF or 0 specifies the time to deassert the freeze Relay Word bit for a permanent loss of data.



**Figure 5.2 Current Channel Freeze Logic for Channel 01 (Similar for Other Current Channels)**

## Sampled Values Alarm Logic (SEL-487B-2 SV Subscriber Relay)

**NOTE:** This functionality is only for the SV subscriber relay and not for the TIDL relay.

While the SV analog channel status Relay Word bits allow the user to monitor the health of individual analog channels and maintain protection element security, the general SV alarm logic alerts the user to potential communication and time source problems. *Figure 5.3* illustrates the SV alarm logic, which generates Relay Word bit SVSALM, which asserts under the following conditions:

- After a falling edge of Relay Word bit SVCC (SV coupled-clocks mode), SVSALM asserts until a subsequent rising edge of SVCC. SVCC = 0 indicates that the SEL-487B-2 SV Subscriber Relay is not operating in coupled-clocks mode, and is instead operating in freewheeling mode. This indicates a potential problem with the time source that serves the relay or the merging unit.
- The relay is in coupled-clocks mode (SVCC = 1), and the total network delay associated with any configured SV data stream is excessive (among Streams 1 through 7, for as many as seven streams). The measured total network delay includes the network path delay and the merging-unit processing delay. The measured total network delay for each stream is compared against the CH\_DLY relay setting. SVSALM assertion through this logic path indicates potential communication network issues or excessive merging-unit processing delays.
- Any configured SV stream is declared invalid (SVSmmOK = 0, mm = 01–07). Problems such as packet corruption and packet loss can cause an SV subscription to be discarded by the SEL-487B-2 SV Subscriber Relay. These may indicate communication network problems.

Note that if the relay has been in freewheeling mode since turning on, the SVSALM logic will not assert through the upper latch shown in *Figure 5.3*. SVSALM will only assert if the relay begins in coupled-clocks mode and subsequently falls out of coupled-clocks mode and into freewheeling mode. If SVSALM asserts in the SEL-487B-2 SV Subscriber Relay, be sure to check your communication network and time sources for potential problems.

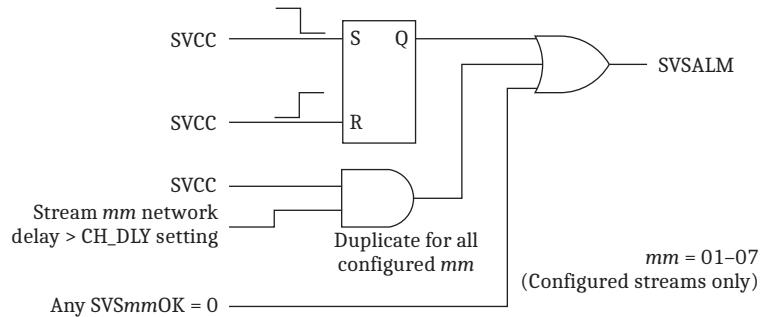


Figure 5.3 General SV Alarm Logic (SVSALM)

## TiDL Alarm Logic (SEL-487B-2 TiDL Relay)

**NOTE:** This functionality is only for the TiDL relay and not for the SV subscriber relay.

While the analog channel status Relay Word bits allow the user to monitor the health of data mapped to analog terminals of the relay, the general TiDL alarm logic alerts the user to any communications issue with a connected and commissioned SEL-TMU. Figure 5.4 illustrates the TiDL alarm logic, which generates Relay Word bit TIDLALM. TIDLALM asserts under the condition that the SEL TiDL relay has identified a communication issue with at least one of its commissioned SEL-TMU.

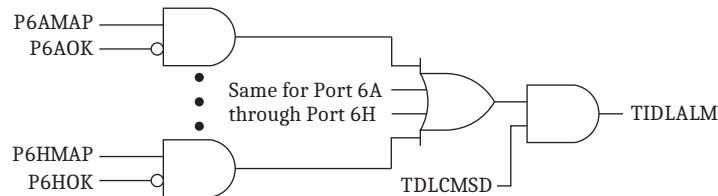


Figure 5.4 General TiDL Alarm Logic (TIDLALM)

## Application Setting SVBLK and Relay Word Bit SVBK\_EX

**NOTE:** The overcurrent elements in the SEL-487B-2 SV Subscriber Relay are inherently secure during data loss because they operate on phase quantities. The differential elements have dedicated blocking logics that are independent of Relay Word bits SVBLK and SVBK\_EX.

In both the SEL-487B-2 SV Subscriber Relay and SEL-487B-2 TiDL Relay, use Global application SELOGIC setting SVBLK to specify the general conditions under which DSS data are unsuitable for use. You are free to specify this equation in any way, but SEL recommends that you use the analog channel blocking Relay Word bits in this equation. For an application that uses current Terminals I01 through I04 for bus differential protection and voltage Terminals V01 through V03 for undervoltage protection, a reasonable setting for SVBLK is (SVBLK := V01BK OR V02BK OR V03BK OR I01BK OR I02BK OR I03BK OR I04BK). Figure 5.5 shows the extended blocking logic.

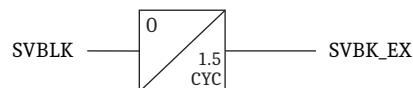


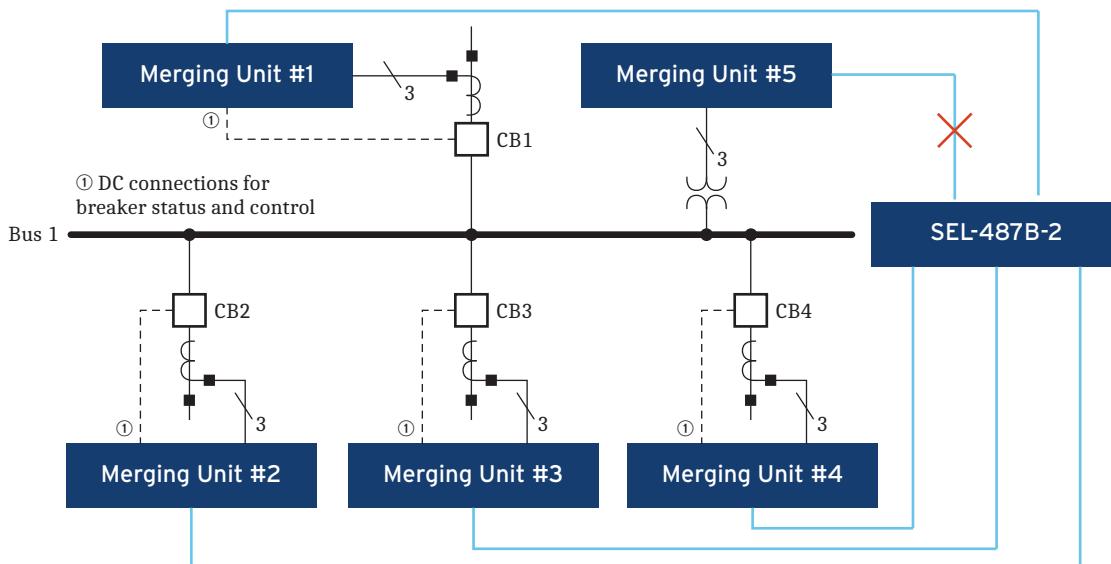
Figure 5.5 Extended Application Blocking Logic (SVBK\_EX)

# Selective Protection Disabling

The term “selective protection disabling” is used in some protection functions to discuss the application of the analog channel status block or freeze Relay Word bits in blocking or freezing certain protection elements and their outputs as a result of a loss of communications with a merging unit.

The goal of selective protection disabling is to maximize the availability of protection functions that are not impacted by the loss of data that are not required by that protection function.

A bus current differential scheme is an example of using selective protection disabling where the bus voltage is provided by a merging unit that is not providing differential current measurements. *Figure 5.6* shows a simplified bus differential scheme with the bus voltage provided by an SEL-TMU, and differential current provided by four other SEL-TMU. In this example application, a loss of communications with the SEL-TMU that is measuring bus voltage only blocks protection elements relying on those voltage measurements and allows for the continued operation of the bus differential elements.



**Figure 5.6 Selective Protection Disabling Overview**

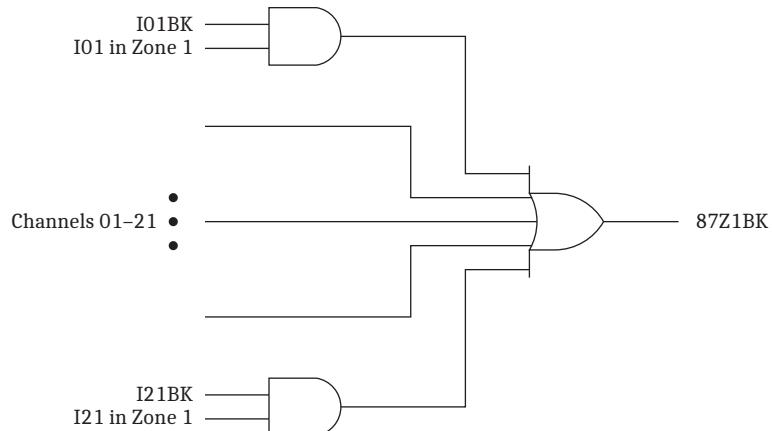
To perform selective protection disabling, some relay protection elements (such as open-phase detection, breaker failure, etc.) are hard-coded to include block and freeze Relay Word bits as needed. Set other elements that provide torque-control equations (such as 27, 59, etc.) to include the block or freeze Relay Word bits in their torque-control equations. Some torque-control equations are set by default to include blocking Relay Word bits, primarily when negative-sequence or zero-sequence quantities are used as default operating quantities. You can customize these torque-control equations and use the idea of torque controlling with these bits in your custom SELOGIC freeform logic to perform selective protection disabling within your custom logic.

## Differential Zone and Check Zone Logic

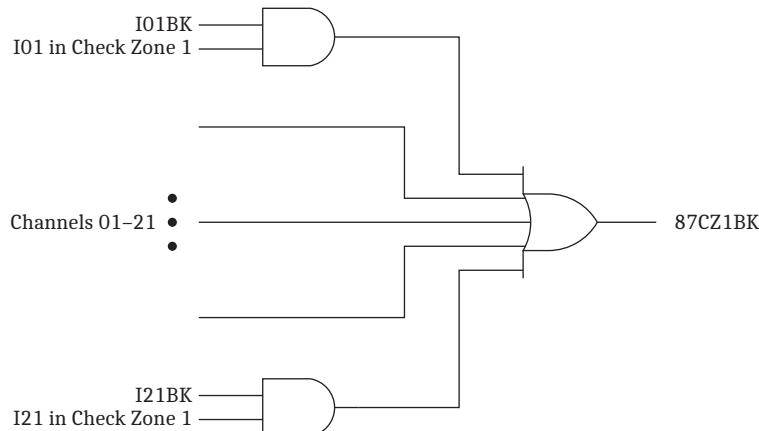
When using DSS data for differential protection, any loss of data on a current terminal within the differential zone or check zone creates a false operating current, compromising the security of the differential element. To keep the differential element secure during such a scenario, the SEL-487B-2 includes dedicated logic to block the differential zones and check zones, as shown in *Figure 5.7* and *Figure 5.8*. Loss of data for currents within the differential zones or check zones blocks the affected differential zones or check zones from operating, subject to the following two conditions:

- Loss of more than three packets (for SV subscriber relays) or seven packets (for TiDL relays) associated with the current channel, resulting in the assertion of the channel blocking bit (ex: I01BK has asserted for Current Channel I01)
- The current channel is included in the differential zone or check zone, according to settings entered by the user (see *Dynamic Zone Selection Logic on page 5.20* and *Dynamic Zone Selection Logic on page 5.20* for details)

For example, if the above criteria are met for any of the current channels included within Differential Zone 1, Relay Word bit 87Z1BK asserts to block Differential Zone 1. If the above criteria are met for any of the current channels included within the Check Zone 1, Relay Word bit 87CZ1BK asserts to block Check Zone 1. The six differential zones and three check zones operate similarly in this regard. In the SEL-487B-2 Relay, these Relay Word bits are included by default in the zone supervision and check zone supervision logic equations (see *Zone Supervision Logic on page 5.20* for details). SEL recommends that you keep this logic in the zone supervision equations, alongside any additional logic you wish to add.



**Figure 5.7 Differential Zone 1 Blocking Logic (Zones 2-6 Are Similar)**



**Figure 5.8 Check Zone 1 Blocking Logic (Check Zones 2 and 3 Are Similar)**

## Busbar Protection Elements

Busbar protection philosophy traditionally calls for two-out-of-two trip criteria, where two separate measuring elements must agree before protection issues a trip signal. Realization of the two-out-of-two trip criteria can occur by using one of the combinations of measuring elements listed below:

- Dual differential element combination (main zone and check zone)
- Differential element and directional element combination (main zone and directional element)

Each combination has an advantage over the other; the weakness of one being the strength of the other. In particular, differential elements (amplitude comparators) are more vulnerable to CT saturation than directional elements (phase comparators), but directional elements (phase comparators) are more vulnerable to high-impedance faults.

CT saturation is a concern in networks with high fault currents. Poor CT selection increases the potential for CT saturation. In networks with impedance grounding, all ground faults are high-impedance faults. Although relays may have been correctly selected in the initial network design, changes in the network may adversely influence the network parameters. For example, network extensions or reduced source impedance result in higher fault current, and deterioration of the substation grounding mat at the substation may result in higher fault impedance for ground faults.

Modern busbar protection relays should not only include protection elements to allow for diverse network parameters, but the implementation of these elements in the relays must ensure continual, uncompromising relay performance, despite changes in network parameters. In general, busbar protection must comply with the following performance requirements:

- Fast operating times for all busbar faults
- Security for external faults with heavy CT saturation
- Minimum delay for evolving faults

The SEL-487B meets the above performance requirements during all system operating conditions. The relay includes six busbar protection elements for the protection of as many as six zones. Each of the six busbar protection elements consists of the following three elements (see *Figure 5.9*):

- Differential element using phasor values
- Directional element using phasor values
- Fault detection logic using instantaneous values

*Figure 5.9* shows a block diagram of one of the six busbar protection elements, with only two (I01 and I02) of the available 21 current inputs connected. The relay uses the highest CT ratio ( $CTR_{MAX}$ ) divided by the lowest CT ratio ( $CTR_{MIN}$ ) to verify that the CT ratio mismatch for the differential protection is less than 10:1. Only CT ratios associated with terminals that are used in the terminal-to-bus-zone settings will be used to determine  $CTR_{MAX}$  and  $CTR_{MIN}$ . Because the relay accepts current inputs from CTs with a 10:1 ratio mismatch, the calculations for the differential elements are performed on per unit values. The relay uses the highest CT ratio ( $CTR_{MAX}$ ) of the installed CT ratios as a reference value in converting the input currents from ampere to per unit values. Using *Equation 5.1*, the relay calculates a normalization factor value (TAP) for each terminal:

$$TAP_{nn} = \frac{CTR_{MAX} \cdot I_{NOM}}{CTR_{nn}}$$

**Equation 5.1**

where:

$TAP_{nn}$  = TAP value for each terminal to convert current from ampere to per unit ( $nn = 01-21$ )

$CTR_{MAX}$  = Highest CT ratio of the terminals used in the terminal-to-bus-zone settings

$I_{NOM}$  = Nominal CT secondary current (1 A or 5 A)

$CTR_{nn}$  = CT ratio of the specific terminal

Using the  $TAP_{nn}$  values, the relay calculates the current in per unit values for each terminal as shown in *Equation 5.2*:

$$InnCR = \frac{Inn}{TAP_{nn}} pu$$

**Equation 5.2**

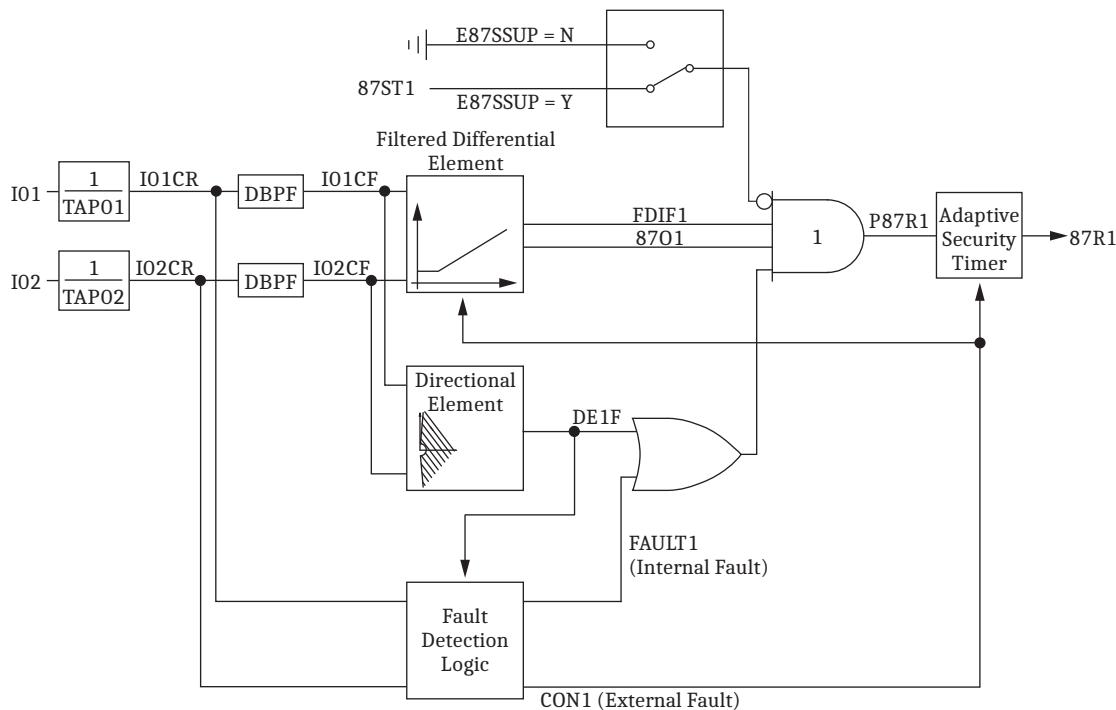
where:

$InnCR$  = Per unit current for Terminals I01–I21

$Inn$  = Current in amperes for Terminals I01–I21

$pu$  = per unit

*Figure 5.9* shows the block diagram for Busbar Protection Element 1, one of six busbar protection elements available in the relay. Throughout the following element descriptions, the numerical part of the Relay Word bits refers either to elements from a specific busbar protection element (1–6) or the specific terminal number (01–21). In most cases, the protection element descriptions refer to elements from Busbar Protection Element 1. For example, FDIF1 in *Figure 5.9* refers to the output from the filtered differential element of Busbar Protection Element 1. I01 and I02 refer to current inputs from Terminal I01 and Terminal I02.



**Figure 5.9 Block Diagram Showing the Logic for Busbar Protection Element 1**

Referring to *Figure 5.9*, after the per unit conversion, the data (I01CR and I02CR) follow two separate paths. One path is through a digital band-pass filter (DBPF) to the filtered differential element and the directional element; the other path brings the instantaneous values to the fault detection logic.

The filtered differential element uses the input currents from each terminal in a protection zone to calculate the operate and restraint currents. The directional element compares the direction of current at a reference terminal to the direction of current at all other terminals in a protection zone to calculate fault direction. Several elements combine in the fault detection logic to distinguish between internal or busbar faults (FAULT1) and external faults (CON1).

AND Gate 1 combines the OR combination of the directional element (DE1F) and internal fault element (FAULT1) with the sensitive differential element (87ST1) to supervise the filtered differential element. P87R1, the output from Gate 1, drives a security timer that controls the final output (87R1) of the busbar protection element.

The logic includes three dedicated check zones (see *Check-Zone Protection Elements on page 5.16*). This flexibility provides the opportunity to configure the dual differential (main zone and check zone) element combination.

## Filtered Differential Element

The following discussion refers to the Filtered Differential Element 1, (with only Terminals 01 and 02 connected to the element) but applies equally well to the remaining five filtered differential elements. Using the output quantities from the

digital band-pass filter (cosine filter), the filtered differential element calculates a restraint quantity, IRT1, and an operating quantity, IOP1, according to *Equation 5.3* and *Equation 5.4*:

$$IRT1 = |I01CF| + |I02CF| \quad \text{Equation 5.3}$$

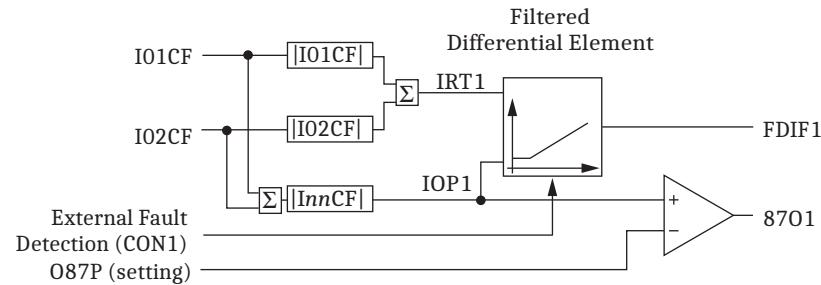
and

$$IOP1 = |I01CF + I02CF| \quad \text{Equation 5.4}$$

where:

I01CF and I02CF = Filtered per unit current values from Terminals I01 and I02

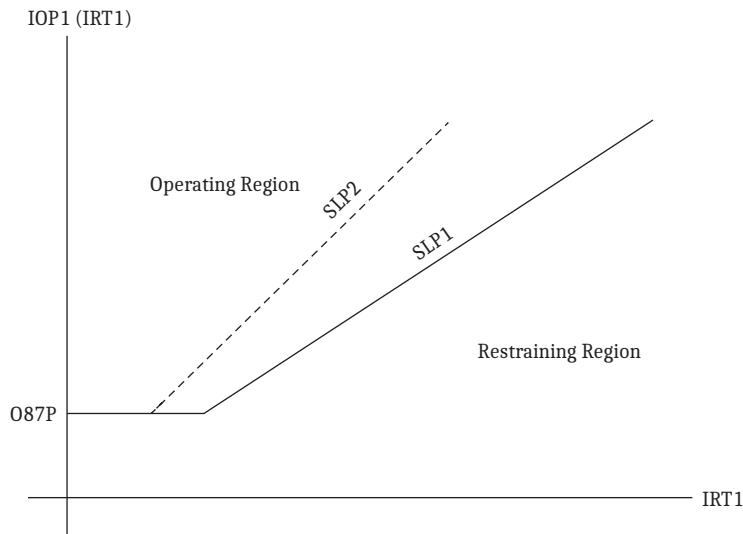
*Figure 5.10* shows a block diagram of the elements necessary for obtaining the differential and restraint quantities used in the filtered differential elements. Relay Word bit FDIF1 is the output from the differential calculation. Relay Word bit 8701 asserts when the differential current exceeds the O87P threshold. Together these two Relay Word bits form the filtered differential element characteristic.



**Figure 5.10 Filtered Differential Element 1**

*Figure 5.11* shows the characteristic of the differential element as a straight line through the origin of the form:

$$IOP1(IRT1) = SLP(1 \cdot IRT1) \quad \text{Equation 5.5}$$

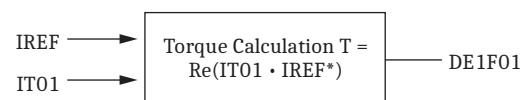
**Figure 5.11 Filtered Differential Element Characteristic**

For operating quantities (IOP1) exceeding the threshold level O87P and falling in the operate region of *Figure 5.11*, the filtered differential element issues an output. There are two slope settings. Slope 1 (SLP1) is effective for internal faults, and Slope 2 (SLP2) is effective for external faults. To change the slope values, first enable the advance settings by setting EADVS := Y in Group Settings and then proceed to change the slope values. When the fault detection logic detects an external fault condition, Relay Word bit CON1 asserts. CON1 switches the slope of the differential characteristic from Slope 1 to Slope 2 to add security to the filtered differential element (see *Fault Detection Logic on page 5.13*).

## Directional Element

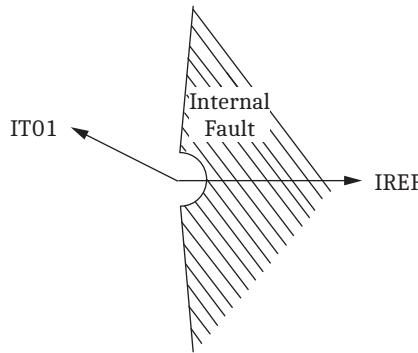
The relay includes directional elements that supervise the filtered differential elements. In particular, the directional elements provide additional security to the filtered differential elements during external faults with heavy CT saturation conditions. Each of the six busbar protection elements has a directional element specific to that differential element.

The directional element compares the direction of current at the reference terminal to the direction of current at all other qualifying terminals in each zone. A qualifying terminal is a terminal with current value greater than the 50DSP threshold setting; the relay selects one of these currents as a reference. For each calculation, the relay uses the real part of the product of the terminal current and the conjugate of the current at the reference terminal, as depicted in *Figure 5.12*.

**Figure 5.12 Torque Calculation Used in the Directional Element to Determine Fault Direction**

The relay declares an internal fault condition when the direction of current at all the remaining terminals coincides with the direction of current at the reference terminal. For the directional element to begin processing, the current values of at least two terminals within the zone must exceed the 50DSP threshold.

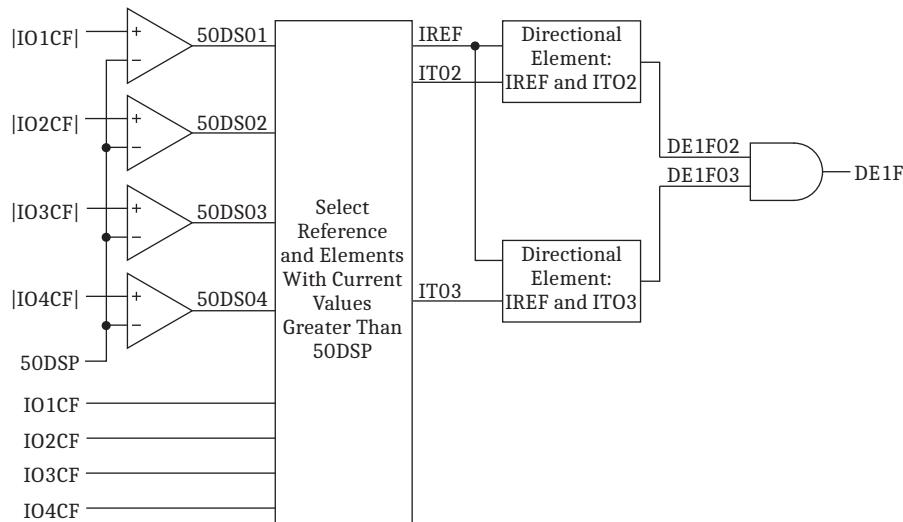
*Figure 5.13* shows the directional element characteristic, the shaded area indicating an internal fault.



**Figure 5.13 Directional Element Characteristic, the Shaded Area Indicating an Internal Fault**

The relay acquires the terminals within each specific protection zone from the zone selection logic. The relay determines the terminals with phase current greater than the 50DSP threshold and selects one of the currents greater than the 50DSP threshold as a reference. The relay establishes fault direction by comparing the direction of current at the reference terminal to that at the remaining terminals in the zone with phase current greater than the 50DSP threshold.

Referring to *Figure 5.14*, consider the case of four terminals in Zone 1, with inputs labeled I01CF, I02CF, I03CF, and I04CF. Further assume that the current magnitude in terminal I04CF is below the 50DSP threshold.

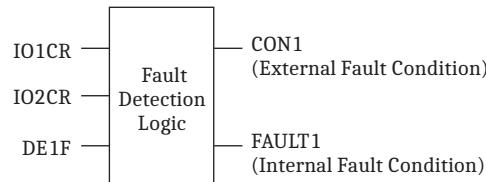


**Figure 5.14 Directional Element Logic**

First, the directional element determines which terminals have phase current magnitude greater than the 50DSP threshold. Because the current magnitude of input I04CF is below the 50DSP threshold, the relay selects only inputs I01CF, I02CF, and I03CF for further processing. The relay selects input I01CF as the reference (IREF) and compares the direction of current I02CF (IT02) and current I03CF (IT03) to this reference. DE1F asserts only if the direction of current at both IT02 and IT03 coincides with the direction of current at the reference terminal according to the directional element characteristic shown in *Figure 5.13*.

## Fault Detection Logic

The fault detection logic distinguishes between external faults (external fault detection logic) and internal faults (internal fault detection logic), as shown in *Figure 5.15*. When the fault detection logic detects an external fault, Relay Word bit CON1 asserts, and when the fault detection logic detects an internal fault, Relay Word bit FAULT1 asserts.



**Figure 5.15 Fault Detection Logic That Distinguishes Between External and Internal Faults**

Elements in the fault detection logic use instantaneous per unit currents to calculate a restraint quantity, IRT1R, and an operating quantity, IOP1R, according to *Equation 5.6* and *Equation 5.7*:

$$\text{IRT1R} = |(\text{I01CR})| + |(\text{I02CR})|$$

**Equation 5.6**

and

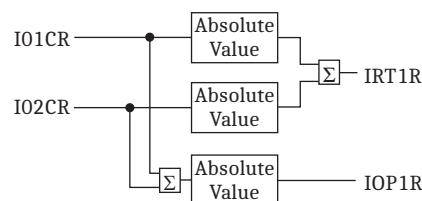
$$\text{IOP1R} = |(\text{I01CR} + \text{I02CR})|$$

**Equation 5.7**

where:

I01CR and I02CR = Instantaneous per unit current from Terminals 01 and 02.

*Figure 5.16* shows a block diagram of how the fault detection logic obtains restraint quantity IRT1R and operating quantity IOP1R.

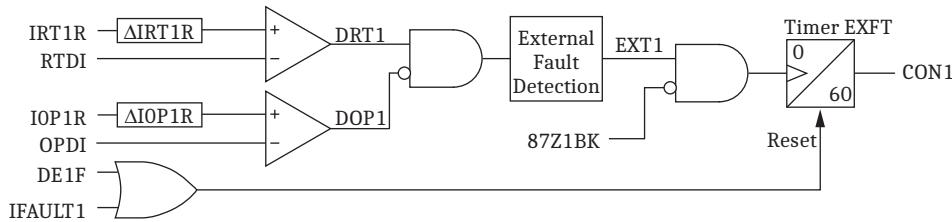


**Figure 5.16 Fault Detection Logic Obtaining Restraint and Operating Quantities**

## External Fault Detection Logic

In general, operating and restraint currents increase simultaneously for internal faults; for external faults, only the restraint current increases if there is no CT saturation. By comparing the change in operating current ( $\Delta\text{IOP1R}$ ) to the change in restraint current ( $\Delta\text{IRT1R}$ ), the relay detects external fault conditions. Because CTs can saturate during external faults, the relay asserts the external fault condition (Relay Word bit CON1) for 60 cycles after detecting an external fault.

*Figure 5.17* shows the logic for detecting external fault conditions.



**Figure 5.17 External Fault Detection Logic**

Asserting CON1 for 60 cycles can slow relay operation for evolving faults (where the fault starts as an external fault and then develops into an internal fault). To prevent delayed tripping, CON1 resets when either the directional element (DE1F) detects an evolving fault or the internal fault detection logic (IFault1) confirms an internal fault condition.

Relay Word bit CON1 controls the operating mode of the relay by asserting when the relay detects an external fault. The relay operates normally with CON1 deasserted but switches to a high-security mode when CON1 asserts. High security causes the following in the relay:

- Slope 1 changes to Slope 2.
- Delay time of the adaptive security timer increases.

Resetting CON1 releases the relay from the high-security mode, and the relay operates with the normal settings.

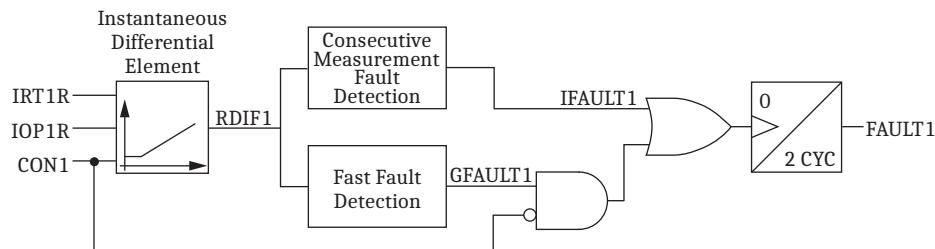
When current data associated with Zone 1 are lost, the corresponding zone blocking bit (87Z1BK) prevents CON1 from asserting.

## Internal Fault Detection Logic

For the internal fault detection logic, the relay uses a characteristic similar to the filtered differential element characteristic.

Figure 5.18 shows the internal fault detection logic consisting of the instantaneous differential element, the consecutive measurement fault detection logic, and the fast fault detection logic. When the raw operate current (IOP1R) exceeds the active slope and the O87P setting, RDIF1 asserts. RDIF1 forms the input into the consecutive measurement fault detection logic and the fast fault detection logic.

The consecutive measurement fault detection logic declares an internal fault when differential current still exists on a consecutive measurement one-half cycle after the instantaneous differential element asserted. When this logic detects an internal fault, the IFAULT1 Relay Word bit asserts.



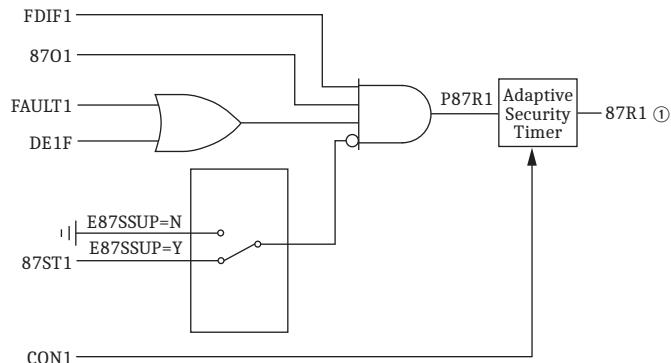
**Figure 5.18 Internal Fault Detection, Instantaneous Differential Element, Consecutive Measurement Fault Detection, and Fast Fault Detection Logics**

If surge (lightning) arresters are installed on busbars, a path to ground exists when these devices conduct, resulting in operating current in the differential elements. The fast fault detection logic qualifies the operating current with a time delay to differentiate between operating current resulting from surge arrester conduction and operating current because of internal faults. If the fast fault detection logic detects an internal fault, Relay Word bit GFAULT1 asserts.

## Protection Element Output Logic

*Figure 5.19* shows the four conditions from the relay measuring and control logic that must be fulfilled to start the security timer (the final stage in asserting the protection element output, Relay Word bit 87R1):

- An output from the filtered differential element, FDIF1
- An output from the filtered differential element threshold, 87O1
- An output from either the directional element (DE1F) or the internal fault detection logic (FAULT1)
- No output from the sensitive differential element (87ST1) with E87SSUP := Y



① See Figure 5.54.

**Figure 5.19 Differential Element Output: Final Conditions and Adaptive Security Timer**

When the four differential element output logic conditions are met, the output P87R1 starts the adaptive security timer. CON1 also controls the security timer time setting; when CON1 asserts, the relay increases the time delay by 0.4 cycles to increase security for the protection element.

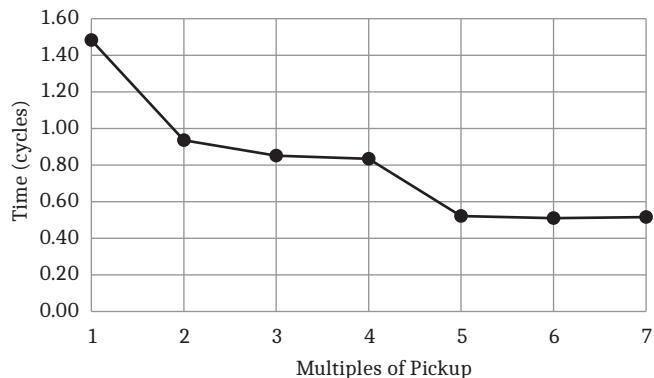
*Table 5.1* shows operating times for the bus differential elements. *Figure 5.20* shows the average operating times (minimum of five trials) for the differential element. Operating times include the time it takes for the 87R element to assert and does not take into consideration the output contact closure time. Tests were performed for 1, 2, 3, 4, 5, 6, and 7 multiples of pickup setting. At 7 times the setting, the deviation was 0.02 cycles. These tests do not include fault resistance. Operating times are the same for 50 Hz and 60 Hz.

**Table 5.1 Restrained Differential Element (87R) Operating Times (Cycles)  
(Sheet 1 of 2)**

Multiples of Pickup	Average
1	1.48
2	0.94
3	0.85

**Table 5.1 Restrained Differential Element (87R) Operating Times (Cycles)  
(Sheet 2 of 2)**

Multiples of Pickup	Average
4	0.83
5	0.52
6	0.51
7	0.52

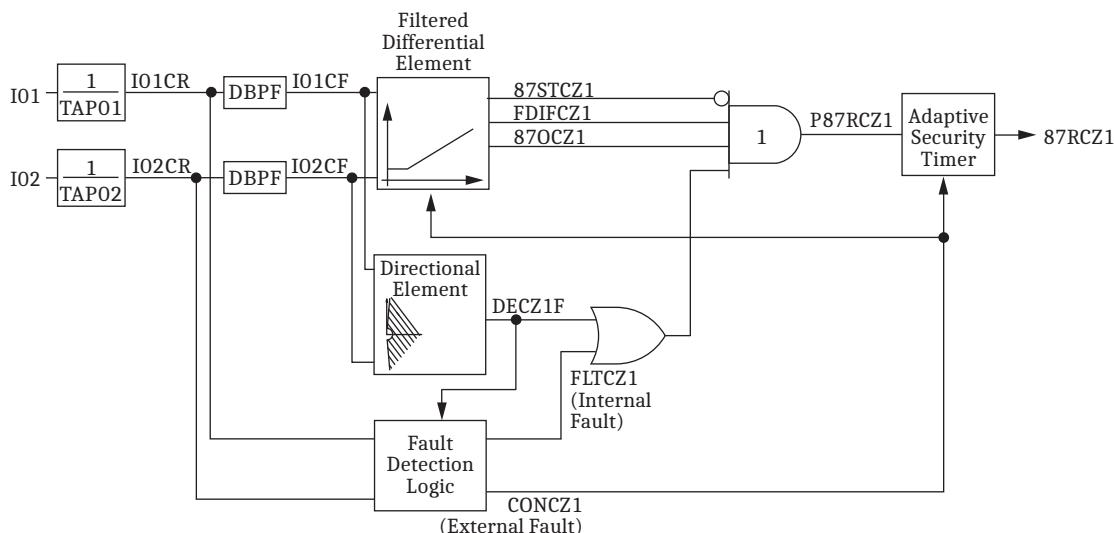


**Figure 5.20 Average 87R Operating Times**

## Check-Zone Protection Elements

The SEL-487B logic includes three dedicated check zones, providing the flexibility and opportunity to configure the dual differential (main zone and check zone) element combination.

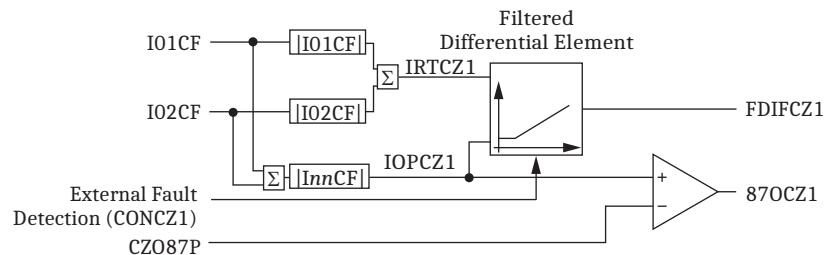
Figure 5.21 shows the block diagram for a Check Zone 1 Protection Element (Check Zones 2 and 3 are similar). Throughout the following element descriptions, the numerical part of the Relay Word bits refers to the specific terminal number (01–21). I01 and I02 refer to current inputs from Terminal I01 and Terminal I02.



**Figure 5.21 Block Diagram Showing Logic for Check-Zone Protection Element 1**

## Check Zone Filtered Differential Element

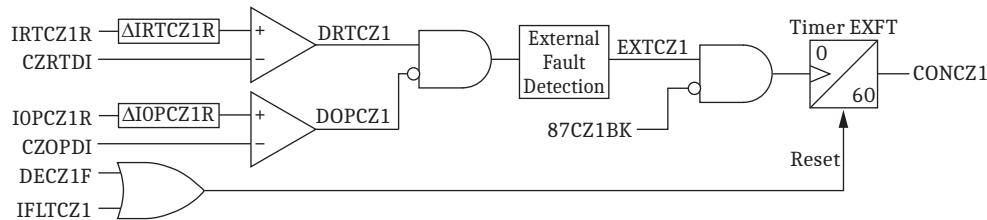
*Figure 5.22* shows a block diagram of the elements necessary for obtaining the differential and restraint quantities used in the check zone filtered differential elements. Relay Word bit FDIFCZ1 is the output from the check zone differential calculation. Relay Word bit 87OCZ1 asserts when the differential current exceeds the CZO87P threshold. Together these two Relay Word bits form the check zone filtered differential element characteristic.



**Figure 5.22 Check Zone Filtered Differential Element 1**

## Check Zone External Fault Detection Logic

*Figure 5.23* shows the logic for detecting external fault conditions.



**Figure 5.23 Check Zone External Fault Detection Logic**

To change the threshold values, first enable the advanced settings (see *Section 8: Settings* for more information on setting the relay) by setting EADVS := Y in Group Settings and then enable the check zone settings by setting ECHKZN := Y.

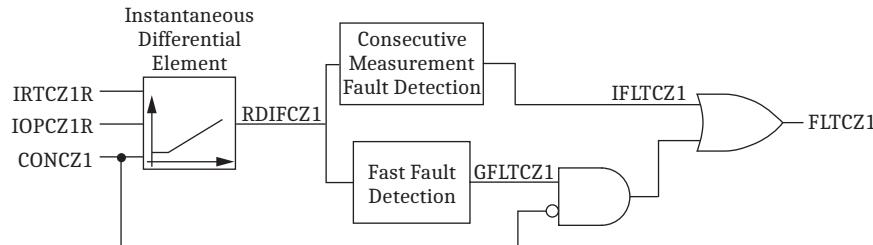
When current data associated with Check Zone 1 are lost, the corresponding check zone blocking bit (87CZ1BK) prevents CONCZ1 from asserting.

## Check Zone Internal Fault Detection Logic

For the internal fault detection logic, the relay uses a characteristic similar to the filtered differential element characteristic.

*Figure 5.24* shows the internal fault detection logic consisting of the instantaneous differential element, the consecutive measurement fault detection logic, and the fast fault detection logic. RDIFCZ1, the output from the instantaneous differential element, forms the input into the consecutive measurement fault detection logic and the fast fault detection logic.

The consecutive measurement fault detection logic declares an internal fault when differential current still exists on a consecutive measurement one-half cycle after the instantaneous differential element asserted. When this logic detects an internal fault, the Relay Word bit IFLTCZ1 asserts.

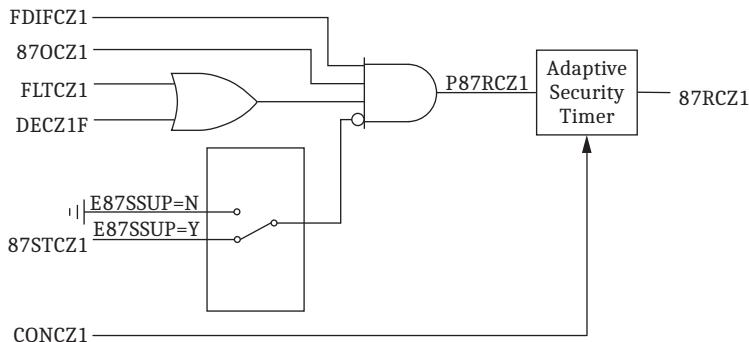


**Figure 5.24 Check Zone Internal Fault Detection, Instantaneous Differential Element, Consecutive Measurements Fault Detection, and Fast Fault Detection Logics**

## Check-Zone Protection Element Output Logic

Figure 5.25 shows the four conditions from the relay measuring and control logic that must be fulfilled to start the security timer (the final stage in asserting the Check-Zone Protection Element output, Relay Word bit 87RCZ1):

- An output from the check-zone filtered differential element (FDIFCZ1)
- An output from the check-zone filtered differential-element threshold (87OCZ1)
- An output from either the check-zone directional element (DECZ1F) or the check zone internal fault detection logic (FLTCZ1)
- No output from the check-zone sensitive differential element (87STCZ1) with E87SSUP := Y



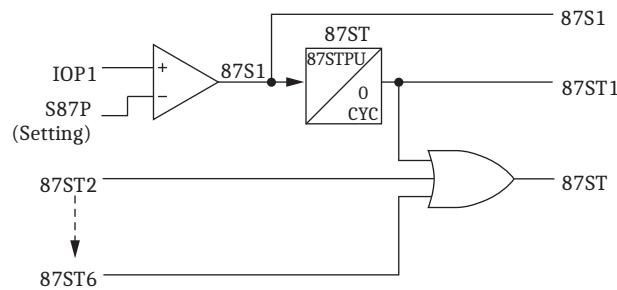
**Figure 5.25 Check Zone Differential Element Output: Final Conditions and Adaptive Security Timer**

When the four differential element output logic conditions are met, the output P87RCZ1 starts the adaptive security timer. CONCZ1 also controls the security timer time setting; when CONCZ1 asserts, the relay increases the time delay by 0.4 cycles to increase security for the protection element.

## Sensitive Differential Element

For each zone, sensitive differential elements detect differential current resulting from CT open or short circuits conditions. If such a condition exceeds a settable delay, the element asserts an alarm. There are two Relay Word bits per zone: an instantaneous Relay Word bit, 87S1, and a time-delayed Relay Word bit, 87ST1.

Use 87ST1, the time-delayed output, for alarming and supervision. Each sensitive differential element compares the sensitive differential element operating quantity, IOP1, against the S87P threshold.

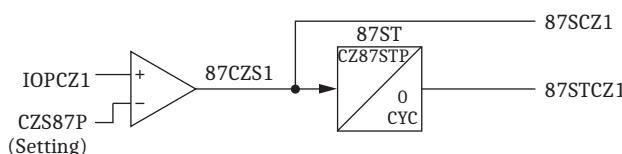


**Figure 5.26 Sensitive Differential Element (87S)**

The status of the sensitive differential element is one of the four conditions considered in the final output logic of the differential protection element (see *Figure 5.26*). With E87SSUP := Y, the output 87ST $n$  supervises the differential protection element. When E87SSUP := N the sensitive differential (87ST $n$ ) element does not supervise the differential protection elements (87R $n$ ). Setting E87SSUP := N only removes the supervision function from the differential element, but does not disable the sensitive differential elements. The sensitive differential elements are still running and available for other functions such as asserting an alarm.

The sensitive differential elements may assert under load conditions if not set properly. To prevent these elements from asserting under load conditions, set the differential threshold setting 50 percent higher than the natural out-of-balance current at the station. Be sure to measure the worst natural out-of-balance current at the station. For example, in a double busbar layout with bus-zone-to-bus-zone connections, first merge the bus-zones before making the measurement (see *Dynamic Zone Selection Logic on page 5.20* and *Bus-Zone-to-Bus-Zone Connections on page 6.28* for more information). Use the MET DIF command to read the per unit operating current values from each protection zone.

## Check Zone Sensitive Differential Element



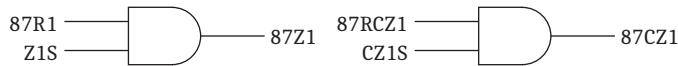
**Figure 5.27 Check Zone Sensitive Differential Element (87S)**

Each check zone has an independent sensitive differential element. There are two Relay Word bits per zone: an instantaneous Relay Word bit, 87SCZ1, and a time-delayed Relay Word bit, 87STCZ1. Use 87STCZ1, the time-delayed output, for alarming and supervision. Each sensitive differential element compares the sensitive differential element operating quantity, IOPCZ1, against the CZS87P threshold.

## Zone Supervision Logic

This logic provides final supervision criteria before a trip signal is issued.

*Figure 5.28* shows the logic for Differential Element 1, but similar logic is available for all six differential elements. Relay Word bit 87R1 is the output from the differential element, and Z1S is a SELLOGIC control equation in the zone configuration settings. The differential trip logic uses Relay Word bit 87Z1, the output from this logic, to determine which terminals to trip. See *Differential Trip Logic* on page 5.52 for more detail.



**Figure 5.28 Zone and Check Zone Supervision Logic**

**NOTE:** Setting E87ZSUP := N sets ZnS to logical 1. This setting prevents the inadvertent blocking of the differential elements.

### CAUTION

Setting E87ZSUP := Y enables the zone supervision in all six zones. If you do not enter any supervision conditions for a particular zone, be sure to enter a 1 at the SELLOGIC control equation prompt.

Setting Z1S is a SELLOGIC control equation in which you can program the conditions for supervising the differential element (87R1). For example, this is the setting in which you enter the output from the check zone differential element during check-zone configuration. Consider the case where a check zone is configured and 87CZ1 is the check zone element output. Both the check zone and the sensitive differential elements must supervise the 87R1 element. With E87SSUP := Y, 87ST1 is already included in the differential element supervision (one of the four final conditions; see *Figure 5.19*). Only the check zone information is required:

**Z1S := 87CZ1**

The SEL-487B-2 has both differential zone blocking logic and check zone blocking logic based on the status of the mapped channels (see *Differential Zone and Check Zone Logic* on page 5.6 for details).

For SEL-487B-2 Relays, NOT 87Z1BK is the default setting for the Zone 1 supervision setting Z1S. With this default setting, the Zone 1 differential element is blocked when a channel is lost that contains current data that are used in Zone 1. For check zone supervision, the Check Zone 1 supervision setting CZ1S has the default value of NOT 87CZ1BK. This blocks the Check Zone 1 element from asserting when a channel is lost that contains current data that are used in Check Zone 1. Zones 1–6 and Check Zones 1–3 operate similarly in this regard.

It is therefore important to use the supervised 87Z1 and 87CZ1 Relay Word bits for protection (and their counterparts for other zones), rather than the un supervised 87R1 and 87RCZ1. To facilitate this supervision and maintain security during data loss conditions, the SEL-487B-2 Relay is configured with E87ZSUP and E87CZSP set to Y by default. SEL recommends that you keep the default logic in the supervision equation, along with any additional logic you want to add.

## Dynamic Zone Selection Logic

Busbar protection involves assigning the appropriate input current values to the corresponding differential elements for calculation of per zone operating and restraint quantities and determining the breakers to trip for differential and breaker failure protection operation. To allow flexible substation configuration without compromising busbar protection, the relay dynamically reassigns input currents to the appropriate differential elements when the station configuration changes.

Disconnect and breaker auxiliary contacts typically provide station configuration information in the form of control inputs, entered into the relay as SELOGIC control equations. By evaluating these SELOGIC control equations, the zone selection logic assigns the currents to the appropriate differential elements. When disconnects are closed in such a way that a solid connection exists between two (or more) zones, the zones merge, and only one zone is active. The active zone after a merge is always the zone with the lowest number. For example, if Zone 3 and Zone 4 merge, Zone 3 encompasses Zone 4.

When the SELOGIC control equation representing the Terminal-to-Bus-Zone becomes a logical 1, the zone selection algorithm processes the current values associated with that particular terminal (see *Table 5.2*). When the equation is logical 0, the current values are neither processed nor considered in the differential calculations. This is also true for the trip output. When the SELOGIC control equation of a terminal is a logical 0, the differential element issues no trip signals to that terminal.

**Table 5.2 Current Values Assigned to the Differential Element as a Function of the Disconnect Status**

SELLOGIC Control Equation	Status	Meaning in the Differential Calculation
I01BZ1V := D891	D891 = 1 (closed)	I01 is part of differential Bus-Zone 1
I01BZ1V := D891	D891 = 0 (open)	I01 is not part of differential Bus-Zone 1

where:

I01BZ1V = SELOGIC control equation declaring the conditions when Terminal 1 connects to Bus-Zone 1

D891 = input from Terminal 1 disconnect auxiliary contact that changes state when the disconnect switch changes state

To properly configure the station, the zone selection algorithm requires the following information:

- Terminals to bus-zones connections,  $I_{qq}BZpV$ .
- Interconnections between bus-zones,  $BZpBZpV$ .

where:

$qq$  = 01–21 (Terminal 1 to Terminal 21)

$p$  = 1–6 (Bus-Zone 1 to 6)

Both  $I_{qq}BZpV$  and  $BZpBZpV$  are SELOGIC control equation variables that you enter in the relay when using the **SET Z** command to set the relay. In SEL Grid Configurator,  $I_{qq}BZpV$  is found in **Group > Zone Configuration > Terminal To Bus-Zone Connections** and  $BZpBZpV$  is found in **Group > Zone Configuration > Bus-Zone To Bus-Zone Connections**.

## Selecting the Zones

The relay runs the zone selection algorithm every protection processing interval and sets the appropriate zone-switching operation (ZSWOPp) Relay Word bits for one cycle when there is a status change in either  $I_{qq}BZpV$  (terminal is connected to or disconnected from a bus-zone) or  $BZpBZpV$  (two or more bus-zones are connected together).

Based on the SELLOGIC control equations  $I_{qq}BZpV$  and  $BZpBZpV$ , the zone selection logic determines the following:

- The bus-zone(s) to be included in each protection zone
- The active terminals to be included in each protection zone
- The terminals to trip for differential and breaker failure protection operations

*Table 5.3* shows the Relay Word bits available in the zone selection logic with their descriptions.

**Table 5.3 Relay Word Bits in the Zone Selection Logic**

Quantity	Description
ZSWOP $p$	Picks up following a change to either bus-zone-to-bus-zone or terminal-to-bus-zone conditions in Zone $p$
ZONE $p$	Differential Zone $p$ is active
$I_{qq}BZpV$	Terminal $qq$ connected to $BZp$
$BZpBZpV$	A connection exists between $BZp$ and $BZp$
$ZNpI_{qq}$	Terminal $qq$ connected to Zone $p$
$ZNpI_{qq}T$	Terminal $qq$ connected to Zone $p$ and will be tripped
$BZpBZpR$	A connection exists between $BZp$ and $BZp$ and the coupler is removed
$ZpBZp$	Bus-Zone $p$ is part of Protective Zone $p$

## Check-Zone Selection

The check-zone function in the SEL-487B-2 has the following properties:

- The relay has three check zones
- There are no Terminal-to-Check-Zone Connection Logic settings,  $I_{qq}CZ1V$
- The relay includes Advance Check Zone settings

The three check zones make it possible to configure a check zone for each of the three phases in a single-relay application.

On the basis that terminals in the check zone are independent of the disconnect auxiliary contact status, there is no need to configure Terminal-to-Check-Zone Connection Logic. Therefore, to include a terminal in the check zone, just enter the Terminal, Check-Zone, Polarity (P,N) settings, as shown below.

```

Check Zone Configuration
Enable Check Zones at Station (Y,N)          ECHKZN := N      ?Y
Check Zone Configuration: Terminal to Check Zone Connections
Terminal, Check-Zone, Polarity (P,N)
? IO1 CZ1 P
Terminal, Check-Zone, Polarity (P,N)
? IO2 CZ1 P
Terminal, Check-Zone, Polarity (P,N)
? IO3 CZ1 P
Terminal, Check-Zone, Polarity (P,N)
? IO4 CZ1 P
Terminal, Check-Zone, Polarity (P,N)
?
Enable Advance Check Zone Settings (Y,N)      EADVCZ := N      ?N

```

In SEL Grid Configurator, go to **Check Zone Configuration > Terminal  $qq$  To Check Zone Connections** and set CT $qqCZp$  ( $p = 1\text{--}3$ ) to Y to include a terminal in a check zone.

When you enter a check zone in the Terminal-to-Check-Zone settings, the corresponding CZONEx ( $x = 1\text{--}3$ ) Relay Word bit asserts. For example, in the above example, Relay Word bit CZONE1 asserts, but not Relay Word bits CZONE2 or CZONE3. Use the **TAR** ASCII command to verify the status of these Relay Word bits.

=>>TAR CZONE1<Enter>					CZONE3	CZONE2	CZONE1
*	*	*	*	*	0	0	1
0	0	0	0	0	0	0	1

The Advance Check Zone Settings provide a method to configure a check zone for applications with in-board CTs (see *Example of Check Zone With Inboard (Bushing) CTs on page 6.19*).

The relay includes Check Zone Supervision settings. Use these settings to disable the entire check zone. In the following example, CZ1S is set to 1 (the default setting), meaning that the check zone is always in service. See *Zone Supervision Logic on page 5.20* for a description of default check zone supervision logic, which secures the check zone during data loss conditions.

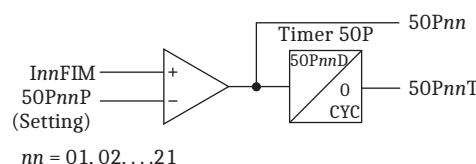
Check Zone Supervision	Differential Element Check Zone Supervision (Y,N)	E87CZSP := N	??
	Check Zone 1 Supervision (SELogic Equation)		
	CZ1S := 1		

## Instantaneous/Delayed Overcurrent Elements

**NOTE:** You can order the SEL-487B-2 as an SV subscriber relay or as a TiDL relay. For SV applications, operating times are delayed by the configured channel delay, CH\_DL.Y. See *SV Network Delays on page 17.25* in the SEL-400 Series Relays Instruction Manual for more details. For TiDL applications, the operating times are delayed by a fixed 1 ms. Use caution when setting relay coordination to account for this added delay.

Each of the 21 terminals includes a single level of phase instantaneous and time-delayed overcurrent elements. *Figure 5.29* shows the logic for the 50Pnn element. Labels FIM (Filtered, Instantaneous, Magnitude) are included for informational purposes and indicate specific processes used in the relay (see *Section 12: Analog Quantities* for more information about analog quantities).

The logic compares the magnitudes of phase input current  $InnFIM$  to a pickup setting  $50PnnP$ . If the current magnitude exceeds the pickup level, Relay Word bit  $50Pnn$  asserts and the timer starts timing. After the time specified by the delay setting  $50PnnD$  expires, a second Relay Word bit,  $50PnnT$ , asserts. Relay Word bit  $50PnnT$  only asserts if Relay Word bit  $50Pnn$  remains asserted for the duration of the  $50PnnD$  time setting. When Relay Word bit  $50Pnn$  deasserts, the timer resets without delay, along with  $50PnnT$  if it has asserted.



**Figure 5.29 Phase Instantaneous and Time-Delayed Overcurrent Elements**

The definite-time overcurrent elements are not enabled in the default settings. Enable the elements by setting E50 := nn ( $nn = 01\text{--}21$ ). After enabling the elements, the definite-time overcurrent elements of all 21 terminals are available but are still set to OFF. For example, assume we want definite-time overcurrent protection for Terminal 05. Set E50 := 5, making the definite-time overcurrent ele-

ments of Terminal 01–Terminal 05 available. Because the default settings for the definite-time overcurrent elements are OFF, the elements are not active. Only enter settings at the definite-time overcurrent protection prompt of Terminal 05. Terminal 05 is the only terminal with definite-time overcurrent protection; the definite-time overcurrent protection for Terminal 01–Terminal 04 remains switched OFF.

## Selectable Time-Overcurrent Elements (51)

**NOTE:** You can order the SEL-487B-2 as an SV subscriber relay or as a TIDL relay. For SV applications, operating times are delayed by the configured channel delay, CH\_DLY. See SV Network Delays on page 17.25 in the SEL-400 Series Relays Instruction Manual for more details. For TIDL applications, the operating times are delayed by a fixed 1 ms. Use caution when setting relay coordination to account for this added delay.

Instead of having dedicated inverse-time overcurrent elements for each current channel, the relay offers the flexibility of an unassigned time-overcurrent element, each with the choice of five US and five IEC operating curves. Unassigned means that the 51 element operating quantities are available for assignment, as the application requires (see *Table 5.6*).

The inverse-time overcurrent elements are not enabled in the default settings. Enable the desired number of elements by setting E51 := nn (nn = 01–21). Choose from any filtered instantaneous phase current quantity magnitudes (I01FIM–I21FIM) to set as the operate quantity, 51Onn.

*Table 5.4* shows the five US characteristics, and *Table 5.5* shows the five IEC characteristics. Each table shows the five operating time equations, together with the five electromechanical reset characteristic equations.

**Table 5.4 U.S. Time-Overcurrent Equations<sup>a</sup>**

Curve Type	Operating Time	Reset Time
U1 (Moderately Inverse)	$T_p = TD \cdot \left( 0.0226 + \frac{0.0104}{M^{0.02} - 1} \right)$	$T_R = TD \cdot \left( \frac{1.08}{1 - M^2} \right)$
U2 (Inverse)	$T_p = TD \cdot \left( 0.180 + \frac{5.95}{M^2 - 1} \right)$	$T_R = TD \cdot \left( \frac{5.95}{1 - M^2} \right)$
U3 (Very Inverse)	$T_p = TD \cdot \left( 0.0963 + \frac{3.88}{M^2 - 1} \right)$	$T_R = TD \cdot \left( \frac{3.88}{1 - M^2} \right)$
U4 (Extremely Inverse)	$T_p = TD \cdot \left( 0.02434 + \frac{5.64}{M^2 - 1} \right)$	$T_R = TD \cdot \left( \frac{5.64}{1 - M^2} \right)$
U5 (Short-Time Inverse)	$T_p = TD \cdot \left( 0.00262 + \frac{0.00342}{M^{0.02} - 1} \right)$	$T_R = TD \cdot \left( \frac{0.323}{1 - M^2} \right)$

<sup>a</sup>  $T_p$  = Operating Time

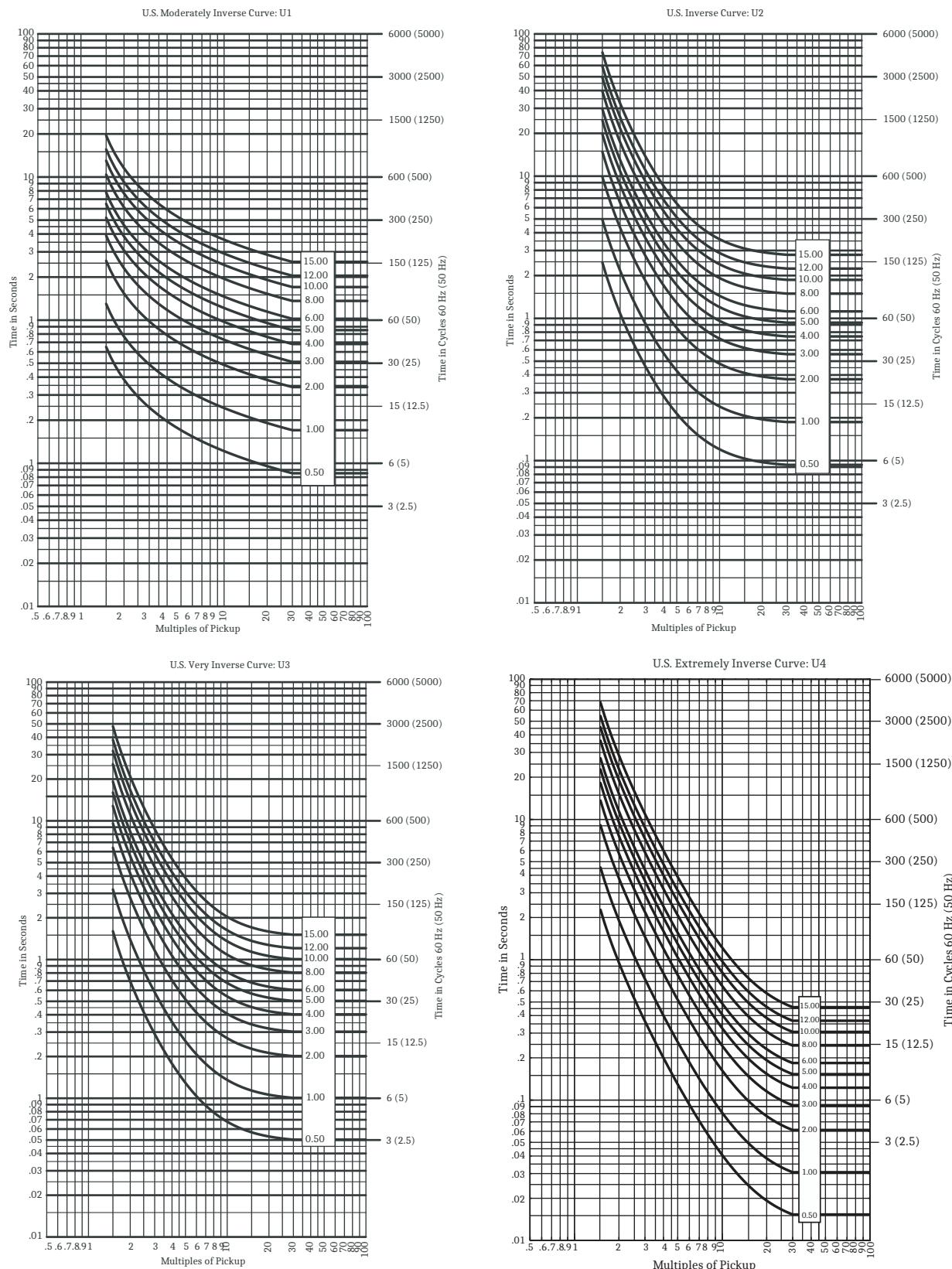
$T_R$  = Reset Time

TD = Time-Delay Setting

M = Measured Current / Pickup Current

**Table 5.5 IEC Time-Overcurrent Equations**

<b>Curve Type</b>	<b>Operating Time</b>	<b>Reset Time</b>
C1 (Standard Inverse)	$T_p = TD \cdot \left( \frac{0.14}{M^{0.02} - 1} \right)$	$T_R = TD \cdot \left( \frac{13.5}{1 - M^2} \right)$
C2 (Very Inverse)	$T_p = TD \cdot \left( \frac{13.5}{M - 1} \right)$	$T_R = TD \cdot \left( \frac{47.3}{1 - M^2} \right)$
C3 (Extremely Inverse)	$T_p = TD \cdot \left( \frac{80}{M^2 - 1} \right)$	$T_R = TD \cdot \left( \frac{80}{1 - M^2} \right)$
C4 (Long-Time Inverse)	$T_p = TD \cdot \left( \frac{120}{M - 1} \right)$	$T_R = TD \cdot \left( \frac{120}{1 - M} \right)$
C5 (Short-Time Inverse)	$T_p = TD \cdot \left( \frac{0.05}{M^{0.04} - 1} \right)$	$T_R = TD \cdot \left( \frac{4.85}{1 - M^2} \right)$

**Selectable Time-Overcurrent Elements (51)****Figure 5.30 U.S. Curves U1, U2, U3, and U4**

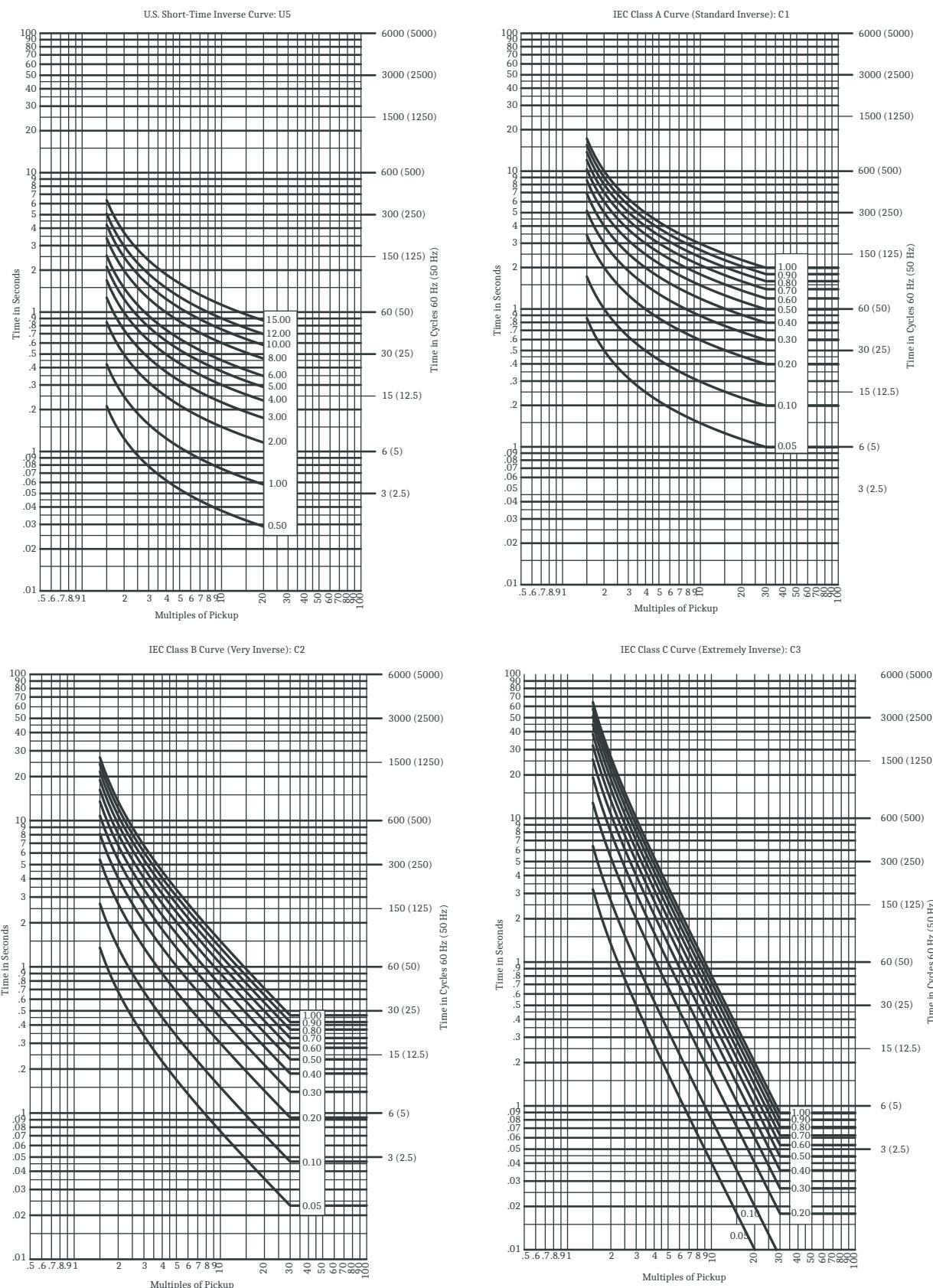
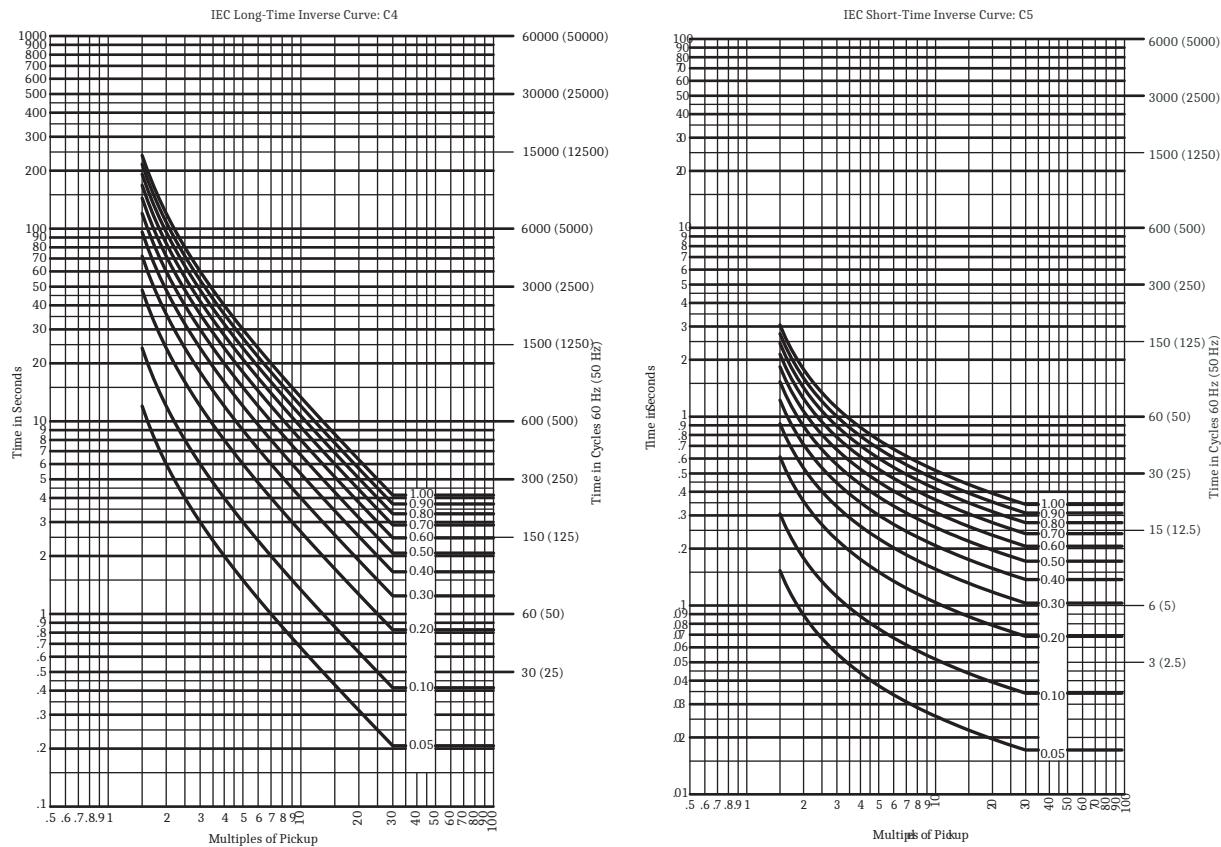


Figure 5.31 U.S. Curve U5 and IEC Curves C1, C2, and C3



**Figure 5.32 IEC Curves C4 and C5**

The 51 overcurrent elements of the relay have dynamic pickup (51Pxx) and time-delay (51TDxx) values. Because these settings can be programmed by means of protection math variables (PMVs), their actual value cannot be checked at setting time. To ensure that the pickup and time-delay values are within their predefined limits, the relay uses a limit check to verify the validity of setting values. Relay Word bits 51TMxx (time-dial limit check) and 51MMxx (pickup-limit check) are used to indicate a setting that is outside of the limit check thresholds. If the maximum limit thresholds are exceeded, the relay uses the maximum limit value. If the minimum limit thresholds are exceeded, the relay uses the minimum limit value (see *Figure 5.33*).

---

#### Example 5.1

---

The Terminal 01 current channel input is 5 A nominal .... From relay part number

51O01 := I01FIM

Therefore 51B101 := 0.25 (lower limit)

And 51B201 := 16.0 (upper limit)

5 A Current Terminal: (Determined by Relay part number and the operating quantity)

B<sub>1</sub> := 0.25 and B<sub>2</sub> := 16.0

**Example 5.1 (Continued)**

The Terminal 01 current channel input is 1 A nominal .... From relay part number

51O01 := I01FIM

Therefore 51B101 := 0.05 (lower limit)

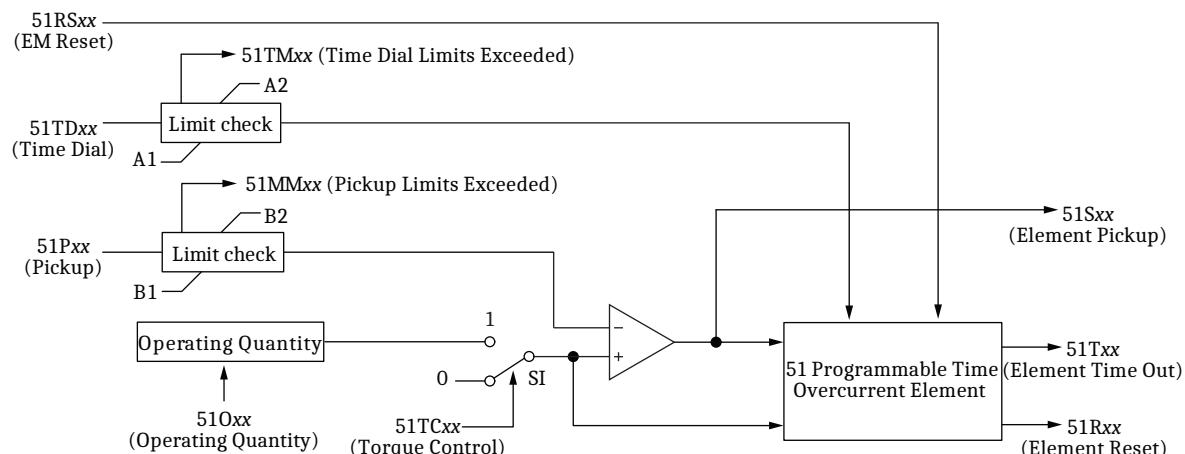
And 51B201 := 3.2 (upper limit)

1 A Current Terminal: (Determined by relay part number and the operating quantity)

$B_1 := 0.05$  and  $B_2 := 3.2$

If the calculated pickup value is greater than 3.2, the relay logic clamps the pickup value at 3.2. Similarly, if the value is less than 0.05, the relay logic clamps the pickup value at 0.05. At the same time that it clamps the values to these limits, the logic sets a limit bit (51MMxx) to indicate to the user that the read-in value is outside the specified limits.

## Logic



**Figure 5.33 Time-Overcurrent Logic**

## Settings Description

### Operating Quantity

The 51 elements are unassigned, so you can select the operating quantity from *Table 5.6*.

**Table 5.6 Time-Overcurrent Operating Quantity List**

Analog Quantity	Description
InnFIM <sup>a</sup>	Filtered Instantaneous Terminal nn Current Magnitude

<sup>a</sup> Where nn = 01-21.

## Pickup and Time-Dial Settings

Pickup setting 51P01, operating on the ratio of the measured current to the pickup setting (multiple of pickup setting), moves the characteristic horizontally to vary the pickup current; time-dial (multiplier) setting 51TD01 moves the curve vertically to vary the operating time for a given multiple of pickup.

Both pickup (51P01) and time-dial (51TD01) settings are math variables instead of fixed settings. SEL math variables, unlike fixed settings that cannot be dynamically changed, allow for the adaptive changing of pickup and time-dial settings without the need for changing relay setting groups. However, if your installation does not require adaptive pickup and/or time-dial settings changes, use the time-overcurrent element as a conventional 51 element. For a conventional element, simply enter the pickup and time-dial settings as numbers, such as:

$$51P01 = 1.5$$

$$51TD01 = 1$$

## Upper and Lower Range Limits

When you use SEL math variables, the selected analog value can exceed the upper value of the pickup range, or it can fall below the lower value of the pickup range. When this happens, the relay assigns the appropriate threshold value to the element and continues to calculate the trip time. For the 51P<sub>nm</sub> pickup settings, the upper threshold is 3.2 for 1 A relays and 16 for 5 A relays. The lower threshold is 0.05 for 1 A relays and 0.25 for 5 A relays. For the 51TD<sub>nmm</sub> time-dial settings, the U.S. curve thresholds are 0.5 and 15, and the IEC thresholds are 0.05 and 1.0. In addition, the relay also asserts the appropriate Relay Word bits: 51MM01 (pickup value out of bounds) and/or 51TM01 (time-dial value out of bounds).

---

### Example 5.2

---

For example, you want a 1 A relay to pick up at 1.5 A when IN201 asserts and to pick up at 2 A when IN202 asserts (IN201 deasserted). Program the following:

$$51P01 := \text{IN201} \cdot 1.5 + \text{IN202} \cdot 2$$

With IN201 asserted (logical 1), and IN202 deasserted (logical 0), the 51P01 setting is:

$$(1 \cdot 1.5) + (0 \cdot 2) = 1.5 + 0 = 1.5$$

When IN202 asserts (IN201 deasserted), the 51P01 setting is:

$$(0 \cdot 1.5) + (1 \cdot 2) = 0 + 2 = 2$$

If, however, IN202 asserts while IN201 is still asserted, the 51P01 setting is:

$$(1 \cdot 1.5) + (1 \cdot 2) = 1.5 + 2 = 3.5$$

Because 3.5 exceeds the upper range value of 3.2, the relay clamps the setting at 3.2 and asserts Relay Word bit 51MM01.

---

## Torque Control

SELOGIC control equation 51TC01 allows you to state the conditions when the element must run. When 51TC01 asserts (logical 1), switch S1 in *Figure 5.33* closes, and the relay evaluates input 51O01. For example, if the element should only measure when the circuit breaker is closed, enter the following:

51TC01 := **IN201** (Breaker auxiliary “A” contact connected to IN201)

With this setting, switch S1 closes only when IN201 is a logical 1. If the element must measure all the time, enter the following:

51TC01 := **1**

## EM Reset

Setting 51RS01 defines whether the curve resets like an electromechanical disk or after one power system cycle when current drops below pickup. If you set 51RS01 = Y, the relay resets according to the reset timer equations for that particular curve (see *Table 5.4* or *Table 5.5*). If you set 51RS01 = N, the relay resets after one power system cycle when current drops below pickup.

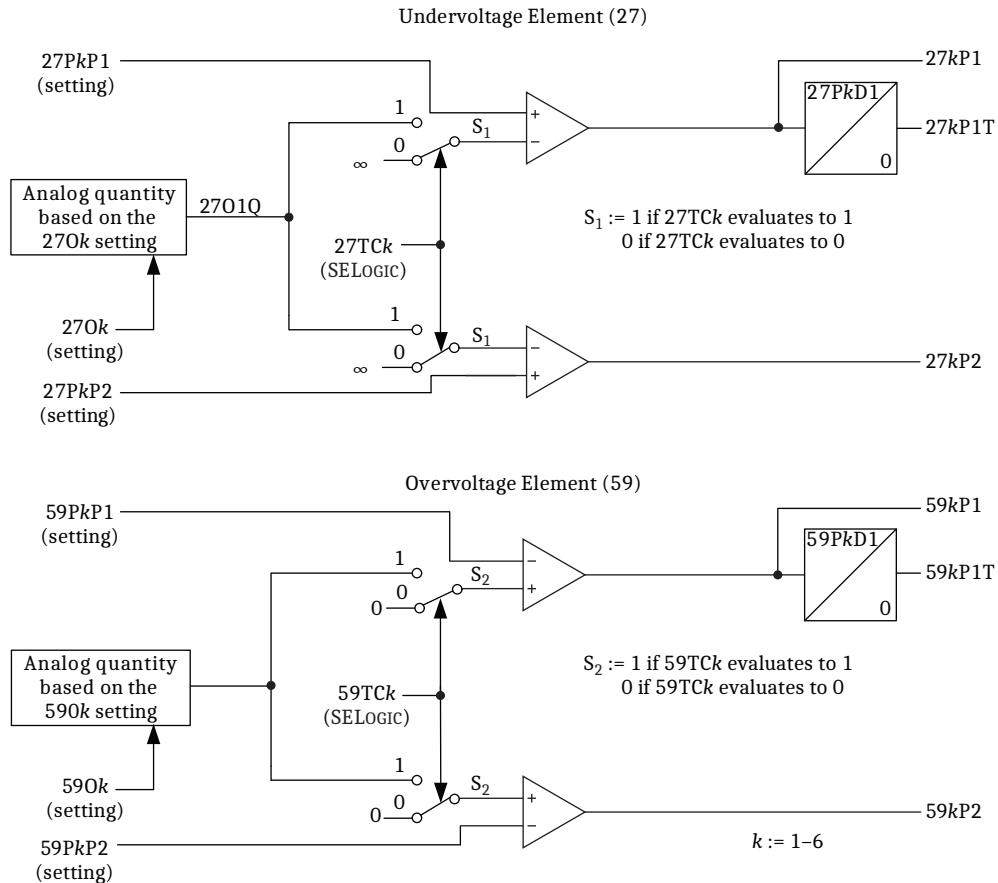
# Over- and Undervoltage Elements

**NOTE:** You can order the SEL-487B-2 as an SV subscriber relay or as a TiDL relay. For SV applications, operating times are delayed by the configured channel delay, CH\_DL.Y. See SV Network Delays on page 17.25 in the SEL-400 Series Relays Instruction Manual for more details. For TiDL applications, the operating times are delayed by a fixed 1 ms. Use caution when setting relay coordination to account for this added delay.

The SEL-487B offers as many as six undervoltage and six overvoltage elements. Each of these 12 elements has two levels, for a total of 24 over- and undervoltage elements. *Figure 5.34* shows the over- and undervoltage element logic.

Use the E27 and E59 settings to enable as many over- and undervoltage elements as you need.

Select any operating quantity shown in *Table 5.7* for the 27Ok settings, and any value from *Table 5.8* for the 59Ok settings as an input quantity (27Ok and 59Ok settings). You can select the same quantity for an undervoltage element as for an overvoltage element.



## 27PkP1 Undervoltage Element Level 1 Pickup

The 27PkP1 ( $k = 1\text{--}6$ ) undervoltage element Level 1 pickup setting is typically used for alarm level indication of undervoltage conditions. The setting is in secondary voltage. The Level 1 pickup has a definite-time delay (27PkD1) that can be used to provide a time delay on the assertion of the undervoltage element.

## 27PkP2 Undervoltage Element Level 2 Pickup

The 27PkP2 ( $k = 1\text{--}6$ ) undervoltage element Level 2 pickup setting is typically used for undervoltage tripping conditions. The setting is in secondary voltage. The Level 2 pickup has no definite-time delay.

## 27TCK Undervoltage Element Torque Control

The 27TCK ( $k = 1\text{--}6$ ) undervoltage element torque control uses a SELLOGIC control equation to provide torque control of the undervoltage elements. All undervoltage elements are blocked from operation when the 27TCK input evaluates to a zero. The default setting of 1 allows the undervoltage elements to always operate.

To provide selective protection disabling of the 27 elements under data loss conditions, include the analog channel status Relay Word bits in the torque-control equations for these elements (see *Analog Channel Statuses on page 5.1* and *Application Setting SVBLK and Relay Word Bit SVBK\_EX on page 5.4*).

## 27PkD1 Undervoltage Element Level 1 Delay

When the system voltage falls below the undervoltage setting value, the undervoltage timer starts timing. Set the delay (in cycles) for which the timer must run before the 27PkD1 ( $k = 1\text{--}6$ ) setting asserts the output.

## E59 Enable Overvoltage Elements

Use the E59 setting to enable the number of overvoltage elements you want to use in the relay. Each overvoltage element provides two pickup setting levels.

## 590k Overvoltage Element Operating Quantity

Select the operating quantity 59Ok ( $k = 1\text{--}6$ ) you want for each voltage terminal from *Table 5.8*.

**Table 5.8 Overvoltage Operating Quantity List**

Label	Description
V01FIM	Voltage Element 01 fundamental filtered voltage
V02FIM	Voltage Element 02 fundamental filtered voltage
V03FIM	Voltage Element 03 fundamental filtered voltage
V1FIM	Positive-sequence fundamental filtered voltage
3V2FIM	Negative-sequence fundamental filtered voltage
3V0FIM	Zero-sequence fundamental filtered voltage

## 59PkP1 Overvoltage Element Level 1 Pickup

Set pickup thresholds for the voltage values above which you want the Level 1 overvoltage elements to assert. The Level 1 pickup has a definite-time delay (59PkD1) that can be used to provide a time delay on the assertion of the overvoltage element.

## 59PkP2 Overvoltage Element Level 2 Pickup

Set pickup thresholds for the voltage values above which you want the Level 2 overvoltage elements to assert.

The 59PkP2 ( $k = 1\text{--}6$ ) overvoltage element Level 2 pickup setting is typically used for overvoltage tripping conditions. The setting is in secondary voltage. The Level 2 pickup has no definite-time delay.

## 59TCk Overvoltage Element Torque Control

Use the torque-control setting to specify conditions under which the overvoltage elements must be active. There is only one setting for both Level 1 and Level 2 elements. With the default setting equal to 1, both levels are active permanently.

To provide selective protection disabling of the 59 elements under data loss conditions, include the analog channel status Relay Word bits in the torque-control equations for these elements (see *Analog Channel Statuses on page 5.1* and *Application Setting SVBLK and Relay Word Bit SVBK\_EX on page 5.4*).

## 59PkD1 Overvoltage Element Level 1 Delay

When the system voltage exceeds the overvoltage setting value, the overvoltage timer starts timing. Set the delay (in cycles) for which the timer must run before the 59PkD1 ( $k = 1\text{--}6$ ) setting asserts the output.

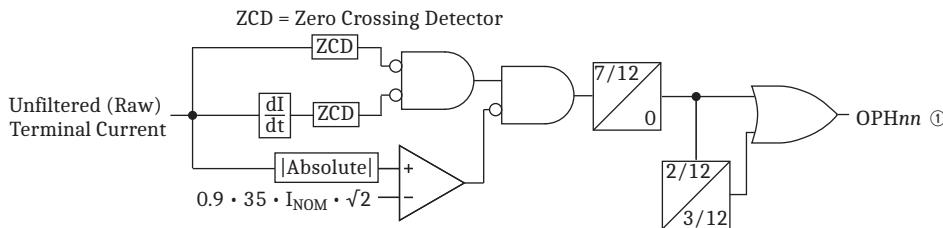
Certain protection philosophies require voltage supervision for a trip. Each SEL-487B provides two levels of negative-sequence voltage and two levels of zero-sequence voltage elements to satisfy this requirement. In addition, the relay also provides two levels of phase undervoltage (27) and overvoltage (59) elements for each of the three phases.

# Open-Phase Detection Logic

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**NOTE:** OPHnn is frozen when the corresponding InnFZ Relay Word bit asserts. See *Analog Channel Statuses on page 5.1* for more information on InnFZ.

Subsidence current results from energy trapped in a CT magnetizing branch after a circuit breaker opens to clear a fault or interrupt load. This current exponentially decays and delays the resetting of instantaneous overcurrent elements used for breaker failure protection. Breaker failure protection requires fast open-phase detection to ensure fast resetting of instantaneous overcurrent elements. *Figure 5.35* shows open-phase logic that asserts SEL-487B open-phase detection elements OPHnn ( $nn = 01, 02, \dots, 21$ ) in less than one cycle, even during subsidence current conditions.



① See Figure 5.58.

**Figure 5.35 Open-Phase Detection**

The relay declares an open phase when the logic does not detect a zero crossing or current value within 7/12 of a power system cycle since the previous measurement. The bottom path in *Figure 5.35* is used to detect when the nominal current input for any channel is nearing the point of clipping at the analog to digital converter. If current channel clipping is imminent, current is above subsidence levels and the open-phase logic is forced to a false condition.

If the SEL-487B-2 loses current data because of communications problems, there is the potential for spurious assertions of the open-phase Relay Word bits. To prevent this, the SEL-487B-2 uses Relay Word bit *InnFZ* to maintain the status of the open-phase logic (see *Analog Channel Statuses on page 5.1*). While Relay Word bit *InnFZ* is asserted, indicating a loss of current data on Current Input *nn*, Relay Word bit *OPHnn* holds its previous state despite the loss of current data and is thus effectively frozen. The duration of the freeze period is limited by the Global setting SVFZDO (see *Analog Channel Statuses on page 5.1*). When DSS communication issues related to current Terminal *m* are resolved, *InnFZ* deasserts and the open-phase logic operates normally.

# Open CT Detection Logic

When a CT opens, there is an incremental increase in operating current and a corresponding incremental decrease in restraint current. The two increments should result in a summation equal to zero.

Figure 5.36 shows the open current transformer detection logic. The change in operating current ( $\Delta IOPnR$ ), the change in restraint current ( $\Delta IRTnR$ ), and operating current ( $IOPn$ ) are the analog inputs to the logic.

The AND gate output asserts when the following conditions are true:

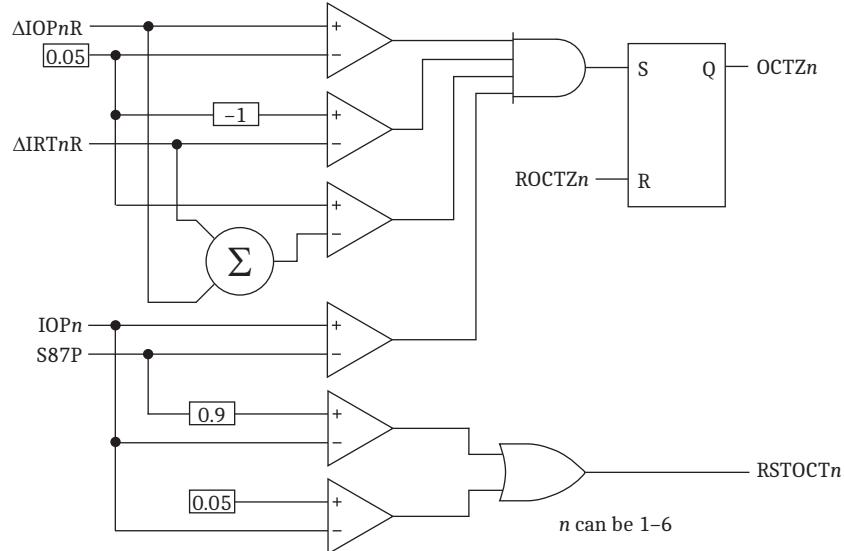
- $\Delta\text{IOPnR}$  is a positive value (greater than or equal to 0.05 pu)
  - $\Delta\text{IRTnR}$  is a negative value (less than -0.05 pu)
  - The sum of  $\Delta\text{IOPnR}$  and  $\Delta\text{IRTnR}$  is very small (less than 0.05 pu)
  - The filtered operating current ( $\text{IOPn}$ ) is greater than or equal to Group Setting S87P

When the AND gate output is asserted, Relay Word bit OCTZ $n$  asserts and is latched. SELOGIC control equation ROCTZ $n$  resets the latch and Relay Word bit OCTZ $n$  clears. Reset has priority over set.

The lower portion of the logic asserts Relay Word bit RSTOCT $n$ . RSTOCT $n$  asserts when any of the following conditions are true:

- IOP $n$  is less than 90 percent of group setting S87P
  - IOP $n$  is less than 0.05

For the SEL-487B-2, the default value for ROCTZn is RSTOCTn OR (87ZnBK AND NOT OCTZn). Including 87ZnBK AND NOT OCTZn in the logic equation secures the open CT logic during current data loss. Include AND NOT OCTZn in the ROCTZn equation for cases where OCTZn asserts prior to a data loss condition. If you modify ROCTZn, include the 87ZnBK AND NOT OCTZn logic to secure ROCTZn for data loss conditions.



**Figure 5.36 Zone n Open CT Detector**

Table 5.9 shows the Relay Word bits available in the check zone selection logic with their descriptions.

**Table 5.9 Relay Word Bits in the Open CT Detection Logic**

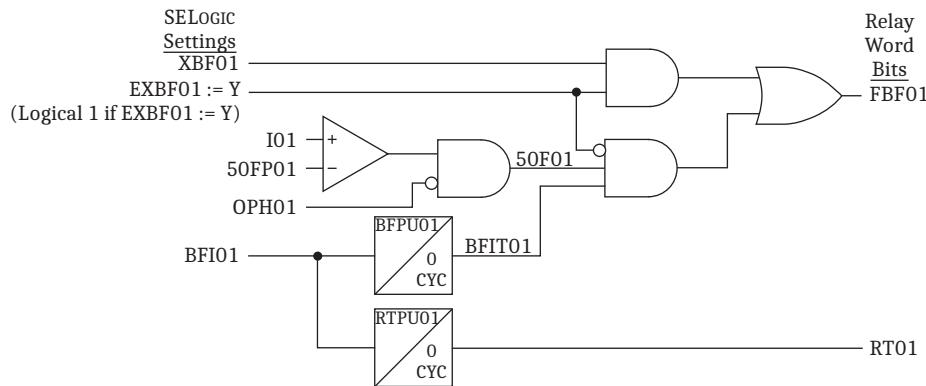
Quantity	Description
OCTZn	Zone n Open CT detected
ROCTZn	Reset Zone n Open CT detector (SELOGIC control equation)
RSTOCTn	Zone n Open CT detection reset

## Circuit Breaker Failure Protection

The SEL-487B has complete breaker failure protection that includes retrip for each of the 21 terminals. This protection uses open-phase detection logic, provided with subcycle current reset, to reduce breaker failure coordination times. Two options are available for application of breaker failure protection:

- Schemes equipped with external breaker failure relays. These schemes send a bus trip (output from the breaker failure relay on the terminal panel) command to the bus protection relay (SEL-487B) that requires only the zone selection and output contacts to operate the appropriate breakers.
- Schemes using the internal breaker failure protection of the SEL-487B. These schemes send a breaker failure initiate (normally a trip output) command to the bus protection relay. The SEL-487B includes breaker failure logic, as well as zone selection and output contacts, to operate the appropriate breakers.

Apply either option exclusively, or use a combination of the two options at the same station. For example, use the breaker failure relays on the feeder panels for protection philosophies requiring discrete breaker failure relays, but use the built-in breaker failure protection in the SEL-487B for all other terminals at the station. Connect breaker failure initiate signals from these terminals to any one of the optoisolated inputs on the interface board. *Figure 5.37* shows logic for Terminal 01; similar logic is available for all 21 terminals.



**Figure 5.37** Breaker Failure Logic

## Schemes Using Internal Breaker Failure Relays

The basic breaker failure logic does not include logic to seal-in the breaker failure initiate signals. For applications where BFI seal-in and extension are required, alternative BFI logic is provided. Set EXBF01 := N to enable the internal breaker failure logic for Terminal 01. Refer to *Figure 5.37*.

### Breaker Failure Logic

The breaker failure logic requires the trip signal to be continuously present for the duration of the breaker failure timer because the BFI signal is not sealed in. If an external BFI signal falls away for one processing interval longer than the debounce dropout time setting of the input, the breaker failure timers reset. Wire breaker failure initiate circuitry, typically a trip output contact from a protection relay, to one of the six independent optoisolated inputs and assign the input to BFI01.

When the trip contact from the protective relay closes to assert BFI01, timers BFPU01 (Terminal I01 circuit breaker failure timer) and RTPU01 (Terminal I01 retrip timer) start timing. If BF101 remains asserted when the retrip timer expires, Relay Word bit RT01 asserts. Use this Relay Word bit as an output to attempt another trip pulse to the circuit breaker before the relay issues a bus trip command. When timer BFPU01 expires, Relay Word bit FBF01 asserts if 50F01 is asserted. Use this Relay Word bit in the circuit breaker tripping logic to cause a circuit breaker failure trip.

If the circuit breaker opens successfully before timer BFPU01 or timer RTPU01 expires, the cessation of current flow on the circuit will cause the fast breaker open detector element OPH01 to assert, dropping out element 50F01. This will block the assertion of the breaker failure Relay Word bit FBF01. If the trip contact from the protective relay opens before timer RTPU01 expires, the BFPU01 timer and RTPU01 timers will drop out and neither RT01 nor FBF01 will assert.

This logic is suitable for applications where two breakers must open to interrupt fault current, such as in breaker-and-a-half and ring-bus configurations. For these applications, breaker failure logic that requires both BFI and 50F to be asserted before the timer starts is often not suitable. The problem occurs because the 50F element may not assert until the first of the two breakers opens and the current redistributes so that all of it goes through the failed breaker. This situation results in a delay of the Breaker 2 breaker failure time equal to the time for Breaker 1 to interrupt the current. The SEL-487B breaker failure logic does not have this problem.

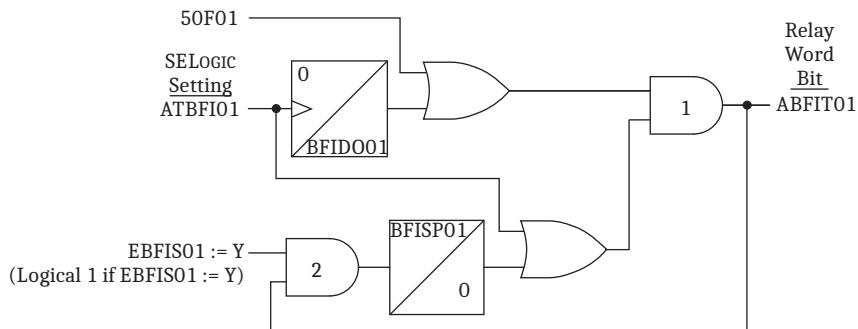
When the SEL-487B-2 loses breaker current data because of communications problems, there is the potential for spurious deassertion of the breaker failure overcurrent Relay Word bits. This could compromise the dependability of the breaker failure logic. To safeguard against this scenario, the breaker failure overcurrent Relay Word bits freeze and maintain their previous status as long as Relay Word bits *InnFZ* are asserted (see *Analog Channel Statuses on page 5.1*). *Table 5.10* lists the Relay Word bits that are frozen under these conditions. As long as the freeze Relay Word bit is asserted (*InnFZ*), the corresponding Relay Word bits in *Table 5.10* freeze and maintain their previous states. The duration of the freeze period is limited by the Global setting SVFZDO (see *Analog Channel Statuses on page 5.1*). When current data are good, *InnFZ* is deasserted and the breaker failure logic operates normally.

**Table 5.10 Breaker Failure Relay Word Bits Frozen During Loss of Breaker Current Data**

Freeze Relay Word Bit Asserted	Breaker Failure Relay Word Bits Frozen
<i>InnFZ</i>	50Fnn

## Alternative Breaker Failure Initiating Input With Extension and/or Seal-In Logic

The alternative BFI logic lets you choose to either extend the breaker failure initiate signal or seal in the breaker failure initiate signal. *Figure 5.38* shows the combined logic for both breaker failure initiating input extension (AND Gate 1) and seal-in (AND Gates 1 and 2) functions. This logic can also be used for applications where it is required to have 50F01 asserted before the breaker failure timer can start.



**Figure 5.38 Circuit Breaker Failure Initiation Extension and Seal In**

### Breaker Failure Initiating Input Seal In

Use the seal-in option if the breaker failure initiation signal is not continuous and fault current is immediately available (single-breaker applications). Referring to *Figure 5.38*, set EXBF01 := N to enable the internal breaker failure logic. Set

EBFIS01 := Y to set the top input of AND Gate 2 to a logical 1. Wire the breaker failure initiate signal to the SEL-487B, and assign the input to ATBFI01. Then assign Relay Word bit ABFIT01 to BFI01 (*Figure 5.37*). On receipt of the breaker failure initiate signal, AND Gate 1 turns on. The output from AND Gate 1 starts the breaker failure timers (*Figure 5.37*) and turns AND Gate 2 on. If the initiate signal is present for longer than the Timer BFISP01 setting, the output from Gate 1 seals in for as long as the current exceeds the 50FP01 threshold. Set the Timer BFISP01 setting longer than a quarter cycle to prevent seal-in for spurious signals, but set it shorter than the initiate signal to ensure seal-in.

## Breaker Failure Initiating Input Extension

Use the extension option in conjunction with the seal in option if the breaker failure initiation signal is not continuous, but fault current is not immediately available to start the breaker failure timers (double-breaker applications).

The logic still requires the current to be above the 50FP01 threshold after timer BFIDO01 times out to keep Gate 1 turned on. Set EXBF01 := N to enable the internal breaker failure logic. Referring to *Figure 5.38*, wire the breaker failure initiate signal to the SEL-487B, and assign the input to ATBFI01. Then assign Relay Word bit ABFIT01 to BFI01 (*Figure 5.37*). In the absence of fault current, and on receipt of the rising edge of the breaker failure initiate signal at input ATBFI01, AND Gate 1 turns on. When AND Gate 1 turns on, Relay Word bit ABFIT01 asserts, causing timers BFP01 and RTP01 to start timing (*Figure 5.37*).

When Breaker 1 opens, enough current flows through Breaker 2 to assert the 50F01 Relay Word bit. Refer to *Figure 5.38* and note that the current flowing through Breaker 2 replaces the output from timer BFIDO01 and keeps Gate 1 turned on, sustaining the input to the breaker failure timers. Set Timer BFIDO01 longer than the time Breaker 1 takes to interrupt the current, but shorter than the Timer BFP01 setting. This setting ensures that, after Breaker 1 opens, Timer BFP01 will continue to run while current greater than 50FP01 is present.

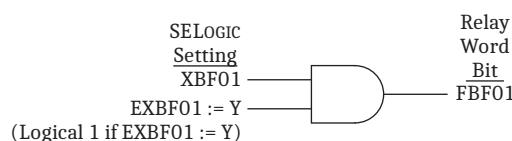
## Supervising Breaker Failure Initiate With the Fault Detector

**NOTE:** Although BFIDO01 is set to 0.0, the timer picks up for one processing interval after assertion.

Use the alternative BFI logic if the breaker failure initiation signal must be supervised by current before the BFP01 timer can start. Set EXBF01 := N to enable the internal breaker failure logic. Referring to *Figure 5.38*, wire the breaker failure initiate signal to the SEL-487B, and assign the input to ATBFI01. Then assign Relay Word bit ABFIT01 to BFI01 (*Figure 5.37*). Set BFIDO01 to 0.0 CYC. In this configuration, the upper input to AND Gate 1 is controlled by 50F01 and the lower input to AND Gate 1 is controlled by ATBFI01. Thus, ABFIT01 will not assert and start the BFP01 and RTP01 timers (*Figure 5.37*) unless both ATBFI01 and 50F01 are asserted.

## Schemes Equipped With External Breaker Failure Relays

Set EXBF01 := Y to enable the external breaker failure logic. This setting effectively reduces the logic to that shown in *Figure 5.39*.



**Figure 5.39 Breaker Failure Logic for External Breaker Failure**

Wire breaker failure initiate circuitry to one of the SEL-487B inputs, and assign the input to XBF01. Relay Word bit FBF01 immediately asserts upon assertion of the input signal.

## Retrip

Some circuit breakers have two separate trip coils. If one trip coil fails, local protection can attempt to energize the second trip coil (often connected to a separate battery) to prevent an impending circuit breaker failure operation. Configure your protection system to always attempt a local retrig using the second trip coil before the circuit breaker failure pickup timer expires. RTPU01 (Retrig Time Delay on Pickup Timer) begins timing when BFI01 asserts. Relay Word bit RT01 (Breaker 1 Retrig) asserts immediately after RTPU01 times out. Assign a control output to trip the circuit breaker when Relay Word bit RT01 asserts.

## Breaker Failure Clearing Times

**NOTE:** You can order the SEL-487B-2 as an SV subscriber relay or as a TIDL relay. For SV applications, operating times are delayed by the configured channel delay, CH\_DLY. See SV Network Delays on page 17.25 in the SEL-400 Series Relays Instruction Manual for more details. For TIDL applications, the operating times are delayed by a fixed 1 ms. Use caution when setting relay coordination to account for this added delay.

Figure 5.40 is based on actual test data at room temperature using various settings. Relay element specifications given in *Section 1: Introduction and Specifications* include the entire temperature range of the relay. Output contact times and DSS channel delays are not included.

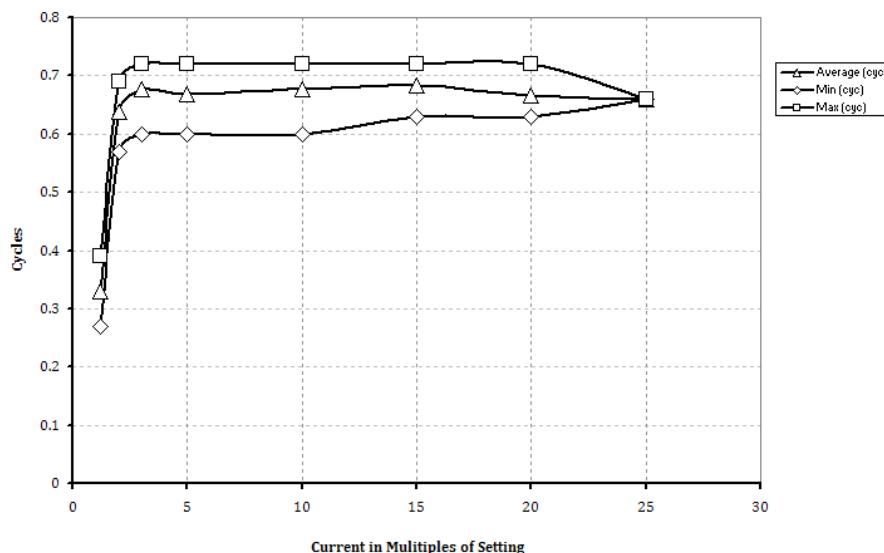
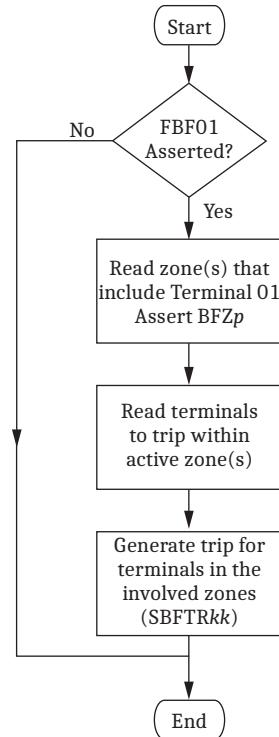


Figure 5.40 Breaker Failure Clearing Times

## Circuit Breaker Failure Trip Logic

Following a breaker failure relay operation, the SEL-487B breaker failure trip logic sends trip signals to all of the breakers the logic identifies as being in the same bus-zone as the faulted breaker. The logic uses breaker failure trip informa-

tion from the internal breaker failure logic and zone selection information to determine which breakers to trip. *Figure 5.41* shows the processing sequence for tripping the breakers according to the breaker failure operation FBF01.



**Figure 5.41 Station Breaker Failure Trip Logic**

For example, assume Terminals I01, I02, I03 and I04 are in Bus-Zone 1, with Terminal 01 failing for an external fault. The logic determines that Terminal 01 is in Bus-Zone 1, just as Terminals 02, 03, and 04 are also in Bus-Zone 1. The relay asserts Relay Word bits SBFTR01, SBFTR02, SBFTR03, and SBFTR04. With the assumption that there are four breakers, assign these four Relay Word bits to the corresponding TR01, TR02, TR03, and TR04 trip equations.

The breaker failure trip logic asserts the breaker failure trips as shown in *Table 5.11*.

**Table 5.11 Station Breaker Failure Trips (Sheet 1 of 2)**

Terminal Within a Zone	Station Breaker Failure Trip Bit
I01	SBFTR01
I02	SBFTR02
I03	SBFTR03
I04	SBFTR04
I05	SBFTR05
I06	SBFTR06
I07	SBFTR07
I08	SBFTR08
I09	SBFTR09
I10	SBFTR10
I11	SBFTR11
I12	SBFTR12

**Table 5.11 Station Breaker Failure Trips (Sheet 2 of 2)**

Terminal Within a Zone	Station Breaker Failure Trip Bit
I13	SBFTR13
I14	SBFTR14
I15	SBFTR15
I16	SBFTR16
I17	SBFTR17
I18	SBFTR18
I19	SBFTR19
I20	SBFTR20
I21	SBFTR21

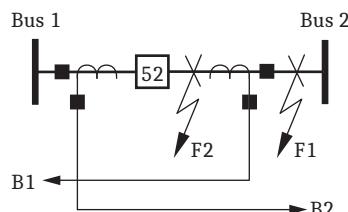
SBFTR is the OR combination of SBFTR01 to SBFTR21.

## Bus Coupler/Bus Sectionalizer Configurations

With the flexibility of SELLOGIC control equations, you can configure any one of the bus sectionalizer (tie breaker) configurations in *Figure 5.42–Figure 5.44* without additional wiring; it is simply a software configuration change.

### CT Either Side of the Breaker With Overlap

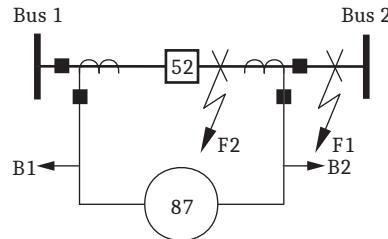
*Figure 5.42* shows a bus sectionalizer with a CT on either side of the circuit breaker with the protection arranged in overlap. For an overlap application, connect the CTs so that each zone of protection (B1 and B2) includes the tie-breaker circuit breaker. For example, for Fault 1, only the differential element of Busbar B2 operates; the differential element of Busbar B1 is stable. However, because of the overlap connections, both differential elements operate for Fault F2.



**Figure 5.42 Two CTs With the Busbar Protection Configured in Overlap**

### CT Either Side of the Breaker With Breaker Differential

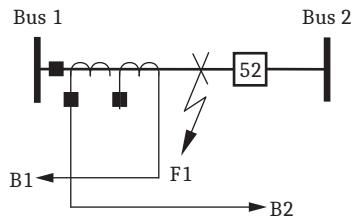
*Figure 5.43* also shows a bus sectionalizer with a CT on either side of the circuit breaker with the protection arranged in a breaker differential application. For a breaker differential application, connect the CTs so that each zone of protection (B1 and B2) excludes the tie-breaker circuit breaker. For example, for Fault F1, the differential element of Busbar B2 operates; the differential element of Busbar B1 is stable. The differential element of both Busbar B1 and Busbar B2 is stable for Fault F2. To provide protection for Fault F2, configure an additional differential zone of protection across the tie-breaker circuit breaker.



**Figure 5.43 Two CTs With the Busbar Protection Configured as Breaker Differential**

## Single CT, Single or Two Cores With Overlap

Figure 5.44 shows a bus sectionalizer with a single CT on one side of the circuit breaker with the protection arranged in overlap.



**Figure 5.44 Single CT With the Busbar Protection Configured in Overlap**

Refer to the application examples in *Section 6: Protection Application Examples* for more information.

## Coupler Security Logic

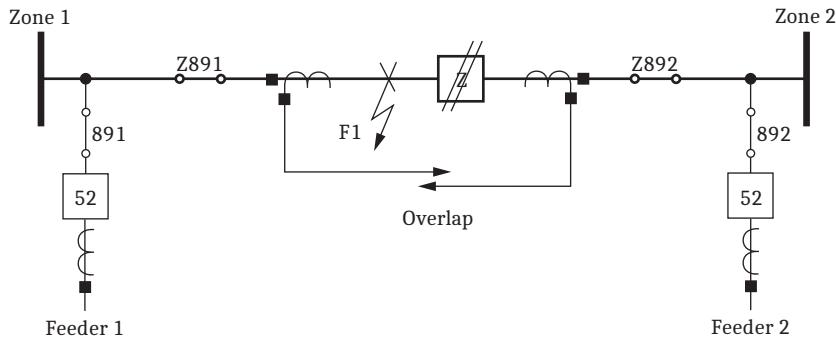
A fault between a bus coupler circuit breaker and CT usually results in the loss of multiple zones as well as in delayed fault clearance, except for where the bus coupler has overlapping zones of protection where both zones are tripped instantaneously. For bus coupler configurations such as breaker differential and single CT applications, fault clearance time usually equals the bus coupler breaker failure time for faults between the CT and the breaker. The coupler security logic includes logic to shorten this time so that it equals the operating time of the bus coupler circuit breaker. Coupler security logic also includes logic to prevent tripping of multiple bus-zones instead of just the faulted bus-zone. Although identifying the faulted bus-zone introduces a trip delay, this delay is still shorter than the bus coupler breaker failure time.

Preventing the loss of multiple bus-zones requires two steps. First, the coupler security logic allows the differential elements to trip only the bus coupler circuit breaker, thereby interrupting the fault current from the unfaulted bus-zone. Then, this logic removes the bus coupler CTs from all differential calculations. Removing the bus coupler CTs from the differential calculations of the unfaulted bus-zone has no effect on the stability of this bus-zone because it no longer contributes to the fault current. However, removing the bus coupler CTs from the differential calculations of the faulted bus-zone causes the differential elements of the faulted bus-zone to operate. This application trips only the faulted bus-zone, thereby preventing the indiscriminate loss of multiple zones, irrespective of the fault position or CT location.

In most cases, breaker auxiliary contacts provide circuit breaker status information. However, circuit breaker auxiliary contact failure or misalignment can result in relay misoperation instead of accelerated tripping. The following discussion describes network operating conditions that may result in relay misoperation and shows how the coupler security logic in the SEL-487B prevents these possible misoperations. Two examples of accelerated tripping show how to apply the coupler security logic to breaker differential and single CT applications. In all cases, assume circuit breaker operating times to be two cycles.

## Network Operating Condition 1

*Figure 5.45* depicts a subset of a substation showing Bus Sectionalizer Breaker Z, and two terminals labeled Feeder 1 and Feeder 2. Zone 1 and Zone 2 are the two bus sections at the station, with the bus sectionalizer busbar protection arranged in overlap. Because both sectionalizer disconnects (Z891 and Z892) are closed, the currents from the sectionalizer CTs are considered in the differential calculations. In this example, the bus sectionalizer circuit breaker is open, and both feeder circuit breakers are closed. *Table 5.12* summarizes the prevailing network operating conditions.



**Figure 5.45 Fault F1 Between Bus Sectionalizer and CT With the Bus Sectionalizer Circuit Breaker Open**

**Table 5.12 Summary of the Network Conditions Shown in Figure 5.45**

Station Conditions	Fault Description
Bus sectionalizer Circuit Breaker Z open Both bus sectionalizer disconnects (Z891 and Z892) closed All other breakers and disconnects closed	Fault F1 develops between the sectionalizer circuit breaker and CT

Assume now that Fault F1 occurs as indicated in *Figure 5.45*. Because the currents from the sectionalizer CTs are considered in the differential calculations, and because the bus sectionalizer busbar protection is arranged in overlap, both zones trip. *Table 5.13* summarizes the event.

**Table 5.13 Summary of the Event for Fault F1 Shown in Figure 5.45**

Tripping for Fault F1	Clearing Time	Zones Lost	Comment
All breakers in both zones trip without time delay	2 cycles	2	Zone 2 tripped unnecessarily

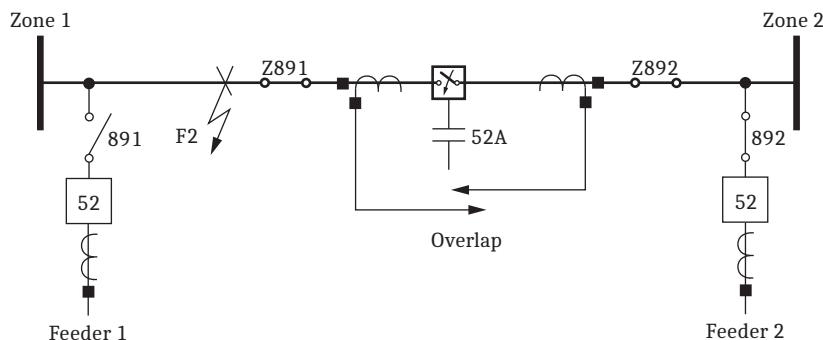
One solution for overcoming this problem is to include the bus sectionalizer circuit breaker auxiliary contact together with the disconnect auxiliary contact as a condition for CT consideration in the differential calculations. With the bus sectionalizer circuit breaker auxiliary contact included in the conditions, the current

inputs from the bus sectionalizer CTs are not considered in the differential calculations when the bus sectionalizer circuit breaker is open. In this case, only Zone 1 trips for Fault F1 in *Figure 5.45*.

Including the bus sectionalizer circuit breaker auxiliary contact solves the problem in Network Operating Condition 1. However, Network Operating Condition 2 shows that the busbar protection is still not completely secure, although the conditions for CT consideration in the differential calculations now include the bus sectionalizer circuit breaker auxiliary contact.

## Network Operating Condition 2

*Figure 5.46* shows the same substation under different operating conditions. The bus sectionalizer circuit breaker auxiliary contact 52A forms part of the conditions for CT consideration in the differential calculations. Although the disconnects are closed, the bus sectionalizer circuit breaker is open and the differential calculations do not consider the bus sectionalizer CT inputs in the differential calculation. Fault F2 in *Figure 5.46* represents grounding straps that were inadvertently left on the busbars in Zone 1. The Feeder 1 circuit breaker is open, and the bus sectionalizing circuit breaker is about to close. *Table 5.14* summarizes the prevailing network operating conditions.



**Figure 5.46 Closing the Bus Sectionalizing Circuit Breaker Onto a Faulted Busbar**

**Table 5.14 Summary of the Events for Fault F2 Shown in Figure 5.46**

Station Conditions	Fault Description
Bus sectionalizer Breaker Z closing Both bus sectionalizer disconnects (Z891 and Z892) are closed All Zone 2 feeder breakers and disconnects (892) are closed All Zone 1 feeder disconnects (891) are open	Sectionalizer breaker closes onto Fault F2

If the bus sectionalizing circuit breaker auxiliary contacts are misaligned or fail in such a way that the CTs from the sectionalizer are not considered in the differential calculation at fault inception, the Zone 2 differential elements misoperate. *Table 5.15* summarizes the event.

**Table 5.15 Summary of the Event for Fault F2 Shown in Figure 5.46**

Tripping for F2	Clearing Time	Zones Lost	Comment
All breakers in Zone 2 trip without time delay (Feeder 2 and Circuit Breaker Z)	2 cycles	1	Incorrect tripping for terminals connected to Zone 2; only terminals connected to Zone 1 (Breaker Z) should have tripped.

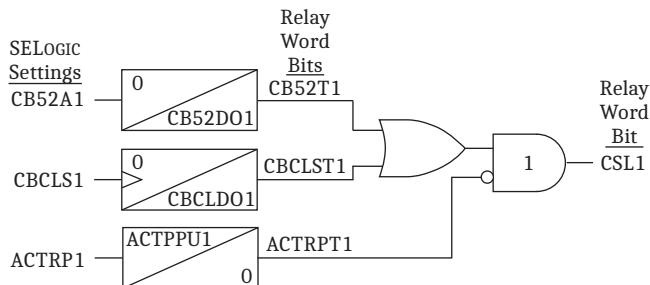
Use the coupler security logic (see *Figure 5.47*) in the SEL-487B to prevent relay misoperation for network conditions 1 and 2.

## Coupler Security Logic

Inserting the bus sectionalizer CTs into the differential calculations before fault inception prevents relay misoperation for Network Operating Condition 2.

*Figure 5.47* shows one of the four coupler security logics available in the relay. Wire a bus sectionalizer auxiliary contact to input CB52A1, and wire the bus sectionalizer circuit breaker closing signal to input CBCLS1. Inputs CB52A1 and CBCLS1 coordinate the bus sectionalizer CT insertion into and removal from the differential calculation. For breaker differential applications, enter CSL1, the output from the coupler security logic, instead of the bus sectionalizer circuit breaker auxiliary contact, as a condition for CT consideration in the differential calculations.

As shown in *Figure 5.47*, the breaker auxiliary contact (CB52A1) and the close signal (CBCLS1) are in parallel. Issuing the close signal to the bus sectionalizer circuit breaker close coil also asserts Relay Word bit CSL1. Timer CBCLD01 maintains the close signal for five cycles (default setting), allowing ample time for the bus sectionalizer circuit breaker auxiliary contact to change state. When Relay Word bit CSL1 asserts, the CTs are immediately considered in the differential calculation. Because the bus sectionalizer CTs are considered in the differential calculation before fault inception, Zone 2 is stable for Network Operating Condition 2.



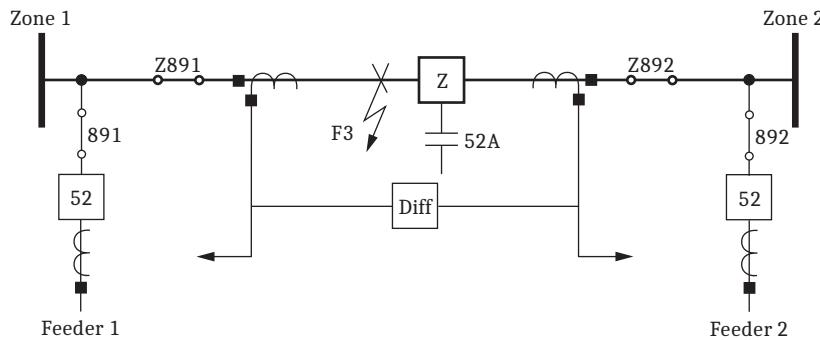
**Figure 5.47 Coupler Security Logic for Accelerated Tripping and Busbar Protection Security for Circuit Breaker Auxiliary Contact Misalignment**

When the bus sectionalizer circuit breaker trips, misaligned circuit breaker auxiliary contacts can remove the bus sectionalizer CTs from the differential calculation while current still flows through the bus sectionalizer circuit breaker. Timer CB52D01 maintains the status of the bus sectionalizer circuit breaker auxiliary contact as closed for four cycles (default setting) after the contact changes state. During this four-cycle time delay, the bus sectionalizer CTs are still considered in the differential calculation, allowing the bus sectionalizer circuit breaker ample time to interrupt the current.

ACTRP1, the third input into the coupler security logic provides an input to accelerate tripping of the bus sectionalizer circuit breaker for faults between bus sectionalizer circuit breaker and CT. Accelerated tripping operating time is the time period greater than the bus sectionalizer circuit breaker operating time (typically 2 cycles) but shorter than the breaker failure time (typically 6–10 cycles).

## Breaker Differential

*Figure 5.48* shows an application of breaker differential protection. There are CTs on either side of the bus sectionalizing circuit breaker, and we configure a differential zone of protection across the bus sectionalizing circuit breaker. This is in addition to Zone 1 and Zone 2 of the busbar protection. Any of the six zones may be used for breaker differential protection. Breaker differential protection is a good choice for stations where preservation of supply is more important than a very fast clearing time.



**Figure 5.48 CTs on Either Side of the Sectionalizer Circuit Breaker With Breaker Differential Across Breaker Z**

We use the coupler security logic (initially without an ACTRP1 input) and consider the relay operation for Fault F3 in *Figure 5.48*. Circuit Breaker Z opens after two cycles, deasserting the input to CB52A1. When Circuit Breaker Z trips, fault current no longer flows from Zone 2, but Zone 1 still contributes to the fault. Four cycles after Circuit Breaker Z trips (CB52D01 default time), Relay Word bit CSL1 deasserts, removing both bus sectionalizing CTs from all three differential elements (breaker differential, Zone 1, and Zone 2). Zone 2 is stable after removing the CTs from the Zone 2 differential calculations because Zone 2 no longer contributes to the fault. However, Zone 1 still contributes to the fault, and removing the CTs from the Zone 1 differential calculations causes the Zone 1 differential elements to operate, clearing the fault. Only one zone is lost, although this loss occurs after a time delay. *Table 5.16* summarizes the events.

**Table 5.16 Summary of the Event for Fault F3 Shown in Figure 5.48**

Relay and Circuit Breaker Operation for F3	Time Delay	Zones Lost	Comment
Breaker differential (87R3) asserts	1 cycle	0	Typical operating time is 0.75 cycle
Bus sectionalizer trips	2 cycles	0	Correct tripping
Timer CB52A1 expires	4 cycles	0	Relay Word bit CSL1 deasserts, unbalancing Zone 1
SEL-487B operating time	1 cycle	0	Typical operating time is 0.75 cycle
All circuit breakers in Zone 1 trip	2 cycles	1	Total clearing time is 10 cycles

Because Fault F3 is external to Zone 1 and Zone 2, both of these zones are stable for as long as the sectionalizing breaker CTs are considered in the differential calculations. If the sectionalizing breaker fails, both Zone 1 and Zone 2 trip only after breaker failure time.

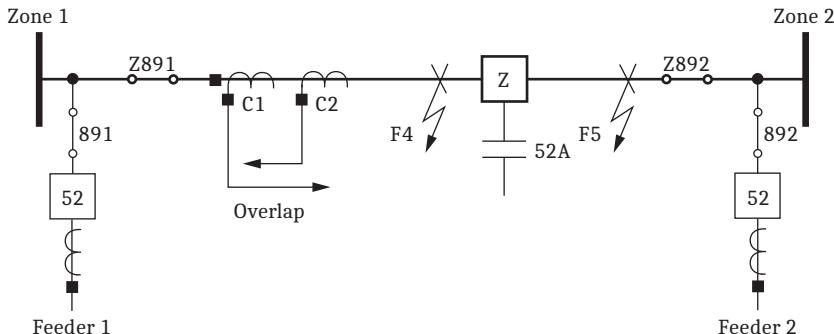
Function ACTRP1 provides an input for removing the bus sectionalizing CTs sooner. One solution is to assign 87R3, the output from the sectionalizer breaker differential element to input ACTRP1. Relay Word bit 87R3 asserts when there is a fault within the sectionalizer zone. With ACTPPU1 set to four cycles, Relay Word bit CSL1 deasserts about two cycles after the sectionalizing circuit breaker interrupts the fault current. *Table 5.17* summarizes the events.

**Table 5.17 Summary of the Event for Fault F3 Using the Accelerated Trip Function**

Relay and Circuit Breaker Operation for F3	Time Delay	Zones Lost	Comment
Breaker differential (87R3) asserts	1 cycle	0	Typical operating time is 0.75 cycle. Timer ACTPPU1 starts timing
Bus sectionalizer trips	2 cycles	0	Correct tripping
Timer ACTPPU1 expires	2 cycles	0	Reduce this setting for faster clearance
SEL-487B operating time	1 cycle	0	Typical operating time is 0.75 cycle
All circuit breakers in Zone 1 trip	2 cycles	1	Total clearing time is 8 cycles

## Single CT Application

*Figure 5.49* shows the same substation, now with only one CT installed on the bus sectionalizer. The busbar protection is connected in overlap. The challenge for the busbar protection is to distinguish between faults F4 and F5. When Fault F5 occurs, Zone 1 is stable and the Zone 2 protection immediately trips Feeder 2 and the bus sectionalizer circuit breaker. Tripping Feeder 2 and the bus sectionalizer circuit breaker clears Fault F5.



**Figure 5.49 Single CT Application With Fault F4 Between the Bus Sectionalizer Circuit Breaker and CT**

When Fault F4 occurs, Zone 1 is stable, and, as before, the Zone 2 protection immediately trips Feeder 2 and the bus sectionalizer circuit breaker. Tripping Feeder 2 and the bus sectionalizer circuit breaker, however, does not clear Fault F4, and fault current still flows through the bus sectionalizer CT. At the same time, the busbar protection also initiates breaker failure protection on Feeder 2 and the bus sectionalizer. This fault current causes the breaker failure protection of the bus sectionalizer to continue timing, although the bus sectionalizer circuit breaker tripped. After the bus sectionalizer failure timer times out, all circuit breakers in Zone 1 trip. Both Zone 1 and Zone 2 trip to clear this fault.

If delayed tripping time for Zone 2 busbar faults is in order, use a combination of the zone supervision and coupler security logic to prevent losing both zones. Assign 87R2, the output from the Zone 2 differential element, to ACTRP1, the

accelerated trip input of the coupler security logic. Assign the negated output from the coupler security logic (NOT CSL1) to supervise the Zone 2 differential element output ( $Z2S := \text{NOT CSL1}$ ). For single CT applications, enter CB52A1, the bus sectionalizer circuit breaker auxiliary contact, as a condition for CT consideration in the differential calculations for the zone supervised by CSL1 (Zone 2 in this case). Then, enter CB52T1, the coupler status timed out bit, as a condition for CT consideration in the differential calculations for the unsupervised zone (Zone 1 in this case).

For faults in Zone 2, trip only the bus sectionalizer circuit breaker. After the bus sectionalizer opens, remove the bus sectionalizer CT from the differential calculations of Zone 2. After a set delay of at least two cycles (to allow the 87R2 element to reset), remove the Zone 2 supervision and the bus sectionalizer CT from the differential calculations of Zone 1. The operation of the logic is as follows:

When either Fault F4 or Fault 5 occurs, the Zone 2 differential element operates to clear the fault. The Zone 2 zone supervision prevents Relay Word bit 87Z2 from asserting, and only the bus sectionalizer circuit breaker receives a trip signal. The circuit breaker trips two cycles later, removing CT cores C1 and eventually C2 from the differential calculations for Zone 1 and Zone 2.

For Fault F4, the bus sectionalizer circuit breaker is open, but fault current still flows through CT Cores C1 and C2. Removing the bus sectionalizer CTs from all differential calculations prevents Zone 2 from operating (current from CT Core C1 removed) but causes Zone 1 to operate (balancing current from CT Core C2 removed).

For Fault F5, tripping the bus sectionalizer circuit breaker interrupts the fault current contribution from Zone 1, and the Zone 1 differential element is stable. The Zone 2 zone supervision prevents tripping of terminals in Zone 2, until Accelerate Trip Timer ACTRP1 times out. When ACTRP1 times out, coupler security logic output CSL1 deasserts. When Relay Word bit CSL1 deasserts, Relay Word bit Z2S asserts, allowing the Zone 2 differential element (87Z2) to operate and issuing a trip signal to all circuit breakers in Zone 2.

## Disconnect Monitor

**NOTE:** Disconnect switch status may be indicated to the SEL-487B-2 via I/O board inputs, TiDL communications, or GOOSE messages.

Disconnect auxiliary contacts provide the zone selection logic with the information required to dynamically assign current inputs to the appropriate differential elements. *Figure 5.50* depicts the logic for Disconnect Logic Circuit 01 in the relay, one of 60 disconnect logic circuits available in the relay. This logic requires both normally open (89A) and/or normally closed (89B) disconnect auxiliary contacts.

*Table 5.18* shows the four possible disconnect auxiliary contact combinations, and the way in which the relay interprets these combinations. Applying the principle of (disconnect) NOT OPEN = (disconnect) CLOSED, the relay properly coordinates the primary current flow and the CT current assignment to the appropriate differential element.

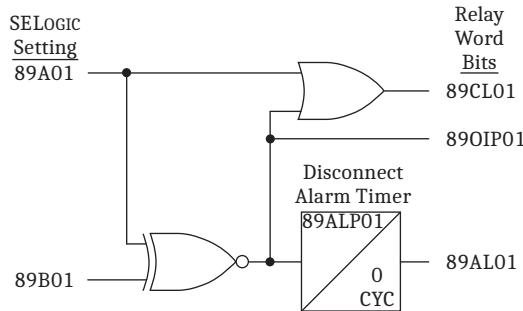
**Table 5.18 Disconnect 89A and 89B Auxiliary Contact Status Interpretation  
(Sheet 1 of 2)**

Case	89A01	89B01	Disconnect Status (89CL01)
1	0	0	Closed (1)
2	0	1	Open (0)

**Table 5.18 Disconnect 89A and 89B Auxiliary Contact Status Interpretation  
(Sheet 2 of 2)**

Case	89A01	89B01	Disconnect Status (89CL01)
3	1	0	Closed (1)
4	1	1	Closed (1)

The following description of the contact combinations assumes the disconnect auxiliary contacts are the only conditions declared in the terminal-to-bus-zone variable settings.



**Figure 5.50 Disconnecting Switch Status Logic**

Case 1 occurs when disconnect auxiliary contact 89A and auxiliary contacts 89B are open simultaneously. This case is the intermediate position in an open-to-close or close-to-open operation. Timer 89ALP01 times for this condition and asserts Relay Word bit 89AL01 when the disconnect auxiliary contacts remain in the intermediate position for a period exceeding the 89ALP01 timer setting. Relay Word bit 89OIP01 also asserts during this period, indicating a disconnect operation in progress condition. The relay considers the disconnect main contact closed during this period, and the CTs are considered in the differential calculations.

Case 2 is the only combination of disconnect auxiliary contacts for which the relay considers the disconnect main contact to be open. This is also the only combination for which the CTs are not considered in the differential calculations.

Case 3 is the only combination of disconnect auxiliary contacts for which the relay confirms the disconnect main contacts to be closed. Relay Word bit 89CL01 asserts to indicate the main contact close position. The CTs are considered in the differential calculations.

Case 4 is an illegitimate condition, with the disconnect auxiliary contacts showing the disconnect main contact to be open and closed simultaneously. Timer 89ALP01 times for this condition and asserts Relay Word bit 89AL01 when the disconnect auxiliary contacts remain in this condition for a period exceeding the timer setting. The relay considers the disconnect main contact closed during this period, and the CTs are considered in the differential calculations.

The relay includes 60 alarm timers that provide individual time settings for 60 disconnect logic circuits. These individual timers are useful in installations where the disconnect travel times differ substantially. In particular, sequentially operated devices (pantographs, for example) have travel times much longer than normal disconnects.

Relay Word bit 89OIP represents the OR combination of Relay Word bits 89OIP01–89OIP60, and Relay Word bit 89AL (not shown) is respectively the OR combination of Relay Word bits 89AL01–89AL60.

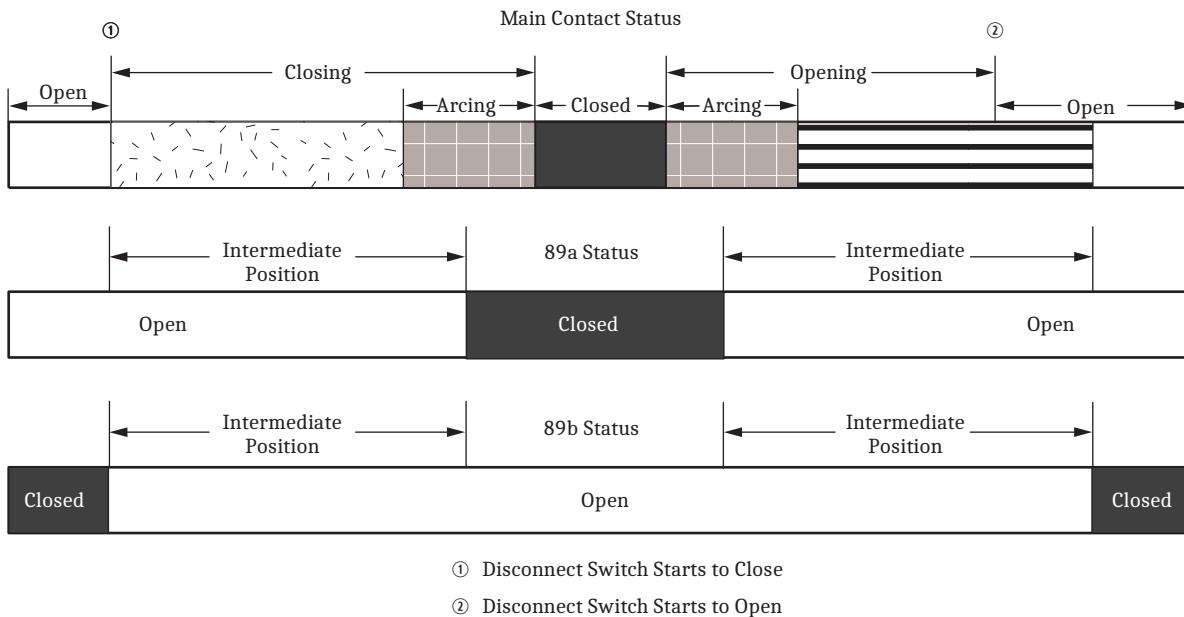
**NOTE:** Use Relay Word bit 89CL01 in SELOGIC control equations when entering the conditions in the terminal-to-bus-zone settings.

To ensure correct differential element operation, the contacts must comply with the requirements listed in *Table 5.19*.

**Table 5.19 Disconnect Auxiliary Contact Requirements to Ensure Correct Differential Element Operation**

Operation	Requirement
From disconnect open to disconnect close operation	Assign the currents to the applicable differential element before the disconnect reaches the arcing point (the point where primary current starts to flow).
From disconnect close to disconnect open operation	Remove the current from the applicable differential element only once the disconnect has passed the arcing point (the point where primary current has stopped flowing).

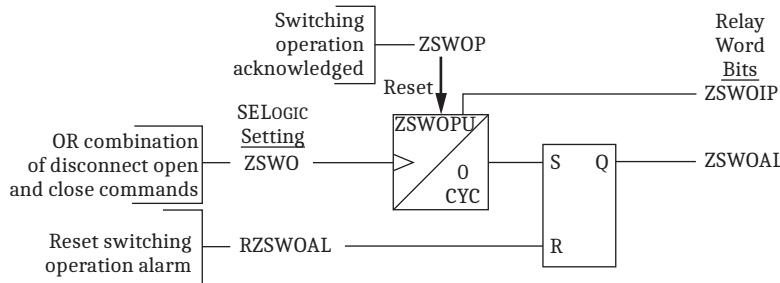
*Figure 5.51* shows the disconnect auxiliary contact requirements with respect to the arcing point.



**Figure 5.51 Disconnecting Switch Main Contact, 89a, and 89b Status for Open-to-Close and Close-to-Open Conditions**

## Zone-Switching Supervision Logic

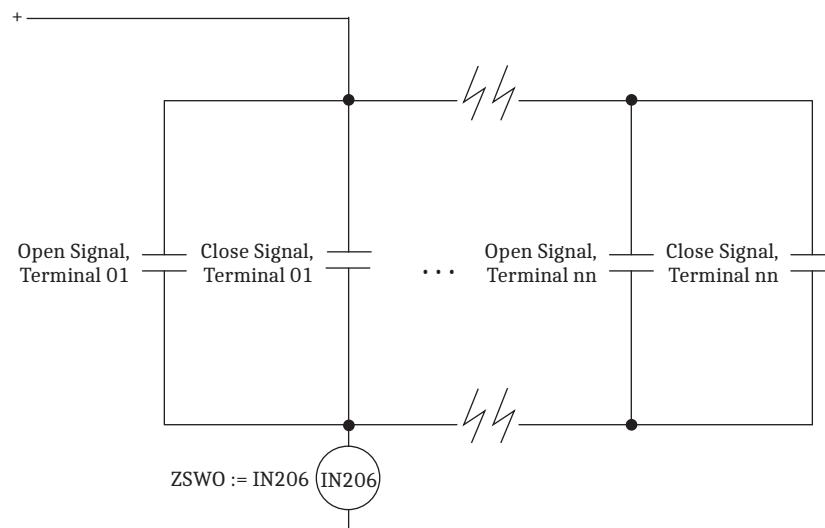
Because the disconnect monitoring logic requires both 89A and 89B disconnect auxiliary contacts, installations with only an 89A (or 89B) contact available cannot use the disconnect monitoring logic. In these installations, there is always uncertainty whether the disconnect auxiliary contact actually changed status. This is important information because busbar protection will misoperate if input currents are assigned to the incorrect differential elements. Zone-switching supervision logic uses the ZSWOP Relay Word bit (see *Dynamic Zone Selection Logic on page 5.20*) that asserts for any terminal-to-bus-zone or bus-zone-to-bus-zone change. In other words, the ZSWOP Relay Word bit provides an acknowledgment that the relay has recognized a change in disconnect auxiliary contact status. *Figure 5.52* shows the logic.



**Figure 5.52 Zone-Switching Supervision Logic**

Asserting Relay Word bit ZSWO activates the logic, the rising edge of ZSWO starting timer ZSWOPU, and asserts the ZSWOIP bit for the period when the timer is timing. When the zone selection logic acknowledges a change in disconnect status, the ZSWOP Relay Word bit asserts and resets the timer. If the Zone Selection does not acknowledge the switching operation within the ZSWOPU time setting, the logic asserts the switching operation alarm ZSWOAL. SELOGIC control equation RZSWOAL provides the input to reset the alarm.

There is only one zone-switching supervision logic in the relay; disconnect open and close commands must be combined externally to the relay for electrically operated disconnects, as shown in *Figure 5.53*.



**Figure 5.53 External Wiring and Initiation Input for Zone-Switching Supervision**

For manually operated disconnects, configure one of the SEL-487B front-panel pushbuttons as an input to assert the ZSWO Relay Word bit. Timer ZSWOPU has a range of more than 27 minutes, allowing ample time for the operating procedures.

## Differential Trip Logic

**NOTE:** See Zone Supervision Logic on page 5.20 for information on default logic that secures the relay during data loss conditions. Be sure to keep this logic alongside any additional logic your application requires.

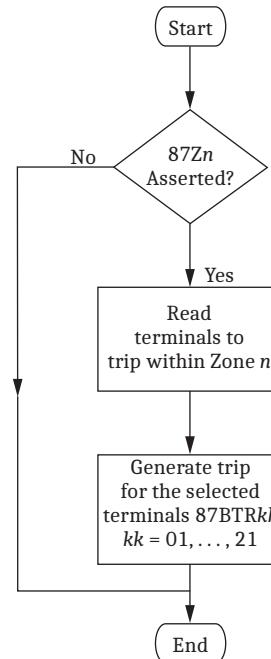
This is the final stage of the differential trip output. *Figure 5.54* is the Bus-Zone portion of *Figure 5.28* from the zone supervision logic. At this point, the differential element has operated (87R1), and all supervising criteria are met (Z1S). The differential trip logic now acquires all Zone 1 terminals and generates a trip output to the appropriate breakers.



① See Figure 5.19.

**Figure 5.54 Differential Element Zone Supervision for Zone 1**

Figure 5.55 shows the processing sequence for tripping the breakers as a function of the differential element operation, 87Z<sub>n</sub>, where n = 1–6.



**Figure 5.55 Bus Differential Trip Logic**

The differential trip logic asserts differential trips as shown in Table 5.20.

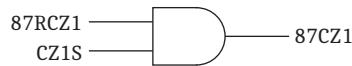
**Table 5.20 Differential Trips (Sheet 1 of 2)**

Terminal Within a Zone	Differential Trip Bit
I01	87BTR01
I02	87BTR02
I03	87BTR03
I04	87BTR04
I05	87BTR05
I06	87BTR06
I07	87BTR07
I08	87BTR08
I09	87BTR09
I10	87BTR10
I11	87BTR11
I12	87BTR12
I13	87BTR13
I14	87BTR14
I15	87BTR15

**Table 5.20 Differential Trips (Sheet 2 of 2)**

Terminal Within a Zone	Differential Trip Bit
I16	87BTR16
I17	87BTR17
I18	87BTR18
I19	87BTR19
I20	87BTR20
I21	87BTR21

This is the final stage of the check zone differential trip output. *Figure 5.56* is the check zone portion of *Figure 5.28* from the zone supervision logic. At this point, the Check Zone Differential Element has operated (87RCZ1), and all supervising criteria are met (CZ1S). The supervised trip output is then asserted (87CZ1). The check zone output is independent of the bus-zones and is not processed by the differential trip logic shown in *Figure 5.55*.

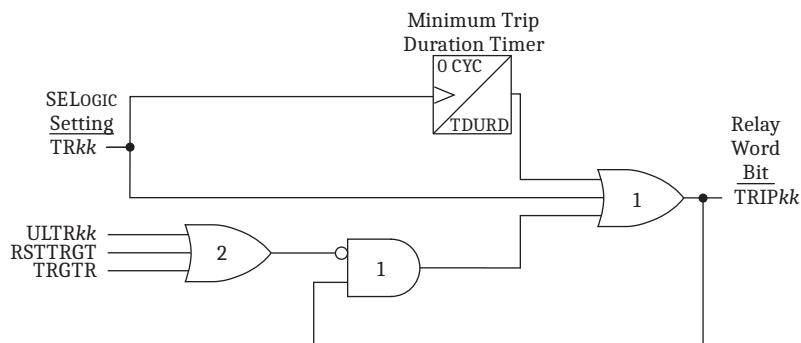


**Figure 5.56 Differential Element Zone Supervision for Check Zone**

## Breaker Trip Logic

*Figure 5.57* shows the tripping logic for Terminal 01 in the SEL-487B. The remaining logic for Terminal 02–Terminal 21 is identical and uses variables TR02–TR21 and ULTR02–ULTR21, and TRIP02–TRIP21, respectively.

**NOTE:** In the trip logic, the set or latch function (TRkk) has priority over the reset or unlatch (ULTRkk) function (kk = 1–21).



**Figure 5.57 Trip Logic for Breaker 1**

Enable the trip logic settings by setting the Global setting NUMBK = kk, where kk is the number of breakers at the station. For example, if you have 12 terminals installed at a substation, set NUMBK = 12.

Asserting TR01 directly asserts TRIP01 via input OR Gate 1 and starts the Minimum Trip Duration Timer (TDURD). TRIP01 asserts for a minimum of TDURD cycles, even if TR01 is asserted for as little as one processing interval, or if the unlatch portion of the logic is asserted before TDURD expires. The default setting of TDURD is 12 cycles.

TRIP01 also seals itself in via AND Gate 1. This AND gate receives the negated inputs from the unlatching functions. As long as ULTR01 or TRGTR are not asserted, TRIP01 remains sealed in. TRIP01 is used to drive an output contact to initiate tripping of the breaker.

You can use one of four methods to unlatch the trip logic. One method is to assert either one of SELOGIC control equation setting ULTR01 or SELOGIC control equation setting RSTTRGT. You can also push the **TARGET RESET** pushbutton on the front panel or send the **TAR R** serial port command to assert Relay Word bit TRGTR for one processing interval. Relay Word bit TRGTR also resets the LED targets on the front panel. In the trip logic, assertion of ULTR01, RSTTRGT, or TRGTR places a zero input on AND Gate 1 and, thereby, breaks the TRIP01 seal-in loop.

Note that TRIP01 is always asserted when TR01 is asserted, regardless of the action of ULTR01 or the **TARGET RESET** commands, and that TRIP01 will be asserted for a minimum of TDURD cycles no matter how short the length of time TR01 has been asserted.

## Circuit Breaker Status Logic

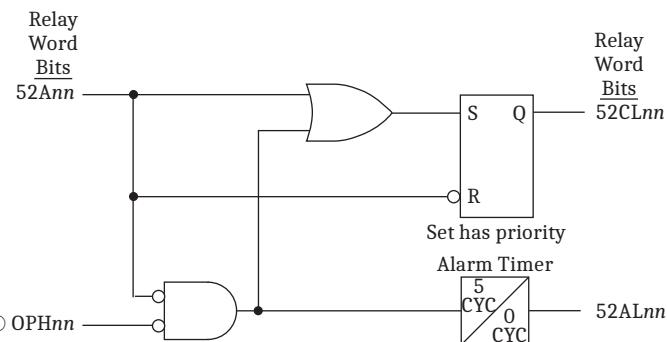
**NOTE:** Circuit breaker status may be indicated to the SEL-487B-2 via I/O board inputs, TiDL communications, or GOOSE messages.

*Figure 5.58* shows the circuit breaker status logic, which uses the combination of breaker 52A (normally open) auxiliary contact and the open-phase detection function, OPH. Because 52B (normally closed) contacts are not always available and as a means to reduce the number of I/O required, the 52B contacts are not required in the logic. However, for applications where the protection philosophy requires a 52B (normally closed) contact, wire the 52B contact into the relay, but use the negated form of the 52B contact in the logic, i.e., NOT 52B (52A01 := NOT IN201).

Relay Word bits 52CL01–52CL21 assert when the breaker is closed. Open-phase detection logic (OPH<sub>nn</sub>) Relay Word bits are included in the circuit breaker status logic to guard against delayed breaker status declaration resulting from possible breaker auxiliary contact misalignment. If a discrepancy between the open-phase detection logic and the breaker auxiliary contact exists for as long as five cycles, the logic generates an alarm that indicates one of the following:

- Possible auxiliary contact supply voltage failure
- Possible failure in an auxiliary contact connection circuit
- Possible failure of the auxiliary contact mechanism

The logic in *Figure 5.58* is generic for three-pole or single-pole breaker mechanisms.



① See Figure 5.35.

**Figure 5.58** Breaker Status and Alarm Logic

Note that OPH $nn$  Relay Word bits assert when no current flows through the circuit breaker, and that set has priority over reset in the circuit breaker status logic. *Table 5.21* shows the output states for all possible breaker conditions.

**Table 5.21 Conditions and Results for the Circuit Breaker Status Logic**

<b>Breaker Status</b>	<b>52A01 or NOT 52B01</b>	<b>OPH01</b>	<b>52CL01</b>	<b>52AL01</b>
Open	0	1 (no current)	0	0
Closed	1	1 (no current)	1	0
Open	0	0 (current flow)	1	1 (after 5 cyc)
Closed	1	0 (current flow)	1	0

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## S E C T I O N 6

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# Protection Application Examples

Configuring the system is the most challenging of the many activities associated with using the SEL-487B-2 Relay. System configuration includes mapping of digital and analog data from merging units, renaming (aliasing) terminals and bus-zones, assigning input contacts to selected relay logics, declaring terminal-to-bus-zone connections, declaring bus-zone-to-bus-zone connections, configuring bus couplers and check zones, and assigning logics to relay outputs. System configuration requires careful consideration of the following items because they both influence the number of SEL-487B Relays and ordering options needed:

- Primary layout of the substation
- Choice of protection elements

This section includes an example application on how to configure the SEL-487B for single-bus differential protection through use of IEC 61850-9-2 Sampled Values (SV). See *Section 6: Protection Application Examples in the SEL-487B-1 Instruction Manual* for general protection philosophy and examples configuring protection settings for other bus configurations. See *Applications on page 1.5* for further information on merging-unit topologies and networking options.

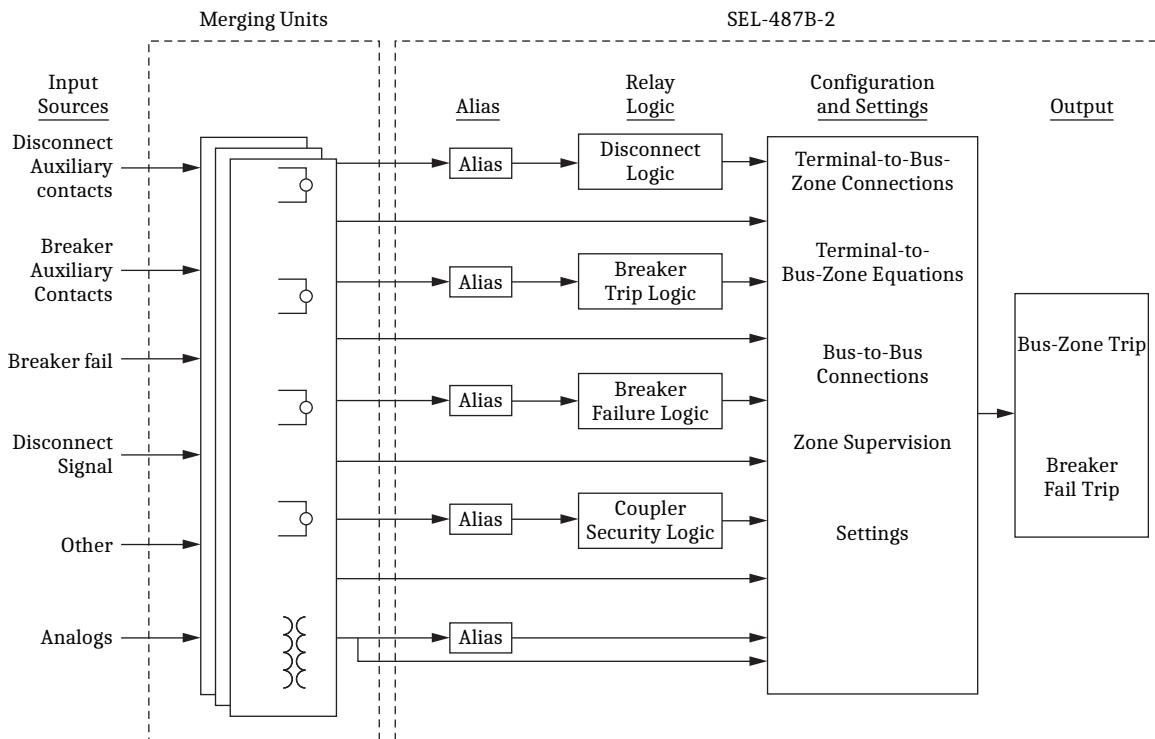
The following discussion provides general guidelines and outlines general factors that should be considered when using ASCII commands to configure your relay. The section also provides application examples for some of the more common busbar layouts. Included in this section are the following topics:

- *Input, Logic, and Output Assigning Process on page 6.1*
- *Relay Differential Element Composition on page 6.2*
- *CT Requirements on page 6.8*
- *Disconnect Requirements on page 6.11*
- *Alias Names on page 6.14*
- *Bus-Zone Configurations on page 6.14*
- *Bus-Zone-to-Bus-Zone Connections on page 6.28*
- *Zone Supervision on page 6.31*
- *Trip Logic on page 6.32*
- *Output Assignments on page 6.32*
- *Summary on page 6.33*
- *Single Bus and Tie Breaker (Three Relays) Application on page 6.35*

## Input, Logic, and Output Assigning Process

*Figure 6.1* shows a block diagram of the merging unit inputs and SEL-487B logic and output assigning processes for system configuration and protection element settings. Digital input merging-unit sources include disconnect and breaker auxiliary contacts, breaker failure initiate signals, and breaker close signals. Analog input merging sources include current and potential transformer measurements.

Use alias settings to assign more meaningful names to primitive Relay Word bits and/or analog names, or use the primitive names of the input quantities to configure and set the relay. The relay has many ready-made logic functions available; however, assign these functions before they become operative. System configuration includes terminal-to-bus-zone and bus-zone-to-bus-zone assignments, zone supervision, and zone-switching supervision settings. Scheme settings include enable settings, differential and sensitive differential element settings, directional element settings, selected relay logic settings, and output assignments.

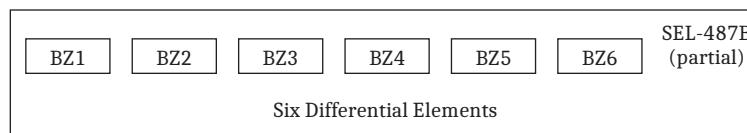


**Note:** See Section 19: Digital Secondary Systems in the SEL-400 Series Relays Instruction Manual for merging-unit networking and time-synchronization details.

**Figure 6.1 Block Diagram of the Input, Logic, and Output Assigning Process for System Configuration Protection Element Settings**

## Relay Differential Element Composition

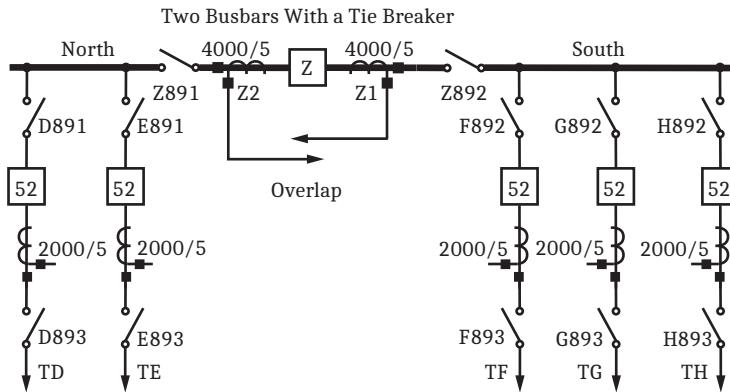
Each SEL-487B accepts as many as 21 current inputs (I01–I21) and then assigns these inputs to any of 6 differential elements (BZ1–BZ6).



**Figure 6.2 Block Diagram Showing Six Differential Elements**

# Single-Relay Application

Because differential calculations occur on a per-phase basis, each phase of a three-phase system must bear a unique identification. *Figure 6.3* shows a typical single-line diagram of a station consisting of two busbars (NORTH and SOUTH), a tie breaker (Z), and four terminals.



**Figure 6.3 Single-Line Diagram of a Station With Two Busbars and a Tie Breaker**

Because the station has no more than seven terminals, a single SEL-487B suffices. *Figure 6.4* shows the SEL-487B and a three-phase representation of Terminal TD, one of the terminals at the station.

Because differential calculations for each protection zone require an individual differential element, assign an individual differential element to each phase. This assignment uses three of the available six differential elements in the relay for Busbar NORTH. In this example, assign the phases and differential elements as shown in *Figure 6.4*. Each assignment is a software assignment, as indicated by the assignment arrows; no electrical wires are required.

Assign the A-Phase differential element of Busbar NORTH to differential element BZ1

Assign the B-Phase differential element of Busbar NORTH to differential element BZ2

Assign the C-Phase differential element of Busbar NORTH to differential element BZ3

To make the bus-zone labels more substation-descriptive, assign the following alias names to the bus-zones, as shown in *Figure 6.4*:

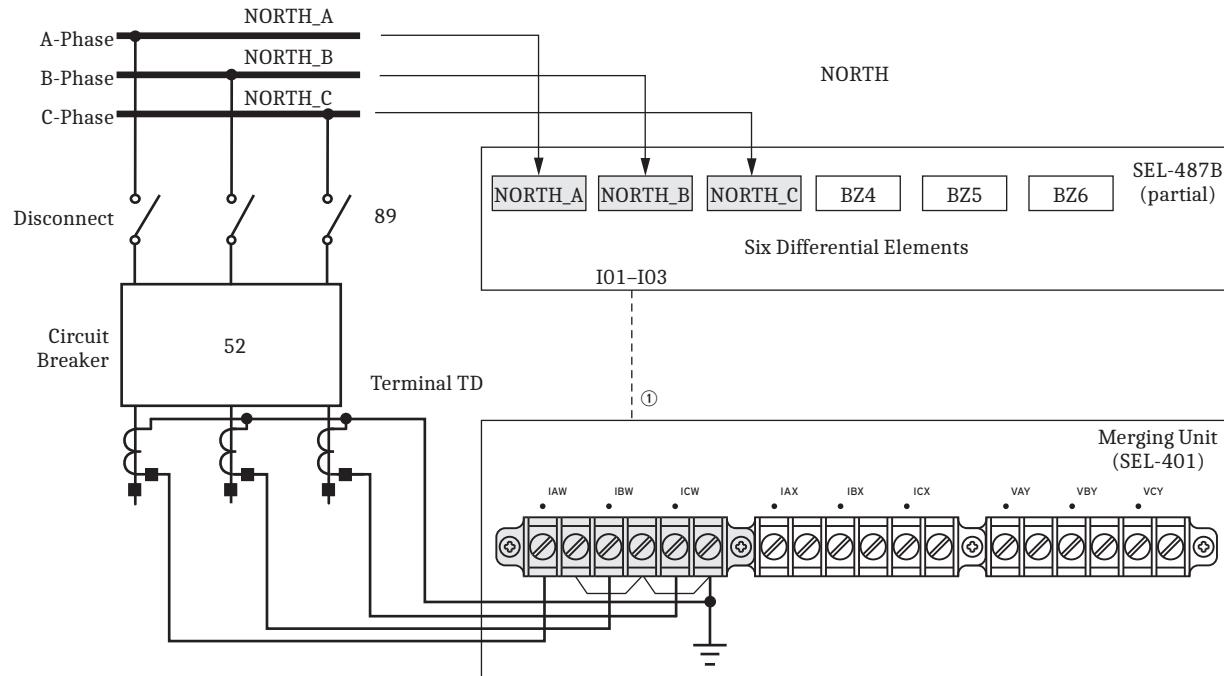
For the A-Phase differential element BZ1, assign NORTH\_A

For the B-Phase differential element BZ2, assign NORTH\_B

For the C-Phase differential element BZ3, assign NORTH\_C

For the current inputs in a single SEL-487B application, wire A-Phase, B-Phase, and C-Phase to merging-unit terminal connections, as shown in *Figure 6.4*. These connections are copper wires connecting the CTs to the merging unit.

The merging-unit connections shown in *Figure 6.4* are specific to the SEL-401 Merging Unit Protection Relay and SEL-421 Line Protection Relay With Sampled Values. If using a different merging unit, check with the manual for that device for connection details.



① See Section 19: Digital Secondary Systems in the SEL-400 Series Relays Instruction Manual for merging-unit networking and time-synchronization details.

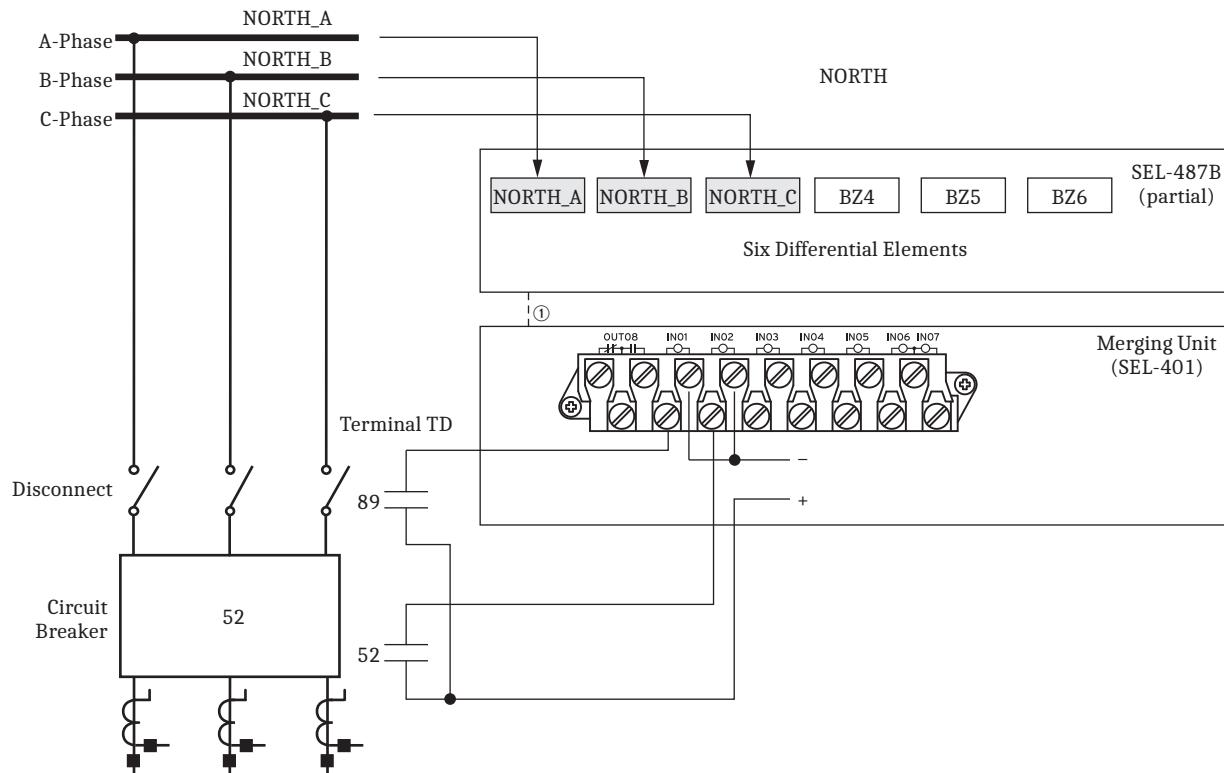
**Figure 6.4 CT Wiring in a Single-Relay Application**

Reference *Figure 6.3* and continue CT connections by wiring the CT inputs from Terminal TE and Terminal Z1 to the corresponding merging units. Connect the CTs from Z2, TF, and TG, following the same procedure to complete protection for both bus-zones.

Digital inputs control the dynamic assignment of input currents to differential elements. If you need dynamic zone selection, wire into the merging units the auxiliary contacts from the disconnect (89), the circuit breaker (52), or any other conditions that must ultimately be considered in the zone selection logic.

*Figure 6.5* shows the disconnect and circuit breaker wiring for Terminal TD.

Only the differential elements are enabled for this example. If you need other functions such as breaker failure protection, wire those inputs to the relay. You need all six zones and all 21 current channels to configure the remaining terminals in the same way. *Table 6.1* shows the complete station analog channel configuration.



① See Section 19: Digital Secondary Systems in the SEL-400 Series Relays Instruction Manual for merging-unit networking and time-synchronization details.

**Figure 6.5** Disconnect and Circuit Breaker Wiring for Terminal TD

**Table 6.1 Complete Station Configuration, Using Two Three-Phase Bus-Zones and All 21 Current Inputs in a Single-Relay Application (Sheet 1 of 2)**

CTs	Bus-Zone	Merging Unit	Merging-Unit Published Analog	SEL-487B Subscribed Analog
TD, A-Phase	NORTH_A	TD	IAW	I01
TD, B-Phase	NORTH_B		IBW	I02
TD, C-Phase	NORTH_C		ICW	I03
TE, A-Phase	NORTH_A	TE	IAW	I04
TE, B-Phase	NORTH_B		IBW	I05
TE, C-Phase	NORTH_C		ICW	I06
TF, A-Phase	SOUTH_A	TF	IAW	I10
TF, B-Phase	SOUTH_B		IBW	I11
TF, C-Phase	SOUTH_C		ICW	I12
TG, A-Phase	SOUTH_A	TG	IAW	I13
TG, B-Phase	SOUTH_B		IBW	I14
TG, C-Phase	SOUTH_C		ICW	I15
TIE-BREAKER		TIE-BREAKER		
Z2, A-Phase	SOUTH_A		IAW	I16
Z2, B-Phase	SOUTH_B		IBW	I17
Z2, C-Phase	SOUTH_C		ICW	I18

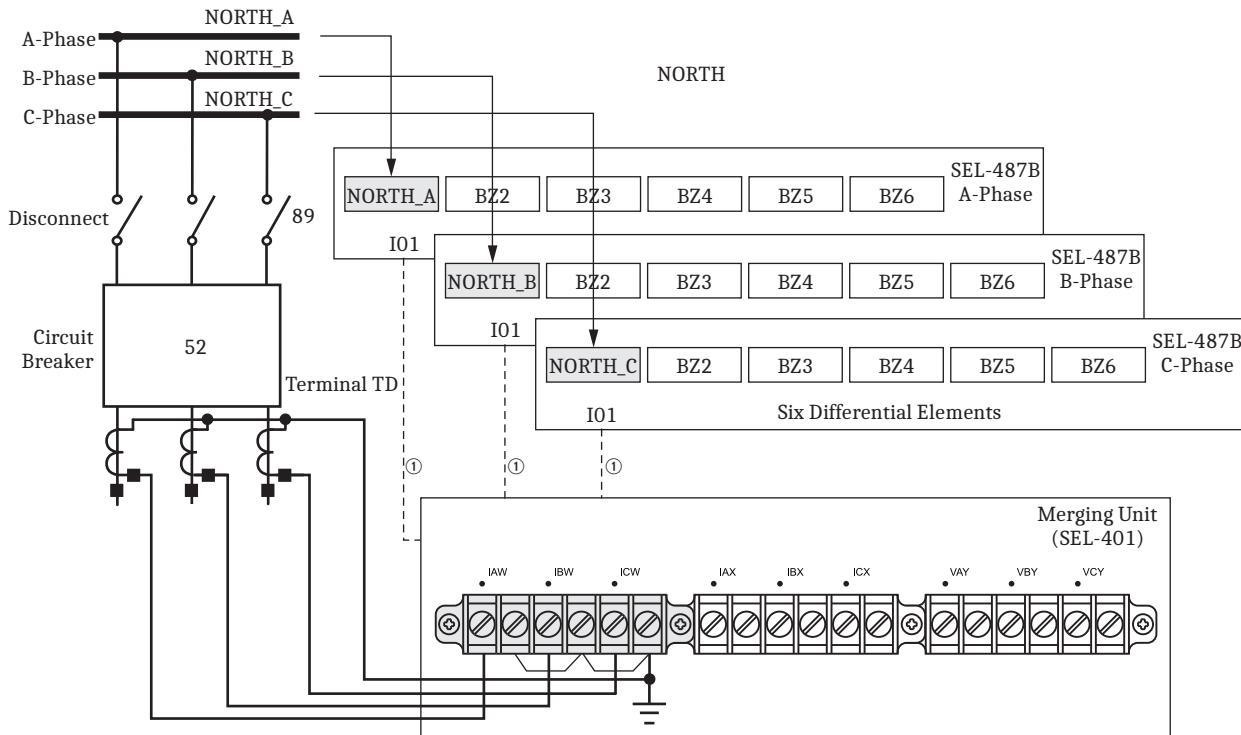
**Table 6.1 Complete Station Configuration, Using Two Three-Phase Bus-Zones and All 21 Current Inputs in a Single-Relay Application (Sheet 2 of 2)**

CTs	Bus-Zone	Merging Unit	Merging-Unit Published Analog	SEL-487B Subscribed Analog
TIE-BREAKER Z1, A-Phase Z1, B-Phase Z1, C-Phase	NORTH_A	TIE-BREAKER	IAX	I07
	NORTH_B		IBX	I08
	NORTH_C		ICX	I09
TH, A-Phase TH, B-Phase TH, C-Phase	SOUTH_A	TH	IAW	I19
	SOUTH_B		IBW	I20
	SOUTH_C		ICW	I21

## Three-Relay Application

Consider now the same station, configured with three SEL-487B Relays instead of one. The three-relay application supports 21 terminal, three-phase differential protection. As before, the label NORTH in the single-line diagram consists of A-Phase, B-Phase, and C-phase, and each of the three phases is assigned to a differential element. NORTH still requires three differential elements, but the application uses one differential element from each of the three relays, as shown in *Figure 6.6*, instead of three elements in the same relay.

Instead of mapping all three phases to the same SEL-487B, as with the single-relay application shown in *Figure 6.6*, each phase maps to a separate SEL-487B. For example, map the A-Phase analog of the merging unit to the A-Phase relay I01 analog; the B-Phase analog of the merging unit to the B-Phase relay I01 analog; and similar for the C-Phase relay.



① See Section 19: Digital Secondary Systems in the SEL-400 Series Relays Instruction Manual for merging-unit networking and time-synchronization details.

**Figure 6.6 CT Wiring in a Three-Relay Application**

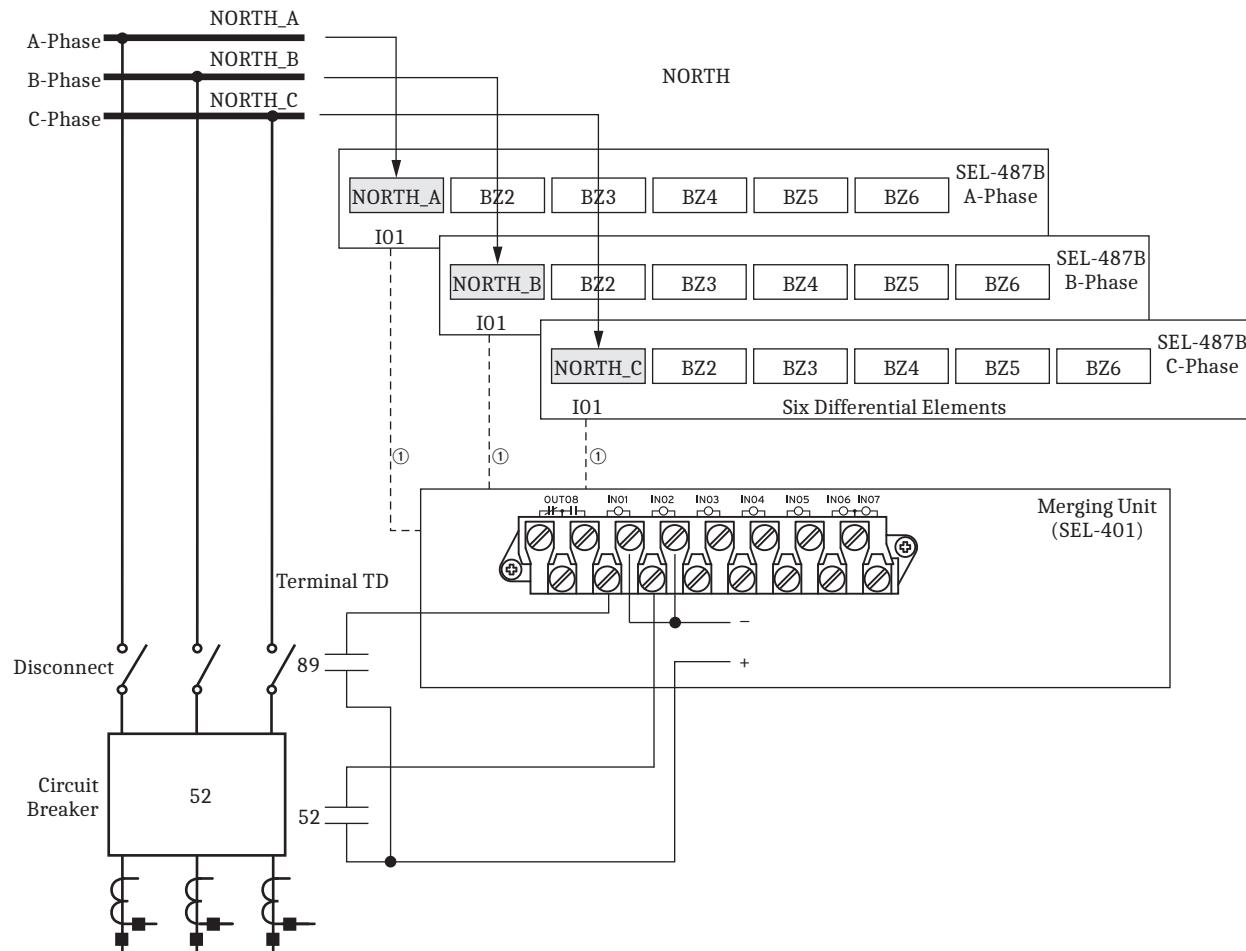
*Table 6.2* shows the analog mapping for one of the three relays with all A-Phase inputs of the station, and two bus-zones assigned. B-Phase and C-Phase relays have similar configurations.

**Table 6.2 Analog Mapping for A-Phase Relay, With All A-Phase Inputs of the Station and Two Bus-Zones Assigned**

CTs	Bus-Zone	Merging Unit	Merging-Unit Published Analog	SEL-487B Subscribed Analog
TD, A-Phase	NORTH_A	TD	IAW	I01
TE, A-Phase	NORTH_A	TE	IAW	I02
TF, A-Phase	SOUTH_A	TF	IAW	I03
TG, A-Phase	SOUTH_A	TG	IAW	I04
TIE-BREAKER Z2, A-Phase	SOUTH_A	TIE-BREAKER	IAW	I05
TIE-BREAKER Z1, A-Phase	NORTH_A	TIE-BREAKER	IAX	I06
TH, A-Phase	SOUTH_A	TH	IAW	I07

Because the differential elements are in three different relays, each of these relays must receive the same information from the digital inputs. *Figure 6.7* shows connections between relays for the case where only one 89 contact and one 52 auxiliary contact are available.

Configure the merging units to publish the measured input status to the appropriate subscriber relay. The applications discussed throughout this section give examples on mapping digitals between merging units and subscriber relays.



① See Section 19: Digital Secondary Systems in the SEL-400 Series Relays Instruction Manual for merging-unit networking and time-synchronization details.

**Figure 6.7 Digital Inputs 52 and 89 Connections**

## CT Requirements

### CT Connections

Connect all CTs to the merging unit in wye configuration. The SEL-487B does not account for delta-connected CTs.

### CT Sizing

Sizing a CT to avoid saturation for maximum asymmetrical fault current is ideal but not always possible. Such sizing requires CTs with C voltage ratings greater than  $(1 + X/R)$  times the burden voltage for the maximum symmetrical fault current, where  $X/R$  is the reactance-to-resistance ratio of the primary system.

As a rule of thumb, CT performance will be satisfactory if the CT secondary maximum symmetrical external fault current multiplied by the total secondary burden in ohms is less than half the C voltage rating of the CT.

For correct operation, the relay algorithm requires that the CTs not saturate for 2 ms following an external fault inception. The IEEE Document *C37.110 Guide for the Application of Current Transformers Used for Protective Relaying Purposes* contains guidelines that will provide a conservative recommendation of the proper CT characteristics needed for low impedance bus differential protection using the SEL-487B. SEL also offers an executable CT saturation program called SEL Two\_CTs to assist in determining the CT performance. This program is available on the SEL-400 Series Product Literature DVD.

## CT Ratio Selection

For installations with different CT ratios, be sure that the highest/lowest CT ratio does not exceed 10. The SEL-487B selects the highest CT ratio and calculates settings TAP01–TAP21, provided that the ratio  $TAP_{MAX}/TAP_{MIN}$  is less than or equal to 10. If the ratio  $TAP_{MAX}/TAP_{MIN}$  is greater than 10, select a different CT ratio.

## CT Grounding

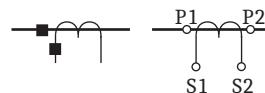
Because each current channel is independent, be sure to apply a ground to each set of three CTs forming the current input from each terminal. Such grounding connections are usually in the form of short jumpers on the rear of the merging unit that together create a common connection among terminals.

## Polarity

IEEE Std C37.110-1996 provides the following definition of polarity:

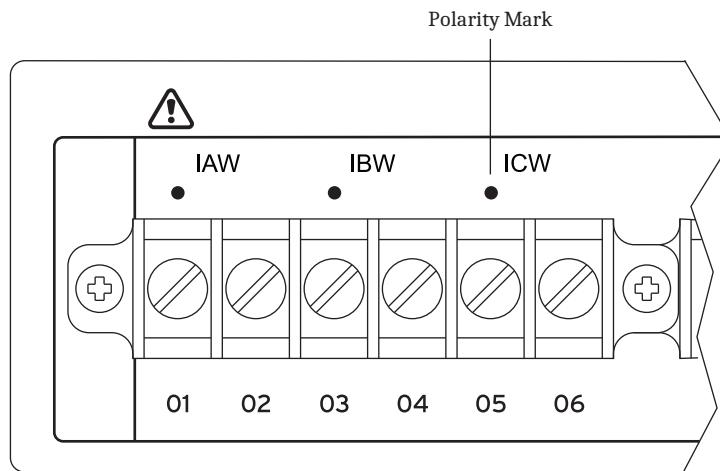
The designation of the relative instantaneous directions of the currents entering the primary terminals and leaving the secondary terminals during most of each half cycle. Primary and secondary terminals are said to have the same polarity when, at a given instant during most of each cycle, the current enters the identified, similarly marked primary lead and leaves the identified, similarly marked secondary terminals in the same direction, as though the two terminals formed a continuous circuit.

*Figure 6.8* shows some of the common polarity marks used to indicate CT polarity.



**Figure 6.8 Polarity Marks**

Polarity marks are also declared on the merging-unit analog input terminals as dots above the relay terminal. *Figure 6.9* shows the polarity marks on an SEL-401.



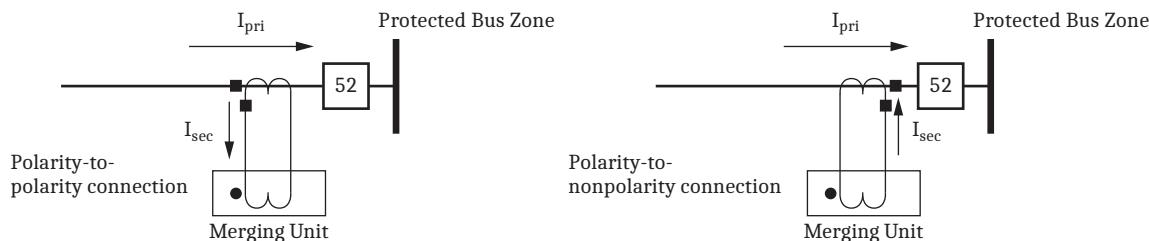
**Figure 6.9 Polarity Marks Above the Odd-Numbered CT Terminals at the Rear of the SEL-401 Merging Unit**

## Guideline for Establishing CT Polarity

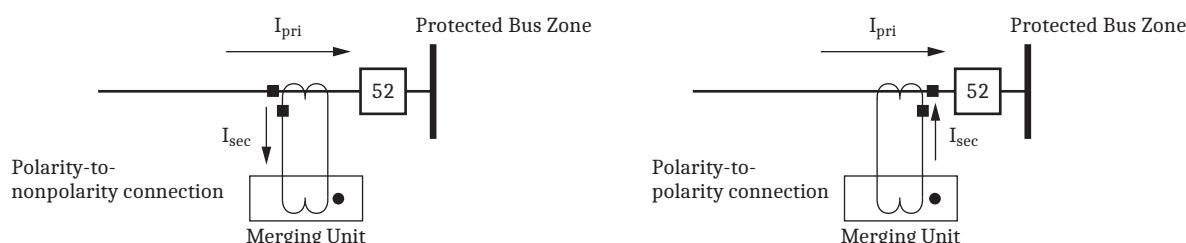
Configure a CT to have a positive polarity when the primary current entering the zone of protection is in phase with the secondary current entering the polarity marked terminal on the merging unit. Because CTs are commonly positioned to point toward the zone of protection, secondary connections are generally polarity-to-polarity or “dot-to-dot.” If a CT points away from the zone of protection, apply a polarity-to-nonnepolarity connection to continue a positive convention. This results in positive polarity declarations for all CTs in software.

If a single CT has two zone boundaries or is shared by an adjacent zone, you cannot use a positive convention for both zones. In this case, configure the CT polarity to be negative for the non-conforming zone.

*Figure 6.10 and Figure 6.11 show examples for determining polarity.*



**Figure 6.10 Declare Positive Polarity in Software (Preferred)**



**Figure 6.11 Declare Negative Polarity in Software**

For simplicity, all application examples in this manual assume polarity-to-polarity connections between the CTs and merging units.

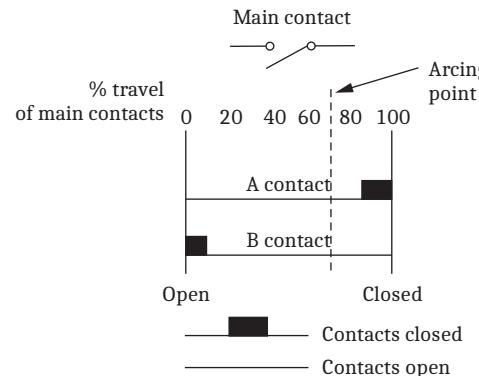
# Disconnect Requirements

Disconnect auxiliary contacts provide Zone Selection Logic with the information required to dynamically assign the appropriate current inputs to the correct differential elements. To ensure correct differential element operation, the contacts must comply with the requirements listed in *Table 6.3*.

**Table 6.3 Disconnect Auxiliary Contact Requirements to Ensure Correct Differential Element Operation**

Operation	Requirement
From disconnect open to disconnect close operation	Assign the currents to the applicable differential element before the disconnect reaches the “arcing” point, the point where primary current starts to flow.
From disconnect close to disconnect open operation	Remove the current from the applicable differential element only once the disconnect has passed the “arcing” point, the point where primary current has stopped flowing.

*Figure 6.12* shows the disconnect auxiliary contact requirements with respect to the arcing point. The position of 0% travel in *Figure 6.12* indicates the position when the main contacts are fully open, and the 100% position when the main contacts are fully closed.



**Figure 6.12 Disconnect Auxiliary Contact Requirements With Respect to the Arcing Point for an Open-to-Close Disconnect Operation**

When both 89A and 89B contacts are available, use the disconnect monitoring logic in the SEL-487B to establish the principle of

$$\text{(disconnect) NOT OPEN} = \text{(disconnect) CLOSED}$$

Applying this principle, the relay properly coordinates the primary current flow and the CT current assignment to the appropriate differential element. When both 89A and 89B disconnect auxiliary contacts are available, use the disconnect monitoring logic to monitor the disconnect operating time and disconnect status.

*Table 6.4* shows the four possible disconnect auxiliary contact combinations and the way the relay interprets these combinations.

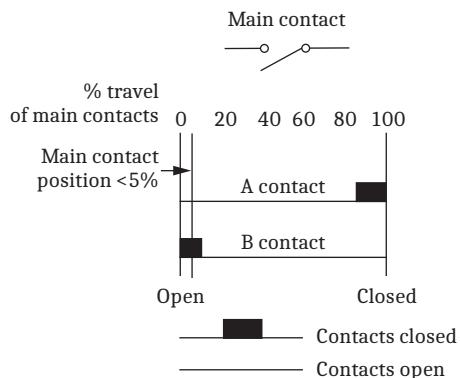
**Table 6.4 Disconnect A and B Auxiliary Contact Status Interpretation**

Case	89A01	89B01	Disconnect Status (89 CLnn)
1	0	0	Closed (1)
2	0	1	Open (0)
3	1	0	Closed (1)
4	1	1	Closed (1)

*Table 6.4* (Disconnect Status column) shows that the output from the disconnect monitor logic interprets the disconnect as always closed, except for Case 2. With this interpretation, the relay assigns the input currents to the applicable differential elements for Case 1, Case 3, and Case 4. The following discussion considers the four cases in more detail.

## Disconnect Open-to-Close Operation

*Figure 6.13* shows the disconnect main contact starting to travel in an open-to-close operation. Auxiliary contact B is still closed, and auxiliary contact A is open. *Table 6.4* shows this as Case 2; the disconnect is considered open, and the current is removed from all differential elements. This is the only combination of auxiliary contacts for which the relay considers the disconnect main contacts to be open.

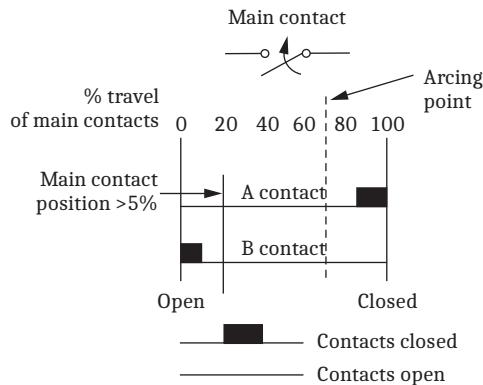


**Figure 6.13 Disconnect Main Contacts and Auxiliary Contact A Open, Auxiliary Contact B Closed; Disconnect Is Considered Open**

## Intermediate Position

*Figure 6.14* shows the intermediate position (Case 1 in *Table 6.4*) in a disconnect open-to-close operation, with both A and B auxiliary contacts open for a period of time. Enter this time duration as the disconnect switch alarm timer setting value (89ALP $nn$ ). By choosing the auxiliary contacts that will change status as soon as disconnect travel starts and close only near the end of travel, the intermediate position time duration can be accurately measured. Should the disconnect remain in the intermediate position for longer than the 89ALP $nn$  ( $nn = 1-60$ ) time setting, the disconnect switch alarm timer expires and asserts 89AL $nn$ , the disconnect monitor alarm.

**NOTE:** The relay includes 60 alarm timers that provide individual time settings for 60 disconnect logic circuits. These individual timers are useful in installations where the disconnect travel times differ substantially. In particular, sequentially operated devices (pantographs, for example) have travel times much longer than normal disconnects. Relay Word bit 89OIP represents the OR combination of Relay Word bits 89OIP01-89OIP60, and Relay Word bit 89AL is respectively the OR combination of Relay Word bits 89AL01-89AL60.

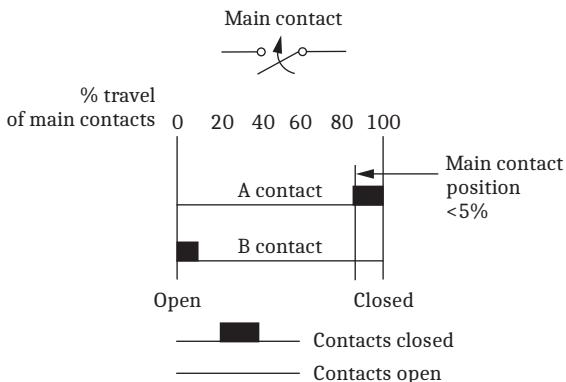


**Figure 6.14 Intermediate Position With Both Auxiliary Contacts Open; the Disconnect Is Considered Closed**

When auxiliary contact B opens, the disconnect is considered closed (Case 1 in Table 6.4). When the disconnect is considered closed, the CT currents are assigned to applicable differential elements, and the disconnect switch alarm timer starts to time. Because disconnect auxiliary contact B opens well in advance of the arcing point, the CT currents are assigned to applicable differential elements before primary current flows.

## Auxiliary Contact A Closes

Figure 6.15 shows contact status after auxiliary contact A closes, with the main contact past the arcing point and approaching the end of the close operation.



**Figure 6.15 The Main Contact Has Completed 95% of Travel; Contact A Is Closed, Contact B Is Open, and the Disconnect Is Considered Closed**

When the A contact closes, the disconnect switch alarm timer stops and the Disconnect Monitoring Logic considers the disconnect main contact to be closed.

## Disconnect Open and Closed Simultaneously

Case 4 is an illegitimate condition, with the disconnect auxiliary contacts showing the disconnect main contact to be open and closed simultaneously. Timer 89ALP $nn$  times for this condition and asserts Relay Word bit 89AL $nn$  when the disconnect auxiliary contacts remain in this condition for a period exceeding the timer setting. The relay considers the disconnect main contact closed during this period, and the CTs are considered in the differential calculations.

## Close-to-Open Operation

For the close-to-open operation, CT currents must remain assigned to the differential elements for as long as primary current flows. When the auxiliary contact A opens (Case 1), we again enter the intermediate position, as depicted in *Figure 6.14*. In the intermediate position, the CT currents are still assigned to the differential elements, and the disconnect switch alarm timer (89AL $nn$ ) starts to time. Only when auxiliary contact B closes (*Figure 6.13*) are the CT currents removed from the differential elements, which are safely past the arcing point.

Many disconnect switches provide only auxiliary contact B. *Table 6.5* shows the two possible disconnect auxiliary contact positions and status interpretations.

**Table 6.5 Disconnect Auxiliary Contact Status Interpretation When Only Auxiliary Contact B Is Available**

89B01	Disconnect Position
0	Closed
1	Open

## Alias Names

Any Relay Word bit, analog quantity, or default terminal name can be renamed with more meaningful names to improve the readability of fault analysis and customized programming. See the description in *Alias Settings on page 12.25 in the SEL-400 Series Relays Instruction Manual* for more details.

## Bus-Zone Configurations

Dynamic zone selection is the process the relay uses to assign or remove CT currents from the differential elements as a function of the Boolean value (logical 0 or logical 1) of a particular SELOGIC control equation. The SELOGIC control equation is a setting in the form of  $InnBZkC$  and  $InnBZkV$  ( $nn = 01\text{--}21$ , and  $k = 1\text{--}6$ ). When setting SELOGIC control equations, use a separate SELOGIC control equation for each busbar to which the terminal can connect.

**NOTE:** In SEL Grid Configurator, the Terminal-to-Bus-Zone connection setting,  $InnBZkC$ , is broken down into two settings:  $CTnnBZk$  and  $TBZPx$  ( $x = 1\text{--}126$ ).  $CTnnBZk$  enables Terminal  $nn$  to be connected to Bus-Zone  $k$ .  $TBZPx$  sets the polarity of the Terminal  $nn$  to Bus-Zone  $k$  connection.

In general, a terminal can be identified as either a normal terminal (feeders, lines, transformers, etc.) or as a tie breaker (bus coupler). For terminals, typical inputs are disconnect auxiliary contacts and, in some cases, circuit breaker auxiliary contacts. Bus couplers have specific logic and configuration options that require inputs in addition to disconnect and circuit breaker auxiliary contacts to ensure security and dependability.

When configuring bus-zone protection, the goal is to accomplish the following:

- Protect the busbars for all operating conditions
- Eliminate all dead zones
- Open the minimum number of breakers when tripping
- Implement the check zone without disconnect supervision, if a check zone is required

When the terminal-to-bus-zone SELOGIC control equation (*InnBZkV* Terminal to Bus Connection Logic) is logical 0, differential calculations do not consider the CT inputs from that specific terminal, and no trip outputs from the differential elements are issued to that terminal. Of particular concern are instances when more than one disconnect for any particular terminal are closed at the same time. When this happens, parallel paths form, possibly resulting in the unbalance of multiple zones, as shown in *Figure 6.16* and *Figure 6.17*. Under balanced conditions, the current toward the busbars equals the current away from the busbars, and the differential current in any differential element is practically zero.

In practice, the most popular implementation for preventing misoperation when parallel paths form is to combine the parallel paths into a single zone and route the CTs to a single differential element. Another option is to use a check zone by combining all terminals at a specific voltage level into a single zone independent of the terminal-to-bus-zone SELOGIC control equations. Using the check zone as a second trip criterion prevents relay misoperation in the case of parallel paths.

In general, apply the following rules when setting terminal-to-bus-zone SELOGIC control equations:

- Observe the correct CT polarity
- Avoid parallel operating conditions
- When parallel paths are unavoidable, take necessary precautions

Two situations exist where parallel paths are unavoidable: when two disconnects are closed simultaneously and when using inboard (bushing) CTs.

## Two Disconnects Closed Simultaneously

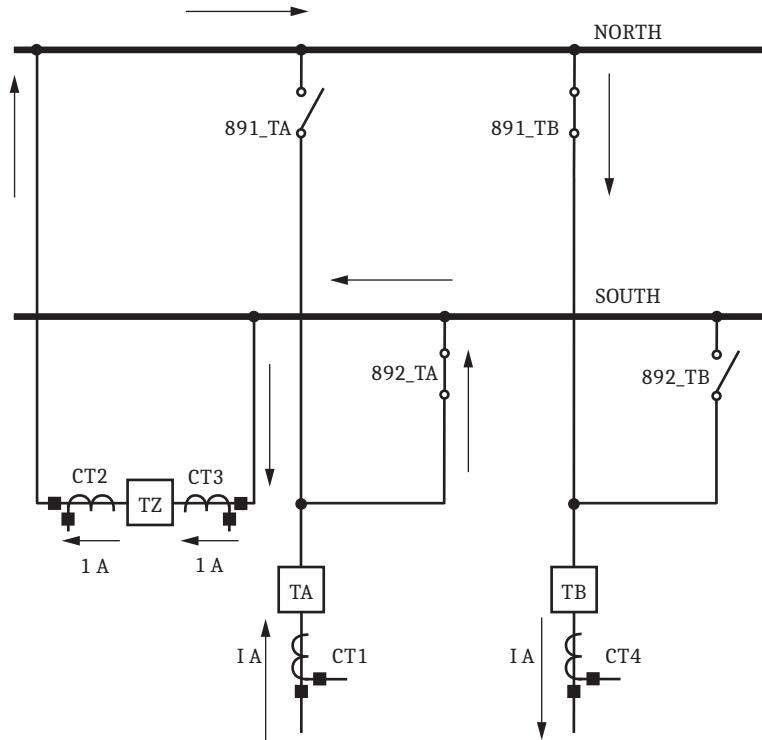
*Figure 6.16* shows a double busbar layout in which two disconnects can be closed simultaneously. With the tie breaker (TZ) connected in overlap, CT1 and CT2 form Differential Element 1, and CT3 and CT4 form Differential Element 2. There are no parallel paths in *Figure 6.16*, and both differential elements are balanced. Calculate the differential currents with the following expression:

$$I_{\text{DIFF1}} = \sum_1^n I_n$$

**Equation 6.1**

where:

- $I_{\text{DIFF1}}$  = The differential current calculated in Differential Element 1  
 $I_n$  = CT currents from the  $n$  terminals assigned to Differential Element 1

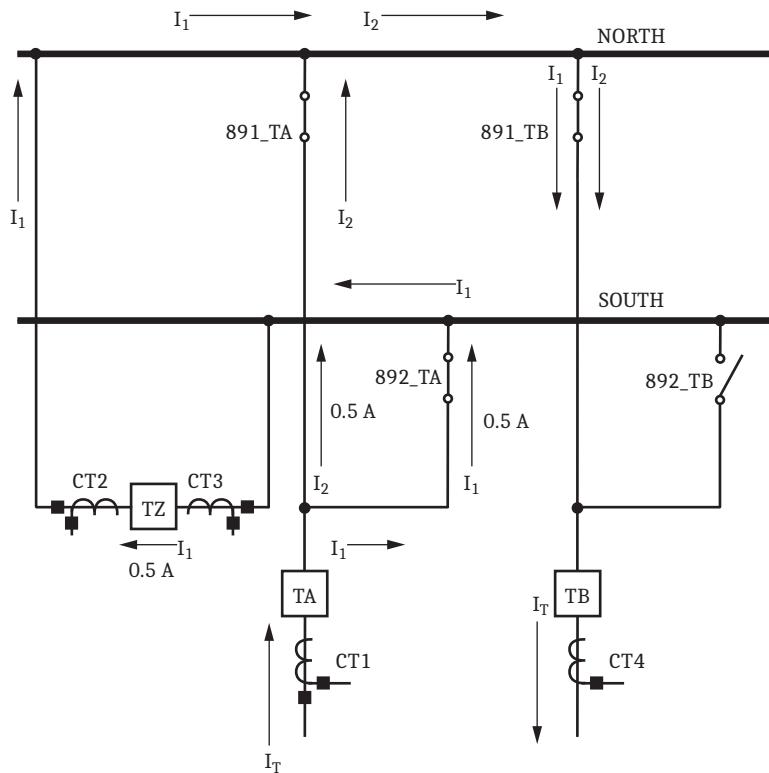


$$I_{\text{DIFF1}} = CT1 - CT2 = 1 - 1 = 0$$

$$I_{\text{DIFF2}} = CT3 - CT4 = 1 - 1 = 0$$

**Figure 6.16 Both Differential Elements Balanced**

Closing 891\_TA in *Figure 6.17* forms a parallel path between the two busbars, and both differential elements are unbalanced.



$$\begin{aligned}I_{\text{DIFF1}} &= CT1 + CT2 = 1 - 0.5 = 0.5 \\I_{\text{DIFF2}} &= CT3 + CT4 = 0.5 - 1 = -0.5 \\I_1 + I_2 &= I_T\end{aligned}$$

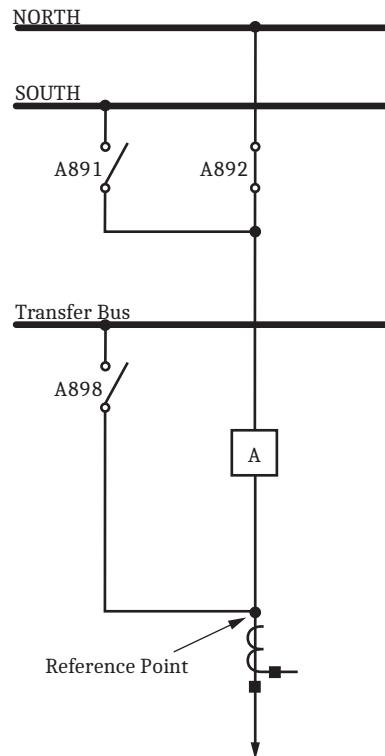
**Figure 6.17 Both Differential Elements Unbalanced**

To prevent misoperation, combine the two bus-zones by stating the conditions governing the combinations during the setting of bus-zones-to-bus-zones connections. When using bushing (inboard) CTs, combining bus-zones involves including a circuit breaker as part of the connection. You can include a circuit breaker provided that the circuit breaker auxiliary contact is wired to a configured merging unit and included in the bus-zones-to-bus-zones settings.

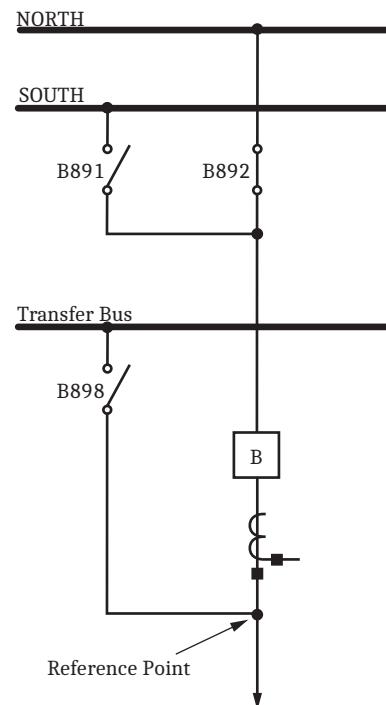
## Inboard (Bushing) CTs

*Figure 6.18* shows an outboard CT, and *Figure 6.19* shows an inboard CT. Defining a CT as inboard or outboard only has meaning when a terminal is on transfer. To define the terms, refer to the area between the circuit breaker and the CT, and determine the connection to the transfer bus.

- Outboard CT: the connection to the transfer bus is between the circuit breaker and the CT (*Figure 6.18*).
- Inboard CT: the connection to the transfer bus is not between the circuit breaker and the CT (*Figure 6.19*).



**Figure 6.18** Outboard CT



**Figure 6.19** Inboard CT

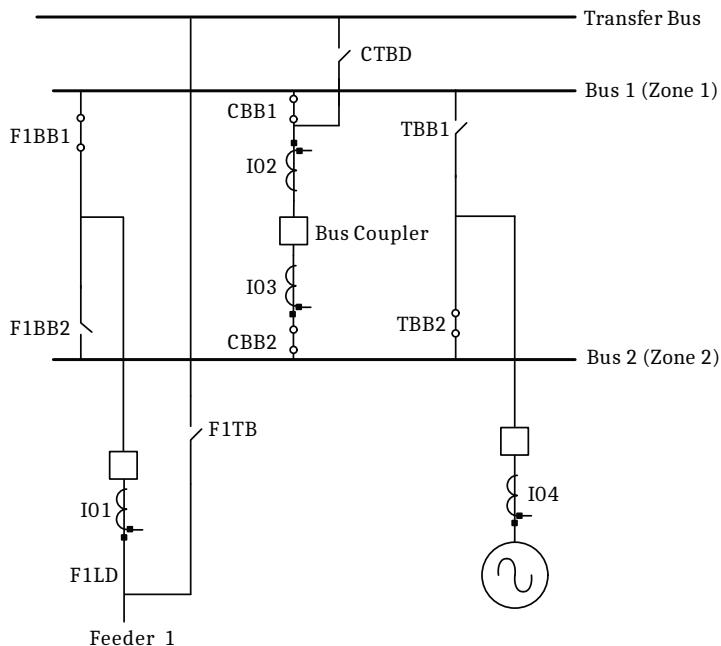
Bushing CTs (typically the source of inboard CTs) present two difficulties to bus protection when a terminal is on transfer:

- A transfer differential zone cannot be formed because of a lack of CT inputs.
- The check zone is unbalanced.

Not having a transfer differential zone is not a major problem if it is understood that the transfer busbar becomes part of the line and forms part of the line protection when a terminal is on transfer. However, the unbalanced check zone usually necessitates blocking busbar protection when a terminal is on transfer.

## Example of Check Zone With Inboard (Bushing) CTs

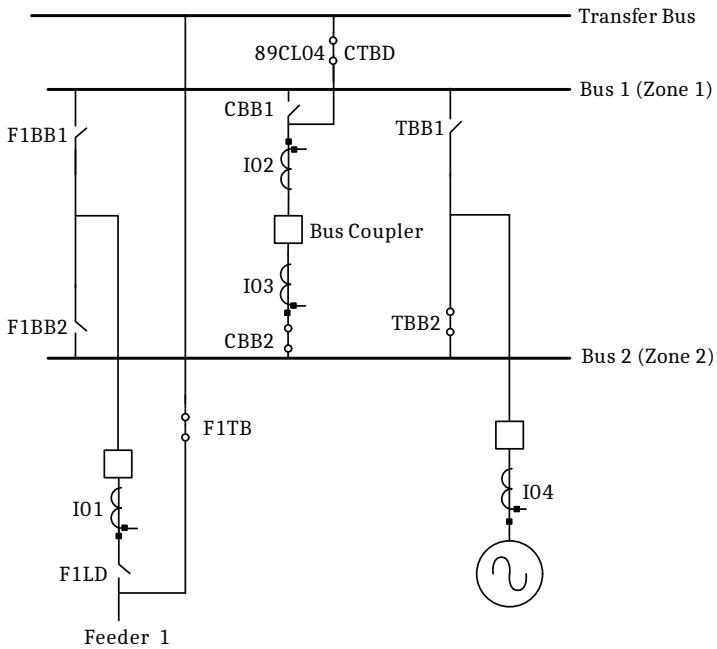
Instead of blocking the check-zone protection when a terminal is on transfer, you can use the Advance Check Zone function to include a terminal from the bus coupler in the check-zone differential element calculations. Although this approach deviates from the practice of having the check-zone CTs independent of disconnect auxiliary contacts, it provides an opportunity to still have a check zone for inboard CT applications. *Figure 6.20* shows an example of an application with inboard CTs that includes a check zone. In *Figure 6.20*, Feeder 1 connects to Bus 1 (i.e., not on transfer). Under these conditions, Zone 1 (formed by I01 and I03), Zone 2 (formed by I02 and I04), and the check zone (formed by I01 and I04) are all balanced.



**Figure 6.20 Normal Operating Conditions**

In *Figure 6.21*, Feeder 1 connects to the Transfer busbar. When Feeder 1 connects to the Transfer busbar, note the following conditions:

1. Line CT I01 of Feeder 1 is no longer in the circuit.
2. Without I01, the current to balance I03 is missing, resulting in an unbalanced Zone 1.
3. Without I01, the current to balance I04 is missing, resulting in an unbalanced check zone.
4. I02 and I04 are still available so that Zone 2 is balanced.



**Figure 6.21 Feeder With Inboard CTs**

To balance Zone 1, we need to remove I03 from the Zone 1 differential element calculations. You can remove I03 with existing settings; either by means of the Terminal-to-Bus-Zone settings or by means of the Zone Supervision settings.

To balance the Check Zone, we need to add I02 to the Check Zone differential element calculations by means of the Advanced Check Zone settings. The steps are as follows:

1. Include I02 in the Terminal to Check Zone Connection settings.
2. Use the Advanced Check Zone settings to remove I02 from the Check Zone differential element calculations, except when Feeder 1 is on transfer.

Following is an example of how to use the Advance Check Zone function to balance the Check Zone for this application.

---

**NOTE:** In SEL Grid Configurator, these settings are made in **Group > Zone Configuration > Check Zone Configuration > Terminal nn to Check Zone Connections.**

---

Check Zone Configuration		
Enable Check Zones at Station (Y,N)	ECHKZN := N	?Y <Enter>
Check Zone Configuration: Terminal to Check Zone Connections		
Terminal, Check-Zone, Polarity (P,N)		
? IO1 CZ1 P <Enter>		
Terminal, Check-Zone, Polarity (P,N)		
? IO2 CZ1 P <Enter>		
Terminal, Check-Zone, Polarity (P,N)		
? IO4 CZ1 P <Enter>		
Terminal, Check-Zone, Polarity (P,N)		
? <Enter>		
Enable Advance Check Zone Settings (Y,N)	EADVCZ := N	? Y <Enter>
Include coupler 1 in check zone 1 (SELLogic Eq.)		
CZ11R := NA		
? 89CL04 <Enter>		
Terminal associated with coupler 1 in CZ1 (Inn)	CZ11M :=	?IO2 <Enter>
Include coupler 2 in check zone 1 (SELLogic Eq.)		
CZ12R := NA		
?END <Enter>		

---

Table 6.6 discusses the above-mentioned settings. Pay close attention to the comments mentioned in Step 4 on page 6.23.

**Table 6.6 Discussion of the Advanced Check Zone Settings**

<b>Step Number</b>	<b>Setting</b>	<b>Comment</b>
Step 1	ECHKZN := Y	Enable the three Check Zones.
Step 2	Terminal, Check-Zone, Polarity (P,N) ? I02 CZ1 P <Enter>	This is the non-conventional setting. Here we add the bus coupler CT to the Check Zone. This is the first part of the solution. Under normal operating conditions (when no terminal is on transfer) the bus coupler CTs must be EXCLUDED from the Check Zone differential element calculations. You MUST complete the second part of this setting under the Advance Check Zone Settings.
Step 3	EADVCZ := Y	Enable the Advance Check Zone Settings.
Step 4	Include coupler 1 in check zone 1 (SELogic Eq.) CZ11R := NA ? 89CL04 <Enter>	This is the second part of the solution. CZ11R is similar to the Terminal to Bus-Zone Connections (i.e., here is where you enter the conditions when the bus coupler CT must be included in the Check Zone differential element calculations). Assuming you assigned Disconnect Logic 89CL04 to the Transfer Disconnect for I02, enter <b>89CL04</b> .  CZ11R defeats the Check zone setting of Step 2. This means that, although the list of Check Zone terminals (Step 2) includes I02, I02 is only included in the Check Zone differential element calculations when CZ11R evaluates to logical 1.
Step 5	CZ11M := I02	Enter the bus coupler terminal (I02 in this example) you want to include in the Check Zone differential element calculations when CZ11R evaluates to logical 1.

Table 6.7 shows the settings for the Advance Check Zone.

**Table 6.7 Advance Check Zone Settings**

<b>Label</b>	<b>Prompt</b>	<b>Default</b>
EADVCZ	Enable Advance Check Zone Settings (Y, N)	N
CZpqR	Include Coupler q in Check Zone p (SELOGIC Eq.)	NA
CZpqM	Terminal associated with Coupler q in CZp (Inn)	

## Terminal Configurations

In essence, busbar protection is assigning the correct CT currents to the appropriate differential elements. Disconnect auxiliary contacts provide the information necessary for busbar protection, and breaker auxiliary contacts provide the breaker status for refining the protection. SELOGIC control equations provide the mechanism for declaring the conditions when the currents are assigned to the appropriate differential elements. Entering data in the relay requires two steps. The first identifies the terminal and attributes, the second involves the creation of the SELOGIC control equation stating the conditions for the CTs to be considered in the differential calculation. Bus couplers (tie breakers) require more condition information when two or more bus-zones are combined.

Step 1. Identify the terminal, the bus-zone to which the terminal can connect, and the CT polarity when this connection is made.

The following is the relay prompt for the *Step 1* entry:

---



---

Terminal, Bus-Zone, Polarity (P,N)  
?

---



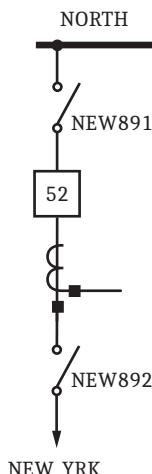
---

Step 2. State the conditions when **Terminal** will be connected to the **Bus-Zone**:

I01BZ2V :=

Think of **Terminal** as the CT of that particular terminal and **Bus-Zone** as the busbar to which the CT will be connected for differential and restraint current calculations. In other words, assign the CT (**Terminal**) to busbar (**Bus-Zone**) under the following conditions:  
**I01BZ2V := <conditions>**.

*Figure 6.22 shows Terminal NEW\_YRK. The differential calculations consider the CT when disconnect NEW891 closes to complete the connection to Bus-Zone NORTH.*



**Figure 6.22 Terminal NEW\_YRK Disconnects NEW892 and NEW891 and Bus-Zone NORTH**

Step 3. Enter the data as follows:

---

```
Terminal, Bus-Zone, Polarity (P,N)
?NEW_YRK,NORTH,P <Enter>
```

---

Entering incorrect information may result in relay misoperation. To reduce potential entry of incorrect information, the relay provides a double check to verify that terminal and bus-zone connections are indeed as intended. The next prompt has two parts:

- The relay states terminal and bus-zone alias names just entered.
- The relay generates a prompt with the primitive terminal and bus-zone names.

Thus, the prompt now appears as follows:

---

```
NEW_YRK to NORTH Connection (SELogic Equation)
I01BZ1V :=
```

---

- Step 4. Enter the conditions under which Terminal NEW\_YRK is to be assigned to Busbar NORTH by specifying the particular disconnect (89) auxiliary contact that will connect the terminal to the busbar.

For example, when Disconnect NEW891 is closed, Terminal NEW\_YRK is connected to Busbar NORTH. A Terminal, Bus-Zone, Polarity (P, N), and I01BZ1V setting is required for each 89 contact that results in a terminal-to-busbar connection. Consider a terminal that can be connected to Busbar 1, Busbar 2, and the transfer bus. Because the terminal connects to three busbars, provide terminal-to-bus-zone (Terminal, Bus-Zone, Polarity) and conditions for consideration in the differential calculations [I01BZnV ( $n = 3$ )] for each of the three busbars.

- Step 5. Enter the following settings for Terminal NEW\_YRK:

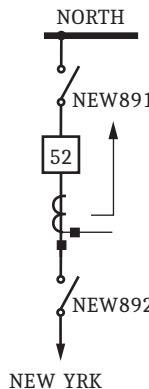
---

```
NEW_YRK to NORTH Connection (SELogic Equation)
I01BZ1V := NEW891 <Enter>
```

---

Entries here assign CT currents to differential elements. Take care to first investigate the position of the CT for each entry. For example, refer to *Figure 6.18*, and observe that regardless of which disconnect closes (A891, A892 or A898), current always flows through the CT. This is not the case with inboard CTs; closing B898 in *Figure 6.19* bypasses the CT, and no current flows in the inboard CT.

- Step 6. Determine the CT polarity assuming a polarity-to-polarity connection. *Figure 6.23* shows that the CT polarity is positive.



**Figure 6.23 Positive CT Polarity for Terminal NEW\_YRK**

- Step 7. Omit the final argument if the CT polarity is positive. For example,

---

```
Terminal, Bus-Zone, Polarity (P,N)
?NEW_YRK,NORTH,P <Enter>
```

---

has the same meaning as

---

```
Terminal, Bus-Zone, Polarity (P,N)
?NEW_YRK,NORTH <Enter>
```

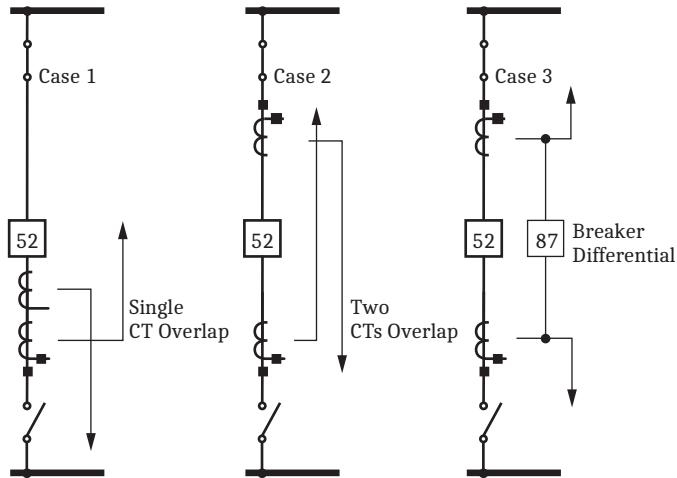
---

In SEL Grid Configurator, go to **Group 1 > Zone Configuration 1 > Terminal Bus-Zone Connections > Terminal 1 To Bus-Zone Connections**. Set CT01BZ1 = Y, TBZP1 = P, and I01BZ1V = NEW891. NEW\_YRK and NORTH are automatically populated into the TBZT1 and TBZB1 fields as the alias names for I01 and BZ1.

## Bus Coupler (Tie Breaker) Configurations

In general, bus couplers are usually configured according to one of the three cases shown in *Figure 6.24*:

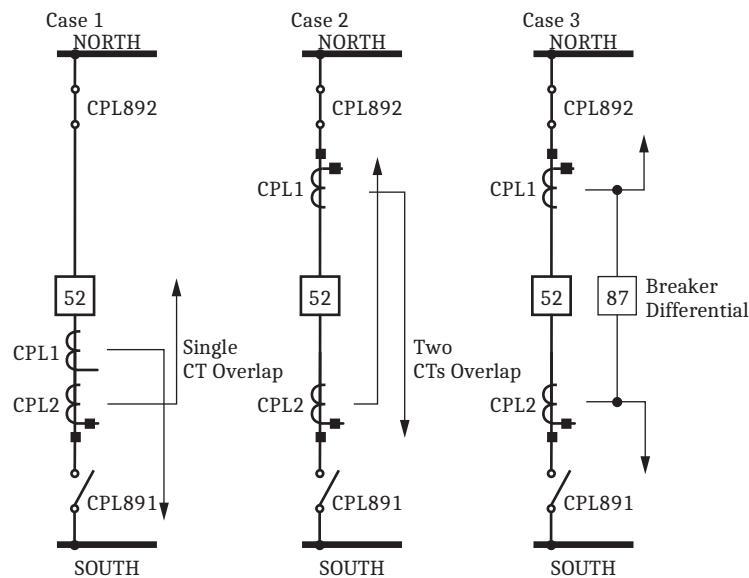
- Case 1: Single CT, single or two cores (two cores shown) with overlap
- Case 2: CT either side of the breaker, configured in overlap
- Case 3: CT either side of the breaker with breaker differential



**Figure 6.24 Three Typical Cases of Bus Coupler Configurations**

A discussion on how to set the three configurations follows.

Label all CTs as indicated in *Figure 6.25* (i.e., CPL1 and CPL2) with the understanding that CPL1 is mapped to Terminal I01, and CPL2 to Terminal I02 of the SEL-487B.



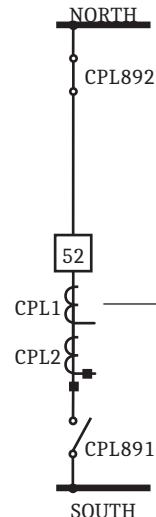
**Figure 6.25 General Information Regarding the Three Typical Bus Coupler Configurations**

## Case 1: Single CT, Single or Two Cores (Two Cores Shown) With Overlap

Step 1. For an overlap, establish the following relationships:

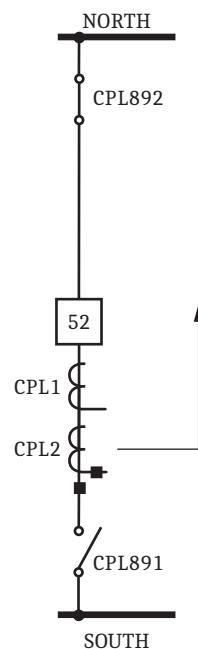
- CPL1 and SOUTH when CPL891 is closed
- CPL2 and NORTH when CPL892 is closed

Step 2. Determine the polarity of Terminal CPL1 assuming a polarity-to-polarity connection. *Figure 6.26* shows that the polarity of Terminal CPL1 is negative.



**Figure 6.26 Negative CT Polarity for Terminal CPL1**

Step 3. Determine the polarity of Terminal CPL2 assuming a polarity-to-polarity connection. *Figure 6.27* shows that the polarity of Terminal CPL2 is positive.



**Figure 6.27 Positive CT Polarity for Terminal CPL2**

Step 4. *Figure 6.28* shows an extract from the **SET Z 1** ASCII command in determining the terminal-to-bus-zone settings in the relay.

---

```
Terminal, Bus-Zone, Polarity (P,N)
? CPL1,SOUTH,N <Enter>
CPL1 to SOUTH Connection (SELogic Equation)
I01BZ2V := CPL891 <Enter>
Terminal, Bus-Zone, Polarity (P,N)
? CPL2,NORTH,P <Enter>
CPL2 to NORTH Connection (SELogic Equation)
I02BZ1V := CPL892 <Enter>
```

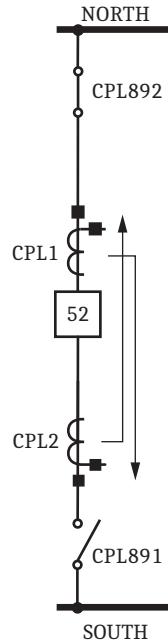
---

**Figure 6.28 Using the SET Z 1 Command to Determine Terminal-to-Bus-Zone Settings**

This concludes the Case 1 configuration.

## Case 2: CT Either Side of the Breaker, Configured in Overlap

- Step 1. As we did before for an overlap, establish the following relationships:
- CPL1 and SOUTH when CPL891 is closed
  - CPL2 and NORTH when CPL892 is closed
- Step 2. Determine the polarity of Terminals CPL1 and CPL2 assuming polarity-to-polarity connections. *Figure 6.29* shows that the polarities of Terminals CPL1 and CPL2 are positive.



**Figure 6.29 Positive CT Polarity for Both Terminals CPL1 and CPL2**

*Figure 6.30* shows an extract from the use of the **SET Z 1** ASCII command to set the terminal-to-bus-zone settings in the relay.

```

Terminal, Bus-Zone, Polarity (P,N)
? CPL1,SOUTH,P <Enter>
CPL1 to SOUTH Connection (SELogic Equation)
I01BZ2V := CPL891 <Enter>
Terminal, Bus-Zone, Polarity (P,N)
? CPL2,NORTH,P <Enter>
CPL21 to NORTH Connection (SELogic Equation)
I02BZ1V := CPL892 <Enter>

```

**Figure 6.30 Using the SET Z 1 Command to Set the Terminal-to-Bus-Zone Settings**

This concludes the configuration for Case 2.

### Case 3: CT Either Side of the Breaker With Breaker Differential

Step 1. Use one of the six available differential elements to configure the breaker differential.

For the bus coupler in the example, three differential elements are required; the third differential element covers only the common area between the two CTs.

In addition to the breaker differential, configure the same CTs (CPL1 and CPL2) to balance SOUTH and NORTH. For the breaker differential, establish the following relationships:

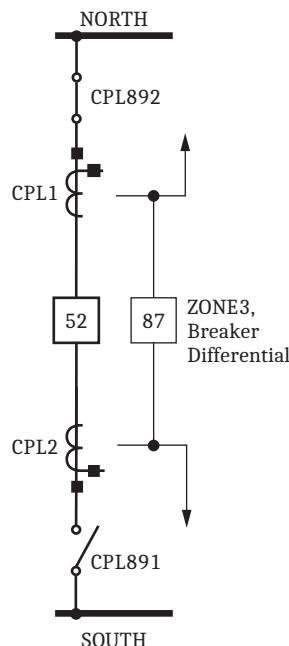
For balancing SOUTH and NORTH:

- > CPL1 and NORTH when CPL892 is closed
- > CPL2 and SOUTH when CPL891 is closed

For the breaker differential:

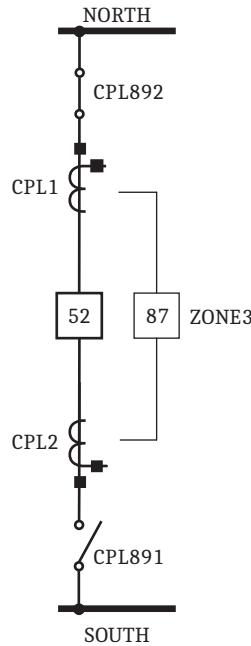
- > CPL1 and ZONE3 when CPL891 or CPL892 is closed
- > CPL2 and ZONE3 when CPL891 or CPL892 is closed

Considering both Terminals CPL1 and CPL2, we determine that both polarities are negative, when we balance SOUTH and NORTH, as shown in *Figure 6.31*.



**Figure 6.31 Negative CT Polarities for Both Terminals CPL1 and CPL2 When Balancing SOUTH and NORTH**

- Step 2. Determine the polarity of Terminals CPL1 and CPL2 for the breaker differential (ZONE3) assuming polarity-to-polarity connections.  
*Figure 6.32* shows that the polarities of Terminals CPL1 and CPL2 for the breaker differential are positive.



**Figure 6.32 Positive CT Polarities for Both Terminals CPL1 and CPL2 for the Breaker Differential**

*Figure 6.33* shows the entries for Terminals CPL1 and CPL2.

---

```

Terminal, Bus-Zone, Polarity (P,N)
? CPL1,NORTH,N <Enter>
CPL1 to NORTH Connection (SELogic Equation)
I01BZ1V := CPL892 <Enter>
Terminal, Bus-Zone, Polarity (P,N)
? CPL1,ZONE3,P <Enter>
CPL1 to ZONE3 Connection (SELogic Equation)
I01BZ3V := CPL891 OR CPL892 <Enter>
Terminal, Bus-Zone, Polarity (P,N)
? CPL2,SOUTH,N <Enter>
CPL2 to SOUTH Connection (SELogic Equation)
I02BZ2V := CPL891 <Enter>
Terminal, Bus-Zone, Polarity (P,N)
? CPL2,ZONE3,P <Enter>
CPL2 to ZONE3 Connection (SELogic Equation)
I02BZ3V := CPL891 OR CPL892 <Enter>

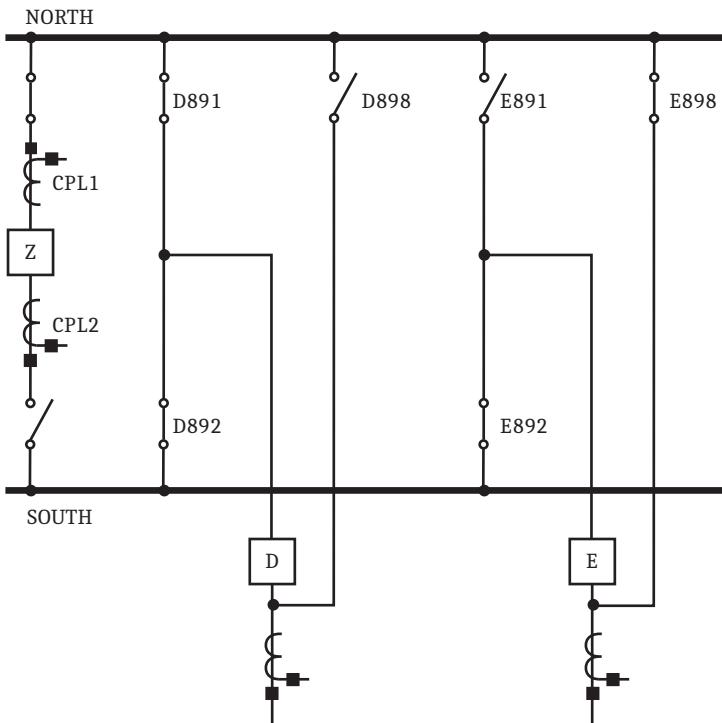
```

---

**Figure 6.33 Entries for Terminals CPL1 and CPL2**

## Bus-Zone-to-Bus-Zone Connections

Bus-zone-to-bus-zone settings are used only when bus-zone-to-bus-zone connections are formed between two or more busbars, particularly when the connection is formed without a circuit breaker between the busbars. For example, closing disconnects D891 and D892 in *Figure 6.34* forms a solid connection between NORTH and SOUTH, and there is no circuit breaker between the busbars.



**Figure 6.34 Forming Bus-Zone-to-Bus-Zone Connections With and Without a Circuit Breaker**

By contrast, closing E892 and E898 or E891, E892, and E898 also forms a connection between Busbar 1 and Busbar 2, but now there exists a circuit breaker between the busbars, namely the Terminal E circuit breaker. The significance of the bus-zone-to-bus-zone connection is twofold.

- Both differential zones (SOUTH and NORTH) must operate when a fault develops on either zone during the time when the two differential zones are connected via disconnects D891 and D892 (or similar connections).
- Parallel paths are formed, and both differential zones may be unbalanced (see *Figure 6.17*).

When two bus-zones are combined, bus coupler CTs are redundant and are removed from the differential calculations.

One protection philosophy requires the tripping of only those circuit breakers that can contribute fault current to optimize breaker maintenance. However, there is also the protection philosophy that requires all breakers in the faulted differential zone to be tripped. To satisfy both protection philosophies, the SEL-487B offers the choice of leaving the bus coupler closed or issuing a trip signal. The first prompt in this group asks you for the two busbars that will be combined.

- Step 1. From *Figure 6.34*, we see that we would enter SOUTH and NORTH at the prompt (without spaces between the differential zone names or the comma).

---

Bus - Zone , Bus - Zone?  
SOUTH, NORTH <Enter>

---

Step 2. Next, the SELogic control equation that declares the digital input conditions which must be a logical 1 for the relay to recognize the combination of SOUTH and NORTH. Again, the relay states the names you enter and then generates a prompt with the primitive names as a double check.

List all of the several possible combinations, separating each combination with the OR function. From *Figure 6.34*, NORTH and SOUTH are combined when D891 and D892 are closed, or when E891 and E892 are closed:

---

```
SOUTH to NORTH Connection (SELogic Equation)
BZ1BZ2V := (D891 AND D892) OR (E891 AND E892) <Enter>
```

---

**NOTE:** When the bus-zone-to-bus-zone SELogic control equation includes the circuit breaker, be sure to also include the breaker auxiliary contact status (not only the disconnect status) to ensure separate bus-zones when the circuit breaker is open.

This setting identifies the particular differential zones that can be combined and the conditions under which this combination can take place.

Step 3. The next setting allows you to select a subset of the conditions stated in the previous setting. In the present example, there is no subset, and the setting is a repeat of the previous setting.

---

```
Remove Terminals when NORTH and SOUTH Bus-Zones merge (SELogic Equation)
BZ1BZ2R := NA
? (D891 AND D892) OR (E891 AND E892) <Enter>
```

---

Step 4. Next, state the terminals to be removed when the two differential zones are combined. In most cases, these terminals are the bus coupler CTs, as is the case in *Figure 6.34*. You would, therefore, enter the bus coupler terminal names at the prompt.

---

```
Terminals Removed when NORTH and SOUTH Bus-Zone merge (Ter k,...,Ter n)
BZ1BZ2M :=
?CPL1,CPL2 <Enter>
```

---

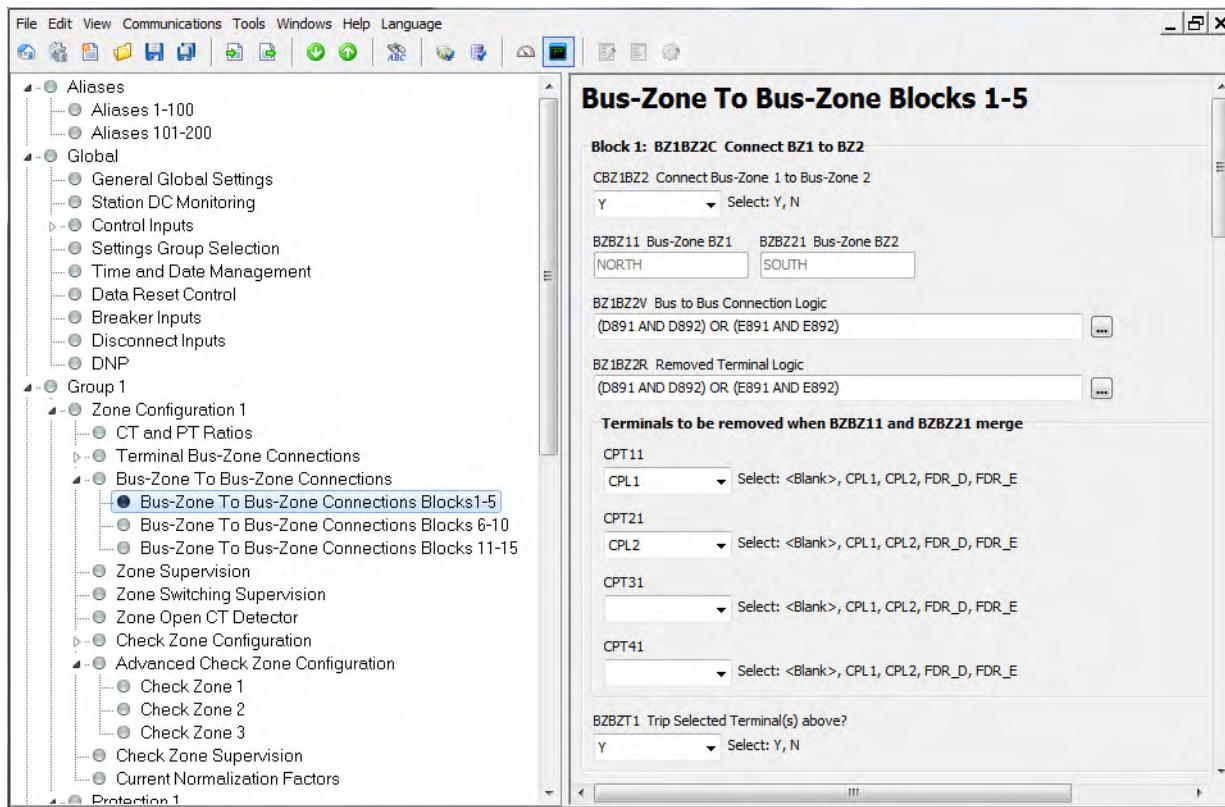
Step 5. To end this group, select whether the bus coupler must be tripped (Y) when a fault occurs in the combined protection zone during the time when the two bus-zones are merged, or whether the bus coupler must not be issued a trip signal (N). Again, as a double check, the relay states the primitive names of the terminals that must be removed:

---

```
Trip Terminals CPL1, CPL2 (Y,N)
BZ1BZ2T := N
? Y <Enter>
```

---

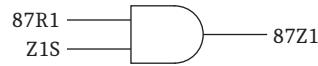
In SEL Grid Configurator, go to **Group 1 > Zone Configuration 1 > Bus-Zone to Bus-Zone Connections > Bus-Zone to Bus-Zone Connections Blocks 1–5**. Set CBZ1BZ2 = Y, BZ1BZ2V = (D891 AND D892) OR (E891 AND E892), BZ1BZ2V = (D891 AND D892) OR (E891 AND E892), CPT11 = CPL1, CPT21 = CPL2, and BZBZT1 = Y. NORTH and SOUTH are automatically populated into the BZBZ11 and BZBZ21 fields as the alias names for BZ1 and BZ2.



**Figure 6.35 Bus-Zone to Bus-Zone Blocks 1-5**

## Zone Supervision

This is the final check before a bus-zone trip (87Z1) is issued for each of the six differential zones. *Figure 6.36* shows the relay logic for this function, where the output from the differential calculations (87R1) is ANDed with the zone supervision conditions. See *Section 5: Protection Functions* for more information.



**Figure 6.36 Zone Supervision Logic**

This is a good place to include the overall check-zone differential element output, if one was configured.

The SEL-487B-2 also contains default logic in the Z1S setting, which secures the differential element in the event of data loss. SEL advises that this functionality not be compromised when adding additional zone supervision logic.

Assume Check Zone 1 was configured. Enter the following to include the check zone.

```
Z1S:= 87CZ1 <Enter>
```

## Trip Logic

*Figure 6.37 shows the steps necessary for assigning protection functions to the trip logic.*

---

**NOTE:** The SEL-487B-2 SV Subscriber has default logic that secures the trip equations, when SEL test mode, via the SVSTST Relay Word bit. See TEST SV on page 14.68 in the SEL-400 Series Relays Instruction Manual for more information.

Make sure all selected protection functions appear in the trip equation.

For example, having selected the breaker failure protection, assign the output from this logic to the output contact, or the contact will not assert when the breaker failure protection operates. For Terminal I06 wired to OUT201, the following includes differential protection, internal breaker failure protection, and time-overcurrent protection.

---

```
=>>SET TR06 <Enter>
Group 1
Trip Logic
Trip 06 (SELLogic Equation)
TR06 := NA
? 87BTRO6 OR SBFTRO6 OR 51PO1T <Enter>
Unlatch Trip 06 (SELLogic Equation)
ULTR06 := NA
? END <Enter>
.
.
Save settings (Y,N) ?Y <Enter>
Saving Settings, Please Wait.....
Settings Saved
```

---

**Figure 6.37 Assign the Protection Functions to the Trip Logic**

## Output Assignments

*Figure 6.38 shows the steps necessary for assigning the output from the trip logic (TRIP06) to output contact OUT201.*

---

```
=>>SET 0 OUT201 <Enter>
Output
Interface Board #1
OUT201 := NA
? TRIP06 <Enter>
OUT202 := NA
? END <Enter>
Output
Main Board
.
.
Save settings (Y,N) ?Y <Enter>
Saving Settings, Please Wait.....
Settings Saved
```

---

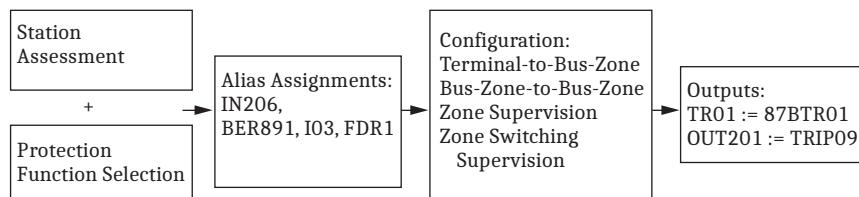
**Figure 6.38 Assigning the Output From the Trip Logic to an Output Contact**

The SEL-487B can physically initiate a breaker trip through the use of output contacts, or it can send the trip signal to the merging unit by using GOOSE messaging.

# Summary

---

In general, system configuration can be summarized in the four-step approach shown in *Figure 6.39*. Use the worksheets provided on the SEL-487B Product Literature CD to collect and organize the data before configuring and setting the relay.



**Figure 6.39 Information Flow Diagram**

Step 1. Assess your station and select appropriate protection functions.

Inspect the substation layout to make the appropriate selection in terms of the number of bus-zones, number of terminals, CT ratio mismatch, I/O count, etc.

As for protection functions, decide whether to use internal or external breaker failure protection, breaker differential, or an overlap coupler CT application (if two sets of CTs are available), etc.

Step 2. Assign alias names.

Because configuration settings use terminal names, assign alias names at this point.

Step 3. Configure your system.

Entries here determine the CT/differential element assignment with the terminal-to-bus-zone and bus-zone-to-bus-zone settings, while zone supervision and zone-switching supervision provide for additional control and information.

Step 4. Assign outputs.

For each terminal, select the relay functions for which the terminal will be issued a trip signal.

Use *Table 6.8–Table 6.13* to assist with *Step 1* of the configuration process.

**Table 6.8 Primary Plant Data**

Items	Requirement for Your Plant
Number of terminals (maximum 21)	
Number of busbars (maximum 6)	
Number of main zones (maximum 6)	
Number of check zones (maximum 3)	
Number of bus couplers or tie breakers (maximum 4) <sup>a</sup>	
Inboard CTs (Y,N)	
Maximum/minimum CT ratio	

<sup>a</sup> Mutually exclusive; sum of bus couplers and bus sections cannot exceed four.

**Table 6.9 Data for Bus Coupler 1 and Bus Coupler 2**

<b>Bus Coupler 1 Data</b>		<b>Bus Coupler 2 Data</b>	
Number of CTs		Number of CTs	
Overlap or differential		Overlap or differential	
Coupler security logic? Y, N <sup>a</sup>		Coupler security logic? Y, N <sup>a</sup>	
Breaker status logic? Y, N <sup>b</sup>		Breaker status logic? Y, N <sup>b</sup>	

<sup>a</sup> Allocate independent optoisolated inputs to the selected logic.

<sup>b</sup> Allocate one grouped optoisolated input to the selected logic for each logic.

**NOTE:** The SEL-487B can receive breaker and disconnect status via I/O board inputs, TiDL communications, or GOOSE messages.

**Table 6.10 Data for Bus Coupler 3 and Bus Coupler 4**

<b>Bus Coupler 3 Data</b>		<b>Bus Coupler 4 Data</b>	
Number of CTs		Number of CTs	
Overlap or differential		Overlap or differential	
Coupler security logic? Y, N <sup>a</sup>		Coupler security logic? Y, N <sup>a</sup>	
Breaker status logic? Y, N <sup>b</sup>		Breaker status logic? Y, N <sup>b</sup>	

<sup>a</sup> Allocate independent optoisolated inputs to the selected logic.

<sup>b</sup> Allocate one grouped optoisolated input to the selected logic for each logic.

**Table 6.11 Disconnect, Breaker, and Input Data**

<b>Items</b>	<b>Requirement for Your Plant</b>
Number of 89A (N/O) contacts? <sup>a</sup>	
Number of 89B (N/C) contacts? <sup>a</sup>	
Disconnect Monitoring Logic? (maximum 60)	
Zone-Switching Supervision Logic?	
Number of 52A contacts	

<sup>a</sup> Allocate independent optoisolated inputs to the selected logic.

**Table 6.12 Breaker Failure Data**

<b>Items</b>	<b>Requirement for Your Plant</b>
Number of internal breaker failure circuits	
Number of external breaker failure circuits	
Additional security? <sup>a</sup>	

<sup>a</sup> Allocate independent optoisolated inputs to the selected logic.

**Table 6.13 End-Zone Protection**

<b>Items</b>	<b>Requirement for Your Plant</b>
Number of 52A (N/O) contacts? <sup>a</sup>	
Number of communication outputs required? <sup>b</sup>	

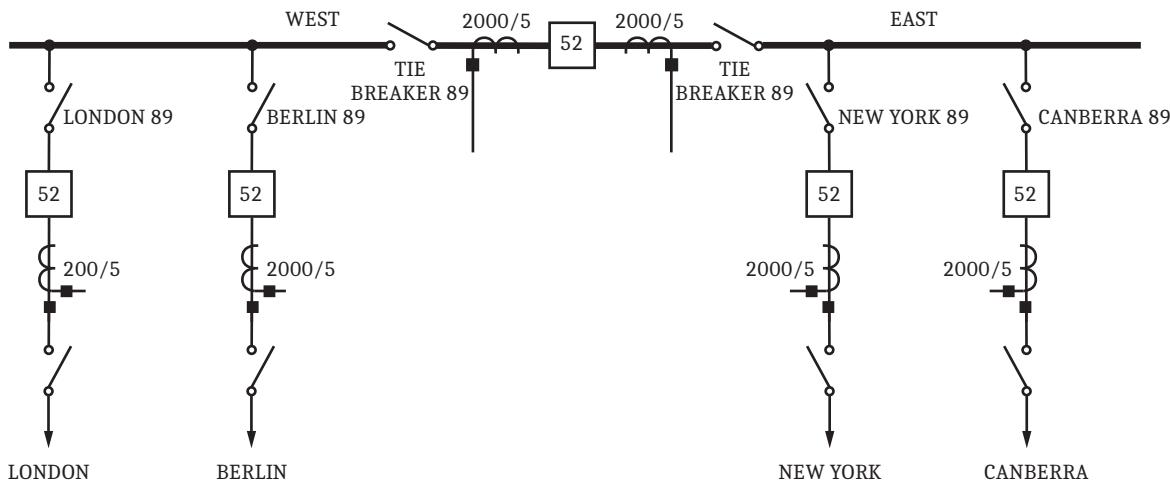
<sup>a</sup> Allocate this number of common optoisolated input contacts.

<sup>b</sup> Allocate this number of independent output contacts.

# Single Bus and Tie Breaker (Three Relays) Application

This application describes the busbar arrangement shown in *Figure 6.40*, a single bus with bus sectionalizer (tie breaker), three-relay application. The busbar arrangement consists of two busbar sections, four feeders, and a tie breaker. Consider the following to set and configure the relay:

- Busbar classification
- Protection philosophy
- Protection functions selection
- Number of SEL-487B Relays
- Merging-unit analog and digital mapping
- Input, logic, and output allocation and alias name assignment
- Station layout update
- Relay setting and configuration



**Figure 6.40 Single Bus With Bus Sectionalizer (Tie Breaker)**

## Busbar Classification

The busbar classification provides general busbar layout and CT positioning (inboard or outboard) information and declares the tie-breaker (bus coupler or sectionalizing breaker) configuration. The classification for this application is:

- Description
  - Single bus with tie breaker
- Current Transformers
  - Outboard (free standing)
- Disconnects
  - Both 89A and 89B disconnect auxiliary contacts are available
- Sectionalizing breaker (tie-breaker) configuration
  - Overlap
- Future expansion
  - Four feeders

## Protection Philosophy

Although the SEL-487B offers a variety of protection and control functions, not all of these functions are applied at every substation. Carefully consider each application before stating the functional requirements. The protection philosophy for this application is as follows:

1. Use the 89 disconnect auxiliary contacts to dynamically configure the station.
2. Use the Disconnect Monitoring Logic.
3. Block the busbar protection for an open-circuit CT.
4. Configure check-zone protection.

## Protection Functions Selection

We select the protection functions early in the relay setting and configuration process because the choice of protection functions determines the number of relay digital inputs and outputs required for the application. Study the protection philosophy to determine which protection and/or control functions to apply to any particular substation. For example, in this application the protection philosophy calls for a check zone, but not for breaker failure protection.

The SEL-487B offers a number of protection functions as standard features but also includes the capability through SELOGIC control equations to create user-configurable functions. To properly identify and categorize the protection philosophy requirements, group the protection functions as follows:

- Standard protection functions (available in the relay)
- User-defined protection functions (created using SELOGIC control equations)

## Standard Functions

Refer to *Protection Philosophy* on page 6.36 and select the standard functions required for the application. *Table 6.14* shows the selection of the standard functions.

**Table 6.14 Selection of the Standard Protection Functions (Sheet 1 of 2)**

Protection Function	Selection	Comment
CT ratio mismatch $\leq 10:1$	Yes	10:1 mismatch is the maximum allowable mismatch
Circuit breaker status logic	No	Not required
Disconnect monitor logic	Yes	89A and 89B disconnect contacts available
Differential protection	Yes	Busbar protection, zone-specific Check-zone protection
Dynamic zone selection logic	Yes	Use the zone selection to reconfigure the differential protection according to the disconnect positions
Sensitive differential protection	Yes	CT open-circuit detection
Zone supervision logic	Yes	Enter the check zone and zone-specific conditions to supervise the zone-specific differential elements
Zone-switching supervision logic	No	89A and 89B disconnect contacts available; therefore, this logic is not required

**Table 6.14 Selection of the Standard Protection Functions (Sheet 2 of 2)**

Protection Function	Selection	Comment
Coupler security logic	No	Two CTs with overlap configuration do not require the coupler security logic
Circuit breaker failure protection	No	Not required
Instantaneous overcurrent protection	No	Not required
Time-overcurrent protection	No	Not required
Phase voltage elements	No	Not required
Zero- or negative-sequence voltage elements	No	Not required

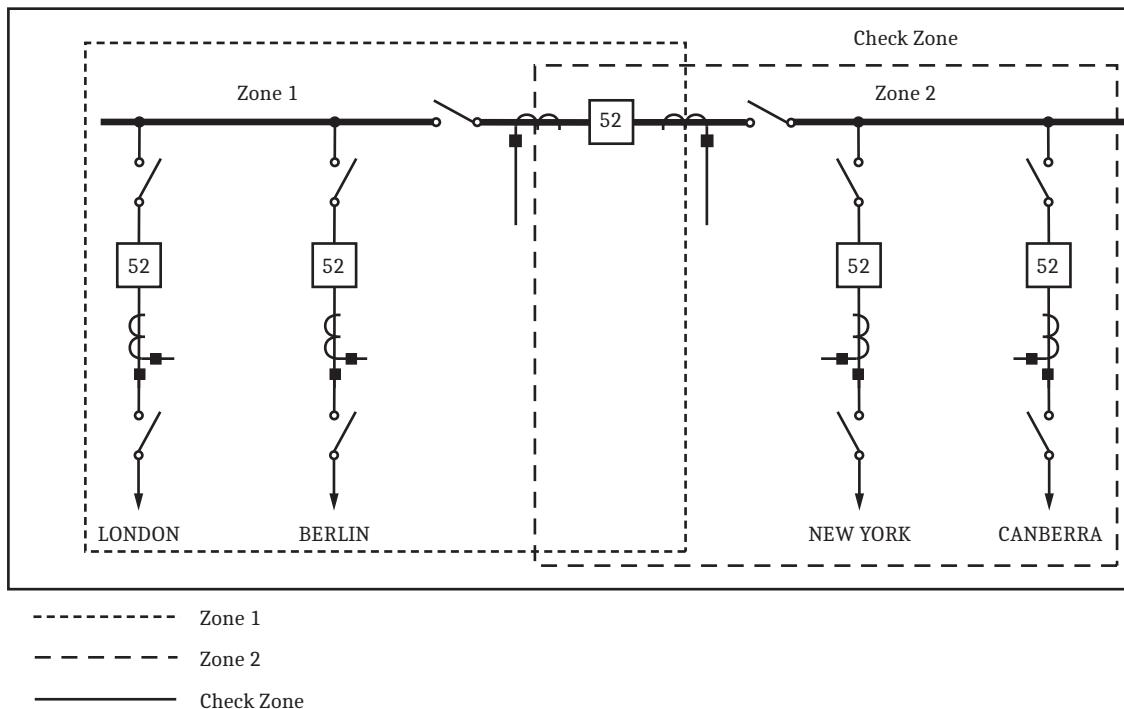
## User-Defined Functions

Because the SEL-487B includes all protection functions necessary for this application as standard protection functions, we do not need any user-defined functions.

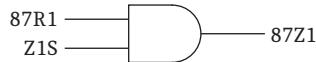
### Check-Zone Protection

*Figure 6.41* shows a station with check-zone protection. Check-zone protection stems from the philosophy of providing an additional trip criterion before issuing a busbar protection trip signal. This philosophy encompasses additional trip criteria such as directional elements and overcurrent elements.

When using check-zone protection as an additional criterion, the practice is to provide a measurement from a second differential element that is independent of the disconnect auxiliary contact status. Using a measurement independent of the disconnect auxiliary contact status prevents differential element misoperation resulting from disconnect auxiliary contact failure.

**Figure 6.41 Station With Two Zone-Specific Bus-Zones and an Overall Check Zone**

Both the Check Zone and either Zone 1 or Zone 2 differential elements must assert before a busbar protection trip output asserts. Use the Differential Element Zone Supervision setting to comply with the requirement for both check zone and zone-specific differential elements to assert. *Figure 6.42* shows the zone supervision logic. Relay Word bit 87R1 is the output from the Zone 1 differential element and Z1S is the SELLOGIC control equation where we enter conditions for supervising the Zone 1 differential element. (See *Zone Configuration Group Settings* on page 6.50 for more detail.)



**Figure 6.42 Zone Supervision Logic**

Create the check-zone protection by configuring a check zone when entering the zone configuration settings (ECHKZN := Y).

## Number of Relays and I/O Boards

Selecting the relay has two parts:

- The number of relays (single-relay application or three-relay application)
- The number of inputs and outputs

The number of analog (CT) inputs determines the number of relays, and the number of digital inputs and outputs determines the number of merging-unit interface boards.

### Number of Relays

Each SEL-487B has 21 current channels and three voltage channels. For stations with as many as 7 three-phase terminals (21 CTs), we can install a single SEL-487B. For stations with more than 21 and as many as 63 CTs, we install three SEL-487B Relays. Use *Equation 6.2* to calculate the number of current channels at the station, and use *Equation 6.3* to calculate the number of zones at the station.

$$\# \text{ of current channels required} = \# \text{ of per-phase station CTs}$$

**Equation 6.2**

$$\# \text{ of bus-zones required} = \# \text{ of per-phase station bus sections}$$

**Equation 6.3**

The number of per-phase CTs at the station is 18 and the number of bus-zones required is 2 (Zone 1 and Zone 2). The number of check zones required is 1 (Check Zone 1). One SEL-487B suffices for these requirements, but the requirement for 4 future feeders increases the number of per-phase CTs to 30. Because each SEL-487B has 21 analog channels, we need 3 relays. This is known as a three-relay application.

In a three-relay application, each relay provides six zones and three check zones of protection for one of the three phases of the power system. This example shows the setting and configuration for the A-Phase relay, so identified with an appended letter A (LOND\_A). For the other two relays, the settings and configuration are the same as for the A-Phase relay, but the appended letter changes according to the letter designation of the relay. For example, the corresponding LOND\_A setting is LOND\_B in the B-Phase relay and LOND\_C in the C-Phase relay.

The number of required merging units depends on merging-unit placement and the number of analog channels supported. See the instruction manual of the merging unit for more details on the number of supported channels.

## Number of Inputs

The protection philosophy and protection function selection determine the number of digital inputs and outputs required for each application.

The number of disconnect logics (NUMDS) required is the number of disconnects for which the protection philosophy requires disconnect monitoring logic. In this example, each of the four feeders requires one disconnect monitoring logic and the tie breaker requires two; therefore, the number of disconnect logics required is six. Each disconnect monitoring logic requires two disconnect auxiliary contact inputs, an 89A and an 89B contact. Use *Equation 6.4* to calculate the number of inputs required for the disconnect auxiliary contacts.

$$\# \text{ inputs required} = 2 \cdot \# \text{ disconnect monitoring logics}$$

**Equation 6.4**

*Table 6.15* summarizes the input contact required for this application.

**Table 6.15 Number of Input Contacts Required**

Input Description	Inputs
Number of inputs required for the disconnect contacts	$6 \cdot 2 = 12$
Total number of inputs	12

Merging-unit placement determines how many inputs are required at each location. Merging-unit inputs must be published to the SEL-487B-2. See *Section 19: Digital Secondary Systems in the SEL-400 Series Relays Instruction Manual* for merging-unit networking and time-synchronization details. See the instruction manual of the merging unit for details on I/O capabilities.

## Number of Output Contacts

Our example station has five circuit breakers, all of which are part of the busbar differential protection. Because all breakers are part of the busbar differential protection, we want to trip each breaker upon differential protection operation. *Table 6.16* shows the breakdown and the total number of output contacts required.

**Table 6.16 Breakdown and the Total Number of Outputs Required**

Output Description	Outputs
Number of output contacts required for tripping	5
Total number of output contacts	5

Merging-unit placement determines how many outputs are required at each location. Merging-unit outputs can be controlled by subscribing to SEL-487B output assignments. See *Section 19: Digital Secondary Systems in the SEL-400 Series Relays Instruction Manual* for merging-unit networking and time-synchronization details. See the instruction manual of the merging unit for details on I/O capabilities.

SEL-401 interface boards may have high-speed, high-interrupting output contacts that provide faster contact closure. Each interface board can be ordered with an option that provides six high-speed, high-interrupting output contacts and two

standard output contacts. For fast busbar fault clearance, assign each circuit breaker trip output to a high-speed, high-interrupting output contact for each of the circuit breakers at the station.

The conclusion from the preceding analysis is that we need three SEL-487B Relays. Choosing to use one merging unit per feeder and another merging unit for the tie breaker requires five merging units, each equipped with a single interface board.

## Input, Logic, and Output Allocation and Alias Name Assignment

At this point we have determined the following:

- The number of SEL-487B Relays required for the application
- The number of input contacts
- The number of output contacts
- The number of merging units
- The selected functions

For example, we have matched the number of CTs at the station with the number of available analog channels in the relay. However, we still need to do the following:

- Map digitals and analogs between the SEL-487B and merging units
- Link specific CT inputs to specific relay analog channels
- Link specific disconnect and circuit breaker inputs to specific relay inputs
- Link relay element/logic outputs to specific relay outputs
- Assign alias names where appropriate

Assign a valid seven-character alias name to any of the following:

- Relay Word bit
- Analog quantity
- Terminal name
- Bus-Zone name
- Check-Zone name

Alias names are valid when they consist of a maximum of seven characters and they are constructed with characters 0–9, uppercase A–Z, or the underscore (\_).

## CT-to-Analog Channel Allocation and CT Alias Assignment

*Table 6.17* shows CT-to-relay analog channel allocations and alias assignments, including merging-unit analog mapping. For example, wire the A-Phase tie-breaker CT1 to the tie-breaker merging-unit (SEL-401) IAW terminal. The IAW terminal is mapped to the SEL-487B I01 analog quantity, which is then assigned the alias name SEC1\_A. *Table 6.17* shows the assignment for the A-Phase relay starting with the tie-breaker CTs, followed by the four terminals, taken left to right from *Figure 6.40*.

**Table 6.17 CTs-to-Analog Channel Allocations and Alias Assignments (Sheet 1 of 2)**

CTs	Merging Unit	Merging-Unit Published Analog	SEL-487B Subscribed Analog	Alias
TIE-BREAKER CT1, A-Phase	TIE-BREAKER	IAW	I01	SEC1_A
TIE-BREAKER CT2, A-Phase	TIE-BREAKER	IAX	I02	SEC2_A

**Table 6.17 CTs-to-Analog Channel Allocations and Alias Assignments (Sheet 2 of 2)**

<b>CTs</b>	<b>Merging Unit</b>	<b>Merging-Unit Published Analog</b>	<b>SEL-487B Subscribed Analog</b>	<b>Alias</b>
LONDON, A-Phase	LONDON	IAW	I03	LOND_A
BERLIN, A-Phase	BERLIN	IAW	I04	BERL_A
NEW YORK, A-Phase	NEW YORK	IAW	I05	NEWY_A
CANBERRA, A-Phase	CANBERRA	IAW	I06	CANB_A

## Bus-Zone Alias Assignment

Each SEL-487B provides six zones of protection. For the A-Phase relay, we use two bus-zones with alias names as shown in *Table 6.18*.

**Table 6.18 Alias Names for the Two Bus-Zones**

<b>Bus-Zone Name</b>	<b>Description</b>	<b>Alias</b>
BZ1	Bus-Zone 1	WEST_A
BZ2	Bus-Zone 2	EAST_A

## Check-Zone Alias Assignment

Each SEL-487B provides three check zones. For the A-Phase relay, we use the check zone with the alias name as shown in *Table 6.19*.

**Table 6.19 Alias Name for the Check Zone**

<b>Check-Zone Name</b>	<b>Description</b>	<b>Alias</b>
CZ1	Check Zone	CHECK_A

## Input to Logic Allocation and Alias Assignment

*Table 6.15* shows that we require 12 digital inputs. We now assign the 12 digital inputs to the selected logic and assign alias names to the inputs and logic elements. Because of the functional requirement of this application, we do not need to use any physical inputs on the SEL-487B.

## Input Contact to Logic Allocation and Alias Assignment

*Table 6.20* shows the disconnect auxiliary contact input allocations and the alias names. Merging-unit (SEL-401) INT4 inputs IN201, IN202, IN203, IN213, IN214, and IN215 are independent inputs for breaker failure initiate inputs; these inputs are not used in the present application. For IEC 61850 SV applications, the digital inputs of the merging units are mapped to virtual bits in the SEL-487B, as shown in *Table 6.20*.

**Table 6.20 Alias Names for the Breaker Status Logic Output Relay Word Bits (Sheet 1 of 2)**

<b>Input Description</b>	<b>Merging Unit</b>	<b>Merging-Unit Published Digital</b>	<b>SEL-487B Subscribed Digital</b>	<b>Alias</b>
TIE-BREAKER disconnect (WEST) NO contact	TIE-BREAKER	IN204	VB001	ISE891A
TIE-BREAKER disconnect (WEST) NC contact	TIE-BREAKER	IN205	VB002	ISE891B
TIE-BREAKER disconnect (EAST) NO contact	TIE-BREAKER	IN206	VB003	ISE892A
TIE-BREAKER disconnect (EAST) NC contact	TIE-BREAKER	IN207	VB004	ISE892B

**Table 6.20 Alias Names for the Breaker Status Logic Output Relay Word Bits (Sheet 2 of 2)**

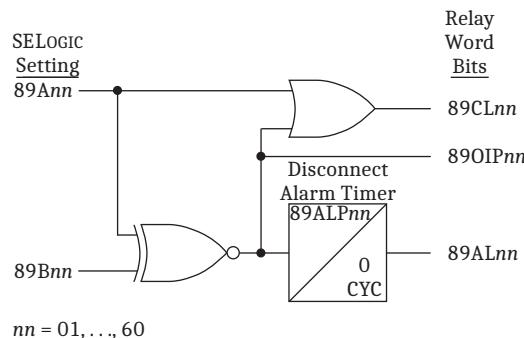
Input Description	Merging Unit	Merging-Unit Published Digital	SEL-487B Subscribed Digital	Alias
LONDON disconnect N/O contact	LONDON	IN204	VB005	ILON89A
LONDON disconnect N/C contact	LONDON	IN205	VB006	ILON89B
BERLIN disconnect N/O contact	BERLIN	IN204	VB007	IBER89A
BERLIN disconnect N/C contact	BERLIN	IN205	VB008	IBER89B
NEW YORK disconnect NO contact	NEW YORK	IN204	VB009	INEW89A
NEW YORK disconnect NC contact	NEW YORK	IN205	VB010	INEW89B
CANBERRA disconnect NO contact	CANBERRA	IN204	VB011	ICAN89A
CANBERRA disconnect NC contact	CANBERRA	IN205	VB012	ICAN89B

## Assign Alias Names to the Selected Standard Logic

Referring to *Table 6.14*, the following is a discussion on each selected function. Alias name assignments are also included.

### Disconnect Monitoring Logic and Disconnect Alias Assignment

*Figure 6.43* shows one of the 60 disconnect monitor logic circuits available in the relay. (See *Disconnect Requirements on page 6.11* for more information on the disconnect auxiliary contact requirements).



**Figure 6.43 One of the Disconnect Monitoring Logic Circuits Available in the Relay**

*Table 6.21* shows the alias names for the disconnect auxiliary contact Relay Word bits.

**Table 6.21 Alias Names for the Disconnect Auxiliary Contact Relay Word Bits (Sheet 1 of 2)**

Input	Description	Alias
89A01	TIE-BREAKER disconnect (WEST) NO contact	SEC891A
89B01	TIE-BREAKER disconnect (WEST) NC contact	SEC891B
89A02	TIE-BREAKER disconnect (EAST) NO contact	SEC892A
89B02	TIE-BREAKER disconnect (EAST) NC contact	SEC892B
89A03	LONDON disconnect NO contact	LON89A
89B03	LONDON disconnect NC contact	LON89B
89A04	BERLIN disconnect NO contact	BER89A

**Table 6.21 Alias Names for the Disconnect Auxiliary Contact Relay Word Bits (Sheet 2 of 2)**

Input	Description	Alias
89B04	BERLIN disconnect NC contact	BER89B
89A05	NEW YORK disconnect NO contact	NEW89A
89B05	NEW YORK disconnect NC contact	NEW89B
89A06	CANBERRA disconnect NO contact	CAN89A
89B06	CANBERRA disconnect NC contact	CAN89B

Wire a normally open disconnect auxiliary contact (89A) and a normally closed disconnect auxiliary contact (89B) from each disconnect to individual merging-unit inputs. Relay Word bits 89CL $nn$  assert when the disconnect monitoring logic interprets that the disconnect main contacts as closed. Use Relay Word bits 89CL $nn$  as conditions in the terminal-to-bus-zone SELOGIC control equations. We also assign alias names to the alarm Relay Word bits (89AL $nn$ ). *Table 6.22* shows the alias names.

**Table 6.22 Alias Names for the Disconnect Monitor Logic Output Relay Word Bits**

Primitive Name	Description	Alias
89CL01	TIE-BREAKER disconnect (WEST) is closed	SEC189C
89CL02	TIE-BREAKER disconnect (EAST) is closed	SEC289C
89CL03	LONDON disconnect is closed	LOND89C
89CL04	BERLIN disconnect is closed	BERL89C
89CL05	NEW YORK disconnect is closed	NEWY89C
89CL06	CANBERRA disconnect is closed	CANB89C
89AL01	TIE-BREAKER disconnect (WEST) alarm	SEC189A
89AL02	TIE-BREAKER disconnect (EAST) alarm	SEC289A
89AL03	LONDON disconnect alarm	LOND89A
89AL04	BERLIN disconnect alarm	BERL89A
89AL05	NEW YORK disconnect alarm	NEWY89A
89AL06	CANBERRA disconnect alarm	CANB89A

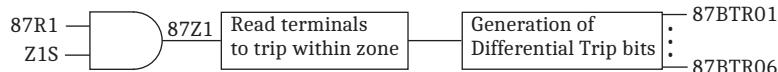
## Differential Trip Logic and Differential Element Alias Assignment

*Figure 6.44* shows the differential trip logic for Differential Element 1. Relay Word bit 87Z1 asserts only if the zone supervision conditions permit an output from the AND gate. (See *Section 5: Protection Functions* for more information). *Table 6.23* shows the Relay Word bits and the alias names for the zone differential protection outputs.

**Table 6.23 Alias Names for the Zone Differential Protection Output Relay Word Bits**

Primitive Name	Description	Alias
87Z1	Zone 1 differential element trip	WESTA_T
87Z2	Zone 2 differential element trip	EASTA_T
87CZ1	Check Zone differential element trip	CHECA_T

Differential trip bits 87BTR01–87BTR06 assert to trip the circuit breakers of the terminals in the faulted bus-zone. (See *Section 5: Protection Functions* for more information.)



**Figure 6.44 Differential Trip Logic for Differential Element 1**

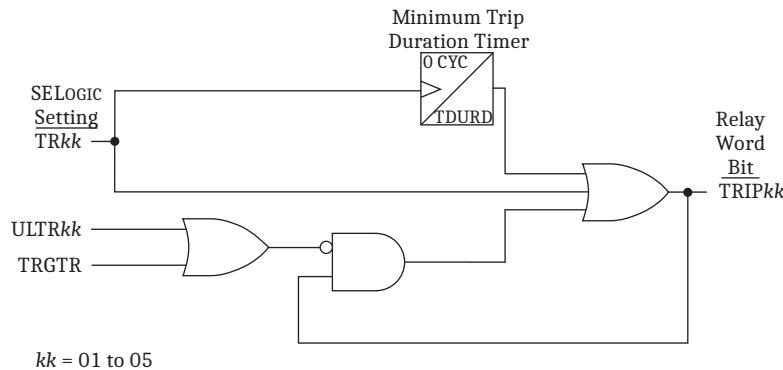
Be sure to include the differential trip bits in the trip equations of all the terminals you want to trip when the differential elements operate (see *Global Settings on page 6.48* for more information). *Table 6.24* shows the primitive differential trip bit names, the alias names for the differential trip bits, and the terminal with which the relay associates each differential trip bit.

**Table 6.24 Primitive Differential Trip Bit Names, Alias Names for the Differential Trip Bits, and Associated Terminals**

Differential Trip Bit	Alias	Comments
87BTR01	87SEC1A	Associated with Terminal 01
87BTR02	87SEC2A	Associated with Terminal 02
87BTR03	87LON_A	Associated with Terminal 03
87BTR04	87BER_A	Associated with Terminal 04
87BTR05	87NEW_A	Associated with Terminal 05
87BTR06	87CAN_A	Associated with Terminal 06

## Breaker Trip Logic and Trip Alias Assignment

*Figure 6.45* shows the general tripping logic in the SEL-487B. (See *Section 5: Protection Functions* for more information).



**Figure 6.45 Breaker Trip Logic**

There exists a direct relationship between the number of circuit breakers setting (NUMBK) and the number of trip equations, i.e., the number of trip equations (TRkk) equals the number of circuit breakers (NUMBK) setting. *Table 6.25* shows the five primitive and alias names for the trip logic of each terminal.

**Table 6.25 Primitive and Alias Names for the Trip Logic of Each Terminal (Sheet 1 of 2)**

Primitive Name	Description	Alias Name
TRIP01	Trip output of the sectionalizing breaker asserted	TRSEC_A
TRIP02	Trip output of the LONDON Terminal asserted	TRLON_A

**Table 6.25 Primitive and Alias Names for the Trip Logic of Each Terminal (Sheet 2 of 2)**

Primitive Name	Description	Alias Name
TRIP03	Trip output of the BERLIN Terminal asserted	TRBER_A
TRIP04	Trip output of the NEW YORK Terminal asserted	TRNEW_A
TRIP05	Trip output of the CANBERRA Terminal asserted	TRCAN_A

## Relay Logic-to-Output Contact Allocation and Alias Assignments

At this point, we have assigned alias names to all relay functions. *Table 6.28* shows the breakdown of the five contact outputs we need for this application. For this application, we send GOOSE trip signals from the SEL-487B to the SEL-401 merging units. Merging units then assign the received GOOSE digitals to the appropriate output contacts in order to trip breakers. SELOGIC variables add RELAY TEST MODE functionality to the trip-logic outputs. The SELOGIC variables alias names are shown in *Table 6.26*.

**Table 6.26 Alias Assignment for Trip Logic Outputs With TEST MODE Security**

Trip Logic Outputs	Description	Associated SELOGIC Variable	Alias
TRSEC_A	TIE-BREAKER trip logic output	PSV01	SECTR_A
TRLON_A	LONDON trip logic output	PSV02	LONTR_A
TRBER_A	BERLIN trip logic output	PSV03	BERTR_A
TRNEW_A	NEW YORK trip logic output	PSV04	NEWTR_A
TRCAN_A	CANBERRA trip logic output	PSV05	CANTR_A

The SEL-487B SELOGIC trip variables (PSV01–PSV05) are mapped to the corresponding merging unit through use of ACCELERATOR Architect SEL-5032 Software. This example uses SEL-401 merging units, which receive GOOSE messages as virtual bits (VB001). *Table 6.27* shows the mapping of SEL-487B SELOGIC trip variables to each merging unit.

**Table 6.27 Trip Logic Mapping to Merging Units**

Output Description	Merging Unit	SEL-487B Published Digital	Merging-Unit Subscribed Digital
TIE-BREAKER trip logic output	TIE-BREAKER	PSV01	VB001
LONDON trip logic output	LONDON	PSV02	VB001
BERLIN trip logic output	BERLIN	PSV03	VB001
NEW YORK trip logic output	NEW YORK	PSV04	VB001
CANBERRA trip logic output	CANBERRA	PSV05	VB001

**Table 6.28 Alias Names for Merging-Unit Output Contact (Sheet 1 of 2)**

Output Description	Merging Unit	Output Contact Assignment	Alias
TIE-BREAKER trip logic output	TIE-BREAKER	OUT201 <sup>a</sup>	SECTR_A
LONDON trip logic output	LONDON	OUT201 <sup>a</sup>	LONTR_A
BERLIN trip logic output	BERLIN	OUT201 <sup>a</sup>	BERTR_A

**Table 6.28 Alias Names for Merging-Unit Output Contact (Sheet 2 of 2)**

Output Description	Merging Unit	Output Contact Assignment	Alias
NEW YORK trip logic output	NEW YORK	OUT201 <sup>a</sup>	NEWTR_A
CANBERRA trip logic output	CANBERRA	OUT201 <sup>a</sup>	CANTR_A

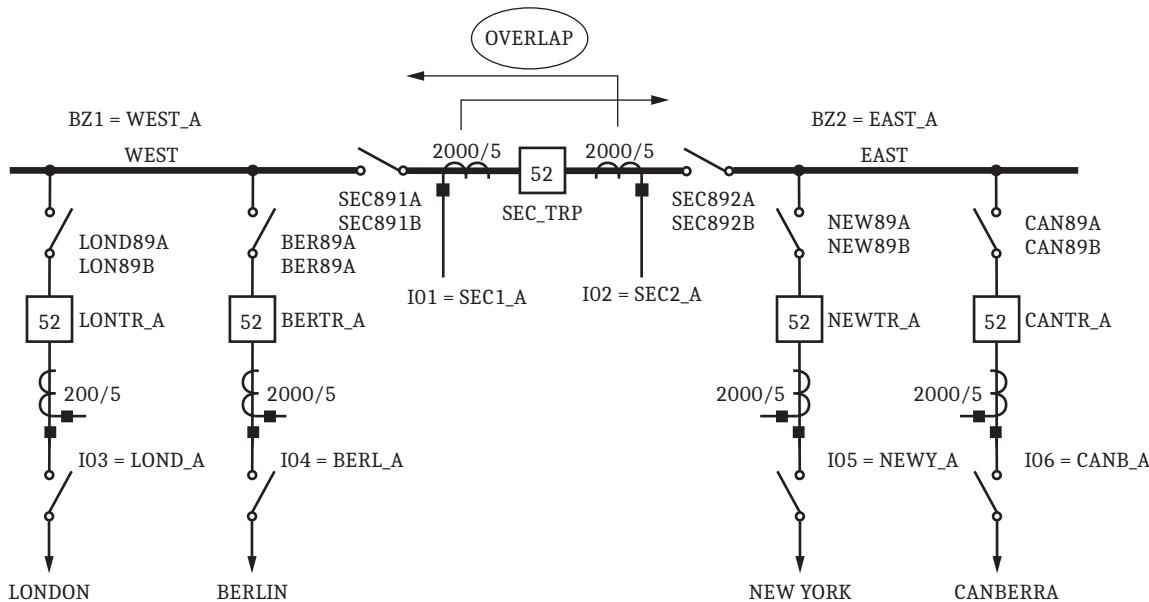
<sup>a</sup> High-speed, high-interrupting outputs.

Each merging unit assigns the received virtual bit to an output contact to trip the respective breaker. For this example, the SEL-487B output GOOSE message is assigned the same alias as the corresponding merging-unit output contact digital, as shown in *Table 6.28*. See *Figure 6.57* for merging-unit output contact logic.

## Station Layout Update (A-Phase)

We are now ready to set and configure the relay. Write all the relevant information on the station diagram, as shown in *Figure 6.46*.

1. Write down the bus-zone, terminal, and disconnect names.
2. Draw in the overlapping zone on the bus section to clearly identify the terminal/zone allocation.
3. Allocate the terminal CTs to the relay input current channels.
4. Allocate the auxiliary terminal contacts to the relay digital inputs.
5. Allocate the digital outputs from the relay to the terminals.

**Figure 6.46 Substation Layout With Specific Terminal Information**

## Setting the Relay

The following describes the settings for this application. We set the following settings classes:

- Alias Settings
- Global Settings

- Zone Configuration Group Settings
- Protection Group Settings
- Control Output Settings

## Alias Settings

We have identified and allocated the alias names to the analog channels and Relay Word bits. We now enter the alias names in the relay. Type **SET T <Enter>** to enter the alias settings class. Many default Relay Word bits have useful alias names ready for use. Type **LIST <Enter>** to see a list of default primitive names and associated alias names, as shown in *Figure 6.47*.

After inspecting the list, we decide the only useful alias names are those of the 16 LEDs, TEST, and ALARM.

---

```
=>>SET T <Enter>
Alias
Relay Aliases
(RW Bit,Analog Qty.,Terminal,Bus-Zone, or Check Zone, 7 Char. Alias [0-9 A-Z _])
1: IO1,"FDR_1"
? LIST <Enter>
1: IO1,"FDR_1"
2: IO2,"FDR_2"
3: IO3,"FDR_3"
4: IO4,"TRFR_1"
5: IO5,"TB_1"
6: IO6,"TB_2"
7: BZ1,"BUS_1"
8: BZ2,"BUS_2"
.
.
.
68: TLED_23,"52_ALRM"
69: TLED_24,"IRIGLED"
1: IO1,"FDR_1"
?
```

---

**Figure 6.47 List of Default Primitive Names and Associated Alias Names**

Type **DELETE 43 <Enter>** at the first action prompt to delete the first 43 default alias names, as shown in *Figure 6.48*.

---

```
1: IO1,"FDR_1"
? DELETE 43 <Enter>
```

---

**Figure 6.48 Deletion of the First 43 Alias Names**

Type **> <Enter>** to advance to the next available line in the settings list. Enter the alias names for the six analog channels and Relay Word bits, as shown in *Figure 6.49*.

```

1: OUT107,"TEST"
? > <Enter>
19:
? IO1,SEC1_A <Enter>
20:
? IO2,SEC2_A <Enter>
21:
? IO3,LOND_A <Enter>
22:
? IO4,BERL_A <Enter>
23:
? IO5,NEWY_A <Enter>
24:
? IO6,CANB_A <Enter>
25:
? BZ1,WEST_A <Enter>
26:
? BZ2,EAST_A <Enter>
27:
? CZ1,CHECK_A <Enter>
28:
? VB001,ISE891A <Enter>
29:
? VB002,ISE891B <Enter>
30:

.

.

?

PSV04,NEWTR_A <Enter>
92:
? PSV05,CANTR_A <Enter>
93:
? END <Enter>
.

.

Save settings (Y,N) ?Y <Enter>
Saving Settings, Please Wait.....
Settings Saved
=>>

```

**Figure 6.49 Analog Quantities and Relay Word Bit Alias Names**

This concludes the alias settings. The next settings class is the Global settings.

## Global Settings

Global settings comprise settings that apply to all protection settings groups. For example, when changing from protection setting Group 1 to protection setting Group 2, Global settings such as station name and relay name still apply.

*Figure 6.50* shows the setting changes we need for our example. Because we declared the alias names in the alias settings class, use either alias names or primitive names when entering settings.

Setting NUMBK equal to five makes five corresponding circuit breaker auxiliary input equations (52A01–52A05) and five corresponding trip equations (TR01–TR05) available for setting. Because we do not need circuit breaker auxiliary contacts for this application, set 52A01–52A05 to NA.

Setting NUMDS declares the number of disconnect logics we need, not the number of disconnect inputs. In our example, we need six disconnect logics. You can set each disconnect travel time individually with the 89ALP<sub>pp</sub> setting (<sub>pp</sub> = 01–06). Travel time is the time period when both disconnect auxiliary contacts are in the open position (see *Figure 6.14* for more information). Measure the travel time during commissioning and adjust the settings appropriately. Based on previous experience with similar equipment, we set the tie-breaker disconnect travel time to 400 cycles in this example.

---

**NOTE:** The relay interprets the number of circuit breakers (NUMBK) as the number of circuit breaker poles, not as the number of circuit breakers.

```

=>SET G <Enter>
Global
General Global Settings

Station Identifier (40 characters)
SID := "Station A"
? <Enter>
Relay Identifier (40 characters)
RID := "Relay 1"
? <Enter>
Number of Breakers (N,1-21)          NUMBK   := 5      ? <Enter>
Number of Disconnects (N,1-60)       NUMDSD  := N      ?6<Enter>
Nominal System Frequency (50,60 Hz)  NFREQ   := 60     ? <Enter>

Global Enables

Station DC Battery Monitor (Y,N)      EDCMON  := N      ? <Enter>
Independent Control Input Settings (Y,N)  EICIS    := N      ? <Enter>
Data Reset Control (Y,N)              EDRSTC  := N      ? <Enter>

Control Inputs (Global)

Input Pickup Delay (0.0-30 ms)        GINPU   := 2.0    ?> <Enter>

Settings Group Selection

Select Setting Group 1 (SELogic Equation)
SS1 := NA
? ><Enter>

Time and Date Management

Date Format (MDY,YMD,DMY)            DATE_F  := MDY    ?> <Enter>

Breaker Inputs

N/O Contact Input -BK01 (SELogic Equation)
52A01 := NA
? ><Enter>

Disconnect Inputs and Timers

N/O Contact Input -DS01 (SELogic Equation)
89A01 := NA
? ISE891A<Enter>
N/C Contact Input -DS01 (SELogic Equation)
89B01 := NA
? ISE891B<Enter>
DS01 Alarm Pickup Delay (0-99999 cyc)  89ALP01 := 300   ?400<Enter>
N/O Contact Input -DS02 (SELogic Equation)
89A02 := NA
? ISE892A<Enter>
N/C Contact Input -DS02 (SELogic Equation)
89B02 := NA
? ISE892B<Enter>
DS02 Alarm Pickup Delay (0-99999 cyc)  89ALP02 := 300   ?400<Enter>
N/O Contact Input -DS03 (SELogic Equation)
89A03 := NA
? ILON89A<Enter>
.
.
.

DS06 Alarm Pickup Delay (0-99999 cyc)  89ALP06 := 300   ?400<Enter>

DNP

Event Summary Lock Period (0-1000 s)    EVELOCK := 0      ? <Enter>
DNP Session Time Base (LOCAL, UTC)      DNPSRC   := UTC    ? <Enter>

Save settings (Y,N) ?Y <Enter>
Saving Settings, Please Wait.....
Settings Saved

=>

```

**Figure 6.50 Global Settings**

This concludes the Global settings. The next settings class is the zone configuration group settings.

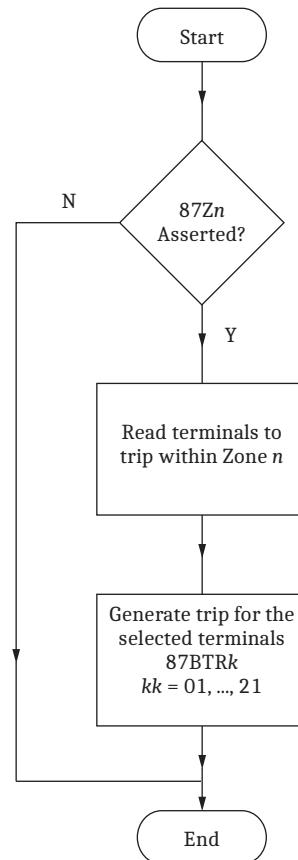
## Zone Configuration Group Settings

The terminal-to-bus-zone SELOGIC control equations identify an analog channel, a differential element, and the conditions for which the relay assigns the analog channel to the differential element. Dynamic zone selection provides a mechanism to automatically reconfigure the zone of protection, without any wiring changes (See *Dynamic Zone Selection Logic on page 5.20* for more information). In this example, the dynamic zone selection logic uses the disconnect auxiliary contacts status to determine the station configuration and assign the input currents from the CTs to the appropriate differential elements. For each terminal, wire an 89A and an 89B disconnect auxiliary contact to the relay.

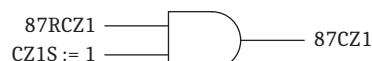
Because the disconnect simultaneously operates all three phases of the terminal, we state the disconnect status in the terminal-to-bus-zone SELOGIC control equations of all three relays. The disconnect status is communicated from the merging unit to all three relays. For example, when we close the busbar disconnect on the LONDON feeder, all three phases (LOND\_A, LOND\_B, and LOND\_C) operate together. Because the relay measures the three phases in three separate relays (phase LOND\_A in the A-Phase relay, phase LOND\_B in B-Phase relay, etc.), we need to convey the disconnect status to all three relays.

The check zone performs supervision, so you must first determine zone configuration settings for the check zone before determining settings for Zone 1 and Zone 2. Configure the check zone by declaring all terminals but the tie-breaker (bus sectionalizer) CTs in the terminal-to-check-zone SELOGIC control equations. Never include the tie-breaker CTs in the check zone. *Figure 6.54* shows the zone configuration group settings.

Use the Differential Element Zone Supervision setting to comply with the requirement for both check zone and zone-specific differential elements to assert before a busbar protection trip output asserts. For this application, we allocated BZ1 for Zone 1, BZ2 for Zone 2, and CZ1 for the overall check zone (see *Table 6.18*). Because the check zone is independent from any other zone, the relay does not follow the differential trip logic shown in *Figure 6.51* when the check zone asserts.

**Figure 6.51 Bus Differential Trip Logic**

The implication of this independence is that the Check Zone Supervision Logic can be left to its default value of 1 as seen in *Figure 6.52*. The same effect is achieved by setting E87CZSP = N.

**Figure 6.52 Check-Zone Supervision Logic**

For the zone-specific elements, enter the Check Zone differential element trip output 87CZ1 as a supervisory condition for each zone, as shown in *Figure 6.53*.

**Figure 6.53 Zone Supervision for Zone 1 (a) and Zone 2 (b)**

Be sure to include Relay Word bit 87CZ1 as the supervisory condition for all zones encompassed by the Check Zone. Set E87ZSUP = Y to enable the Differential Element Zone Supervision settings, then enter the supervision settings.

For the ease of setting the zone configuration settings for the new substation, delete the existing zone configuration group default settings. With the zone configuration group default settings deleted, the setting prompts no longer reference the default settings. The zone configuration group default settings are for a specific substation with arbitrarily selected alias names, serving only as an example.

---

**NOTE:** Be sure to preserve the default zone supervision logic in the SEL-487B-2. See *Figure 6.54* for an example.

```

=>>SET Z TE<Enter>
Zone Config Group 1
Potential Transformer Ratio

Potential Transformer Ratio -V01 (1-10000) PTR1 := 2000 ?> <Enter>

Current Transformer Ratio

Current Transformer Ratio -I01 (1-50000) CTR01 := 600 ?400<Enter>
Current Transformer Ratio -I02 (1-50000) CTR02 := 600 ?400<Enter>
Current Transformer Ratio -I03 (1-50000) CTR03 := 600 ?40<Enter>
Current Transformer Ratio -I04 (1-50000) CTR04 := 600 ?400<Enter>
Current Transformer Ratio -I05 (1-50000) CTR05 := 600 ?400<Enter>
Current Transformer Ratio -I06 (1-50000) CTR06 := 600 ?400<Enter>
Current Transformer Ratio -I07 (1-50000) CTR07 := 600 ?> <Enter>

Zone Configuration: Terminal to Bus-Zone Connections

Terminal, Bus-Zone, Polarity (P,N)
I01BZ1C := SEC1_A, WEAT_A, P
? DELETE 100<Enter>
Terminal, Bus-Zone, Polarity (P,N)
? I01 BZ2 P<Enter>
SEC1_A to EAST_A Connection (SELLogic Equation)
I01BZ2V := NA
? SEC189C AND SEC289C<Enter>
Terminal, Bus-Zone, Polarity (P,N)
? I02 BZ1 P<Enter>
SEC2_A to WEAT_A Connection (SELLogic Equation)
I02BZ1V := NA
? SEC189C AND SEC289C<Enter>
Terminal, Bus-Zone, Polarity (P,N)
? I03 BZ1 P<Enter>
LOND_A to WEAT_A Connection (SELLogic Equation)
I03BZ1V := NA
? LOND89C<Enter>
Terminal, Bus-Zone, Polarity (P,N)
? I04 BZ1 P<Enter>
BERL_A to WEAT_A Connection (SELLogic Equation)
I04BZ1V := NA
? BERL89C<Enter>
Terminal, Bus-Zone, Polarity (P,N)
? I05 BZ2 P<Enter>
NEWY_A to EAST_A Connection (SELLogic Equation)
I05BZ2V := NA
? NEWY89C<Enter>
Terminal, Bus-Zone, Polarity (P,N)
? I06 BZ2 P<Enter>
CANB_A to EAST_A Connection (SELLogic Equation)
I06BZ2V := NA
? CANB89C<Enter>
Terminal, Bus-Zone, Polarity (P,N)
? <Enter>

Zone Configuration: Bus-Zone to Bus-Zone Connections

Bus-Zone, Bus-Zone
? <Enter>

Zone Supervision

Differential Element Zone Supervision (Y,N) E87ZSUP := N ?Y<Enter>
Zone 1 Supervision (SELLogic Equation)
Z1S := NOT 87Z1BK
? 87CZ1 AND NOT 87Z1BK<Enter>
Zone 2 Supervision (SELLogic Equation)
Z2S := NOT 87Z2BK
? 87CZ1 AND NOT 87Z2BK<Enter>

Zone Switching Supervision

Zone Switching Supervision (Y,N) EZWSUP := N ? <Enter>

```

Figure 6.54 Zone Configuration Group Settings

---

```

Zone Open CT Detector

Reset Zone 1 Open CT Detector (SELogic Equation)
ROCTZ1 := RSTOCT1 OR (87Z1BK AND NOT OCTZ1)
? <Enter>
Reset Zone 2 Open CT Detector (SELogic Equation)
ROCTZ2 := RSTOCT2 OR (87Z2BK AND NOT OCTZ2)
? <Enter>
Check Zone Configuration
Enable Check Zones at Station (Y,N)           ECHKZN := N      ?Y<Enter>
Check Zone Configuration: Terminal to Check Zone Connections

Terminal, Check-Zone, Polarity (P,N)
? IO3 CZ1 P<Enter>
Terminal, Check-Zone, Polarity (P,N)
? IO4 CZ1 P<Enter>
Terminal, Check-Zone, Polarity (P,N)
? IO5 CZ1 P<Enter>
Terminal, Check-Zone, Polarity (P,N)
? IO6 CZ1 P<Enter>
Terminal, Check-Zone, Polarity (P,N)
?

Enable Advance Check Zone Settings (Y,N)       EADVCZ := N      ? <Enter>

Check Zone Supervision

Differential Element Check Zone Supervision (Y,N)   E87CZSP := N      ? <Enter>

Current Normalization Factor

Normalization Factor -IO1                      TAP01 := 5.00 ?
Normalization Factor -IO2                      TAP02 := 5.00 ?
Normalization Factor -IO3                      TAP03 := 50.00 ?
Normalization Factor -IO4                      TAP04 := 5.00 ?
Normalization Factor -IO5                      TAP05 := 5.00 ?
Normalization Factor -IO6                      TAP06 := 5.00 ?

Save settings (Y,N) ?Y <Enter>
Saving Settings, Please Wait.....
Settings Saved
=>

```

---

**Figure 6.54 Zone Configuration Group Settings (Continued)**

This concludes the zone configuration group settings. The next settings class is the protection group settings.

## Protection Group Settings

Settings of this class comprise the protection functions, starting with the function enable settings. Default settings for the differential elements are 60 percent for Slope 1 and 80 percent for Slope 2. To change the slope settings, first enable the advance settings by setting EADVS := Y.

With EADVS := Y, the slope settings and incremental restrained and operating current settings become available.

The protection philosophy calls for the blocking of the busbar protection for an open CT condition. Use the sensitive differential element by setting E87SSUP := Y (see *Figure 5.19* and *Figure 5.26* for more information). Set ECSL := N, ETOS := N, EBFL := N, E50 := N, E51 := N, and EVOLT := N because we do not use the coupler security logic, terminal out of service, breaker failure protection, overcurrent elements, or voltage elements in this application.

Setting NUMBK equal to five makes five corresponding circuit breaker auxiliary input equations (52A01–52A05) and five corresponding trip equations (TR01–TR05) available for setting. There are five trip equations available, but there are six analog channels (I01–I06) at the station. Each of the six analog channels has a corresponding differential trip bit that asserts (*Table 6.24*) when the differential element asserts. Be sure to include these differential trip bits in the trip equations

of all circuit breakers you want to trip. Because the tie breaker has two analog channels but only one circuit breaker, include both differential trip bits (87SEC1A and 87SEC2A) in trip equation TR01.

The trip logic latches the trip outputs TRIP $kk$  after TR $kk$  assertion. One way to deassert the trip outputs is to press the TARGET RESET pushbutton on the front panel. An alternative method is to enter specific reset conditions at the ULTR $kk$  settings.

Although each SEL-487B includes 21 trip logics, there is only one Minimum Trip Duration Time Delay (TDURD) setting. Set the timer TDURD longer than the clearing time of the slowest circuit breaker at the station. For this application, we use the default values for the Sensitive Differential Element, the Restrained Differential Element, the Directional Element, and the Trip Duration Timer.

Figure 6.55 shows the group settings.

---

```
=>>SET <Enter>
Group 1
Relay Configuration

Sensitive Differential Element Supervision (Y,N) E87SSUP := Y ? <Enter>
Coupler Security Logic (N,1-4) ECSL := N ? <Enter>
Terminal Out of Service (N,1-21) ETOS := 5 ?N <Enter>
Breaker Failure Logic (N,1-21) EBFL := 6 ?N <Enter>
Definite Time Overcurrent Elements (N,1-21) E50 := N ? <Enter>
Inverse Time Overcurrent Elements (N,1-21) E51 := N ? <Enter>
Enable Under Voltage Elements (N,1-6) E27 := N ? <Enter>
Enable Over Voltage Elements (N,1-6) E59 := N ? <Enter>
Advanced Settings (Y,N) EADVS := N ? <Enter>

Sensitive Differential Element
Sensitive Differential Element Pickup (0.05-1 pu) S87P := 0.10 ?> <Enter>
Check Zone Sensitive Differential Element
CZ Sensitive Diff. Element Pickup (0.05-1 pu) CZS87P := 0.10 ?> <Enter>

Restrained Differential Element
Restrained Diff Element Pickup (0.10-4 pu) 087P := 1.00 ?> <Enter>
Check Zone Restrained Differential Element
CZ Restrained Diff Element Pickup (0.10-4 pu) CZ087P := 1.00 ?> <Enter>

Directional Element
Dir Element O/C Supervision Pickup (0.05-3 pu) 50DSP := 0.05 ?> <Enter>

Trip Logic
Trip 01 (SELLogic Equation)
TR01 := SBFTR01 OR 87SEC1A
? 87SEC1A OR 87SEC2A <Enter>
Unlatch Trip 01 (SELLogic Equation)
ULTR01 := NA
?

Trip 02 (SELLogic Equation)
TR02 := SBFTR02 OR 87SEC2A
? 87LON_A <Enter>
Unlatch Trip 02 (SELLogic Equation)
ULTR02 := NA
?

Trip 03 (SELLogic Equation)
TR03 := SBFTR03 OR 87LON_A
? 87BER_A <Enter>
Unlatch Trip 03 (SELLogic Equation)
ULTR03 := NA
?
```

---

**Figure 6.55 Protection Group Settings**

---

```

Trip 04 (SELogic Equation)
TR04 := SBFTR04 OR 87BER_A
? 87NEW_A<Enter>
Unlatch Trip 04 (SELogic Equation)
ULTR04 := NA
?

Trip 05 (SELogic Equation)
TR05 := SBFTR05 OR 87NEW_A OR SBFTR06 OR 87CAN_A
? 87CAN_A<Enter>
Unlatch Trip 05 (SELogic Equation)
ULTR05 := NA
?

Minimum Trip Duration Time Delay (2.000-8000 cyc)    TDURD    := 12.000 ?> <Enter>
Group 1
.
.
.

Save settings (Y,N) ?Y <Enter>
Saving Settings, Please Wait.....
Settings Saved
=>>

```

---

**Figure 6.55 Protection Group Settings (Continued)**

This concludes the protection group settings. The next settings class is the control output settings.

## Protection SELOGIC Settings

In this settings class, we assign the logic or Relay Word bits in the relay to SELOGIC variables that are mapped to the merging units through use of GOOSE messaging. These GOOSE messages are processed within the merging unit to issue a physical three-phase trip signal to the associated breaker. We need five merging-unit outputs for this example. Although not specifically called for in the protection philosophy, it is good practice to also include the default TEST and ALARM outputs in the relay settings.

We include Protection Latch Bit PLT03 in the output equation. With PLT03 included in every output equation, the **RELAY TEST MODE** pushbutton disables all relay output contacts and merging-unit trip messages. See *Table 8.45* for more details on RELAY TEST MODE SELOGIC.

---

```

=>>SET L <Enter>
Protection 1
1: PSV01 := NA
? TRSEC_A AND NOT PLT03 <Enter>
2: PSV02 := NA
? TRLON_A AND NOT PLT03 <Enter>
3: PSV03 := NA
? TRBER_A AND NOT PLT03 <Enter>
4: PSV04 := NA
? TRNEW_A AND NOT PLT03 <Enter>
5: PSV05 := NA
? TRCAN_A AND NOT PLT03 <Enter>

.
.

Save settings (Y,N) ?Y
Saving Settings, Please Wait.....
Settings Saved
=>>

```

---

**Figure 6.56 SEL-487B Protection SELOGIC Settings**

```
=>>SET 0 <Enter>
Output
Interface Board #1
OUT201 := NA
? VB001 <Enter>
.
.
Save settings (Y,N) ?Y
Saving Settings, Please Wait.....
Settings Saved
=>>
```

**Figure 6.57 Merging-Unit Output Settings**

---

---

## S E C T I O N 7

---

# Metering, Monitoring, and Reporting

The SEL-487B-2 Relay provides extensive capabilities for monitoring substation components, metering important power system parameters, and reporting on power system performance. The relay provides the following useful features:

- *Metering on page 7.1*
- *Station DC Battery System Monitor on page 7.7*
- *Reporting on page 7.8*

See *Section 7: Metering, Section 8: Monitoring, and Section 9: Reporting in the SEL-400 Series Relays Instruction Manual* for general information. This section contains details specific to the SEL-487B.

## Metering

---

The SEL-487B provides one-cycle average metering for measuring power system conditions and differential protection values. Each SEL-487B processes 21 currents, 3 voltages, and 1 battery monitor.

**NOTE:** For the SEL-487B-2, loss of communications with a merging unit causes the corresponding metering information to be reported as zero.

Use the **MET** command to access the metering functions. Issuing the **MET** command with no options returns the fundamental frequency primary measurement quantities listed in *Table 7.1*.

**Table 7.1 Instantaneous Metering Quantities—Voltages and Currents**

Metered Quantity	Symbol	Units
Phase voltage magnitude	V01–V03	kV
Phase voltage angle	$\angle V01, -\angle V03$	degrees
Phase current magnitude	I01–I21	A
Phase current angle	$\angle I01, -\angle I21$	degrees

The **MET** command followed by a number, **MET *k***, specifies the number of times the command will repeat (*k* can range from 1 to 32767). This is useful for troubleshooting or investigating uncharacteristic power system conditions. With other command options, you can view currents from the terminals.

*Table 7.2* shows the **MET** command options, followed by a short description of each option.

**Table 7.2 MET Command—Metering Only (Sheet 1 of 2)**

Name <sup>a</sup>	Description
<b>MET <i>k</i></b>	Displays fundamental primary phase information <i>k</i> times for all terminals
<b>MET <i>k</i> CZ<sub>q</sub></b>	Displays fundamental primary phase information <i>k</i> times for all terminals in Check Zone <i>q</i>
<b>MET <i>k</i> Z<sub>n</sub></b>	Displays fundamental primary phase information <i>k</i> times for all terminals in Zone <i>n</i>

**Table 7.2 MET Command—Metering Only (Sheet 2 of 2)**

Name <sup>a</sup>	Description
<b>MET SEC k</b>	Displays fundamental secondary phase information $k$ times for all terminals
<b>MET SEC <math>k</math> CZ<math>q</math></b>	Displays fundamental secondary phase information $k$ times for all terminals in Check Zone $q$
<b>MET SEC <math>k</math> Zn</b>	Displays fundamental secondary phase information $k$ times for all terminals in Zone $n$
<b>MET DIF</b>	Displays per unit operating and restraint currents for all active zones
<b>MET BAT</b>	Displays station battery measurements
<b>MET RBM</b>	Reset station battery max/min measurements
<b>MET ANA</b>	Displays the analog values used with MIRRORED BITS communications
<b>MET PMV</b>	Displays all the Protection Math Variables
<b>MET AMV</b>	Displays all the Automation Math Variables

<sup>a</sup>  $k = 1-32767$ ;  $n = 1-6$ ;  $q = 1-3$ .

## Instantaneous Metering

**NOTE:** The SEL-487B-2 does not support frequency tracking. Metering accuracies are specified at nominal frequency.

Use the **MET** command to obtain the current and voltage quantities in primary values, as shown in *Table 7.3*.

**Table 7.3 Information Available With the MET Command**

Command	Information
<b>MET</b>	Primary current magnitudes and angles from all 21 terminals in amperes. Primary voltage magnitudes and angles from the 3 voltage inputs in kV.

*Figure 7.1* shows the relay response to the **MET** command.

```
=>>MET <Enter>
Relay 1                               Date: 09/10/2018 Time: 15:55:01.820
Station A                               Serial Number: 1181840172

      Primary Currents
Terminal   MAG(A)    ANG(DEG)   Terminal   MAG(A)    ANG(DEG)
FDR_1     2397.801   0.00       I12        0.000    24.81
FDR_2     2997.321   0.00       I13        0.000    58.82
FDR_3     1797.586   180.00     I14        0.000    28.81
TRFR_1    3597.324   180.00     I15        0.000    83.86
TB_1      5398.234   180.00     I16        0.000   -130.34
TB_2      5397.541   0.00       I17        0.000   -142.62
I07       0.000     37.69       I18        0.000   -118.68
I08       0.000     168.78      I19        0.000   -146.11
I09       0.000     169.83      I20        0.000    80.32
I10       0.000     96.44       I21        0.000   -19.29
I11       0.000     136.89

      Primary Voltages
Terminal   MAG(kV)   ANG(DEG)
V01       141.969   0.00
V02       132.001  -120.06
V03       128.031  119.99

=>>
```

**Figure 7.1 Relay Response to the MET Command**

All angles are referenced to the voltage connected to Voltage Terminal V01. If the voltage at Terminal V01 is not available, the relay selects V02 and then V03 as the reference. In the absence of voltage inputs, the relay references the current input of I01, provided the current is above  $0.05 \cdot I_{NOM}$ . If I01 is not above this

current level, the relay references the current from I02, if available. If I02 is not available, the relay continues to I03, I04, and so on until it finds a current input above  $0.05 \cdot I_{NOM}$ .

For check-zone-specific primary values information, use the **MET CZ $q$**  ( $q = 1-3$ ) command. *Table 7.4* shows the information, including the CT polarity, included in Check Zone  $q$ .

**Table 7.4 Information Available With the MET CZ $q$  Command**

Command <sup>a</sup>	Information
<b>MET CZ<math>q</math></b>	Primary current magnitudes, angles, and CT polarities from the active terminals in amperes. Primary voltage magnitudes and angles from the three voltage inputs in kV.

<sup>a</sup>  $q = 1-3$ .

For the relay to display any measured values, at least one Terminal-to-Check-Zone equation must be a logical 1 (i.e., at least one terminal must be connected to the Check Zone). *Figure 7.2* shows the relay response to the **MET CZ1** command if no such connection exists.

```
=>>MET CZ1 <Enter>
Specified zone is inactive
```

**Figure 7.2 Response to MET CZ1 Command When All Terminals Are Inactive**

*Figure 7.3* shows the relay response of one phase in a three-relay application when Terminals I01 and I02 are connected to Check Zone 1.

```
=>>MET CZ1 <Enter>
Relay 1                               Date: 09/10/2018 Time: 23:51:51.027
Station A                             Serial Number: 1181840172
Current Terminals in Check Zone 1
    Primary Currents
Terminal   MAG(A)   ANG(DEG)   POL
FDR_1      98.131     0.00       P
FDR_2      98.677    180.00      P
    Primary Voltages
Terminal   MAG(kV)   ANG(DEG)
V01        133.990     0.00
V02        133.990   -119.99
V03        133.990    120.00
```

**Figure 7.3 Response to the MET CZ1 Command of One Phase in a Three-Relay Application**

For zone-specific primary values information, use the **MET Z $n$**  ( $n = 1-6$ ) command. *Table 7.5* shows the information, including the CT polarity and Bus-Zones, included in Protection Zone  $n$ , if two Bus-Zones are combined.

**Table 7.5 Information Available With the MET Z $n$  Command**

Command <sup>a</sup>	Information
<b>MET Z<math>n</math></b>	Primary current magnitudes, angles, and CT polarities from the active terminals in Amperes. Primary voltage magnitudes and angles from the three voltage inputs in kV. Bus-Zones in Protection Zone $n$ .

<sup>a</sup>  $n = 1-6$ .

For the relay to display any measured values, at least one Terminal-to-Bus-Zone equation must be a logical 1 (i.e., at least one terminal must be connected to the specified Bus-Zone). *Figure 7.4* shows the relay response to the **MET Zn** command if no such connection exists.

---

```
=>>MET Z1 <Enter>
All terminals in the specified zone are inactive
```

---

**Figure 7.4 Response to MET Z1 Command When All Terminals Are Inactive**

*Figure 7.5* shows the relay response of one phase in a three-relay application when Terminals I01 and I02 are connected to Bus-Zone 1.

---

```
=>>MET Z1 <Enter>
Relay 1                               Date: 09/10/2018 Time: 13:56:37.718
Station A                             Serial Number: 1181840172
Current Terminals in Protection Zone 1
    Primary Currents
    Terminal   MAG(A)   ANG(DEG)   POL
        FDR_1     98.131      0.00     P
        FDR_2     98.677    180.00     P
    Primary Voltages
    Terminal   MAG(kV)   ANG(DEG)
        V01       133.990      0.00
        V02       133.990   -119.99
        V03       133.990    120.00
Bus-Zones in Protection Zone 1
BUS_1

=>>
```

---

**Figure 7.5 Response to the MET Z1 Command of One Phase in a Three-Relay Application**

**MET SEC** provides secondary information similar to the **MET** command, but includes the CT and PT ratios, as shown in *Table 7.6*.

**Table 7.6 Information Available With the MET SEC Command**

Command	Information
<b>MET SEC</b>	Secondary current magnitudes, angles, and CT ratios from all 21 terminals in amperes. Secondary voltage magnitudes and angles from the three voltage inputs in volts, and each PT ratio.

*Figure 7.6* shows the relay response to the **MET SEC** command of one phase in a three-relay application.

```
=>>MET SEC <Enter>
Relay 1
Station A
Date: 09/10/2018 Time: 17:05:15.192
Serial Number: 1181840172

Secondary Currents
Terminal MAG(A) ANG(DEG) CTR Terminal MAG(A) ANG(DEG) CTR
FDR_1 3.996 0.00 600 I12 0.000 164.98 600
FDR_2 4.997 0.00 600 I13 0.001 -44.57 600
FDR_3 2.996 180.00 600 I14 0.001 -77.58 600
TRFR_1 5.996 180.00 600 I15 0.001 -2.76 600
TB_1 8.997 180.00 600 I16 0.002 -35.83 600
TB_2 8.993 0.00 600 I17 0.000 -42.29 600
I07 0.002 -71.23 600 I18 0.001 -133.51 600
I08 0.002 -108.60 600 I19 0.002 -177.14 600
I09 0.002 -22.11 600 I20 0.001 165.61 600
I10 0.000 34.53 600 I21 0.002 -21.72 600
I11 0.000 -58.25 600

Secondary Voltages
Terminal MAG(V) ANG(DEG) PTR
V01 63.982 0.00 2000
V02 64.011 -120.06 2000
V03 64.021 120.00 2000
```

&gt;&gt;&gt;

**Figure 7.6 Relay Response to the MET SEC Command of One Phase of a Three-Relay Application**

For check-zone-specific secondary information, use the **MET SEC CZ $q$**  ( $q = 1-3$ ) command. The information includes the CT polarity, as shown in *Table 7.7*.

**Table 7.7 Information Available With the MET SEC CZ $q$  Command**

Command <sup>a</sup>	Information
<b>MET SEC CZ<math>q</math></b>	Secondary current magnitudes, angles, CT ratios, and polarities from the active terminals in Check Zone $q$ in amperes. Secondary voltage magnitudes and angles from the three voltage inputs in volts, and each PT ratio.

<sup>a</sup>  $q = 1-3$ .

*Figure 7.7* shows the relay response to the **MET SEC CZ1** command of one phase in a three-relay application with these terminals connected to Check Zone 1.

```
=>>MET SEC CZ1 <Enter>
Relay 1
Station A
Date: 09/10/2018 Time: 23:51:51.027
Serial Number: 1181840172

Current Terminals in Check Zone 1

Secondary Currents
Terminal MAG(A) ANG(DEG) CTR POL
FDR_1 3.996 0.00 600 P
FDR_2 4.997 0.00 600 P

Secondary Voltages
Terminal MAG(V) ANG(DEG) PTR
V01 66.996 0.00 1000
V02 66.996 -120.00 2000
```

&gt;&gt;&gt;

**Figure 7.7 Response to the MET SEC CZ1 Command of One Phase in a Three-Relay Application**

For zone-specific secondary information, use the **MET SEC Z $n$**  ( $n = 1-6$ ) command. The information includes the CT polarity, as shown in *Table 7.8*.

**Table 7.8 Information Available With the MET SEC Zn Command**

Command <sup>a</sup>	Information
<b>MET SEC Zn</b>	Secondary current magnitudes, angles, CT ratios, and polarities from the active terminals in the specific zone in amperes. Secondary voltage magnitudes and angles from the three voltage inputs in volts, and each PT ratio. Bus-Zones in Protection Zone n.

<sup>a</sup> n = 1-6.

Figure 7.8 shows the relay response to the **MET SEC Zn** command of one phase in a three-relay application with these terminals connected to Bus-Zone 1.

```
=>>MET SEC Z1 <Enter>
Relay 1                               Date: 09/10/2018 Time: 15:00:43.237
Station A                             Serial Number: 1181840172
Current Terminals in Protection Zone 1
    Secondary Currents
Terminal MAG(A) ANG(DEG) CTR POL
FDR_1   3.996   0.00   600 P
FDR_2   4.997   0.00   600 P
TB_1    8.997  180.00   600 P
    Secondary Voltages
Terminal MAG(V) ANG(DEG) PTR
V01    66.996   0.00  1000
V02    66.996 -120.00  2000
V03    66.996  120.00  2000
Bus-Zones in Protection Zone 1
BUS_1
=>>
```

**Figure 7.8 Relay Response to the MET SEC Z1 Command of One Phase in a Three-Relay Application**

## Differential Metering

**NOTE:** A zone is active when any IqqBZpV (qq = 01-21, p = 1-6) Relay Word bit asserts. For example, Zone 1 becomes active when Relay Word bit I0IBZ1V asserts. The check zone is active when any IqqCZ1V (qq = 01-21) Relay Word bit asserts and ECHKZN := Y.

View the differential currents of all active zones with the **MET DIF** command. The information includes per unit operating and restraint currents from each active zone, as well as the reference current, as shown in *Table 7.9*. The reference current is the product of the SEL-487B nominal current and the maximum CT ratio in an active zone as defined in the zone configuration settings.

**Table 7.9 Information Available With the MET DIF Command**

Command	Information
<b>MET DIF</b>	Operate current of all active zones and check zones in per unit. Restraint current of all active zones and check zones in per unit. Product of relay nominal current and highest CT ratio of the connected CTs, used as reference current.

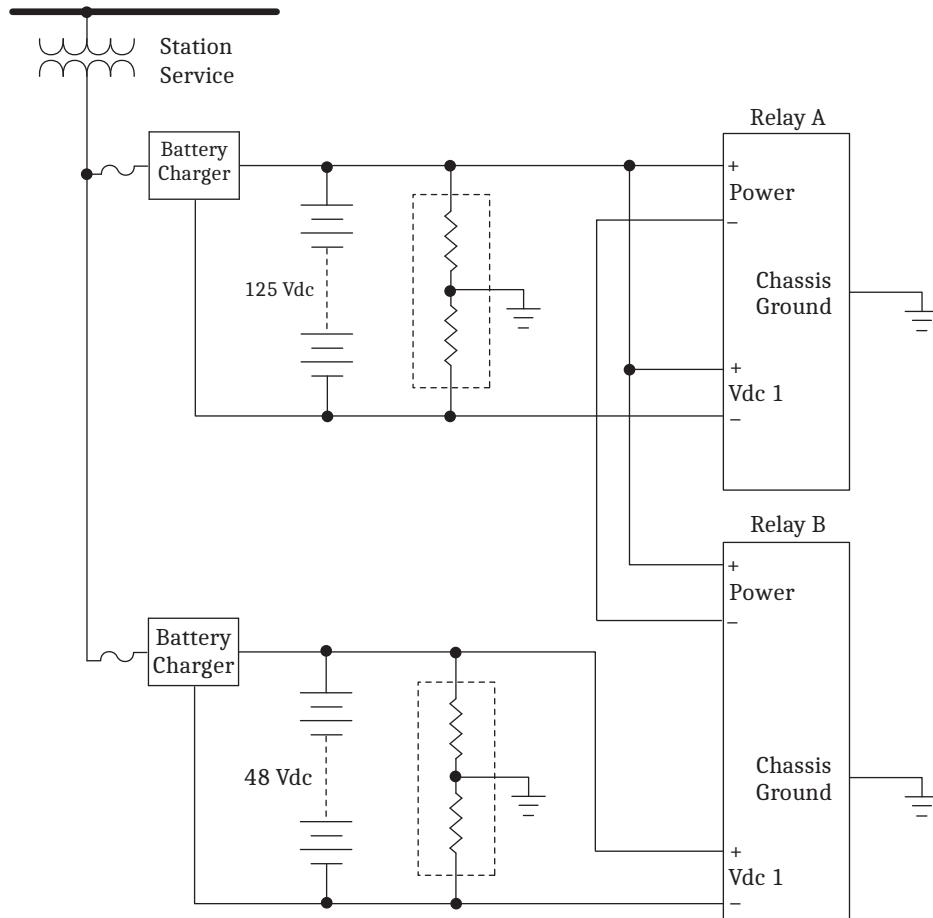
Figure 7.9 shows the relay response to the **MET DIF** command of one phase in a three-relay application when Bus-Zones 1 and 2 are active.

```
=>>MET DIF <Enter>
Relay 1
Station A
Operate Currents          Restraint Currents
(Per Unit)                 (Per Unit)
ZONE   IOP      IRT
1     0.00    0.25
2     0.01    0.44
Current Reference (A)
IREF
800
=>>
```

**Figure 7.9 Relay Response to the MET DIF Command of One Phase in a Three-Relay Application**

## Station DC Battery System Monitor

The SEL-487B automatically monitors station battery system health by measuring the dc voltage, ac ripple, and voltage between each battery terminal and ground. Each relay provides one dc monitor channel, Vdc1. See *Section 8: Monitoring in the SEL-400 Series Relays Instruction Manual* for a complete description of the battery monitor.



**Figure 7.10 Typical Station DC Battery System**

The dc battery monitor measures the station battery voltage applied at the rear-panel terminals labeled **Vdc1** (+ and -). In a three-relay application, connect the 125 Vdc supply to the monitoring connections of the first relay, and the 48 Vdc supply to the monitoring connections of the second relay. See *Section 6: Protection Application Examples* for more information about single- and three-relay applications.

## Reporting

---

The SEL-487B relay features comprehensive power system data analysis capabilities. These are described in *Section 9: Reporting in the SEL-400 Series Relays Instruction Manual*. This section describes reporting characteristics that are unique to the SEL-487B.

## Data Processing

The SEL-487B processes protection logic at a different rate than other SEL-400 Series Relays. *Table 7.10* summarizes the available analog quantities from protection elements and the processing rate of each. Notice that the relay processes the protection elements at two different rates:

- Current Differential Elements, Check Zone Elements, Breaker Failure Protection, Under- and Overvoltage Elements = every 1/12 cycle
- Overcurrent Elements (50/51) protection elements = every 1/6 cycle

**Table 7.10 Protection Element Analog Quantities and Processing Rates**

Analog Quantity	Description	Sample Rate (Power System Cycle)
$InnFIM$ , $InnFIA$ ( $nn = 1\text{--}21$ )	Filtered Instantaneous Phase Current Magnitude, Angle	1/12
$VmmFM$ , $VmmFA$ ( $mm = 01\text{--}03$ )	Filtered Instantaneous Phase Voltage Magnitude, Angle	1/12
DC1	DC Monitor Voltage	1/12
$PMVnn$ ( $nn = 01\text{--}64$ )	Protection Math Variable	1/12
$51Pmm$ ( $mm = 1\text{--}21$ )	51 Element Pickup Setting	1/6
$51TDmm$ ( $mm = 1\text{--}21$ )	51 Element Time Dial Setting	1/6

*Table 7.11* summarizes the available digital inputs and the processing rate of each.

**Table 7.11 Processing Rates of Digital Inputs**

Digital	Sample Rate (Power System Cycle)
100 rows of event reporting digital elements	1/12
Un-debounced digital contact inputs	2 kHz

## Duration of Data Captures and Event Reports

The SEL-487B stores high-resolution raw and filtered data. The number of stored high-resolution raw data captures and event reports is a function of the quantity of data contained in each capture.

*Table 7.12* lists the maximum number of data captures/event reports the relay stores in nonvolatile memory when ERDIG = S for various report lengths and sample rates. The relay automatically overwrites the oldest events with the newest events when the nonvolatile storage capacity is exceeded.

---

**NOTE:** Consider the total capture time when choosing a value for setting LER at the SRATE := 8 kHz. At LER := 3.0, the relay records at least 11 data captures when ERDIG = S. These and smaller LER settings are sufficient for most power system disturbances.

The relay stores high-resolution raw and filtered event data in nonvolatile memory. *Table 7.12* lists the storage capability of the SEL-487B for common event reports.

The lower rows of *Table 7.12* show the number of event reports the relay stores with the maximum data capture lengths (LER) for each SRATE sampling rate setting. Table entries are the maximum number of stored events; these can vary by 10 percent according to relay memory usage.

**Table 7.12 Event Report Nonvolatile Storage Capability When ERDIG = S**

<b>Event Report Length</b>	<b>Maximum Number of Stored Reports</b>			
	<b>8 kHz</b>	<b>4 kHz</b>	<b>2 kHz</b>	<b>1 kHz</b>
0.25 seconds	103	128	147	168
0.50 seconds	71	70	85	114
1.0 seconds	37	40	45	55
3.0 seconds	11	14	15	20
6.0 seconds	N/A	6	8	10
12.0 seconds	N/A	N/A	4	5
24.0 seconds	N/A	N/A	N/A	2

When the event report digital setting is set to include all Relay Word bits in the event report (ERDIG = A), the maximum number of stored reports is reduced as shown in *Table 7.13*.

**Table 7.13 Event Report Nonvolatile Storage Capability When ERDIG = A**

<b>Event Report Length</b>	<b>Maximum Number of Stored Reports</b>			
	<b>8 kHz</b>	<b>4 kHz</b>	<b>2 kHz</b>	<b>1 kHz</b>
0.25 seconds	78	92	102	113
0.50 seconds	43	52	58	65
1.0 seconds	N/A	27	31	35
3.0 seconds	N/A	N/A	10	12
6.0 seconds	N/A	N/A	N/A	5
12.0 seconds	N/A	N/A	N/A	N/A
24.0 seconds	N/A	N/A	N/A	N/A

## Event Reports, Event Summaries, and Event Histories

See *Section 9: Reporting in the SEL-400 Series Relays Instruction Manual* for an overview of event reports, event summaries, and event histories. This section describes the characteristics of these that are unique to the SEL-487B.

## Base Set of Relay Word Bits

The following Relay Word bits are always included in COMTRADE event reports: ZONE1–ZONE6, CZONE1–CZONE3, 87BTR, 87BTR01–87BTR21, SBFTR, SBFTR01–SBFTR21, TRIP, TRIP01–TRIP21, 87Z1–87Z6, BFZ1–BFZ6, ER, RMBnA, TMBnA, RMBnB, TMBnB, ROKA, RBADA, CBADA, LBOKA, ROKB, RBADB, CBADB, LBOKB, TLED\_1, TLED\_2, TLED\_3, TLED\_4, TLED\_5, TLED\_6, TLED\_7, TLED\_8, TLED\_9, TLED\_10, TLED\_11, TLED\_12, TLED\_13, TLED\_14, TLED\_15, TLED\_16, TLED\_17, TLED\_18, TLED\_19, TLED\_20, TLED\_21, TLED\_22, TLED\_23, TLED\_24, Z1BZ1, Z1BZ2, Z1BZ3, Z1BZ4, Z1BZ5, Z1BZ6, Z2BZ2, Z2BZ3, Z2BZ4, Z2BZ5, Z2BZ6, Z3BZ3, Z3BZ4, Z3BZ5, Z3BZ6, Z4BZ4, Z4BZ5, Z4BZ6, Z5BZ5, Z5BZ6, Z6BZ6.

## COMTRADE Relay Word Bit Behavior

The ERDG setting specifies Relay Word bits to include in event reporting. In COMTRADE files, the relay captures and records the status of all Relay Word bits in the same row of a Relay Word bit specified in the ERDG setting list. Therefore, additional Relay Word bit statuses are captured in a COMTRADE file that are not specified in the ERDG setting list. See *Section 11: Relay Word Bits* for Relay Word bits and their common row with other bits.

## Event Reports

### Report Header and Analog Section of the Event Report

The first portion of an event report is the report header and the analog section. See *Figure 7.11* for the location of items included in a sample analog section of an event report. If you want to view only the analog portion of an event report, use the **EVE A** command.

The report header is the standard SEL-487B header, listing the relay identifiers, event number, date, and time. Report headers help you organize report data. Each event report begins with information about the relay and the event, such as the RID setting (Relay ID), the SID setting (Station ID), and the firmware checksum (CID). The FID string identifies the relay model, Flash firmware version, and the date code of the firmware. See *Appendix A: Firmware, ICD File, and Manual Versions* for a description of the FID string. To complete the header, the relay reports a date and time stamp to indicate the internal clock time when the relay triggered the event.

The event report column labels follow the header. The data underneath the analog column labels contain samples of power system voltages and currents in primary kilovolts and primary amperes, respectively. These quantities are instantaneous values scaled by  $\sqrt{2} / 2$  (0.707). Although you may not use all 24 channels of the SEL-487B in your application, all 24 channels' samples are always displayed in the event report. To display all 24 channels, the event report consists of three groups. Current channels I01–I11 are displayed in the first group as shown in *Figure 7.11*. The second group contains I12–I21, and the third group contains voltage channels V01–V03.

*Figure 7.11* contains selected data from the analog section of a 4-samples/cycle event report. The bracketed numbers at the left of the report (for example, [5]) indicate the cycle number; *Figure 7.11* presents eight cycles of 4-samples/cycle data. The trigger row includes a > character to indicate the trigger point. This is the dividing point between the prefault or PRE time and the fault or remainder of the data capture.

The row that the relay uses for the fault analogs in the event summary is the row 1.25 cycles after the event trigger. The relay marks this row on the event report with an asterisk (\*) character immediately after the last analog column.

=>EVE <Enter>																		
Relay 1 Station A						Date: 09/10/2018 Time: 16:27:50.514 Serial Number: 1181840172						Header						
FID=SEL-487B-2-R400-V0-Z100100-D20180910						Event Number = 10006				CID=0xA0B5		Firmware ID						
<b>Currents (Pri. Amps)</b>																		
I01 I02 I03 I04 I05 I06 I07 I08 I09 I10 I11																		
[1]																		
-596	-595	596	595	1194	-1191	-1	-2	-1	0	0	0	One Cycle of Data						
-79	-82	80	79	159	-157	-1	0	2	0	0	0							
596	595	-595	-594	-1193	1190	1	0	0	0	0	0							
80	82	-80	-80	-160	158	1	-1	-2	0	0	0							
[2]																		
-595	-595	594	594	1194	-1190	-1	0	0	0	0	0	One Cycle of Data						
-80	-82	80	80	159	-159	-1	1	2	0	0	0							
595	595	-594	-594	-1193	1190	1	1	0	0	0	1							
81	84	-80	-81	-160	160	2	0	-2	0	0	0							
[3]																		
-596	-596	595	594	1192	-1190	-1	-1	0	0	0	0	One Cycle of Data						
-81	-82	80	81	161	-160	-1	0	2	0	0	0							
595	595	-595	-594	-1193	1190	2	1	0	0	0	-1							
81	83	-81	-81	-162	160	0	-1	-2	0	0	0							
[4]																		
-596	-594	595	594	1193	-1190	-2	-1	1	0	0	1	One Cycle of Data						
-82	-84	81	81	163	-161	0	1	2	0	0	0							
596	595	-594	-594	-1193	1190	1	0	0	0	0	0							
82	84	-81	-82	-163	161	1	0	-2	0	0	0							
[5]																		
-596	-595	595	595	1192	-1189	-1	0	0	0	0	0	One Cycle of Data						
-82	-85	81	82	164	-163	-1	0	2	0	0	0							
595	595	-594	-594	-1193	1190	1	0	0	0	0	0							
82	85	-81	-82	-165	163	1	0	-2	-1	1	1							
[6]																		
-595	-594	595	594	1193	-1190	-1	0	1	0	0	0	One Cycle of Data						
-83	-86	82	82	166	-162	0	1	3	-1	-1	-1							
1955	595	-595	-594	-1193	1189	1	1	-1	1	0	0							
479	86	-83	-82	-166	164	0	-1	-2	1	0	0							
[7]																		
-4938	-595	594	593	1193	-1189	-1	-1	1	-2	0>	Trigger	One Cycle of Data						
-891	-86	83	83	166	-166	0	0	2	1	0	0							
6552	594	-595	-594	-1192	1190	1	1	0	0	0	0							
910	86	-83	-83	-167	165	0	0	-2	0	1	1							
[8]																		
-6550	-595	594	594	1192	-1190	-1	0	0	0	0	-1	One Cycle of Data						
-910	-86	84	84	168	-165	-1	0	2	-1	0*	0*							
6551	595	-593	-593	-1191	1189	1	0	0	1	1	1							
910	86	-84	-84	-169	166	1	1	-1	0	0	0							
.	.	.	.	.	.	.	.	.	.	.	.							
=>>																		

**Figure 7.11 Analog Section of the Event Report**

**Table 7.14 Event Report Metered Analog Quantities**

Analog Quantity	Description
I01-I21	Filtered current vector
V01-V03	Filtered voltage vector

For the event report (different from the raw data oscillography), you can select as many as 20 additional analog quantities from the available analog quantities in the relay (see *Section 12: Analog Quantities*). These user-defined analog quantities follow the 24 fixed channels.

## Differential Report

The differential report is not a part of the **EVE** command (without any parameters) response. Use the **EVE DIF** command to specify that the differential report is to be displayed. If so specified, the fixed and user-configurable analog quantities will no longer be displayed, although the event summary and relay settings will be appended following the differential quantities. The analog part of the differential report only displays differential current for each active differential zone and active check zone, as shown in *Figure 7.12*.

---

```
=>>EVE DIF <Enter>
Relay 1                               Date: 09/10/2018 Time: 16:27:50.514
Station A                               Serial Number: 1181840172
FID=SEL-487B-2-R400-V0-Z100100-D20180910 Event Number = 10006      CID=0xA0B5

Differential Quantities (Per Unit)
IOP1  IRT1  IOP2  IRT2

[1]
0.00  0.80  0.00  0.80
0.00  0.80  0.00  0.80
0.00  0.80  0.00  0.80
0.00  0.80  0.00  0.80
.
.

[7]
1.45  2.26  0.00  0.80>
1.47  2.27  0.00  0.80
2.00  2.81  0.00  0.80
2.00  2.81  0.00  0.80
[8]
2.00  2.81  0.00  0.80
2.00  2.81  0.00  0.80*
2.00  2.81  0.00  0.80
2.00  2.81  0.00  0.80

Differential Quantities (Per Unit)
IOPCZ1 IRTCZ1

[1]
0.00  0.80
0.00  0.80
0.00  0.80
0.00  0.80
.
.

[7]
1.45  2.25 >
1.47  2.27
2.00  2.80
2.01  2.81
[8]
2.01  2.80
2.01  2.80 *
2.01  2.80
2.01  2.80
[9]
2.01  2.80
2.01  2.80
2.01  2.80
2.01  2.80
```

---

**Figure 7.12 Differential Report**

## Digital Section of the Event Report

The second portion of an event report is the digital section. Inspect the digital data to evaluate relay element response during an event. See *Figure 7.13* for the locations of items in a sample event report digital section. If you want to view only the digital portion of an event report, use the **EVE D** command (see *Section 14: ASCII Command Reference in the SEL-400 Series Relays Instruction*

*Manual* for details). In the digital portion of the event report, the relay indicates deasserted elements with a period (.) and asserted elements with an asterisk (\*) character.

The element and digital information labels are single character columns. Read these columns from top to bottom. The trigger row includes a > character following immediately after the last digital element column to indicate the trigger point. The relay marks the row used in event summary (1.25 cycles after the trigger point) with an asterisk (\*) character at the right of the last digital element column.

---

ZZ	D	FFFFTT	N	
12	TT	I T FFFF TT 1231B0	O	
	FFFTBB	FBN 1231B	_____U	A
TT	123112	FFS	_____	TTTTTT TL
RR	_____	_____	BBBBBB	RRRRR1 EA
II	BBBBBB	EES	FFFFF	IIIIIO SR
PP	FFFFF	NNW	IIIII	PPPPP6 TM
<hr/>				
[1]	.....	.....	.....	.
	..	..	..	*
	..	..	..	*
	..	..	..	*
[2]	.....	.....	.....	.
	..	..	..	*
	..	..	..	*
	..	..	..	*
[3]	.....	.....	.....	.
	..	..	..	*
	..	..	..	*
	..	..	..	*
[4]	.....	.....	.....	.
	..	..	..	*
	..	..	..	*
	..	..	..	*
[5]	.....	.....	.....	.
	..	..	..	*
	..	..	..	*
	..	..	..	*
[6]	.....	.....	.....	.
	..	..	..	*
	..	..	..	*
	..	..	..	*
[7]	*.	.....	**..*	.*>
	*.	.....	**..*	.
	*.	.....	**..*	.
	*.	.....	**..*	.
[8]	*.	.....	**..*	.
	*.	.....	**..*	.
	*.	.....	**..*	.
	*.	.....	**..*	.

---

Figure 7.13 Digital Section of the Event Report

## Event Summary Section of the Event Report

The third portion of an event report is the summary section. See *Figure 7.14* for the location of items included in a sample summary section of an event report. If you want to exclude the summary portion from an event report, use the **EVE NSUM** command. See *EVENT on page 14.32 in the SEL-400 Series Relays Instruction Manual* for details.

The information in the summary portion of the event report is the same information in the event summary, except that the report header does not appear immediately before the event information when you view a summary in the event report. See *Event Summary on page 7.14* for a description of the items in the summary portion of the event report.

```
=>>SUM <Enter>

Relay 1 Date: 09/10/2018 Time: 12:33:51.078
Serial Number: 1181840172
Event: 87BTR Time Source: OTHER
Event Number: 10057 Group: 1
Targets: TLED_1 TLED_6 TLED_7 TLED_8

Fault: I01 I02 I03 I04 I05 I06 I07 I08 I09 I10 I11
MAG(A) 14964 14966 14968 14969 14957 14966 22146 22138 22135 14960 14959
ANG(DEG) 178 59 -61 179 59 -61 0 -120 120 -179 61

I12 I13 I14 I15 I16 I17 I18 I19 I20 I21
MAG(A) 14973 14967 14964 14968 22140 22134 22136 1167.8 1167.8 1167.8
ANG(DEG) -59 -178 62 -58 2 -117 123 0 -120 121

V01 V02 V03
MAG(kV) 67.8 67.8 67.8
ANG(DEG) 0 -120 121

Tripped Terminals
I07 I08 I09 I10 I11 I12 I16 I17 I18

Bus-Zones in Protection Zone 4
BZ4
.
.

Bus-Zones in Protection Zone 6
BZ6

=>>
```

**Figure 7.14 Summary Section of the Event Report**

## Event Summary

You can retrieve a summary version of stored event reports as event summaries. These short-form reports present vital information about a triggered event. The relay generates an event in response to power system faults and other trigger events. See *Figure 7.15* for a sample event summary.

Relay SEL 487B-2 Station A												Date: 09/10/2018 Time: 19:49:20.975 Serial Number: 1181840172	Report Header
Event: ER												Time Source: HIRIG	
Event Number: 10004												Group: 1	Event Information
Targets:TLED_1 TLED_2 TLED_3													
Fault: I01 I02 I03 I04 I05 I06 I07 I08 I09 I10 I11													
MAG(A) 15783 12343 15669 15789 12344 15671 15794 12348 15672 11615 512													
ANG(DEG) -32 -140 102 -32 -140 102 -32 -140 102 -45 -161													
I12 I13 I14 I15 I16 I17 I18 I19 I20 I21													
MAG(A) 1845 11616 512 1846 11616 512 1846 11625 512 1846													
ANG(DEG) 90 -45 -161 90 -45 -161 90 -45 -161 90													
V01 V02 V03													
MAG(kV) 26.9 38.6 32.5													
ANG(DEG) 0 -104 124													

**Figure 7.15 Sample Event Summary Report**

The event summary contains the following information:

- Standard report header
- Relay and terminal identification
- Event date and time
- Event type
- Time source
- Event number
- Active settings group at trigger time
- Targets
- Fault currents and voltages
- Tripped terminals
- Bus-Zone in protection zone

Targets are displayed only if a rising edge of Relay Word bits 87BTR, SBFTR, or TRIP asserted before the end of the event report. When a trip occurs, the relay displays the aliases of the latched targeting bits asserted on the last row of the event. Current and voltage analog quantities in the summary are the values 1.25 cycles after the event trigger.

*Table 7.15* defines the various event types in fault reporting priority. Fault event type 87BTR (busbar protection trip) has reporting priority over event type SBFTR (breaker failure). If more than one event type asserts, the relay reports only the highest priority event type. For example, you can trigger an event when there is no fault condition on the power system by using the **TRI** command. In this case, when there is no fault, the relay reports the event type as TRIG.

**Table 7.15 Event Types**

Event Type	Event Trigger
87BTR	Rising edge of Relay Word Bit 87BTR, the OR combination of a busbar - protection trip output to any Terminal.
SBFTR	Rising edge of Relay Word Bit SBFTR, the OR combination of a breaker failure trip output to any Terminal.
TRIP	Rising edge of Relay Word Bit TRIP.
ER	The relay generates the event with elements in the SELOGIC control equation ER.
TRIG	The relay generates the event in response to the <b>TRI</b> command.

## Event History

The event history gives you a quick look at recent relay activity. The relay labels each new event with a unique number from 10000 to 42767. (At 42767, the top of the numbering range, the relay returns to 10000 for the next event number and then continues to increment.) See *Figure 7.16* for a sample event history.

The event history contains the following:

- Standard report header
- Relay and terminal identification
- Event date and time
- Event type
- Time source
- Event number

- Active settings group at trigger time
- Targets
- Fault currents and voltages
- Tripped terminals
- Bus-Zones in protection zones

Figure 7.16 is a sample event history from a computer terminal.

---

=>HIS<Enter>						
Relay 1 Station A				Date: 09/10/2018 Time: 14:44:27.063	Serial Number: 1181840172	
#	DATE	TIME	EVENT	GRP	TARGETS	
10006	06/06/2018	16:27:50.514	87BTR	1	87_DIFF	ZONE_1
10005	06/06/2018	15:52:39.732	ER	1		
10004	06/06/2018	15:52:34.742	87BTR	1	87_DIFF	ZONE_1 ZONE_2
10003	05/25/2018	20:37:20.899	87BTR	1	87_DIFF	ZONE_1 ZONE_2
10002	05/19/2018	10:53:59.742	87BTR	1	87_DIFF	ZONE_1 ZONE_2
10001	05/18/2018	21:15:45.369	87BTR	1	87_DIFF	ZONE_1 ZONE_2
10000	05/18/2018	20:46:13.497	87BTR	1	87_DIFF	ZONE_1 ZONE_2
Event Number			Event Type		Active Group	

---

**Figure 7.16 Sample Event History**

The event types in the event history are the same as the event types in the event summary. See *Table 7.15* for event types.

---

---

## S E C T I O N   8

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# Settings

*Section 12: Settings in the SEL-400 Series Relays Instruction Manual* describes common platform settings. This section contains tables of relay settings for the SEL-487B-2 Relay.

The relay hides some settings based upon other settings. If you set an enable setting to OFF, for example, the relay hides all settings associated with that enable setting. This section does not explain rules for hiding settings; these rules are discussed in the applications sections of the instruction manual where appropriate.

The settings prompts in this section are similar to the ASCII terminal and SEL Grid Configurator Software prompts. The prompts in this section are unabridged and show all possible setting options.

For information on using settings in protection and automation, see the examples in *Section 6: Protection Application Examples*. The section contains information on the following settings classes.

- *Alias Settings on page 8.1*
- *Automation Freeform SELOGIC Control Equations on page 8.20*
- *DNP3 Settings—Custom Maps on page 8.26*
- *Front-Panel Settings on page 8.21*
- *Global Settings on page 8.3*
- *Group Settings on page 8.12*
- *Notes Settings on page 8.20*
- *Output Settings on page 8.21*
- *Port Settings on page 8.25*
- *Protection Freeform SELOGIC Control Equations on page 8.20*
- *Report Settings on page 8.24*
- *Zone Configuration Settings on page 8.7*

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## Alias Settings

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See *Alias Settings on page 12.25 in the SEL-400 Series Relays Instruction Manual* for a complete description of alias settings. The SEL-487B supports aliases for terminal names and bus-zone names, in addition to Relay Word bits and analog quantities. *Table 8.1* lists the default alias settings for the SEL-487B.

**Table 8.1 Default Alias Settings (Sheet 1 of 3)**

Label	Default
I01	FDR_1
I02	FDR_2
I03	FDR_3

**Table 8.1 Default Alias Settings (Sheet 2 of 3)**

<b>Label</b>	<b>Default</b>
I04	TRFR_1
I05	TB_1
I06	TB_2
BZ1	BUS_1
BZ2	BUS_2
FBF01	F1_BF
FBF02	F2_BF
FBF03	F3_BF
FBF04	T1_BF
FBF05	TB1_BF
FBF06	TB2_BF
87Z1	Z1_TRIP
87Z2	Z2_TRIP
IN201	F1_BFI
IN202	F2_BFI
IN203	F3_BFI
IN204	T1_BFI
IN205	TB_BFI
PLT01	DIFF_EN
PLT02	BF_EN
PLT03	TNS_SW
87ST1	CTZ1_AN
87ST2	CTZ2_AN
SBFTR01	F1_BFT
SBFTR02	F2_BFT
SBFTR03	F3_BFT
SBFTR04	T1_BFT
SBFTR05	TB1_BFT
SBFTR06	TB2_BFT
87BTR01	F1_DPT
87BTR02	F2_DPT
87BTR03	F3_DPT
87BTR04	T1_DPT
87BTR05	TB1_DPT
87BTR06	TB2_DPT
OUT201	F1_TRP
OUT202	F2_TRP
OUT203	F3_TRP
OUT204	T1_TRP
OUT205	TB_TRP
OUT207	TEST

**Table 8.1 Default Alias Settings (Sheet 3 of 3)**

<b>Label</b>	<b>Default</b>
OUT208	NOALARM
TLED_1	87_DIFF
TLED_2	BK_FAIL
TLED_3	ZONE_1
TLED_4	ZONE_2
TLED_5	ZONE_3
TLED_6	ZONE_4
TLED_7	ZONE_5
TLED_8	ZONE_6
TLED_9	50_TRIP
TLED_10	51_TRIP
TLED_11	CT_ALRM
TLED_12	87_BLK
TLED_13	TOS
TLED_14	89_OIP
TLED_15	89_ALRM
TLED_16	PT_ALRM
TLED_17	27_LED
TLED_18	59_LED
TLED_19	V01_ON
TLED_20	V02_ON
TLED_21	V03_ON
TLED_22	FLT_LED
TLED_23	52_ALRM
TLED_24	IRIGLED

## Global Settings

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**Table 8.2 Global Settings Categories (Sheet 1 of 2)**

<b>Settings</b>	<b>Reference</b>
General Global Settings	<i>Table 8.3</i>
Global Enables	<i>Table 8.4</i>
Station DC Monitor	<i>Table 8.5</i>
Control Inputs (Global)	<i>Table 8.6</i>
Interface Board #1 Control Inputs	<i>Table 8.7</i>
Interface Board #n Control Inputs	<i>Table 8.8</i>
Settings Group Selection	<i>Table 8.9</i>
Time and Date Management	<i>Table 8.10</i>
Data Reset Control	<i>Table 8.11</i>
Breaker Inputs	<i>Table 8.12</i>

**Table 8.2 Global Settings Categories (Sheet 2 of 2)**

Settings	Reference
Disconnects Inputs and Timers	Table 8.13
Access Control	Table 8.14
DNP	Table 8.15
SV and TiDL Application Settings	Table 8.16

**Table 8.3 General Global Settings**

Setting	Prompt	Default
SID	Station Identifier (40 characters)	Station A
RID	Relay Identifier (40 characters)	Relay 1
CONAM	Company Name (5 characters)	abcde
NUMBK	Number of Breakers (N, 1–21)	5
NUMDS	Number of Disconnects (N, 1–60)	N
NFREQ	Nominal System Frequency (50, 60 Hz)	60

**Table 8.4 Global Enables**

Setting	Prompt	Default
EDCMON	Station DC Battery Monitor (Y, N)	N
EICIS	Independent Control Input Settings (Y, N)	N
EDRSTC	Data Reset Control (Y, N)	N
EGADVS	Advanced Global Settings (Y, N)	N

**Table 8.5 Station DC Monitor**

Setting	Prompt	Default
DC1LFP	Low Level Fail Pickup (OFF, 15–300 Vdc)	100
DC1LWP	Low Level Warn Pickup (OFF, 15–300 Vdc)	127
DC1HWP	High Level Warn Pickup (OFF, 15–300 Vdc)	137
DC1HFP	High Level Fail Pickup (OFF, 15–300 Vdc)	142
DC1RP	Peak-to-Peak AC Ripple Pickup (1–300 Vac)	9
DC1GF	Ground Detection Factor (1.00–2.00)	1.05

**Table 8.6 Control Inputs (Global)**

Setting	Prompt	Default	Increment
GINPU <sup>a</sup>	Input Pickup Delay (0.0–30 ms)	2.0	0.5
GINDO <sup>a</sup>	Input Dropout Delay (0.0–30 ms)	2.0	0.5
GINP <sup>a</sup>	Input Pickup Level (16 - 250 VDC)	85 <sup>b</sup>	1
GINDF <sup>a</sup>	Input Dropout Level (10-100% of pickup level)	80 <sup>c</sup>	1

<sup>a</sup> Hidden if EICIS = Y.

<sup>b</sup> Change default to: 16 if I/O Board Position B has 24 V inputs, 34 if I/O Board Position B has 48 V inputs, 78 if I/O Board Position B has 110 V inputs, 89 if I/O Board Position B has 125 V inputs, 156 if I/O Board Position B has 220 V inputs, 178 if I/O Board Position B has 250 V inputs.

<sup>c</sup> Setting value must satisfy GINDF • (GINP/100) > 15.

**Table 8.7 Interface Board #1 Control Inputs**

<b>Setting</b>	<b>Prompt</b>	<b>Default</b>	<b>Increment</b>
IN201PU	Input IN201 Pickup Delay (0.0–30 ms)	2.0 <sup>a</sup>	0.5
IN201DO	Input IN201 Dropout Delay (0.0–30 ms)	2.0 <sup>a</sup>	0.5
•	•	•	•
•	•	•	•
•	•	•	•
IN224PU	Input IN224 Pickup Delay (0.0–30 ms)	2.0 <sup>a</sup>	0.5
IN224DO	Input IN224 Dropout Delay (0.0–30 ms)	2.0 <sup>a</sup>	0.5

<sup>a</sup> If EICIS = N, these settings are the same as GINPU and GINDO.

**NOTE:** The 300, 400, and 500 level inputs are virtual inputs that are only available to the TiDL relay and are mapped from connected SEL-TMU according to your configured TiDL topology.

**Table 8.8 Interface Board #n<sup>a</sup> Control Inputs**

<b>Setting</b>	<b>Prompt</b>	<b>Default</b>	<b>Increment</b>
INammP <sup>b, c, d</sup>	Input INamm Pickup Level (16–250 Vdc)	85 <sup>e</sup>	
INammPU <sup>b, c, d</sup>	Input INamm Pickup Delay (0.0 - 30 ms)	2.0	0.5
INammDO <sup>b, c, d</sup>	Input INamm Dropout Delay (0.0 - 30 ms)	2.0	0.5

<sup>a</sup> n = 2, 3, or 4 (Interface Board #2 relates to 300 level mapped inputs, Interface Board #3 relates to 400 level mapped inputs, and Interface Board #4 relates to 500 level mapped inputs).

<sup>b</sup> a = 3, 4, or 5 to indicate 300, 400, or 500 level mapped inputs.

<sup>c</sup> mm = 01-24, indicates mapped input within the a input level.

<sup>d</sup> Hidden and forced to default if EICIS = N.

<sup>e</sup> Change default to: 16 if I/O Board Position B has 24 V inputs, 34 if I/O Board Position B has 48 V inputs, 78 if I/O Board Position B has 110 V inputs, 89 if I/O Board Position B has 125 V inputs, 156 if I/O Board Position C has 220 V inputs, 178 if I/O Board Position D has 250 V inputs.

**Table 8.9 Settings Group Selection**

<b>Setting</b>	<b>Prompt</b>	<b>Default</b>
SS1	Select Setting Group 1 (SELOGIC Equation)	NA
SS2	Select Setting Group 2 (SELOGIC Equation)	NA
SS3	Select Setting Group 3 (SELOGIC Equation)	NA
SS4	Select Setting Group 4 (SELOGIC Equation)	NA
SS5	Select Setting Group 5 (SELOGIC Equation)	NA
SS6	Select Setting Group 6 (SELOGIC Equation)	NA
TGR	Group Change Delay (1–54000 cycles)	180

**Table 8.10 Time and Date Management (Sheet 1 of 2)**

<b>Setting</b>	<b>Prompt</b>	<b>Default</b>
DATE_F	Date Format (MDY, YMD, DMY)	MDY
IRIGC	IRIG-B Control Bits Definition (NONE, C37.118)	NONE
UTCOFF <sup>a</sup>	Offset From UTC to Local Time (-15.5 to 15.5)	-8

**Table 8.10 Time and Date Management (Sheet 2 of 2)**

Setting	Prompt	Default
BEG_DST <sup>b</sup>	Begin DST ( <i>hh, n, d, mm</i> , or OFF)	"2, 2, 1, 3"
END_DST	End DST ( <i>hh, n, d</i> , or <i>mm</i> )	"2, 1, 1, 11"

<sup>a</sup> All data, reports, and commands from the relay are displayed in local time, referenced to an internal UTC master clock. Use the UTCOFF setting to specify the time offset from UTC time reference with respect to the relay location. (The only data still displayed in UTC time is streaming IEC 61850 data.)

<sup>b</sup> The BEG\_DST (and END\_DST) daylight-saving time setting consists of four fields or OFF:  
 hh = local time hour (0-23); defines when daylight-saving time begins.  
 n = the week of the month when daylight-saving time begins (1-3, L); occurs in either the 1st, 2nd, 3rd, or last week of the month.  
 d = day of the week (1-7); Sunday is the first day of the week.  
 mm = month (1-12).  
 OFF = hides the daylight-saving time settings.

**Table 8.11 Data Reset Control**

Setting	Prompt	Default
RST_BAT	Reset Battery Monitoring (SELOGIC Equation)	NA
RSTTRGT	Target Reset (SELOGIC Equation)	NA
RSTDNPPE	Reset DNP Fault Summary Data (SELOGIC Equation)	TRGTR
RST_HAL	Reset Warning Alarm Pulsing (SELOGIC Equation)	NA

**Table 8.12 Breaker Inputs**

Setting	Prompt	Default
52A01	N/O Contact Input–BK01 (SELOGIC Equation)	NA
•	•	•
•	•	•
•	•	•
52A21	N/O Contact Input–BK21 (SELOGIC Equation)	NA

**Table 8.13 Disconnect Inputs**

Setting	Prompt	Default	Increment
89A01	N/O Contact Inputs–DS01 (SELOGIC Equation)	NA	
89B01	N/C Contact Inputs–DS01 (SELOGIC Equation)	NA	
89ALP01	DS01 Alarm Pickup Delay (0–99999 cyc)	300	1
•	•	•	
•	•	•	
•	•	•	
89A60	N/O Contact Inputs–DS60 (SELOGIC Equation)	NA	
89B60	N/C Contact Inputs–DS60 (SELOGIC Equation)	NA	
89ALP60	DS60 Alarm Pickup Delay (0–99999 cyc)	300	1

**Table 8.14 Access Control**

Setting	Prompt	Default
EACC	Enable ACC access level (SELOGIC Equation)	1
E2AC	Enable ACC–2AC access levels (SELOGIC Equation)	1

**Table 8.15 DNP**

<b>Setting</b>	<b>Prompt</b>	<b>Default</b>	<b>Increment</b>
EVELOCK	Event Summary Lock Period (0–1000 s)	0	1
DNPSRC	DNP Session Time Base (LOCAL,UTC)	UTC	

**Table 8.16 SV and TiDL Application Settings**

<b>Setting</b>	<b>Prompt</b>	<b>Default</b>
SVBLK	SV Subscriber Relay: Blocking Condition for SV Applications (SELOGIC Equation)  TiDL Relay: Blocking Condition for TiDL Applications (SELOGIC Equation)	I01BK OR I02BK OR I03BK OR I04BK OR I05BK OR I06BK
SVFZDO	SV Subscriber Relay: SV Application Freeze Dropout Time (OFF, 0.000-99999 cyc)  TiDL Relay: TiDL Application Freeze Dropout Time (OFF, 0.000-99999 cyc)	OFF

## Zone Configuration Settings

The following zone configuration settings are the default settings for all six setting groups. You can set each of the six zone configuration setting groups independently.

**Table 8.17 Zone Configuration Settings Categories**

<b>Settings</b>	<b>Reference</b>
Potential Transformer Ratios	<i>Table 8.18</i>
Current Transformer Ratios	<i>Table 8.19</i>
Terminal-to-Bus-Zone Connections	<i>Table 8.20, Table 8.21</i>
Bus-Zone-to-Bus-Zone Connections	<i>Table 8.22, Table 8.23</i>
Zone Supervision	<i>Table 8.24</i>
Zone Switching Supervision	<i>Table 8.25</i>
Zone Open CT Detection	<i>Table 8.26</i>
Check Zone Configuration and Terminal-to-Check-Zone Connections	<i>Table 8.27, Table 8.28</i>
Check Zone Supervision	<i>Table 8.29</i>
Current Normalization Factor	a

<sup>a</sup> This setting is included here because it appears in the read-back information as TAPnn values (nn = 01–21). However, the user cannot set these values; the SEL-487B calculates these internally using the nominal current and CT ratios. See Section 5: Protection Functions for more information.

**Table 8.18 Potential Transformer Ratios**

<b>Setting</b>	<b>Prompt</b>	<b>Default</b>
PTR1	Potential Transformer Ratio–V01 (1–10000)	2000
PTR2	Potential Transformer Ratio–V02 (1–10000)	2000
PTR3	Potential Transformer Ratio–V03 (1–10000)	2000

**Table 8.19 Current Transformer Ratios**

<b>Setting</b>	<b>Prompt</b>	<b>Default</b>
CTR01	Current Transformer Ratio-I01 (1–15000)	600
CTR02	Current Transformer Ratio-I02 (1–15000)	600
•	•	•
•	•	•
•	•	•
CTR21	Current Transformer Ratio-I21 (1–15000)	600

**Table 8.20 Terminal-to-Bus-Zone Connections, Terminal Emulation Program View**

<b>Setting</b>	<b>Prompt</b>	<b>Default</b>
I01BZ1C	Terminal, Bus-Zone, Polarity (P, N)	FDR_1, BUS_1,P
I01BZ1V	FDR_1 to BUS_1 Connection (SELOGIC Equation)	DIFF_EN AND NOT TOS01
I02BZ1C	Terminal, Bus-Zone, Polarity (P, N)	FDR_2, BUS_1,P
I02BZ1V	FDR_2 to BUS_1 Connection (SELOGIC Equation)	DIFF_EN AND NOT TOS02
I03BZ2C	Terminal, Bus-Zone, Polarity (P, N)	FDR_3, BUS_2,P
I03BZ2V	FDR_3 to BUS_2 Connection (SELOGIC Equation)	DIFF_EN AND NOT TOS03
I04BZ2C	Terminal, Bus-Zone, Polarity (P, N)	TRFR_1, BUS_2,P
I04BZ2V	TRFR_1 to BUS_2 Connection (SELOGIC Equation)	DIFF_EN AND NOT TOS04
I05BZ1C	Terminal, Bus-Zone, Polarity (P, N)	TB_1, BUS_1,P
I05BZ1V	TB_1 to BUS_1 Connection (SELOGIC Equation)	DIFF_EN AND NOT TOS05
I06BZ2C	Terminal, Bus-Zone, Polarity (P, N)	TB_2, BUS_2,P
I06BZ2V	TB_2 to BUS_2 Connection (SELOGIC Equation)	DIFF_EN AND NOT TOS05
•	•	•
•	•	•
•	•	•
InnBZpCa <sup>a</sup> , b	Terminal, Bus-Zone, Polarity (P, N)	None
InnBZpV	Inn to BZp Connection (SELOGIC Equation)	NA

<sup>a</sup> nn = 1–21.<sup>b</sup> p = 1–6.**Table 8.21 Terminal-to-Bus-Zone Connections, SEL Grid Configurator View (Sheet 1 of 2)**

<b>Setting</b>	<b>Prompt</b>	<b>Default</b>
CT01BZ1	Connect Terminal 01 to Bus-Zone 1 (Select: Y,N)	Y
TBZT1	Terminal I01	FDR_1 <sup>d</sup>
TBZB1	Bus-Zone BZ1	BUS_1 <sup>d</sup>
TBZP1	Polarity I01-BZ1 (Select: P,N)	P
I01BZ1V	Terminal to Bus Connection Logic (SELOGIC Equation)	DIFF_EN AND NOT TOS01
CT01BZ2	Connect Terminal 01 to Bus-Zone 2 (Select: Y,N)	N
TBZT2	Terminal I01	d
TBZB2	Bus-Zone BZ2	d
TBZP2	Polarity I01-BZ2 (Select: P,N)	P

**Table 8.21 Terminal-to-Bus-Zone Connections, SEL Grid Configurator View (Sheet 2 of 2)**

<b>Setting</b>	<b>Prompt</b>	<b>Default</b>
I01BZ2V	Terminal to Bus Connection Logic (SELOGIC Equation)	NA
•	•	•
•	•	•
•	•	•
CTnnBZp <sup>a,b</sup>	Connect Terminal <i>nn</i> to Bus-Zone <i>p</i> (Select: Y, N)	Y
TBZTb <sup>c</sup>	Terminal <i>Inn</i>	d
TBZBb <sup>c</sup>	Bus-Zone BZ <i>p</i>	d
TBZPb <sup>c</sup>	Polarity <i>Inn</i> -BZ <i>p</i> (Select: P, N)	P
InnBZpV <sup>a,b</sup>	Terminal to Bus Connection Logic (SELOGIC Equation)	NA

<sup>a</sup> nn = 1-21.<sup>b</sup> p = 1-6.<sup>c</sup> b = 1-126. The setting shown in the Terminal Emulation Program, InnBZpC, is equivalent to the combination of the three block settings: TBZTb, TBZBb, TBZPb. These settings are separated into 126 block in the SEL Grid Configurator view to show configuration options for every terminal to bus-zone connection option. (21 terminals • 6 bus-zones = 126 blocks).<sup>d</sup> This setting is shown for clarity and not user-configurable. It is active when CTnnBZp = Y and defaults to the terminal, bus, or alias name.**Table 8.22 Bus-Zone-to-Bus-Zone Connections, Terminal Emulation Program View**

<b>Setting</b>	<b>Prompt</b>	<b>Default</b>
BZpBZmC <sup>a, b</sup>	Bus-Zone, Bus-Zone	None
BZpBZmV <sup>a, b</sup>	BZ <i>p</i> to BZ <i>m</i> Connection (SELOGIC Equation)	NA
BZpBZmR <sup>a, b</sup>	Connection to Remove Terminals when BZ <i>p</i> and BZ <i>m</i> merge (SELOGIC Equation)	NA
BZpBZmM <sup>a, b</sup>	Terminals Removed when BZ <i>p</i> and BZ <i>m</i> Bus-Zones merge (Ter k, . . . , Ter n) <sup>c</sup>	None
BZpBZmT <sup>a, b</sup>	Trip Terminals Ter k, . . . , Ter n (Y, N)	N

<sup>a</sup> p = 1-6.<sup>b</sup> m = 1-6.<sup>c</sup> Terminal k, Terminal 1, or Terminal n (maximum of four terminals from 01-21).**Table 8.23 Bus-Zone-to-Bus-Zone Connections, SEL Grid Configurator View (Sheet 1 of 2)**

<b>Setting</b>	<b>Prompt</b>	<b>Default</b>
CBZ1BZ2	Connect Bus-Zone 1 to Bus-Zone 2 (Select: Y,N)	N
BZBZ11	Bus-Zone BZ1	BUS_1 <sup>a</sup>
BZBZ21	Bus-Zone BZ2	BUS_2 <sup>a</sup>
BZ1BZ2V	Bus to Bus Connection Logic (SELOGIC Equation)	NA
BZ1BZ2R	Removed Terminal Logic (SELOGIC Equation)	NA
CPT11	Terminals to be removed when BZBZ11 and BZBZ21 merge (Select: <Blank>, FDR_1, FDR_2, FDR_3, TRFR_1, TB_1, TB_2)	<Blank>
CPT21	Terminals to be removed when BZBZ11 and BZBZ21 merge (Select: <Blank>, FDR_1, FDR_2, FDR_3, TRFR_1, TB_1, TB_2)	<Blank>

**Table 8.23 Bus-Zone-to-Bus-Zone Connections, SEL Grid Configurator View (Sheet 2 of 2)**

<b>Setting</b>	<b>Prompt</b>	<b>Default</b>
CPT31	Terminals to be removed when BZBZ11 and BZBZ21 merge (Select: <Blank>, FDR_1, FDR_2, FDR_3, TRFR_1, TB_1, TB_2)	<Blank>
CPT41	Terminals to be removed when BZBZ11 and BZBZ21 merge (Select: <Blank>, FDR_1, FDR_2, FDR_3, TRFR_1, TB_1, TB_2)	<Blank>
BZBZT1	Trip Selected Terminal(s) above? (Select: Y,N)	N
•	•	•
•	•	•
•	•	•
CBZ <sub>p</sub> BZ <sub>m</sub> <sup>b,c</sup>	Connect Bus-Zone <i>p</i> to Bus-Zone <i>m</i> (Select: Y,N)	N
BZBZ1 <sub>b</sub> <sup>d</sup>	Bus-Zone BZ <sub>p</sub>	BZ <sub>p</sub> <sup>a</sup>
BZBZ2 <sub>b</sub>	Bus-Zone BZ <sub>m</sub>	BZ <sub>m</sub> <sup>a</sup>
BZ <sub>p</sub> BZ <sub>m</sub> V	Bus to Bus Connection Logic (SELOGIC Equation)	NA
BZ <sub>p</sub> BZ <sub>m</sub> R	Removed Terminal Logic (SELOGIC Equation)	NA
CPT1 <sub>b</sub> <sup>e</sup>	Terminals to be removed when BZBZ1 <sub>b</sub> and BZBZ2 <sub>b</sub> merge (Select: <Blank>)	<Blank>
CPT2 <sub>b</sub>	Terminals to be removed when BZBZ1 <sub>b</sub> and BZBZ2 <sub>b</sub> merge (Select: <Blank>)	<Blank>
CPT3 <sub>b</sub>	Terminals to be removed when BZBZ1 <sub>b</sub> and BZBZ2 <sub>b</sub> merge (Select: <Blank>)	<Blank>
CPT4 <sub>b</sub>	Terminals to be removed when BZBZ1 <sub>b</sub> and BZBZ2 <sub>b</sub> merge (Select: <Blank>)	<Blank>
BZBZT <sub>b</sub>	Trip Selected Terminal(s) above? (Select: Y,N)	N

<sup>a</sup> This setting is shown for clarity and not user-configurable. It is active when CBZ<sub>p</sub>BZ<sub>m</sub> =Y and defaults to the bus or alias name.

<sup>b</sup> p = 1–6.

<sup>c</sup> m = 1–6.

<sup>d</sup> b = 1–15. These settings are separated into 15 blocks in the SEL Grid Configurator view to show configuration options for every bus-zone-to-bus-zone connection option.

<sup>e</sup> The setting shown in the Terminal Emulation Program, BZ<sub>p</sub>BZ<sub>m</sub>M, is equivalent to the combination of the four SEL Grid Configurator block settings: CPT1<sub>b</sub>, CPT2<sub>b</sub>, CPT3<sub>b</sub>, CPT4<sub>b</sub>.

**Table 8.24 Zone Supervision**

<b>Setting</b>	<b>Prompt</b>	<b>Default</b>
E87ZSUP	Differential Element Zone Supervision (Y, N)	Y
Z1S	Zone 1 Supervision (SELOGIC Equation)	NOT 87Z1BK
Z2S	Zone 2 Supervision (SELOGIC Equation)	NOT 87Z2BK
Z3S	Zone 3 Supervision (SELOGIC Equation)	NOT 87Z3BK
Z4S	Zone 4 Supervision (SELOGIC Equation)	NOT 87Z4BK
Z5S	Zone 5 Supervision (SELOGIC Equation)	NOT 87Z5BK
Z6S	Zone 6 Supervision (SELOGIC Equation)	NOT 87Z6BK

**Table 8.25 Zone Switching Supervision (Sheet 1 of 2)**

<b>Setting</b>	<b>Prompt</b>	<b>Default</b>
EZSWSUP	Zone Switching Supervision (Y, N)	N
ZSWO	Zone Switching Operation (SELOGIC Equation)	NA

**Table 8.25 Zone Switching Supervision (Sheet 2 of 2)**

<b>Setting</b>	<b>Prompt</b>	<b>Default</b>
RZSWOAL	Reset Zone Switching Op Alarm (SELOGIC Equation)	NA
ZSWOPU	Zone Switching Op Pickup Delay (0–99999 cyc)	1800

**Table 8.26 Zone Open CT Detection**

<b>Setting</b>	<b>Prompt</b>	<b>Default</b>
ROCTZ1	Reset Zone 1 Open CT Detector (SELOGIC Equation)	RSTOCT1 OR (87Z1BK AND NOT OCTZ1)
ROCTZ2	Reset Zone 2 Open CT Detector (SELOGIC Equation)	RSTOCT2 OR (87Z2BK AND NOT OCTZ2)
ROCTZ3	Reset Zone 3 Open CT Detector (SELOGIC Equation)	RSTOCT3 OR (87Z3BK AND NOT OCTZ3)
ROCTZ4	Reset Zone 4 Open CT Detector (SELOGIC Equation)	RSTOCT4 OR (87Z4BK AND NOT OCTZ4)
ROCTZ5	Reset Zone 5 Open CT Detector (SELOGIC Equation)	RSTOCT5 OR (87Z5BK AND NOT OCTZ5)
ROCTZ6	Reset Zone 6 Open CT Detector (SELOGIC Equation)	RSTOCT6 OR (87Z6BK AND NOT OCTZ6)

**Table 8.27 Check Zone Configuration and Terminal-to-Check-Zone Connections, Terminal Emulation Program View**

<b>Setting</b>	<b>Prompt</b>	<b>Default</b>
ECHKZN	Enable Check Zones at Station (Y, N)	N
InnCZpC <sup>a, b</sup>	Terminal, Check-Zone, Polarity (P, N)	None
EADVCZ	Enable Advance Check Zone Settings (Y, N)	N
CZpqR <sup>b, c</sup>	Include Coupler <i>q</i> in Check Zone <i>p</i> (SELOGIC Equation)	NA
CZpqM <sup>a, b, c</sup>	<i>Inn</i> to CZ <i>p</i> Connection (SELOGIC Equation)	

<sup>a</sup> nn = 1–21.

<sup>b</sup> p = 1–3.

<sup>c</sup> q = 1–4.

**Table 8.28 Check Zone Configuration and Terminal-to-Check-Zone Connections, SEL Grid Configurator View (Sheet 1 of 2)**

<b>Setting</b>	<b>Prompt</b>	<b>Default</b>
CT01CZ1	Connect Terminal 1 to Check-Zone 1 (Select: Y, N)	N
TCZT1	Terminal I01	FDR_1 <sup>a</sup>
TCZC1	Check Zone CZ1	CZ1 <sup>a</sup>
TCZP1	Polarity I01-CZ1 (Select: P, N)	P
•	•	•
•	•	•
•	•	•
CTnnCZp <sup>b,c</sup>	Connect Terminal <i>Inn</i> to Check-Zone <i>p</i> (Select: Y, N)	N
TCZTb <sup>d</sup>	Terminal <i>Inn</i>	<i>Inn</i> <sup>a</sup>

**Table 8.28 Check Zone Configuration and Terminal-to-Check-Zone Connections, SEL Grid Configurator View (Sheet 2 of 2)**

Setting	Prompt	Default
TCZCb	Check Zone CZp	CZp <sup>a</sup>
TCZPb	Polarity Inn-CZp (Select: P, N)	P

<sup>a</sup> This setting is shown for clarity and not user-configurable. It is active when CTnnCZp = Y and defaults to the terminal, check zone or alias name.

<sup>b</sup> nn = 1-21.

<sup>c</sup> p = 1-3.

<sup>d</sup> b = 1-63. These settings are separated into 63 blocks in the SEL Grid Configurator view to show configuration options for every Terminal-to-Check-Zone connection option (21 terminals • 3 check zones). The setting shown in the Terminal Emulation Program, InnCZpC, is equivalent to the combination of the three SEL Grid Configurator block settings: TCZTb, TCZCb, TCZPb.

**Table 8.29 Check Zone Supervision**

Setting	Prompt	Default
E87CZSP	Differential Element Check Zone Supervision (Y, N)	Y
CZnS <sup>a</sup>	Check Zone n Supervision (SELOGIC Control Equation) <sup>b</sup>	NOT 87CZnBK

<sup>a</sup> n = 1-3.

<sup>b</sup> 0 is not a valid value for this setting.

## Group Settings

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**Table 8.30 Group Settings Categories**

Settings	Reference
Relay Configuration	Table 8.31
Sensitive Differential Elements	Table 8.32
Check Zone Sensitive Differential Elements	Table 8.33
Restrained Differential Elements	Table 8.34
Check Zone Restrained Differential Elements	Table 8.35
Phase Directional Element	Table 8.36
Coupler Security Logic	Table 8.37
Terminal Out of Service	Table 8.38
Breaker Failure Logic	Table 8.39
Definite-Time Overcurrent Elements	Table 8.40
Inverse-Time Overcurrent Elements	Table 8.41
Under- and Overvoltage Elements	Table 8.42, Table 8.43
Trip Logic	Table 8.44

**Table 8.31 Relay Configuration (Sheet 1 of 2)**

Setting	Prompt	Default
E87SSUP	Sensitive Differential Element Supervision (Y, N)	Y
ECSL	Coupler Security Logic (N, 1-4)	N
ETOS	Terminal Out of Service (N, 1-21)	5
EBFL	Breaker Failure Logic (N, 1-21)	6

**Table 8.31 Relay Configuration (Sheet 2 of 2)**

<b>Setting</b>	<b>Prompt</b>	<b>Default</b>
E50	Definite-Time Overcurrent Elements (N, 1–21)	N
E51	Inverse-Time Overcurrent Elements (N, 1–21)	N
EADVS	Advanced Settings (Y, N)	N
E27	Enable Under Voltage Elements (N, 1–6)	N
E59	Enable Over Voltage Elements (N, 1–6)	N

**Table 8.32 Sensitive Differential Elements**

<b>Setting</b>	<b>Prompt</b>	<b>Default</b>	<b>Increment</b>
S87P	Sensitive Differential Element Pickup (0.05–1 pu)	0.10	0.01
87STPU	87S Timer Pickup Delay (50–6000 cyc)	300	1

**Table 8.33 Check Zone Sensitive Differential Elements<sup>a</sup>**

<b>Setting</b>	<b>Prompt</b>	<b>Default</b>	<b>Increment</b>
CZS87P	Check Zone Sensitive Differential Element Pickup (0.05–1 pu)	0.10	0.01
CZ87STP	Check Zone 87S Time Pickup Delay (50–6000 cyc)	300	1

<sup>a</sup> Available when ECHKZN := Y.**Table 8.34 Restrained Differential Elements**

<b>Setting</b>	<b>Prompt</b>	<b>Default</b>	<b>Increment</b>
O87P	Restrained Diff Element Pickup (0.10–4 pu)	1.00	0.01
SLP1	Restrained Slope 1 Percentage (15–90%)	60	1
SLP2	Restrained Slope 2 Percentage (50–90%)	80	1
RTDI	Incr Restrained Current Threshold (0.10–10 pu)	1.20	0.01
OPDI	Incr Operating Current Threshold (0.10–10 pu)	1.20	0.01

**Table 8.35 Check Zone Restrained Differential Elements<sup>a</sup>**

<b>Setting</b>	<b>Prompt</b>	<b>Default</b>	<b>Increment</b>
CZO87P	Check Zone Restrained Diff Element Pickup (0.10–4 pu)	1.00	0.01
CZSLP1	Check Zone Restrained Slope 1 Percentage (5–90%)	60	1
CZSLP2	Check Zone Restrained Slope 2 Percentage (15–90%)	80	1
CZRTDI	Check Zone Incr Restrained Current Threshold (0.10–10 pu)	1.20	0.01
CZOPDI	Check Zone Incr Operating Current Threshold (0.10–10 pu)	1.20	0.01

<sup>a</sup> Available when ECHKZN := Y.**Table 8.36 Phase Directional Element**

<b>Setting</b>	<b>Prompt</b>	<b>Default</b>	<b>Increment</b>
50DSP	Dir Element O/C Supervision Pickup (0.05–3 pu)	0.05	0.01

**Table 8.37 Coupler Security Logic (1-4)**

<b>Setting</b>	<b>Prompt</b>	<b>Default</b>	<b>Increment</b>
CB52A1	Coupler 1 Status (SELOGIC Equation)	NA	
CB52DO1	Coupler 1 Status Dropout Delay (0.00–1000 cyc)	4	0.083
CBCLS1	Coupler 1 Close Command (SELOGIC Equation)	NA	
CBCLDO1	Coupler 1 Close Command D/O Delay (0.00–1000 cyc)	5	0.083
ACTRP1	Coupler 1 Acc Trip (SELOGIC Equation)	NA	
ACTPPU1	Coupler 1 Acc Trip Pickup Delay (0.00–1000 cyc)	4	0.083
•	•	•	•
•	•	•	•
•	•	•	•
CB52A4	Coupler 4 Status (SELOGIC Equation)	NA	
CB52DO4	Coupler 4 Status Dropout Delay (0.00–1000 cyc)	4	0.083
CBCLS4	Coupler 4 Close Command (SELOGIC Equation)	NA	
CBCLDO4	Coupler 4 Close Command D/O Delay (0.00–1000 cyc)	5	0.083
ACTRP4	Coupler 4 Acc Trip (SELOGIC Equation)	NA	
ACTPPU4	Coupler 4 Acc Trip Pickup Delay (0.00–1000 cyc)	4	0.083

**Table 8.38 Terminal Out of Service (1-21)**

<b>Setting</b>	<b>Prompt</b>	<b>Default</b>
TOS01	Terminal 01 Out-of-Service (SELOGIC Equation)	LB01
TOS02	Terminal 02 Out-of-Service (SELOGIC Equation)	LB02
TOS03	Terminal 03 Out-of-Service (SELOGIC Equation)	LB03
TOS04	Terminal 04 Out-of-Service (SELOGIC Equation)	LB04
TOS05	Terminal 05 Out-of-Service (SELOGIC Equation)	LB05
TOS06	Terminal 06 Out-of-Service (SELOGIC Equation)	NA
•	•	•
•	•	•
•	•	•
TOS21	Terminal 21 Out-of-Service (SELOGIC Equation)	NA

**Table 8.39 Breaker Failure Logic (1-21) (Sheet 1 of 4)**

<b>Setting</b>	<b>Prompt</b>	<b>Default</b>	<b>Increment</b>
<b>Breaker 01 Failure Logic</b>			
EXBF01	External Breaker Fail–BK01 (Y, N)	N	
XBF01	External Brkr Fail Init–BK01 (SELOGIC Equation)	NA	
50FP01	Fault Current Pickup–BK01 (0.50–50 amps, sec)	3.00	0.01
BFP01	Brkr Fail Init Pickup Delay–BK01 (0.00–6000 cyc)	6.00	0.083
RTPU01	Retrip Delay–BK01 (0.00–6000 cyc)	3.00	0.083
BFI01	Breaker Fail Initiate–BK01 (SELOGIC Equation)	F1_BFI AND BF_EN	
ATBFI01	Alt Breaker Fail Initiate–BK01 (SELOGIC Equation)	NA	
EBFIS01	Breaker Fail Initiate Seal-In–BK01 (Y, N)	N	

**Table 8.39 Breaker Failure Logic (1-21) (Sheet 2 of 4)**

<b>Setting</b>	<b>Prompt</b>	<b>Default</b>	<b>Increment</b>
BFISP01	Breaker Fail Init Seal-In Delay–BK01 (0.00–1000 cyc)	0.50	0.083
BFIDO01	Brkr Fail Init Dropout Delay–BK01 (0.00–1000 cyc)	1.50	0.083
<b>Breaker O2 Failure Logic</b>			
EXBF02	External Breaker Fail–BK02 (Y, N)	N	
XBF02	External Brkr Fail Init–BK02 (SELOGIC Equation)	NA	
50FP02	Fault Current Pickup–BK02 (0.50–50 amps, sec)	3.00	0.01
BFPU02	Brkr Fail Init Pickup Delay–BK02 (0.00–6000 cyc)	6.00	0.083
RTPU02	Retrip Delay–BK02 (0.00–6000 cyc)	3.00	0.083
BFI02	Breaker Fail Initiate–BK02 (SELOGIC Equation)	F2_BFI AND BF_EN	
ATBFI02	Alt Breaker Fail Initiate–BK02 (SELOGIC Equation)	NA	
EBFIS02	Breaker Fail Initiate Seal-In–BK02 (Y, N)	N	
BFISP02	Breaker Fail Init Seal-In Delay–BK02 (0.00–1000 cyc)	0.50	0.083
BFIDO02	Brkr Fail Init Dropout Delay–BK02 (0.00–1000 cyc)	1.50	0.083
<b>Breaker O3 Failure Logic</b>			
EXBF03	External Breaker Fail–BK03 (Y, N)	N	
XBF03	External Brkr Fail Init–BK03 (SELOGIC Equation)	NA	
50FP03	Fault Current Pickup–BK03 (0.50–50 amps, sec)	3.00	0.01
BFPU03	Brkr Fail Init Pickup Delay–BK03 (0.00–6000 cyc)	6.00	0.083
RTPU03	Retrip Delay–BK03 (0.00–6000 cyc)	3.00	0.083
BFI03	Breaker Fail Initiate–BK03 (SELOGIC Equation)	F3_BFI AND BF_EN	
ATBFI03	Alt Breaker Fail Initiate–BK03 (SELOGIC Equation)	NA	
EBFIS03	Breaker Fail Initiate Seal-In–BK03 (Y, N)	N	
BFISP03	Breaker Fail Init Seal-In Delay–BK03 (0.00–1000 cyc)	0.50	0.083
BFIDO03	Brkr Fail Init Dropout Delay–BK03 (0.00–1000 cyc)	1.50	0.083
<b>Breaker O4 Failure Logic</b>			
EXBF04	External Breaker Fail–BK04 (Y, N)	N	
XBF04	External Brkr Fail Init–BK04 (SELOGIC Equation)	NA	
50FP04	Fault Current Pickup–BK04 (0.50–50 amps, sec)	3.00	0.01
BFPU04	Brkr Fail Init Pickup Delay–BK04 (0.00–6000 cyc)	6.00	0.083
RTPU04	Retrip Time Delay–BK04 (0.00–6000 cyc)	3.00	0.083
BFI04	Breaker Fail Initiate–BK04 (SELOGIC Equation)	T1_BFI AND BF_EN	
ATBFI04	Alt Breaker Fail Initiate–BK04 (SELOGIC Equation)	NA	
EBFIS04	Breaker Fail Initiate Seal-In–BK04 (Y, N)	N	

**Table 8.39 Breaker Failure Logic (1-21) (Sheet 3 of 4)**

<b>Setting</b>	<b>Prompt</b>	<b>Default</b>	<b>Increment</b>
BFISP04	Breaker Fail Init Seal-In Delay–BK04 (0.00–1000 cyc)	0.50	0.083
BFIDO04	Brkr Fail Init Dropout Delay–BK04 (0.00–1000 cyc)	1.50	0.083
<b>Breaker 05 Failure Logic</b>			
EXBF05	External Breaker Fail–BK05 (Y, N)	N	
XBF05	External Brkr Fail Init–BK05 (SELOGIC Equation)	NA	
50FP05	Fault Current Pickup–BK05 (0.50–50 amps, sec)	3.00	0.01
BFPU05	Brkr Fail Init Pickup Delay–BK05 (0.00–6000 cyc)	6.00	0.083
RTPU05	Retrip Delay–BK05 (0.00–6000 cyc)	3.00	0.083
BFI05	Breaker Fail Initiate–BK05 (SELOGIC Equation)	TB_BFI AND BF_EN	
ATBFI05	Alt Breaker Fail Initiate–BK05 (SELOGIC Equation)	NA	
EBFIS05	Breaker Fail Initiate Seal-In–BK05 (Y, N)	N	
BFISP05	Breaker Fail Init Seal-In Delay–BK05 (0.00–1000 cyc)	0.50	0.083
BFIDO05	Brkr Fail Init Dropout Delay–BK05 (0.00–1000 cyc)	1.50	0.083
<b>Breaker 06 Failure Logic</b>			
EXBF06	Enable External Breaker Fail–BK06 (Y, N)	N	
XBF06	External Brkr Fail Init–BK06 (SELOGIC Equation)	NA	
50FP06	Fault Current Pickup–BK06 (0.50–50 amps, sec)	3.00	0.01
BFPU06	Brkr Fail Init Pickup Delay–BK06 (0.00–6000 cyc)	6.00	0.083
RTPU06	Retrip Delay–BK06 (0.00–6000 cyc)	3.00	0.083
BFI06	Breaker Fail Initiate–BK06 (SELOGIC Equation)	IN206 AND BF_EN	
ATBFI06	Alt Breaker Fail Initiate–BK06 (SELOGIC Equation)	NA	
EBFIS06	Breaker Fail Initiate Seal-In–BK06 (Y, N)	N	
BFISP06	Breaker Fail Init Seal-In Delay–BK06 (0.00–1000 cyc)	0.50	0.083
BFIDO06	Brkr Fail Init Dropout Delay–BK06 (0.00–1000 cyc)	1.50	0.083
<b>Breaker 07 Failure Logic</b>			
EXBF07	External Breaker Fail–BK07 (Y, N)	N	
XBF07	External Brkr Fail Init–BK07 (SELOGIC Equation)	NA	
50FP07	Fault Current Pickup–BK07 (0.50–50 amps, sec)	3.00	0.01
BFPU07	Brkr Fail Init Pickup Delay–BK07 (0.00–6000 cyc)	6.00	0.083
RTPU07	Retrip Delay–BK07 (0.00–6000 cyc)	3.00	0.083
BFI07	Breaker Fail Initiate–BK07 (SELOGIC Equation)	NA	
ATBFI07	Alt Breaker Fail Initiate–BK07 (SELOGIC Equation)	NA	
EBFIS07	Breaker Fail Initiate Seal-In–BK07 (Y, N)	N	

**Table 8.39 Breaker Failure Logic (1-21) (Sheet 4 of 4)**

<b>Setting</b>	<b>Prompt</b>	<b>Default</b>	<b>Increment</b>
BFISP07	Breaker Fail Init Seal-In Delay–BK07 (0.00–1000 cyc)	0.50	0.083
BFIDO07	Brkr Fail Init Dropout Delay–BK07 (0.00–1000 cyc)	1.50	0.083
<b>Breaker 08 Failure Logic</b>			
EXBF08	External Breaker Fail–BK08 (Y, N)	Y	
XBF08	External Brkr Fail Init–BK08 (SELOGIC Equation)	NA	
50FP08	Fault Current Pickup–BK08 (0.50–50 amps, sec)	3.00	0.01
BFP08	Brkr Fail Init Pickup Delay–BK08 (0.00–6000 cyc)	6.00	0.083
RTPU08	Retrip Delay–BK08 (0.00–6000 cyc)	3.00	0.083
BFI08	Breaker Fail Initiate–BK08 (SELOGIC Equation)	NA	
ATBFI08	Alt Breaker Fail Initiate–BK08 (SELOGIC Equation)	NA	
EBFIS08	Breaker Fail Initiate Seal-In–BK08 (Y, N)	N	
BFISP08	Breaker Fail Init Seal-In Delay–BK08 (0.00–1000 cyc)	0.50	0.083
BFIDO08	Brkr Fail Init Dropout Delay–BK08 (0.00–1000 cyc)	1.50	0.083
•	•	•	•
•	•	•	•
•	•	•	•
<b>Breaker 21 Failure Logic</b>			
EXBF21	External Breaker Fail–BK21 (Y, N)	Y	
XBF21	External Brkr Fail Init–BK21 (SELOGIC Equation)	NA	
50FP21	Fault Current Pickup–BK21 (0.50–50 amps, sec)	3.00	0.01
BFP21	Brkr Fail Init Pickup Delay–BK21 (0.00–6000 cyc)	6.00	0.083
RTPU21	Retrip Delay–BK21 (0.00–6000 cyc)	3.00	0.083
BFI21	Breaker Fail Initiate–BK21 (SELOGIC Equation)	NA	
ATBFI21	Alt Breaker Fail Initiate–BK21 (SELOGIC Equation)	NA	
EBFIS21	Breaker Fail Initiate Seal-In–BK21 (Y, N)	N	
BFISP21	Breaker Fail Init Seal-In Delay–BK21 (0.00–1000 cyc)	0.50	0.083
BFIDO21	Brkr Fail Init Dropout Delay–BK21 (0.00–1000 cyc)	1.50	0.083

**Table 8.40 Definite-Time Overcurrent Elements**

<b>Setting</b>	<b>Prompt</b>	<b>Default</b>	<b>Increment</b>
50P01P	Terminal 01 Pickup (OFF, 0.25–100 amps, sec)	OFF	0.01
50P01D	Terminal 01 Pickup Delay (0.00–99999 cyc)	10.00	0.167
•	•	•	•
•	•	•	•
•	•	•	•
50P21P	Terminal 21 Pickup (OFF, 0.25–100 amps, sec)	OFF	0.01
50P21D	Terminal 21 Pickup Delay (0.00–99999 cyc)	10.00	0.167

**Table 8.41 Inverse-Time Overcurrent Elements**

<b>Setting</b>	<b>Prompt</b>	<b>Default</b>
51O01	Inverse Time O/C 01 Operate Quantity	I01FIM
51P01 <sup>a</sup>	Inverse Time O/C 01 Pickup (SELOGIC Equation) (0.25–16 amps, sec)	0.50
51C01	Inverse Time O/C 01 Curve (U1–U5, C1–C5)	U1
51TD01	Inverse Time O/C 01 Time Dial (0.50–15) [U1–U5] or Inverse Time O/C 01 Time Dial (0.05–1) [C1–C5]	0.50
51RS01	Inverse Time O/C 01 EM Reset (Y, N)	Y
51TC01	Inverse Time O/C 01 Torque Cont (SELOGIC Equation)	1
•	•	•
•	•	•
•	•	•
51O21	Inverse Time O/C 21 Operate Quantity	I21FIM
51P21 <sup>a</sup>	Inverse Time O/C 21 Pickup (SELOGIC Equation) (0.50–16 amps, sec)	0.50
51C21	Inverse Time O/C 21 Curve (U1–U5, C1–C5)	U1
51TD21	Inverse Time O/C 21 Time Dial (0.50–15) [U1–U5] or Inverse Time O/C 21 Time Dial (0.05–1) [C1–C5]	0.50
51RS21	Inverse Time O/C 21 EM Reset (Y, N)	Y
51TC21	Inverse Time O/C 21 Torque Cont (SELOGIC Equation)	1

<sup>a</sup> The acceptable range of result of the math equation must be within specific limits depending on the nominal current. For 5 A nominal current input, the range is 0.25–16.0 A, sec. For 1 A nominal current input, 0.05–3.2 A, sec. See Section 5: Protection Functions for more information.

**Table 8.42 Undervoltage Elements**

<b>Setting</b>	<b>Prompt</b>	<b>Default</b>	<b>Increment</b>
270n <sup>a</sup>	U/V Element n Operating Quantity	V1FIM	
27PnP1 <sup>a</sup>	U/V Element n Level 1 P/U (2.00–300 V, sec)	20.00	0.01
27TCn <sup>a</sup>	U/V Element n Torque Control (SELOGIC Eqn)	NOT (V01BK OR V02BK OR V03BK)	
27PnD1 <sup>a</sup>	U/V Element n Level 1 Delay (0.00–16000 cyc)	10.00	0.167
27PnP2 <sup>a</sup>	U/V Element n Level 2 P/U (2.00–300 V, sec)	15.00	0.01

<sup>a</sup> n = 1–6.

**Table 8.43 Overvoltage Elements**

<b>Setting</b>	<b>Prompt</b>	<b>Default</b>	<b>Increment</b>
590n <sup>a</sup>	O/V Element n Operating Quantity	V1FIM	
59PnP1 <sup>a</sup>	O/V Element n Level 1 P/U (2.00–300 V, sec)	76.00	0.01
59TCn <sup>a</sup>	O/V Element n Torque Control (SELOGIC Eqn)	1	
59PnD1 <sup>a</sup>	O/V Element n Level 1 Delay (0.00–16000 cyc)	10.00	0.167
59PnP2 <sup>a</sup>	O/V Element n Level 2 P/U (2.00–300 V, sec)	80.00	0.01

<sup>a</sup> n = 1–6.

**Table 8.44 Trip Logic**

<b>Setting</b>	<b>Prompt</b>	<b>Default</b>	<b>Increment</b>
TR01	Trip 01 (SELOGIC Equation)	SV Subscriber Relay: (F1_BFT OR F1_DPT) AND NOT SVSTST TiDL Relay: F1_BFT OR F1_DPT	
ULTR01	Unlatch Trip 01 (SELOGIC Equation)	NA	
TR02	Trip 02 (SELOGIC Equation)	SV Subscriber Relay: (F2_BFT OR F2_DPT) AND NOT SVSTST TiDL Relay: F2_BFT OR F2_DPT	
ULTR02	Unlatch Trip 02 (SELOGIC Equation)	NA	
TR03	Trip 03 (SELOGIC Equation)	SV Subscriber Relay: (F3_BFT OR F3_DPT) AND NOT SVSTST TiDL Relay: F3_BFT OR F3_DPT	
ULTR03	Unlatch Trip 03 (SELOGIC Equation)	NA	
TR04	Trip 04 (SELOGIC Equation)	SV Subscriber Relay: (T1_BFT OR T1_DPT) AND NOT SVSTST TiDL Relay: T1_BFT OR T1_DPT	
ULTR04	Unlatch Trip 04 (SELOGIC Equation)	NA	
TR05	Trip 05 (SELOGIC Equation)	SV Subscriber Relay: (TB1_BFT OR TB1_DPT OR TB2_BFT OR TB2_DPT) AND NOT SVSTST TiDL Relay: TB1_BFT OR TB1_DPT OR TB2_BFT OR TB2_DPT	
ULTR05	Unlatch Trip 05 (SELOGIC Equation)	NA	
TR06	Trip 06 (SELOGIC Equation)	NA	
ULTR06	Unlatch Trip 06 (SELOGIC Equation)	NA	
•	•	•	
•	•	•	
•	•	•	
TR21	Trip 21 (SELOGIC Equation)	NA	
ULTR21	Unlatch Trip 21 (SELOGIC Equation)	NA	
TDURD	Minimum Trip Duration Time Delay (2.000–8000 cyc)	12.000	0.083
ER	Event Report Trigger Equation (SELOGIC Equation)	R_TRIG 87ST	

## Protection Freeform SELogic Control Equations

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The following protection freeform SELogic control equation settings are the default settings for all six settings groups. You can set each of the six protection freeform SELogic control equation setting groups independently. See *Multiple Setting Groups on page 12.4* in the *SEL-400 Series Relays Instruction Manual*.

**Table 8.45 Protection Freeform SELogic Control Equations**

Label	Default
PLT01S :=	NOT DIFF_EN AND PLT04 # DIFFERENTIAL ENABLED
PLT01R :=	PCT02Q AND DIFF_EN AND NOT PLT04
PLT02S :=	NOT BF_EN AND PLT05 # BREAKER FAILURE ENABLED
PLT02R :=	PCT03Q AND BF_EN AND NOT PLT05
PLT03S :=	NOT TNS_SW AND PLT06 # RELAY TEST MODE
PLT03R :=	PCT04Q AND TNS_SW AND NOT PLT06
PLT04S :=	PB1_PUL AND NOT DIFF_EN # ONLY ONE OP PER PB1 PRESS
PLT04R :=	PB1_PUL AND DIFF_EN
PLT05S :=	PB2_PUL AND NOT BF_EN # ONLY ONE OP PER PB2 PRESS
PLT05R :=	PB2_PUL AND BF_EN
PLT06S :=	PB4_PUL AND NOT TNS_SW # ONLY ONE OP PER PB4 PRESS
PLT06R :=	PB4_PUL AND TNS_SW
PCT01PU :=	240
PCT01IN :=	PCT01IN := 3V2FIM > 20 OR 3V0FIM > 20
PCT02PU :=	60 # 1 SEC DELAY DISABLE ON PB1
PCT02IN :=	PB1
PCT03PU :=	60 # 1 SEC DELAY DISABLE ON PB2
PCT03IN :=	PB2
PCT04PU :=	60 # 1 SEC DELAY DISABLE ON PB4
PCT04IN :=	PB4

## Automation Freeform SELogic Control Equations

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See *Automation Freeform SELogic Control Equations on page 12.26* in the *SEL-400 Series Relays Instruction Manual* for a description of automation SELogic control equations. The SEL-487B supports 10 blocks of 100 lines.

## Notes Settings

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Use the Notes settings like a text pad to leave notes about the relay. See *Notes Settings on page 12.29* in the *SEL-400 Series Relays Instruction Manual* for additional information on Notes settings.

# Output Settings

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*Output Settings on page 12.26 in the SEL-400 Series Relays Instruction Manual* contains a description of the relay output settings. This subsection describes SEL-487B-specific default values.

**Table 8.46 Main Board**

Setting	Default
OUT201	TRIP01 AND NOT TNS_SW
OUT202	TRIP02 AND NOT TNS_SW
OUT203	TRIP03 AND NOT TNS_SW
OUT204	TRIP04 AND NOT TNS_SW
OUT205	TRIP05 AND NOT TNS_SW
OUT206	NA
OUT207	TNS_SW #RELAY TEST MODE
OUT208	NOT (SALARM OR HALARM)

All interface board default output SELOGIC equations default to NA.

# Front-Panel Settings

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See *Front-Panel Settings on page 12.20 in the SEL-400 Series Relays Instruction Manual* for a complete description of front-panel settings. This subsection lists the SEL-487B-specific default settings values.

**Table 8.47 Front-Panel Settings (Sheet 1 of 4)**

Setting	Default
FP_TO	15
EN_LED_C	G
TR_LED_C	R
PB1_LED	DIFF_EN # Differential Protection Enabled
PB1_COL	AO
PB2_LED	BF_EN # Breaker Failure Enabled
PB2_COL	AO
PB3_LED	NA
PB3_COL	AO
PB4_LED	TNS_SW # Test Normal Switch Enabled
PB4_COL	AO
PB5_LED	NA
PB5_COL	AO
PB6_LED	NA
PB6_COL	AO
PB7_LED	NA
PB7_COL	AO

**Table 8.47 Front-Panel Settings (Sheet 2 of 4)**

Setting	Default
PB8_LED	NA
PB8_COL	AO
PB9_LED	NA
PB9_COL	AO
PB10LED	NA
PB10COL	AO
PB11LED	NA
PB11COL	AO
PB12LED	NA
PB12COL	AO
T1_LED	87BTR
T1LEDL	Y
T1LEDC	RO
T2_LED	SBFTR
T2LEDL	Y
T2LEDC	RO
T3_LED	Z1_TRIP
T3LEDL	Y
T3LEDC	RO
T4_LED	Z2_TRIP
T4LEDL	Y
T4LEDC	RO
T5_LED	87Z3
T5LEDL	Y
T5LEDC	RO
T6_LED	87Z4
T6LEDL	Y
T6LEDC	RO
T7_LED	87Z5
T7LEDL	Y
T7LEDC	RO
T8_LED	87Z6
T8LEDL	Y
T8LEDC	RO
T9_LED	50P01T OR 50P02T OR...50P21T
T9LEDL	Y
T9LEDC	RO
T10_LED	51T01 OR 51T02 OR...51T21
T10LEDL	Y
T10LEDC	RO

**Table 8.47 Front-Panel Settings (Sheet 3 of 4)**

<b>Setting</b>	<b>Default</b>
T11_LED	87ST
T11LEDL	N
T11LEDC	RO
T12_LED	NOT (Z1S AND Z2S AND...Z6S)
T12LEDL	Y
T12LEDC	RO
T13_LED	TOS01 OR TOS02 OR...TOS21
T13LEDL	N
T13LEDC	RO
T14_LED	89IOP
T14LEDL	N
T14LEDC	RO
T15_LED	89AL
T15LEDL	N
T15LEDC	RO
T16_LED	PCT01Q
T16LEDL	Y
T16LEDC	RO
T17_LED	271P1 OR 272P1 OR 272P2 OR 273P1 OR 273P2
T17LEDL	N
T17LEDC	RO
T18_LED	591P1 OR 591P2 OR 292P1 OR 592P2 OR 593P1 OR 593P2
T18LEDL	N
T18LEDC	RO
T19_LED	V01FIM>55
T19LEDL	N
T19LEDC	RO
T20_LED	V02FIM>55
T20LEDL	N
T20LEDC	RO
T21_LED	V03FIM>55
T21LEDL	N
T21LEDC	RO
T22_LED	FAULT
T22LEDL	N
T22LEDC	RO
T23_LED	52AL
T23LEDL	N
T23LEDC	RO
T24_LED	TIRIG

**Table 8.47 Front-Panel Settings (Sheet 4 of 4)**

<b>Setting</b>	<b>Default</b>
T24LEDL	N
T24LEDC	RO

The SEL-487B supports the SCROLDD, STA\_BAT, FUND\_VI, DIFF, and ZONECFG choices for selectable screens, as described in *Table 12.38 in the SEL-400 Series Relays Instruction Manual*.

## Report Settings

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The SEL-487B contains the Report Settings described in *Report Settings on page 12.27 in the SEL-400 Series Relays Instruction Manual*, except that the SEL-487B does not support HIF event reports.

The rows containing the following Relay Word bits count against the 100 row limit for event report digitals even if they are not selected by the user: ZONE1–ZONE6, CZONE1, CZONE2, CZONE, 387BTR, 87BTR01–87BTR21, SBFTR, SBFTR01–SBFTR21, TRIP, TRIP01–TRIP21, 87Z1–87Z6, BFZ1–BFZ6, ER, RMBnA, TMBnA, RMBnB, TMBnB, ROKA, RBADA, CBADA, LBOKA, ROKB, RBADB, CBADB, LBOKB, TLED\_1, TLED\_2, TLED\_3, TLED\_4, TLED\_5, TLED\_6, TLED\_7, TLED\_8, TLED\_9, TLED\_10, TLED\_11, TLED\_12, TLED\_13, TLED\_14, TLED\_15, TLED\_16, TLED\_17, TLED\_18, TLED\_19, TLED\_20, TLED\_21, TLED\_22, TLED\_23, TLED\_24, Z1BZ1, Z1BZ2, Z1BZ3, Z1BZ4, Z1BZ5, Z1BZ6, Z2BZ2, Z2BZ3, Z2BZ4, Z2BZ5, Z2BZ6, Z3BZ3, Z3BZ4, Z3BZ5, Z3BZ6, Z4BZ4, Z4BZ5, Z4BZ6, Z5BZ5, Z5BZ6, Z6BZ6, ( $n = 1$ –8; see *Section 11: Relay Word Bits* for a list of Relay Word bits available in the SEL-487B).

**Table 8.48 Default Event Report Settings (Sheet 1 of 2)**

<b>Position</b>	<b>Primitive Name</b>	<b>Alias Name</b>
1	87Z1	Z1_TRIP
2	87Z2	Z2_TRIP
3	#	
4	FBF01	F1_BF
5	FBF02	F2_BF
6	FBF03	F3_BF
7	FBF04	T1_BF
8	FBF05	TB1_BF
9	FBF06	TB2_BF
10	#	
11	PLT01	DIFF_EN
12	PLT02	BF_EN
13	PLT03	TNS_SW
14	#	
15	IN201	F1_BFI
16	IN202	F2_BFI
17	IN203	F3_BFI

**Table 8.48 Default Event Report Settings (Sheet 2 of 2)**

<b>Position</b>	<b>Primitive Name</b>	<b>Alias Name</b>
18	IN204	T1_BFI
19	IN205	TB_BFI
20	#	
21	OUT201	F1_TRIP
22	OUT202	F2_TRIP
23	OUT203	F3_TRIP
24	OUT204	T1_TRIP
25	OUT205	TB_TRIP
26	OUT206	
27	#	
28	OUT207	TEST
29	OUT208	NOALARM
30	SVSALM	
31	I01OK	
32	I02OK	
33	I03OK	
34	I04OK	
35	I05OK	
36	I06OK	

## Port Settings

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The SEL-487B Port settings are described in *Port Settings on page 12.6 in the SEL-400 Series Relays Instruction Manual*.

The Fast Message read data access settings listed in *Table 12.8 in the SEL-400 Series Relays Instruction Manual* are included in the SEL-487B, except FMRDMND and FMRBRKR.

**Table 8.49 MIRRORED BITS Protocol Default Settings**

<b>Setting</b>	<b>Default</b>
MBANA1	PMV58
MBANA2	PMV59
MBANA3	PMV60
MBANA4	PMV61
MBANA5	PMV62
MBANA6	PMV63
MBANA7	PMV64

## DNP3 Settings—Custom Maps

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The SEL-487B DNP3 custom map settings operate as described in *DNP3 Settings—Custom Maps* on page 12.19 in the *SEL-400 Series Relays Instruction Manual*. See *Section 10: Communications Interfaces* for the default map configuration.

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## S E C T I O N   9

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# ASCII Command Reference

You can use a communications terminal or terminal emulation program to set and operate the SEL-487B-2 Relay. This section explains the commands that you send to the SEL-487B using SEL ASCII communications protocol. The relay responds to commands such as settings, metering, and control operations.

This section lists all the commands supported by the relay, but most are described in *Section 14: ASCII Command Reference in the SEL-400 Series Relays Instruction Manual*. This section provides information on commands and command options that are unique to the SEL-487B.

This section lists American National Standard Code for Information Interchange (ASCII) commands alphabetically. Commands, command options, and command variables that you enter are shown in bold. Lowercase italic letters and words in a command represent command variables that you determine based on the application (for example, Zone *n* = 1–6, remote bit number *nn* = 01–96, and *level*).

Command options appear with brief explanations about the command function. Refer to the references listed with the commands for more information on the relay function corresponding to the command or examples of the relay response to the command.

You can simplify the task of entering commands by shortening any ASCII command to the first three characters (upper- or lowercase); for example, **ACCESS** becomes **ACC**. Always send a carriage return <CR> character, or a carriage return character followed by a line feed character <CR><LF>, to command the relay to process the ASCII command. Usually, most terminals and terminal programs interpret the Enter key as a <CR>. For example, to send the **ACCESS** command, type **ACC <Enter>**.

Tables in this section show the access level(s) where the command or command option is active. Access levels in the SEL-487B are Access Level 0, Access Level 1, Access Level B (breaker), Access Level P (protection), Access Level A (automation), Access Level O (output), and Access Level 2.

## Description of Commands

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*Table 9.1* lists all the commands supported by the relay with the corresponding links to the descriptions in *Section 14: ASCII Command Reference in the SEL-400 Series Relays Instruction Manual*.

## Command List

Table 9.1 SEL-487B List of Commands (Sheet 1 of 2)

Command	Location of Command in Section 14: ASCII Command Reference in the SEL-400 Series Relays Instruction Manual
<b>2ACCESS</b>	<i>2ACCESS on page 14.1</i>
<b>AACCESS</b>	<i>AACCESS on page 14.3</i>
<b>ACCESS</b>	<i>ACCESS on page 14.3</i>
<b>BACCESS</b>	<i>BACCESS on page 14.3</i>
<b>BNAME</b>	<i>BNAME on page 14.4</i>
<b>CAL</b>	<i>CAL on page 14.5</i>
<b>CASCII</b>	<i>CASCII on page 14.6</i>
<b>CEVENT</b>	<i>CEVENT on page 14.7</i> (In the SEL-487B, <b>CEV L</b> provides a 12-samples/cycle large-resolution event report.)
<b>CFG CTNOM <i>i</i></b>	<i>CFG CTNOM on page 14.10</i> (in the SEL-487B, the nominal current choices are 1 and 5 for 1 A nominal and 5 A nominal CT inputs.)
<b>CHISTORY</b>	<i>CHISTORY on page 14.11</i>
<b>COMMUNICATIONS <i>c</i></b>	<i>COMMUNICATIONS on page 14.12</i>
<b>COM PRP</b>	<i>COM PRP on page 14.14</i>
<b>COM PTP</b>	<i>COM PTP on page 14.14</i>
<b>COM SV</b>	<i>COM SV on page 14.17</i>
<b>COM SV</b>	<i>COM SV on page 14.17</i>
<b>CONTROL <i>nn</i></b>	<i>CONTROL nn on page 14.24</i>
<b>COPY</b>	<i>COPY on page 14.25</i> (In addition to the typical classes, the zone (Z) class can also be copied using the <b>COPY</b> command.)
<b>CPR</b>	<i>CPR on page 14.26</i>
<b>CSER</b>	<i>CSER on page 14.26</i>
<b>CSTATUS</b>	<i>CSTATUS on page 14.28</i>
<b>CSUMMARY</b>	<i>CSUMMARY on page 14.28</i>
<b>DATE</b>	<i>DATE on page 14.29</i>
<b>DNAME X</b>	<i>DNAME X on page 14.30</i>
<b>DNP</b>	<i>DNP on page 14.30</i>
<b>ETHERNET</b>	<i>ETHERNET on page 14.30</i>
<b>EVENT</b>	<i>EVENT on page 14.32</i> (The SEL-487B supports large resolution 12-samples/cycle event reports.)
<b>EXIT</b>	<i>EXIT on page 14.36</i>
<b>FILE</b>	<i>FILE on page 14.36</i>
<b>GOOSE</b>	<i>GOOSE on page 14.37</i>
<b>GROUP</b>	<i>GROUP on page 14.40</i>
<b>HELP</b>	<i>HELP on page 14.40</i>
<b>HISTORY</b>	<i>HISTORY on page 14.40</i>
<b>ID</b>	<i>ID on page 14.42</i>
<b>LOOPBACK</b>	<i>LOOPBACK on page 14.43</i>
<b>MAC</b>	<i>MAC on page 14.45</i>
<b>MAP</b>	<i>MAP on page 14.45</i>

**Table 9.1 SEL-487B List of Commands (Sheet 2 of 2)**

<b>Command</b>	<b>Location of Command in Section 14: ASCII Command Reference in the SEL-400 Series Relays Instruction Manual</b>
<b>METER</b>	<i>METER</i> on page 14.46 (For all other <b>METER</b> options, see <i>METER</i> on page 9.4 in this section.)
<b>MET AMV</b>	<i>MET AMV</i> on page 14.46
<b>MET ANA</b>	<i>MET ANA</i> on page 14.47
<b>MET BAT</b>	<i>MET BAT</i> on page 14.47 (The SEL-487B provides battery metering for one battery monitor channel.)
<b>MET CZq</b>	See <i>MET CZq</i> on page 9.4 in this section.
<b>MET DIF</b>	See <i>MET DIF</i> on page 9.4 in this section.
<b>MET PMV</b>	<i>MET PMV</i> on page 14.49
<b>MET SEC</b>	See <i>MET SEC</i> on page 9.5 in this section.
<b>MET SEC CZn</b>	See <i>MET SEC CZq</i> on page 9.5 in this section.
<b>MET SEC Zn</b>	See <i>MET SEC Zn</i> on page 9.5 in this section.
<b>MET Zn</b>	See <i>MET Zn</i> on page 9.5 in this section.
<b>OACCESS</b>	<i>OACCESS</i> on page 14.50
<b>OPEN n</b>	<i>OPEN n</i> on page 14.50 (The SEL-487B supports 21 circuit breakers, designated 1–21.)
<b>PACCESS</b>	<i>PACCESS</i> on page 14.51
<b>PASSWORD</b>	<i>PASSWORD</i> on page 14.51
<b>PING</b>	<i>PING</i> on page 14.52
<b>PORT</b>	<i>PORT</i> on page 14.52
<b>PROFILE</b>	<i>PROFILE</i> on page 14.53
<b>PULSE</b>	<i>PULSE</i> on page 14.54
<b>QUIT</b>	<i>QUIT</i> on page 14.54
<b>SER</b>	<i>SER</i> on page 14.55
<b>SET</b>	<i>SET</i> on page 14.57 (Table 9.9 lists the options available in the SEL-487B.)
<b>SHOW</b>	<i>SHOW</i> on page 14.58 (Table 9.10 lists the class and instance options available in the SEL-487B.)
<b>SNS</b>	<i>SNS</i> on page 14.59
<b>STATUS</b>	<i>STATUS</i> on page 14.59
<b>SUMMARY</b>	<i>SUMMARY</i> on page 14.61
<b>TARGET</b>	<i>TARGET</i> on page 14.62
<b>TEST DB</b>	<i>TEST DB</i> on page 14.64
<b>TEST DB2</b>	<i>TEST DB2</i> on page 14.65
<b>TEST FM</b>	<i>TEST FM</i> on page 14.67
<b>TEST SV</b>	<i>TEST SV</i> on page 14.68
<b>TIME</b>	<i>TIME</i> on page 14.70
<b>TIME Q</b>	<i>TIME Q</i> on page 14.71
<b>TRIGGER</b>	<i>TRIGGER</i> on page 14.72
<b>VECTOR</b>	<i>VECTOR</i> on page 14.72
<b>VERSION</b>	<i>VERSION</i> on page 14.72
<b>VIEW</b>	<i>VIEW</i> on page 14.74
<b>ZONE</b>	See <i>ZONE</i> on page 9.7 in this section.
<b>ZON T</b>	See <i>ZON T</i> on page 9.8 in this section.
<b>ZON k</b>	See <i>ZON k</i> on page 9.8 in this section.

## METER

The **METER** command displays reports about quantities the relay measures in the power system and internal relay operating quantities. For more information on power system measurements, see *Section 7: Metering, Monitoring, and Reporting*.

### MET

**NOTE:** Data obtained with the **MET** command during dynamic zone selection may be unreliable.

Use the **MET** command to view fundamental metering quantities. The relay filters harmonics to present only measured quantities at the power system fundamental operating frequency.

**Table 9.2 MET Command**

Command	Description	Access Level
<b>MET</b>	Display fundamental metering data.	1, B, P, A, O, 2
<b>MET <i>k</i></b>	Display fundamental metering data successively for <i>k</i> times.	1, B, P, A, O, 2

Some situations require that you repeatedly monitor the power system for a brief period; specify a number after any **MET** command to automatically repeat the command.

### MET CZq

Use the **MET CZq** (*q* = 1–3) command to view the current magnitude, angle, and polarity of each terminal in Check Zone *q* and the voltage in primary values.

**Table 9.3 MET CZq Command**

Command <sup>a</sup>	Description	Access Level
<b>MET CZq</b>	Display primary metering data for Check Zone <i>q</i> .	1, B, P, A, O, 2
<b>MET CZq <i>k</i></b>	Display primary metering data for Check Zone <i>q</i> successively for <i>k</i> times.	1, B, P, A, O, 2

<sup>a</sup> *q* = 1–3.

If an alias name for the terminal exists, the relay displays the alias name.

### MET DIF

Use the **MET DIF** command to view the operate and restraint differential currents in the active zones in per unit values as well as the reference current (IREF).

**Table 9.4 MET DIF Command**

Command	Description	Access Level
<b>MET DIF</b>	Display the operate and restraint differential currents and IREF metering data.	1, B, P, A, O, 2
<b>MET DIF <i>k</i></b>	Display the operate and restraint differential currents and IREF metering data successively for <i>k</i> times.	1, B, P, A, O, 2

## MET SEC

Use the **MET SEC** command to view the current magnitude, angle, and CT ratio of each terminal. The view also includes voltage magnitudes in secondary values.

**Table 9.5 MET SEC Command**

Command	Description	Access Level
<b>MET SEC</b>	Display secondary metering data.	1, B, P, A, O, 2
<b>MET SEC <i>k</i></b>	Display secondary metering data successively for <i>k</i> times.	1, B, P, A, O, 2

If an alias name for the terminal exists, the relay displays the alias name.

## MET SEC CZq

Use the **MET SEC CZq** (*q* = 1–3) command to view the current magnitude, angle, CT ratio, and polarity of each terminal in check zone and the voltage in secondary values.

**Table 9.6 MET SEC CZq Command**

Command <sup>a</sup>	Description	Access Level
<b>MET SEC CZq</b>	Display secondary metering data for Check Zone <i>q</i> .	1, B, P, A, O, 2
<b>MET SEC CZq <i>k</i></b>	Display secondary metering data for Check Zone <i>q</i> successively for <i>k</i> times.	1, B, P, A, O, 2

<sup>a</sup> *q* = 1–3.

If an alias name for the terminal exists, the relay displays the alias name.

## MET SEC Zn

Use the **MET SEC Zn** command to view the current magnitude, angle, CT ratio, and polarity of each terminal in a particular protection zone (*n* = 1–6), the bus-zones in Protection Zone *n*, and the voltage in secondary values.

**Table 9.7 MET SEC Zn Command**

Command <sup>a</sup>	Description	Access Level
<b>MET SEC Zn</b>	Display secondary metering data.	1, B, P, A, O, 2
<b>MET SEC Zn <i>k</i></b>	Display secondary metering data successively for <i>k</i> times.	1, B, P, A, O, 2

<sup>a</sup> Parameter *n* is 1–6 to indicate 6 zones.

If an alias name for the terminal exists, the relay displays the alias name.

## MET Zn

Use the **MET Zn** command to view the current magnitude, angle, and polarity of each terminal in a particular protection zone (*n* = 1–6), the bus-zones in Protection Zone *n*, and the voltage in primary values.

**Table 9.8 MET Zn Command**

Command	Description	Access Level
<b>MET Zn</b>	Display primary metering data.	1, B, P, A, O, 2
<b>MET Zn k</b>	Display primary metering data successively for <i>k</i> times.	1, B, P, A, O, 2

If an alias name for the terminal exists, the relay displays the alias name.

## SET

Table 9.9 lists the options specifically available in the SEL-487B.

**Table 9.9 SET Command Overview**

Command	Description	Access Level
<b>SET</b>	Set the Group relay settings, beginning at the first setting in the active group.	P, 2
<b>SET n<sup>a</sup></b>	Set the Group <i>n</i> relay settings, beginning at the first setting in the group.	P, 2
<b>SET A</b>	Set the Automation SELOGIC control equation relay settings in Block 1.	A, 2
<b>SET A m<sup>b</sup></b>	Set the Automation SELOGIC control equation relay settings in Block <i>m</i> .	A, 2
<b>SET D</b>	Set the serial port DNP3 remapping settings, beginning at the first setting in this class.	P, A, O, 2
<b>SET F</b>	Set the Front Panel relay settings, beginning at the first setting in this class.	P, A, O, 2
<b>SET G</b>	Set the Global relay settings, beginning at the first setting in this class.	P, A, O, 2
<b>SET L</b>	Set the Protection SELOGIC control equation relay settings for the active group.	P, 2
<b>SET L n<sup>a</sup></b>	Set the Protection SELOGIC relay settings for Group <i>n</i> .	P, 2
<b>SET O</b>	Set the Output SELOGIC control equation relay settings, beginning at OUT101.	O, 2
<b>SET P</b>	Set the port presently in use, beginning at the first setting for this port.	P, A, O, 2
<b>SET P p<sup>c</sup></b>	Set the communications port relay settings for PORT <i>p</i> , beginning at the first setting for this port.	P, A, O, 2
<b>SET R</b>	Set the Report relay settings, beginning at the first setting for this class.	P, A, O, 2
<b>SET T</b>	Set the alias settings.	P, A, O, 2
<b>SET Z</b>	Set the active group zone configuration settings, beginning at the first setting.	P, 2
<b>SET Z n<sup>a</sup></b>	Set the configuration setting for Group <i>n</i> , beginning at the first setting.	P, 2

<sup>a</sup> Parameter *n* = 1–6, representing Group 1–Group 6.

<sup>b</sup> Parameter *m* = 1–10, representing Block 1–Block 10.

<sup>c</sup> Parameter *p* = 1–3, F, or 5, corresponding to PORT 1–PORT 3, PORT F, or PORT 5.

# SHOW

Table 9.10 lists the class and instance options available in the SEL-487B.

**Table 9.10 SHO Command Overview**

Command	Description	Access Level
<b>SHO</b>	Show the Group relay settings, beginning at the first setting in the active group.	1, B, P, A, O, 2
<b>SHO <i>n</i><sup>a</sup></b>	Show Group <i>n</i> settings, beginning at the first setting in Group <i>n</i> .	1, B, P, A, O, 2
<b>SHO A</b>	Show the Automation SELOGIC control equation relay settings in Block 1.	1, B, P, A, O, 2
<b>SHO A <i>m</i><sup>b</sup></b>	Show the Automation SELOGIC control equation relay settings in Block <i>m</i> .	1, B, P, A, O, 2
<b>SHO D</b>	Show the serial DNP3 remapping settings.	1, B, P, A, O, 2
<b>SHO F</b>	Show the Front Panel relay settings, beginning at the first setting in this class.	1, B, P, A, O, 2
<b>SHO G</b>	Show the Global relay settings, beginning at the first setting in this class.	1, B, P, A, O, 2
<b>SHO L</b>	Show the Protection SELOGIC control equation relay settings for the active group.	1, B, P, A, O, 2
<b>SHO L <i>n</i><sup>a</sup></b>	Show the Protection SELOGIC control equation relay settings for Group <i>n</i> .	1, B, P, A, O, 2
<b>SHO O</b>	Show the Output SELOGIC control equation relay settings, beginning at OUT101.	1, B, P, A, O, 2
<b>SHO P</b>	Show the relay settings for the port presently in use, beginning at the first setting.	1, B, P, A, O, 2
<b>SHO P <i>p</i><sup>c</sup></b>	Show the communications port relay settings for PORT <i>p</i> , beginning at the first setting for this port.	1, B, P, A, O, 2
<b>SHO R</b>	Show the Report relay settings, beginning at the first setting for this class.	1, B, P, A, O, 2
<b>SHO T</b>	Show the alias settings.	1, B, P, A, O, 2
<b>SHO Z</b>	Show the zone configuration settings for the active group.	1, B, P, A, O, 2
<b>SHO Z <i>n</i><sup>a</sup></b>	Show the zone configuration settings for Group <i>n</i> .	1, B, P, A, O, 2

<sup>a</sup> Parameter n = 1–6, representing Group 1–Group 6.

<sup>b</sup> Parameter m = 1–10, representing Block 1–Block 10.

<sup>c</sup> Parameter p = 1–3, F, and 5 which corresponds to PORT I–PORT 3, PORT F, and PORT 5.

# ZONE

The **ZONE** command causes the relay to display the active protection zones and the terminal and bus-zone names in each active protection zone, where active means a zone with at least one terminal in the zone.

Use the **ZON** command to display the terminal and bus-names associated with all active zones.

**Table 9.11 ZON Command**

Command	Description	Access Level
<b>ZON</b>	Display the terminal and bus-zone names associated with all active zones.	1, B, P, A, O, 2

## ZON T

Use the **ZON T** command to display the terminal names in each active zone, selected for tripping by differential and breaker failure protection.

**Table 9.12 ZON T Command**

Command	Description	Access Level
<b>ZON T</b>	Display the terminals programmed for tripping in all zones.	1, B, P, A, O, 2

When two zones combine, the combined zone includes the terminals from both merged zones. Not all terminals in the combined zone may be required to trip for a differential-element operation. **ZON T** provides a list of all terminals assigned to trip in all the zones at the station, and **ZON T k** provides a list of the terminals to trip in a specific zone.

## ZON k

Use the **ZON k** ( $k = 1\text{--}6$ ) command to display the terminals in Zone  $k$ , if Zone  $k$  is active.

**Table 9.13 ZON k Command**

Command	Description	Access Level
<b>ZON k<sup>a</sup></b>	Display the terminals in Zone $k$ .	1, B, P, A, O, 2

<sup>a</sup> Parameter  $k$  is 1–6.

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## S E C T I O N   1 0

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# Communications Interfaces

*Section 15: Communications Interfaces* through *Section 18: Synchrophasors in the SEL-400 Series Relays Instruction Manual* describe the various communications interfaces and protocols used in SEL-400 Series Relays. This section describes aspects of the communications protocols that are unique to the SEL-487B-2 Relay. The following topics are discussed:

- *Communications Database on page 10.1*
- *DNP3 Communication on page 10.6*
- *IEC 61850 Communication on page 10.13*

## Communications Database

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The SEL-487B maintains a database to describe itself to external devices via the SEL Fast Message Data Access protocol. This database includes a variety of data within the relay that are available to devices connected in a serial or Ethernet network. The database includes the regions and data described in *Table 10.1*. Use the **MAP** and **VIEW** commands to display maps and contents of the database regions. See *Section 14: ASCII Command Reference in the SEL-400 Series Relays Instruction Manual* for more information on the **MAP** and **VIEW** commands.

**Table 10.1 SEL-487B Database Regions**

Region Name	Contents	Update Rate
LOCAL	Relay identification data including FID, Relay ID, Station ID, and active protection settings group	Updated on settings change and whenever monitored values change
METER	Metering and measurement data	0.5 s
TARGET	Selected rows of Relay Word bit data	0.5 s
HISTORY	Relay event history records for the 10 most recent events	Within 15 s of any new event
STATUS	Self-test diagnostic status data	5 s
ANALOGS	Protection and automation math variables	0.5 s

Data within the Ethernet card regions are available for access by external devices via the SEL Fast Message protocol.

The LOCAL region contains the device FID, SID, and RID. It will also provide appropriate status points. This region is updated on settings changes and whenever monitored status points change (see *Table 10.2*).

**Table 10.2 SEL-487B Database Structure—LOCAL Region**

<b>Address (Hex)</b>	<b>Name</b>	<b>Type</b>	<b>Description</b>
0000	FID	char[48]	FID string
0030	BFID	char[48]	SELBOOT FID string
0060	SER_NUM	char[16]	Device Serial number, from factory settings
0070	PART_NUM	char[24]	Device part number, from factory settings
0088	CONFIG	char[8]	Device configuration string (as reported in <b>ID</b> command)
0090	SPECIAL	char[8]	Special device configuration string (as reported in <b>ID</b> command)
0098	DEVICE_ID	char[40]	Relay ID setting, from Global settings
00C0	NODE_ID	char[40]	Station ID from Global settings
00E8	GROUP	int	Active group
00E9	STATUS	int	Status indication: 0 for okay, 1 for failure

The METER region contains all the basic meter and energy information. This region is updated every 0.5 seconds. See *Table 10.3* for the map.

**Table 10.3 SEL-487B Database Structure—METER Region (Sheet 1 of 3)**

<b>Address (Hex)</b>	<b>Name</b>	<b>Type</b>	<b>Description</b>
1000	_YEAR	int	4-digit year when data were sampled
1001	DAY_OF_YEAR	int	1–366 day when data were sampled
1002	TIME(ms)	long int	Time of day in ms when data were sampled (0–86,400,000)
1004	FREQ	float	System frequency (Hertz)
1006	VDC	float	Battery voltage (Volts)
1008, 100A	I01	float[2]	I01 current magnitude (amperes primary) and phase (degrees)
100C, 100E	I02	float[2]	I02 current magnitude (amperes primary) and phase (degrees)
1010, 1012	I03	float[2]	I03 current magnitude (amperes primary) and phase (degrees)
1014, 1016	I04	float[2]	I04 current magnitude (amperes primary) and phase (degrees)
1018, 101A	I05	float[2]	I05 current magnitude (amperes primary) and phase (degrees)
101C, 101E	I06	float[2]	I06 current magnitude (amperes primary) and phase (degrees)
1020, 1022	I07	float[2]	I07 current magnitude (amperes primary) and phase (degrees)
1024, 1026	I08	float[2]	I08 current magnitude (amperes primary) and phase (degrees)
1028, 102A	I09	float[2]	I09 current magnitude (amperes primary) and phase (degrees)
102C, 102E	I10	float[2]	I10 current magnitude (amperes primary) and phase (degrees)
1030, 1032	I11	float[2]	I11 current magnitude (amperes primary) and phase (degrees)

**Table 10.3 SEL-487B Database Structure—METER Region (Sheet 2 of 3)**

<b>Address (Hex)</b>	<b>Name</b>	<b>Type</b>	<b>Description</b>
1034, 1036	I12	float[2]	I12 current magnitude (amperes primary) and phase (degrees)
1038, 103A	I13	float[2]	I13 current magnitude (amperes primary) and phase (degrees)
103C, 103E	I14	float[2]	I14 current magnitude (amperes primary) and phase (degrees)
1040, 1042	I15	float[2]	I15 current magnitude (amperes primary) and phase (degrees)
1044, 1046	I16	float[2]	I16 current magnitude (amperes primary) and phase (degrees)
1048, 104A	I17	float[2]	I17 current magnitude (amperes primary) and phase (degrees)
104C, 104E	I18	float[2]	I18 current magnitude (amperes primary) and phase (degrees)
1050, 1052	I19	float[2]	I19 current magnitude (amperes primary) and phase (degrees)
1054, 1056	I20	float[2]	I20 current magnitude (amperes primary) and phase (degrees)
1058, 105A	I21	float[2]	I21 current magnitude (amperes primary) and phase (degrees)
105C	RSRVD1	float[6]	Reserved for 3 future currents; always report as 0
1068, 106A	V01	float[2]	V01 voltage magnitude (Volts primary) and phase (degrees)
106C, 106E	V02	float[2]	V02 voltage magnitude (Volts primary) and phase (degrees)
1070, 1072	V03	float[2]	V03 voltage magnitude (Volts primary) and phase (degrees)
1074	RSRVD2	float[6]	Reserved for 3 future voltages; always report as 0
1080	IOP1	float	Zone 1 Operating Current (per unit)
1082	IOP2	float	Zone 2 Operating Current (per unit)
1084	IOP3	float	Zone 3 Operating Current (per unit)
1086	IOP4	float	Zone 4 Operating Current (per unit)
1088	IOP5	float	Zone 5 Operating Current (per unit)
108A	IOP6	float	Zone 6 Operating Current (per unit)
108C	IRT1	float	Zone 1 Restraint Current (per unit)
108E	IRT2	float	Zone 2 Restraint Current (per unit)
1090	IRT3	float	Zone 3 Restraint Current (per unit)
1092	IRT4	float	Zone 4 Restraint Current (per unit)
1094	IRT5	float	Zone 5 Restraint Current (per unit)
1096	IRT6	float	Zone 6 Restraint Current (per unit)
1098	IOPCZ1	float	Check Zone 1 Operating Current (per unit)
109A	IRTCZ1	float	Check Zone 1 Restraint Current (per unit)
109C	IOPCZ2	float	Check Zone 2 Operating Current (per unit)
109E	IRTCZ2	float	Check Zone 2 Restraint Current (per unit)

**Table 10.3 SEL-487B Database Structure—METER Region (Sheet 3 of 3)**

<b>Address (Hex)</b>	<b>Name</b>	<b>Type</b>	<b>Description</b>
10A0	IOPCZ3	float	Check Zone 3 Operating Current (per unit)
10A2	IRTCZ3	float	Check Zone 3 Restraint Current (per unit)

The TARGET region contains the entire visible Relay Word plus the rows designated specifically for the TARGET region. This region is updated every 0.5 seconds. See *Table 10.4* for the map. See *Section 11: Relay Word Bits* for detailed information on the Relay Word bits.

**Table 10.4 SEL-487B Database Structure—TARGET Region**

<b>Address (Hex)</b>	<b>Name</b>	<b>Type</b>	<b>Description</b>
3000	_YEAR	int	4-digit year when data were sampled
3001	DAY_OF_YEAR	int	1–366 day when data were sampled
3002	TIME(ms)	long int	Time of day in ms when data were sampled (0–86,400,000)
3004	TARGET	char[~543]	Entire Relay Word with bit labels

The HISTORY region contains all information available in a History report for the most recent 10 events. This region is updated within 15 seconds of any new events. See *Table 10.5* for the map.

**Table 10.5 SEL-487B Database Structure—HISTORY Region**

<b>Address (Hex)</b>	<b>Name</b>	<b>Type</b>	<b>Description</b>
4000	_YEAR	int	4-digit year when data were sampled
4001	DAY_OF_YEAR	int	1–366 day when data were sampled
4002	TIME(ms)	long int	Time of day in ms when data were sampled (0–86,400,000)
4004	REF_NUM	int[10]	Event serial number (10000–42767)
400E	MONTH	int[10]	Month of event
4018	DAY	int[10]	Day of event
4022	YEAR	int[10]	Year of event
402C	HOUR	int[10]	Hour of event
4036	MIN	int[10]	Minute of event
4040	SEC	int[10]	Second of event
404A	MSEC	int[10]	Milliseconds of event
4054	EVENT	char[100]	Event type string
40B8	GROUP	int[10]	Active group during fault
40C2	TARGETS	char[1000]	System targets from event (100 characters per event)

The STATUS region contains complete relay status information. This region is updated every 5 seconds. See *Table 10.6* for the map.

**Table 10.6 SEL-487B Database Structure—STATUS Region**

Address (Hex)	Name	Type	Description
6000	_YEAR	int	4-digit year when data were sampled
6001	DAY_OF_YEAR	int	1–366 day when data were sampled
6002	TIME(ms)	long int	Time of day in ms when data were sampled (0–86,400,000)
6004	CH1_24(mV)	int[24]	Channel offsets, use 0 if not measured
601C	MOF(mV)	int	Master offset
601D	MOF2(mV)	int	Master offset 2
601E	OFF_WARN	char[8]	Offset warning string
6026	OFF_FAIL	char[8]	Offset failure string
602E	PS3(V)	float	3.3 Volt power supply voltage
6030	PS5(V)	float	5 Volt power supply voltage
6032	PS_N5(V)	float	-5 Volt regulated voltage
6034	PS15(V)	float	15 Volt power supply voltage
6036	PS_N15(V)	float	-15 Volt power supply voltage
6038	PS_WARN	char[8]	Power supply warning string
6040	PS_FAIL	char[8]	Power supply failure string
6048	HW_FAIL	char[40]	Hardware failure strings
6070	CC_STA	char[40]	Comm. card status strings
6098	PORT_STA	char[160]	Serial port status strings
6138	TIME_SRC	char[10]	Time source
6142	LOG_ERR	char[40]	SELOGIC error strings
616A	TEST_MD	char[160]	Test mode string
620A	WARN	char[32]	Warning strings for any active warnings
622A	FAIL	char[64]	Failure strings for any active failures

The ANALOGS region contains protection and automation variables. This region is updated every 0.5 seconds. See *Table 10.7* for the map.

**Table 10.7 SEL-487B Database Structure—ANALOGS Region**

Address (Hex)	Name	Type	Description
7000	_YEAR	int	4-digit year when data were sampled
7001	DAY_OF_YEAR	int	1–366 day when data were sampled
7002	TIME(ms)	long int	Time of day in ms when data were sampled (0–86,400,000)
7004	PMV01_64	float[64]	PMV01–PMV64
7084	AMV001_256	float[256]	AMV001–AMV256

The database is virtual device 1 in the relay. You can display the contents of a region using the **MAP 1:region** command (where region is one of the database region names listed in *Table 10.1*). An example of the **MAP** command is shown in *Figure 10.1*.

```
=>>MAP 1:METER <Enter>
Virtual Device 1, Data Region METER Map

Data Item      Starting Address    Type
_____
_YEAR          1000h           int
_DAY_OF_YEAR   1001h           int
TIME(ms)       1002h           int[2]
FREQ           1004h           float
VDC            1006h           float
I01            1008h           float[2]
I02            100ch           float[2]
I03            1010h           float[2]
I04            1014h           float[2]
I05            1018h           float[2]
I06            101ch           float[2]
I07            1020h           float[2]
I08            1024h           float[2]
I09            1028h           float[2]
I10            102ch           float[2]
I11            1030h           float[2]
I12            1034h           float[2]
I13            1038h           float[2]
I14            103ch           float[2]
I15            1040h           float[2]
I16            1044h           float[2]
I17            1048h           float[2]
I18            104ch           float[2]
I19            1050h           float[2]
I20            1054h           float[2]
I21            1058h           float[2]
RSRVD1         105ch           float[6]
V01            1068h           float[2]
V02            106ch           float[2]
V03            1070h           float[2]
RSRVD2         1074h           float[6]
IOP1           1080h           float
IOP2           1082h           float
IOP3           1084h           float
IOP4           1086h           float
IOP5           1088h           float
IOP6           108ah           float
IRT1           108ch           float
IRT2           108eh           float
IRT3           1090h           float
IRT4           1092h           float
IRT5           1094h           float
IRT6           1096h           float
IOPCZ1         1098h           float
IRTCZ1         109ah           float
IOPCZ2         109ch           float
IRTCZ2         109eh           float
IOPCZ3         10a0h           float
IRTCZ3         10a2h           float
```

**Figure 10.1 MAP 1:METER Command Example**

## DNP3 Communication

DNP3 operation is described in *Section 16: DNP3 Communication* in the *SEL-400 Series Relay Instruction Manual*. This subsection describes aspects of DNP3 communications that are unique to the SEL-487B.

## Reference Data Map

*Table 10.8* shows the SEL-487B DNP3 reference data map. The reference data map contains all of the data available to the DNP3 protocol. You can use the default map or the custom DNP3 mapping functions of the SEL-487B to include only the points required by your application.

The entire Relay Word (*Table 11.1*) is part of the DNP3 reference map. You may include any label in the Relay Word as part of a DNP3 custom map. Note that Binary Inputs registered as SER points (SET R settings) will maintain SER-quality time stamps for DNP3 events.

The SEL-487B scales analog values by the indicated settings or fixed scaling. Analog inputs for event (fault) summary reporting use a default scale factor of 1 and dead band of ANADBM. Per-point scaling and deadband settings specified in a custom DNP3 map will override defaults.

**Table 10.8 SEL-487B DNP3 Reference Data Map (Sheet 1 of 3)**

Object	Label	Description
<b>Binary Inputs</b>		
01, 02	RLYDIS	Relay disabled
01, 02	STFAIL	Relay diagnostic failure
01, 02	STWARN	Relay diagnostic warning
01, 02	STSET	Settings change or relay restart
01, 02	UNRDEV	New relay event available
01, 02	NUNREV	An unread event exists, newer than the event in the event summary AIs
01, 02	Relay Word	Relay Word bit label. See <i>Section 11: Relay Word Bits</i> .
<b>Binary Outputs</b>		
10, 12	RB01–RB96	Remote bits RB01–RB96
10, 12	RB01:RB02 RB03:RB04 RB05:RB06 • • • RB93:RB94 RB95:RB96	Remote bit pairs RB01–RB96
10, 12	OC $n$	Pulse Open Circuit Breaker $n$ command, where $n = 1\text{--}21$
10, 12	OC $n$ :NOOP	Open/Close pair for Circuit Breaker $n$ , where $n = 1\text{--}21$ (the close portion has no action)
10, 12	RST_BAT	Reset battery monitor data
10, 12	RSTTRGT	Reset front-panel targets
10, 12	RSTDNPE	Reset (clear) DNP3 Event Summary AIs
10, 12	NXTEVE	Load next fault event into DNP3 Event Summary AIs
<b>Binary Counters</b>		
20, 22	ACTGRP	Active settings group
20, 22	ACN01CV–ACN32CV	Automation SELOGIC counter value 1–32
20, 22	PCN01CV–PCN32CV	Protection SELOGIC counter value 1–32
<b>Analog Inputs</b>		
30, 32	$I_{nn}FM^a$	1-cycle average phase current (magnitude), where $nn = 01\text{--}21$
30, 32	$I_{nn}FA^a$	1-cycle average phase current (angle), where $nn = 01\text{--}21$
30, 32	$V_{mm}FM^b$	1-cycle average phase voltage (magnitude), where $mm = 01\text{--}03$
30, 32	$V_{mm}FA^b$	1-cycle average phase voltage (angle), where $mm = 01\text{--}03$

**Table 10.8 SEL-487B DNP3 Reference Data Map (Sheet 2 of 3)**

<b>Object</b>	<b>Label</b>	<b>Description</b>
30, 32	DC1 <sup>c</sup>	Station battery 1 dc voltage
30, 32	IOPkF <sup>d</sup>	Zone <i>k</i> one-cycle average operating current ( <i>k</i> = 1–6)
30, 32	IRTkF <sup>d</sup>	Zone <i>k</i> one-cycle average restraint current ( <i>k</i> = 1–6)
30, 32	IOPCZpF <sup>d</sup>	Check Zone <i>p</i> one-cycle average operating current ( <i>p</i> = 1–3)
30, 32	IRTCZpF <sup>d</sup>	Check Zone <i>p</i> one-cycle average restraint current ( <i>p</i> = 1–3)
30, 32	PMV001–PMV064 <sup>c</sup>	Protection SELOGIC math variables
30, 32	AMV001–AMV256 <sup>c</sup>	Automation SELOGIC math variables
30, 32	PNC01CV–PNC32CV <sup>c</sup>	Protection SELOGIC counter current value
30, 32	TODMS <sup>c</sup>	UTC time of day in milliseconds (0–86400000)
30, 32	ANC01CV–ANC32CV <sup>c</sup>	Automation SELOGIC counter current value
30, 32	ACTGRP <sup>c</sup>	Active group setting
30, 32	THR <sup>c</sup>	UTC time, hour (0–23)
30, 32	TMIN <sup>c</sup>	UTC time, minute (0–59)
30, 32	TSEC <sup>c</sup>	UTC time, seconds (0–59)
30, 32	TMSEC <sup>c</sup>	UTC time, milliseconds (0–999)
30, 32	DDOM <sup>c</sup>	UTC date, day of the month (1–31)
30, 32	DMON <sup>c</sup>	UTC date, month (1–12)
30, 32	DYEAR <sup>c</sup>	UTC date, year (2000–2200)
30, 32	TLODMS <sup>c</sup>	Local time of day in milliseconds (0–86400000)
30, 32	TLHR <sup>c</sup>	Local time, hour (0–23)
30, 32	TLMIN <sup>c</sup>	Local time, minute (0–59)
30, 32	TLSEC <sup>c</sup>	Local time, seconds (0–59)
30, 32	TLMSEC <sup>c</sup>	Local time, milliseconds (0–999)
30, 32	DLDOMC <sup>c</sup>	Local date, day of the month (1–31)
30, 32	DLDYC <sup>c</sup>	Local date, day of the year (1–366)
30, 32	DLMONC <sup>c</sup>	Local date, month (1–12)
30, 32	DLYEAR <sup>c</sup>	Local date, year (2000–2200)
30, 32	RA001–RA256 <sup>c</sup>	Remote analogs from Ethernet card
30, 32	RAO01–RAO64 <sup>c</sup>	Remote analog output
30, 32	RLYTEMP <sup>c</sup>	Relay internal temperature (deg. C)
30, 32	MAXGRP	Maximum number of protection groups
<b>Event Summary Analog Inputs</b>		
30, 32 <sup>e</sup>	FTYPE <sup>c, e</sup>	Fault type
30, 32 <sup>e</sup>	FTAR1 <sup>c, e</sup>	Fault targets (upper byte is 1st target row, lower byte is 2nd target row)
30, 32 <sup>e</sup>	FTAR2 <sup>c, e</sup>	Fault targets (upper byte is 3rd target row, lower byte is 0)
30, 32 <sup>e</sup>	FGRPC, <sup>e</sup>	Fault settings group
30, 32 <sup>e</sup>	FTIMEUH, FTIMEUM, FTIMEUL <sup>c, e</sup>	Fault time (UTC) in DNP3 format—high, middle, and low 16 bits
30, 32 <sup>e</sup>	FTIMEH, FTIMEM, FTIMEL <sup>c, e</sup>	Fault time (local) in DNP3 format—high, middle, and low 16 bits
30, 32 <sup>e</sup>	FUNR <sup>c, e</sup>	Number of unread fault summaries

**Table 10.8 SEL-487B DNP3 Reference Data Map (Sheet 3 of 3)**

Object	Label	Description
<b>Analog Outputs</b>		
40, 41	ACTGRP	Active settings group
40, 41	RA001–RA256	Remote Analogs

<sup>a</sup> Default current scaling DECPLA on magnitudes and scale factor of 100 on angles. Deadband ANADBA on magnitudes and ANADBM on angles.<sup>b</sup> Default voltage scaling DECPLV on magnitudes and scale factor of 100 on angles. Deadband ANADBV on magnitudes and ANADBM on angles.<sup>c</sup> Default scale factor of 1 and deadband ANADBM.<sup>d</sup> Default miscellaneous scaling DECPLM and dead band ANADBM.<sup>e</sup> Event data shall be generated for all Event Summary Analog Inputs if any of them change beyond their dead band after scaling.

## Binary Outputs

Use the Trip and Close, Latch On/Off, and Pulse On operations with Object 12 control relay output block command messages to operate the points shown in *Table 10.9*. Pulse operations provide a pulse with a duration of one protection processing interval. Cancel an operation in progress by issuing a NUL Trip/Close Code with a NUL Operation Type.

**Table 10.9 SEL-487B Object 12 Control Operations**

Label	Close/Any	Trip/Any	NUL/Latch On	NUL/Latch Off	NUL/Pulse On	NUL/Pulse Off
RB01–RB96	Pulse on Remote Bit RB01–RB96	Pulse on Remote Bit RB01–RB96	Set Remote Bit RB01–RB96	Clear Remote Bit RB01–RB96	Pulse on Remote Bit RB01–RB96	Clear Remote Bit RB01–RB96
RB <sub>xx</sub> : RB <sub>yy</sub>	Pulse on RB <sub>yy</sub> RB01–RB96	Pulse on RB <sub>xx</sub> RB01–RB96	Pulse RB <sub>yy</sub>	Pulse RB <sub>xx</sub>	Pulse RB <sub>yy</sub>	Pulse RB <sub>xx</sub>
OC <sub>x</sub>	Open Circuit Breaker <i>x</i> (Pulse on OC <sub>x</sub> ) <i>x</i> = 01–21	Open Circuit Breaker <i>x</i> (Pulse on OC <sub>x</sub> ) <i>x</i> = 01–21	Set OC <sub>x</sub> <i>x</i> = 01–21	Clear OC <sub>x</sub> <i>x</i> = 01–21	Open Circuit Breaker <i>x</i> (Pulse on OC <sub>x</sub> ) <i>x</i> = 01–21	Clear OC <sub>x</sub> <i>x</i> = 01–21
OC <sub>x</sub> : NOOP	No action	Open Circuit Breaker <i>x</i> (Pulse on OC <sub>x</sub> ) <i>x</i> = 1–21	No action	Pulse On OC <sub>x</sub>	No action	Pulse OC <sub>x</sub>
RST_BAT	Reset battery monitoring	Reset breaker monitoring	Reset battery monitoring	No action	Reset battery monitoring	No action
RSTTRGT	Reset front-panel targets	Reset front-panel targets	Reset front-panel targets	No action	Reset front-panel targets	No action
RSTDNPE	Reset DNP3 event summary	Reset DNP3 event summary	Reset DNP3 event summary	No action	Reset DNP3 event summary	No action
NXTEVE	Load oldest unread relay event summary (FIFO)	Load oldest unread relay event summary (FIFO)	Load oldest unread relay event summary (FIFO)	Load newest relay event (LIFO)	Load oldest unread relay event summary (FIFO)	Load newest event summary (LIFO)

## Relay Fault Summary Data

When a relay event occurs (TRIP asserts, ER asserts, or TRI asserts), whose fault location is in the range of MINDIST to MAXDIST, the data shall be made available to DNP. If MINDIST is set to OFF, then there is no minimum. Similarly, if MAXDIST is set to OFF, there is no maximum.

In either mode, DNP3 events for all event summary analog inputs (see *Table 10.8*) will be generated if any of them change beyond their deadband value after scaling (usually whenever a new relay event occurs and is loaded into the event summary analog inputs). Events are detected approximately twice a second by the scanning process.

See *Table 10.10* for the components of the FTYPE analog input point. The bit asserted in the upper byte indicates the event cause (Trigger, Trip, ER element, etc.). The lower byte of FTYPE is always 0. If no bits are asserted in the upper byte, there is no valid fault summary loaded.

**Table 10.10 Object 30, 32, FTYPE Upper Byte-Event Cause**

Bit Position									Value	Event Cause
7	6	5	4	3	2	1	0			
								0	No fault summary loaded	
						X		1	Trigger command	
				X				4	Trip element	
			X					8	Event report element	
		X						16	Breaker failure trip	
	X							32	Differential trip	

## Default Data Map

*Table 10.11* shows the SEL-487B default DNP3 data map. The default data map is an automatically generated subset of the reference map. All data maps are initialized to the default values. If the default maps are not appropriate, you can also use the custom DNP mapping commands **SET D n** and **SHOW D n**, where *n* is the map number, to edit or create the map required for your application.

**Table 10.11 SEL-487B DNP3 Default Data Map (Sheet 1 of 4)**

Object	Index	Label	Description
<b>Binary Inputs</b>			
01, 02	0	RLYDIS	Relay disabled
01, 02	1	TRIPLED	Trip LED
01, 02	2	STFAIL	Relay diagnostic failure
01, 02	3	STWARN	Relay diagnostic warning
01, 02	4	STSET	Settings have changed or relay restarted
01, 02	5	SALARM	Software alarm
01, 02	6	HALARM	Hardware alarm
01, 02	7	BADPASS	Invalid password attempt alarm
01, 02	8	UNRDEV	Unread fault summary available
01, 02	9	OPH01	Terminal 1 open-phase detector
01, 02	10	OPH02	Terminal 2 open-phase detector
01, 02	11	OPH03	Terminal 3 open-phase detector
01, 02	12	OPH04	Terminal 4 open-phase detector
01, 02	13	OPH05	Terminal 5 open-phase detector
01, 02	14	OPH06	Terminal 6 open-phase detector
01, 02	15	52A01	Circuit Breaker 1 open status
01, 02	16	52AL01	Circuit Breaker 1 alarm
01, 02	17	52A02	Circuit Breaker 2 open status
01, 02	18	52AL02	Circuit Breaker 2 alarm
01, 02	19	52A03	Circuit Breaker 3 open status

**Table 10.11 SEL-487B DNP3 Default Data Map (Sheet 2 of 4)**

<b>Object</b>	<b>Index</b>	<b>Label</b>	<b>Description</b>
01, 02	20	52AL03	Circuit Breaker 3 alarm
01, 02	21	52A04	Circuit Breaker 4 open status
01, 02	22	52AL04	Circuit Breaker 4 alarm
01, 02	23	89A01	Disconnect 1 closed status
01, 02	24	89AL01	Disconnect 1 alarm
01, 02	25	89A02	Disconnect 2 closed status
01, 02	26	89AL02	Disconnect 2 alarm
01, 02	27	89A03	Disconnect 3 closed status
01, 02	28	89AL03	Disconnect 3 alarm
01, 02	29	89A04	Disconnect 4 closed status
01, 02	30	89AL04	Disconnect 4 alarm
01, 02	31	89A05	Disconnect 5 closed status
01, 02	32	89AL05	Disconnect 5 alarm
01, 02	33	89A06	Disconnect 6 closed status
01, 02	34	89AL06	Disconnect 6 alarm
01, 02	35	89A07	Disconnect 7 closed status
01, 02	36	89AL07	Disconnect 7 alarm
01, 02	37	89A08	Disconnect 8 closed status
01, 02	38	89AL08	Disconnect 8 alarm
01, 02	39	TLED_1	Target LED 1 on relay front panel
01, 02	40	TLED_2	Target LED 2 on relay front panel
01, 02	41	TLED_3	Target LED 3 on relay front panel
01, 02	42	TLED_4	Target LED 4 on relay front panel
01, 02	43	TLED_5	Target LED 5 on relay front panel
01, 02	44	TLED_6	Target LED 6 on relay front panel
01, 02	45	TLED_7	Target LED 7 on relay front panel
01, 02	46	TLED_8	Target LED 8 on relay front panel
01, 02	47	TLED_9	Target LED 9 on relay front panel
01, 02	48	TLED_10	Target LED 10 on relay front panel
01, 02	49	TLED_11	Target LED 11 on relay front panel
01, 02	50	TLED_12	Target LED 12 on relay front panel
01, 02	51	TLED_13	Target LED 13 on relay front panel
01, 02	52	TLED_14	Target LED 14 on relay front panel
01, 02	53	TLED_15	Target LED 15 on relay front panel
01, 02	54	TLED_16	Target LED 16 on relay front panel
01, 02	55	IN201	Optional I/O Board 1
01, 02	56	IN202	Optional I/O Board 2
01, 02	57	IN203	Optional I/O Board 3
01, 02	58	IN204	Optional I/O Board 4
01, 02	59	IN205	Optional I/O Board 5
01, 02	60	IN206	Optional I/O Board 6

**Table 10.11 SEL-487B DNP3 Default Data Map (Sheet 3 of 4)**

<b>Object</b>	<b>Index</b>	<b>Label</b>	<b>Description</b>
01, 02	61	IN207	Optional I/O Board 7
01, 02	62	PSV01	Protection SELOGIC Variable 1
01, 02	63	PSV02	Protection SELOGIC Variable 2
01, 02	64	PSV03	Protection SELOGIC Variable 3
01, 02	65	PSV04	Protection SELOGIC Variable 4
01, 02	66	PSV05	Protection SELOGIC Variable 5
01, 02	67	PSV06	Protection SELOGIC Variable 6
01, 02	68	PSV07	Protection SELOGIC Variable 7
01, 02	69	PSV08	Protection SELOGIC Variable 8
01, 02	70	ASV001	Automation SELOGIC Variable 1
01, 02	71	ASV002	Automation SELOGIC Variable 2
01, 02	72	ASV003	Automation SELOGIC Variable 3
01, 02	73	ASV004	Automation SELOGIC Variable 4
01, 02	74	ASV005	Automation SELOGIC Variable 5
01, 02	75	ASV006	Automation SELOGIC Variable 6
01, 02	76	ASV007	Automation SELOGIC Variable 7
01, 02	77	ASV008	Automation SELOGIC Variable 8
01, 02	78	OUT201	Optional I/O Board 1
01, 02	79	OUT202	Optional I/O Board 2
01, 02	80	OUT203	Optional I/O Board 3
01, 02	81	OUT204	Optional I/O Board 4
01, 02	82	OUT205	Optional I/O Board 5
01, 02	83	OUT206	Optional I/O Board 6
01, 02	84	OUT207	Optional I/O Board 7
<b>Binary Outputs</b>			
10, 12	0–31	RB01–RB32	Remote bits RB01–RB32
10, 12	32	OC01	Pulse Open Circuit Breaker 1 command
10, 12	33	OC02	Pulse Open Circuit Breaker 2 command
10, 12	34	OC03	Pulse Open Circuit Breaker 3 command
10, 12	35	OC04	Pulse Open Circuit Breaker 4 command
10, 12	36	RST_BAT	Reset battery monitor data
10, 12	37	RSTTRGT	Reset front-panel targets
10, 12	38	RSTDNPE	Reset (clear) DNP3 Event Summary AIs
<b>Binary Counters</b>			
20, 22	0	ACTGRP	Active settings group
<b>Analog Inputs</b>			
30, 32	0	I01FM	1-cycle average Terminal 1 current (magnitude)
30, 32	1	I01FA	1-cycle average Terminal 1 current (angle)
30, 32	2	I02FM	1-cycle average Terminal 2 current (magnitude)
30, 32	3	I02FA	1-cycle average Terminal 2 current (angle)
30, 32	4	I03FM	1-cycle average Terminal 3 current (magnitude)

**Table 10.11 SEL-487B DNP3 Default Data Map (Sheet 4 of 4)**

<b>Object</b>	<b>Index</b>	<b>Label</b>	<b>Description</b>
30, 32	5	I03FA	1-cycle average Terminal 3 current (angle)
30, 32	6	I04FM	1-cycle average Terminal 4 current (magnitude)
30, 32	7	I04FA	1-cycle average Terminal 4 current (angle)
30, 32	8	I05FM	1-cycle average Terminal 5 current (magnitude)
30, 32	9	I05FA	1-cycle average Terminal 5 current (angle)
30, 32	10	I06FM	1-cycle average Terminal 6 current (magnitude)
30, 32	11	I06FA	1-cycle average Terminal 6 current (angle)
30, 32	12	V01FM	1-cycle average Terminal 1 voltage (magnitude)
30, 32	13	V01FA	1-cycle average Terminal 1 voltage (angle)
30, 32	14	V02FM	1-cycle average Terminal 2 voltage (magnitude)
30, 32	15	V02FA	1-cycle average Terminal 2 voltage (angle)
30, 32	16	V03FM	1-cycle average Terminal 3 voltage (magnitude)
30, 32	17	V03FA	1-cycle average Terminal 3 voltage (angle)
30, 32	18	FTYPE	Fault type
30, 32	19	FTAR1	Fault targets (Upper byte is 1st target row, lower byte is 2nd target row)
30, 32	20	FTAR2	Fault targets (Upper byte is 3rd target row, lower byte is 0)
30, 32	21	FGRP	Fault settings group
30, 32	22	FTIMEUH	Fault time (UTC) in DNP3 format (high 16 bits)
30, 32	23	FTIMEUM	Fault time (UTC) in DNP3 format (middle 16 bits)
30, 32	24	FTIMEUL	Fault time (UTC) in DNP3 format (low 16 bits)
30, 32	25	FUNR	Number of unread fault summaries
30, 32	26	RLYTEMP	Internal box temperature in degrees Celsius
<b>Analog Outputs</b>			
40, 41	0	ACTGRP	Active settings group

## IEC 61850 Communication

General IEC 61850 operation is described in *Section 17: IEC 61850 Communication in the SEL-400 Series Relays Instruction Manual*. This section describes characteristics of IEC 61850 that are specific to the SEL-487B.

### Logical Nodes

*Table 10.12–Table 10.13* show the logical nodes (LNs) supported in the SEL-487B and the Relay Word bits or Measured Values mapped to those LNs. Additionally, the relay supports the CFG Logical Device logical nodes as described in *Section 17: IEC 61850 Communication in the SEL-400 Series Relays Instruction Manual*.

*Table 10.12* shows the LNs associated with protection elements, defined as Logical Device PRO.

**Table 10.12 Logical Device: PRO (Protection) (Sheet 1 of 10)**

<b>Logical Node</b>	<b>Attribute</b>	<b>Data Source</b>	<b>Comment</b>
<b>Functional Constraint = CO</b>			
BKRCSWI1	Pos.Oper.ctlVal	OC01:NOOP <sup>a</sup>	Circuit Breaker 1 open command
BKRCSWI2	Pos.Oper.ctlVal	OC02:NOOP <sup>a</sup>	Circuit Breaker 2 open command
BKRCSWI3	Pos.Oper.ctlVal	OC03:NOOP <sup>a</sup>	Circuit Breaker 3 open command
BKRCSWI4	Pos.Oper.ctlVal	OC04:NOOP <sup>a</sup>	Circuit Breaker 4 open command
BKRCSWI5	Pos.Oper.ctlVal	OC05:NOOP <sup>a</sup>	Circuit Breaker 5 open command
BKRCSWI6	Pos.Oper.ctlVal	OC06:NOOP <sup>a</sup>	Circuit Breaker 6 open command
BKRCSWI7	Pos.Oper.ctlVal	OC07:NOOP <sup>a</sup>	Circuit Breaker 7 open command
BKRCSWI8	Pos.Oper.ctlVal	OC08:NOOP <sup>a</sup>	Circuit Breaker 8 open command
BKRCSWI9	Pos.Oper.ctlVal	OC09:NOOP <sup>a</sup>	Circuit Breaker 9 open command
BKRCSWI10	Pos.Oper.ctlVal	OC10:NOOP <sup>a</sup>	Circuit Breaker 10 open command
BKRCSWI11	Pos.Oper.ctlVal	OC11:NOOP <sup>a</sup>	Circuit Breaker 11 open command
BKRCSWI12	Pos.Oper.ctlVal	OC12:NOOP <sup>a</sup>	Circuit Breaker 12 open command
BKRCSWI13	Pos.Oper.ctlVal	OC13:NOOP <sup>a</sup>	Circuit Breaker 13 open command
BKRCSWI14	Pos.Oper.ctlVal	OC14:NOOP <sup>a</sup>	Circuit Breaker 14 open command
BKRCSWI15	Pos.Oper.ctlVal	OC15:NOOP <sup>a</sup>	Circuit Breaker 15 open command
BKRCSWI16	Pos.Oper.ctlVal	OC16:NOOP <sup>a</sup>	Circuit Breaker 16 open command
BKRCSWI17	Pos.Oper.ctlVal	OC17:NOOP <sup>a</sup>	Circuit Breaker 17 open command
BKRCSWI18	Pos.Oper.ctlVal	OC18:NOOP <sup>a</sup>	Circuit Breaker 18 open command
BKRCSWI19	Pos.Oper.ctlVal	OC19:NOOP <sup>a</sup>	Circuit Breaker 19 open command
BKRCSWI20	Pos.Oper.ctlVal	OC20:NOOP <sup>a</sup>	Circuit Breaker 20 open command
BKRCSWI21	Pos.Oper.ctlVal	OC21:NOOP <sup>a</sup>	Circuit Breaker 21 open command
<b>Functional Constraint = ST</b>			
BFR1RBRF1	Str.general	BFI01	Circuit Breaker 1 breaker failure initiate SELOGIC control equation
BFR1RBRF1	OpEx.general	FBF01	Circuit Breaker 1 failure
BFR1RBRF1	OpIn.general	RT01	Circuit Breaker 1 retrip
BFR2RBRF2	Str.general	BFI02	Circuit Breaker 2 breaker failure initiate SELOGIC control equation
BFR2RBRF2	OpEx.general	FBF02	Circuit Breaker 2 failure
BFR2RBRF2	OpIn.general	RT02	Circuit Breaker 2 retrip
BFR3RBRF3	Str.general	BFI03	Circuit Breaker 3 breaker failure initiate SELOGIC control equation
BFR3RBRF3	OpEx.general	FBF03	Circuit Breaker 3 failure
BFR3RBRF3	OpIn.general	RT03	Circuit Breaker 3 retrip
BFR4RBRF4	Str.general	BFI04	Circuit Breaker 4 breaker failure initiate SELOGIC control equation
BFR4RBRF4	OpEx.general	FBF04	Circuit Breaker 4 failure
BFR4RBRF4	OpIn.general	RT04	Circuit Breaker 4 retrip
BFR5RBRF5	Str.general	BFI05	Circuit Breaker 5 breaker failure initiate SELOGIC control equation
BFR5RBRF5	OpEx.general	FBF05	Circuit Breaker 5 failure
BFR5RBRF5	OpIn.general	RT05	Circuit Breaker 5 retrip
BFR6RBRF6	Str.general	BFI06	Circuit Breaker 6 breaker failure initiate SELOGIC control equation
BFR6RBRF6	OpEx.general	FBF06	Circuit Breaker 6 failure
BFR6RBRF6	OpIn.general	RT06	Circuit Breaker 6 retrip

**Table 10.12 Logical Device: PRO (Protection) (Sheet 2 of 10)**

<b>Logical Node</b>	<b>Attribute</b>	<b>Data Source</b>	<b>Comment</b>
BFR7RBRF7	Str.general	BFI07	Circuit Breaker 7 breaker failure initiate SELOGIC control equation
BFR7RBRF7	OpEx.general	FBF07	Circuit Breaker 7 failure
BFR7RBRF7	OpIn.general	RT07	Circuit Breaker 7 retrip
BFR8RBRF8	Str.general	BFI08	Circuit Breaker 8 breaker failure initiate SELOGIC control equation
BFR8RBRF8	OpEx.general	FBF08	Circuit Breaker 8 failure
BFR8RBRF8	OpIn.general	RT08	Circuit Breaker 8 retrip
BFR9RBRF9	Str.general	BFI09	Circuit Breaker 9 breaker failure initiate SELOGIC control equation
BFR9RBRF9	OpEx.general	FBF09	Circuit Breaker 9 failure
BFR9RBRF9	OpIn.general	RT09	Circuit Breaker 9 retrip
BFR10RBRF10	Str.general	BFI10	Circuit Breaker 10 breaker failure initiate SELOGIC control equation
BFR10RBRF10	OpEx.general	FBF10	Circuit Breaker 10 failure
BFR10RBRF10	OpIn.general	RT10	Circuit Breaker 10 retrip
BFR11RBRF11	Str.general	BFI11	Circuit Breaker 11 breaker failure initiate SELOGIC control equation
BFR11RBRF11	OpEx.general	FBF11	Circuit Breaker 11 failure
BFR11RBRF11	OpIn.general	RT11	Circuit Breaker 11 retrip
BFR12RBRF12	Str.general	BFI12	Circuit Breaker 12 breaker failure initiate SELOGIC control equation
BFR12RBRF12	OpEx.general	FBF12	Circuit Breaker 12 failure
BFR12RBRF12	OpIn.general	RT12	Circuit Breaker 12 retrip
BFR13RBRF13	Str.general	BFI13	Circuit Breaker 13 breaker failure initiate SELOGIC control equation
BFR13RBRF13	OpEx.general	FBF13	Circuit Breaker 13 failure
BFR13RBRF13	OpIn.general	RT13	Circuit Breaker 13 retrip
BFR14RBRF14	Str.general	BFI14	Circuit Breaker 14 breaker failure initiate SELOGIC control equation
BFR14RBRF14	OpEx.general	FBF14	Circuit Breaker 14 failure
BFR14RBRF14	OpIn.general	RT14	Circuit Breaker 14 retrip
BFR15RBRF15	Str.general	BFI15	Circuit Breaker 15 breaker failure initiate SELOGIC control equation
BFR15RBRF15	OpEx.general	FBF15	Circuit Breaker 15 failure
BFR15RBRF15	OpIn.general	RT15	Circuit Breaker 15 retrip
BFR16RBRF16	Str.general	BFI16	Circuit Breaker 16 breaker failure initiate SELOGIC control equation
BFR16RBRF16	OpEx.general	FBF16	Circuit Breaker 16 failure
BFR16RBRF16	OpIn.general	RT16	Circuit Breaker 16 retrip
BFR17RBRF17	Str.general	BFI17	Circuit Breaker 17 breaker failure initiate SELOGIC control equation
BFR17RBRF17	OpEx.general	FBF17	Circuit Breaker 17 failure
BFR17RBRF17	OpIn.general	RT17	Circuit Breaker 17 retrip
BFR18RBRF18	Str.general	BFI18	Circuit Breaker 18 breaker failure initiate SELOGIC control equation
BFR18RBRF18	OpEx.general	FBF18	Circuit Breaker 18 failure
BFR18RBRF18	OpIn.general	RT18	Circuit Breaker 18 retrip
BFR19RBRF19	Str.general	BFI19	Circuit Breaker 19 breaker failure initiate SELOGIC control equation
BFR19RBRF19	OpEx.general	FBF19	Circuit Breaker 19 failure
BFR19RBRF19	OpIn.general	RT19	Circuit Breaker 19 retrip
BFR20RBRF20	Str.general	BFI20	Circuit Breaker 20 breaker failure initiate SELOGIC control equation
BFR20RBRF20	OpEx.general	FBF20	Circuit Breaker 20 failure

**Table 10.12 Logical Device: PRO (Protection) (Sheet 3 of 10)**

<b>Logical Node</b>	<b>Attribute</b>	<b>Data Source</b>	<b>Comment</b>
BFR20RBRF20	OpIn.general	RT20	Circuit Breaker 20 retrip
BFR21RBRF21	Str.general	BFI21	Circuit Breaker 21 breaker failure initiate SELOGIC control equation
BFR21RBRF21	OpEx.general	FBF21	Circuit Breaker 21 failure
BFR21RBRF21	OpIn.general	RT21	Circuit Breaker 21 retrip
BKRCSWI1	Loc.stVal	LOC	Control authority at local (bay) level
BKRCSWI1	LocSta.stVal	LOCSTA	Control authority at station level
BKRCSWI1	OpOpn.general	OC01	Circuit Breaker 01 open command
BKRCSWI1	Pos.stVal	52CL01?1:2 <sup>b</sup>	Circuit Breaker 01 closed
BKRCSWI2	Loc.stVal	LOC	Control authority at local (bay) level
BKRCSWI2	LocSta.stVal	LOCSTA	Control authority at station level
BKRCSWI2	OpOpn.general	OC02	Circuit Breaker 02 open command
BKRCSWI2	Pos.stVal	52CL02?1:2 <sup>b</sup>	Circuit Breaker 02 closed
BKRCSWI3	Loc.stVal	LOC	Control authority at local (bay) level
BKRCSWI3	LocSta.stVal	LOCSTA	Control authority at station level
BKRCSWI3	OpOpn.general	OC03	Circuit Breaker 03 open command
BKRCSWI3	Pos.stVal	52CL03?1:2 <sup>b</sup>	Circuit Breaker 03 closed
BKRCSWI4	Loc.stVal	LOC	Control authority at local (bay) level
BKRCSWI4	LocSta.stVal	LOCSTA	Control authority at station level
BKRCSWI4	OpOpn.general	OC04	Circuit Breaker 04 open command
BKRCSWI4	Pos.stVal	52CL04?1:2 <sup>b</sup>	Circuit Breaker 04 closed
BKRCSWI5	Loc.stVal	LOC	Control authority at local (bay) level
BKRCSWI5	LocSta.stVal	LOCSTA	Control authority at station level
BKRCSWI5	OpOpn.general	OC05	Circuit Breaker 05 open command
BKRCSWI5	Pos.stVal	52CL05?1:2 <sup>b</sup>	Circuit Breaker 05 closed
BKRCSWI6	Loc.stVal	LOC	Control authority at local (bay) level
BKRCSWI6	LocSta.stVal	LOCSTA	Control authority at station level
BKRCSWI6	OpOpn.general	OC06	Circuit Breaker 06 open command
BKRCSWI6	Pos.stVal	52CL06?1:2 <sup>b</sup>	Circuit Breaker 06 closed
BKRCSWI7	Loc.stVal	LOC	Control authority at local (bay) level
BKRCSWI7	LocSta.stVal	LOCSTA	Control authority at station level
BKRCSWI7	OpOpn.general	OC07	Circuit Breaker 07 open command
BKRCSWI7	Pos.stVal	52CL07?1:2 <sup>b</sup>	Circuit Breaker 07 closed
BKRCSWI8	Loc.stVal	LOC	Control authority at local (bay) level
BKRCSWI8	LocSta.stVal	LOCSTA	Control authority at station level
BKRCSWI8	OpOpn.general	OC08	Circuit Breaker 08 open command
BKRCSWI8	Pos.stVal	52CL08?1:2 <sup>b</sup>	Circuit Breaker 08 closed
BKRCSWI9	Loc.stVal	LOC	Control authority at local (bay) level
BKRCSWI9	LocSta.stVal	LOCSTA	Control authority at station level
BKRCSWI9	OpOpn.general	OC09	Circuit Breaker 09 open command
BKRCSWI9	Pos.stVal	52CL09?1:2 <sup>b</sup>	Circuit Breaker 09 closed
BKRCSWI10	Loc.stVal	LOC	Control authority at local (bay) level

**Table 10.12 Logical Device: PRO (Protection) (Sheet 4 of 10)**

<b>Logical Node</b>	<b>Attribute</b>	<b>Data Source</b>	<b>Comment</b>
BKRCSWI10	LocSta.stVal	LOCSTA	Control authority at station level
BKRCSWI10	OpOpn.general	OC10	Circuit Breaker 10 open command
BKRCSWI10	Pos.stVal	52CL10?1:2 <sup>b</sup>	Circuit Breaker 10 closed
BKRCSWI11	Loc.stVal	LOC	Control authority at local (bay) level
BKRCSWI11	LocSta.stVal	LOCSTA	Control authority at station level
BKRCSWI11	OpOpn.general	OC11	Circuit Breaker 11 open command
BKRCSWI11	Pos.stVal	52CL11?1:2 <sup>b</sup>	Circuit Breaker 11 closed
BKRCSWI12	Loc.stVal	LOC	Control authority at local (bay) level
BKRCSWI12	LocSta.stVal	LOCSTA	Control authority at station level
BKRCSWI12	OpOpn.general	OC12	Circuit Breaker 12 open command
BKRCSWI12	Pos.stVal	52CL12?1:2 <sup>b</sup>	Circuit Breaker 12 closed
BKRCSWI13	Loc.stVal	LOC	Control authority at local (bay) level
BKRCSWI13	LocSta.stVal	LOCSTA	Control authority at station level
BKRCSWI13	OpOpn.general	OC13	Circuit Breaker 13 open command
BKRCSWI13	Pos.stVal	52CL13?1:2 <sup>b</sup>	Circuit Breaker 13 closed
BKRCSWI14	Loc.stVal	LOC	Control authority at local (bay) level
BKRCSWI14	LocSta.stVal	LOCSTA	Control authority at station level
BKRCSWI14	OpOpn.general	OC14	Circuit Breaker 14 open command
BKRCSWI14	Pos.stVal	52CL14?1:2 <sup>b</sup>	Circuit Breaker 14 closed
BKRCSWI15	Loc.stVal	LOC	Control authority at local (bay) level
BKRCSWI15	LocSta.stVal	LOCSTA	Control authority at station level
BKRCSWI15	OpOpn.general	OC15	Circuit Breaker 15 open command
BKRCSWI15	Pos.stVal	52CL15?1:2 <sup>b</sup>	Circuit Breaker 15 closed
BKRCSWI16	Loc.stVal	LOC	Control authority at local (bay) level
BKRCSWI16	LocSta.stVal	LOCSTA	Control authority at station level
BKRCSWI16	OpOpn.general	OC16	Circuit Breaker 16 open command
BKRCSWI16	Pos.stVal	52CL16?1:2 <sup>b</sup>	Circuit Breaker 16 closed
BKRCSWI17	Loc.stVal	LOC	Control authority at local (bay) level
BKRCSWI17	LocSta.stVal	LOCSTA	Control authority at station level
BKRCSWI17	OpOpn.general	OC17	Circuit Breaker 17 open command
BKRCSWI17	Pos.stVal	52CL17?1:2 <sup>b</sup>	Circuit Breaker 17 closed
BKRCSWI18	Loc.stVal	LOC	Control authority at local (bay) level
BKRCSWI18	LocSta.stVal	LOCSTA	Control authority at station level
BKRCSWI18	OpOpn.general	OC18	Circuit Breaker 18 open command
BKRCSWI18	Pos.stVal	52CL18?1:2 <sup>b</sup>	Circuit Breaker 18 closed
BKRCSWI19	Loc.stVal	LOC	Control authority at local (bay) level
BKRCSWI19	LocSta.stVal	LOCSTA	Control authority at station level
BKRCSWI19	OpOpn.general	OC19	Circuit Breaker 19 open command
BKRCSWI19	Pos.stVal	52CL19?1:2 <sup>b</sup>	Circuit Breaker 19 closed
BKRCSWI20	Loc.stVal	LOC	Control authority at local (bay) level
BKRCSWI20	LocSta.stVal	LOCSTA	Control authority at station level

**Table 10.12 Logical Device: PRO (Protection) (Sheet 5 of 10)**

<b>Logical Node</b>	<b>Attribute</b>	<b>Data Source</b>	<b>Comment</b>
BKRCSWI20	OpOpn.general	OC20	Circuit Breaker 20 open command
BKRCSWI20	Pos.stVal	52CL20?1:2 <sup>b</sup>	Circuit Breaker 20 closed
BKRCSWI21	Loc.stVal	LOC	Control authority at local (bay) level
BKRCSWI21	LocSta.stVal	LOCSTA	Control authority at station level
BKRCSWI21	OpOpn.general	OC21	Circuit Breaker 21 open command
BKRCSWI21	Pos.stVal	52CL21?1:2 <sup>b</sup>	Circuit Breaker 21 closed
D87RPDIF1	Op.general	87R1	Zone 1 restraint differential-element picked up
D87RPDIF1	Str.general	P87R1	Zone 1 instantaneous differential-element picked up
D87RPDIF2	Op.general	87R2	Zone 2 restraint differential-element picked up
D87RPDIF2	Str.general	P87R2	Zone 2 instantaneous differential-element picked up
D87RPDIF3	Op.general	87R3	Zone 3 restraint differential-element picked up
D87RPDIF3	Str.general	P87R3	Zone 3 instantaneous differential-element picked up
D87RPDIF4	Op.general	87R4	Zone 4 restraint differential-element picked up
D87RPDIF4	Str.general	P87R4	Zone 4 instantaneous differential-element picked up
D87RPDIF5	Op.general	87R5	Zone 5 restraint differential-element picked up
D87RPDIF5	Str.general	P87R5	Zone 5 instantaneous differential-element picked up
D87RPDIF6	Op.general	87R6	Zone 6 restraint differential-element picked up
D87RPDIF6	Str.general	P87R6	Zone 6 instantaneous differential-element picked up
FLTRDRE1	FltTyp.stVal	FLTYPE <sup>c</sup>	Affected phases for the latest event
FLTRDRE1	FltCaus.stVal	FLTCAUS <sup>d</sup>	Event cause for the latest event
FLTRDRE1	FltNum.stVal	FLRNUM	Event number
FLTRDRE1	RcdMade.stVal	FLREP	Event report present
LLN0	Loc.stVal	LOC	Control authority at local (bay) level
LLN0	LocSta.stVal	LOCSTA	Control authority at station level
LLN0	Mod.stVal	I60MOD <sup>e</sup>	IEC 61850 Mode/Behavior status
PROLPHD1	PhyHealth.stVal	EN?3:1 <sup>f</sup>	Relay enabled
T87ZPTRC1	Tr.general	87Z1	Zone 1 differential-element trip
T87ZPTRC2	Tr.general	87Z2	Zone 2 differential-element trip
T87ZPTRC3	Tr.general	87Z3	Zone 3 differential-element trip
T87ZPTRC4	Tr.general	87Z4	Zone 4 differential-element trip
T87ZPTRC5	Tr.general	87Z5	Zone 5 differential-element trip
T87ZPTRC6	Tr.general	87Z6	Zone 6 differential-element trip
TRIPPTRC7	Tr.general	TRIP01	Terminal 01 trip output
TRIPPTRC8	Tr.general	TRIP02	Terminal 02 trip output
TRIPPTRC9	Tr.general	TRIP03	Terminal 03 trip output
TRIPPTRC10	Tr.general	TRIP04	Terminal 04 trip output
TRIPPTRC11	Tr.general	TRIP05	Terminal 05 trip output
TRIPPTRC12	Tr.general	TRIP06	Terminal 06 trip output
TRIPPTRC13	Tr.general	TRIP07	Terminal 07 trip output
TRIPPTRC14	Tr.general	TRIP08	Terminal 08 trip output
TRIPPTRC15	Tr.general	TRIP09	Terminal 09 trip output

**Table 10.12 Logical Device: PRO (Protection) (Sheet 6 of 10)**

<b>Logical Node</b>	<b>Attribute</b>	<b>Data Source</b>	<b>Comment</b>
TRIPPTRC16	Tr.general	TRIP10	Terminal 10 trip output
TRIPPTRC17	Tr.general	TRIP11	Terminal 11 trip output
TRIPPTRC18	Tr.general	TRIP12	Terminal 12 trip output
TRIPPTRC19	Tr.general	TRIP13	Terminal 13 trip output
TRIPPTRC20	Tr.general	TRIP14	Terminal 14 trip output
TRIPPTRC21	Tr.general	TRIP15	Terminal 15 trip output
TRIPPTRC22	Tr.general	TRIP16	Terminal 16 trip output
TRIPPTRC23	Tr.general	TRIP17	Terminal 17 trip output
TRIPPTRC24	Tr.general	TRIP18	Terminal 18 trip output
TRIPPTRC25	Tr.general	TRIP19	Terminal 19 trip output
TRIPPTRC26	Tr.general	TRIP20	Terminal 20 trip output
TRIPPTRC27	Tr.general	TRIP21	Terminal 21 trip output
X52AXCBR1	Loc.stVal	LOC	IED local status
X52AXCBR1	Pos.stVal	52CL01?1:2 <sup>b</sup>	Circuit Breaker 01 closed
X52AXCBR2	Loc.stVal	LOC	IED local status
X52AXCBR2	Pos.stVal	52CL02?1:2 <sup>b</sup>	Circuit Breaker 02 closed
X52AXCBR3	Loc.stVal	LOC	IED local status
X52AXCBR3	Pos.stVal	52CL03?1:2 <sup>b</sup>	Circuit Breaker 03 closed
X52AXCBR4	Loc.stVal	LOC	IED local status
X52AXCBR4	Pos.stVal	52CL04?1:2 <sup>b</sup>	Circuit Breaker 04 closed
X52AXCBR5	Loc.stVal	LOC	IED local status
X52AXCBR5	Pos.stVal	52CL05?1:2 <sup>b</sup>	Circuit Breaker 05 closed
X52AXCBR6	Loc.stVal	LOC	IED local status
X52AXCBR6	Pos.stVal	52CL06?1:2 <sup>b</sup>	Circuit Breaker 06 closed
X52AXCBR7	Loc.stVal	LOC	IED local status
X52AXCBR7	Pos.stVal	52CL07?1:2 <sup>b</sup>	Circuit Breaker 07 closed
X52AXCBR8	Loc.stVal	LOC	IED local status
X52AXCBR8	Pos.stVal	52CL08?1:2 <sup>b</sup>	Circuit Breaker 08 closed
X52AXCBR9	Loc.stVal	LOC	IED local status
X52AXCBR9	Pos.stVal	52CL09?1:2 <sup>b</sup>	Circuit Breaker 09 closed
X52AXCBR10	Loc.stVal	LOC	IED local status
X52AXCBR10	Pos.stVal	52CL10?1:2 <sup>b</sup>	Circuit Breaker 10 closed
X52AXCBR11	Loc.stVal	LOC	IED local status
X52AXCBR11	Pos.stVal	52CL11?1:2 <sup>b</sup>	Circuit Breaker 11 closed
X52AXCBR12	Loc.stVal	LOC	IED local status
X52AXCBR12	Pos.stVal	52CL12?1:2 <sup>b</sup>	Circuit Breaker 12 closed
X52AXCBR13	Loc.stVal	LOC	IED local status
X52AXCBR13	Pos.stVal	52CL13?1:2 <sup>b</sup>	Circuit Breaker 13 closed
X52AXCBR14	Loc.stVal	LOC	IED local status
X52AXCBR14	Pos.stVal	52CL14?1:2 <sup>b</sup>	Circuit Breaker 14 closed
X52AXCBR15	Loc.stVal	LOC	IED local status

**Table 10.12 Logical Device: PRO (Protection) (Sheet 7 of 10)**

Logical Node	Attribute	Data Source	Comment
X52AXCBR15	Pos.stVal	52CL15?1:2 <sup>b</sup>	Circuit Breaker 15 closed
X52AXCBR16	Loc.stVal	LOC	IED local status
X52AXCBR16	Pos.stVal	52CL16?1:2 <sup>b</sup>	Circuit Breaker 16 closed
X52AXCBR17	Loc.stVal	LOC	IED local status
X52AXCBR17	Pos.stVal	52CL17?1:2 <sup>b</sup>	Circuit Breaker 17 closed
X52AXCBR18	Loc.stVal	LOC	IED local status
X52AXCBR18	Pos.stVal	52CL18?1:2 <sup>b</sup>	Circuit Breaker 18 closed
X52AXCBR19	Loc.stVal	LOC	IED local status
X52AXCBR19	Pos.stVal	52CL19?1:2 <sup>b</sup>	Circuit Breaker 19 closed
X52AXCBR20	Loc.stVal	LOC	IED local status
X52AXCBR20	Pos.stVal	52CL20?1:2 <sup>b</sup>	Circuit Breaker 20 closed
X52AXCBR21	Loc.stVal	LOC	IED local status
X52AXCBR21	Pos.stVal	52CL21?1:2 <sup>b</sup>	Circuit Breaker 21 closed
X89CLXSWI1	Loc.stVal	LOC	IED local status
X89CLXSWI1	Pos.stVal	89CL01?1:2 <sup>b</sup>	Disconnect 01 closed
X89CLXSWI2	Loc.stVal	LOC	IED local status
X89CLXSWI2	Pos.stVal	89CL02?1:2 <sup>b</sup>	Disconnect 02 closed
X89CLXSWI3	Loc.stVal	LOC	IED local status
X89CLXSWI3	Pos.stVal	89CL03?1:2 <sup>b</sup>	Disconnect 03 closed
X89CLXSWI4	Loc.stVal	LOC	IED local status
X89CLXSWI4	Pos.stVal	89CL04?1:2 <sup>b</sup>	Disconnect 04 closed
X89CLXSWI5	Loc.stVal	LOC	IED local status
X89CLXSWI5	Pos.stVal	89CL05?1:2 <sup>b</sup>	Disconnect 05 closed
X89CLXSWI6	Loc.stVal	LOC	IED local status
X89CLXSWI6	Pos.stVal	89CL06?1:2 <sup>b</sup>	Disconnect 06 closed
X89CLXSWI7	Loc.stVal	LOC	IED local status
X89CLXSWI7	Pos.stVal	89CL07?1:2 <sup>b</sup>	Disconnect 07 closed
X89CLXSWI8	Loc.stVal	LOC	IED local status
X89CLXSWI8	Pos.stVal	89CL08?1:2 <sup>b</sup>	Disconnect 08 closed
X89CLXSWI9	Loc.stVal	LOC	IED local status
X89CLXSWI9	Pos.stVal	89CL09?1:2 <sup>b</sup>	Disconnect 09 closed
X89CLXSWI10	Loc.stVal	LOC	IED local status
X89CLXSWI10	Pos.stVal	89CL10?1:2 <sup>b</sup>	Disconnect 10 closed
X89CLXSWI11	Loc.stVal	LOC	IED local status
X89CLXSWI11	Pos.stVal	89CL11?1:2 <sup>b</sup>	Disconnect 11 closed
X89CLXSWI12	Loc.stVal	LOC	IED local status
X89CLXSWI12	Pos.stVal	89CL12?1:2 <sup>b</sup>	Disconnect 12 closed
X89CLXSWI13	Loc.stVal	LOC	IED local status
X89CLXSWI13	Pos.stVal	89CL13?1:2 <sup>b</sup>	Disconnect 13 closed
X89CLXSWI14	Loc.stVal	LOC	IED local status
X89CLXSWI14	Pos.stVal	89CL14?1:2 <sup>b</sup>	Disconnect 14 closed

**Table 10.12 Logical Device: PRO (Protection) (Sheet 8 of 10)**

<b>Logical Node</b>	<b>Attribute</b>	<b>Data Source</b>	<b>Comment</b>
X89CLXSWI15	Loc.stVal	LOC	IED local status
X89CLXSWI15	Pos.stVal	89CL15?1:2 <sup>b</sup>	Disconnect 15 closed
X89CLXSWI16	Loc.stVal	LOC	IED local status
X89CLXSWI16	Pos.stVal	89CL16?1:2 <sup>b</sup>	Disconnect 16 closed
X89CLXSWI17	Loc.stVal	LOC	IED local status
X89CLXSWI17	Pos.stVal	89CL17?1:2 <sup>b</sup>	Disconnect 17 closed
X89CLXSWI18	Loc.stVal	LOC	IED local status
X89CLXSWI18	Pos.stVal	89CL18?1:2 <sup>b</sup>	Disconnect 18 closed
X89CLXSWI19	Loc.stVal	LOC	IED local status
X89CLXSWI19	Pos.stVal	89CL19?1:2 <sup>b</sup>	Disconnect 19 closed
X89CLXSWI20	Loc.stVal	LOC	IED local status
X89CLXSWI20	Pos.stVal	89CL20?1:2 <sup>b</sup>	Disconnect 20 closed
X89CLXSWI21	Loc.stVal	LOC	IED local status
X89CLXSWI21	Pos.stVal	89CL21?1:2 <sup>b</sup>	Disconnect 21 closed
X89CLXSWI22	Loc.stVal	LOC	IED local status
X89CLXSWI22	Pos.stVal	89CL22?1:2 <sup>b</sup>	Disconnect 22 closed
X89CLXSWI23	Loc.stVal	LOC	IED local status
X89CLXSWI23	Pos.stVal	89CL23?1:2 <sup>b</sup>	Disconnect 23 closed
X89CLXSWI24	Loc.stVal	LOC	IED local status
X89CLXSWI24	Pos.stVal	89CL24?1:2 <sup>b</sup>	Disconnect 24 closed
X89CLXSWI25	Loc.stVal	LOC	IED local status
X89CLXSWI25	Pos.stVal	89CL25?1:2 <sup>b</sup>	Disconnect 25 closed
X89CLXSWI26	Loc.stVal	LOC	IED local status
X89CLXSWI26	Pos.stVal	89CL26?1:2 <sup>b</sup>	Disconnect 26 closed
X89CLXSWI27	Loc.stVal	LOC	IED local status
X89CLXSWI27	Pos.stVal	89CL27?1:2 <sup>b</sup>	Disconnect 27 closed
X89CLXSWI28	Loc.stVal	LOC	IED local status
X89CLXSWI28	Pos.stVal	89CL28?1:2 <sup>b</sup>	Disconnect 28 closed
X89CLXSWI29	Loc.stVal	LOC	IED local status
X89CLXSWI29	Pos.stVal	89CL29?1:2 <sup>b</sup>	Disconnect 29 closed
X89CLXSWI30	Loc.stVal	LOC	IED local status
X89CLXSWI30	Pos.stVal	89CL30?1:2 <sup>b</sup>	Disconnect 30 closed
X89CLXSWI31	Loc.stVal	LOC	IED local status
X89CLXSWI31	Pos.stVal	89CL31?1:2 <sup>b</sup>	Disconnect 31 closed
X89CLXSWI32	Loc.stVal	LOC	IED local status
X89CLXSWI32	Pos.stVal	89CL32?1:2 <sup>b</sup>	Disconnect 32 closed
X89CLXSWI33	Loc.stVal	LOC	IED local status
X89CLXSWI33	Pos.stVal	89CL33?1:2 <sup>b</sup>	Disconnect 33 closed
X89CLXSWI34	Loc.stVal	LOC	IED local status
X89CLXSWI34	Pos.stVal	89CL34?1:2 <sup>b</sup>	Disconnect 34 closed
X89CLXSWI35	Loc.stVal	LOC	IED local status

**Table 10.12 Logical Device: PRO (Protection) (Sheet 9 of 10)**

<b>Logical Node</b>	<b>Attribute</b>	<b>Data Source</b>	<b>Comment</b>
X89CLXSWI35	Pos.stVal	89CL35?1:2 <sup>b</sup>	Disconnect 35 closed
X89CLXSWI36	Loc.stVal	LOC	IED local status
X89CLXSWI36	Pos.stVal	89CL36?1:2 <sup>b</sup>	Disconnect 36 closed
X89CLXSWI37	Loc.stVal	LOC	IED local status
X89CLXSWI37	Pos.stVal	89CL37?1:2 <sup>b</sup>	Disconnect 37 closed
X89CLXSWI38	Loc.stVal	LOC	IED local status
X89CLXSWI38	Pos.stVal	89CL38?1:2 <sup>b</sup>	Disconnect 38 closed
X89CLXSWI39	Loc.stVal	LOC	IED local status
X89CLXSWI39	Pos.stVal	89CL39?1:2 <sup>b</sup>	Disconnect 39 closed
X89CLXSWI40	Loc.stVal	LOC	IED local status
X89CLXSWI40	Pos.stVal	89CL40?1:2 <sup>b</sup>	Disconnect 40 closed
X89CLXSWI41	Loc.stVal	LOC	IED local status
X89CLXSWI41	Pos.stVal	89CL41?1:2 <sup>b</sup>	Disconnect 41 closed
X89CLXSWI42	Loc.stVal	LOC	IED local status
X89CLXSWI42	Pos.stVal	89CL42?1:2 <sup>b</sup>	Disconnect 42 closed
X89CLXSWI43	Loc.stVal	LOC	IED local status
X89CLXSWI43	Pos.stVal	89CL43?1:2 <sup>b</sup>	Disconnect 43 closed
X89CLXSWI44	Loc.stVal	LOC	IED local status
X89CLXSWI44	Pos.stVal	89CL44?1:2 <sup>b</sup>	Disconnect 44 closed
X89CLXSWI45	Loc.stVal	LOC	IED local status
X89CLXSWI45	Pos.stVal	89CL45?1:2 <sup>b</sup>	Disconnect 45 closed
X89CLXSWI46	Loc.stVal	LOC	IED local status
X89CLXSWI46	Pos.stVal	89CL46?1:2 <sup>b</sup>	Disconnect 46 closed
X89CLXSWI47	Loc.stVal	LOC	IED local status
X89CLXSWI47	Pos.stVal	89CL47?1:2 <sup>b</sup>	Disconnect 47 closed
X89CLXSWI48	Loc.stVal	LOC	IED local status
X89CLXSWI48	Pos.stVal	89CL48?1:2 <sup>b</sup>	Disconnect 48 closed
X89CLXSWI49	Loc.stVal	LOC	IED local status
X89CLXSWI49	Pos.stVal	89CL49?1:2 <sup>b</sup>	Disconnect 49 closed
X89CLXSWI50	Loc.stVal	LOC	IED local status
X89CLXSWI50	Pos.stVal	89CL50?1:2 <sup>b</sup>	Disconnect 50 closed
X89CLXSWI51	Loc.stVal	LOC	IED local status
X89CLXSWI51	Pos.stVal	89CL51?1:2 <sup>b</sup>	Disconnect 51 closed
X89CLXSWI52	Loc.stVal	LOC	IED local status
X89CLXSWI52	Pos.stVal	89CL52?1:2 <sup>b</sup>	Disconnect 52 closed
X89CLXSWI53	Loc.stVal	LOC	IED local status
X89CLXSWI53	Pos.stVal	89CL53?1:2 <sup>b</sup>	Disconnect 53 closed
X89CLXSWI54	Loc.stVal	LOC	IED local status
X89CLXSWI54	Pos.stVal	89CL54?1:2 <sup>b</sup>	Disconnect 54 closed
X89CLXSWI55	Loc.stVal	LOC	IED local status
X89CLXSWI55	Pos.stVal	89CL55?1:2 <sup>b</sup>	Disconnect 55 closed

**Table 10.12 Logical Device: PRO (Protection) (Sheet 10 of 10)**

<b>Logical Node</b>	<b>Attribute</b>	<b>Data Source</b>	<b>Comment</b>
X89CLXSWI56	Loc.stVal	LOC	IED local status
X89CLXSWI56	Pos.stVal	89CL56?1:2 <sup>b</sup>	Disconnect 56 closed
X89CLXSWI57	Loc.stVal	LOC	IED local status
X89CLXSWI57	Pos.stVal	89CL57?1:2 <sup>b</sup>	Disconnect 57 closed
X89CLXSWI58	Loc.stVal	LOC	IED local status
X89CLXSWI58	Pos.stVal	89CL58?1:2 <sup>b</sup>	Disconnect 58 closed
X89CLXSWI59	Loc.stVal	LOC	IED local status
X89CLXSWI59	Pos.stVal	89CL59?1:2 <sup>b</sup>	Disconnect 59 closed
X89CLXSWI60	Loc.stVal	LOC	IED local status
X89CLXSWI60	Pos.stVal	89CL60?1:2 <sup>b</sup>	Disconnect 60 closed
<b>Functional Constraint = DC</b>			
LLN0	NamPlt.swRev	VERFID	Relay FID string
PROLPHD1	PhyNam.model	PARNUM	Relay part number
PROLPHD1	PhyNam.serNum	SERNUM	Relay serial number
PROLPHD1	PhyNam.hwRev	HWREV <sup>g</sup>	Hardware version of the relay mainboard
<b>Functional Constraint = SP</b>			
LLN0	GrRef.setSrcRef	IdName	Functional name
LLN0	MltLev.setVal	MLTLEV	Multi-level control authority

<sup>a</sup> Writing a value of 1 pulses the first bit. Writing a value of 0 results in no operation.<sup>b</sup> If closed, value = 2. If open, value = 1.<sup>c</sup> FLTTYPE is an internal data source derived from the event summary and is not available to the user. Refer to Table 10.14 for more details.<sup>d</sup> FLTCAUS is an internal data source derived from the event summary and is not available to the user. Refer to Table 10.15 for more details.<sup>e</sup> I60MOD is an internal data source derived from the I850MOD analog quantity and is not available to the user.<sup>f</sup> If enabled, value = 1. If disabled, value = 3.<sup>g</sup> HWREV is an internal data source and is not available to the user.

*Table 10.13 shows the LNs associated with measuring elements, defined as Logical Device MET.*

**Table 10.13 Logical Device: MET (Metering) (Sheet 1 of 3)**

<b>Logical Node</b>	<b>Attribute</b>	<b>Data Source</b>	<b>Comment</b>
<b>Functional Constraint = DC</b>			
LLN0	NamPlt.swRev	VERFID	Relay FID string
METLPHD1	PhyNam.model	PARNUM	Relay part number
METLPHD1	PhyNam.serNum	SERNUM	Relay serial number
METLPHD1	PhyNam.hwRev	HWREV <sup>a</sup>	Hardware version of the relay mainboard
<b>Functional Constraint = ST</b>			
LLN0	Loc.stVal	LOC	Control authority at local (bay) level
LLN0	LocSta.stVal	LOCSTA	Control authority at station level
LLN0	Mod.stVal	I60MOD <sup>b</sup>	IEC 61850 mode/behavior status
METLPHD1	PhyHealth.stVal	EN?3:1 <sup>c</sup>	Relay enabled
DCZBAT1	BatWrn.stVal	DC1W	DC monitor warning alarm
DCZBAT1	BatFail.stVal	DC1F	DC monitor fail alarm

**Table 10.13 Logical Device: MET (Metering) (Sheet 2 of 3)**

<b>Logical Node</b>	<b>Attribute</b>	<b>Data Source</b>	<b>Comment</b>
DCZBAT1	BatGndFlt.stVal	DC1G	DC monitor ground fault alarm
DCZBAT1	BatDvAlm.stVal	DC1R	DC monitor alarm for ac ripple
<b>Functional Constraint = MX</b>			
DCZBAT1	Vol.instMag.f	DC1	Station battery dc voltage
IOPMMXN1	Amp.instMag.f	IOP1F	1-cycle average Zone 1 operating current
IOPMMXN2	Amp.instMag.f	IOP2F	1-cycle average Zone 2 operating current
IOPMMXN3	Amp.instMag.f	IOP3F	1-cycle average Zone 3 operating current
IOPMMXN4	Amp.instMag.f	IOP4F	1-cycle average Zone 4 operating current
IOPMMXN5	Amp.instMag.f	IOP5F	1-cycle average Zone 5 operating current
IOPMMXN6	Amp.instMag.f	IOP6F	1-cycle average Zone 6 operating current
IRTMMXN1	Amp.instMag.f	IRT1F	1-cycle average Zone 1 restraint current
IRTMMXN2	Amp.instMag.f	IRT2F	1-cycle average Zone 2 restraint current
IRTMMXN3	Amp.instMag.f	IRT3F	1-cycle average Zone 3 restraint current
IRTMMXN4	Amp.instMag.f	IRT4F	1-cycle average Zone 4 restraint current
IRTMMXN5	Amp.instMag.f	IRT5F	1-cycle average Zone 5 restraint current
IRTMMXN6	Amp.instMag.f	IRT6F	1-cycle average Zone 6 restraint current
METMMXN1	Amp.instMag.f	I01FM	1-cycle average Phase 01 current (magnitude)
METMMXN2	Amp.instMag.f	I02FM	1-cycle average Phase 02 current (magnitude)
METMMXN3	Amp.instMag.f	I03FM	1-cycle average Phase 03 current (magnitude)
METMMXN4	Amp.instMag.f	I04FM	1-cycle average Phase 04 current (magnitude)
METMMXN5	Amp.instMag.f	I05FM	1-cycle average Phase 05 current (magnitude)
METMMXN6	Amp.instMag.f	I06FM	1-cycle average Phase 06 current (magnitude)
METMMXN7	Amp.instMag.f	I07FM	1-cycle average Phase 07 current (magnitude)
METMMXN8	Amp.instMag.f	I08FM	1-cycle average Phase 08 current (magnitude)
METMMXN9	Amp.instMag.f	I09FM	1-cycle average Phase 09 current (magnitude)
METMMXN10	Amp.instMag.f	I10FM	1-cycle average Phase 10 current (magnitude)
METMMXN11	Amp.instMag.f	I11FM	1-cycle average Phase 11 current (magnitude)
METMMXN12	Amp.instMag.f	I12FM	1-cycle average Phase 12 current (magnitude)
METMMXN13	Amp.instMag.f	I13FM	1-cycle average Phase 13 current (magnitude)
METMMXN14	Amp.instMag.f	I14FM	1-cycle average Phase 14 current (magnitude)
METMMXN15	Amp.instMag.f	I15FM	1-cycle average Phase 15 current (magnitude)
METMMXN16	Amp.instMag.f	I16FM	1-cycle average Phase 16 current (magnitude)
METMMXN17	Amp.instMag.f	I17FM	1-cycle average Phase 17 current (magnitude)
METMMXN18	Amp.instMag.f	I18FM	1-cycle average Phase 18 current (magnitude)
METMMXN19	Amp.instMag.f	I19FM	1-cycle average Phase 19 current (magnitude)
METMMXN20	Amp.instMag.f	I20FM	1-cycle average Phase 20 current (magnitude)
METMMXN21	Am.instMag.f	I21FM	1-cycle average Phase 21 current (magnitude)
METVMMXN1	Vol.instMag.f	V01FM	1-cycle average Phase 01 voltage (magnitude)
METVMMXN2	Vol.instMag.f	V02FM	1-cycle average Phase 02 voltage (magnitude)
METVMMXN3	Vol.instMag.f	V03FM	1-cycle average Phase 03 voltage (magnitude)

**Table 10.13 Logical Device: MET (Metering) (Sheet 3 of 3)**

<b>Logical Node</b>	<b>Attribute</b>	<b>Data Source</b>	<b>Comment</b>
Functional Constraint = SP			
LLN0	GrRef.setSrcRef	IdName	Functional name
LLN0	MltLev.setVal	MLTLEV	Multi-level control authority

<sup>a</sup> HWREV is an internal data source and is not available to the user.<sup>b</sup> I60MOD is an internal data source derived from the I850MOD analog quantity and is not available to the user.<sup>c</sup> If enabled, value = 1. If disabled, value = 3.**Table 10.14 FLTYPE-Fault Type**

<b>Value</b>	<b>Fault Type</b>
0	No fault type identified/present

**Table 10.15 FLTCAUS-Fault Cause**

<b>Value</b>	<b>Fault Cause</b>
0	No fault summary loaded
1	Trigger command
2	Trip element
3	Event report element
4	Differential trip
5	Breaker failure trip

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## S E C T I O N   1 1

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# Relay Word Bits

This section contains tables of the Relay Word bits available in the SEL-487B-2 Relay. *Table 11.1* lists the Relay Word bits in alphabetical order; *Table 11.2* lists every Relay Word bit row and the bits contained within each row.

## Alphabetical List

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**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 1 of 79)**

Name	Bit Description	Row
271P1	Undervoltage Element 1, Level 1 asserted	221
271P1T	Undervoltage Element 1, Level 1 timed out	221
271P2	Undervoltage Element 1, Level 2 asserted	221
272P1	Undervoltage Element 2, Level 1 asserted	221
272P1T	Undervoltage Element 2, Level 1 timed out	221
272P2	Undervoltage Element 2, Level 2 asserted	221
273P1	Undervoltage Element 3, Level 1 asserted	222
273P1T	Undervoltage Element 3, Level 1 timed out	222
273P2	Undervoltage Element 3, Level 2 asserted	222
274P1	Undervoltage Element 4, Level 1 asserted	222
274P1T	Undervoltage Element 4, Level 1 timed out	222
274P2	Undervoltage Element 4, Level 2 asserted	222
275P1	Undervoltage Element 5, Level 1 asserted	223
275P1T	Undervoltage Element 5, Level 1 timed out	223
275P2	Undervoltage Element 5, Level 2 asserted	223
276P1	Undervoltage Element 6, Level 1 asserted	223
276P1T	Undervoltage Element 6, Level 1 timed out	223
276P2	Undervoltage Element 6, Level 2 asserted	223
27TC1	Undervoltage Element 1, torque control	221
27TC2	Undervoltage Element 2, torque control	221
27TC3	Undervoltage Element 3, torque control	222
27TC4	Undervoltage Element 4, torque control	222
27TC5	Undervoltage Element 5, torque control	223
27TC6	Undervoltage Element 6, torque control	223
50DS01	Terminal 01 directional element current threshold exceeded	173
50DS02	Terminal 02 directional element current threshold exceeded	173
50DS03	Terminal 03 directional element current threshold exceeded	173
50DS04	Terminal 04 directional element current threshold exceeded	173

**11.2** | Relay Word Bits  
Alphabetical List

**Table 11.1 Alphabetical List of Relay Word Bits (Sheet 2 of 79)**

Name	Bit Description	Row
50DS05	Terminal 05 directional element current threshold exceeded	173
50DS06	Terminal 06 directional element current threshold exceeded	173
50DS07	Terminal 07 directional element current threshold exceeded	173
50DS08	Terminal 08 directional element current threshold exceeded	173
50DS09	Terminal 09 directional element current threshold exceeded	174
50DS10	Terminal 10 directional element current threshold exceeded	174
50DS11	Terminal 11 directional element current threshold exceeded	174
50DS12	Terminal 12 directional element current threshold exceeded	174
50DS13	Terminal 13 directional element current threshold exceeded	174
50DS14	Terminal 14 directional element current threshold exceeded	174
50DS15	Terminal 15 directional element current threshold exceeded	174
50DS16	Terminal 16 directional element current threshold exceeded	174
50DS17	Terminal 17 directional element current threshold exceeded	175
50DS18	Terminal 18 directional element current threshold exceeded	175
50DS19	Terminal 19 directional element current threshold exceeded	175
50DS20	Terminal 20 directional element current threshold exceeded	175
50DS21	Terminal 21 directional element current threshold exceeded	175
50F01	Circuit Breaker 1 breaker failure current threshold exceeded	183
50F02	Circuit Breaker 2 breaker failure current threshold exceeded	184
50F03	Circuit Breaker 3 breaker failure current threshold exceeded	185
50F04	Circuit Breaker 4 breaker failure current threshold exceeded	186
50F05	Circuit Breaker 5 breaker failure current threshold exceeded	187
50F06	Circuit Breaker 6 breaker failure current threshold exceeded	188
50F07	Circuit Breaker 7 breaker failure current threshold exceeded	189
50F08	Circuit Breaker 8 breaker failure current threshold exceeded	190
50F09	Circuit Breaker 9 breaker failure current threshold exceeded	191
50F10	Circuit Breaker 10 breaker failure current threshold exceeded	192
50F11	Circuit Breaker 11 breaker failure current threshold exceeded	193
50F12	Circuit Breaker 12 breaker failure current threshold exceeded	194
50F13	Circuit Breaker 13 breaker failure current threshold exceeded	195
50F14	Circuit Breaker 14 breaker failure current threshold exceeded	196
50F15	Circuit Breaker 15 breaker failure current threshold exceeded	197
50F16	Circuit Breaker 16 breaker failure current threshold exceeded	198
50F17	Circuit Breaker 17 breaker failure current threshold exceeded	199
50F18	Circuit Breaker 18 breaker failure current threshold exceeded	200
50F19	Circuit Breaker 19 breaker failure current threshold exceeded	201
50F20	Circuit Breaker 20 breaker failure current threshold exceeded	202
50F21	Circuit Breaker 21 breaker failure current threshold exceeded	203
50P01	Terminal 01 instantaneous overcurrent element	207
50P01T	Terminal 01 definite-time overcurrent element timed out	207
50P02	Terminal 02 instantaneous overcurrent element	207

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 3 of 79)**

Name	Bit Description	Row
50P02T	Terminal 02 definite-time overcurrent element timed out	207
50P03	Terminal 03 instantaneous overcurrent element	207
50P03T	Terminal 03 definite-time overcurrent element timed out	207
50P04	Terminal 04 instantaneous overcurrent element	207
50P04T	Terminal 04 definite-time overcurrent element timed out	207
50P05	Terminal 05 instantaneous overcurrent element	208
50P05T	Terminal 05 definite-time overcurrent element timed out	208
50P06	Terminal 06 instantaneous overcurrent element	208
50P06T	Terminal 06 definite-time overcurrent element timed out	208
50P07	Terminal 07 instantaneous overcurrent element	208
50P07T	Terminal 07 definite-time overcurrent element timed out	208
50P08	Terminal 08 instantaneous overcurrent element	208
50P08T	Terminal 08 definite-time overcurrent element timed out	208
50P09	Terminal 09 instantaneous overcurrent element	209
50P09T	Terminal 09 definite-time overcurrent element timed out	209
50P10	Terminal 10 instantaneous overcurrent element	209
50P10T	Terminal 10 definite-time overcurrent element timed out	209
50P11	Terminal 11 instantaneous overcurrent element	209
50P11T	Terminal 11 definite-time overcurrent element timed out	209
50P12	Terminal 12 instantaneous overcurrent element	209
50P12T	Terminal 12 definite-time overcurrent element timed out	209
50P13	Terminal 13 instantaneous overcurrent element	210
50P13T	Terminal 13 definite-time overcurrent element timed out	210
50P14	Terminal 14 instantaneous overcurrent element	210
50P14T	Terminal 14 definite-time overcurrent element timed out	210
50P15	Terminal 15 instantaneous overcurrent element	210
50P15T	Terminal 15 definite-time overcurrent element timed out	210
50P16	Terminal 16 instantaneous overcurrent element	210
50P16T	Terminal 16 definite-time overcurrent element timed out	210
50P17	Terminal 17 instantaneous overcurrent element	211
50P17T	Terminal 17 definite-time overcurrent element timed out	211
50P18	Terminal 18 instantaneous overcurrent element	211
50P18T	Terminal 18 definite-time overcurrent element timed out	211
50P19	Terminal 19 instantaneous overcurrent element	211
50P19T	Terminal 19 definite-time overcurrent element timed out	211
50P20	Terminal 20 instantaneous overcurrent element	211
50P20T	Terminal 20 definite-time overcurrent element timed out	211
50P21	Terminal 21 instantaneous overcurrent element	212
50P21T	Terminal 21 definite-time overcurrent element timed out	212
51MM01	Inverse-time Element 01 pickup setting outside of specified limits	219
51MM02	Inverse-time Element 02 pickup setting outside of specified limits	219

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 4 of 79)**

Name	Bit Description	Row
51MM03	Inverse-time Element 03 pickup setting outside of specified limits	219
51MM04	Inverse-time Element 04 pickup setting outside of specified limits	219
51MM05	Inverse-time Element 05 pickup setting outside of specified limits	220
51MM06	Inverse-time Element 06 pickup setting outside of specified limits	220
51MM07	Inverse-time Element 07 pickup setting outside of specified limits	220
51MM08	Inverse-time Element 08 pickup setting outside of specified limits	220
51MM09	Inverse-time Element 09 pickup setting outside of specified limits	232
51MM10	Inverse-time Element 10 pickup setting outside of specified limits	232
51MM11	Inverse-time Element 11 pickup setting outside of specified limits	232
51MM12	Inverse-time Element 12 pickup setting outside of specified limits	232
51MM13	Inverse-time Element 13 pickup setting outside of specified limits	233
51MM14	Inverse-time Element 14 pickup setting outside of specified limits	233
51MM15	Inverse-time Element 15 pickup setting outside of specified limits	233
51MM16	Inverse-time Element 16 pickup setting outside of specified limits	233
51MM17	Inverse-time Element 17 pickup setting outside of specified limits	234
51MM18	Inverse-time Element 18 pickup setting outside of specified limits	234
51MM19	Inverse-time Element 19 pickup setting outside of specified limits	234
51MM20	Inverse-time Element 20 pickup setting outside of specified limits	234
51MM21	Inverse-time Element 21 pickup setting outside of specified limits	252
51R01	Inverse-time Element 01 reset	254
51R02	Inverse-time Element 02 reset	254
51R03	Inverse-time Element 03 reset	254
51R04	Inverse-time Element 04 reset	254
51R05	Inverse-time Element 05 reset	254
51R06	Inverse-time Element 06 reset	254
51R07	Inverse-time Element 07 reset	254
51R08	Inverse-time Element 08 reset	254
51R09	Inverse-time Element 09 reset	253
51R10	Inverse-time Element 10 reset	253
51R11	Inverse-time Element 11 reset	253
51R12	Inverse-time Element 12 reset	253
51R13	Inverse-time Element 13 reset	253
51R14	Inverse-time Element 14 reset	253
51R15	Inverse-time Element 15 reset	253
51R16	Inverse-time Element 16 reset	253
51R17	Inverse-time Element 17 reset	381
51R18	Inverse-time Element 18 reset	381
51R19	Inverse-time Element 19 reset	381
51R20	Inverse-time Element 20 reset	381
51R21	Inverse-time Element 21 reset	381
51S01	Inverse-time Element 01 picked up	213

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 5 of 79)**

Name	Bit Description	Row
51S02	Inverse-time Element 02 picked up	213
51S03	Inverse-time Element 03 picked up	213
51S04	Inverse-time Element 04 picked up	213
51S05	Inverse-time Element 05 picked up	214
51S06	Inverse-time Element 06 picked up	214
51S07	Inverse-time Element 07 picked up	214
51S08	Inverse-time Element 08 picked up	214
51S09	Inverse-time Element 09 picked up	215
51S10	Inverse-time Element 10 picked up	215
51S11	Inverse-time Element 11 picked up	215
51S12	Inverse-time Element 12 picked up	215
51S13	Inverse-time Element 13 picked up	216
51S14	Inverse-time Element 14 picked up	216
51S15	Inverse-time Element 15 picked up	216
51S16	Inverse-time Element 16 picked up	216
51S17	Inverse-time Element 17 picked up	217
51S18	Inverse-time Element 18 picked up	217
51S19	Inverse-time Element 19 picked up	217
51S20	Inverse-time Element 20 picked up	217
51S21	Inverse-time Element 21 picked up	218
51T01	Inverse-time Element 01 timed out	213
51T02	Inverse-time Element 02 timed out	213
51T03	Inverse-time Element 03 timed out	213
51T04	Inverse-time Element 04 timed out	213
51T05	Inverse-time Element 05 timed out	214
51T06	Inverse-time Element 06 timed out	214
51T07	Inverse-time Element 07 timed out	214
51T08	Inverse-time Element 08 timed out	214
51T09	Inverse-time Element 09 timed out	215
51T10	Inverse-time Element 10 timed out	215
51T11	Inverse-time Element 11 timed out	215
51T12	Inverse-time Element 12 timed out	215
51T13	Inverse-time Element 13 timed out	216
51T14	Inverse-time Element 14 timed out	216
51T15	Inverse-time Element 15 timed out	216
51T16	Inverse-time Element 16 timed out	216
51T17	Inverse-time Element 17 timed out	217
51T18	Inverse-time Element 18 timed out	217
51T19	Inverse-time Element 19 timed out	217
51T20	Inverse-time Element 20 timed out	217
51T21	Inverse-time Element 21 timed out	218

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 6 of 79)**

Name	Bit Description	Row
51TM01	Inverse-time Element 01 time-dial setting outside of specified limits	219
51TM02	Inverse-time Element 02 time-dial setting outside of specified limits	219
51TM03	Inverse-time Element 03 time-dial setting outside of specified limits	219
51TM04	Inverse-time Element 04 time-dial setting outside of specified limits	219
51TM05	Inverse-time Element 05 time-dial setting outside of specified limits	220
51TM06	Inverse-time Element 06 time-dial setting outside of specified limits	220
51TM07	Inverse-time Element 07 time-dial setting outside of specified limits	220
51TM08	Inverse-time Element 08 time-dial setting outside of specified limits	220
51TM09	Inverse-time Element 09 time-dial setting outside of specified limits	232
51TM10	Inverse-time Element 10 time-dial setting outside of specified limits	232
51TM11	Inverse-time Element 11 time-dial setting outside of specified limits	232
51TM12	Inverse-time Element 12 time-dial setting outside of specified limits	232
51TM13	Inverse-time Element 13 time-dial setting outside of specified limits	233
51TM14	Inverse-time Element 14 time-dial setting outside of specified limits	233
51TM15	Inverse-time Element 15 time-dial setting outside of specified limits	233
51TM16	Inverse-time Element 16 time-dial setting outside of specified limits	233
51TM17	Inverse-time Element 17 time-dial setting outside of specified limits	234
51TM18	Inverse-time Element 18 time-dial setting outside of specified limits	234
51TM19	Inverse-time Element 19 time-dial setting outside of specified limits	234
51TM20	Inverse-time Element 20 time-dial setting outside of specified limits	234
51TM21	Inverse-time Element 21 time-dial setting outside of specified limits	252
52A01	Circuit Breaker 01 status	7
52A02	Circuit Breaker 02 status	7
52A03	Circuit Breaker 03 status	7
52A04	Circuit Breaker 04 status	8
52A05	Circuit Breaker 05 status	8
52A06	Circuit Breaker 06 status	8
52A07	Circuit Breaker 07 status	9
52A08	Circuit Breaker 08 status	9
52A09	Circuit Breaker 09 status	10
52A10	Circuit Breaker 10 status	10
52A11	Circuit Breaker 11 status	10
52A12	Circuit Breaker 12 status	11
52A13	Circuit Breaker 13 status	11
52A14	Circuit Breaker 14 status	11
52A15	Circuit Breaker 15 status	12
52A16	Circuit Breaker 16 status	12
52A17	Circuit Breaker 17 status	13
52A18	Circuit Breaker 18 status	13
52A19	Circuit Breaker 19 status	13
52A20	Circuit Breaker 20 status	14

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 7 of 79)**

<b>Name</b>	<b>Bit Description</b>	<b>Row</b>
52A21	Circuit Breaker 21 status	14
52AL	Any circuit breaker alarm	14
52AL01	Circuit Breaker 01 alarm	7
52AL02	Circuit Breaker 02 alarm	7
52AL03	Circuit Breaker 03 alarm	7
52AL04	Circuit Breaker 04 alarm	8
52AL05	Circuit Breaker 05 alarm	8
52AL06	Circuit Breaker 06 alarm	9
52AL07	Circuit Breaker 07 alarm	9
52AL08	Circuit Breaker 08 alarm	9
52AL09	Circuit Breaker 09 alarm	10
52AL10	Circuit Breaker 10 alarm	10
52AL11	Circuit Breaker 11 alarm	10
52AL12	Circuit Breaker 12 alarm	11
52AL13	Circuit Breaker 13 alarm	11
52AL14	Circuit Breaker 14 alarm	12
52AL15	Circuit Breaker 15 alarm	12
52AL16	Circuit Breaker 16 alarm	12
52AL17	Circuit Breaker 17 alarm	13
52AL18	Circuit Breaker 18 alarm	13
52AL19	Circuit Breaker 19 alarm	13
52AL20	Circuit Breaker 20 alarm	14
52AL21	Circuit Breaker 21 alarm	14
52CL01	Circuit Breaker 01 closed	7
52CL02	Circuit Breaker 02 closed	7
52CL03	Circuit Breaker 03 closed	8
52CL04	Circuit Breaker 04 closed	8
52CL05	Circuit Breaker 05 closed	8
52CL06	Circuit Breaker 06 closed	9
52CL07	Circuit Breaker 07 closed	9
52CL08	Circuit Breaker 08 closed	9
52CL09	Circuit Breaker 09 closed	10
52CL10	Circuit Breaker 10 closed	10
52CL11	Circuit Breaker 11 closed	11
52CL12	Circuit Breaker 12 closed	11
52CL13	Circuit Breaker 13 closed	11
52CL14	Circuit Breaker 14 closed	12
52CL15	Circuit Breaker 15 closed	12
52CL16	Circuit Breaker 16 closed	12
52CL17	Circuit Breaker 17 closed	13
52CL18	Circuit Breaker 18 closed	13

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 8 of 79)**

<b>Name</b>	<b>Bit Description</b>	<b>Row</b>
52CL19	Circuit Breaker 19 closed	14
52CL20	Circuit Breaker 20 closed	14
52CL21	Circuit Breaker 21 closed	14
591P1	Overvoltage Element 1, Level 1 asserted	224
591P1T	Overvoltage Element 1, Level 1 timed out	224
591P2	Overvoltage Element 1, Level 2 asserted	224
592P1	Overvoltage Element 2, Level 1 asserted	224
592P1T	Overvoltage Element 2, Level 1 timed out	224
592P2	Overvoltage Element 2, Level 2 asserted	224
593P1	Overvoltage Element 3, Level 1 asserted	225
593P1T	Overvoltage Element 3, Level 1 timed out	225
593P2	Overvoltage Element 3, Level 2 asserted	225
594P1	Overvoltage Element 4, Level 1 asserted	225
594P1T	Overvoltage Element 4, Level 1 timed out	225
594P2	Overvoltage Element 4, Level 2 asserted	225
595P1	Overvoltage Element 5, Level 1 asserted	226
595P1T	Overvoltage Element 5, Level 1 timed out	226
595P2	Overvoltage Element 5, Level 2 asserted	226
596P1	Overvoltage Element 6, Level 1 asserted	226
596P1T	Overvoltage Element 6, Level 1 timed out	226
596P2	Overvoltage Element 6, Level 2 asserted	226
59TC1	Overvoltage Element 1, torque control	224
59TC2	Overvoltage Element 2, torque control	224
59TC3	Overvoltage Element 3, torque control	225
59TC4	Overvoltage Element 4, torque control	225
59TC5	Overvoltage Element 5, torque control	226
59TC6	Overvoltage Element 6, torque control	226
87BTR	Any terminal bus-zone differential trip asserted	231
87BTR01	Terminal 01 bus-zone differential trip asserted	228
87BTR02	Terminal 02 bus-zone differential trip asserted	228
87BTR03	Terminal 03 bus-zone differential trip asserted	228
87BTR04	Terminal 04 bus-zone differential trip asserted	228
87BTR05	Terminal 05 bus-zone differential trip asserted	228
87BTR06	Terminal 06 bus-zone differential trip asserted	228
87BTR07	Terminal 07 bus-zone differential trip asserted	228
87BTR08	Terminal 08 bus-zone differential trip asserted	228
87BTR09	Terminal 09 bus-zone differential trip asserted	229
87BTR10	Terminal 10 bus-zone differential trip asserted	229
87BTR11	Terminal 11 bus-zone differential trip asserted	229
87BTR12	Terminal 12 bus-zone differential trip asserted	229
87BTR13	Terminal 13 bus-zone differential trip asserted	229

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 9 of 79)**

Name	Bit Description	Row
87BTR14	Terminal 14 bus-zone differential trip asserted	229
87BTR15	Terminal 15 bus-zone differential trip asserted	229
87BTR16	Terminal 16 bus-zone differential trip asserted	229
87BTR17	Terminal 17 bus-zone differential trip asserted	230
87BTR18	Terminal 18 bus-zone differential trip asserted	230
87BTR19	Terminal 19 bus-zone differential trip asserted	230
87BTR20	Terminal 20 bus-zone differential trip asserted	230
87BTR21	Terminal 21 bus-zone differential trip asserted	230
87CZ1	Check Zone 1 differential-element trip	447
87CZ1BK	Check Zone 1 blocking bit (because of loss of SV data)	502
87CZ2	Check Zone 2 differential-element trip	447
87CZ2BK	Check Zone 2 blocking bit (because of loss of SV data)	502
87CZ3	Check Zone 3 differential-element trip	447
87CZ3BK	Check Zone 3 blocking bit (because of loss of SV data)	502
87O1	Zone 1 restraint differential operating current above O87P	159
87O2	Zone 2 restraint differential operating current above O87P	161
87O3	Zone 3 restraint differential operating current above O87P	163
87O4	Zone 4 restraint differential operating current above O87P	165
87O5	Zone 5 restraint differential operating current above O87P	167
87O6	Zone 6 restraint differential operating current above O87P	169
87OCZ1	Check Zone 1 restraint differential operating current above CZO87P	450
87OCZ2	Check Zone 2 restraint differential operating current above CZO87P	452
87OCZ3	Check Zone 3 restraint differential operating current above CZO87P	454
87R1	Zone 1 restraint differential element picked up	159
87R2	Zone 2 restraint differential element picked up	161
87R3	Zone 3 restraint differential element picked up	163
87R4	Zone 4 restraint differential element picked up	165
87R5	Zone 5 restraint differential element picked up	167
87R6	Zone 6 restraint differential element picked up	169
87RCZ1	Check Zone 1 restraint differential element picked up	450
87RCZ2	Check Zone 2 restraint differential element picked up	452
87RCZ3	Check Zone 3 restraint differential element picked up	454
87S1	Zone 1 sensitive differential element picked up	157
87S2	Zone 2 sensitive differential element picked up	157
87S3	Zone 3 sensitive differential element picked up	157
87S4	Zone 4 sensitive differential element picked up	157
87S5	Zone 5 sensitive differential element picked up	157
87S6	Zone 6 sensitive differential element picked up	157
87SCZ1	Check Zone 1 sensitive differential element picked up	448
87SCZ2	Check Zone 2 sensitive differential element picked up	448
87SCZ3	Check Zone 3 sensitive differential element picked up	448

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 10 of 79)**

Name	Bit Description	Row
87ST	Any sensitive differential-element timer timed out	158
87ST1	Zone 1 sensitive differential element timed out	158
87ST2	Zone 2 sensitive differential element timed out	158
87ST3	Zone 3 sensitive differential element timed out	158
87ST4	Zone 4 sensitive differential element timed out	158
87ST5	Zone 5 sensitive differential element timed out	158
87ST6	Zone 6 sensitive differential element timed out	158
87STCZ1	Check Zone 1 sensitive differential element timed out	449
87STCZ2	Check Zone 2 sensitive differential element timed out	449
87STCZ3	Check Zone 3 sensitive differential element timed out	449
87Z1	Zone 1 differential-element trip	235
87Z1BK	Differential Zone 1 blocking bit (because of loss of SV data)	501
87Z2	Zone 2 differential-element trip	235
87Z2BK	Differential Zone 2 blocking bit (because of loss of SV data)	501
87Z3	Zone 3 differential-element trip	235
87Z3BK	Differential Zone 3 blocking bit (because of loss of SV data)	501
87Z4	Zone 4 differential-element trip	235
87Z4BK	Differential Zone 4 blocking bit (because of loss of SV data)	501
87Z5	Zone 5 differential-element trip	235
87Z5BK	Differential Zone 5 blocking bit (because of loss of SV data)	501
87Z6	Zone 6 differential-element trip	235
87Z6BK	Differential Zone 6 blocking bit (because of loss of SV data)	501
89A01	Disconnect 01 A auxiliary contact closed	17
89A02	Disconnect 02 A auxiliary contact closed	17
89A03	Disconnect 03 A auxiliary contact closed	18
89A04	Disconnect 04 A auxiliary contact closed	18
89A05	Disconnect 05 A auxiliary contact closed	19
89A06	Disconnect 06 A auxiliary contact closed	20
89A07	Disconnect 07 A auxiliary contact closed	20
89A08	Disconnect 08 A auxiliary contact closed	21
89A09	Disconnect 09 A auxiliary contact closed	22
89A10	Disconnect 10 A auxiliary contact closed	22
89A11	Disconnect 11 A auxiliary contact closed	23
89A12	Disconnect 12 A auxiliary contact closed	23
89A13	Disconnect 13 A auxiliary contact closed	24
89A14	Disconnect 14 A auxiliary contact closed	25
89A15	Disconnect 15 A auxiliary contact closed	25
89A16	Disconnect 16 A auxiliary contact closed	26
89A17	Disconnect 17 A auxiliary contact closed	27
89A18	Disconnect 18 A auxiliary contact closed	27
89A19	Disconnect 19 A auxiliary contact closed	28

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 11 of 79)**

Name	Bit Description	Row
89A20	Disconnect 20 A auxiliary contact closed	28
89A21	Disconnect 21 A auxiliary contact closed	29
89A22	Disconnect 22 A auxiliary contact closed	30
89A23	Disconnect 23 A auxiliary contact closed	30
89A24	Disconnect 24 A auxiliary contact closed	31
89A25	Disconnect 25 A auxiliary contact closed	32
89A26	Disconnect 26 A auxiliary contact closed	32
89A27	Disconnect 27 A auxiliary contact closed	33
89A28	Disconnect 28 A auxiliary contact closed	33
89A29	Disconnect 29 A auxiliary contact closed	34
89A30	Disconnect 30 A auxiliary contact closed	35
89A31	Disconnect 31 A auxiliary contact closed	35
89A32	Disconnect 32 A auxiliary contact closed	36
89A33	Disconnect 33 A auxiliary contact closed	37
89A34	Disconnect 34 A auxiliary contact closed	37
89A35	Disconnect 35 A auxiliary contact closed	38
89A36	Disconnect 36 A auxiliary contact closed	38
89A37	Disconnect 37 A auxiliary contact closed	39
89A38	Disconnect 38 A auxiliary contact closed	40
89A39	Disconnect 39 A auxiliary contact closed	40
89A40	Disconnect 40 A auxiliary contact closed	41
89A41	Disconnect 41 A auxiliary contact closed	42
89A42	Disconnect 42 A auxiliary contact closed	42
89A43	Disconnect 43 A auxiliary contact closed	43
89A44	Disconnect 44 A auxiliary contact closed	43
89A45	Disconnect 45 A auxiliary contact closed	44
89A46	Disconnect 46 A auxiliary contact closed	45
89A47	Disconnect 47 A auxiliary contact closed	45
89A48	Disconnect 48 A auxiliary contact closed	46
89A49	Disconnect 49 A auxiliary contact closed	47
89A50	Disconnect 50 A auxiliary contact closed	47
89A51	Disconnect 51 A auxiliary contact closed	48
89A52	Disconnect 52 A auxiliary contact closed	48
89A53	Disconnect 53 A auxiliary contact closed	49
89A54	Disconnect 54 A auxiliary contact closed	50
89A55	Disconnect 55 A auxiliary contact closed	50
89A56	Disconnect 56 A auxiliary contact closed	51
89A57	Disconnect 57 A auxiliary contact closed	52
89A58	Disconnect 58 A auxiliary contact closed	52
89A59	Disconnect 59 A auxiliary contact closed	53
89A60	Disconnect 60 A auxiliary contact closed	53

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 12 of 79)**

Name	Bit Description	Row
89AL	Any disconnect auxiliary contact discrepancy alarm	55
89AL01	Disconnect 01 auxiliary contact discrepancy alarm	17
89AL02	Disconnect 02 auxiliary contact discrepancy alarm	18
89AL03	Disconnect 03 auxiliary contact discrepancy alarm	18
89AL04	Disconnect 04 auxiliary contact discrepancy alarm	19
89AL05	Disconnect 05 auxiliary contact discrepancy alarm	20
89AL06	Disconnect 06 auxiliary contact discrepancy alarm	20
89AL07	Disconnect 07 auxiliary contact discrepancy alarm	21
89AL08	Disconnect 08 auxiliary contact discrepancy alarm	21
89AL09	Disconnect 09 auxiliary contact discrepancy alarm	22
89AL10	Disconnect 10 auxiliary contact discrepancy alarm	23
89AL11	Disconnect 11 auxiliary contact discrepancy alarm	23
89AL12	Disconnect 12 auxiliary contact discrepancy alarm	24
89AL13	Disconnect 13 auxiliary contact discrepancy alarm	25
89AL14	Disconnect 14 auxiliary contact discrepancy alarm	25
89AL15	Disconnect 15 auxiliary contact discrepancy alarm	26
89AL16	Disconnect 16 auxiliary contact discrepancy alarm	26
89AL17	Disconnect 17 auxiliary contact discrepancy alarm	27
89AL18	Disconnect 18 auxiliary contact discrepancy alarm	28
89AL19	Disconnect 19 auxiliary contact discrepancy alarm	28
89AL20	Disconnect 20 auxiliary contact discrepancy alarm	29
89AL21	Disconnect 21 auxiliary contact discrepancy alarm	30
89AL22	Disconnect 22 auxiliary contact discrepancy alarm	30
89AL23	Disconnect 23 auxiliary contact discrepancy alarm	31
89AL24	Disconnect 24 auxiliary contact discrepancy alarm	31
89AL25	Disconnect 25 auxiliary contact discrepancy alarm	32
89AL26	Disconnect 26 auxiliary contact discrepancy alarm	33
89AL27	Disconnect 27 auxiliary contact discrepancy alarm	33
89AL28	Disconnect 28 auxiliary contact discrepancy alarm	34
89AL29	Disconnect 29 auxiliary contact discrepancy alarm	35
89AL30	Disconnect 30 auxiliary contact discrepancy alarm	35
89AL31	Disconnect 31 auxiliary contact discrepancy alarm	36
89AL32	Disconnect 32 auxiliary contact discrepancy alarm	36
89AL33	Disconnect 33 auxiliary contact discrepancy alarm	37
89AL34	Disconnect 34 auxiliary contact discrepancy alarm	38
89AL35	Disconnect 35 auxiliary contact discrepancy alarm	38
89AL36	Disconnect 36 auxiliary contact discrepancy alarm	39
89AL37	Disconnect 37 auxiliary contact discrepancy alarm	40
89AL38	Disconnect 38 auxiliary contact discrepancy alarm	40
89AL39	Disconnect 39 auxiliary contact discrepancy alarm	41
89AL40	Disconnect 40 auxiliary contact discrepancy alarm	41

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 13 of 79)**

<b>Name</b>	<b>Bit Description</b>	<b>Row</b>
89AL41	Disconnect 41 auxiliary contact discrepancy alarm	42
89AL42	Disconnect 42 auxiliary contact discrepancy alarm	43
89AL43	Disconnect 43 auxiliary contact discrepancy alarm	43
89AL44	Disconnect 44 auxiliary contact discrepancy alarm	44
89AL45	Disconnect 45 auxiliary contact discrepancy alarm	45
89AL46	Disconnect 46 auxiliary contact discrepancy alarm	45
89AL47	Disconnect 47 auxiliary contact discrepancy alarm	46
89AL48	Disconnect 48 auxiliary contact discrepancy alarm	46
89AL49	Disconnect 49 auxiliary contact discrepancy alarm	47
89AL50	Disconnect 50 auxiliary contact discrepancy alarm	48
89AL51	Disconnect 51 auxiliary contact discrepancy alarm	48
89AL52	Disconnect 52 auxiliary contact discrepancy alarm	49
89AL53	Disconnect 53 auxiliary contact discrepancy alarm	50
89AL54	Disconnect 54 auxiliary contact discrepancy alarm	50
89AL55	Disconnect 55 auxiliary contact discrepancy alarm	51
89AL56	Disconnect 56 auxiliary contact discrepancy alarm	51
89AL57	Disconnect 57 auxiliary contact discrepancy alarm	52
89AL58	Disconnect 58 auxiliary contact discrepancy alarm	53
89AL59	Disconnect 59 auxiliary contact discrepancy alarm	53
89AL60	Disconnect 60 auxiliary contact discrepancy alarm	54
89B01	Disconnect 01 B auxiliary contact closed	17
89B02	Disconnect 02 B auxiliary contact closed	17
89B03	Disconnect 03 B auxiliary contact closed	18
89B04	Disconnect 04 B auxiliary contact closed	19
89B05	Disconnect 05 B auxiliary contact closed	19
89B06	Disconnect 06 B auxiliary contact closed	20
89B07	Disconnect 07 B auxiliary contact closed	20
89B08	Disconnect 08 B auxiliary contact closed	21
89B09	Disconnect 09 B auxiliary contact closed	22
89B10	Disconnect 10 B auxiliary contact closed	22
89B11	Disconnect 11 B auxiliary contact closed	23
89B12	Disconnect 12 B auxiliary contact closed	24
89B13	Disconnect 13 B auxiliary contact closed	24
89B14	Disconnect 14 B auxiliary contact closed	25
89B15	Disconnect 15 B auxiliary contact closed	25
89B16	Disconnect 16 B auxiliary contact closed	26
89B17	Disconnect 17 B auxiliary contact closed	27
89B18	Disconnect 18 B auxiliary contact closed	27
89B19	Disconnect 19 B auxiliary contact closed	28
89B20	Disconnect 20 B auxiliary contact closed	29
89B21	Disconnect 21 B auxiliary contact closed	29

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 14 of 79)**

Name	Bit Description	Row
89B22	Disconnect 22 B auxiliary contact closed	30
89B23	Disconnect 23 B auxiliary contact closed	30
89B24	Disconnect 24 B auxiliary contact closed	31
89B25	Disconnect 25 B auxiliary contact closed	32
89B26	Disconnect 26 B auxiliary contact closed	32
89B27	Disconnect 27 B auxiliary contact closed	33
89B28	Disconnect 28 B auxiliary contact closed	34
89B29	Disconnect 29 B auxiliary contact closed	34
89B30	Disconnect 30 B auxiliary contact closed	35
89B31	Disconnect 31 B auxiliary contact closed	35
89B32	Disconnect 32 B auxiliary contact closed	36
89B33	Disconnect 33 B auxiliary contact closed	37
89B34	Disconnect 34 B auxiliary contact closed	37
89B35	Disconnect 35 B auxiliary contact closed	38
89B36	Disconnect 36 B auxiliary contact closed	39
89B37	Disconnect 37 B auxiliary contact closed	39
89B38	Disconnect 38 B auxiliary contact closed	40
89B39	Disconnect 39 B auxiliary contact closed	40
89B40	Disconnect 40 B auxiliary contact closed	41
89B41	Disconnect 41 B auxiliary contact closed	42
89B42	Disconnect 42 B auxiliary contact closed	42
89B43	Disconnect 43 B auxiliary contact closed	43
89B44	Disconnect 44 B auxiliary contact closed	44
89B45	Disconnect 45 B auxiliary contact closed	44
89B46	Disconnect 46 B auxiliary contact closed	45
89B47	Disconnect 47 B auxiliary contact closed	45
89B48	Disconnect 48 B auxiliary contact closed	46
89B49	Disconnect 49 B auxiliary contact closed	47
89B50	Disconnect 50 B auxiliary contact closed	47
89B51	Disconnect 51 B auxiliary contact closed	48
89B52	Disconnect 52 B auxiliary contact closed	49
89B53	Disconnect 53 B auxiliary contact closed	49
89B54	Disconnect 54 B auxiliary contact closed	50
89B55	Disconnect 55 B auxiliary contact closed	50
89B56	Disconnect 56 B auxiliary contact closed	51
89B57	Disconnect 57 B auxiliary contact closed	52
89B58	Disconnect 58 B auxiliary contact closed	52
89B59	Disconnect 59 B auxiliary contact closed	53
89B60	Disconnect 60 B auxiliary contact closed	54
89CL01	Disconnect 01 closed	17
89CL02	Disconnect 02 closed	17

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 15 of 79)**

<b>Name</b>	<b>Bit Description</b>	<b>Row</b>
89CL03	Disconnect 03 closed	18
89CL04	Disconnect 04 closed	19
89CL05	Disconnect 05 closed	19
89CL06	Disconnect 06 closed	20
89CL07	Disconnect 07 closed	21
89CL08	Disconnect 08 closed	21
89CL09	Disconnect 09 closed	22
89CL10	Disconnect 10 closed	22
89CL11	Disconnect 11 closed	23
89CL12	Disconnect 12 closed	24
89CL13	Disconnect 13 closed	24
89CL14	Disconnect 14 closed	25
89CL15	Disconnect 15 closed	26
89CL16	Disconnect 16 closed	26
89CL17	Disconnect 17 closed	27
89CL18	Disconnect 18 closed	27
89CL19	Disconnect 19 closed	28
89CL20	Disconnect 20 closed	29
89CL21	Disconnect 21 closed	29
89CL22	Disconnect 22 closed	30
89CL23	Disconnect 23 closed	31
89CL24	Disconnect 24 closed	31
89CL25	Disconnect 25 closed	32
89CL26	Disconnect 26 closed	32
89CL27	Disconnect 27 closed	33
89CL28	Disconnect 28 closed	34
89CL29	Disconnect 29 closed	34
89CL30	Disconnect 30 closed	35
89CL31	Disconnect 31 closed	36
89CL32	Disconnect 32 closed	36
89CL33	Disconnect 33 closed	37
89CL34	Disconnect 34 closed	37
89CL35	Disconnect 35 closed	38
89CL36	Disconnect 36 closed	39
89CL37	Disconnect 37 closed	39
89CL38	Disconnect 38 closed	40
89CL39	Disconnect 39 closed	41
89CL40	Disconnect 40 closed	41
89CL41	Disconnect 41 closed	42
89CL42	Disconnect 42 closed	42
89CL43	Disconnect 43 closed	43

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 16 of 79)**

Name	Bit Description	Row
89CL44	Disconnect 44 closed	44
89CL45	Disconnect 45 closed	44
89CL46	Disconnect 46 closed	45
89CL47	Disconnect 47 closed	46
89CL48	Disconnect 48 closed	46
89CL49	Disconnect 49 closed	47
89CL50	Disconnect 50 closed	47
89CL51	Disconnect 51 closed	48
89CL52	Disconnect 52 closed	49
89CL53	Disconnect 53 closed	49
89CL54	Disconnect 54 closed	50
89CL55	Disconnect 55 closed	51
89CL56	Disconnect 56 closed	51
89CL57	Disconnect 57 closed	52
89CL58	Disconnect 58 closed	52
89CL59	Disconnect 59 closed	53
89CL60	Disconnect 60 closed	54
89OIP	Any disconnect operation in progress	55
89OIP01	Disconnect 01 operation in progress	17
89OIP02	Disconnect 02 operation in progress	18
89OIP03	Disconnect 03 operation in progress	18
89OIP04	Disconnect 04 operation in progress	19
89OIP05	Disconnect 05 operation in progress	19
89OIP06	Disconnect 06 operation in progress	20
89OIP07	Disconnect 07 operation in progress	21
89OIP08	Disconnect 08 operation in progress	21
89OIP09	Disconnect 09 operation in progress	22
89OIP10	Disconnect 10 operation in progress	23
89OIP11	Disconnect 11 operation in progress	23
89OIP12	Disconnect 12 operation in progress	24
89OIP13	Disconnect 13 operation in progress	24
89OIP14	Disconnect 14 operation in progress	25
89OIP15	Disconnect 15 operation in progress	26
89OIP16	Disconnect 16 operation in progress	26
89OIP17	Disconnect 17 operation in progress	27
89OIP18	Disconnect 18 operation in progress	28
89OIP19	Disconnect 19 operation in progress	28
89OIP20	Disconnect 20 operation in progress	29
89OIP21	Disconnect 21 operation in progress	29
89OIP22	Disconnect 22 operation in progress	30
89OIP23	Disconnect 23 operation in progress	31

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 17 of 79)**

Name	Bit Description	Row
89OIP24	Disconnect 24 operation in progress	31
89OIP25	Disconnect 25 operation in progress	32
89OIP26	Disconnect 26 operation in progress	33
89OIP27	Disconnect 27 operation in progress	33
89OIP28	Disconnect 28 operation in progress	34
89OIP29	Disconnect 29 operation in progress	34
89OIP30	Disconnect 30 operation in progress	35
89OIP31	Disconnect 31 operation in progress	36
89OIP32	Disconnect 32 operation in progress	36
89OIP33	Disconnect 33 operation in progress	37
89OIP34	Disconnect 34 operation in progress	38
89OIP35	Disconnect 35 operation in progress	38
89OIP36	Disconnect 36 operation in progress	39
89OIP37	Disconnect 37 operation in progress	39
89OIP38	Disconnect 38 operation in progress	40
89OIP39	Disconnect 39 operation in progress	41
89OIP40	Disconnect 40 operation in progress	41
89OIP41	Disconnect 41 operation in progress	42
89OIP42	Disconnect 42 operation in progress	43
89OIP43	Disconnect 43 operation in progress	43
89OIP44	Disconnect 44 operation in progress	44
89OIP45	Disconnect 45 operation in progress	44
89OIP46	Disconnect 46 operation in progress	45
89OIP47	Disconnect 47 operation in progress	46
89OIP48	Disconnect 48 operation in progress	46
89OIP49	Disconnect 49 operation in progress	47
89OIP50	Disconnect 50 operation in progress	48
89OIP51	Disconnect 51 operation in progress	48
89OIP52	Disconnect 52 operation in progress	49
89OIP53	Disconnect 53 operation in progress	49
89OIP54	Disconnect 54 operation in progress	50
89OIP55	Disconnect 55 operation in progress	51
89OIP56	Disconnect 56 operation in progress	51
89OIP57	Disconnect 57 operation in progress	52
89OIP58	Disconnect 58 operation in progress	53
89OIP59	Disconnect 59 operation in progress	53
89OIP60	Disconnect 60 operation in progress	54
ABFIT01	Circuit Breaker 1 alternative circuit breaker failure initiate	183
ABFIT02	Circuit Breaker 2 alternative circuit breaker failure initiate	184
ABFIT03	Circuit Breaker 3 alternative circuit breaker failure initiate	185
ABFIT04	Circuit Breaker 4 alternative circuit breaker failure initiate	186

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 18 of 79)**

Name	Bit Description	Row
ABFIT05	Circuit Breaker 5 alternative circuit breaker failure initiate	187
ABFIT06	Circuit Breaker 6 alternative circuit breaker failure initiate	188
ABFIT07	Circuit Breaker 7 alternative circuit breaker failure initiate	189
ABFIT08	Circuit Breaker 8 alternative circuit breaker failure initiate	190
ABFIT09	Circuit Breaker 9 alternative circuit breaker failure initiate	191
ABFIT10	Circuit Breaker 10 alternative circuit breaker failure initiate	192
ABFIT11	Circuit Breaker 11 alternative circuit breaker failure initiate	193
ABFIT12	Circuit Breaker 12 alternative circuit breaker failure initiate	194
ABFIT13	Circuit Breaker 13 alternative circuit breaker failure initiate	195
ABFIT14	Circuit Breaker 14 alternative circuit breaker failure initiate	196
ABFIT15	Circuit Breaker 15 alternative circuit breaker failure initiate	197
ABFIT16	Circuit Breaker 16 alternative circuit breaker failure initiate	198
ABFIT17	Circuit Breaker 17 alternative circuit breaker failure initiate	199
ABFIT18	Circuit Breaker 18 alternative circuit breaker failure initiate	200
ABFIT19	Circuit Breaker 19 alternative circuit breaker failure initiate	201
ABFIT20	Circuit Breaker 20 alternative circuit breaker failure initiate	202
ABFIT21	Circuit Breaker 21 alternative circuit breaker failure initiate	203
ACCESS	A user is connected at Access Level B or higher	377
ACCESSP	Pulsed when higher level access achieved	377
ACN01Q	Automation counter Output 1	366
ACN01R	Automation counter Reset 1	370
ACN02Q	Automation counter Output 2	366
ACN02R	Automation counter Reset 2	370
ACN03Q	Automation counter Output 3	366
ACN03R	Automation counter Reset 3	370
ACN04Q	Automation counter Output 4	366
ACN04R	Automation counter Reset 4	370
ACN05Q	Automation counter Output 5	366
ACN05R	Automation counter Reset 5	370
ACN06Q	Automation counter Output 6	366
ACN06R	Automation counter Reset 6	370
ACN07Q	Automation counter Output 7	366
ACN07R	Automation counter Reset 7	370
ACN08Q	Automation counter Output 8	366
ACN08R	Automation counter Reset 8	370
ACN09Q	Automation counter Output 9	367
ACN09R	Automation counter Reset 9	371
ACN10Q	Automation counter Output 10	367
ACN10R	Automation counter Reset 10	371
ACN11Q	Automation counter Output 11	367
ACN11R	Automation counter Reset 11	371

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 19 of 79)**

Name	Bit Description	Row
ACN12Q	Automation counter Output 12	367
ACN12R	Automation counter Reset 12	371
ACN13Q	Automation counter Output 13	367
ACN13R	Automation counter Reset 13	371
ACN14Q	Automation counter Output 14	367
ACN14R	Automation counter Reset 14	371
ACN15Q	Automation counter Output 15	367
ACN15R	Automation counter Reset 15	371
ACN16Q	Automation counter Output 16	367
ACN16R	Automation counter Reset 16	371
ACN17Q	Automation counter Output 17	368
ACN17R	Automation counter Reset 17	372
ACN18Q	Automation counter Output 18	368
ACN18R	Automation counter Reset 18	372
ACN19Q	Automation counter Output 19	368
ACN19R	Automation counter Reset 19	372
ACN20Q	Automation counter Output 20	368
ACN20R	Automation counter Reset 20	372
ACN21Q	Automation counter Output 21	368
ACN21R	Automation counter Reset 21	372
ACN22Q	Automation counter Output 22	368
ACN22R	Automation counter Reset 22	372
ACN23Q	Automation counter Output 23	368
ACN23R	Automation counter Reset 23	372
ACN24Q	Automation counter Output 24	368
ACN24R	Automation counter Reset 24	372
ACN25Q	Automation counter Output 25	369
ACN25R	Automation counter Reset 25	373
ACN26Q	Automation counter Output 26	369
ACN26R	Automation counter Reset 26	373
ACN27Q	Automation counter Output 27	369
ACN27R	Automation counter Reset 27	373
ACN28Q	Automation counter Output 28	369
ACN28R	Automation counter Reset 28	373
ACN29Q	Automation counter Output 29	369
ACN29R	Automation counter Reset 29	373
ACN30Q	Automation counter Output 30	369
ACN30R	Automation counter Reset 30	373
ACN31Q	Automation counter Output 31	369
ACN31R	Automation counter Reset 31	373
ACN32Q	Automation counter Output 32	369

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 20 of 79)**

Name	Bit Description	Row
ACN32R	Automation counter Reset 32	373
ACT01Q	Automation SELOGIC conditioning timer Output 01	528
ACT02Q	Automation SELOGIC conditioning timer Output 02	528
ACT03Q	Automation SELOGIC conditioning timer Output 03	528
ACT04Q	Automation SELOGIC conditioning timer Output 04	528
ACT05Q	Automation SELOGIC conditioning timer Output 05	528
ACT06Q	Automation SELOGIC conditioning timer Output 06	528
ACT07Q	Automation SELOGIC conditioning timer Output 07	528
ACT08Q	Automation SELOGIC conditioning timer Output 08	528
ACT09Q	Automation SELOGIC conditioning timer Output 09	529
ACT10Q	Automation SELOGIC conditioning timer Output 10	529
ACT11Q	Automation SELOGIC conditioning timer Output 11	529
ACT12Q	Automation SELOGIC conditioning timer Output 12	529
ACT13Q	Automation SELOGIC conditioning timer Output 13	529
ACT14Q	Automation SELOGIC conditioning timer Output 14	529
ACT15Q	Automation SELOGIC conditioning timer Output 15	529
ACT16Q	Automation SELOGIC conditioning timer Output 16	529
ACT17Q	Automation SELOGIC conditioning timer Output 17	530
ACT18Q	Automation SELOGIC conditioning timer Output 18	530
ACT19Q	Automation SELOGIC conditioning timer Output 19	530
ACT20Q	Automation SELOGIC conditioning Timer Output 20	530
ACT21Q	Automation SELOGIC conditioning timer Output 21	530
ACT22Q	Automation SELOGIC conditioning timer Output 22	530
ACT23Q	Automation SELOGIC conditioning timer Output 23	530
ACT24Q	Automation SELOGIC conditioning timer Output 24	530
ACT25Q	Automation SELOGIC conditioning timer Output 25	531
ACT26Q	Automation SELOGIC conditioning timer Output 26	531
ACT27Q	Automation SELOGIC conditioning timer Output 27	531
ACT28Q	Automation SELOGIC conditioning timer Output 28	531
ACT29Q	Automation SELOGIC conditioning timer Output 29	531
ACT30Q	Automation SELOGIC conditioning timer Output 30	531
ACT31Q	Automation SELOGIC conditioning timer Output 31	531
ACT32Q	Automation SELOGIC conditioning timer Output 32	531
ACTRP1	Coupler 1 accelerated trip SELOGIC control equation	176
ACTRP2	Coupler 2 accelerated trip SELOGIC control equation	177
ACTRP3	Coupler 3 accelerated trip SELOGIC control equation	178
ACTRP4	Coupler 4 accelerated trip SELOGIC control equation	179
ACTRPT1	Coupler 1 accelerated trip timed out	176
ACTRPT2	Coupler 2 accelerated trip timed out	177
ACTRPT3	Coupler 3 accelerated trip timed out	178
ACTRPT4	Coupler 4 accelerated trip timed out	179

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 21 of 79)**

Name	Bit Description	Row
AFRTEXA	Automation SELOGIC control equation first execution automation	375
AFRTEXP	Automation SELOGIC control equation first execution protection	375
ALT01	Automation Latch 1	354
ALT02	Automation Latch 2	354
ALT03	Automation Latch 3	354
ALT04	Automation Latch 4	354
ALT05	Automation Latch 5	354
ALT06	Automation Latch 6	354
ALT07	Automation Latch 7	354
ALT08	Automation Latch 8	354
ALT09	Automation Latch 9	355
ALT10	Automation Latch 10	355
ALT11	Automation Latch 11	355
ALT12	Automation Latch 12	355
ALT13	Automation Latch 13	355
ALT14	Automation Latch 14	355
ALT15	Automation Latch 15	355
ALT16	Automation Latch 16	355
ALT17	Automation Latch 17	356
ALT18	Automation Latch 18	356
ALT19	Automation Latch 19	356
ALT20	Automation Latch 20	356
ALT21	Automation Latch 21	356
ALT22	Automation Latch 22	356
ALT23	Automation Latch 23	356
ALT24	Automation Latch 24	356
ALT25	Automation Latch 25	357
ALT26	Automation Latch 26	357
ALT27	Automation Latch 27	357
ALT28	Automation Latch 28	357
ALT29	Automation Latch 29	357
ALT30	Automation Latch 30	357
ALT31	Automation Latch 31	357
ALT32	Automation Latch 32	357
ANOKA	Channel A MIRRORED BITS analog transfer OK	404
ANOKB	Channel B MIRRORED BITS analog transfer OK	405
AST01Q	Automation sequencing timer Output 1	358
AST01R	Automation sequencing timer Reset 1	362
AST02Q	Automation sequencing timer Output 2	358
AST02R	Automation sequencing timer Reset 2	362
AST03Q	Automation sequencing timer Output 3	358

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 22 of 79)**

Name	Bit Description	Row
AST03R	Automation sequencing timer Reset 3	362
AST04Q	Automation sequencing timer Output 4	358
AST04R	Automation sequencing timer Reset 4	362
AST05Q	Automation sequencing timer Output 5	358
AST05R	Automation sequencing timer Reset 5	362
AST06Q	Automation sequencing timer Output 6	358
AST06R	Automation sequencing timer Reset 6	362
AST07Q	Automation sequencing timer Output 7	358
AST07R	Automation sequencing timer Reset 7	362
AST08Q	Automation sequencing timer Output 8	358
AST08R	Automation sequencing timer Reset 8	362
AST09Q	Automation sequencing timer Output 9	359
AST09R	Automation sequencing timer Reset 9	363
AST10Q	Automation sequencing timer Output 10	359
AST10R	Automation sequencing timer Reset 10	363
AST11Q	Automation sequencing timer Output 11	359
AST11R	Automation sequencing timer Reset 11	363
AST12Q	Automation sequencing timer Output 12	359
AST12R	Automation sequencing timer Reset 12	363
AST13Q	Automation sequencing timer Output 13	359
AST13R	Automation sequencing timer Reset 13	363
AST14Q	Automation sequencing timer Output 14	359
AST14R	Automation sequencing timer Reset 14	363
AST15Q	Automation sequencing timer Output 15	359
AST15R	Automation sequencing timer Reset 15	363
AST16Q	Automation sequencing timer Output 16	359
AST16R	Automation sequencing timer Reset 16	363
AST17Q	Automation sequencing timer Output 17	360
AST17R	Automation sequencing timer Reset 17	364
AST18Q	Automation sequencing timer Output 18	360
AST18R	Automation sequencing timer Reset 18	364
AST19Q	Automation sequencing timer Output 19	360
AST19R	Automation sequencing timer Reset 19	364
AST20Q	Automation sequencing timer Output 20	360
AST20R	Automation sequencing timer Reset 20	364
AST21Q	Automation sequencing timer Output 21	360
AST21R	Automation sequencing timer Reset 21	364
AST22Q	Automation sequencing timer Output 22	360
AST22R	Automation sequencing timer Reset 22	364
AST23Q	Automation sequencing timer Output 23	360
AST23R	Automation sequencing timer Reset 23	364

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 23 of 79)**

Name	Bit Description	Row
AST24Q	Automation sequencing timer Output 24	360
AST24R	Automation sequencing timer Reset 24	364
AST25Q	Automation sequencing timer Output 25	361
AST25R	Automation sequencing timer Reset 25	365
AST26Q	Automation sequencing timer Output 26	361
AST26R	Automation sequencing timer Reset 26	365
AST27Q	Automation sequencing timer Output 27	361
AST27R	Automation sequencing timer Reset 27	365
AST28Q	Automation sequencing timer Output 28	361
AST28R	Automation sequencing timer Reset 28	365
AST29Q	Automation sequencing timer Output 29	361
AST29R	Automation sequencing timer Reset 29	365
AST30Q	Automation sequencing timer Output 30	361
AST30R	Automation sequencing timer Reset 30	365
AST31Q	Automation sequencing timer Output 31	361
AST31R	Automation sequencing timer Reset 31	365
AST32Q	Automation sequencing timer Output 32	361
AST32R	Automation sequencing timer Reset 32	365
ASV001	Automation SELOGIC control equation Variable 1	322
ASV002	Automation SELOGIC control equation Variable 2	322
ASV003	Automation SELOGIC control equation Variable 3	322
ASV004	Automation SELOGIC control equation Variable 4	322
ASV005	Automation SELOGIC control equation Variable 5	322
ASV006	Automation SELOGIC control equation Variable 6	322
ASV007	Automation SELOGIC control equation Variable 7	322
ASV008	Automation SELOGIC control equation Variable 8	322
ASV009	Automation SELOGIC control equation Variable 9	323
ASV010	Automation SELOGIC control equation Variable 10	323
ASV011	Automation SELOGIC control equation Variable 11	323
ASV012	Automation SELOGIC control equation Variable 12	323
ASV013	Automation SELOGIC control equation Variable 13	323
ASV014	Automation SELOGIC control equation Variable 14	323
ASV015	Automation SELOGIC control equation Variable 15	323
ASV016	Automation SELOGIC control equation Variable 16	323
ASV017	Automation SELOGIC control equation Variable 17	324
ASV018	Automation SELOGIC control equation Variable 18	324
ASV019	Automation SELOGIC control equation Variable 19	324
ASV020	Automation SELOGIC control equation Variable 20	324
ASV021	Automation SELOGIC control equation Variable 21	324
ASV022	Automation SELOGIC control equation Variable 22	324
ASV023	Automation SELOGIC control equation Variable 23	324

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 24 of 79)**

Name	Bit Description	Row
ASV024	Automation SELOGIC control equation Variable 24	324
ASV025	Automation SELOGIC control equation Variable 25	325
ASV026	Automation SELOGIC control equation Variable 26	325
ASV027	Automation SELOGIC control equation Variable 27	325
ASV028	Automation SELOGIC control equation Variable 28	325
ASV029	Automation SELOGIC control equation Variable 29	325
ASV030	Automation SELOGIC control equation Variable 30	325
ASV031	Automation SELOGIC control equation Variable 31	325
ASV032	Automation SELOGIC control equation Variable 32	325
ASV033	Automation SELOGIC control equation Variable 33	326
ASV034	Automation SELOGIC control equation Variable 34	326
ASV035	Automation SELOGIC control equation Variable 35	326
ASV036	Automation SELOGIC control equation Variable 36	326
ASV037	Automation SELOGIC control equation Variable 37	326
ASV038	Automation SELOGIC control equation Variable 38	326
ASV039	Automation SELOGIC control equation Variable 39	326
ASV040	Automation SELOGIC control equation Variable 40	326
ASV041	Automation SELOGIC control equation Variable 41	327
ASV042	Automation SELOGIC control equation Variable 42	327
ASV043	Automation SELOGIC control equation Variable 43	327
ASV044	Automation SELOGIC control equation Variable 44	327
ASV045	Automation SELOGIC control equation Variable 45	327
ASV046	Automation SELOGIC control equation Variable 46	327
ASV047	Automation SELOGIC control equation Variable 47	327
ASV048	Automation SELOGIC control equation Variable 48	327
ASV049	Automation SELOGIC control equation Variable 49	328
ASV050	Automation SELOGIC control equation Variable 50	328
ASV051	Automation SELOGIC control equation Variable 51	328
ASV052	Automation SELOGIC control equation Variable 52	328
ASV053	Automation SELOGIC control equation Variable 53	328
ASV054	Automation SELOGIC control equation Variable 54	328
ASV055	Automation SELOGIC control equation Variable 55	328
ASV056	Automation SELOGIC control equation Variable 56	328
ASV057	Automation SELOGIC control equation Variable 57	329
ASV058	Automation SELOGIC control equation Variable 58	329
ASV059	Automation SELOGIC control equation Variable 59	329
ASV060	Automation SELOGIC control equation Variable 60	329
ASV061	Automation SELOGIC control equation Variable 61	329
ASV062	Automation SELOGIC control equation Variable 62	329
ASV063	Automation SELOGIC control equation Variable 63	329
ASV064	Automation SELOGIC control equation Variable 64	329

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 25 of 79)**

Name	Bit Description	Row
ASV065	Automation SELOGIC control equation Variable 65	330
ASV066	Automation SELOGIC control equation Variable 66	330
ASV067	Automation SELOGIC control equation Variable 67	330
ASV068	Automation SELOGIC control equation Variable 68	330
ASV069	Automation SELOGIC control equation Variable 69	330
ASV070	Automation SELOGIC control equation Variable 70	330
ASV071	Automation SELOGIC control equation Variable 71	330
ASV072	Automation SELOGIC control equation Variable 72	330
ASV073	Automation SELOGIC control equation Variable 73	331
ASV074	Automation SELOGIC control equation Variable 74	331
ASV075	Automation SELOGIC control equation Variable 75	331
ASV076	Automation SELOGIC control equation Variable 76	331
ASV077	Automation SELOGIC control equation Variable 77	331
ASV078	Automation SELOGIC control equation Variable 78	331
ASV079	Automation SELOGIC control equation Variable 79	331
ASV080	Automation SELOGIC control equation Variable 80	331
ASV081	Automation SELOGIC control equation Variable 81	332
ASV082	Automation SELOGIC control equation Variable 82	332
ASV083	Automation SELOGIC control equation Variable 83	332
ASV084	Automation SELOGIC control equation Variable 84	332
ASV085	Automation SELOGIC control equation Variable 85	332
ASV086	Automation SELOGIC control equation Variable 86	332
ASV087	Automation SELOGIC control equation Variable 87	332
ASV088	Automation SELOGIC control equation Variable 88	332
ASV089	Automation SELOGIC control equation Variable 89	333
ASV090	Automation SELOGIC control equation Variable 90	333
ASV091	Automation SELOGIC control equation Variable 91	333
ASV092	Automation SELOGIC control equation Variable 92	333
ASV093	Automation SELOGIC control equation Variable 93	333
ASV094	Automation SELOGIC control equation Variable 94	333
ASV095	Automation SELOGIC control equation Variable 95	333
ASV096	Automation SELOGIC control equation Variable 96	333
ASV097	Automation SELOGIC control equation Variable 097	334
ASV098	Automation SELOGIC control equation Variable 098	334
ASV099	Automation SELOGIC control equation Variable 099	334
ASV100	Automation SELOGIC control equation Variable 100	334
ASV101	Automation SELOGIC control equation Variable 101	334
ASV102	Automation SELOGIC control equation Variable 102	334
ASV103	Automation SELOGIC control equation Variable 103	334
ASV104	Automation SELOGIC control equation Variable 104	334
ASV105	Automation SELOGIC control equation Variable 105	335

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 26 of 79)**

Name	Bit Description	Row
ASV106	Automation SELOGIC control equation Variable 106	335
ASV107	Automation SELOGIC control equation Variable 107	335
ASV108	Automation SELOGIC control equation Variable 108	335
ASV109	Automation SELOGIC control equation Variable 109	335
ASV110	Automation SELOGIC control equation Variable 110	335
ASV111	Automation SELOGIC control equation Variable 111	335
ASV112	Automation SELOGIC control equation Variable 112	335
ASV113	Automation SELOGIC control equation Variable 113	336
ASV114	Automation SELOGIC control equation Variable 114	336
ASV115	Automation SELOGIC control equation Variable 115	336
ASV116	Automation SELOGIC control equation Variable 116	336
ASV117	Automation SELOGIC control equation Variable 117	336
ASV118	Automation SELOGIC control equation Variable 118	336
ASV119	Automation SELOGIC control equation Variable 119	336
ASV120	Automation SELOGIC control equation Variable 120	336
ASV121	Automation SELOGIC control equation Variable 121	337
ASV122	Automation SELOGIC control equation Variable 122	337
ASV123	Automation SELOGIC control equation Variable 123	337
ASV124	Automation SELOGIC control equation Variable 124	337
ASV125	Automation SELOGIC control equation Variable 125	337
ASV126	Automation SELOGIC control equation Variable 126	337
ASV127	Automation SELOGIC control equation Variable 127	337
ASV128	Automation SELOGIC control equation Variable 128	337
ASV129	Automation SELOGIC control equation Variable 129	338
ASV130	Automation SELOGIC control equation Variable 130	338
ASV131	Automation SELOGIC control equation Variable 131	338
ASV132	Automation SELOGIC control equation Variable 132	338
ASV133	Automation SELOGIC control equation Variable 133	338
ASV134	Automation SELOGIC control equation Variable 134	338
ASV135	Automation SELOGIC control equation Variable 135	338
ASV136	Automation SELOGIC control equation Variable 136	338
ASV137	Automation SELOGIC control equation Variable 137	339
ASV138	Automation SELOGIC control equation Variable 138	339
ASV139	Automation SELOGIC control equation Variable 139	339
ASV140	Automation SELOGIC control equation Variable 140	339
ASV141	Automation SELOGIC control equation Variable 141	339
ASV142	Automation SELOGIC control equation Variable 142	339
ASV143	Automation SELOGIC control equation Variable 143	339
ASV144	Automation SELOGIC control equation Variable 144	339
ASV145	Automation SELOGIC control equation Variable 145	340
ASV146	Automation SELOGIC control equation Variable 146	340

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 27 of 79)**

Name	Bit Description	Row
ASV147	Automation SELOGIC control equation Variable 147	340
ASV148	Automation SELOGIC control equation Variable 148	340
ASV149	Automation SELOGIC control equation Variable 149	340
ASV150	Automation SELOGIC control equation Variable 150	340
ASV151	Automation SELOGIC control equation Variable 151	340
ASV152	Automation SELOGIC control equation Variable 152	340
ASV153	Automation SELOGIC control equation Variable 153	341
ASV154	Automation SELOGIC control equation Variable 154	341
ASV155	Automation SELOGIC control equation Variable 155	341
ASV156	Automation SELOGIC control equation Variable 156	341
ASV157	Automation SELOGIC control equation Variable 157	341
ASV158	Automation SELOGIC control equation Variable 158	341
ASV159	Automation SELOGIC control equation Variable 159	341
ASV160	Automation SELOGIC control equation Variable 160	341
ASV161	Automation SELOGIC control equation Variable 161	342
ASV162	Automation SELOGIC control equation Variable 162	342
ASV163	Automation SELOGIC control equation Variable 163	342
ASV164	Automation SELOGIC control equation Variable 164	342
ASV165	Automation SELOGIC control equation Variable 165	342
ASV166	Automation SELOGIC control equation Variable 166	342
ASV167	Automation SELOGIC control equation Variable 167	342
ASV168	Automation SELOGIC control equation Variable 168	342
ASV169	Automation SELOGIC control equation Variable 169	343
ASV170	Automation SELOGIC control equation Variable 170	343
ASV171	Automation SELOGIC control equation Variable 171	343
ASV172	Automation SELOGIC control equation Variable 172	343
ASV173	Automation SELOGIC control equation Variable 173	343
ASV174	Automation SELOGIC control equation Variable 174	343
ASV175	Automation SELOGIC control equation Variable 175	343
ASV176	Automation SELOGIC control equation Variable 176	343
ASV177	Automation SELOGIC control equation Variable 177	344
ASV178	Automation SELOGIC control equation Variable 178	344
ASV179	Automation SELOGIC control equation Variable 179	344
ASV180	Automation SELOGIC control equation Variable 180	344
ASV181	Automation SELOGIC control equation Variable 181	344
ASV182	Automation SELOGIC control equation Variable 182	344
ASV183	Automation SELOGIC control equation Variable 183	344
ASV184	Automation SELOGIC control equation Variable 184	344
ASV185	Automation SELOGIC control equation Variable 185	345
ASV186	Automation SELOGIC control equation Variable 186	345
ASV187	Automation SELOGIC control equation Variable 187	345

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 28 of 79)**

Name	Bit Description	Row
ASV188	Automation SELOGIC control equation Variable 188	345
ASV189	Automation SELOGIC control equation Variable 189	345
ASV190	Automation SELOGIC control equation Variable 190	345
ASV191	Automation SELOGIC control equation Variable 191	345
ASV192	Automation SELOGIC control equation Variable 192	345
ASV193	Automation SELOGIC control equation Variable 193	346
ASV194	Automation SELOGIC control equation Variable 194	346
ASV195	Automation SELOGIC control equation Variable 195	346
ASV196	Automation SELOGIC control equation Variable 196	346
ASV197	Automation SELOGIC control equation Variable 197	346
ASV198	Automation SELOGIC control equation Variable 198	346
ASV199	Automation SELOGIC control equation Variable 199	346
ASV200	Automation SELOGIC control equation Variable 200	346
ASV201	Automation SELOGIC control equation Variable 201	347
ASV202	Automation SELOGIC control equation Variable 202	347
ASV203	Automation SELOGIC control equation Variable 203	347
ASV204	Automation SELOGIC control equation Variable 204	347
ASV205	Automation SELOGIC control equation Variable 205	347
ASV206	Automation SELOGIC control equation Variable 206	347
ASV207	Automation SELOGIC control equation Variable 207	347
ASV208	Automation SELOGIC control equation Variable 208	347
ASV209	Automation SELOGIC control equation Variable 209	348
ASV210	Automation SELOGIC control equation Variable 210	348
ASV211	Automation SELOGIC control equation Variable 211	348
ASV212	Automation SELOGIC control equation Variable 212	348
ASV213	Automation SELOGIC control equation Variable 213	348
ASV214	Automation SELOGIC control equation Variable 214	348
ASV215	Automation SELOGIC control equation Variable 215	348
ASV216	Automation SELOGIC control equation Variable 216	348
ASV217	Automation SELOGIC control equation Variable 217	349
ASV218	Automation SELOGIC control equation Variable 218	349
ASV219	Automation SELOGIC control equation Variable 219	349
ASV220	Automation SELOGIC control equation Variable 220	349
ASV221	Automation SELOGIC control equation Variable 221	349
ASV222	Automation SELOGIC control equation Variable 222	349
ASV223	Automation SELOGIC control equation Variable 223	349
ASV224	Automation SELOGIC control equation Variable 224	349
ASV225	Automation SELOGIC control equation Variable 225	350
ASV226	Automation SELOGIC control equation Variable 226	350
ASV227	Automation SELOGIC control equation Variable 227	350
ASV228	Automation SELOGIC control equation Variable 228	350

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 29 of 79)**

Name	Bit Description	Row
ASV229	Automation SELOGIC control equation Variable 229	350
ASV230	Automation SELOGIC control equation Variable 230	350
ASV231	Automation SELOGIC control equation Variable 231	350
ASV232	Automation SELOGIC control equation Variable 232	350
ASV233	Automation SELOGIC control equation Variable 233	351
ASV234	Automation SELOGIC control equation Variable 234	351
ASV235	Automation SELOGIC control equation Variable 235	351
ASV236	Automation SELOGIC control equation Variable 236	351
ASV237	Automation SELOGIC control equation Variable 237	351
ASV238	Automation SELOGIC control equation Variable 238	351
ASV239	Automation SELOGIC control equation Variable 239	351
ASV240	Automation SELOGIC control equation Variable 240	351
ASV241	Automation SELOGIC control equation Variable 241	352
ASV242	Automation SELOGIC control equation Variable 242	352
ASV243	Automation SELOGIC control equation Variable 243	352
ASV244	Automation SELOGIC control equation Variable 244	352
ASV245	Automation SELOGIC control equation Variable 245	352
ASV246	Automation SELOGIC control equation Variable 246	352
ASV247	Automation SELOGIC control equation Variable 247	352
ASV248	Automation SELOGIC control equation Variable 248	352
ASV249	Automation SELOGIC control equation Variable 249	353
ASV250	Automation SELOGIC control equation Variable 250	353
ASV251	Automation SELOGIC control equation Variable 251	353
ASV252	Automation SELOGIC control equation Variable 252	353
ASV253	Automation SELOGIC control equation Variable 253	353
ASV254	Automation SELOGIC control equation Variable 254	353
ASV255	Automation SELOGIC control equation Variable 255	353
ASV256	Automation SELOGIC control equation Variable 256	353
ATBFI01	Circuit Breaker 1 alternative breaker failure initiate SELOGIC control equation	183
ATBFI02	Circuit Breaker 2 alternative breaker failure initiate SELOGIC control equation	184
ATBFI03	Circuit Breaker 3 alternative breaker failure initiate SELOGIC control equation	185
ATBFI04	Circuit Breaker 4 alternative breaker failure initiate SELOGIC control equation	186
ATBFI05	Circuit Breaker 5 alternative breaker failure initiate SELOGIC control equation	187
ATBFI06	Circuit Breaker 6 alternative breaker failure initiate SELOGIC control equation	188
ATBFI07	Circuit Breaker 7 alternative breaker failure initiate SELOGIC control equation	189
ATBFI08	Circuit Breaker 8 alternative breaker failure initiate SELOGIC control equation	190
ATBFI09	Circuit Breaker 9 alternative breaker failure initiate SELOGIC control equation	191
ATBFI10	Circuit Breaker 10 alternative breaker failure initiate SELOGIC control equation	192
ATBFI11	Circuit Breaker 11 alternative breaker failure initiate SELOGIC control equation	193
ATBFI12	Circuit Breaker 12 alternative breaker failure initiate SELOGIC control equation	194
ATBFI13	Circuit Breaker 13 alternative breaker failure initiate SELOGIC control equation	195

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 30 of 79)**

Name	Bit Description	Row
ATBFI14	Circuit Breaker 14 alternative breaker failure initiate SELOGIC control equation	196
ATBFI15	Circuit Breaker 15 alternative breaker failure initiate SELOGIC control equation	197
ATBFI16	Circuit Breaker 16 alternative breaker failure initiate SELOGIC control equation	198
ATBFI17	Circuit Breaker 17 alternative breaker failure initiate SELOGIC control equation	199
ATBFI18	Circuit Breaker 18 alternative breaker failure initiate SELOGIC control equation	200
ATBFI19	Circuit Breaker 19 alternative breaker failure initiate SELOGIC control equation	201
ATBFI20	Circuit Breaker 20 alternative breaker failure initiate SELOGIC control equation	202
ATBFI21	Circuit Breaker 21 alternative breaker failure initiate SELOGIC control equation	203
AUNRLBL	Automation SELOGIC control equation unresolved label	375
BADPASS	Pulsed when the user enters three successive bad passwords	376
BFI01	Circuit Breaker 1 breaker failure initiate SELOGIC control equation	183
BFI02	Circuit Breaker 2 breaker failure initiate SELOGIC control equation	184
BFI03	Circuit Breaker 3 breaker failure initiate SELOGIC control equation	185
BFI04	Circuit Breaker 4 breaker failure initiate SELOGIC control equation	186
BFI05	Circuit Breaker 5 breaker failure initiate SELOGIC control equation	187
BFI06	Circuit Breaker 6 breaker failure initiate SELOGIC control equation	188
BFI07	Circuit Breaker 7 breaker failure initiate SELOGIC control equation	189
BFI08	Circuit Breaker 8 breaker failure initiate SELOGIC control equation	190
BFI09	Circuit Breaker 9 breaker failure initiate SELOGIC control equation	191
BFI10	Circuit Breaker 10 breaker failure initiate SELOGIC control equation	192
BFI11	Circuit Breaker 11 breaker failure initiate SELOGIC control equation	193
BFI12	Circuit Breaker 12 breaker failure initiate SELOGIC control equation	194
BFI13	Circuit Breaker 13 breaker failure initiate SELOGIC control equation	195
BFI14	Circuit Breaker 14 breaker failure initiate SELOGIC control equation	196
BFI15	Circuit Breaker 15 breaker failure initiate SELOGIC control equation	197
BFI16	Circuit Breaker 16 breaker failure initiate SELOGIC control equation	198
BFI17	Circuit Breaker 17 breaker failure initiate SELOGIC control equation	199
BFI18	Circuit Breaker 18 breaker failure initiate SELOGIC control equation	200
BFI19	Circuit Breaker 19 breaker failure initiate SELOGIC control equation	201
BFI20	Circuit Breaker 20 breaker failure initiate SELOGIC control equation	202
BFI21	Circuit Breaker 21 breaker failure initiate SELOGIC control equation	203
BFIT01	Circuit Breaker 1 breaker failure timed out	183
BFIT02	Circuit Breaker 2 breaker failure timed out	184
BFIT03	Circuit Breaker 3 breaker failure timed out	185
BFIT04	Circuit Breaker 4 breaker failure timed out	186
BFIT05	Circuit Breaker 5 breaker failure timed out	187
BFIT06	Circuit Breaker 6 breaker failure timed out	188
BFIT07	Circuit Breaker 7 breaker failure timed out	189
BFIT08	Circuit Breaker 8 breaker failure timed out	190
BFIT09	Circuit Breaker 9 breaker failure timed out	191
BFIT10	Circuit Breaker 10 breaker failure timed out	192

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 31 of 79)**

Name	Bit Description	Row
BFIT11	Circuit Breaker 11 breaker failure timed out	193
BFIT12	Circuit Breaker 12 breaker failure timed out	194
BFIT13	Circuit Breaker 13 breaker failure timed out	195
BFIT14	Circuit Breaker 14 breaker failure timed out	196
BFIT15	Circuit Breaker 15 breaker failure timed out	197
BFIT16	Circuit Breaker 16 breaker failure timed out	198
BFIT17	Circuit Breaker 17 breaker failure timed out	199
BFIT18	Circuit Breaker 18 breaker failure timed out	200
BFIT19	Circuit Breaker 19 breaker failure timed out	201
BFIT20	Circuit Breaker 20 breaker failure timed out	202
BFIT21	Circuit Breaker 21 breaker failure timed out	203
BFZ1	Zone 1 breaker failure	240
BFZ2	Zone 2 breaker failure	240
BFZ3	Zone 3 breaker failure	240
BFZ4	Zone 4 breaker failure	240
BFZ5	Zone 5 breaker failure	240
BFZ6	Zone 6 breaker failure	240
BLKLPTS	Block low-priority source from updating relay time	379
BNC_BNP	Bad jitter on BNC port and the IRIG-B signal is lost afterward	472
BNC_OK	IRIG-B signal from BNC port is available and has sufficient quality	472
BNC_RST	Disqualify BNC IRIG-B time source	472
BNC_SET	Qualify BNC IRIG-B time source	472
BNC_TIM	A valid IRIG-B time source is detected on BNC port	473
BNCSYNC	Synchronized to a high-quality BNC IRIG source	474
BRKENAB	Asserts to indicate breaker control enable jumper is installed	377
BZ1BZ2R	A connection exists between BZ1 and BZ2 and a coupler is removed	136
BZ1BZ2V	A connection exists between BZ1 and BZ2	128
BZ1BZ3R	A connection exists between BZ1 and BZ3 and a coupler is removed	136
BZ1BZ3V	A connection exists between BZ1 and BZ3	128
BZ1BZ4R	A connection exists between BZ1 and BZ4 and a coupler is removed	136
BZ1BZ4V	A connection exists between BZ1 and BZ4	128
BZ1BZ5R	A connection exists between BZ1 and BZ5 and a coupler is removed	136
BZ1BZ5V	A connection exists between BZ1 and BZ5	128
BZ1BZ6R	A connection exists between BZ1 and BZ6 and a coupler is removed	136
BZ1BZ6V	A connection exists between BZ1 and BZ6	128
BZ2BZ3R	A connection exists between BZ2 and BZ3 and a coupler is removed	137
BZ2BZ3V	A connection exists between BZ2 and BZ3	129
BZ2BZ4R	A connection exists between BZ2 and BZ4 and a coupler is removed	137
BZ2BZ4V	A connection exists between BZ2 and BZ4	129
BZ2BZ5R	A connection exists between BZ2 and BZ5 and a coupler is removed	137
BZ2BZ5V	A connection exists between BZ2 and BZ5	129

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 32 of 79)**

Name	Bit Description	Row
BZ2BZ6R	A connection exists between BZ2 and BZ6 and a coupler is removed	137
BZ2BZ6V	A connection exists between BZ2 and BZ6	129
BZ3BZ4R	A connection exists between BZ3 and BZ4 and a coupler is removed	138
BZ3BZ4V	A connection exists between BZ3 and BZ4	130
BZ3BZ5R	A connection exists between BZ3 and BZ5 and a coupler is removed	138
BZ3BZ5V	A connection exists between BZ3 and BZ5	130
BZ3BZ6R	A connection exists between BZ3 and BZ6 and a coupler is removed	138
BZ3BZ6V	A connection exists between BZ3 and BZ6	130
BZ4BZ5R	A connection exists between BZ4 and BZ5 and a coupler is removed	139
BZ4BZ5V	A connection exists between BZ4 and BZ5	131
BZ4BZ6R	A connection exists between BZ4 and BZ6 and a coupler is removed	139
BZ4BZ6V	A connection exists between BZ4 and BZ6	131
BZ5BZ6R	A connection exists between BZ5 and BZ6 and a coupler is removed	140
BZ5BZ6V	A connection exists between BZ5 and BZ6	132
CB52A1	Coupler 1 status SELOGIC control equation	176
CB52A2	Coupler 2 status SELOGIC control equation	177
CB52A3	Coupler 3 status SELOGIC control equation	178
CB52A4	Coupler 4 status SELOGIC control equation	179
CB52T1	Coupler 1 status timed out	176
CB52T2	Coupler 2 status timed out	177
CB52T3	Coupler 3 status timed out	178
CB52T4	Coupler 4 status timed out	179
CBADA	Channel A MIRRORED BITS unavailability	404
CBADB	Channel B MIRRORED BITS unavailability	405
CBCLS1	Coupler 1 close command SELOGIC control equation	176
CBCLS2	Coupler 2 close command SELOGIC control equation	177
CBCLS3	Coupler 3 close command SELOGIC control equation	178
CBCLS4	Coupler 4 close command SELOGIC control equation	179
CBCLST1	Coupler 1 close command timed out	176
CBCLST2	Coupler 2 close command timed out	177
CBCLST3	Coupler 3 close command timed out	178
CBCLST4	Coupler 4 close command timed out	179
CHSG	Asserted during settings group change	255
CON1	Zone 1 in high-security mode	159
CON2	Zone 2 in high-security mode	161
CON3	Zone 3 in high-security mode	163
CON4	Zone 4 in high-security mode	165
CON5	Zone 5 in high-security mode	167
CON6	Zone 6 in high-security mode	169
CONCZ1	Check Zone 1 in high-security mode	450
CONCZ2	Check Zone 2 in high-security mode	452

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 33 of 79)**

<b>Name</b>	<b>Bit Description</b>	<b>Row</b>
CONCZ3	Check Zone 3 in high-security mode	454
CSL1	Coupler 1 security logic picked up	176
CSL2	Coupler 2 security logic picked up	177
CSL3	Coupler 3 security logic picked up	178
CSL4	Coupler 4 security logic picked up	179
CZ11R	Include Bus Coupler 1 in Check Zone 1	407
CZ12R	Include Bus Coupler 2 in Check Zone 1	407
CZ13R	Include Bus Coupler 3 in Check Zone 1	407
CZ14R	Include Bus Coupler 4 in Check Zone 1	407
CZ1S	Check Zone 1 supervision asserted	446
CZ21R	Include Bus Coupler 1 in Check Zone 2	407
CZ22R	Include Bus Coupler 2 in Check Zone 2	407
CZ23R	Include Bus Coupler 3 in Check Zone 2	407
CZ24R	Include Bus Coupler 4 in Check Zone 2	407
CZ2S	Check Zone 2 supervision asserted	446
CZ31R	Include Bus Coupler 1 in Check Zone 3	443
CZ32R	Include Bus Coupler 2 in Check Zone 3	443
CZ33R	Include Bus Coupler 3 in Check Zone 3	443
CZ34R	Include Bus Coupler 4 in Check Zone 3	443
CZ3S	Check Zone 3 supervision asserted	446
CZONE1	Check Zone 1 is active	445
CZONE2	Check Zone 2 is active	445
CZONE3	Check Zone 3 is active	445
DC1F	DC monitor fail alarm	227
DC1G	DC monitor ground fault alarm	227
DC1R	DC monitor alarm for ac ripple	227
DC1W	DC monitor warning alarm	227
DE1F	Zone 1 forward directional element picked up	172
DE2F	Zone 2 forward directional element picked up	172
DE3F	Zone 3 forward directional element picked up	172
DE4F	Zone 4 forward directional element picked up	172
DE5F	Zone 5 forward directional element picked up	172
DE6F	Zone 6 forward directional element picked up	172
DECZ1F	Check Zone 1 forward directional element picked up	456
DECZ2F	Check Zone 2 forward directional element picked up	456
DECZ3F	Check Zone 3 forward directional element picked up	456
DOKA	Channel A MIRRORED BITS communications normal status	404
DOKB	Channel B MIRRORED BITS communications normal status	405
DOP1	Zone 1 incremental operating current picked up	159
DOP2	Zone 2 incremental operating current picked up	161
DOP3	Zone 3 incremental operating current picked up	163

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 34 of 79)**

Name	Bit Description	Row
DOP4	Zone 4 incremental operating current picked up	165
DOP5	Zone 5 incremental operating current picked up	167
DOP6	Zone 6 incremental operating current picked up	169
DOPCZ1	Check Zone 1 incremental operating current picked up	450
DOPCZ2	Check Zone 2 incremental operating current picked up	452
DOPCZ3	Check Zone 3 incremental operating current picked up	454
DRT1	Zone 1 incremental restraint current picked up	159
DRT2	Zone 2 incremental restraint current picked up	161
DRT3	Zone 3 incremental restraint current picked up	163
DRT4	Zone 4 incremental restraint current picked up	165
DRT5	Zone 5 incremental restraint current picked up	167
DRT6	Zone 6 incremental restraint current picked up	169
DRTCZ1	Check Zone 1 incremental restraint current picked up	450
DRTCZ2	Check Zone 2 incremental restraint current picked up	452
DRTCZ3	Check Zone 3 incremental restraint current picked up	454
DST	Daylight-saving time	470
DSTP	IRIG-B daylight-saving time pending	470
E2AC	Enable Levels 1–2 access (SELOGIC control equation)	377
EACC	Enable Level 1 access (SELOGIC control equation)	377
EN	Relay enabled	0
ER	Event report trigger equation (SELOGIC control equation)	241
EVELOCK	Event summary lock period	241
EXT1	Zone 1 external fault declaration	159
EXT2	Zone 2 external fault declaration	161
EXT3	Zone 3 external fault declaration	163
EXT4	Zone 4 external fault declaration	165
EXT5	Zone 5 external fault declaration	167
EXT6	Zone 6 external fault declaration	169
EXTCZ1	Check Zone 1 external fault declaration	450
EXTCZ2	Check Zone 2 external fault declaration	452
EXTCZ3	Check Zone 3 external fault declaration	454
FAULT	Busbar fault in any zone	171
FAULT1	Zone 1 fault detector picked up	159
FAULT2	Zone 2 fault detector picked up	161
FAULT3	Zone 3 fault detector picked up	163
FAULT4	Zone 4 fault detector picked up	165
FAULT5	Zone 5 fault detector picked up	167
FAULT6	Zone 6 fault detector picked up	169
FBF01	Circuit Breaker 1 failure	183
FBF02	Circuit Breaker 2 failure	184
FBF03	Circuit Breaker 3 failure	185

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 35 of 79)**

<b>Name</b>	<b>Bit Description</b>	<b>Row</b>
FBF04	Circuit Breaker 4 failure	186
FBF05	Circuit Breaker 5 failure	187
FBF06	Circuit Breaker 6 failure	188
FBF07	Circuit Breaker 7 failure	189
FBF08	Circuit Breaker 8 failure	190
FBF09	Circuit Breaker 9 failure	191
FBF10	Circuit Breaker 10 failure	192
FBF11	Circuit Breaker 11 failure	193
FBF12	Circuit Breaker 12 failure	194
FBF13	Circuit Breaker 13 failure	195
FBF14	Circuit Breaker 14 failure	196
FBF15	Circuit Breaker 15 failure	197
FBF16	Circuit Breaker 16 failure	198
FBF17	Circuit Breaker 17 failure	199
FBF18	Circuit Breaker 18 failure	200
FBF19	Circuit Breaker 19 failure	201
FBF20	Circuit Breaker 20 failure	202
FBF21	Circuit Breaker 21 failure	203
FDIF1	Zone 1 filtered restrained differential element picked up	160
FDIF2	Zone 2 filtered restrained differential element picked up	162
FDIF3	Zone 3 filtered restrained differential element picked up	164
FDIF4	Zone 4 filtered restrained differential element picked up	166
FDIF5	Zone 5 filtered restrained differential element picked up	168
FDIF6	Zone 6 filtered restrained differential element picked up	170
FDIFCZ1	Check Zone 1 filtered restrained differential element picked up	451
FDIFCZ2	Check Zone 2 filtered restrained differential element picked up	453
FDIFCZ3	Check Zone 3 filtered restrained differential element picked up	455
FLTCZ1	Check Zone 1 fault detector picked up	450
FLTCZ2	Check Zone 2 fault detector picked up	452
FLTCZ3	Check Zone 3 fault detector picked up	454
FSERP1	Fast SER enabled for serial PORT 1	444
FSERP2	Fast SER enabled for serial PORT 2	444
FSERP3	Fast SER enabled for serial PORT 3	444
FSERP5	Fast SER enabled for serial PORT 5	444
FSERPF	Fast SER enabled for serial PORT F	444
GFAULT1	Zone 1 fast fault detection	160
GFAULT2	Zone 2 fast fault detection	162
GFAULT3	Zone 3 fast fault detection	164
GFAULT4	Zone 4 fast fault detection	166
GFAULT5	Zone 5 fast fault detection	168
GFAULT6	Zone 6 fast fault detection	170

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 36 of 79)**

Name	Bit Description	Row
GFLTCZ1	Check Zone 1 fast fault detection	451
GFLTCZ2	Check Zone 2 fast fault detection	453
GFLTCZ3	Check Zone 3 fast fault detection	455
GRPSW	Pulsed when settings group changes	376
HALARM	Relay diagnostic failure or warning	376
HALARMA	Relay warning periodic alarm	376
HALARML	Latching relay failure alarm	376
HALARMP	Relay warning alarm pulse	376
I01BK	Terminal I01 is not OK (use for blocking)	488
I01BZ1V	Terminal I01 connected to BZ1	56
I01BZ2V	Terminal I01 connected to BZ2	60
I01BZ3V	Terminal I01 connected to BZ3	64
I01BZ4V	Terminal I01 connected to BZ4	68
I01BZ5V	Terminal I01 connected to BZ5	72
I01BZ6V	Terminal I01 connected to BZ6	76
I01FZ	Terminal I01 freeze bit for use in open phase logic and breaker failure logic	496
I01MAP	Terminal I01 is mapped in a subscription	480
I01OK	Terminal I01 configured channel data OK	484
I02BK	Terminal I02 is not OK (use for blocking)	488
I02BZ1V	Terminal I02 connected to BZ1	56
I02BZ2V	Terminal I02 connected to BZ2	60
I02BZ3V	Terminal I02 connected to BZ3	64
I02BZ4V	Terminal I02 connected to BZ4	68
I02BZ5V	Terminal I02 connected to BZ5	72
I02BZ6V	Terminal I02 connected to BZ6	76
I02FZ	Terminal I02 freeze bit for use in open phase logic and breaker failure logic	496
I02MAP	Terminal I02 is mapped in a subscription	480
I02OK	Terminal I02 configured channel data OK	484
I03BK	Terminal I03 is not OK (use for blocking)	488
I03BZ1V	Terminal I03 connected to BZ1	56
I03BZ2V	Terminal I03 connected to BZ2	60
I03BZ3V	Terminal I03 connected to BZ3	64
I03BZ4V	Terminal I03 connected to BZ4	68
I03BZ5V	Terminal I03 connected to BZ5	72
I03BZ6V	Terminal I03 connected to BZ6	76
I03FZ	Terminal I03 freeze bit for use in open phase logic and breaker failure logic	496
I03MAP	Terminal I03 is mapped in a subscription	480
I03OK	Terminal I03 configured channel data OK	484
I04BK	Terminal I04 is not OK (use for blocking)	488
I04BZ1V	Terminal I04 connected to BZ1	56
I04BZ2V	Terminal I04 connected to BZ2	60

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 37 of 79)**

<b>Name</b>	<b>Bit Description</b>	<b>Row</b>
I04BZ3V	Terminal I04 connected to BZ3	64
I04BZ4V	Terminal I04 connected to BZ4	68
I04BZ5V	Terminal I04 connected to BZ5	72
I04BZ6V	Terminal I04 connected to BZ6	76
I04FZ	Terminal I04 freeze bit for use in open phase logic and breaker failure logic	496
I04MAP	Terminal I04 is mapped in a subscription	480
I04OK	Terminal I04 configured channel data OK	484
I05BK	Terminal I05 is not OK (use for blocking)	489
I05BZ1V	Terminal I05 connected to BZ1	56
I05BZ2V	Terminal I05 connected to BZ2	60
I05BZ3V	Terminal I05 connected to BZ3	64
I05BZ4V	Terminal I05 connected to BZ4	68
I05BZ5V	Terminal I05 connected to BZ5	72
I05BZ6V	Terminal I05 connected to BZ6	76
I05FZ	Terminal I05 freeze bit for use in open phase logic and breaker failure logic	497
I05MAP	Terminal I05 is mapped in a subscription	481
I05OK	Terminal I05 configured channel data OK	485
I06BK	Terminal I06 is not OK (use for blocking)	489
I06BZ1V	Terminal I06 connected to BZ1	56
I06BZ2V	Terminal I06 connected to BZ2	60
I06BZ3V	Terminal I06 connected to BZ3	64
I06BZ4V	Terminal I06 connected to BZ4	68
I06BZ5V	Terminal I06 connected to BZ5	72
I06BZ6V	Terminal I06 connected to BZ6	76
I06FZ	Terminal I06 freeze bit for use in open phase logic and breaker failure logic	497
I06MAP	Terminal I06 is mapped in a subscription	481
I06OK	Terminal I06 configured channel data OK	485
I07BK	Terminal I07 is not OK (use for blocking)	489
I07BZ1V	Terminal I07 connected to BZ1	56
I07BZ2V	Terminal I07 connected to BZ2	60
I07BZ3V	Terminal I07 connected to BZ3	64
I07BZ4V	Terminal I07 connected to BZ4	68
I07BZ5V	Terminal I07 connected to BZ5	72
I07BZ6V	Terminal I07 connected to BZ6	76
I07FZ	Terminal I07 freeze bit for use in open phase logic and breaker failure logic	497
I07MAP	Terminal I07 is mapped in a subscription	481
I07OK	Terminal I07 configured channel data OK	485
I08BK	Terminal I08 is not OK (use for blocking)	489
I08BZ1V	Terminal I08 connected to BZ1	56
I08BZ2V	Terminal I08 connected to BZ2	60
I08BZ3V	Terminal I08 connected to BZ3	64

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 38 of 79)**

<b>Name</b>	<b>Bit Description</b>	<b>Row</b>
I08BZ4V	Terminal I08 connected to BZ4	68
I08BZ5V	Terminal I08 connected to BZ5	72
I08BZ6V	Terminal I08 connected to BZ6	76
I08FZ	Terminal I08 freeze bit for use in open phase logic and breaker failure logic	497
I08MAP	Terminal I08 is mapped in a subscription	481
I08OK	Terminal I08 configured channel data OK	485
I09BK	Terminal I09 is not OK (use for blocking)	490
I09BZ1V	Terminal I09 connected to BZ1	57
I09BZ2V	Terminal I09 connected to BZ2	61
I09BZ3V	Terminal I09 connected to BZ3	65
I09BZ4V	Terminal I09 connected to BZ4	69
I09BZ5V	Terminal I09 connected to BZ5	73
I09BZ6V	Terminal I09 connected to BZ6	77
I09FZ	Terminal I09 freeze bit for use in open phase logic and breaker failure logic	498
I09MAP	Terminal I09 is mapped in a subscription	482
I09OK	Terminal I09 configured channel data OK	486
I10BK	Terminal I10 is not OK (use for blocking)	488
I10BZ1V	Terminal I10 connected to BZ1	57
I10BZ2V	Terminal I10 connected to BZ2	61
I10BZ3V	Terminal I10 connected to BZ3	65
I10BZ4V	Terminal I10 connected to BZ4	69
I10BZ5V	Terminal I10 connected to BZ5	73
I10BZ6V	Terminal I10 connected to BZ6	77
I10FZ	Terminal I10 freeze bit for use in open phase logic and breaker failure logic	496
I10MAP	Terminal I10 is mapped in a subscription	480
I10OK	Terminal I10 configured channel data OK	484
I11BK	Terminal I11 is not OK (use for blocking)	488
I11BZ1V	Terminal I11 connected to BZ1	57
I11BZ2V	Terminal I11 connected to BZ2	61
I11BZ3V	Terminal I11 connected to BZ3	65
I11BZ4V	Terminal I11 connected to BZ4	69
I11BZ5V	Terminal I11 connected to BZ5	73
I11BZ6V	Terminal I11 connected to BZ6	77
I11FZ	Terminal I11 freeze bit for use in open phase logic and breaker failure logic	496
I11MAP	Terminal I11 is mapped in a subscription	480
I11OK	Terminal I11 configured channel data OK	484
I12BK	Terminal I12 is not OK (use for blocking)	488
I12BZ1V	Terminal I12 connected to BZ1	57
I12BZ2V	Terminal I12 connected to BZ2	61
I12BZ3V	Terminal I12 connected to BZ3	65
I12BZ4V	Terminal I12 connected to BZ4	69

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 39 of 79)**

Name	Bit Description	Row
I12BZ5V	Terminal I12 connected to BZ5	73
I12BZ6V	Terminal I12 connected to BZ6	77
I12FZ	Terminal I12 freeze bit for use in open phase logic and breaker failure logic	496
I12MAP	Terminal I12 is mapped in a subscription	480
I12OK	Terminal I12 configured channel data OK	484
I13BK	Terminal I13 is not OK (use for blocking)	488
I13BZ1V	Terminal I13 connected to BZ1	57
I13BZ2V	Terminal I13 connected to BZ2	61
I13BZ3V	Terminal I13 connected to BZ3	65
I13BZ4V	Terminal I13 connected to BZ4	69
I13BZ5V	Terminal I13 connected to BZ5	73
I13BZ6V	Terminal I13 connected to BZ6	77
I13FZ	Terminal I13 freeze bit for use in open phase logic and breaker failure logic	496
I13MAP	Terminal I13 is mapped in a subscription	480
I13OK	Terminal I13 configured channel data OK	484
I14BK	Terminal I14 is not OK (use for blocking)	489
I14BZ1V	Terminal I14 connected to BZ1	57
I14BZ2V	Terminal I14 connected to BZ2	61
I14BZ3V	Terminal I14 connected to BZ3	65
I14BZ4V	Terminal I14 connected to BZ4	69
I14BZ5V	Terminal I14 connected to BZ5	73
I14BZ6V	Terminal I14 connected to BZ6	77
I14FZ	Terminal I14 freeze bit for use in open phase logic and breaker failure logic	497
I14MAP	Terminal I14 is mapped in a subscription	481
I14OK	Terminal I14 configured channel data OK	485
I15BK	Terminal I15 is not OK (use for blocking)	489
I15BZ1V	Terminal I15 connected to BZ1	57
I15BZ2V	Terminal I15 connected to BZ2	61
I15BZ3V	Terminal I15 connected to BZ3	65
I15BZ4V	Terminal I15 connected to BZ4	69
I15BZ5V	Terminal I15 connected to BZ5	73
I15BZ6V	Terminal I15 connected to BZ6	77
I15FZ	Terminal I15 freeze bit for use in open phase logic and breaker failure logic	497
I15MAP	Terminal I15 is mapped in a subscription	481
I15OK	Terminal I15 configured channel data OK	485
I16BK	Terminal I16 is not OK (use for blocking)	489
I16BZ1V	Terminal I16 connected to BZ1	57
I16BZ2V	Terminal I16 connected to BZ2	61
I16BZ3V	Terminal I16 connected to BZ3	65
I16BZ4V	Terminal I16 connected to BZ4	69
I16BZ5V	Terminal I16 connected to BZ5	73

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 40 of 79)**

Name	Bit Description	Row
I16BZ6V	Terminal I16 connected to BZ6	77
I16FZ	Terminal I16 freeze bit for use in open phase logic and breaker failure logic	497
I16MAP	Terminal I16 is mapped in a subscription	481
I16OK	Terminal I16 configured channel data OK	485
I17BK	Terminal I17 is not OK (use for blocking)	489
I17BZ1V	Terminal I17 connected to BZ1	58
I17BZ2V	Terminal I17 connected to BZ2	62
I17BZ3V	Terminal I17 connected to BZ3	66
I17BZ4V	Terminal I17 connected to BZ4	70
I17BZ5V	Terminal I17 connected to BZ5	74
I17BZ6V	Terminal I17 connected to BZ6	78
I17FZ	Terminal I17 freeze bit for use in open phase logic and breaker failure logic	497
I17MAP	Terminal I17 is mapped in a subscription	481
I17OK	Terminal I17 configured channel data OK	485
I18BK	Terminal I18 is not OK (use for blocking)	490
I18BZ1V	Terminal I18 connected to BZ1	58
I18BZ2V	Terminal I18 connected to BZ2	62
I18BZ3V	Terminal I18 connected to BZ3	66
I18BZ4V	Terminal I18 connected to BZ4	70
I18BZ5V	Terminal I18 connected to BZ5	74
I18BZ6V	Terminal I18 connected to BZ6	78
I18FZ	Terminal I18 freeze bit for use in open phase logic and breaker failure logic	498
I18MAP	Terminal I18 is mapped in a subscription	482
I18OK	Terminal I18 configured channel data OK	486
I19BK	Terminal I19 is not OK (use for blocking)	490
I19BZ1V	Terminal I19 connected to BZ1	58
I19BZ2V	Terminal I19 connected to BZ2	62
I19BZ3V	Terminal I19 connected to BZ3	66
I19BZ4V	Terminal I19 connected to BZ4	70
I19BZ5V	Terminal I19 connected to BZ5	74
I19BZ6V	Terminal I19 connected to BZ6	78
I19FZ	Terminal I19 freeze bit for use in open phase logic and breaker failure logic	498
I19MAP	Terminal I19 is mapped in a subscription	482
I19OK	Terminal I19 configured channel data OK	486
I20BK	Terminal I20 is not OK (use for blocking)	490
I20BZ1V	Terminal I20 connected to BZ1	58
I20BZ2V	Terminal I20 connected to BZ2	62
I20BZ3V	Terminal I20 connected to BZ3	66
I20BZ4V	Terminal I20 connected to BZ4	70
I20BZ5V	Terminal I20 connected to BZ5	74
I20BZ6V	Terminal I20 connected to BZ6	78

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 41 of 79)**

Name	Bit Description	Row
I20FZ	Terminal I20 freeze bit for use in open phase logic and breaker failure logic	498
I20MAP	Terminal I20 is mapped in a subscription	482
I20OK	Terminal I20 configured channel data OK	486
I21BK	Terminal I21 is not OK (use for blocking)	490
I21BZ1V	Terminal I21 connected to BZ1	58
I21BZ2V	Terminal I21 connected to BZ2	62
I21BZ3V	Terminal I21 connected to BZ3	66
I21BZ4V	Terminal I21 connected to BZ4	70
I21BZ5V	Terminal I21 connected to BZ5	74
I21BZ6V	Terminal I21 connected to BZ6	78
I21FZ	Terminal I21 freeze bit for use in open phase logic and breaker failure logic	498
I21MAP	Terminal I21 is mapped in a subscription	482
I21OK	Terminal I21 configured channel data OK	486
IFault1	Zone 1 fault detection	160
IFault2	Zone 2 fault detection	162
IFault3	Zone 3 fault detection	164
IFault4	Zone 4 fault detection	166
IFault5	Zone 5 fault detection	168
IFault6	Zone 6 fault detection	170
IFLTCZ1	Check Zone 1 fault detection	451
IFLTCZ2	Check Zone 2 fault detection	453
IFLTCZ3	Check Zone 3 fault detection	455
IN201	Optional I/O Board 1 Input 01	276
IN202	Optional I/O Board 1 Input 02	276
IN203	Optional I/O Board 1 Input 03	276
IN204	Optional I/O Board 1 Input 04	276
IN205	Optional I/O Board 1 Input 05	276
IN206	Optional I/O Board 1 Input 06	276
IN207	Optional I/O Board 1 Input 07	276
IN208	Optional I/O Board 1 Input 08	276
IN209	Optional I/O Board 1 Input 09	277
IN210	Optional I/O Board 1 Input 10	277
IN211	Optional I/O Board 1 Input 11	277
IN212	Optional I/O Board 1 Input 12	277
IN213	Optional I/O Board 1 Input 13	277
IN214	Optional I/O Board 1 Input 14	277
IN215	Optional I/O Board 1 Input 15	277
IN216	Optional I/O Board 1 Input 16	277
IN217	Optional I/O Board 1 Input 17	278
IN218	Optional I/O Board 1 Input 18	278
IN219	Optional I/O Board 1 Input 19	278

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 42 of 79)**

Name	Bit Description	Row
IN220	Optional I/O Board 1 Input 20	278
IN221	Optional I/O Board 1 Input 21	278
IN222	Optional I/O Board 1 Input 22	278
IN223	Optional I/O Board 1 Input 23	278
IN224	Optional I/O Board 1 Input 24	278
LB_DP01	Local Bit 01 status display (SELOGIC control equation)	461
LB_DP02	Local Bit 02 status display (SELOGIC control equation)	461
LB_DP03	Local Bit 03 status display (SELOGIC control equation)	461
LB_DP04	Local Bit 04 status display (SELOGIC control equation)	461
LB_DP05	Local Bit 05 status display (SELOGIC control equation)	461
LB_DP06	Local Bit 06 status display (SELOGIC control equation)	461
LB_DP07	Local Bit 07 status display (SELOGIC control equation)	461
LB_DP08	Local Bit 08 status display (SELOGIC control equation)	461
LB_DP09	Local Bit 09 status display (SELOGIC control equation)	462
LB_DP10	Local Bit 10 status display (SELOGIC control equation)	462
LB_DP11	Local Bit 11 status display (SELOGIC control equation)	462
LB_DP12	Local Bit 12 status display (SELOGIC control equation)	462
LB_DP13	Local Bit 13 status display (SELOGIC control equation)	462
LB_DP14	Local Bit 14 status display (SELOGIC control equation)	462
LB_DP15	Local Bit 15 status display (SELOGIC control equation)	462
LB_DP16	Local Bit 16 status display (SELOGIC control equation)	462
LB_DP17	Local Bit 17 status display (SELOGIC control equation)	463
LB_DP18	Local Bit 18 status display (SELOGIC control equation)	463
LB_DP19	Local Bit 19 status display (SELOGIC control equation)	463
LB_DP20	Local Bit 20 status display (SELOGIC control equation)	463
LB_DP21	Local Bit 21 status display (SELOGIC control equation)	463
LB_DP22	Local Bit 22 status display (SELOGIC control equation)	463
LB_DP23	Local Bit 23 status display (SELOGIC control equation)	463
LB_DP24	Local Bit 24 status display (SELOGIC control equation)	463
LB_DP25	Local Bit 25 status display (SELOGIC control equation)	464
LB_DP26	Local Bit 26 status display (SELOGIC control equation)	464
LB_DP27	Local Bit 27 status display (SELOGIC control equation)	464
LB_DP28	Local Bit 28 status display (SELOGIC control equation)	464
LB_DP29	Local Bit 29 status display (SELOGIC control equation)	464
LB_DP30	Local Bit 30 status display (SELOGIC control equation)	464
LB_DP31	Local Bit 31 status display (SELOGIC control equation)	464
LB_DP32	Local Bit 32 status display (SELOGIC control equation)	464
LB_DP33	Local Bit 33 status display (SELOGIC control equation)	540
LB_DP34	Local Bit 34 status display (SELOGIC control equation)	540
LB_DP35	Local Bit 35 status display (SELOGIC control equation)	540
LB_DP36	Local Bit 36 status display (SELOGIC control equation)	540

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 43 of 79)**

Name	Bit Description	Row
LB_DP37	Local Bit 37 status display (SELOGIC control equation)	540
LB_DP38	Local Bit 38 status display (SELOGIC control equation)	540
LB_DP39	Local Bit 39 status display (SELOGIC control equation)	540
LB_DP40	Local Bit 40 status display (SELOGIC control equation)	540
LB_DP41	Local Bit 41 status display (SELOGIC control equation)	541
LB_DP42	Local Bit 42 status display (SELOGIC control equation)	541
LB_DP43	Local Bit 43 status display (SELOGIC control equation)	541
LB_DP44	Local Bit 44 status display (SELOGIC control equation)	541
LB_DP45	Local Bit 45 status display (SELOGIC control equation)	541
LB_DP46	Local Bit 46 status display (SELOGIC control equation)	541
LB_DP47	Local Bit 47 status display (SELOGIC control equation)	541
LB_DP48	Local Bit 48 status display (SELOGIC control equation)	541
LB_DP49	Local Bit 49 status display (SELOGIC control equation)	542
LB_DP50	Local Bit 50 status display (SELOGIC control equation)	542
LB_DP51	Local Bit 51 status display (SELOGIC control equation)	542
LB_DP52	Local Bit 52 status display (SELOGIC control equation)	542
LB_DP53	Local Bit 53 status display (SELOGIC control equation)	542
LB_DP54	Local Bit 54 status display (SELOGIC control equation)	542
LB_DP55	Local Bit 55 status display (SELOGIC control equation)	542
LB_DP56	Local Bit 56 status display (SELOGIC control equation)	542
LB_DP57	Local Bit 57 status display (SELOGIC control equation)	543
LB_DP58	Local Bit 58 status display (SELOGIC control equation)	543
LB_DP59	Local Bit 59 status display (SELOGIC control equation)	543
LB_DP60	Local Bit 60 status display (SELOGIC control equation)	543
LB_DP61	Local Bit 61 status display (SELOGIC control equation)	543
LB_DP62	Local Bit 62 status display (SELOGIC control equation)	543
LB_DP63	Local Bit 63 status display (SELOGIC control equation)	543
LB_DP64	Local Bit 64 status display (SELOGIC control equation)	543
LB_SP01	Local Bit 01 supervision (SELOGIC control equation)	457
LB_SP02	Local Bit 02 supervision (SELOGIC control equation)	457
LB_SP03	Local Bit 03 supervision (SELOGIC control equation)	457
LB_SP04	Local Bit 04 supervision (SELOGIC control equation)	457
LB_SP05	Local Bit 05 supervision (SELOGIC control equation)	457
LB_SP06	Local Bit 06 supervision (SELOGIC control equation)	457
LB_SP07	Local Bit 07 supervision (SELOGIC control equation)	457
LB_SP08	Local Bit 08 supervision (SELOGIC control equation)	457
LB_SP09	Local Bit 09 supervision (SELOGIC control equation)	458
LB_SP10	Local Bit 10 supervision (SELOGIC control equation)	458
LB_SP11	Local Bit 11 supervision (SELOGIC control equation)	458
LB_SP12	Local Bit 12 supervision (SELOGIC control equation)	458
LB_SP13	Local Bit 13 supervision (SELOGIC control equation)	458

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 44 of 79)**

Name	Bit Description	Row
LB_SP14	Local Bit 14 supervision (SELOGIC control equation)	458
LB_SP15	Local Bit 15 supervision (SELOGIC control equation)	458
LB_SP16	Local Bit 16 supervision (SELOGIC control equation)	458
LB_SP17	Local Bit 17 supervision (SELOGIC control equation)	459
LB_SP18	Local Bit 18 supervision (SELOGIC control equation)	459
LB_SP19	Local Bit 19 supervision (SELOGIC control equation)	459
LB_SP20	Local Bit 20 supervision (SELOGIC control equation)	459
LB_SP21	Local Bit 21 supervision (SELOGIC control equation)	459
LB_SP22	Local Bit 22 supervision (SELOGIC control equation)	459
LB_SP23	Local Bit 23 supervision (SELOGIC control equation)	459
LB_SP24	Local Bit 24 supervision (SELOGIC control equation)	459
LB_SP25	Local Bit 25 supervision (SELOGIC control equation)	460
LB_SP26	Local Bit 26 supervision (SELOGIC control equation)	460
LB_SP27	Local Bit 27 supervision (SELOGIC control equation)	460
LB_SP28	Local Bit 28 supervision (SELOGIC control equation)	460
LB_SP29	Local Bit 29 supervision (SELOGIC control equation)	460
LB_SP30	Local Bit 30 supervision (SELOGIC control equation)	460
LB_SP31	Local Bit 31 supervision (SELOGIC control equation)	460
LB_SP32	Local Bit 32 supervision (SELOGIC control equation)	460
LB_SP33	Local Bit 33 supervision (SELOGIC control equation)	536
LB_SP34	Local Bit 34 supervision (SELOGIC control equation)	536
LB_SP35	Local Bit 35 supervision (SELOGIC control equation)	536
LB_SP36	Local Bit 36 supervision (SELOGIC control equation)	536
LB_SP37	Local Bit 37 supervision (SELOGIC control equation)	536
LB_SP38	Local Bit 38 supervision (SELOGIC control equation)	536
LB_SP39	Local Bit 39 supervision (SELOGIC control equation)	536
LB_SP40	Local Bit 40 supervision (SELOGIC control equation)	536
LB_SP41	Local Bit 41 supervision (SELOGIC control equation)	537
LB_SP42	Local Bit 42 supervision (SELOGIC control equation)	537
LB_SP43	Local Bit 43 supervision (SELOGIC control equation)	537
LB_SP44	Local Bit 44 supervision (SELOGIC control equation)	537
LB_SP45	Local Bit 45 supervision (SELOGIC control equation)	537
LB_SP46	Local Bit 46 supervision (SELOGIC control equation)	537
LB_SP47	Local Bit 47 supervision (SELOGIC control equation)	537
LB_SP48	Local Bit 48 supervision (SELOGIC control equation)	537
LB_SP49	Local Bit 49 supervision (SELOGIC control equation)	538
LB_SP50	Local Bit 50 supervision (SELOGIC control equation)	538
LB_SP51	Local Bit 51 supervision (SELOGIC control equation)	538
LB_SP52	Local Bit 52 supervision (SELOGIC control equation)	538
LB_SP53	Local Bit 53 supervision (SELOGIC control equation)	538
LB_SP54	Local Bit 54 supervision (SELOGIC control equation)	538

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 45 of 79)**

<b>Name</b>	<b>Bit Description</b>	<b>Row</b>
LB_SP55	Local Bit 55 supervision (SELOGIC control equation)	538
LB_SP56	Local Bit 56 supervision (SELOGIC control equation)	538
LB_SP57	Local Bit 57 supervision (SELOGIC control equation)	539
LB_SP58	Local Bit 58 supervision (SELOGIC control equation)	539
LB_SP59	Local Bit 59 supervision (SELOGIC control equation)	539
LB_SP60	Local Bit 60 supervision (SELOGIC control equation)	539
LB_SP61	Local Bit 61 supervision (SELOGIC control equation)	539
LB_SP62	Local Bit 62 supervision (SELOGIC control equation)	539
LB_SP63	Local Bit 63 supervision (SELOGIC control equation)	539
LB_SP64	Local Bit 64 supervision (SELOGIC control equation)	539
LB01	Local Bit 01	256
LB02	Local Bit 02	256
LB03	Local Bit 03	256
LB04	Local Bit 04	256
LB05	Local Bit 05	256
LB06	Local Bit 06	256
LB07	Local Bit 07	256
LB08	Local Bit 08	256
LB09	Local Bit 09	257
LB10	Local Bit 10	257
LB11	Local Bit 11	257
LB12	Local Bit 12	257
LB13	Local Bit 13	257
LB14	Local Bit 14	257
LB15	Local Bit 15	257
LB16	Local Bit 16	257
LB17	Local Bit 17	258
LB18	Local Bit 18	258
LB19	Local Bit 19	258
LB20	Local Bit 20	258
LB21	Local Bit 21	258
LB22	Local Bit 22	258
LB23	Local Bit 23	258
LB24	Local Bit 24	258
LB25	Local Bit 25	259
LB26	Local Bit 26	259
LB27	Local Bit 27	259
LB28	Local Bit 28	259
LB29	Local Bit 29	259
LB30	Local Bit 30	259
LB31	Local Bit 31	259

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 46 of 79)**

Name	Bit Description	Row
LB32	Local Bit 32	259
LB33	Local Bit 33	532
LB34	Local Bit 34	532
LB35	Local Bit 35	532
LB36	Local Bit 36	532
LB37	Local Bit 37	532
LB38	Local Bit 38	532
LB39	Local Bit 39	532
LB40	Local Bit 40	532
LB41	Local Bit 41	533
LB42	Local Bit 42	533
LB43	Local Bit 43	533
LB44	Local Bit 44	533
LB45	Local Bit 45	533
LB46	Local Bit 46	533
LB47	Local Bit 47	533
LB48	Local Bit 48	533
LB49	Local Bit 49	534
LB50	Local Bit 50	534
LB51	Local Bit 51	534
LB52	Local Bit 52	534
LB53	Local Bit 53	534
LB54	Local Bit 54	534
LB55	Local Bit 55	534
LB56	Local Bit 56	534
LB57	Local Bit 57	535
LB58	Local Bit 58	535
LB59	Local Bit 59	535
LB60	Local Bit 60	535
LB61	Local Bit 61	535
LB62	Local Bit 62	535
LB63	Local Bit 63	535
LB64	Local Bit 64	535
LBOKA	Channel A MIRRORED BITS normal status (loopback)	404
LBOKB	Channel B MIRRORED BITS normal status (loopback mode)	405
LINK5A	Link status of PORT 5A connection	441
LINK5B	Link status of PORT 5B connection	441
LINK5C	Link status of PORT 5C connection	441
LINK5D	Link status of PORT 5D connection	441
LINK5E	Link status of PORT 5E connection	441
LNKFAIL	Link status of the active station bus port	441

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 47 of 79)**

Name	Bit Description	Row
LNKFL2	Link status of the active process bus port	441
LOC	Control authority at local (bay) level	524
LOCSTA	Control authority at station level	524
LPHDSIM	IEC 61850 Logical Node for Physical Device Simulation	406
LPSEC	Direction of the upcoming leap second. During the time that LPSECP is asserted, if LPSEC is asserted, the upcoming leap second is deleted; otherwise, the leap second is added.	470
LPSECP	Leap second pending	470
MATHERR	SELOGIC control equation math error	374
MLTLEV	Multi-level control authority	524
OC01	Circuit Breaker 01 open command	249
OC02	Circuit Breaker 02 open command	249
OC03	Circuit Breaker 03 open command	249
OC04	Circuit Breaker 04 open command	249
OC05	Circuit Breaker 05 open command	249
OC06	Circuit Breaker 06 open command	249
OC07	Circuit Breaker 07 open command	249
OC08	Circuit Breaker 08 open command	249
OC09	Circuit Breaker 09 open command	250
OC10	Circuit Breaker 10 open command	250
OC11	Circuit Breaker 11 open command	250
OC12	Circuit Breaker 12 open command	250
OC13	Circuit Breaker 13 open command	250
OC14	Circuit Breaker 14 open command	250
OC15	Circuit Breaker 15 open command	250
OC16	Circuit Breaker 16 open command	250
OC17	Circuit Breaker 17 open command	251
OC18	Circuit Breaker 18 open command	251
OC19	Circuit Breaker 19 open command	251
OC20	Circuit Breaker 20 open command	251
OC21	Circuit Breaker 21 open command	251
OCTZ1	Zone 1 open CT detection	155
OCTZ2	Zone 2 open CT detection	155
OCTZ3	Zone 3 open CT detection	155
OCTZ4	Zone 4 open CT detection	155
OCTZ5	Zone 5 open CT detection	155
OCTZ6	Zone 6 open CT detection	155
OPH01	Terminal 01 open phase detected	4
OPH02	Terminal 02 open phase detected	4
OPH03	Terminal 03 open phase detected	4
OPH04	Terminal 04 open phase detected	4
OPH05	Terminal 05 open phase detected	4

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 48 of 79)**

Name	Bit Description	Row
OPH06	Terminal 06 open phase detected	4
OPH07	Terminal 07 open phase detected	4
OPH08	Terminal 08 open phase detected	4
OPH09	Terminal 09 open phase detected	5
OPH10	Terminal 10 open phase detected	5
OPH11	Terminal 11 open phase detected	5
OPH12	Terminal 12 open phase detected	5
OPH13	Terminal 13 open phase detected	5
OPH14	Terminal 14 open phase detected	5
OPH15	Terminal 15 open phase detected	5
OPH16	Terminal 16 open phase detected	5
OPH17	Terminal 17 open phase detected	6
OPH18	Terminal 18 open phase detected	6
OPH19	Terminal 19 open phase detected	6
OPH20	Terminal 20 open phase detected	6
OPH21	Terminal 21 open phase detected	6
OUT201–OUT208	Optional I/O Board 1 Output 1–8	388
OUT209–OUT216	Optional I/O Board 1 Output 9–16	389
OUT301–OUT308	Optional I/O Board 2 Output 1–8	390
OUT301S–OUT308S	Mapped OUT301–OUT308 contact status	506
OUT309–OUT316	Optional I/O Board 2 Output 9–16	391
OUT309S–OUT316S	Mapped OUT309–OUT316 contact status	507
OUT401–OUT408	Optional I/O Board 3 Output 1–8	392
OUT401S–OUT408S	Mapped OUT401–OUT408 contact status	508
OUT409–OUT416	Optional I/O Board 3 Output 9–16	393
OUT409S–OUT416S	Mapped OUT409–OUT416 contact status	509
OUT501–OUT508	Optional I/O Board 4 Output 1–8	394
OUT501S–OUT508S	Mapped OUT501–OUT508 contact status	510
OUT509–OUT516	Optional I/O Board 4 Output 9–16	395
OUT509S–OUT516S	Mapped OUT509–OUT516 contact status	511
P5ABSW	PORT 5A or 5B has just become active	473
P5ASEL	PORT 5A active/inactive	442
P5BSEL	PORT 5B active/inactive	442
P5CDSW	PORT 5C or 5D has just become active	474
P5CSEL	PORT 5C active/inactive	442
P5DSEL	PORT 5D active/inactive	442
P5ESEL	PORT 5E active/inactive	442
P6AMAP	PORT 6A mapped	512
P6AOK	PORT 6A OK	516
P6BMAP	PORT 6B mapped	512
P6BOK	PORT 6B OK	516

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 49 of 79)**

Name	Bit Description	Row
P6CMAP	PORT 6C mapped	512
P6COK	PORT 6C OK	516
P6DMAP	PORT 6D mapped	512
P6DOK	PORT 6D OK	516
P6EMAP	PORT 6E mapped	512
P6EOK	PORT 6E OK	516
P6FMAP	PORT 6F mapped	512
P6FOK	PORT 6F OK	516
P6GMAP	PORT 6G mapped	512
P6GOK	PORT 6G OK	516
P6HMAP	PORT 6H mapped	512
P6HOK	PORT 6H OK	516
P87R1	Zone 1 instantaneous differential element picked up	159
P87R2	Zone 2 instantaneous differential element picked up	161
P87R3	Zone 3 instantaneous differential element picked up	163
P87R4	Zone 4 instantaneous differential element picked up	165
P87R5	Zone 5 instantaneous differential element picked up	167
P87R6	Zone 6 instantaneous differential element picked up	169
P87RCZ1	Check Zone 1 instantaneous differential element picked up	450
P87RCZ2	Check Zone 2 instantaneous differential element picked up	452
P87RCZ3	Check Zone 3 instantaneous differential element picked up	454
PASSDIS	Asserts to indicate password disable jumper is installed	377
PB1	Pushbutton 1	382
PB1_LED	Pushbutton 1 LED	398
PB1_PUL	Pushbutton 1 pulse input	396
PB10	Pushbutton 10	383
PB10LED	Pushbutton 10 LED	399
PB10PUL	Pushbutton 10 pulse input	397
PB11	Pushbutton 11	383
PB11LED	Pushbutton 11 LED	399
PB11PUL	Pushbutton 11 pulse input	397
PB12	Pushbutton 12	383
PB12LED	Pushbutton 12 LED	399
PB12PUL	Pushbutton 12 pulse input	397
PB2	Pushbutton 2	382
PB2_LED	Pushbutton 2 LED	398
PB2_PUL	Pushbutton 2 pulse input	396
PB3	Pushbutton 3	382
PB3_LED	Pushbutton 3 LED	398
PB3_PUL	Pushbutton 3 pulse input	396
PB4	Pushbutton 4	382

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 50 of 79)**

Name	Bit Description	Row
PB4_LED	Pushbutton 4 LED	398
PB4_PUL	Pushbutton 4 pulse input	396
PB5	Pushbutton 5	382
PB5_LED	Pushbutton 5 LED	398
PB5_PUL	Pushbutton 5 pulse input	396
PB6	Pushbutton 6	382
PB6_LED	Pushbutton 6 LED	398
PB6_PUL	Pushbutton 6 pulse input	396
PB7	Pushbutton 7	382
PB7_LED	Pushbutton 7 LED	398
PB7_PUL	Pushbutton 7 pulse input	396
PB8	Pushbutton 8	382
PB8_LED	Pushbutton 8 LED	398
PB8_PUL	Pushbutton 8 pulse input	396
PB9	Pushbutton 9	383
PB9_LED	Pushbutton 9 LED	399
PB9_PUL	Pushbutton 9 pulse input	397
PCN01Q	Protection counter Output 01	314
PCN01R	Protection counter Reset 01	318
PCN02Q	Protection counter Output 02	314
PCN02R	Protection counter Reset 02	318
PCN03Q	Protection counter Output 03	314
PCN03R	Protection counter Reset 03	318
PCN04Q	Protection counter Output 04	314
PCN04R	Protection counter Reset 04	318
PCN05Q	Protection counter Output 05	314
PCN05R	Protection counter Reset 05	318
PCN06Q	Protection counter Output 06	314
PCN06R	Protection counter Reset 06	318
PCN07Q	Protection counter Output 07	314
PCN07R	Protection counter Reset 07	318
PCN08Q	Protection counter Output 08	314
PCN08R	Protection counter Reset 08	318
PCN09Q	Protection counter Output 09	315
PCN09R	Protection counter Reset 09	319
PCN10Q	Protection counter Output 10	315
PCN10R	Protection counter Reset 10	319
PCN11Q	Protection counter Output 11	315
PCN11R	Protection counter Reset 11	319
PCN12Q	Protection counter Output 12	315
PCN12R	Protection counter Reset 12	319

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 51 of 79)**

<b>Name</b>	<b>Bit Description</b>	<b>Row</b>
PCN13Q	Protection counter Output 13	315
PCN13R	Protection counter Reset 13	319
PCN14Q	Protection counter Output 14	315
PCN14R	Protection counter Reset 14	319
PCN15Q	Protection counter Output 15	315
PCN15R	Protection counter Reset 15	319
PCN16Q	Protection counter Output 16	315
PCN16R	Protection counter Reset 16	319
PCN17Q	Protection counter Output 17	316
PCN17R	Protection counter Reset 17	320
PCN18Q	Protection counter Output 18	316
PCN18R	Protection counter Reset 18	320
PCN19Q	Protection counter Output 19	316
PCN19R	Protection counter Reset 19	320
PCN20Q	Protection counter Output 20	316
PCN20R	Protection counter Reset 20	320
PCN21Q	Protection counter Output 21	316
PCN21R	Protection counter Reset 21	320
PCN22Q	Protection counter Output 22	316
PCN22R	Protection counter Reset 22	320
PCN23Q	Protection counter Output 23	316
PCN23R	Protection counter Reset 23	320
PCN24Q	Protection counter Output 24	316
PCN24R	Protection counter Reset 24	320
PCN25Q	Protection counter Output 25	317
PCN25R	Protection counter Reset 25	321
PCN26Q	Protection counter Output 26	317
PCN26R	Protection counter Reset 26	321
PCN27Q	Protection counter Output 27	317
PCN27R	Protection counter Reset 27	321
PCN28Q	Protection counter Output 28	317
PCN28R	Protection counter Reset 28	321
PCN29Q	Protection counter Output 29	317
PCN29R	Protection counter Reset 29	321
PCN30Q	Protection counter Output 30	317
PCN30R	Protection counter Reset 30	321
PCN31Q	Protection counter Output 31	317
PCN31R	Protection counter Reset 31	321
PCN32Q	Protection counter Output 32	317
PCN32R	Protection counter Reset 32	321
PCT01Q	Protection conditioning timer Output 01	304

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 52 of 79)**

Name	Bit Description	Row
PCT02Q	Protection conditioning timer Output 02	304
PCT03Q	Protection conditioning timer Output 03	304
PCT04Q	Protection conditioning timer Output 04	304
PCT05Q	Protection conditioning timer Output 05	304
PCT06Q	Protection conditioning timer Output 06	304
PCT07Q	Protection conditioning timer Output 07	304
PCT08Q	Protection conditioning timer Output 08	304
PCT09Q	Protection conditioning timer Output 09	305
PCT10Q	Protection conditioning timer Output 10	305
PCT11Q	Protection conditioning timer Output 11	305
PCT12Q	Protection conditioning timer Output 12	305
PCT13Q	Protection conditioning timer Output 13	305
PCT14Q	Protection conditioning timer Output 14	305
PCT15Q	Protection conditioning timer Output 15	305
PCT16Q	Protection conditioning timer Output 16	305
PPRTEX	Protection SELOGIC control equation first execution	374
PLT01	Protection Latch 01	300
PLT02	Protection Latch 02	300
PLT03	Protection Latch 03	300
PLT04	Protection Latch 04	300
PLT05	Protection Latch 05	300
PLT06	Protection Latch 06	300
PLT07	Protection Latch 07	300
PLT08	Protection Latch 08	300
PLT09	Protection Latch 09	301
PLT10	Protection Latch 10	301
PLT11	Protection Latch 11	301
PLT12	Protection Latch 12	301
PLT13	Protection Latch 13	301
PLT14	Protection Latch 14	301
PLT15	Protection Latch 15	301
PLT16	Protection Latch 16	301
PLT17	Protection Latch 17	302
PLT18	Protection Latch 18	302
PLT19	Protection Latch 19	302
PLT20	Protection Latch 20	302
PLT21	Protection Latch 21	302
PLT22	Protection Latch 22	302
PLT23	Protection Latch 23	302
PLT24	Protection Latch 24	302
PLT25	Protection Latch 25	303

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 53 of 79)**

<b>Name</b>	<b>Bit Description</b>	<b>Row</b>
PLT26	Protection Latch 26	303
PLT27	Protection Latch 27	303
PLT28	Protection Latch 28	303
PLT29	Protection Latch 29	303
PLT30	Protection Latch 30	303
PLT31	Protection Latch 31	303
PLT32	Protection Latch 32	303
PRPAGOK	PRP PORT 5A GOOSE status	544
PRPASOK	PRP PORT 5A SV status	544
PRPBGOK	PRP PORT 5B GOOSE status	544
PRPBSOK	PRP PORT 5B SV status	544
PRPCGOK	PRP PORT 5C GOOSE status	544
PRPDGOK	PRP PORT 5D GOOSE status	544
PST01Q	Protection sequencing timer Output 01	306
PST01R	Protection sequencing timer Reset 01	310
PST02Q	Protection sequencing timer Output 02	306
PST02R	Protection sequencing timer Reset 02	310
PST03Q	Protection sequencing timer Output 03	306
PST03R	Protection sequencing timer Reset 03	310
PST04Q	Protection sequencing timer Output 04	306
PST04R	Protection sequencing timer Reset 04	310
PST05Q	Protection sequencing timer Output 05	306
PST05R	Protection sequencing timer Reset 05	310
PST06Q	Protection sequencing timer Output 06	306
PST06R	Protection sequencing timer Reset 06	310
PST07Q	Protection sequencing timer Output 07	306
PST07R	Protection sequencing timer Reset 07	310
PST08Q	Protection sequencing timer Output 08	306
PST08R	Protection sequencing timer Reset 08	310
PST09Q	Protection sequencing timer Output 09	307
PST09R	Protection sequencing timer Reset 09	311
PST10Q	Protection sequencing timer Output 10	307
PST10R	Protection sequencing timer Reset 10	311
PST11Q	Protection sequencing timer Output 11	307
PST11R	Protection sequencing timer Reset 11	311
PST12Q	Protection sequencing timer Output 12	307
PST12R	Protection sequencing timer Reset 12	311
PST13Q	Protection sequencing timer Output 13	307
PST13R	Protection sequencing timer Reset 13	311
PST14Q	Protection sequencing timer Output 14	307
PST14R	Protection sequencing timer Reset 14	311

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 54 of 79)**

Name	Bit Description	Row
PST15Q	Protection sequencing timer Output 15	307
PST15R	Protection sequencing timer Reset 15	311
PST16Q	Protection sequencing timer Output 16	307
PST16R	Protection sequencing timer Reset 16	311
PST17Q	Protection sequencing timer Output 17	308
PST17R	Protection sequencing timer Reset 17	312
PST18Q	Protection sequencing timer Output 18	308
PST18R	Protection sequencing timer Reset 18	312
PST19Q	Protection sequencing timer Output 19	308
PST19R	Protection sequencing timer Reset 19	312
PST20Q	Protection sequencing timer Output 20	308
PST20R	Protection sequencing timer Reset 20	312
PST21Q	Protection sequencing timer Output 21	308
PST21R	Protection sequencing timer Reset 21	312
PST22Q	Protection sequencing timer Output 22	308
PST22R	Protection sequencing timer Reset 22	312
PST23Q	Protection sequencing timer Output 23	308
PST23R	Protection sequencing timer Reset 23	312
PST24Q	Protection sequencing timer Output 24	308
PST24R	Protection sequencing timer Reset 24	312
PST25Q	Protection sequencing timer Output 25	309
PST25R	Protection sequencing timer Reset 25	313
PST26Q	Protection sequencing timer Output 26	309
PST26R	Protection sequencing timer Reset 26	313
PST27Q	Protection sequencing timer Output 27	309
PST27R	Protection sequencing timer Reset 27	313
PST28Q	Protection sequencing timer Output 28	309
PST28R	Protection sequencing timer Reset 28	313
PST29Q	Protection sequencing timer Output 29	309
PST29R	Protection sequencing timer Reset 29	313
PST30Q	Protection sequencing timer Output 30	309
PST30R	Protection sequencing timer Reset 30	313
PST31Q	Protection sequencing timer Output 31	309
PST31R	Protection sequencing timer Reset 31	313
PST32Q	Protection sequencing timer Output 32	309
PST32R	Protection sequencing timer Reset 32	313
PSV01	Protection SELOGIC control equation Variable 01	292
PSV02	Protection SELOGIC control equation Variable 02	292
PSV03	Protection SELOGIC control equation Variable 03	292
PSV04	Protection SELOGIC control equation Variable 04	292
PSV05	Protection SELOGIC control equation Variable 05	292

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 55 of 79)**

Name	Bit Description	Row
PSV06	Protection SELOGIC control equation Variable 06	292
PSV07	Protection SELOGIC control equation Variable 07	292
PSV08	Protection SELOGIC control equation Variable 08	292
PSV09	Protection SELOGIC control equation Variable 09	293
PSV10	Protection SELOGIC control equation Variable 10	293
PSV11	Protection SELOGIC control equation Variable 11	293
PSV12	Protection SELOGIC control equation Variable 12	293
PSV13	Protection SELOGIC control equation Variable 13	293
PSV14	Protection SELOGIC control equation Variable 14	293
PSV15	Protection SELOGIC control equation Variable 15	293
PSV16	Protection SELOGIC control equation Variable 16	293
PSV17	Protection SELOGIC control equation Variable 17	294
PSV18	Protection SELOGIC control equation Variable 18	294
PSV19	Protection SELOGIC control equation Variable 19	294
PSV20	Protection SELOGIC control equation Variable 20	294
PSV21	Protection SELOGIC control equation Variable 21	294
PSV22	Protection SELOGIC control equation Variable 22	294
PSV23	Protection SELOGIC control equation Variable 23	294
PSV24	Protection SELOGIC control equation Variable 24	294
PSV25	Protection SELOGIC control equation Variable 25	295
PSV26	Protection SELOGIC control equation Variable 26	295
PSV27	Protection SELOGIC control equation Variable 27	295
PSV28	Protection SELOGIC control equation Variable 28	295
PSV29	Protection SELOGIC control equation Variable 29	295
PSV30	Protection SELOGIC control equation Variable 30	295
PSV31	Protection SELOGIC control equation Variable 31	295
PSV32	Protection SELOGIC control equation Variable 32	295
PSV33	Protection SELOGIC control equation Variable 33	296
PSV34	Protection SELOGIC control equation Variable 34	296
PSV35	Protection SELOGIC control equation Variable 35	296
PSV36	Protection SELOGIC control equation Variable 36	296
PSV37	Protection SELOGIC control equation Variable 37	296
PSV38	Protection SELOGIC control equation Variable 38	296
PSV39	Protection SELOGIC control equation Variable 39	296
PSV40	Protection SELOGIC control equation Variable 40	296
PSV41	Protection SELOGIC control equation Variable 41	297
PSV42	Protection SELOGIC control equation Variable 42	297
PSV43	Protection SELOGIC control equation Variable 43	297
PSV44	Protection SELOGIC control equation Variable 44	297
PSV45	Protection SELOGIC control equation Variable 45	297
PSV46	Protection SELOGIC control equation Variable 46	297

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 56 of 79)**

Name	Bit Description	Row
PSV47	Protection SELOGIC control equation Variable 47	297
PSV48	Protection SELOGIC control equation Variable 48	297
PSV49	Protection SELOGIC control equation Variable 49	298
PSV50	Protection SELOGIC control equation Variable 50	298
PSV51	Protection SELOGIC control equation Variable 51	298
PSV52	Protection SELOGIC control equation Variable 52	298
PSV53	Protection SELOGIC control equation Variable 53	298
PSV54	Protection SELOGIC control equation Variable 54	298
PSV55	Protection SELOGIC control equation Variable 55	298
PSV56	Protection SELOGIC control equation Variable 56	298
PSV57	Protection SELOGIC control equation Variable 57	299
PSV58	Protection SELOGIC control equation Variable 58	299
PSV59	Protection SELOGIC control equation Variable 59	299
PSV60	Protection SELOGIC control equation Variable 60	299
PSV61	Protection SELOGIC control equation Variable 61	299
PSV62	Protection SELOGIC control equation Variable 62	299
PSV63	Protection SELOGIC control equation Variable 63	299
PSV64	Protection SELOGIC control equation Variable 64	299
PTP_BNP	Bad jitter on PTP signals and the PTP signal is lost afterward	474
PTP_OK	PTP is available and has sufficient quality	473
PTP_RST	Disqualify PTP time source	473
PTP_SET	Qualify PTP time source	473
PTP_TIM	A valid PTP time source is detected	473
PTPSYNC	Synchronized to a high-quality PTP source	474
PUNRLBL	Protection SELOGIC control equation unresolved label	374
RB01	Remote Bit 01	271
RB02	Remote Bit 02	271
RB03	Remote Bit 03	271
RB04	Remote Bit 04	271
RB05	Remote Bit 05	271
RB06	Remote Bit 06	271
RB07	Remote Bit 07	271
RB08	Remote Bit 08	271
RB09	Remote Bit 09	270
RB10	Remote Bit 10	270
RB11	Remote Bit 11	270
RB12	Remote Bit 12	270
RB13	Remote Bit 13	270
RB14	Remote Bit 14	270
RB15	Remote Bit 15	270
RB16	Remote Bit 16	270

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 57 of 79)**

Name	Bit Description	Row
RB17	Remote Bit 17	269
RB18	Remote Bit 18	269
RB19	Remote Bit 19	269
RB20	Remote Bit 20	269
RB21	Remote Bit 21	269
RB22	Remote Bit 22	269
RB23	Remote Bit 23	269
RB24	Remote Bit 24	269
RB25	Remote Bit 25	268
RB26	Remote Bit 26	268
RB27	Remote Bit 27	268
RB28	Remote Bit 28	268
RB29	Remote Bit 29	268
RB30	Remote Bit 30	268
RB31	Remote Bit 31	268
RB32	Remote Bit 32	268
RB33	Remote Bit 33	267
RB34	Remote Bit 34	267
RB35	Remote Bit 35	267
RB36	Remote Bit 36	267
RB37	Remote Bit 37	267
RB38	Remote Bit 38	267
RB39	Remote Bit 39	267
RB40	Remote Bit 40	267
RB41	Remote Bit 41	266
RB42	Remote Bit 42	266
RB43	Remote Bit 43	266
RB44	Remote Bit 44	266
RB45	Remote Bit 45	266
RB46	Remote Bit 46	266
RB47	Remote Bit 47	266
RB48	Remote Bit 48	266
RB49	Remote Bit 49	265
RB50	Remote Bit 50	265
RB51	Remote Bit 51	265
RB52	Remote Bit 52	265
RB53	Remote Bit 53	265
RB54	Remote Bit 54	265
RB55	Remote Bit 55	265
RB56	Remote Bit 56	265
RB57	Remote Bit 57	264

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 58 of 79)**

Name	Bit Description	Row
RB58	Remote Bit 58	264
RB59	Remote Bit 59	264
RB60	Remote Bit 60	264
RB61	Remote Bit 61	264
RB62	Remote Bit 62	264
RB63	Remote Bit 63	264
RB64	Remote Bit 64	264
RB65	Remote Bit 65	263
RB66	Remote Bit 66	263
RB67	Remote Bit 67	263
RB68	Remote Bit 68	263
RB69	Remote Bit 69	263
RB70	Remote Bit 70	263
RB71	Remote Bit 71	263
RB72	Remote Bit 72	263
RB73	Remote Bit 73	262
RB74	Remote Bit 74	262
RB75	Remote Bit 75	262
RB76	Remote Bit 76	262
RB77	Remote Bit 77	262
RB78	Remote Bit 78	262
RB79	Remote Bit 79	262
RB80	Remote Bit 80	262
RB81	Remote Bit 81	261
RB82	Remote Bit 82	261
RB83	Remote Bit 83	261
RB84	Remote Bit 84	261
RB85	Remote Bit 85	261
RB86	Remote Bit 86	261
RB87	Remote Bit 87	261
RB88	Remote Bit 88	261
RB89	Remote Bit 89	260
RB90	Remote Bit 90	260
RB91	Remote Bit 91	260
RB92	Remote Bit 92	260
RB93	Remote Bit 93	260
RB94	Remote Bit 94	260
RB95	Remote Bit 95	260
RB96	Remote Bit 96	260
RBADA	Channel A MIRRORED BITS outage too long	404
RBADB	Channel B MIRRORED BITS outage too long	405

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 59 of 79)**

Name	Bit Description	Row
RDIF1	Zone 1 unfiltered restrained differential element picked up	160
RDIF2	Zone 2 unfiltered restrained differential element picked up	162
RDIF3	Zone 3 unfiltered restrained differential element picked up	164
RDIF4	Zone 4 unfiltered restrained differential element picked up	166
RDIF5	Zone 5 unfiltered restrained differential element picked up	168
RDIF6	Zone 6 unfiltered restrained differential element picked up	170
RDIFCZ1	Check Zone 1 unfiltered restrained differential element picked up	451
RDIFCZ2	Check Zone 2 unfiltered restrained differential element picked up	453
RDIFCZ3	Check Zone 3 unfiltered restrained differential element picked up	455
RMB1A	Channel A receive MIRRORED BIT 1	400
RMB1B	Channel B receive MIRRORED BIT 1	402
RMB2A	Channel A receive MIRRORED BIT 2	400
RMB2B	Channel B receive MIRRORED BIT 2	402
RMB3A	Channel A receive MIRRORED BIT 3	400
RMB3B	Channel B receive MIRRORED BIT 3	402
RMB4A	Channel A receive MIRRORED BIT 4	400
RMB4B	Channel B receive MIRRORED BIT 4	402
RMB5A	Channel A receive MIRRORED BIT 5	400
RMB5B	Channel B receive MIRRORED BIT 5	402
RMB6A	Channel A receive MIRRORED BIT 6	400
RMB6B	Channel B receive MIRRORED BIT 6	402
RMB7A	Channel A receive MIRRORED BIT 7	400
RMB7B	Channel B receive MIRRORED BIT 7	402
RMB8A	Channel A receive MIRRORED BIT 8	400
RMB8B	Channel B receive MIRRORED BIT 8	402
ROCTZ1	Zone 1 open CT logic reset	154
ROCTZ2	Zone 2 open CT logic reset	154
ROCTZ3	Zone 3 open CT logic reset	154
ROCTZ4	Zone 4 open CT logic reset	154
ROCTZ5	Zone 5 open CT logic reset	154
ROCTZ6	Zone 6 open CT logic reset	154
ROKA	Channel A MIRRORED BITS normal status (non-loopback)	404
ROKB	Channel B MIRRORED BITS normal status (non-loopback mode)	405
RST_BAT	Reset battery monitoring	440
RST_HAL	Reset HALARMA	440
RSTDNPE	Reset DNP fault summary data	440
RSTOCT1	Zone 1 open CT detection reset	156
RSTOCT2	Zone 2 open CT detection reset	156
RSTOCT3	Zone 3 open CT detection reset	156
RSTOCT4	Zone 4 open CT detection reset	156
RSTOCT5	Zone 5 open CT detection reset	156

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 60 of 79)**

Name	Bit Description	Row
RSTOCT6	Zone 6 open CT detection reset	156
RSTTRGT	Target reset (SELOGIC control equation)	440
RT01	Circuit Breaker 1 retrip	183
RT02	Circuit Breaker 2 retrip	184
RT03	Circuit Breaker 3 retrip	185
RT04	Circuit Breaker 4 retrip	186
RT05	Circuit Breaker 5 retrip	187
RT06	Circuit Breaker 6 retrip	188
RT07	Circuit Breaker 7 retrip	189
RT08	Circuit Breaker 8 retrip	190
RT09	Circuit Breaker 9 retrip	191
RT10	Circuit Breaker 10 retrip	192
RT11	Circuit Breaker 11 retrip	193
RT12	Circuit Breaker 12 retrip	194
RT13	Circuit Breaker 13 retrip	195
RT14	Circuit Breaker 14 retrip	196
RT15	Circuit Breaker 15 retrip	197
RT16	Circuit Breaker 16 retrip	198
RT17	Circuit Breaker 17 retrip	199
RT18	Circuit Breaker 18 retrip	200
RT19	Circuit Breaker 19 retrip	201
RT20	Circuit Breaker 20 retrip	202
RT21	Circuit Breaker 21 retrip	203
RZSWOAL	Reset zone-switching operation alarm	152
SALARM	Non-diagnostic alarm pulse	376
SBFTR	Any circuit breaker failure trip	239
SBFTR01	Circuit Breaker 01 breaker failure trip	236
SBFTR02	Circuit Breaker 02 breaker failure trip	236
SBFTR03	Circuit Breaker 03 breaker failure trip	236
SBFTR04	Circuit Breaker 04 breaker failure trip	236
SBFTR05	Circuit Breaker 05 breaker failure trip	236
SBFTR06	Circuit Breaker 06 breaker failure trip	236
SBFTR07	Circuit Breaker 07 breaker failure trip	236
SBFTR08	Circuit Breaker 08 breaker failure trip	236
SBFTR09	Circuit Breaker 09 breaker failure trip	237
SBFTR10	Circuit Breaker 10 breaker failure trip	237
SBFTR11	Circuit Breaker 11 breaker failure trip	237
SBFTR12	Circuit Breaker 12 breaker failure trip	237
SBFTR13	Circuit Breaker 13 breaker failure trip	237
SBFTR14	Circuit Breaker 14 breaker failure trip	237
SBFTR15	Circuit Breaker 15 breaker failure trip	237

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 61 of 79)**

Name	Bit Description	Row
SBFTR16	Circuit Breaker 16 breaker failure trip	237
SBFTR17	Circuit Breaker 17 breaker failure trip	238
SBFTR18	Circuit Breaker 18 breaker failure trip	238
SBFTR19	Circuit Breaker 19 breaker failure trip	238
SBFTR20	Circuit Breaker 20 breaker failure trip	238
SBFTR21	Circuit Breaker 21 breaker failure trip	238
SC850BM	SELOGIC control for IEC 61850 Blocked Mode	504
SC850LS	SELOGIC control for control authority at station level	524
SC850SM	SELOGIC control for IEC 61850 Simulation Mode	504
SC850TM	SELOGIC control for IEC 61850 Test Mode	504
SER_BNP	Bad jitter on the serial port and the IRIG-B signal is lost afterward	473
SER_OK	IRIG-B signal from serial port 1 is available and has sufficient quality	472
SER_RST	Disqualify serial IRIG-B time source	472
SER_SET	Qualify serial IRIG-B time source	472
SER_TIM	A valid IRIG-B time source is detected on serial port	473
SERSYNC	Synchronized to a high-quality serial IRIG source	474
SETCHG	Pulsed when settings change	376
SG1	Settings Group 1 active	255
SG2	Settings Group 2 active	255
SG3	Settings Group 3 active	255
SG4	Settings Group 4 active	255
SG5	Settings Group 5 active	255
SG6	Settings Group 6 active	255
SPEN	Signal Profiling enabled	467
SVBK_EX	Extended general blocking bit for SV applications	500
SVBLK	General blocking bit for SV applications	500
SVCC	Coupled clock mode indication	479
SVS01OK	Subscription 01 is valid	476
SVS02OK	Subscription 02 is valid	476
SVS03OK	Subscription 03 is valid	476
SVS04OK	Subscription 04 is valid	476
SVS05OK	Subscription 05 is valid	476
SVS06OK	Subscription 06 is valid	476
SVS07OK	Subscription 07 is valid	476
SVSALM	General SV subscription alarm	479
SVSTST	SV subscription unit in test mode	479
TBNC	The active relay time source is BNC IRIG	378
TDLCMSD	TiDL active topology commissioned	520
TESTDB	Communications card database test bit	406
TESTDB2	DNP test bit	406
TESTFM	Fast Meter test bit	406

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 62 of 79)**

Name	Bit Description	Row
TESTPUL	Pulse test bit	406
TGLOBAL	Relay calendar clock and ADC sampling synchronized to a high-priority Global time source	379
TIDLALM	TiDL alarm	520
TIRIG	Assert while time is based on IRIG for both mark and value	378
TLED_1	Front-panel target LED 1	1
TLED_10	Front-panel target LED 10	2
TLED_11	Front-panel target LED 11	2
TLED_12	Front-panel target LED 12	2
TLED_13	Front-panel target LED 13	2
TLED_14	Front-panel target LED 14	2
TLED_15	Front-panel target LED 15	2
TLED_16	Front-panel target LED 16	2
TLED_17	Front-panel target LED 17	3
TLED_18	Front-panel target LED 18	3
TLED_19	Front-panel target LED 19	3
TLED_2	Front-panel target LED 2	1
TLED_20	Front-panel target LED 20	3
TLED_21	Front-panel target LED 21	3
TLED_22	Front-panel target LED 22	3
TLED_23	Front-panel target LED 23	3
TLED_24	Front-panel target LED 24	3
TLED_3	Front-panel target LED 3	1
TLED_4	Front-panel target LED 4	1
TLED_5	Front-panel target LED 5	1
TLED_6	Front-panel target LED 6	1
TLED_7	Front-panel target LED 7	1
TLED_8	Front-panel target LED 8	1
TLED_9	Front-panel target LED 9	2
TLOCAL	Relay calendar clock and ADC sampling synchronized to a high-priority local time source	379
TMB1A	Channel A transmit MIRRORED BIT 1	401
TMB1B	Channel B transmit MIRRORED BIT 1	403
TMB2A	Channel A transmit MIRRORED BIT 2	401
TMB2B	Channel B transmit MIRRORED BIT 2	403
TMB3A	Channel A transmit MIRRORED BIT 3	401
TMB3B	Channel B transmit MIRRORED BIT 3	403
TMB4A	Channel A transmit MIRRORED BIT 4	401
TMB4B	Channel B transmit MIRRORED BIT 4	403
TMB5A	Channel A transmit MIRRORED BIT 5	401
TMB5B	Channel B transmit MIRRORED BIT 5	403
TMB6A	Channel A transmit MIRRORED BIT 6	401
TMB6B	Channel B transmit MIRRORED BIT 6	403

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 63 of 79)**

<b>Name</b>	<b>Bit Description</b>	<b>Row</b>
TMB7A	Channel A transmit MIRRORED BIT 7	401
TMB7B	Channel B transmit MIRRORED BIT 7	403
TMB8A	Channel A transmit MIRRORED BIT 8	401
TMB8B	Channel B transmit MIRRORED BIT 8	403
TOS01	Terminal 01 out of service	180
TOS02	Terminal 02 out of service	180
TOS03	Terminal 03 out of service	180
TOS04	Terminal 04 out of service	180
TOS05	Terminal 05 out of service	180
TOS06	Terminal 06 out of service	180
TOS07	Terminal 07 out of service	180
TOS08	Terminal 08 out of service	180
TOS09	Terminal 09 out of service	181
TOS10	Terminal 10 out of service	181
TOS11	Terminal 11 out of service	181
TOS12	Terminal 12 out of service	181
TOS13	Terminal 13 out of service	181
TOS14	Terminal 14 out of service	181
TOS15	Terminal 15 out of service	181
TOS16	Terminal 16 out of service	181
TOS17	Terminal 17 out of service	182
TOS18	Terminal 18 out of service	182
TOS19	Terminal 19 out of service	182
TOS20	Terminal 20 out of service	182
TOS21	Terminal 21 out of service	182
TPLLEXT	Update PLL using external signal	379
TPTP	The active relay time source is PTP	378
TQUAL1	Time quality, binary, add 1 when asserted	470
TQUAL2	Time quality, binary, add 2 when asserted	470
TQUAL4	Time quality, binary, add 4 when asserted	470
TQUAL8	Time quality, binary, add 8 when asserted	470
TRGTR	Reset all active target Relay Words	466
TRIP	Any terminal trip output	245
TRIP01	Terminal 01 trip output	242
TRIP02	Terminal 02 trip output	242
TRIP03	Terminal 03 trip output	242
TRIP04	Terminal 04 trip output	242
TRIP05	Terminal 05 trip output	242
TRIP06	Terminal 06 trip output	242
TRIP07	Terminal 07 trip output	242
TRIP08	Terminal 08 trip output	242

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 64 of 79)**

Name	Bit Description	Row
TRIP09	Terminal 09 trip output	243
TRIP10	Terminal 10 trip output	243
TRIP11	Terminal 11 trip output	243
TRIP12	Terminal 12 trip output	243
TRIP13	Terminal 13 trip output	243
TRIP14	Terminal 14 trip output	243
TRIP15	Terminal 15 trip output	243
TRIP16	Terminal 16 trip output	243
TRIP17	Terminal 17 trip output	244
TRIP18	Terminal 18 trip output	244
TRIP19	Terminal 19 trip output	244
TRIP20	Terminal 20 trip output	244
TRIP21	Terminal 21 trip output	244
TRIPLED	Trip LED	0
TSER	The active relay time source is serial IRIG	378
TSNTPB	Asserts if time was synchronized with backup NTP server before SNTP time-out period expired	379
TSNTPP	Asserts if time was synchronized with primary NTP server before SNTP time-out period expired	379
TSOK	Assert if current time-source accuracy is sufficient for synchronized phasor measurements	378
TSSW	High-priority time source switching	379
TSYNC	Assert when ADC sampling is synchronized to a valid high-priority time source	379
TSYNCA	Assert while the time mark from time source or fixed internal source is not synchronized	378
TUPDH	Assert if the update source is a high-priority time source	378
TUTC1	IRIG-B offset hours from UTC time, binary, add 1 if asserted	469
TUTC2	IRIG-B offset hours from UTC time, binary, add 2 if asserted	469
TUTC4	IRIG-B offset hours from UTC time, binary, add 4 if asserted	469
TUTC8	IRIG-B offset hours from UTC time, binary, add 8 if asserted	469
TUTCH	IRIG-B offset half-hour from UTC time, binary, add 0.5 if asserted	469
TUTCS	IRIG-B offset hours sign from UTC time, subtract the UTC offset if TUTCS is asserted, add otherwise	469
ULTR01	Terminal 01 unlatch trip	246
ULTR02	Terminal 02 unlatch trip	246
ULTR03	Terminal 03 unlatch trip	246
ULTR04	Terminal 04 unlatch trip	246
ULTR05	Terminal 05 unlatch trip	246
ULTR06	Terminal 06 unlatch trip	246
ULTR07	Terminal 07 unlatch trip	246
ULTR08	Terminal 08 unlatch trip	246
ULTR09	Terminal 09 unlatch trip	247
ULTR10	Terminal 10 unlatch trip	247
ULTR11	Terminal 11 unlatch trip	247
ULTR12	Terminal 12 unlatch trip	247
ULTR13	Terminal 13 unlatch trip	247

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 65 of 79)**

Name	Bit Description	Row
ULTR14	Terminal 14 unlatch trip	247
ULTR15	Terminal 15 unlatch trip	247
ULTR16	Terminal 16 unlatch trip	247
ULTR17	Terminal 17 unlatch trip	248
ULTR18	Terminal 18 unlatch trip	248
ULTR19	Terminal 19 unlatch trip	248
ULTR20	Terminal 20 unlatch trip	248
ULTR21	Terminal 21 unlatch trip	248
UPD_BLK	Block updating internal clock period and master time	472
UPD_EN	Enable updating internal clock with a selected external time source	378
V01BK	Terminal V01 is not OK (use for blocking)	490
V01MAP	Terminal V01 is mapped in a subscription	482
V01OK	Terminal V01 configured channel data OK	486
V02BK	Terminal V02 is not OK (use for blocking)	490
V02MAP	Terminal V02 is mapped in a subscription	482
V02OK	Terminal V02 configured channel data OK	486
V03BK	Terminal V03 is not OK (use for blocking)	490
V03MAP	Terminal V03 is mapped in a subscription	482
V03OK	Terminal V03 configured channel data OK	486
VB001	Virtual Bit 001	439
VB002	Virtual Bit 002	439
VB003	Virtual Bit 003	439
VB004	Virtual Bit 004	439
VB005	Virtual Bit 005	439
VB006	Virtual Bit 006	439
VB007	Virtual Bit 007	439
VB008	Virtual Bit 008	439
VB009	Virtual Bit 009	438
VB010	Virtual Bit 010	438
VB011	Virtual Bit 011	438
VB012	Virtual Bit 012	438
VB013	Virtual Bit 013	438
VB014	Virtual Bit 014	438
VB015	Virtual Bit 015	438
VB016	Virtual Bit 016	438
VB017	Virtual Bit 017	437
VB018	Virtual Bit 018	437
VB019	Virtual Bit 019	437
VB020	Virtual Bit 020	437
VB021	Virtual Bit 021	437
VB022	Virtual Bit 022	437

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 66 of 79)**

Name	Bit Description	Row
VB023	Virtual Bit 023	437
VB024	Virtual Bit 024	437
VB025	Virtual Bit 025	436
VB026	Virtual Bit 026	436
VB027	Virtual Bit 027	436
VB028	Virtual Bit 028	436
VB029	Virtual Bit 029	436
VB030	Virtual Bit 030	436
VB031	Virtual Bit 031	436
VB032	Virtual Bit 032	436
VB033	Virtual Bit 033	435
VB034	Virtual Bit 034	435
VB035	Virtual Bit 035	435
VB036	Virtual Bit 036	435
VB037	Virtual Bit 037	435
VB038	Virtual Bit 038	435
VB039	Virtual Bit 039	435
VB040	Virtual Bit 040	435
VB041	Virtual Bit 041	434
VB042	Virtual Bit 042	434
VB043	Virtual Bit 043	434
VB044	Virtual Bit 044	434
VB045	Virtual Bit 045	434
VB046	Virtual Bit 046	434
VB047	Virtual Bit 047	434
VB048	Virtual Bit 048	434
VB049	Virtual Bit 049	433
VB050	Virtual Bit 050	433
VB051	Virtual Bit 051	433
VB052	Virtual Bit 052	433
VB053	Virtual Bit 053	433
VB054	Virtual Bit 054	433
VB055	Virtual Bit 055	433
VB056	Virtual Bit 056	433
VB057	Virtual Bit 057	432
VB058	Virtual Bit 058	432
VB059	Virtual Bit 059	432
VB060	Virtual Bit 060	432
VB061	Virtual Bit 061	432
VB062	Virtual Bit 062	432
VB063	Virtual Bit 063	432

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 67 of 79)**

<b>Name</b>	<b>Bit Description</b>	<b>Row</b>
VB064	Virtual Bit 064	432
VB065	Virtual Bit 065	431
VB066	Virtual Bit 066	431
VB067	Virtual Bit 067	431
VB068	Virtual Bit 068	431
VB069	Virtual Bit 069	431
VB070	Virtual Bit 070	431
VB071	Virtual Bit 071	431
VB072	Virtual Bit 072	431
VB073	Virtual Bit 073	430
VB074	Virtual Bit 074	430
VB075	Virtual Bit 075	430
VB076	Virtual Bit 076	430
VB077	Virtual Bit 077	430
VB078	Virtual Bit 078	430
VB079	Virtual Bit 079	430
VB080	Virtual Bit 080	430
VB081	Virtual Bit 081	429
VB082	Virtual Bit 082	429
VB083	Virtual Bit 083	429
VB084	Virtual Bit 084	429
VB085	Virtual Bit 085	429
VB086	Virtual Bit 086	429
VB087	Virtual Bit 087	429
VB088	Virtual Bit 088	429
VB089	Virtual Bit 089	428
VB090	Virtual Bit 090	428
VB091	Virtual Bit 091	428
VB092	Virtual Bit 092	428
VB093	Virtual Bit 093	428
VB094	Virtual Bit 094	428
VB095	Virtual Bit 095	428
VB096	Virtual Bit 096	428
VB097	Virtual Bit 097	427
VB098	Virtual Bit 098	427
VB099	Virtual Bit 099	427
VB100	Virtual Bit 100	427
VB101	Virtual Bit 101	427
VB102	Virtual Bit 102	427
VB103	Virtual Bit 103	427
VB104	Virtual Bit 104	427

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 68 of 79)**

Name	Bit Description	Row
VB105	Virtual Bit 105	426
VB106	Virtual Bit 106	426
VB107	Virtual Bit 107	426
VB108	Virtual Bit 108	426
VB109	Virtual Bit 109	426
VB110	Virtual Bit 110	426
VB111	Virtual Bit 111	426
VB112	Virtual Bit 112	426
VB113	Virtual Bit 113	425
VB114	Virtual Bit 114	425
VB115	Virtual Bit 115	425
VB116	Virtual Bit 116	425
VB117	Virtual Bit 117	425
VB118	Virtual Bit 118	425
VB119	Virtual Bit 119	425
VB120	Virtual Bit 120	425
VB121	Virtual Bit 121	424
VB122	Virtual Bit 122	424
VB123	Virtual Bit 123	424
VB124	Virtual Bit 124	424
VB125	Virtual Bit 125	424
VB126	Virtual Bit 126	424
VB127	Virtual Bit 127	424
VB128	Virtual Bit 128	424
VB129	Virtual Bit 129	423
VB130	Virtual Bit 130	423
VB131	Virtual Bit 131	423
VB132	Virtual Bit 132	423
VB133	Virtual Bit 133	423
VB134	Virtual Bit 134	423
VB135	Virtual Bit 135	423
VB136	Virtual Bit 136	423
VB137	Virtual Bit 137	422
VB138	Virtual Bit 138	422
VB139	Virtual Bit 139	422
VB140	Virtual Bit 140	422
VB141	Virtual Bit 141	422
VB142	Virtual Bit 142	422
VB143	Virtual Bit 143	422
VB144	Virtual Bit 144	422
VB145	Virtual Bit 145	421

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 69 of 79)**

Name	Bit Description	Row
VB146	Virtual Bit 146	421
VB147	Virtual Bit 147	421
VB148	Virtual Bit 148	421
VB149	Virtual Bit 149	421
VB150	Virtual Bit 150	421
VB151	Virtual Bit 151	421
VB152	Virtual Bit 152	421
VB153	Virtual Bit 153	420
VB154	Virtual Bit 154	420
VB155	Virtual Bit 155	420
VB156	Virtual Bit 156	420
VB157	Virtual Bit 157	420
VB158	Virtual Bit 158	420
VB159	Virtual Bit 159	420
VB160	Virtual Bit 160	420
VB161	Virtual Bit 161	419
VB162	Virtual Bit 162	419
VB163	Virtual Bit 163	419
VB164	Virtual Bit 164	419
VB165	Virtual Bit 165	419
VB166	Virtual Bit 166	419
VB167	Virtual Bit 167	419
VB168	Virtual Bit 168	419
VB169	Virtual Bit 169	418
VB170	Virtual Bit 170	418
VB171	Virtual Bit 171	418
VB172	Virtual Bit 172	418
VB173	Virtual Bit 173	418
VB174	Virtual Bit 174	418
VB175	Virtual Bit 175	418
VB176	Virtual Bit 176	418
VB177	Virtual Bit 177	417
VB178	Virtual Bit 178	417
VB179	Virtual Bit 179	417
VB180	Virtual Bit 180	417
VB181	Virtual Bit 181	417
VB182	Virtual Bit 182	417
VB183	Virtual Bit 183	417
VB184	Virtual Bit 184	417
VB185	Virtual Bit 185	416
VB186	Virtual Bit 186	416

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 70 of 79)**

Name	Bit Description	Row
VB187	Virtual Bit 187	416
VB188	Virtual Bit 188	416
VB189	Virtual Bit 189	416
VB190	Virtual Bit 190	416
VB191	Virtual Bit 191	416
VB192	Virtual Bit 192	416
VB193	Virtual Bit 193	415
VB194	Virtual Bit 194	415
VB195	Virtual Bit 195	415
VB196	Virtual Bit 196	415
VB197	Virtual Bit 197	415
VB198	Virtual Bit 198	415
VB199	Virtual Bit 199	415
VB200	Virtual Bit 200	415
VB201	Virtual Bit 201	414
VB202	Virtual Bit 202	414
VB203	Virtual Bit 203	414
VB204	Virtual Bit 204	414
VB205	Virtual Bit 205	414
VB206	Virtual Bit 206	414
VB207	Virtual Bit 207	414
VB208	Virtual Bit 208	414
VB209	Virtual Bit 209	413
VB210	Virtual Bit 210	413
VB211	Virtual Bit 211	413
VB212	Virtual Bit 212	413
VB213	Virtual Bit 213	413
VB214	Virtual Bit 214	413
VB215	Virtual Bit 215	413
VB216	Virtual Bit 216	413
VB217	Virtual Bit 217	412
VB218	Virtual Bit 218	412
VB219	Virtual Bit 219	412
VB220	Virtual Bit 220	412
VB221	Virtual Bit 221	412
VB222	Virtual Bit 222	412
VB223	Virtual Bit 223	412
VB224	Virtual Bit 224	412
VB225	Virtual Bit 225	411
VB226	Virtual Bit 226	411
VB227	Virtual Bit 227	411

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 71 of 79)**

Name	Bit Description	Row
VB228	Virtual Bit 228	411
VB229	Virtual Bit 229	411
VB230	Virtual Bit 230	411
VB231	Virtual Bit 231	411
VB232	Virtual Bit 232	411
VB233	Virtual Bit 233	410
VB234	Virtual Bit 234	410
VB235	Virtual Bit 235	410
VB236	Virtual Bit 236	410
VB237	Virtual Bit 237	410
VB238	Virtual Bit 238	410
VB239	Virtual Bit 239	410
VB240	Virtual Bit 240	410
VB241	Virtual Bit 241	409
VB242	Virtual Bit 242	409
VB243	Virtual Bit 243	409
VB244	Virtual Bit 244	409
VB245	Virtual Bit 245	409
VB246	Virtual Bit 246	409
VB247	Virtual Bit 247	409
VB248	Virtual Bit 248	409
VB249	Virtual Bit 249	408
VB250	Virtual Bit 250	408
VB251	Virtual Bit 251	408
VB252	Virtual Bit 252	408
VB253	Virtual Bit 253	408
VB254	Virtual Bit 254	408
VB255	Virtual Bit 255	408
VB256	Virtual Bit 256	408
XBF01	Circuit Breaker 1 external breaker failure input (SELOGIC control equation)	183
XBF02	Circuit Breaker 2 external breaker failure input (SELOGIC control equation)	184
XBF03	Circuit Breaker 3 external breaker failure input (SELOGIC control equation)	185
XBF04	Circuit Breaker 4 external breaker failure input (SELOGIC control equation)	186
XBF05	Circuit Breaker 5 external breaker failure input (SELOGIC control equation)	187
XBF06	Circuit Breaker 6 external breaker failure input (SELOGIC control equation)	188
XBF07	Circuit Breaker 7 external breaker failure input (SELOGIC control equation)	189
XBF08	Circuit Breaker 8 external breaker failure input (SELOGIC control equation)	190
XBF09	Circuit Breaker 9 external breaker failure input (SELOGIC control equation)	191
XBF10	Circuit Breaker 10 external breaker failure input (SELOGIC control equation)	192
XBF11	Circuit Breaker 11 external breaker failure input (SELOGIC control equation)	193
XBF12	Circuit Breaker 12 external breaker failure input (SELOGIC control equation)	194

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 72 of 79)**

Name	Bit Description	Row
XBF13	Circuit Breaker 13 external breaker failure input (SELOGIC control equation)	195
XBF14	Circuit Breaker 14 external breaker failure input (SELOGIC control equation)	196
XBF15	Circuit Breaker 15 external breaker failure input (SELOGIC control equation)	197
XBF16	Circuit Breaker 16 external breaker failure input (SELOGIC control equation)	198
XBF17	Circuit Breaker 17 external breaker failure input (SELOGIC control equation)	199
XBF18	Circuit Breaker 18 external breaker failure input (SELOGIC control equation)	200
XBF19	Circuit Breaker 19 external breaker failure input (SELOGIC control equation)	201
XBF20	Circuit Breaker 20 external breaker failure input (SELOGIC control equation)	202
XBF21	Circuit Breaker 21 external breaker failure input (SELOGIC control equation)	203
YEAR1	IRIG-B year information, binary-coded-decimal, add 1 if asserted	468
YEAR10	IRIG-B year information, binary-coded-decimal, add 10 if asserted	468
YEAR2	IRIG-B year information, binary-coded-decimal, add 2 if asserted	468
YEAR20	IRIG-B year information, binary-coded-decimal, add 20 if asserted	468
YEAR4	IRIG-B year information, binary-coded-decimal, add 4 if asserted	468
YEAR40	IRIG-B year information, binary-coded-decimal, add 40 if asserted	468
YEAR8	IRIG-B year information, binary-coded-decimal, add 8 if asserted	468
YEAR80	IRIG-B year information, binary-coded-decimal, add 80 if asserted	468
Z1BZ1	Bus-Zone 1 is part of Protective Zone 1	144
Z1BZ2	Bus-Zone 2 is part of Protective Zone 1	144
Z1BZ3	Bus-Zone 3 is part of Protective Zone 1	144
Z1BZ4	Bus-Zone 4 is part of Protective Zone 1	144
Z1BZ5	Bus-Zone 5 is part of Protective Zone 1	144
Z1BZ6	Bus-Zone 6 is part of Protective Zone 1	144
Z1S	Zone 1 supervision asserted	153
Z2BZ2	Bus-Zone 2 is part of Protective Zone 2	145
Z2BZ3	Bus-Zone 3 is part of Protective Zone 2	145
Z2BZ4	Bus-Zone 4 is part of Protective Zone 2	145
Z2BZ5	Bus-Zone 5 is part of Protective Zone 2	145
Z2BZ6	Bus-Zone 6 is part of Protective Zone 2	145
Z2S	Zone 2 supervision asserted	153
Z3BZ3	Bus-Zone 3 is part of Protective Zone 3	146
Z3BZ4	Bus-Zone 4 is part of Protective Zone 3	146
Z3BZ5	Bus-Zone 5 is part of Protective Zone 3	146
Z3BZ6	Bus-Zone 6 is part of Protective Zone 3	146
Z3S	Zone 3 supervision asserted	153
Z4BZ4	Bus-Zone 4 is part of Protective Zone 4	147
Z4BZ5	Bus-Zone 5 is part of Protective Zone 4	147
Z4BZ6	Bus-Zone 6 is part of Protective Zone 4	147
Z4S	Zone 4 supervision asserted	153
Z5BZ5	Bus-Zone 5 is part of Protective Zone 5	148
Z5BZ6	Bus-Zone 6 is part of Protective Zone 5	148

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 73 of 79)**

Name	Bit Description	Row
Z5S	Zone 5 supervision asserted	153
Z6BZ6	Bus-Zone 6 is part of Protective Zone 6	149
Z6S	Zone 6 supervision asserted	153
ZN1I01	Terminal 01 connected to Zone 1	80
ZN1I01T	Terminal 01 connected to Zone 1 and will be tripped	104
ZN1I02	Terminal 02 connected to Zone 1	80
ZN1I02T	Terminal 02 connected to Zone 1 and will be tripped	104
ZN1I03	Terminal 03 connected to Zone 1	80
ZN1I03T	Terminal 03 connected to Zone 1 and will be tripped	104
ZN1I04	Terminal 04 connected to Zone 1	80
ZN1I04T	Terminal 04 connected to Zone 1 and will be tripped	104
ZN1I05	Terminal 05 connected to Zone 1	80
ZN1I05T	Terminal 05 connected to Zone 1 and will be tripped	104
ZN1I06	Terminal 06 connected to Zone 1	80
ZN1I06T	Terminal 06 connected to Zone 1 and will be tripped	104
ZN1I07	Terminal 07 connected to Zone 1	80
ZN1I07T	Terminal 07 connected to Zone 1 and will be tripped	104
ZN1I08	Terminal 08 connected to Zone 1	80
ZN1I08T	Terminal 08 connected to Zone 1 and will be tripped	104
ZN1I09	Terminal 09 connected to Zone 1	81
ZN1I09T	Terminal 09 connected to Zone 1 and will be tripped	105
ZN1I10	Terminal 10 connected to Zone 1	81
ZN1I10T	Terminal 10 connected to Zone 1 and will be tripped	105
ZN1I11	Terminal 11 connected to Zone 1	81
ZN1I11T	Terminal 11 connected to Zone 1 and will be tripped	105
ZN1I12	Terminal 12 connected to Zone 1	81
ZN1I12T	Terminal 12 connected to Zone 1 and will be tripped	105
ZN1I13	Terminal 13 connected to Zone 1	81
ZN1I13T	Terminal 13 connected to Zone 1 and will be tripped	105
ZN1I14	Terminal 14 connected to Zone 1	81
ZN1I14T	Terminal 14 connected to Zone 1 and will be tripped	105
ZN1I15	Terminal 15 connected to Zone 1	81
ZN1I15T	Terminal 15 connected to Zone 1 and will be tripped	105
ZN1I16	Terminal 16 connected to Zone 1	81
ZN1I16T	Terminal 16 connected to Zone 1 and will be tripped	105
ZN1I17	Terminal 17 connected to Zone 1	82
ZN1I17T	Terminal 17 connected to Zone 1 and will be tripped	106
ZN1I18	Terminal 18 connected to Zone 1	82
ZN1I18T	Terminal 18 connected to Zone 1 and will be tripped	106
ZN1I19	Terminal 19 connected to Zone 1	82
ZN1I19T	Terminal 19 connected to Zone 1 and will be tripped	106

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 74 of 79)**

<b>Name</b>	<b>Bit Description</b>	<b>Row</b>
ZN1I20	Terminal 20 connected to Zone 1	82
ZN1I20T	Terminal 20 connected to Zone 1 and will be tripped	106
ZN1I21	Terminal 21 connected to Zone 1	82
ZN1I21T	Terminal 21 connected to Zone 1 and will be tripped	106
ZN2I01	Terminal 01 connected to Zone 2	84
ZN2I01T	Terminal 01 connected to Zone 2 and will be tripped	108
ZN2I02	Terminal 02 connected to Zone 2	84
ZN2I02T	Terminal 02 connected to Zone 2 and will be tripped	108
ZN2I03	Terminal 03 connected to Zone 2	84
ZN2I03T	Terminal 03 connected to Zone 2 and will be tripped	108
ZN2I04	Terminal 04 connected to Zone 2	84
ZN2I04T	Terminal 04 connected to Zone 2 and will be tripped	108
ZN2I05	Terminal 05 connected to Zone 2	84
ZN2I05T	Terminal 05 connected to Zone 2 and will be tripped	108
ZN2I06	Terminal 06 connected to Zone 2	84
ZN2I06T	Terminal 06 connected to Zone 2 and will be tripped	108
ZN2I07	Terminal 07 connected to Zone 2	84
ZN2I07T	Terminal 07 connected to Zone 2 and will be tripped	108
ZN2I08	Terminal 08 connected to Zone 2	84
ZN2I08T	Terminal 08 connected to Zone 2 and will be tripped	108
ZN2I09	Terminal 09 connected to Zone 2	85
ZN2I09T	Terminal 09 connected to Zone 2 and will be tripped	109
ZN2I10	Terminal 10 connected to Zone 2	85
ZN2I10T	Terminal 10 connected to Zone 2 and will be tripped	109
ZN2I11	Terminal 11 connected to Zone 2	85
ZN2I11T	Terminal 11 connected to Zone 2 and will be tripped	109
ZN2I12	Terminal 12 connected to Zone 2	85
ZN2I12T	Terminal 12 connected to Zone 2 and will be tripped	109
ZN2I13	Terminal 13 connected to Zone 2	85
ZN2I13T	Terminal 13 connected to Zone 2 and will be tripped	109
ZN2I14	Terminal 14 connected to Zone 2	85
ZN2I14T	Terminal 14 connected to Zone 2 and will be tripped	109
ZN2I15	Terminal 15 connected to Zone 2	85
ZN2I15T	Terminal 15 connected to Zone 2 and will be tripped	109
ZN2I16	Terminal 16 connected to Zone 2	85
ZN2I16T	Terminal 16 connected to Zone 2 and will be tripped	109
ZN2I17	Terminal 17 connected to Zone 2	86
ZN2I17T	Terminal 17 connected to Zone 2 and will be tripped	110
ZN2I18	Terminal 18 connected to Zone 2	86
ZN2I18T	Terminal 18 connected to Zone 2 and will be tripped	110
ZN2I19	Terminal 19 connected to Zone 2	86

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 75 of 79)**

<b>Name</b>	<b>Bit Description</b>	<b>Row</b>
ZN2I19T	Terminal 19 connected to Zone 2 and will be tripped	110
ZN2I20	Terminal 20 connected to Zone 2	86
ZN2I20T	Terminal 20 connected to Zone 2 and will be tripped	110
ZN2I21	Terminal 21 connected to Zone 2	86
ZN2I21T	Terminal 21 connected to Zone 2 and will be tripped	110
ZN3I01	Terminal 01 connected to Zone 3	88
ZN3I01T	Terminal 01 connected to Zone 3 and will be tripped	112
ZN3I02	Terminal 02 connected to Zone 3	88
ZN3I02T	Terminal 02 connected to Zone 3 and will be tripped	112
ZN3I03	Terminal 03 connected to Zone 3	88
ZN3I03T	Terminal 03 connected to Zone 3 and will be tripped	112
ZN3I04	Terminal 04 connected to Zone 3	88
ZN3I04T	Terminal 04 connected to Zone 3 and will be tripped	112
ZN3I05	Terminal 05 connected to Zone 3	88
ZN3I05T	Terminal 05 connected to Zone 3 and will be tripped	112
ZN3I06	Terminal 06 connected to Zone 3	88
ZN3I06T	Terminal 06 connected to Zone 3 and will be tripped	112
ZN3I07	Terminal 07 connected to Zone 3	88
ZN3I07T	Terminal 07 connected to Zone 3 and will be tripped	112
ZN3I08	Terminal 08 connected to Zone 3	88
ZN3I08T	Terminal 08 connected to Zone 3 and will be tripped	112
ZN3I09	Terminal 09 connected to Zone 3	89
ZN3I09T	Terminal 09 connected to Zone 3 and will be tripped	113
ZN3I10	Terminal 10 connected to Zone 3	89
ZN3I10T	Terminal 10 connected to Zone 3 and will be tripped	113
ZN3I11	Terminal 11 connected to Zone 3	89
ZN3I11T	Terminal 11 connected to Zone 3 and will be tripped	113
ZN3I12	Terminal 12 connected to Zone 3	89
ZN3I12T	Terminal 12 connected to Zone 3 and will be tripped	113
ZN3I13	Terminal 13 connected to Zone 3	89
ZN3I13T	Terminal 13 connected to Zone 3 and will be tripped	113
ZN3I14	Terminal 14 connected to Zone 3	89
ZN3I14T	Terminal 14 connected to Zone 3 and will be tripped	113
ZN3I15	Terminal 15 connected to Zone 3	89
ZN3I15T	Terminal 15 connected to Zone 3 and will be tripped	113
ZN3I16	Terminal 16 connected to Zone 3	89
ZN3I16T	Terminal 16 connected to Zone 3 and will be tripped	113
ZN3I17	Terminal 17 connected to Zone 3	90
ZN3I17T	Terminal 17 connected to Zone 3 and will be tripped	114
ZN3I18	Terminal 18 connected to Zone 3	90
ZN3I18T	Terminal 18 connected to Zone 3 and will be tripped	114

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 76 of 79)**

<b>Name</b>	<b>Bit Description</b>	<b>Row</b>
ZN3I19	Terminal 19 connected to Zone 3	90
ZN3I19T	Terminal 19 connected to Zone 3 and will be tripped	114
ZN3I20	Terminal 20 connected to Zone 3	90
ZN3I20T	Terminal 20 connected to Zone 3 and will be tripped	114
ZN3I21	Terminal 21 connected to Zone 3	90
ZN3I21T	Terminal 21 connected to Zone 3 and will be tripped	114
ZN4I01	Terminal 01 connected to Zone 4	92
ZN4I01T	Terminal 01 connected to Zone 4 and will be tripped	116
ZN4I02	Terminal 02 connected to Zone 4	92
ZN4I02T	Terminal 02 connected to Zone 4 and will be tripped	116
ZN4I03	Terminal 03 connected to Zone 4	92
ZN4I03T	Terminal 03 connected to Zone 4 and will be tripped	116
ZN4I04	Terminal 04 connected to Zone 4	92
ZN4I04T	Terminal 04 connected to Zone 4 and will be tripped	116
ZN4I05	Terminal 05 connected to Zone 4	92
ZN4I05T	Terminal 05 connected to Zone 4 and will be tripped	116
ZN4I06	Terminal 06 connected to Zone 4	92
ZN4I06T	Terminal 06 connected to Zone 4 and will be tripped	116
ZN4I07	Terminal 07 connected to Zone 4	92
ZN4I07T	Terminal 07 connected to Zone 4 and will be tripped	116
ZN4I08	Terminal 08 connected to Zone 4	92
ZN4I08T	Terminal 08 connected to Zone 4 and will be tripped	116
ZN4I09	Terminal 09 connected to Zone 4	93
ZN4I09T	Terminal 09 connected to Zone 4 and will be tripped	117
ZN4I10	Terminal 10 connected to Zone 4	93
ZN4I10T	Terminal 10 connected to Zone 4 and will be tripped	117
ZN4I11	Terminal 11 connected to Zone 4	93
ZN4I11T	Terminal 11 connected to Zone 4 and will be tripped	117
ZN4I12	Terminal 12 connected to Zone 4	93
ZN4I12T	Terminal 12 connected to Zone 4 and will be tripped	117
ZN4I13	Terminal 13 connected to Zone 4	93
ZN4I13T	Terminal 13 connected to Zone 4 and will be tripped	117
ZN4I14	Terminal 14 connected to Zone 4	93
ZN4I14T	Terminal 14 connected to Zone 4 and will be tripped	117
ZN4I15	Terminal 15 connected to Zone 4	93
ZN4I15T	Terminal 15 connected to Zone 4 and will be tripped	117
ZN4I16	Terminal 16 connected to Zone 4	93
ZN4I16T	Terminal 16 connected to Zone 4 and will be tripped	117
ZN4I17	Terminal 17 connected to Zone 4	94
ZN4I17T	Terminal 17 connected to Zone 4 and will be tripped	118
ZN4I18	Terminal 18 connected to Zone 4	94

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 77 of 79)**

<b>Name</b>	<b>Bit Description</b>	<b>Row</b>
ZN4I18T	Terminal 18 connected to Zone 4 and will be tripped	118
ZN4I19	Terminal 19 connected to Zone 4	94
ZN4I19T	Terminal 19 connected to Zone 4 and will be tripped	118
ZN4I20	Terminal 20 connected to Zone 4	94
ZN4I20T	Terminal 20 connected to Zone 4 and will be tripped	118
ZN4I21	Terminal 21 connected to Zone 4	94
ZN4I21T	Terminal 21 connected to Zone 4 and will be tripped	118
ZN5I01	Terminal 01 connected to Zone 5	96
ZN5I01T	Terminal 01 connected to Zone 5 and will be tripped	120
ZN5I02	Terminal 02 connected to Zone 5	96
ZN5I02T	Terminal 02 connected to Zone 5 and will be tripped	120
ZN5I03	Terminal 03 connected to Zone 5	96
ZN5I03T	Terminal 03 connected to Zone 5 and will be tripped	120
ZN5I04	Terminal 04 connected to Zone 5	96
ZN5I04T	Terminal 04 connected to Zone 5 and will be tripped	120
ZN5I05	Terminal 05 connected to Zone 5	96
ZN5I05T	Terminal 05 connected to Zone 5 and will be tripped	120
ZN5I06	Terminal 06 connected to Zone 5	96
ZN5I06T	Terminal 06 connected to Zone 5 and will be tripped	120
ZN5I07	Terminal 07 connected to Zone 5	96
ZN5I07T	Terminal 07 connected to Zone 5 and will be tripped	120
ZN5I08	Terminal 08 connected to Zone 5	96
ZN5I08T	Terminal 08 connected to Zone 5 and will be tripped	120
ZN5I09	Terminal 09 connected to Zone 5	97
ZN5I09T	Terminal 09 connected to Zone 5 and will be tripped	121
ZN5I10	Terminal 10 connected to Zone 5	97
ZN5I10T	Terminal 10 connected to Zone 5 and will be tripped	121
ZN5I11	Terminal 11 connected to Zone 5	97
ZN5I11T	Terminal 11 connected to Zone 5 and will be tripped	121
ZN5I12	Terminal 12 connected to Zone 5	97
ZN5I12T	Terminal 12 connected to Zone 5 and will be tripped	121
ZN5I13	Terminal 13 connected to Zone 5	97
ZN5I13T	Terminal 13 connected to Zone 5 and will be tripped	121
ZN5I14	Terminal 14 connected to Zone 5	97
ZN5I14T	Terminal 14 connected to Zone 5 and will be tripped	121
ZN5I15	Terminal 15 connected to Zone 5	97
ZN5I15T	Terminal 15 connected to Zone 5 and will be tripped	121
ZN5I16	Terminal 16 connected to Zone 5	97
ZN5I16T	Terminal 16 connected to Zone 5 and will be tripped	121
ZN5I17	Terminal 17 connected to Zone 5	98
ZN5I17T	Terminal 17 connected to Zone 5 and will be tripped	122

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 78 of 79)**

Name	Bit Description	Row
ZN5I18	Terminal 18 connected to Zone 5	98
ZN5I18T	Terminal 18 connected to Zone 5 and will be tripped	122
ZN5I19	Terminal 19 connected to Zone 5	98
ZN5I19T	Terminal 19 connected to Zone 5 and will be tripped	122
ZN5I20	Terminal 20 connected to Zone 5	98
ZN5I20T	Terminal 20 connected to Zone 5 and will be tripped	122
ZN5I21	Terminal 21 connected to Zone 5	98
ZN5I21T	Terminal 21 connected to Zone 5 and will be tripped	122
ZN6I01	Terminal 01 connected to Zone 6	100
ZN6I01T	Terminal 01 connected to Zone 6 and will be tripped	124
ZN6I02	Terminal 02 connected to Zone 6	100
ZN6I02T	Terminal 02 connected to Zone 6 and will be tripped	124
ZN6I03	Terminal 03 connected to Zone 6	100
ZN6I03T	Terminal 03 connected to Zone 6 and will be tripped	124
ZN6I04	Terminal 04 connected to Zone 6	100
ZN6I04T	Terminal 04 connected to Zone 6 and will be tripped	124
ZN6I05	Terminal 05 connected to Zone 6	100
ZN6I05T	Terminal 05 connected to Zone 6 and will be tripped	124
ZN6I06	Terminal 06 connected to Zone 6	100
ZN6I06T	Terminal 06 connected to Zone 6 and will be tripped	124
ZN6I07	Terminal 07 connected to Zone 6	100
ZN6I07T	Terminal 07 connected to Zone 6 and will be tripped	124
ZN6I08	Terminal 08 connected to Zone 6	100
ZN6I08T	Terminal 08 connected to Zone 6 and will be tripped	124
ZN6I09	Terminal 09 connected to Zone 6	101
ZN6I09T	Terminal 09 connected to Zone 6 and will be tripped	125
ZN6I10	Terminal 10 connected to Zone 6	101
ZN6I10T	Terminal 10 connected to Zone 6 and will be tripped	125
ZN6I11	Terminal 11 connected to Zone 6	101
ZN6I11T	Terminal 11 connected to Zone 6 and will be tripped	125
ZN6I12	Terminal 12 connected to Zone 6	101
ZN6I12T	Terminal 12 connected to Zone 6 and will be tripped	125
ZN6I13	Terminal 13 connected to Zone 6	101
ZN6I13T	Terminal 13 connected to Zone 6 and will be tripped	125
ZN6I14	Terminal 14 connected to Zone 6	101
ZN6I14T	Terminal 14 connected to Zone 6 and will be tripped	125
ZN6I15	Terminal 15 connected to Zone 6	101
ZN6I15T	Terminal 15 connected to Zone 6 and will be tripped	125
ZN6I16	Terminal 16 connected to Zone 6	101
ZN6I16T	Terminal 16 connected to Zone 6 and will be tripped	125
ZN6I17	Terminal 17 connected to Zone 6	102

**Table 11.1 Alphabetic List of Relay Word Bits (Sheet 79 of 79)**

Name	Bit Description	Row
ZN6I17T	Terminal 17 connected to Zone 6 and will be tripped	126
ZN6I18	Terminal 18 connected to Zone 6	102
ZN6I18T	Terminal 18 connected to Zone 6 and will be tripped	126
ZN6I19	Terminal 19 connected to Zone 6	102
ZN6I19T	Terminal 19 connected to Zone 6 and will be tripped	126
ZN6I20	Terminal 20 connected to Zone 6	102
ZN6I20T	Terminal 20 connected to Zone 6 and will be tripped	126
ZN6I21	Terminal 21 connected to Zone 6	102
ZN6I21T	Terminal 21 connected to Zone 6 and will be tripped	126
ZONE1	Differential Zone 1 is active	150
ZONE2	Differential Zone 2 is active	150
ZONE3	Differential Zone 3 is active	150
ZONE4	Differential Zone 4 is active	150
ZONE5	Differential Zone 5 is active	150
ZONE6	Differential Zone 6 is active	150
ZSWO	Zone-switching operation	152
ZSWOAL	Zone-switching operation alarm	152
ZSWOIP	Zone-switching operation in progress	152
ZSWOP	Change to either bus-zone-to-bus-zone or terminal-to-bus-zone conditions in any zone	151
ZSWOP1	Change to either bus-zone-to-bus-zone or terminal-to-bus-zone conditions in Zone 1	151
ZSWOP2	Change to either bus-zone-to-bus-zone or terminal-to-bus-zone conditions in Zone 2	151
ZSWOP3	Change to either bus-zone-to-bus-zone or terminal-to-bus-zone conditions in Zone 3	151
ZSWOP4	Change to either bus-zone-to-bus-zone or terminal-to-bus-zone conditions in Zone 4	151
ZSWOP5	Change to either bus-zone-to-bus-zone or terminal-to-bus-zone conditions in Zone 5	151
ZSWOP6	Change to either bus-zone-to-bus-zone or terminal-to-bus-zone conditions in Zone 6	151

## Row List

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**Table 11.2 Row List of Relay Word Bits (Sheet 1 of 97)**

Row	Name	Bit Description
Enable and Target LEDs		
0	EN	Relay enabled
0	TRIPLED	Trip LED
0	*	Reserved

**Table 11.2 Row List of Relay Word Bits (Sheet 2 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
<b>Target LEDs</b>		
1	TLED_1	Front-panel target LED 1
1	TLED_2	Front-panel target LED 2
1	TLED_3	Front-panel target LED 3
1	TLED_4	Front-panel target LED 4
1	TLED_5	Front-panel target LED 5
1	TLED_6	Front-panel target LED 6
1	TLED_7	Front-panel target LED 7
1	TLED_8	Front-panel target LED 8
2	TLED_9	Front-panel target LED 9
2	TLED_10	Front-panel target LED 10
2	TLED_11	Front-panel target LED 11
2	TLED_12	Front-panel target LED 12
2	TLED_13	Front-panel target LED 13
2	TLED_14	Front-panel target LED 14
2	TLED_15	Front-panel target LED 15
2	TLED_16	Front-panel target LED 16
3	TLED_17	Front-panel target LED 17
3	TLED_18	Front-panel target LED 18
3	TLED_19	Front-panel target LED 19
3	TLED_20	Front-panel target LED 20
3	TLED_21	Front-panel target LED 21
3	TLED_22	Front-panel target LED 22
3	TLED_23	Front-panel target LED 23
3	TLED_24	Front-panel target LED 24
<b>Open-Phase Detectors</b>		
4	OPH08	Terminal 08 open phase detected
4	OPH07	Terminal 07 open phase detected
4	OPH06	Terminal 06 open phase detected
4	OPH05	Terminal 05 open phase detected
4	OPH04	Terminal 04 open phase detected
4	OPH03	Terminal 03 open phase detected
4	OPH02	Terminal 02 open phase detected
4	OPH01	Terminal 01 open phase detected
5	OPH16	Terminal 16 open phase detected
5	OPH15	Terminal 15 open phase detected
5	OPH14	Terminal 14 open phase detected
5	OPH13	Terminal 13 open phase detected
5	OPH12	Terminal 12 open phase detected
5	OPH11	Terminal 11 open phase detected
5	OPH10	Terminal 10 open phase detected

**Table 11.2 Row List of Relay Word Bits (Sheet 3 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
5	OPH09	Terminal 09 open phase detected
6	*	Reserved
6	*	Reserved
6	*	Reserved
6	OPH21	Terminal 21 open phase detected
6	OPH20	Terminal 20 open phase detected
6	OPH19	Terminal 19 open phase detected
6	OPH18	Terminal 18 open phase detected
6	OPH17	Terminal 17 open phase detected
<b>52 Status</b>		
7	52AL03	Circuit Breaker 03 alarm
7	52A03	Circuit Breaker 03 status
7	52CL02	Circuit Breaker 02 closed
7	52AL02	Circuit Breaker 02 alarm
7	52A02	Circuit Breaker 02 status
7	52CL01	Circuit Breaker 01 closed
7	52AL01	Circuit Breaker 01 alarm
7	52A01	Circuit Breaker 01 status
8	52A06	Circuit Breaker 06 status
8	52CL05	Circuit Breaker 05 closed
8	52AL05	Circuit Breaker 05 alarm
8	52A05	Circuit Breaker 05 status
8	52CL04	Circuit Breaker 04 closed
8	52AL04	Circuit Breaker 04 alarm
8	52A04	Circuit Breaker 04 status
8	52CL03	Circuit Breaker 03 closed
9	52CL08	Circuit Breaker 08 closed
9	52AL08	Circuit Breaker 08 alarm
9	52A08	Circuit Breaker 08 status
9	52CL07	Circuit Breaker 07 closed
9	52AL07	Circuit Breaker 07 alarm
9	52A07	Circuit Breaker 07 status
9	52CL06	Circuit Breaker 06 closed
9	52AL06	Circuit Breaker 06 alarm
10	52AL11	Circuit Breaker 11 alarm
10	52A11	Circuit Breaker 11 status
10	52CL10	Circuit Breaker 10 closed
10	52AL10	Circuit Breaker 10 alarm
10	52A10	Circuit Breaker 10 status
10	52CL09	Circuit Breaker 09 closed
10	52AL09	Circuit Breaker 09 alarm

**Table 11.2 Row List of Relay Word Bits (Sheet 4 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
10	52A09	Circuit Breaker 09 status
11	52A14	Circuit Breaker 14 status
11	52CL13	Circuit Breaker 13 closed
11	52AL13	Circuit Breaker 13 alarm
11	52A13	Circuit Breaker 13 status
11	52CL12	Circuit Breaker 12 closed
11	52AL12	Circuit Breaker 12 alarm
11	52A12	Circuit Breaker 12 status
11	52CL11	Circuit Breaker 11 closed
12	52CL16	Circuit Breaker 16 closed
12	52AL16	Circuit Breaker 16 alarm
12	52A16	Circuit Breaker 16 status
12	52CL15	Circuit Breaker 15 closed
12	52AL15	Circuit Breaker 15 alarm
12	52A15	Circuit Breaker 15 status
12	52CL14	Circuit Breaker 14 closed
12	52AL14	Circuit Breaker 14 alarm
13	52AL19	Circuit Breaker 19 alarm
13	52A19	Circuit Breaker 19 status
13	52CL18	Circuit Breaker 18 closed
13	52AL18	Circuit Breaker 18 alarm
13	52A18	Circuit Breaker 18 status
13	52CL17	Circuit Breaker 17 closed
13	52AL17	Circuit Breaker 17 alarm
13	52A17	Circuit Breaker 17 status
14	52AL	Any circuit breaker alarm
14	52CL21	Circuit Breaker 21 closed
14	52AL21	Circuit Breaker 21 alarm
14	52A21	Circuit Breaker 21 status
14	52CL20	Circuit Breaker 20 closed
14	52AL20	Circuit Breaker 20 alarm
14	52A20	Circuit Breaker 20 status
14	52CL19	Circuit Breaker 19 closed
15	*	Reserved
16	*	Reserved
<b>89 Disconnect Status</b>		
17	89CL02	Disconnect 02 closed
17	89B02	Disconnect 02 B auxiliary contact closed
17	89A02	Disconnect 02 A auxiliary contact closed
17	89AL01	Disconnect 01 auxiliary contact discrepancy alarm
17	89OIP01	Disconnect 01 operation in progress

**Table 11.2 Row List of Relay Word Bits (Sheet 5 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
17	89CL01	Disconnect 01 closed
17	89B01	Disconnect 01 B auxiliary contact closed
17	89A01	Disconnect 01 A auxiliary contact closed
18	89A04	Disconnect 04 A auxiliary contact closed
18	89AL03	Disconnect 03 auxiliary contact discrepancy alarm
18	89OIP03	Disconnect 03 operation in progress
18	89CL03	Disconnect 03 closed
18	89B03	Disconnect 03 B auxiliary contact closed
18	89A03	Disconnect 03 A auxiliary contact closed
18	89AL02	Disconnect 02 auxiliary contact discrepancy alarm
18	89OIP02	Disconnect 02 operation in progress
19	89OIP05	Disconnect 05 operation in progress
19	89CL05	Disconnect 05 closed
19	89B05	Disconnect 05 B auxiliary contact closed
19	89A05	Disconnect 05 A auxiliary contact closed
19	89AL04	Disconnect 04 auxiliary contact discrepancy alarm
19	89OIP04	Disconnect 04 operation in progress
19	89CL04	Disconnect 04 closed
19	89B04	Disconnect 04 B auxiliary contact closed
20	89B07	Disconnect 07 B auxiliary contact closed
20	89A07	Disconnect 07 A auxiliary contact closed
20	89AL06	Disconnect 06 auxiliary contact discrepancy alarm
20	89OIP06	Disconnect 06 operation in progress
20	89CL06	Disconnect 06 closed
20	89B06	Disconnect 06 B auxiliary contact closed
20	89A06	Disconnect 06 A auxiliary contact closed
20	89AL05	Disconnect 05 auxiliary contact discrepancy alarm
21	89AL08	Disconnect 08 auxiliary contact discrepancy alarm
21	89OIP08	Disconnect 08 operation in progress
21	89CL08	Disconnect 08 closed
21	89B08	Disconnect 08 B auxiliary contact closed
21	89A08	Disconnect 08 A auxiliary contact closed
21	89AL07	Disconnect 07 auxiliary contact discrepancy alarm
21	89OIP07	Disconnect 07 operation in progress
21	89CL07	Disconnect 07 closed
22	89CL10	Disconnect 10 closed
22	89B10	Disconnect 10 B auxiliary contact closed
22	89A10	Disconnect 10 A auxiliary contact closed
22	89AL09	Disconnect 09 auxiliary contact discrepancy alarm
22	89OIP09	Disconnect 09 operation in progress
22	89CL09	Disconnect 09 closed

**Table 11.2 Row List of Relay Word Bits (Sheet 6 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
22	89B09	Disconnect 09 B auxiliary contact closed
22	89A09	Disconnect 09 A auxiliary contact closed
23	89A12	Disconnect 12 A auxiliary contact closed
23	89AL11	Disconnect 11 auxiliary contact discrepancy alarm
23	89OIP11	Disconnect 11 operation in progress
23	89CL11	Disconnect 11 closed
23	89B11	Disconnect 11 B auxiliary contact closed
23	89A11	Disconnect 11 A auxiliary contact closed
23	89AL10	Disconnect 10 auxiliary contact discrepancy alarm
23	89OIP10	Disconnect 10 operation in progress
24	89OIP13	Disconnect 13 operation in progress
24	89CL13	Disconnect 13 closed
24	89B13	Disconnect 13 B auxiliary contact closed
24	89A13	Disconnect 13 A auxiliary contact closed
24	89AL12	Disconnect 12 auxiliary contact discrepancy alarm
24	89OIP12	Disconnect 12 operation in progress
24	89CL12	Disconnect 12 closed
24	89B12	Disconnect 12 B auxiliary contact closed
25	89B15	Disconnect 15 B auxiliary contact closed
25	89A15	Disconnect 15 A auxiliary contact closed
25	89AL14	Disconnect 14 auxiliary contact discrepancy alarm
25	89OIP14	Disconnect 14 operation in progress
25	89CL14	Disconnect 14 closed
25	89B14	Disconnect 14 B auxiliary contact closed
25	89A14	Disconnect 14 A auxiliary contact closed
25	89AL13	Disconnect 13 auxiliary contact discrepancy alarm
26	89AL16	Disconnect 16 auxiliary contact discrepancy alarm
26	89OIP16	Disconnect 16 operation in progress
26	89CL16	Disconnect 16 closed
26	89B16	Disconnect 16 B auxiliary contact closed
26	89A16	Disconnect 16 A auxiliary contact closed
26	89AL15	Disconnect 15 auxiliary contact discrepancy alarm
26	89OIP15	Disconnect 15 operation in progress
26	89CL15	Disconnect 15 closed
27	89CL18	Disconnect 18 closed
27	89B18	Disconnect 18 B auxiliary contact closed
27	89A18	Disconnect 18 A auxiliary contact closed
27	89AL17	Disconnect 17 auxiliary contact discrepancy alarm
27	89OIP17	Disconnect 17 operation in progress
27	89CL17	Disconnect 17 closed
27	89B17	Disconnect 17 B auxiliary contact closed

**Table 11.2 Row List of Relay Word Bits (Sheet 7 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
27	89A17	Disconnect 17 A auxiliary contact closed
28	89A20	Disconnect 20 A auxiliary contact closed
28	89AL19	Disconnect 19 auxiliary contact discrepancy alarm
28	89OIP19	Disconnect 19 operation in progress
28	89CL19	Disconnect 19 closed
28	89B19	Disconnect 19 B auxiliary contact closed
28	89A19	Disconnect 19 A auxiliary contact closed
28	89AL18	Disconnect 18 auxiliary contact discrepancy alarm
28	89OIP18	Disconnect 18 operation in progress
29	89OIP21	Disconnect 21 operation in progress
29	89CL21	Disconnect 21 closed
29	89B21	Disconnect 21 B auxiliary contact closed
29	89A21	Disconnect 21 A auxiliary contact closed
29	89AL20	Disconnect 20 auxiliary contact discrepancy alarm
29	89OIP20	Disconnect 20 operation in progress
29	89CL20	Disconnect 20 closed
29	89B20	Disconnect 20 B auxiliary contact closed
30	89B23	Disconnect 23 B auxiliary contact closed
30	89A23	Disconnect 23 A auxiliary contact closed
30	89AL22	Disconnect 22 auxiliary contact discrepancy alarm
30	89OIP22	Disconnect 22 operation in progress
30	89CL22	Disconnect 22 closed
30	89B22	Disconnect 22 B auxiliary contact closed
30	89A22	Disconnect 22 A auxiliary contact closed
30	89AL21	Disconnect 21 auxiliary contact discrepancy alarm
31	89AL24	Disconnect 24 auxiliary contact discrepancy alarm
31	89OIP24	Disconnect 24 operation in progress
31	89CL24	Disconnect 24 closed
31	89B24	Disconnect 24 B auxiliary contact closed
31	89A24	Disconnect 24 A auxiliary contact closed
31	89AL23	Disconnect 23 auxiliary contact discrepancy alarm
31	89OIP23	Disconnect 23 operation in progress
31	89CL23	Disconnect 23 closed
32	89CL26	Disconnect 26 closed
32	89B26	Disconnect 26 B auxiliary contact closed
32	89A26	Disconnect 26 A auxiliary contact closed
32	89AL25	Disconnect 25 auxiliary contact discrepancy alarm
32	89OIP25	Disconnect 25 operation in progress
32	89CL25	Disconnect 25 closed
32	89B25	Disconnect 25 B auxiliary contact closed
32	89A25	Disconnect 25 A auxiliary contact closed

**Table 11.2 Row List of Relay Word Bits (Sheet 8 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
33	89A28	Disconnect 28 A auxiliary contact closed
33	89AL27	Disconnect 27 auxiliary contact discrepancy alarm
33	89OIP27	Disconnect 27 operation in progress
33	89CL27	Disconnect 27 closed
33	89B27	Disconnect 27 B auxiliary contact closed
33	89A27	Disconnect 27 A auxiliary contact closed
33	89AL26	Disconnect 26 auxiliary contact discrepancy alarm
33	89OIP26	Disconnect 26 operation in progress
34	89OIP29	Disconnect 29 operation in progress
34	89CL29	Disconnect 29 closed
34	89B29	Disconnect 29 B auxiliary contact closed
34	89A29	Disconnect 29 A auxiliary contact closed
34	89AL28	Disconnect 28 auxiliary contact discrepancy alarm
34	89OIP28	Disconnect 28 operation in progress
34	89CL28	Disconnect 28 closed
34	89B28	Disconnect 28 B auxiliary contact closed
35	89B31	Disconnect 31 B auxiliary contact closed
35	89A31	Disconnect 31 A auxiliary contact closed
35	89AL30	Disconnect 30 auxiliary contact discrepancy alarm
35	89OIP30	Disconnect 30 operation in progress
35	89CL30	Disconnect 30 closed
35	89B30	Disconnect 30 B auxiliary contact closed
35	89A30	Disconnect 30 A auxiliary contact closed
35	89AL29	Disconnect 29 auxiliary contact discrepancy alarm
36	89AL32	Disconnect 32 auxiliary contact discrepancy alarm
36	89OIP32	Disconnect 32 operation in progress
36	89CL32	Disconnect 32 closed
36	89B32	Disconnect 32 B auxiliary contact closed
36	89A32	Disconnect 32 A auxiliary contact closed
36	89AL31	Disconnect 31 auxiliary contact discrepancy alarm
36	89OIP31	Disconnect 31 operation in progress
36	89CL31	Disconnect 31 closed
37	89CL34	Disconnect 34 closed
37	89B34	Disconnect 34 B auxiliary contact closed
37	89A34	Disconnect 34 A auxiliary contact closed
37	89AL33	Disconnect 33 auxiliary contact discrepancy alarm
37	89OIP33	Disconnect 33 operation in progress
37	89CL33	Disconnect 33 closed
37	89B33	Disconnect 33 B auxiliary contact closed
37	89A33	Disconnect 33 A auxiliary contact closed
38	89A36	Disconnect 36 A auxiliary contact closed

**Table 11.2 Row List of Relay Word Bits (Sheet 9 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
38	89AL35	Disconnect 35 auxiliary contact discrepancy alarm
38	89OIP35	Disconnect 35 operation in progress
38	89CL35	Disconnect 35 closed
38	89B35	Disconnect 35 B auxiliary contact closed
38	89A35	Disconnect 35 A auxiliary contact closed
38	89AL34	Disconnect 34 auxiliary contact discrepancy alarm
38	89OIP34	Disconnect 34 operation in progress
39	89OIP37	Disconnect 37 operation in progress
39	89CL37	Disconnect 37 closed
39	89B37	Disconnect 37 B auxiliary contact closed
39	89A37	Disconnect 37 A auxiliary contact closed
39	89AL36	Disconnect 36 auxiliary contact discrepancy alarm
39	89OIP36	Disconnect 36 operation in progress
39	89CL36	Disconnect 36 closed
39	89B36	Disconnect 36 B auxiliary contact closed
40	89B39	Disconnect 39 B auxiliary contact closed
40	89A39	Disconnect 39 A auxiliary contact closed
40	89AL38	Disconnect 38 auxiliary contact discrepancy alarm
40	89OIP38	Disconnect 38 operation in progress
40	89CL38	Disconnect 38 closed
40	89B38	Disconnect 38 B auxiliary contact closed
40	89A38	Disconnect 38 A auxiliary contact closed
40	89AL37	Disconnect 37 auxiliary contact discrepancy alarm
41	89AL40	Disconnect 40 auxiliary contact discrepancy alarm
41	89OIP40	Disconnect 40 operation in progress
41	89CL40	Disconnect 40 closed
41	89B40	Disconnect 40 B auxiliary contact closed
41	89A40	Disconnect 40 A auxiliary contact closed
41	89AL39	Disconnect 39 auxiliary contact discrepancy alarm
41	89OIP39	Disconnect 39 operation in progress
41	89CL39	Disconnect 39 closed
42	89CL42	Disconnect 42 closed
42	89B42	Disconnect 42 B auxiliary contact closed
42	89A42	Disconnect 42 A auxiliary contact closed
42	89AL41	Disconnect 41 auxiliary contact discrepancy alarm
42	89OIP41	Disconnect 41 operation in progress
42	89CL41	Disconnect 41 closed
42	89B41	Disconnect 41 B auxiliary contact closed
42	89A41	Disconnect 41 A auxiliary contact closed
43	89A44	Disconnect 44 A auxiliary contact closed
43	89AL43	Disconnect 43 auxiliary contact discrepancy alarm

**Table 11.2 Row List of Relay Word Bits (Sheet 10 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
43	89OIP43	Disconnect 43 operation in progress
43	89CL43	Disconnect 43 closed
43	89B43	Disconnect 43 B auxiliary contact closed
43	89A43	Disconnect 43 A auxiliary contact closed
43	89AL42	Disconnect 42 auxiliary contact discrepancy alarm
43	89OIP42	Disconnect 42 operation in progress
44	89OIP45	Disconnect 45 operation in progress
44	89CL45	Disconnect 45 closed
44	89B45	Disconnect 45 B auxiliary contact closed
44	89A45	Disconnect 45 A auxiliary contact closed
44	89AL44	Disconnect 44 auxiliary contact discrepancy alarm
44	89OIP44	Disconnect 44 operation in progress
44	89CL44	Disconnect 44 closed
44	89B44	Disconnect 44 B auxiliary contact closed
45	89B47	Disconnect 47 B auxiliary contact closed
45	89A47	Disconnect 47 A auxiliary contact closed
45	89AL46	Disconnect 46 auxiliary contact discrepancy alarm
45	89OIP46	Disconnect 46 operation in progress
45	89CL46	Disconnect 46 closed
45	89B46	Disconnect 46 B auxiliary contact closed
45	89A46	Disconnect 46 A auxiliary contact closed
45	89AL45	Disconnect 45 auxiliary contact discrepancy alarm
46	89AL48	Disconnect 48 auxiliary contact discrepancy alarm
46	89OIP48	Disconnect 48 operation in progress
46	89CL48	Disconnect 48 closed
46	89B48	Disconnect 48 B auxiliary contact closed
46	89A48	Disconnect 48 A auxiliary contact closed
46	89AL47	Disconnect 47 auxiliary contact discrepancy alarm
46	89OIP47	Disconnect 47 operation in progress
46	89CL47	Disconnect 47 closed
47	89CL50	Disconnect 50 closed
47	89B50	Disconnect 50 B auxiliary contact closed
47	89A50	Disconnect 50 A auxiliary contact closed
47	89AL49	Disconnect 49 auxiliary contact discrepancy alarm
47	89OIP49	Disconnect 49 operation in progress
47	89CL49	Disconnect 49 closed
47	89B49	Disconnect 49 B auxiliary contact closed
47	89A49	Disconnect 49 A auxiliary contact closed
48	89A52	Disconnect 52 A auxiliary contact closed
48	89AL51	Disconnect 51 auxiliary contact discrepancy alarm
48	89OIP51	Disconnect 51 operation in progress

**Table 11.2 Row List of Relay Word Bits (Sheet 11 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
48	89CL51	Disconnect 51 closed
48	89B51	Disconnect 51 B auxiliary contact closed
48	89A51	Disconnect 51 A auxiliary contact closed
48	89AL50	Disconnect 50 auxiliary contact discrepancy alarm
48	89OIP50	Disconnect 50 operation in progress
49	89OIP53	Disconnect 53 operation in progress
49	89CL53	Disconnect 53 closed
49	89B53	Disconnect 53 B auxiliary contact closed
49	89A53	Disconnect 53 A auxiliary contact closed
49	89AL52	Disconnect 52 auxiliary contact discrepancy alarm
49	89OIP52	Disconnect 52 operation in progress
49	89CL52	Disconnect 52 closed
49	89B52	Disconnect 52 B auxiliary contact closed
50	89B55	Disconnect 55 B auxiliary contact closed
50	89A55	Disconnect 55 A auxiliary contact closed
50	89AL54	Disconnect 54 auxiliary contact discrepancy alarm
50	89OIP54	Disconnect 54 operation in progress
50	89CL54	Disconnect 54 closed
50	89B54	Disconnect 54 B auxiliary contact closed
50	89A54	Disconnect 54 A auxiliary contact closed
50	89AL53	Disconnect 53 auxiliary contact discrepancy alarm
51	89AL56	Disconnect 56 auxiliary contact discrepancy alarm
51	89OIP56	Disconnect 56 operation in progress
51	89CL56	Disconnect 56 closed
51	89B56	Disconnect 56 B auxiliary contact closed
51	89A56	Disconnect 56 A auxiliary contact closed
51	89AL55	Disconnect 55 auxiliary contact discrepancy alarm
51	89OIP55	Disconnect 55 operation in progress
51	89CL55	Disconnect 55 closed
52	89CL58	Disconnect 58 closed
52	89B58	Disconnect 58 B auxiliary contact closed
52	89A58	Disconnect 58 A auxiliary contact closed
52	89AL57	Disconnect 57 auxiliary contact discrepancy alarm
52	89OIP57	Disconnect 57 operation in progress
52	89CL57	Disconnect 57 closed
52	89B57	Disconnect 57 B auxiliary contact closed
52	89A57	Disconnect 57 A auxiliary contact closed
53	89A60	Disconnect 60 A auxiliary contact closed
53	89AL59	Disconnect 59 auxiliary contact discrepancy alarm
53	89OIP59	Disconnect 59 operation in progress
53	89CL59	Disconnect 59 closed

**Table 11.2 Row List of Relay Word Bits (Sheet 12 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
53	89B59	Disconnect 59 B auxiliary contact closed
53	89A59	Disconnect 59 A auxiliary contact closed
53	89AL58	Disconnect 58 auxiliary contact discrepancy alarm
53	89OIP58	Disconnect 58 operation in progress
54	*	Reserved
54	89AL60	Disconnect 60 auxiliary contact discrepancy alarm
54	89OIP60	Disconnect 60 operation in progress
54	89CL60	Disconnect 60 closed
54	89B60	Disconnect 60 B auxiliary contact closed
55	*	Reserved
55	89OIP	Any Disconnect operation in progress
55	89AL	Any Disconnect auxiliary contact discrepancy alarm
<b>Terminal-to-Bus-Zone Connection</b>		
56	I08BZ1V	Terminal I08 connected to BZ1
56	I07BZ1V	Terminal I07 connected to BZ1
56	I06BZ1V	Terminal I06 connected to BZ1
56	I05BZ1V	Terminal I05 connected to BZ1
56	I04BZ1V	Terminal I04 connected to BZ1
56	I03BZ1V	Terminal I03 connected to BZ1
56	I02BZ1V	Terminal I02 connected to BZ1
56	I01BZ1V	Terminal I01 connected to BZ1
57	I16BZ1V	Terminal I16 connected to BZ1
57	I15BZ1V	Terminal I15 connected to BZ1
57	I14BZ1V	Terminal I14 connected to BZ1
57	I13BZ1V	Terminal I13 connected to BZ1
57	I12BZ1V	Terminal I12 connected to BZ1
57	I11BZ1V	Terminal I11 connected to BZ1
57	I10BZ1V	Terminal I10 connected to BZ1
57	I09BZ1V	Terminal I09 connected to BZ1
58	*	Reserved
58	*	Reserved
58	*	Reserved
58	I21BZ1V	Terminal I21 connected to BZ1

**Table 11.2 Row List of Relay Word Bits (Sheet 13 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
58	I20BZ1V	Terminal I20 connected to BZ1
58	I19BZ1V	Terminal I19 connected to BZ1
58	I18BZ1V	Terminal I18 connected to BZ1
58	I17BZ1V	Terminal I17 connected to BZ1
59	*	Reserved
60	I08BZ2V	Terminal I08 connected to BZ2
60	I07BZ2V	Terminal I07 connected to BZ2
60	I06BZ2V	Terminal I06 connected to BZ2
60	I05BZ2V	Terminal I05 connected to BZ2
60	I04BZ2V	Terminal I04 connected to BZ2
60	I03BZ2V	Terminal I03 connected to BZ2
60	I02BZ2V	Terminal I02 connected to BZ2
60	I01BZ2V	Terminal I01 connected to BZ2
61	I16BZ2V	Terminal I16 connected to BZ2
61	I15BZ2V	Terminal I15 connected to BZ2
61	I14BZ2V	Terminal I14 connected to BZ2
61	I13BZ2V	Terminal I13 connected to BZ2
61	I12BZ2V	Terminal I12 connected to BZ2
61	I11BZ2V	Terminal I11 connected to BZ2
61	I10BZ2V	Terminal I10 connected to BZ2
61	I09BZ2V	Terminal I09 connected to BZ2
62	*	Reserved
62	*	Reserved
62	*	Reserved
62	I21BZ2V	Terminal I21 connected to BZ2
62	I20BZ2V	Terminal I20 connected to BZ2
62	I19BZ2V	Terminal I19 connected to BZ2
62	I18BZ2V	Terminal I18 connected to BZ2
62	I17BZ2V	Terminal I17 connected to BZ2
63	*	Reserved
64	I08BZ3V	Terminal I08 connected to BZ3
64	I07BZ3V	Terminal I07 connected to BZ3
64	I06BZ3V	Terminal I06 connected to BZ3
64	I05BZ3V	Terminal I05 connected to BZ3
64	I04BZ3V	Terminal I04 connected to BZ3
64	I03BZ3V	Terminal I03 connected to BZ3
64	I02BZ3V	Terminal I02 connected to BZ3
64	I01BZ3V	Terminal I01 connected to BZ3
65	I16BZ3V	Terminal I16 connected to BZ3
65	I15BZ3V	Terminal I15 connected to BZ3
65	I14BZ3V	Terminal I14 connected to BZ3

**Table 11.2 Row List of Relay Word Bits (Sheet 14 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
65	I13BZ3V	Terminal I13 connected to BZ3
65	I12BZ3V	Terminal I12 connected to BZ3
65	I11BZ3V	Terminal I11 connected to BZ3
65	I10BZ3V	Terminal I10 connected to BZ3
65	I09BZ3V	Terminal I09 connected to BZ3
66	*	Reserved
66	*	Reserved
66	*	Reserved
66	I21BZ3V	Terminal I21 connected to BZ3
66	I20BZ3V	Terminal I20 connected to BZ3
66	I19BZ3V	Terminal I19 connected to BZ3
66	I18BZ3V	Terminal I18 connected to BZ3
66	I17BZ3V	Terminal I17 connected to BZ3
67	*	Reserved
68	I08BZ4V	Terminal I08 connected to BZ4
68	I07BZ4V	Terminal I07 connected to BZ4
68	I06BZ4V	Terminal I06 connected to BZ4
68	I05BZ4V	Terminal I05 connected to BZ4
68	I04BZ4V	Terminal I04 connected to BZ4
68	I03BZ4V	Terminal I03 connected to BZ4
68	I02BZ4V	Terminal I02 connected to BZ4
68	I01BZ4V	Terminal I01 connected to BZ4
69	I16BZ4V	Terminal I16 connected to BZ4
69	I15BZ4V	Terminal I15 connected to BZ4
69	I14BZ4V	Terminal I14 connected to BZ4
69	I13BZ4V	Terminal I13 connected to BZ4
69	I12BZ4V	Terminal I12 connected to BZ4
69	I11BZ4V	Terminal I11 connected to BZ4
69	I10BZ4V	Terminal I10 connected to BZ4
69	I09BZ4V	Terminal I09 connected to BZ4
70	*	Reserved
70	*	Reserved
70	*	Reserved
70	I21BZ4V	Terminal I21 connected to BZ4
70	I20BZ4V	Terminal I20 connected to BZ4
70	I19BZ4V	Terminal I19 connected to BZ4
70	I18BZ4V	Terminal I18 connected to BZ4
70	I17BZ4V	Terminal I17 connected to BZ4
71	*	Reserved
72	I08BZ5V	Terminal I08 connected to BZ5
72	I07BZ5V	Terminal I07 connected to BZ5

**Table 11.2 Row List of Relay Word Bits (Sheet 15 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
72	I06BZ5V	Terminal I06 connected to BZ5
72	I05BZ5V	Terminal I05 connected to BZ5
72	I04BZ5V	Terminal I04 connected to BZ5
72	I03BZ5V	Terminal I03 connected to BZ5
72	I02BZ5V	Terminal I02 connected to BZ5
72	I01BZ5V	Terminal I01 connected to BZ5
73	I16BZ5V	Terminal I16 connected to BZ5
73	I15BZ5V	Terminal I15 connected to BZ5
73	I14BZ5V	Terminal I14 connected to BZ5
73	I13BZ5V	Terminal I13 connected to BZ5
73	I12BZ5V	Terminal I12 connected to BZ5
73	I11BZ5V	Terminal I11 connected to BZ5
73	I10BZ5V	Terminal I10 connected to BZ5
73	I09BZ5V	Terminal I09 connected to BZ5
74	*	Reserved
74	*	Reserved
74	*	Reserved
74	I21BZ5V	Terminal I21 connected to BZ5
74	I20BZ5V	Terminal I20 connected to BZ5
74	I19BZ5V	Terminal I19 connected to BZ5
74	I18BZ5V	Terminal I18 connected to BZ5
74	I17BZ5V	Terminal I17 connected to BZ5
75	*	Reserved
76	I08BZ6V	Terminal I08 connected to BZ6
76	I07BZ6V	Terminal I07 connected to BZ6
76	I06BZ6V	Terminal I06 connected to BZ6
76	I05BZ6V	Terminal I05 connected to BZ6
76	I04BZ6V	Terminal I04 connected to BZ6
76	I03BZ6V	Terminal I03 connected to BZ6
76	I02BZ6V	Terminal I02 connected to BZ6
76	I01BZ6V	Terminal I01 connected to BZ6
77	I16BZ6V	Terminal I16 connected to BZ6
77	I15BZ6V	Terminal I15 connected to BZ6
77	I14BZ6V	Terminal I14 connected to BZ6
77	I13BZ6V	Terminal I13 connected to BZ6
77	I12BZ6V	Terminal I12 connected to BZ6
77	I11BZ6V	Terminal I11 connected to BZ6
77	I10BZ6V	Terminal I10 connected to BZ6
77	I09BZ6V	Terminal I09 connected to BZ6
78	*	Reserved
78	*	Reserved

**Table 11.2 Row List of Relay Word Bits (Sheet 16 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
78	*	Reserved
78	I21BZ6V	Terminal I21 connected to BZ6
78	I20BZ6V	Terminal I20 connected to BZ6
78	I19BZ6V	Terminal I19 connected to BZ6
78	I18BZ6V	Terminal I18 connected to BZ6
78	I17BZ6V	Terminal I17 connected to BZ6
79	*	Reserved
80	ZN1I08	Terminal 08 connected to Zone 1
80	ZN1I07	Terminal 07 connected to Zone 1
80	ZN1I06	Terminal 06 connected to Zone 1
80	ZN1I05	Terminal 05 connected to Zone 1
80	ZN1I04	Terminal 04 connected to Zone 1
80	ZN1I03	Terminal 03 connected to Zone 1
80	ZN1I02	Terminal 02 connected to Zone 1
80	ZN1I01	Terminal 01 connected to Zone 1
81	ZN1I16	Terminal 16 connected to Zone 1
81	ZN1I15	Terminal 15 connected to Zone 1
81	ZN1I14	Terminal 14 connected to Zone 1
81	ZN1I13	Terminal 13 connected to Zone 1
81	ZN1I12	Terminal 12 connected to Zone 1
81	ZN1I11	Terminal 11 connected to Zone 1
81	ZN1I10	Terminal 10 connected to Zone 1
81	ZN1I09	Terminal 09 connected to Zone 1
82	*	Reserved
82	*	Reserved
82	*	Reserved
82	ZN1I21	Terminal 21 connected to Zone 1
82	ZN1I20	Terminal 20 connected to Zone 1
82	ZN1I19	Terminal 19 connected to Zone 1
82	ZN1I18	Terminal 18 connected to Zone 1
82	ZN1I17	Terminal 17 connected to Zone 1
83	*	Reserved
84	ZN2I08	Terminal 08 connected to Zone 2
84	ZN2I07	Terminal 07 connected to Zone 2
84	ZN2I06	Terminal 06 connected to Zone 2
84	ZN2I05	Terminal 05 connected to Zone 2
84	ZN2I04	Terminal 04 connected to Zone 2
84	ZN2I03	Terminal 03 connected to Zone 2
84	ZN2I02	Terminal 02 connected to Zone 2
84	ZN2I01	Terminal 01 connected to Zone 2
85	ZN2I16	Terminal 16 connected to Zone 2

**Table 11.2 Row List of Relay Word Bits (Sheet 17 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
85	ZN2I15	Terminal 15 connected to Zone 2
85	ZN2I14	Terminal 14 connected to Zone 2
85	ZN2I13	Terminal 13 connected to Zone 2
85	ZN2I12	Terminal 12 connected to Zone 2
85	ZN2I11	Terminal 11 connected to Zone 2
85	ZN2I10	Terminal 10 connected to Zone 2
85	ZN2I09	Terminal 09 connected to Zone 2
86	*	Reserved
86	*	Reserved
86	*	Reserved
86	ZN2I21	Terminal 21 connected to Zone 2
86	ZN2I20	Terminal 20 connected to Zone 2
86	ZN2I19	Terminal 19 connected to Zone 2
86	ZN2I18	Terminal 18 connected to Zone 2
86	ZN2I17	Terminal 17 connected to Zone 2
87	*	Reserved
88	ZN3I08	Terminal 08 connected to Zone 3
88	ZN3I07	Terminal 07 connected to Zone 3
88	ZN3I06	Terminal 06 connected to Zone 3
88	ZN3I05	Terminal 05 connected to Zone 3
88	ZN3I04	Terminal 04 connected to Zone 3
88	ZN3I03	Terminal 03 connected to Zone 3
88	ZN3I02	Terminal 02 connected to Zone 3
88	ZN3I01	Terminal 01 connected to Zone 3
89	ZN3I16	Terminal 16 connected to Zone 3
89	ZN3I15	Terminal 15 connected to Zone 3
89	ZN3I14	Terminal 14 connected to Zone 3
89	ZN3I13	Terminal 13 connected to Zone 3
89	ZN3I12	Terminal 12 connected to Zone 3
89	ZN3I11	Terminal 11 connected to Zone 3
89	ZN3I10	Terminal 10 connected to Zone 3
89	ZN3I09	Terminal 09 connected to Zone 3
90	*	Reserved
90	*	Reserved
90	*	Reserved
90	ZN3I21	Terminal 21 connected to Zone 3
90	ZN3I20	Terminal 20 connected to Zone 3
90	ZN3I19	Terminal 19 connected to Zone 3
90	ZN3I18	Terminal 18 connected to Zone 3
90	ZN3I17	Terminal 17 connected to Zone 3
91	*	Reserved

**Table 11.2 Row List of Relay Word Bits (Sheet 18 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
92	ZN4I08	Terminal 08 connected to Zone 4
92	ZN4I07	Terminal 07 connected to Zone 4
92	ZN4I06	Terminal 06 connected to Zone 4
92	ZN4I05	Terminal 05 connected to Zone 4
92	ZN4I04	Terminal 04 connected to Zone 4
92	ZN4I03	Terminal 03 connected to Zone 4
92	ZN4I02	Terminal 02 connected to Zone 4
92	ZN4I01	Terminal 01 connected to Zone 4
93	ZN4I16	Terminal 16 connected to Zone 4
93	ZN4I15	Terminal 15 connected to Zone 4
93	ZN4I14	Terminal 14 connected to Zone 4
93	ZN4I13	Terminal 13 connected to Zone 4
93	ZN4I12	Terminal 12 connected to Zone 4
93	ZN4I11	Terminal 11 connected to Zone 4
93	ZN4I10	Terminal 10 connected to Zone 4
93	ZN4I09	Terminal 09 connected to Zone 4
94	*	Reserved
94	*	Reserved
94	*	Reserved
94	ZN4I21	Terminal 21 connected to Zone 4
94	ZN4I20	Terminal 20 connected to Zone 4
94	ZN4I19	Terminal 19 connected to Zone 4
94	ZN4I18	Terminal 18 connected to Zone 4
94	ZN4I17	Terminal 17 connected to Zone 4
95	*	Reserved
96	ZN5I08	Terminal 08 connected to Zone 5
96	ZN5I07	Terminal 07 connected to Zone 5
96	ZN5I06	Terminal 06 connected to Zone 5
96	ZN5I05	Terminal 05 connected to Zone 5
96	ZN5I04	Terminal 04 connected to Zone 5
96	ZN5I03	Terminal 03 connected to Zone 5
96	ZN5I02	Terminal 02 connected to Zone 5
96	ZN5I01	Terminal 01 connected to Zone 5
97	ZN5I16	Terminal 16 connected to Zone 5
97	ZN5I15	Terminal 15 connected to Zone 5
97	ZN5I14	Terminal 14 connected to Zone 5
97	ZN5I13	Terminal 13 connected to Zone 5
97	ZN5I12	Terminal 12 connected to Zone 5
97	ZN5I11	Terminal 11 connected to Zone 5
97	ZN5I10	Terminal 10 connected to Zone 5
97	ZN5I09	Terminal 09 connected to Zone 5

**Table 11.2 Row List of Relay Word Bits (Sheet 19 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
98	*	Reserved
98	*	Reserved
98	*	Reserved
98	ZN5I21	Terminal 21 connected to Zone 5
98	ZN5I20	Terminal 20 connected to Zone 5
98	ZN5I19	Terminal 19 connected to Zone 5
98	ZN5I18	Terminal 18 connected to Zone 5
98	ZN5I17	Terminal 17 connected to Zone 5
99	*	Reserved
100	ZN6I08	Terminal 08 connected to Zone 6
100	ZN6I07	Terminal 07 connected to Zone 6
100	ZN6I06	Terminal 06 connected to Zone 6
100	ZN6I05	Terminal 05 connected to Zone 6
100	ZN6I04	Terminal 04 connected to Zone 6
100	ZN6I03	Terminal 03 connected to Zone 6
100	ZN6I02	Terminal 02 connected to Zone 6
100	ZN6I01	Terminal 01 connected to Zone 6
101	ZN6I16	Terminal 16 connected to Zone 6
101	ZN6I15	Terminal 15 connected to Zone 6
101	ZN6I14	Terminal 14 connected to Zone 6
101	ZN6I13	Terminal 13 connected to Zone 6
101	ZN6I12	Terminal 12 connected to Zone 6
101	ZN6I11	Terminal 11 connected to Zone 6
101	ZN6I10	Terminal 10 connected to Zone 6
101	ZN6I09	Terminal 09 connected to Zone 6
102	*	Reserved
102	*	Reserved
102	*	Reserved
102	ZN6I21	Terminal 21 connected to Zone 6
102	ZN6I20	Terminal 20 connected to Zone 6
102	ZN6I19	Terminal 19 connected to Zone 6
102	ZN6I18	Terminal 18 connected to Zone 6
102	ZN6I17	Terminal 17 connected to Zone 6
103	*	Reserved
104	ZN1I08T	Terminal 08 connected to Zone 1 and will be tripped
104	ZN1I07T	Terminal 07 connected to Zone 1 and will be tripped
104	ZN1I06T	Terminal 06 connected to Zone 1 and will be tripped
104	ZN1I05T	Terminal 05 connected to Zone 1 and will be tripped
104	ZN1I04T	Terminal 04 connected to Zone 1 and will be tripped
104	ZN1I03T	Terminal 03 connected to Zone 1 and will be tripped
104	ZN1I02T	Terminal 02 connected to Zone 1 and will be tripped

**Table 11.2 Row List of Relay Word Bits (Sheet 20 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
104	ZN1I01T	Terminal 01 connected to Zone 1 and will be tripped
105	ZN1I16T	Terminal 16 connected to Zone 1 and will be tripped
105	ZN1I15T	Terminal 15 connected to Zone 1 and will be tripped
105	ZN1I14T	Terminal 14 connected to Zone 1 and will be tripped
105	ZN1I13T	Terminal 13 connected to Zone 1 and will be tripped
105	ZN1I12T	Terminal 12 connected to Zone 1 and will be tripped
105	ZN1I11T	Terminal 11 connected to Zone 1 and will be tripped
105	ZN1I10T	Terminal 10 connected to Zone 1 and will be tripped
105	ZN1I09T	Terminal 09 connected to Zone 1 and will be tripped
106	*	Reserved
106	*	Reserved
106	*	Reserved
106	ZN1I21T	Terminal 21 connected to Zone 1 and will be tripped
106	ZN1I20T	Terminal 20 connected to Zone 1 and will be tripped
106	ZN1I19T	Terminal 19 connected to Zone 1 and will be tripped
106	ZN1I18T	Terminal 18 connected to Zone 1 and will be tripped
106	ZN1I17T	Terminal 17 connected to Zone 1 and will be tripped
107	*	Reserved
108	ZN2I08T	Terminal 08 connected to Zone 2 and will be tripped
108	ZN2I07T	Terminal 07 connected to Zone 2 and will be tripped
108	ZN2I06T	Terminal 06 connected to Zone 2 and will be tripped
108	ZN2I05T	Terminal 05 connected to Zone 2 and will be tripped
108	ZN2I04T	Terminal 04 connected to Zone 2 and will be tripped
108	ZN2I03T	Terminal 03 connected to Zone 2 and will be tripped
108	ZN2I02T	Terminal 02 connected to Zone 2 and will be tripped
108	ZN2I01T	Terminal 01 connected to Zone 2 and will be tripped
109	ZN2I16T	Terminal 16 connected to Zone 2 and will be tripped
109	ZN2I15T	Terminal 15 connected to Zone 2 and will be tripped
109	ZN2I14T	Terminal 14 connected to Zone 2 and will be tripped
109	ZN2I13T	Terminal 13 connected to Zone 2 and will be tripped
109	ZN2I12T	Terminal 12 connected to Zone 2 and will be tripped
109	ZN2I11T	Terminal 11 connected to Zone 2 and will be tripped
109	ZN2I10T	Terminal 10 connected to Zone 2 and will be tripped
109	ZN2I09T	Terminal 09 connected to Zone 2 and will be tripped
110	*	Reserved
110	*	Reserved
110	*	Reserved
110	ZN2I21T	Terminal 21 connected to Zone 2 and will be tripped
110	ZN2I20T	Terminal 20 connected to Zone 2 and will be tripped
110	ZN2I19T	Terminal 19 connected to Zone 2 and will be tripped
110	ZN2I18T	Terminal 18 connected to Zone 2 and will be tripped

**Table 11.2 Row List of Relay Word Bits (Sheet 21 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
110	ZN2I17T	Terminal 17 connected to Zone 2 and will be tripped
111	*	Reserved
112	ZN3I08T	Terminal 08 connected to Zone 3 and will be tripped
112	ZN3I07T	Terminal 07 connected to Zone 3 and will be tripped
112	ZN3I06T	Terminal 06 connected to Zone 3 and will be tripped
112	ZN3I05T	Terminal 05 connected to Zone 3 and will be tripped
112	ZN3I04T	Terminal 04 connected to Zone 3 and will be tripped
112	ZN3I03T	Terminal 03 connected to Zone 3 and will be tripped
112	ZN3I02T	Terminal 02 connected to Zone 3 and will be tripped
112	ZN3I01T	Terminal 01 connected to Zone 3 and will be tripped
113	ZN3I16T	Terminal 16 connected to Zone 3 and will be tripped
113	ZN3I15T	Terminal 15 connected to Zone 3 and will be tripped
113	ZN3I14T	Terminal 14 connected to Zone 3 and will be tripped
113	ZN3I13T	Terminal 13 connected to Zone 3 and will be tripped
113	ZN3I12T	Terminal 12 connected to Zone 3 and will be tripped
113	ZN3I11T	Terminal 11 connected to Zone 3 and will be tripped
113	ZN3I10T	Terminal 10 connected to Zone 3 and will be tripped
113	ZN3I09T	Terminal 09 connected to Zone 3 and will be tripped
114	*	Reserved
114	*	Reserved
114	*	Reserved
114	ZN3I21T	Terminal 21 connected to Zone 3 and will be tripped
114	ZN3I20T	Terminal 20 connected to Zone 3 and will be tripped
114	ZN3I19T	Terminal 19 connected to Zone 3 and will be tripped
114	ZN3I18T	Terminal 18 connected to Zone 3 and will be tripped
114	ZN3I17T	Terminal 17 connected to Zone 3 and will be tripped
115	*	Reserved
116	ZN4I08T	Terminal 08 connected to Zone 4 and will be tripped
116	ZN4I07T	Terminal 07 connected to Zone 4 and will be tripped
116	ZN4I06T	Terminal 06 connected to Zone 4 and will be tripped
116	ZN4I05T	Terminal 05 connected to Zone 4 and will be tripped
116	ZN4I04T	Terminal 04 connected to Zone 4 and will be tripped
116	ZN4I03T	Terminal 03 connected to Zone 4 and will be tripped
116	ZN4I02T	Terminal 02 connected to Zone 4 and will be tripped
116	ZN4I01T	Terminal 01 connected to Zone 4 and will be tripped
117	ZN4I16T	Terminal 16 connected to Zone 4 and will be tripped
117	ZN4I15T	Terminal 15 connected to Zone 4 and will be tripped
117	ZN4I14T	Terminal 14 connected to Zone 4 and will be tripped
117	ZN4I13T	Terminal 13 connected to Zone 4 and will be tripped
117	ZN4I12T	Terminal 12 connected to Zone 4 and will be tripped
117	ZN4I11T	Terminal 11 connected to Zone 4 and will be tripped

**Table 11.2 Row List of Relay Word Bits (Sheet 22 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
117	ZN4I10T	Terminal 10 connected to Zone 4 and will be tripped
117	ZN4I09T	Terminal 09 connected to Zone 4 and will be tripped
118	*	Reserved
118	*	Reserved
118	*	Reserved
118	ZN4I21T	Terminal 21 connected to Zone 4 and will be tripped
118	ZN4I20T	Terminal 20 connected to Zone 4 and will be tripped
118	ZN4I19T	Terminal 19 connected to Zone 4 and will be tripped
118	ZN4I18T	Terminal 18 connected to Zone 4 and will be tripped
118	ZN4I17T	Terminal 17 connected to Zone 4 and will be tripped
119	*	Reserved
120	ZN5I08T	Terminal 08 connected to Zone 5 and will be tripped
120	ZN5I07T	Terminal 07 connected to Zone 5 and will be tripped
120	ZN5I06T	Terminal 06 connected to Zone 5 and will be tripped
120	ZN5I05T	Terminal 05 connected to Zone 5 and will be tripped
120	ZN5I04T	Terminal 04 connected to Zone 5 and will be tripped
120	ZN5I03T	Terminal 03 connected to Zone 5 and will be tripped
120	ZN5I02T	Terminal 02 connected to Zone 5 and will be tripped
120	ZN5I01T	Terminal 01 connected to Zone 5 and will be tripped
121	ZN5I16T	Terminal 16 connected to Zone 5 and will be tripped
121	ZN5I15T	Terminal 15 connected to Zone 5 and will be tripped
121	ZN5I14T	Terminal 14 connected to Zone 5 and will be tripped
121	ZN5I13T	Terminal 13 connected to Zone 5 and will be tripped
121	ZN5I12T	Terminal 12 connected to Zone 5 and will be tripped
121	ZN5I11T	Terminal 11 connected to Zone 5 and will be tripped
121	ZN5I10T	Terminal 10 connected to Zone 5 and will be tripped
121	ZN5I09T	Terminal 09 connected to Zone 5 and will be tripped
122	*	Reserved
122	*	Reserved
122	*	Reserved
122	ZN5I21T	Terminal 21 connected to Zone 5 and will be tripped
122	ZN5I20T	Terminal 20 connected to Zone 5 and will be tripped
122	ZN5I19T	Terminal 19 connected to Zone 5 and will be tripped
122	ZN5I18T	Terminal 18 connected to Zone 5 and will be tripped
122	ZN5I17T	Terminal 17 connected to Zone 5 and will be tripped
123	*	Reserved
124	ZN6I08T	Terminal 08 connected to Zone 6 and will be tripped
124	ZN6I07T	Terminal 07 connected to Zone 6 and will be tripped
124	ZN6I06T	Terminal 06 connected to Zone 6 and will be tripped
124	ZN6I05T	Terminal 05 connected to Zone 6 and will be tripped
124	ZN6I04T	Terminal 04 connected to Zone 6 and will be tripped

**Table 11.2 Row List of Relay Word Bits (Sheet 23 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
124	ZN6I03T	Terminal 03 connected to Zone 6 and will be tripped
124	ZN6I02T	Terminal 02 connected to Zone 6 and will be tripped
124	ZN6I01T	Terminal 01 connected to Zone 6 and will be tripped
125	ZN6I16T	Terminal 16 connected to Zone 6 and will be tripped
125	ZN6I15T	Terminal 15 connected to Zone 6 and will be tripped
125	ZN6I14T	Terminal 14 connected to Zone 6 and will be tripped
125	ZN6I13T	Terminal 13 connected to Zone 6 and will be tripped
125	ZN6I12T	Terminal 12 connected to Zone 6 and will be tripped
125	ZN6I11T	Terminal 11 connected to Zone 6 and will be tripped
125	ZN6I10T	Terminal 10 connected to Zone 6 and will be tripped
125	ZN6I09T	Terminal 09 connected to Zone 6 and will be tripped
126	*	Reserved
126	*	Reserved
126	*	Reserved
126	ZN6I21T	Terminal 21 connected to Zone 6 and will be tripped
126	ZN6I20T	Terminal 20 connected to Zone 6 and will be tripped
126	ZN6I19T	Terminal 19 connected to Zone 6 and will be tripped
126	ZN6I18T	Terminal 18 connected to Zone 6 and will be tripped
126	ZN6I17T	Terminal 17 connected to Zone 6 and will be tripped
127	*	Reserved
<b>Bus-Zone-to-Bus-Zone Connection</b>		
128	*	Reserved
128	*	Reserved
128	BZ1BZ6V	A connection exists between BZ1 and BZ6
128	BZ1BZ5V	A connection exists between BZ1 and BZ5
128	BZ1BZ4V	A connection exists between BZ1 and BZ4
128	BZ1BZ3V	A connection exists between BZ1 and BZ3
128	BZ1BZ2V	A connection exists between BZ1 and BZ2
128	*	Reserved
129	*	Reserved
129	*	Reserved
129	BZ2BZ6V	A connection exists between BZ2 and BZ6
129	BZ2BZ5V	A connection exists between BZ2 and BZ5
129	BZ2BZ4V	A connection exists between BZ2 and BZ4
129	BZ2BZ3V	A connection exists between BZ2 and BZ3
129	*	Reserved
129	*	Reserved
130	*	Reserved
130	*	Reserved
130	BZ3BZ6V	A connection exists between BZ3 and BZ6
130	BZ3BZ5V	A connection exists between BZ3 and BZ5

**Table 11.2 Row List of Relay Word Bits (Sheet 24 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
130	BZ3BZ4V	A connection exists between BZ3 and BZ4
130	*	Reserved
130	*	Reserved
130	*	Reserved
131	*	Reserved
131	*	Reserved
131	BZ4BZ6V	A connection exists between BZ4 and BZ6
131	BZ4BZ5V	A connection exists between BZ4 and BZ5
131	*	Reserved
132	*	Reserved
132	*	Reserved
132	BZ5BZ6V	A connection exists between BZ5 and BZ6
132	*	Reserved
133	*	Reserved
133	*	Reserved
134	*	Reserved
135	*	Reserved
136	*	Reserved
136	*	Reserved
136	BZ1BZ6R	A connection exists between BZ1 and BZ6 and a coupler is removed
136	BZ1BZ5R	A connection exists between BZ1 and BZ5 and a coupler is removed
136	BZ1BZ4R	A connection exists between BZ1 and BZ4 and a coupler is removed
136	BZ1BZ3R	A connection exists between BZ1 and BZ3 and a coupler is removed
136	BZ1BZ2R	A connection exists between BZ1 and BZ2 and a coupler is removed
136	*	Reserved
137	*	Reserved
137	*	Reserved
137	BZ2BZ6R	A connection exists between BZ2 and BZ6 and a coupler is removed
137	BZ2BZ5R	A connection exists between BZ2 and BZ5 and a coupler is removed
137	BZ2BZ4R	A connection exists between BZ2 and BZ4 and a coupler is removed
137	BZ2BZ3R	A connection exists between BZ2 and BZ3 and a coupler is removed
137	*	Reserved
137	*	Reserved
138	*	Reserved

**Table 11.2 Row List of Relay Word Bits (Sheet 25 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
138	*	Reserved
138	BZ3BZ6R	A connection exists between BZ3 and BZ6 and a coupler is removed
138	BZ3BZ5R	A connection exists between BZ3 and BZ5 and a coupler is removed
138	BZ3BZ4R	A connection exists between BZ3 and BZ4 and a coupler is removed
138	*	Reserved
138	*	Reserved
138	*	Reserved
139	*	Reserved
139	*	Reserved
139	BZ4BZ6R	A connection exists between BZ4 and BZ6 and a coupler is removed
139	BZ4BZ5R	A connection exists between BZ4 and BZ5 and a coupler is removed
139	*	Reserved
140	*	Reserved
140	*	Reserved
140	BZ5BZ6R	A connection exists between BZ5 and BZ6 and a coupler is removed
140	*	Reserved
141	*	Reserved
142	*	Reserved
143	*	Reserved
143	*	Reserved
144	*	Reserved
144	*	Reserved
144	Z1BZ6	Bus-Zone 6 is part of Protective Zone 1
144	Z1BZ5	Bus-Zone 5 is part of Protective Zone 1
144	Z1BZ4	Bus-Zone 4 is part of Protective Zone 1
144	Z1BZ3	Bus-Zone 3 is part of Protective Zone 1
144	Z1BZ2	Bus-Zone 2 is part of Protective Zone 1
144	Z1BZ1	Bus-Zone 1 is part of Protective Zone 1
145	*	Reserved
145	*	Reserved
145	Z2BZ6	Bus-Zone 6 is part of Protective Zone 2
145	Z2BZ5	Bus-Zone 5 is part of Protective Zone 2
145	Z2BZ4	Bus-Zone 4 is part of Protective Zone 2
145	Z2BZ3	Bus-Zone 3 is part of Protective Zone 2

**Table 11.2 Row List of Relay Word Bits (Sheet 26 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
145	Z2BZ2	Bus-Zone 2 is part of Protective Zone 2
145	*	Reserved
146	*	Reserved
146	*	Reserved
146	Z3BZ6	Bus-Zone 6 is part of Protective Zone 3
146	Z3BZ5	Bus-Zone 5 is part of Protective Zone 3
146	Z3BZ4	Bus-Zone 4 is part of Protective Zone 3
146	Z3BZ3	Bus-Zone 3 is part of Protective Zone 3
146	*	Reserved
146	*	Reserved
147	*	Reserved
147	*	Reserved
147	Z4BZ6	Bus-Zone 6 is part of Protective Zone 4
147	Z4BZ5	Bus-Zone 5 is part of Protective Zone 4
147	Z4BZ4	Bus-Zone 4 is part of Protective Zone 4
147	*	Reserved
147	*	Reserved
147	*	Reserved
148	*	Reserved
148	*	Reserved
148	Z5BZ6	Bus-Zone 6 is part of Protective Zone 5
148	Z5BZ5	Bus-Zone 5 is part of Protective Zone 5
148	*	Reserved
149	*	Reserved
149	*	Reserved
149	Z6BZ6	Bus-Zone 6 is part of Protective Zone 6
149	*	Reserved
<b>Zone Selection</b>		
150	*	Reserved
150	*	Reserved
150	ZONE6	Differential Zone 6 is active
150	ZONE5	Differential Zone 5 is active
150	ZONE4	Differential Zone 4 is active
150	ZONE3	Differential Zone 3 is active

**Table 11.2 Row List of Relay Word Bits (Sheet 27 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
150	ZONE2	Differential Zone 2 is active
150	ZONE1	Differential Zone 1 is active
151	*	Reserved
151	ZSWOP	Change to either bus-zone-to-bus-zone or terminal-to-bus-zone conditions in any zone
151	ZSWOP6	Change to either bus-zone-to-bus-zone or terminal-to-bus-zone conditions in Zone 6
151	ZSWOP5	Change to either bus-zone-to-bus-zone or terminal-to-bus-zone conditions in Zone 5
151	ZSWOP4	Change to either bus-zone-to-bus-zone or terminal-to-bus-zone conditions in Zone 4
151	ZSWOP3	Change to either bus-zone-to-bus-zone or terminal-to-bus-zone conditions in Zone 3
151	ZSWOP2	Change to either bus-zone-to-bus-zone or terminal-to-bus-zone conditions in Zone 2
151	ZSWOP1	Change to either bus-zone-to-bus-zone or terminal-to-bus-zone conditions in Zone 1
152	*	Reserved
152	ZSWOAL	Zone switching operation alarm
152	ZSWOIP	Zone switching operation in progress
152	ZSWO	Zone switching operation
152	RZSWOAL	Reset zone switching operation alarm
<b>Zone Supervision</b>		
153	*	Reserved
153	*	Reserved
153	Z6S	Zone 6 supervision asserted
153	Z5S	Zone 5 supervision asserted
153	Z4S	Zone 4 supervision asserted
153	Z3S	Zone 3 supervision asserted
153	Z2S	Zone 2 supervision asserted
153	Z1S	Zone 1 supervision asserted
<b>Open CT Detector</b>		
154	*	Reserved
154	*	Reserved
154	ROCTZ6	Zone 6 open CT logic reset
154	ROCTZ5	Zone 5 open CT logic reset
154	ROCTZ4	Zone 4 open CT logic reset
154	ROCTZ3	Zone 3 open CT logic reset
154	ROCTZ2	Zone 2 open CT logic reset
154	ROCTZ1	Zone 1 open CT logic reset
155	*	Reserved
155	*	Reserved
155	OCTZ6	Zone 6 open CT detection
155	OCTZ5	Zone 5 open CT detection
155	OCTZ4	Zone 4 open CT detection

**Table 11.2 Row List of Relay Word Bits (Sheet 28 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
155	OCTZ3	Zone 3 open CT detection
155	OCTZ2	Zone 2 open CT detection
155	OCTZ1	Zone 1 open CT detection
156	*	Reserved
156	*	Reserved
156	RSTOCT6	Zone 6 open CT detection reset
156	RSTOCT5	Zone 5 open CT detection reset
156	RSTOCT4	Zone 4 open CT detection reset
156	RSTOCT3	Zone 3 open CT detection reset
156	RSTOCT2	Zone 2 open CT detection reset
156	RSTOCT1	Zone 1 open CT detection reset
<b>Sensitive Element (87S)</b>		
157	*	Reserved
157	*	Reserved
157	87S6	Zone 6 sensitive differential element picked up
157	87S5	Zone 5 sensitive differential element picked up
157	87S4	Zone 4 sensitive differential element picked up
157	87S3	Zone 3 sensitive differential element picked up
157	87S2	Zone 2 sensitive differential element picked up
157	87S1	Zone 1 sensitive differential element picked up
158	*	Reserved
158	87ST	Any sensitive differential-element timer timed out
158	87ST6	Zone 6 sensitive differential element timed out
158	87ST5	Zone 5 sensitive differential element timed out
158	87ST4	Zone 4 sensitive differential element timed out
158	87ST3	Zone 3 sensitive differential element timed out
158	87ST2	Zone 2 sensitive differential element timed out
158	87ST1	Zone 1 sensitive differential element timed out
<b>Differential Elements</b>		
159	87R1	Zone 1 restraint differential element picked up
159	P87R1	Zone 1 instantaneous differential element picked up
159	87O1	Zone 1 restraint differential operating current above O87P
159	FAULT1	Zone 1 fault detector picked up
159	CON1	Zone 1 in high-security mode
159	EXT1	Zone 1 external fault declaration
159	DOP1	Zone 1 incremental operating current picked up
159	DRT1	Zone 1 incremental restraint current picked up
160	*	Reserved

**Table 11.2 Row List of Relay Word Bits (Sheet 29 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
160	FDIF1	Zone 1 filtered restrained differential element picked up
160	RDIF1	Zone 1 unfiltered restrained differential element picked up
160	IFAULT1	Zone 1 fault detection
160	GFAULT1	Zone 1 fast fault detection
161	87R2	Zone 2 restraint differential element picked up
161	P87R2	Zone 2 instantaneous differential element picked up
161	87O2	Zone 2 restraint differential operating current above O87P
161	FAULT2	Zone 2 fault detector picked up
161	CON2	Zone 2 in high-security mode
161	EXT2	Zone 2 external fault declaration
161	DOP2	Zone 2 incremental operating current picked up
161	DRT2	Zone 2 incremental restraint current picked up
162	*	Reserved
162	FDIF2	Zone 2 filtered restrained differential element picked up
162	RDIF2	Zone 2 unfiltered restrained differential element picked up
162	IFAULT2	Zone 2 fault detection
162	GFAULT2	Zone 2 fast fault detection
163	87R3	Zone 3 restraint differential element picked up
163	P87R3	Zone 3 instantaneous differential element picked up
163	87O3	Zone 3 restraint differential operating current above O87P
163	FAULT3	Zone 3 fault detector picked up
163	CON3	Zone 3 in high-security mode
163	EXT3	Zone 3 external fault declaration
163	DOP3	Zone 3 incremental operating current picked up
163	DRT3	Zone 3 incremental restraint current picked up
164	*	Reserved
164	FDIF3	Zone 3 filtered restrained differential element picked up
164	RDIF3	Zone 3 unfiltered restrained differential element picked up
164	IFAULT3	Zone 3 fault detection
164	GFAULT3	Zone 3 fast fault detection
165	87R4	Zone 4 restraint differential element picked up
165	P87R4	Zone 4 instantaneous differential element picked up
165	87O4	Zone 4 restraint differential operating current above O87P
165	FAULT4	Zone 4 fault detector picked up
165	CON4	Zone 4 in high-security mode

**Table 11.2 Row List of Relay Word Bits (Sheet 30 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
165	EXT4	Zone 4 external fault declaration
165	DOP4	Zone 4 incremental operating current picked up
165	DRT4	Zone 4 incremental restraint current picked up
166	*	Reserved
166	FDIF4	Zone 4 filtered restrained differential element picked up
166	RDIF4	Zone 4 unfiltered restrained differential element picked up
166	IFAULT4	Zone 4 fault detection
166	GFAULT4	Zone 4 fast fault detection
167	87R5	Zone 5 restraint differential element picked up
167	P87R5	Zone 5 instantaneous differential element picked up
167	87O5	Zone 5 restraint differential operating current above O87P
167	FAULT5	Zone 5 fault detector picked up
167	CON5	Zone 5 in high-security mode
167	EXT5	Zone 5 external fault declaration
167	DOP5	Zone 5 incremental operating current picked up
167	DRT5	Zone 5 incremental restraint current picked up
168	*	Reserved
168	FDIF5	Zone 5 filtered restrained differential element picked up
168	RDIF5	Zone 5 unfiltered restrained differential element picked up
168	IFAULT5	Zone 5 fault detection
168	GFAULT5	Zone 5 fast fault detection
169	87R6	Zone 6 restraint differential element picked up
169	P87R6	Zone 6 instantaneous differential element picked up
169	87O6	Zone 6 restraint differential operating current above O87P
169	FAULT6	Zone 6 fault detector picked up
169	CON6	Zone 6 in high-security mode
169	EXT6	Zone 6 external fault declaration
169	DOP6	Zone 6 incremental operating current picked up
169	DRT6	Zone 6 incremental restraint current picked up
170	*	Reserved
170	FDIF6	Zone 6 filtered restrained differential element picked up
170	RDIF6	Zone 6 unfiltered restrained differential element picked up

**Table 11.2 Row List of Relay Word Bits (Sheet 31 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
170	IFault6	Zone 6 fault detection
170	GFAULT6	Zone 6 fast fault detection
171	*	Reserved
171	FAULT	Busbar fault in any zone
<b>Directional Element (Diff Zone)</b>		
172	*	Reserved
172	*	Reserved
172	DE6F	Zone 6 forward directional element picked up
172	DE5F	Zone 5 forward directional element picked up
172	DE4F	Zone 4 forward directional element picked up
172	DE3F	Zone 3 forward directional element picked up
172	DE2F	Zone 2 forward directional element picked up
172	DE1F	Zone 1 forward directional element picked up
173	50DS08	Terminal 08 directional element current threshold exceeded
173	50DS07	Terminal 07 directional element current threshold exceeded
173	50DS06	Terminal 06 directional element current threshold exceeded
173	50DS05	Terminal 05 directional element current threshold exceeded
173	50DS04	Terminal 04 directional element current threshold exceeded
173	50DS03	Terminal 03 directional element current threshold exceeded
173	50DS02	Terminal 02 directional element current threshold exceeded
173	50DS01	Terminal 01 directional element current threshold exceeded
174	50DS16	Terminal 16 directional element current threshold exceeded
174	50DS15	Terminal 15 directional element current threshold exceeded
174	50DS14	Terminal 14 directional element current threshold exceeded
174	50DS13	Terminal 13 directional element current threshold exceeded
174	50DS12	Terminal 12 directional element current threshold exceeded
174	50DS11	Terminal 11 directional element current threshold exceeded
174	50DS10	Terminal 10 directional element current threshold exceeded
174	50DS09	Terminal 09 directional element current threshold exceeded
175	*	Reserved
175	*	Reserved
175	*	Reserved
175	50DS21	Terminal 21 directional element current threshold exceeded
175	50DS20	Terminal 20 directional element current threshold exceeded
175	50DS19	Terminal 19 directional element current threshold exceeded

**Table 11.2 Row List of Relay Word Bits (Sheet 32 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
175	50DS18	Terminal 18 directional element current threshold exceeded
175	50DS17	Terminal 17 directional element current threshold exceeded
<b>Coupler Security Logic</b>		
176	*	Reserved
176	CSL1	Coupler 1 security logic picked up
176	ACTRPT1	Coupler 1 accelerated trip timed out
176	ACTRP1	Coupler 1 accelerated trip SELOGIC control equation
176	CBCLST1	Coupler 1 close command timed out
176	CBCLS1	Coupler 1 close command SELOGIC control equation
176	CB52T1	Coupler 1 status timed out
176	CB52A1	Coupler 1 status SELOGIC control equation
177	*	Reserved
177	CSL2	Coupler 2 security logic picked up
177	ACTRPT2	Coupler 2 accelerated trip timed out
177	ACTRP2	Coupler 2 accelerated trip SELOGIC control equation
177	CBCLST2	Coupler 2 close command timed out
177	CBCLS2	Coupler 2 close command SELOGIC control equation
177	CB52T2	Coupler 2 status timed out
177	CB52A2	Coupler 2 status SELOGIC control equation
178	*	Reserved
178	CSL3	Coupler 3 security logic picked up
178	ACTRPT3	Coupler 3 accelerated trip timed out
178	ACTRP3	Coupler 3 accelerated trip SELOGIC control equation
178	CBCLST3	Coupler 3 close command timed out
178	CBCLS3	Coupler 3 close command SELOGIC control equation
178	CB52T3	Coupler 3 status timed out
178	CB52A3	Coupler 3 status SELOGIC control equation
179	*	Reserved
179	CSL4	Coupler 4 security logic picked up
179	ACTRPT4	Coupler 4 accelerated trip timed out
179	ACTRP4	Coupler 4 accelerated trip SELOGIC control equation
179	CBCLST4	Coupler 4 close command timed out
179	CBCLS4	Coupler 4 close command SELOGIC control equation
179	CB52T4	Coupler 4 status timed out
179	CB52A4	Coupler 4 status SELOGIC control equation
<b>Terminal Out of Service</b>		
180	TOS08	Terminal 08 out of service
180	TOS07	Terminal 07 out of service
180	TOS06	Terminal 06 out of service
180	TOS05	Terminal 05 out of service
180	TOS04	Terminal 04 out of service

**Table 11.2 Row List of Relay Word Bits (Sheet 33 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
180	TOS03	Terminal 03 out of service
180	TOS02	Terminal 02 out of service
180	TOS01	Terminal 01 out of service
181	TOS16	Terminal 16 out of service
181	TOS15	Terminal 15 out of service
181	TOS14	Terminal 14 out of service
181	TOS13	Terminal 13 out of service
181	TOS12	Terminal 12 out of service
181	TOS11	Terminal 11 out of service
181	TOS10	Terminal 10 out of service
181	TOS09	Terminal 09 out of service
182	*	Reserved
182	*	Reserved
182	*	Reserved
182	TOS21	Terminal 21 out of service
182	TOS20	Terminal 20 out of service
182	TOS19	Terminal 19 out of service
182	TOS18	Terminal 18 out of service
182	TOS17	Terminal 17 out of service
<b>Breaker Failure</b>		
183	FBF01	Circuit Breaker 1 failure
183	XBF01	Circuit Breaker 1 external breaker failure input (SELOGIC control equation)
183	RT01	Circuit Breaker 1 retrip
183	ABFIT01	Circuit Breaker 1 alternative circuit breaker failure initiate
183	ATBFI01	Circuit Breaker 1 alternative breaker failure initiate SELOGIC control equation
183	BFIT01	Circuit Breaker 1 breaker failure timed out
183	BFI01	Circuit Breaker 1 breaker failure initiate SELOGIC control equation
183	50F01	Circuit Breaker 1 breaker failure current threshold exceeded
184	FBF02	Circuit Breaker 2 failure
184	XBF02	Circuit Breaker 2 external breaker failure input (SELOGIC control equation)
184	RT02	Circuit Breaker 2 retrip
184	ABFIT02	Circuit Breaker 2 alternative circuit breaker failure initiate
184	ATBFI02	Circuit Breaker 2 alternative breaker failure initiate SELOGIC control equation
184	BFIT02	Circuit Breaker 2 breaker failure timed out
184	BFI02	Circuit Breaker 2 breaker failure initiate SELOGIC control equation
184	50F02	Circuit Breaker 2 breaker failure current threshold exceeded
185	FBF03	Circuit Breaker 3 failure
185	XBF03	Circuit Breaker 3 external breaker failure input (SELOGIC control equation)
185	RT03	Circuit Breaker 3 retrip
185	ABFIT03	Circuit Breaker 3 alternative circuit breaker failure initiate
185	ATBFI03	Circuit Breaker 3 alternative breaker failure initiate SELOGIC control equation

**Table 11.2 Row List of Relay Word Bits (Sheet 34 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
185	BFIT03	Circuit Breaker 3 breaker failure timed out
185	BFI03	Circuit Breaker 3 breaker failure initiate SELOGIC control equation
185	50F03	Circuit Breaker 3 breaker failure current threshold exceeded
186	FBF04	Circuit Breaker 4 failure
186	XBF04	Circuit Breaker 4 external breaker failure input (SELOGIC control equation)
186	RT04	Circuit Breaker 4 retrip
186	ABFIT04	Circuit Breaker 4 alternative circuit breaker failure initiate
186	ATBFI04	Circuit Breaker 4 alternative breaker failure initiate SELOGIC control equation
186	BFIT04	Circuit Breaker 4 breaker failure timed out
186	BFI04	Circuit Breaker 4 breaker failure initiate SELOGIC control equation
186	50F04	Circuit Breaker 4 breaker failure current threshold exceeded
187	FBF05	Circuit Breaker 5 failure
187	XBF05	Circuit Breaker 5 external breaker failure input (SELOGIC control equation)
187	RT05	Circuit Breaker 5 retrip
187	ABFIT05	Circuit Breaker 5 alternative circuit breaker failure initiate
187	ATBFI05	Circuit Breaker 5 alternative breaker failure initiate SELOGIC control equation
187	BFIT05	Circuit Breaker 5 breaker failure timed out
187	BFI05	Circuit Breaker 5 breaker failure initiate SELOGIC control equation
187	50F05	Circuit Breaker 5 breaker failure current threshold exceeded
188	FBF06	Circuit Breaker 6 failure
188	XBF06	Circuit Breaker 6 external breaker failure input (SELOGIC control equation)
188	RT06	Circuit Breaker 6 retrip
188	ABFIT06	Circuit Breaker 6 alternative circuit breaker failure initiate
188	ATBFI06	Circuit Breaker 6 alternative breaker failure initiate SELOGIC control equation
188	BFIT06	Circuit Breaker 6 breaker failure timed out
188	BFI06	Circuit Breaker 6 breaker failure initiate SELOGIC control equation
188	50F06	Circuit Breaker 6 breaker failure current threshold exceeded
189	FBF07	Circuit Breaker 7 failure
189	XBF07	Circuit Breaker 7 external breaker failure input (SELOGIC control equation)
189	RT07	Circuit Breaker 7 retrip
189	ABFIT07	Circuit Breaker 7 alternative circuit breaker failure initiate
189	ATBFI07	Circuit Breaker 7 alternative breaker failure initiate SELOGIC control equation
189	BFIT07	Circuit Breaker 7 breaker failure timed out
189	BFI07	Circuit Breaker 7 breaker failure initiate SELOGIC control equation
189	50F07	Circuit Breaker 7 breaker failure current threshold exceeded
190	FBF08	Circuit Breaker 8 failure
190	XBF08	Circuit Breaker 8 external breaker failure input (SELOGIC control equation)
190	RT08	Circuit Breaker 8 retrip
190	ABFIT08	Circuit Breaker 8 alternative circuit breaker failure initiate
190	ATBFI08	Circuit Breaker 8 alternative breaker failure initiate SELOGIC control equation
190	BFIT08	Circuit Breaker 8 breaker failure timed out

**Table 11.2 Row List of Relay Word Bits (Sheet 35 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
190	BFI08	Circuit Breaker 8 breaker failure initiate SELOGIC control equation
190	50F08	Circuit Breaker 8 breaker failure current threshold exceeded
191	FBF09	Circuit Breaker 9 failure
191	XBF09	Circuit Breaker 9 external breaker failure input (SELOGIC control equation)
191	RT09	Circuit Breaker 9 retrip
191	ABFIT09	Circuit Breaker 9 alternative circuit breaker failure initiate
191	ATBFI09	Circuit Breaker 9 alternative breaker failure initiate SELOGIC control equation
191	BFIT09	Circuit Breaker 9 breaker failure timed out
191	BFI09	Circuit Breaker 9 breaker failure initiate SELOGIC control equation
191	50F09	Circuit Breaker 9 breaker failure current threshold exceeded
192	FBF10	Circuit Breaker 10 failure
192	XBF10	Circuit Breaker 10 external breaker failure input (SELOGIC control equation)
192	RT10	Circuit Breaker 10 retrip
192	ABFIT10	Circuit Breaker 10 alternative circuit breaker failure initiate
192	ATBFI10	Circuit Breaker 10 alternative breaker failure initiate SELOGIC control equation
192	BFIT10	Circuit Breaker 10 breaker failure timed out
192	BFI10	Circuit Breaker 10 breaker failure initiate SELOGIC control equation
192	50F10	Circuit Breaker 10 breaker failure current threshold exceeded
193	FBF11	Circuit Breaker 11 failure
193	XBF11	Circuit Breaker 11 external breaker failure input (SELOGIC control equation)
193	RT11	Circuit Breaker 11 retrip
193	ABFIT11	Circuit Breaker 11 alternative circuit breaker failure initiate
193	ATBFI11	Circuit Breaker 11 alternative breaker failure initiate SELOGIC control equation
193	BFIT11	Circuit Breaker 11 breaker failure timed out
193	BFI11	Circuit Breaker 11 breaker failure initiate SELOGIC control equation
193	50F11	Circuit Breaker 11 breaker failure current threshold exceeded
194	FBF12	Circuit Breaker 12 failure
194	XBF12	Circuit Breaker 12 external breaker failure input (SELOGIC control equation)
194	RT12	Circuit Breaker 12 retrip
194	ABFIT12	Circuit Breaker 12 alternative circuit breaker failure initiate
194	ATBFI12	Circuit Breaker 12 alternative breaker failure initiate SELOGIC control equation
194	BFIT12	Circuit Breaker 12 breaker failure timed out
194	BFI12	Circuit Breaker 12 breaker failure initiate SELOGIC control equation
194	50F12	Circuit Breaker 12 breaker failure current threshold exceeded
195	FBF13	Circuit Breaker 13 failure
195	XBF13	Circuit Breaker 13 external breaker failure input (SELOGIC control equation)
195	RT13	Circuit Breaker 13 retrip
195	ABFIT13	Circuit Breaker 13 alternative circuit breaker failure initiate
195	ATBFI13	Circuit Breaker 13 alternative breaker failure initiate SELOGIC control equation
195	BFIT13	Circuit Breaker 13 breaker failure timed out
195	BFI13	Circuit Breaker 13 breaker failure initiate SELOGIC control equation

**Table 11.2 Row List of Relay Word Bits (Sheet 36 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
195	50F13	Circuit Breaker 13 breaker failure current threshold exceeded
196	FBF14	Circuit Breaker 14 failure
196	XBF14	Circuit Breaker 14 external breaker failure input (SELOGIC control equation)
196	RT14	Circuit Breaker 14 retrip
196	ABFIT14	Circuit Breaker 14 alternative circuit breaker failure initiate
196	ATBFI14	Circuit Breaker 14 alternative breaker failure initiate SELOGIC control equation
196	BFIT14	Circuit Breaker 14 breaker failure timed out
196	BFI14	Circuit Breaker 14 breaker failure initiate SELOGIC control equation
196	50F14	Circuit Breaker 14 breaker failure current threshold exceeded
197	FBF15	Circuit Breaker 15 failure
197	XBF15	Circuit Breaker 15 external breaker failure input (SELOGIC control equation)
197	RT15	Circuit Breaker 15 retrip
197	ABFIT15	Circuit Breaker 15 alternative circuit breaker failure initiate
197	ATBFI15	Circuit Breaker 15 alternative breaker failure initiate SELOGIC control equation
197	BFIT15	Circuit Breaker 15 breaker failure timed out
197	BFI15	Circuit Breaker 15 breaker failure initiate SELOGIC control equation
197	50F15	Circuit Breaker 15 breaker failure current threshold exceeded
198	FBF16	Circuit Breaker 16 failure
198	XBF16	Circuit Breaker 16 external breaker failure input (SELOGIC control equation)
198	RT16	Circuit Breaker 16 retrip
198	ABFIT16	Circuit Breaker 16 alternative circuit breaker failure initiate
198	ATBFI16	Circuit Breaker 16 alternative breaker failure initiate SELOGIC control equation
198	BFIT16	Circuit Breaker 16 breaker failure timed out
198	BFI16	Circuit Breaker 16 breaker failure initiate SELOGIC control equation
198	50F16	Circuit Breaker 16 breaker failure current threshold exceeded
199	FBF17	Circuit Breaker 17 failure
199	XBF17	Circuit Breaker 17 external breaker failure input (SELOGIC control equation)
199	RT17	Circuit Breaker 17 retrip
199	ABFIT17	Circuit Breaker 17 alternative circuit breaker failure initiate
199	ATBFI17	Circuit Breaker 17 alternative breaker failure initiate SELOGIC control equation
199	BFIT17	Circuit Breaker 17 breaker failure timed out
199	BFI17	Circuit Breaker 17 breaker failure initiate SELOGIC control equation
199	50F17	Circuit Breaker 17 breaker failure current threshold exceeded
200	FBF18	Circuit Breaker 18 failure
200	XBF18	Circuit Breaker 18 external breaker failure input (SELOGIC control equation)
200	RT18	Circuit Breaker 18 retrip
200	ABFIT18	Circuit Breaker 18 alternative circuit breaker failure initiate
200	ATBFI18	Circuit Breaker 18 alternative breaker failure initiate SELOGIC control equation
200	BFIT18	Circuit Breaker 18 breaker failure timed out
200	BFI18	Circuit Breaker 18 breaker failure initiate SELOGIC control equation
200	50F18	Circuit Breaker 18 breaker failure current threshold exceeded

**Table 11.2 Row List of Relay Word Bits (Sheet 37 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
201	FBF19	Circuit Breaker 19 failure
201	XBF19	Circuit Breaker 19 external breaker failure input (SELOGIC control equation)
201	RT19	Circuit Breaker 19 retrip
201	ABFIT19	Circuit Breaker 19 alternative circuit breaker failure initiate
201	ATBFI19	Circuit Breaker 19 alternative breaker failure initiate SELOGIC control equation
201	BFIT19	Circuit Breaker 19 breaker failure timed out
201	BFI19	Circuit Breaker 19 breaker failure initiate SELOGIC control equation
201	50F19	Circuit Breaker 19 breaker failure current threshold exceeded
202	FBF20	Circuit Breaker 20 failure
202	XBF20	Circuit Breaker 20 external breaker failure input (SELOGIC control equation)
202	RT20	Circuit Breaker 20 retrip
202	ABFIT20	Circuit Breaker 20 alternative circuit breaker failure initiate
202	ATBFI20	Circuit Breaker 20 alternative breaker failure initiate SELOGIC control equation
202	BFIT20	Circuit Breaker 20 breaker failure timed out
202	BFI20	Circuit Breaker 20 breaker failure initiate SELOGIC control equation
202	50F20	Circuit Breaker 20 breaker failure current threshold exceeded
203	FBF21	Circuit Breaker 21 failure
203	XBF21	Circuit Breaker 21 external breaker failure input (SELOGIC control equation)
203	RT21	Circuit Breaker 21 retrip
203	ABFIT21	Circuit Breaker 21 alternative circuit breaker failure initiate
203	ATBFI21	Circuit Breaker 21 alternative breaker failure initiate SELOGIC control equation
203	BFIT21	Circuit Breaker 21 breaker failure timed out
203	BFI21	Circuit Breaker 21 breaker failure initiate SELOGIC control equation
203	50F21	Circuit Breaker 21 breaker failure current threshold exceeded
204	*	Reserved
205	*	Reserved
206	*	Reserved

**Overcurrent Elements**

207	50P04T	Terminal 04 definite-time overcurrent element timed out
207	50P04	Terminal 04 instantaneous overcurrent element
207	50P03T	Terminal 03 definite-time overcurrent element timed out
207	50P03	Terminal 03 instantaneous overcurrent element
207	50P02T	Terminal 02 definite-time overcurrent element timed out
207	50P02	Terminal 02 instantaneous overcurrent element
207	50P01T	Terminal 01 definite-time overcurrent element timed out
207	50P01	Terminal 01 instantaneous overcurrent element
208	50P08T	Terminal 08 definite-time overcurrent element timed out
208	50P08	Terminal 08 instantaneous overcurrent element
208	50P07T	Terminal 07 definite-time overcurrent element timed out
208	50P07	Terminal 07 instantaneous overcurrent element
208	50P06T	Terminal 06 definite-time overcurrent element timed out

**Table 11.2 Row List of Relay Word Bits (Sheet 38 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
208	50P06	Terminal 06 instantaneous overcurrent element
208	50P05T	Terminal 05 definite-time overcurrent element timed out
208	50P05	Terminal 05 instantaneous overcurrent element
209	50P12T	Terminal 12 definite-time overcurrent element timed out
209	50P12	Terminal 12 instantaneous overcurrent element
209	50P11T	Terminal 11 definite-time overcurrent element timed out
209	50P11	Terminal 11 instantaneous overcurrent element
209	50P10T	Terminal 10 definite-time overcurrent element timed out
209	50P10	Terminal 10 instantaneous overcurrent element
209	50P09T	Terminal 09 definite-time overcurrent element timed out
209	50P09	Terminal 09 instantaneous overcurrent element
210	50P16T	Terminal 16 definite-time overcurrent element timed out
210	50P16	Terminal 16 instantaneous overcurrent element
210	50P15T	Terminal 15 definite-time overcurrent element timed out
210	50P15	Terminal 15 instantaneous overcurrent element
210	50P14T	Terminal 14 definite-time overcurrent element timed out
210	50P14	Terminal 14 instantaneous overcurrent element
210	50P13T	Terminal 13 definite-time overcurrent element timed out
210	50P13	Terminal 13 instantaneous overcurrent element
211	50P20T	Terminal 20 definite-time overcurrent element timed out
211	50P20	Terminal 20 instantaneous overcurrent element
211	50P19T	Terminal 19 definite-time overcurrent element timed out
211	50P19	Terminal 19 instantaneous overcurrent element
211	50P18T	Terminal 18 definite-time overcurrent element timed out
211	50P18	Terminal 18 instantaneous overcurrent element
211	50P17T	Terminal 17 definite-time overcurrent element timed out
211	50P17	Terminal 17 instantaneous overcurrent element
212	*	Reserved
212	50P21T	Terminal 21 definite-time overcurrent element timed out
212	50P21	Terminal 21 instantaneous overcurrent element
<b>Inverse-Time Overcurrent Elements</b>		
213	51S04	Inverse-time Element 04 picked up
213	51T04	Inverse-time Element 04 timed out
213	51S03	Inverse-time Element 03 picked up
213	51T03	Inverse-time Element 03 timed out
213	51S02	Inverse-time Element 02 picked up

**Table 11.2 Row List of Relay Word Bits (Sheet 39 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
213	51T02	Inverse-time Element 02 timed out
213	51S01	Inverse-time Element 01 picked up
213	51T01	Inverse-time Element 01 timed out
214	51S08	Inverse-time Element 08 picked up
214	51T08	Inverse-time Element 08 timed out
214	51S07	Inverse-time Element 07 picked up
214	51T07	Inverse-time Element 07 timed out
214	51S06	Inverse-time Element 06 picked up
214	51T06	Inverse-time Element 06 timed out
214	51S05	Inverse-time Element 05 picked up
214	51T05	Inverse-time Element 05 timed out
215	51S12	Inverse-time Element 12 picked up
215	51T12	Inverse-time Element 12 timed out
215	51S11	Inverse-time Element 11 picked up
215	51T11	Inverse-time Element 11 timed out
215	51S10	Inverse-time Element 10 picked up
215	51T10	Inverse-time Element 10 timed out
215	51S09	Inverse-time Element 09 picked up
215	51T09	Inverse-time Element 09 timed out
216	51S16	Inverse-time Element 16 picked up
216	51T16	Inverse-time Element 16 timed out
216	51S15	Inverse-time Element 15 picked up
216	51T15	Inverse-time Element 15 timed out
216	51S14	Inverse-time Element 14 picked up
216	51T14	Inverse-time Element 14 timed out
216	51S13	Inverse-time Element 13 picked up
216	51T13	Inverse-time Element 13 timed out
217	51S20	Inverse-time Element 20 picked up
217	51T20	Inverse-time Element 20 timed out
217	51S19	Inverse-time Element 19 picked up
217	51T19	Inverse-time Element 19 timed out
217	51S18	Inverse-time Element 18 picked up
217	51T18	Inverse-time Element 18 timed out
217	51S17	Inverse-time Element 17 picked up
217	51T17	Inverse-time Element 17 timed out
218	*	Reserved

**Table 11.2 Row List of Relay Word Bits (Sheet 40 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
218	51S21	Inverse-time Element 21 picked up
218	51T21	Inverse-time Element 21 timed out
219	51MM04	Inverse-time Element 04 pickup setting outside of specified limits
219	51TM04	Inverse-time Element 04 time-dial setting outside of specified limits
219	51MM03	Inverse-time Element 03 pickup setting outside of specified limits
219	51TM03	Inverse-time Element 03 time-dial setting outside of specified limits
219	51MM02	Inverse-time Element 02 pickup setting outside of specified limits
219	51TM02	Inverse-time Element 02 time-dial setting outside of specified limits
219	51MM01	Inverse-time Element 01 pickup setting outside of specified limits
219	51TM01	Inverse-time Element 01 time-dial setting outside of specified limits
220	51MM08	Inverse-time Element 08 pickup setting outside of specified limits
220	51TM08	Inverse-time Element 08 time-dial setting outside of specified limits
220	51MM07	Inverse-time Element 07 pickup setting outside of specified limits
220	51TM07	Inverse-time Element 07 time-dial setting outside of specified limits
220	51MM06	Inverse-time Element 06 pickup setting outside of specified limits
220	51TM06	Inverse-time Element 06 time-dial setting outside of specified limits
220	51MM05	Inverse-time Element 05 pickup setting outside of specified limits
220	51TM05	Inverse-time Element 05 time-dial setting outside of specified limits
<b>Under- and Overvoltage Elements</b>		
221	271P1	Undervoltage Element 1, Level 1 asserted
221	271P1T	Undervoltage Element 1, Level 1 timed out
221	271P2	Undervoltage Element 1, Level 2 asserted
221	27TC1	Undervoltage Element 1, torque control
221	272P1	Undervoltage Element 2, Level 1 asserted
221	272P1T	Undervoltage Element 2, Level 1 timed out
221	272P2	Undervoltage Element 2, Level 2 asserted
221	27TC2	Undervoltage Element 2, torque control
222	273P1	Undervoltage Element 3, Level 1 asserted
222	273P1T	Undervoltage Element 3, Level 1 timed out
222	273P2	Undervoltage Element 3, Level 2 asserted
222	27TC3	Undervoltage Element 3, torque control
222	274P1	Undervoltage Element 4, Level 1 asserted
222	274P1T	Undervoltage Element 4, Level 1 timed out
222	274P2	Undervoltage Element 4, Level 2 asserted
222	27TC4	Undervoltage Element 4, torque control
223	275P1	Undervoltage Element 5, Level 1 asserted
223	275P1T	Undervoltage Element 5, Level 1 timed out
223	275P2	Undervoltage Element 5, Level 2 asserted
223	27TC5	Undervoltage Element 5, torque control
223	276P1	Undervoltage Element 6, Level 1 asserted
223	276P1T	Undervoltage Element 6, Level 1 timed out

**Table 11.2 Row List of Relay Word Bits (Sheet 41 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
223	276P2	Undervoltage Element 6, Level 2 asserted
223	27TC6	Undervoltage Element 6, torque control
224	591P1	Overvoltage Element 1, Level 1 asserted
224	591P1T	Overvoltage Element 1, Level 1 timed out
224	591P2	Overvoltage Element 1, Level 2 asserted
224	59TC1	Overvoltage Element 1, torque control
224	592P1	Overvoltage Element 2, Level 1 asserted
224	592P1T	Overvoltage Element 2, Level 1 timed out
224	592P2	Overvoltage Element 2, Level 2 asserted
224	59TC2	Overvoltage Element 2, torque control
225	593P1	Overvoltage Element 3, Level 1 asserted
225	593P1T	Overvoltage Element 3, Level 1 timed out
225	593P2	Overvoltage Element 3, Level 2 asserted
225	59TC3	Overvoltage Element 3, torque control
225	594P1	Overvoltage Element 4, Level 1 asserted
225	594P1T	Overvoltage Element 4, Level 1 timed out
225	594P2	Overvoltage Element 4, Level 2 asserted
225	59TC4	Overvoltage Element 4, torque control
226	595P1	Overvoltage Element 5, Level 1 asserted
226	595P1T	Overvoltage Element 5, Level 1 timed out
226	595P2	Overvoltage Element 5, Level 2 asserted
226	59TC5	Overvoltage Element 5, torque control
226	596P1	Overvoltage Element 6, Level 1 asserted
226	596P1T	Overvoltage Element 6, Level 1 timed out
226	596P2	Overvoltage Element 6, Level 2 asserted
226	59TC6	Overvoltage Element 6, torque control
<b>Battery Monitor</b>		
227	DC1F	DC monitor fail alarm
227	DC1W	DC monitor warning alarm
227	DC1G	DC monitor ground fault alarm
227	DC1R	DC monitor alarm for ac ripple
227	*	Reserved
<b>Bus-Zone Trip</b>		
228	87BTR08	Terminal 08 bus-zone differential trip asserted
228	87BTR07	Terminal 07 bus-zone differential trip asserted
228	87BTR06	Terminal 06 bus-zone differential trip asserted
228	87BTR05	Terminal 05 bus-zone differential trip asserted
228	87BTR04	Terminal 04 bus-zone differential trip asserted

**Table 11.2 Row List of Relay Word Bits (Sheet 42 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
228	87BTR03	Terminal 03 bus-zone differential trip asserted
228	87BTR02	Terminal 02 bus-zone differential trip asserted
228	87BTR01	Terminal 01 bus-zone differential trip asserted
229	87BTR16	Terminal 16 bus-zone differential trip asserted
229	87BTR15	Terminal 15 bus-zone differential trip asserted
229	87BTR14	Terminal 14 bus-zone differential trip asserted
229	87BTR13	Terminal 13 bus-zone differential trip asserted
229	87BTR12	Terminal 12 bus-zone differential trip asserted
229	87BTR11	Terminal 11 bus-zone differential trip asserted
229	87BTR10	Terminal 10 bus-zone differential trip asserted
229	87BTR09	Terminal 09 bus-zone differential trip asserted
230	*	Reserved
230	*	Reserved
230	*	Any terminal bus-zone differential trip asserted
230	87BTR21	Terminal 21 bus-zone differential trip asserted
230	87BTR20	Terminal 20 bus-zone differential trip asserted
230	87BTR19	Terminal 19 bus-zone differential trip asserted
230	87BTR18	Terminal 18 bus-zone differential trip asserted
230	87BTR17	Terminal 17 bus-zone differential trip asserted
231	*	Reserved
231	87BTR	Any terminal bus-zone differential trip asserted

**Inverse-Time Overcurrent Elements**

232	51MM12	Inverse-time Element 12 pickup setting outside of specified limits
232	51TM12	Inverse-time Element 12 time-dial setting outside of specified limits
232	51MM11	Inverse-time Element 11 pickup setting outside of specified limits
232	51TM11	Inverse-time Element 11 time-dial setting outside of specified limits
232	51MM10	Inverse-time Element 10 pickup setting outside of specified limits
232	51TM10	Inverse-time Element 10 time-dial setting outside of specified limits
232	51MM09	Inverse-time Element 09 pickup setting outside of specified limits
232	51TM09	Inverse-time Element 09 time-dial setting outside of specified limits
233	51MM16	Inverse-time Element 16 pickup setting outside of specified limits
233	51TM16	Inverse-time Element 16 time-dial setting outside of specified limits
233	51MM15	Inverse-time Element 15 pickup setting outside of specified limits
233	51TM15	Inverse-time Element 15 time-dial setting outside of specified limits
233	51MM14	Inverse-time Element 14 pickup setting outside of specified limits

**Table 11.2 Row List of Relay Word Bits (Sheet 43 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
233	51TM14	Inverse-time Element 14 time-dial setting outside of specified limits
233	51MM13	Inverse-time Element 13 pickup setting outside of specified limits
233	51TM13	Inverse-time Element 13 time-dial setting outside of specified limits
234	51MM20	Inverse-time Element 20 pickup setting outside of specified limits
234	51TM20	Inverse-time Element 20 time-dial setting outside of specified limits
234	51MM19	Inverse-time Element 19 pickup setting outside of specified limits
234	51TM19	Inverse-time Element 19 time-dial setting outside of specified limits
234	51MM18	Inverse-time Element 18 pickup setting outside of specified limits
234	51TM18	Inverse-time Element 18 time-dial setting outside of specified limits
234	51MM17	Inverse-time Element 17 pickup setting outside of specified limits
234	51TM17	Inverse-time Element 17 time-dial setting outside of specified limits
<b>Bus-Zone Trip</b>		
235	*	Reserved
235	*	Reserved
235	87Z6	Zone 6 differential-element trip
235	87Z5	Zone 5 differential-element trip
235	87Z4	Zone 4 differential-element trip
235	87Z3	Zone 3 differential-element trip
235	87Z2	Zone 2 differential-element trip
235	87Z1	Zone 1 differential-element trip
<b>Breaker Failure Trip</b>		
236	SBFTR08	Circuit Breaker 08 breaker failure trip
236	SBFTR07	Circuit Breaker 07 breaker failure trip
236	SBFTR06	Circuit Breaker 06 breaker failure trip
236	SBFTR05	Circuit Breaker 05 breaker failure trip
236	SBFTR04	Circuit Breaker 04 breaker failure trip
236	SBFTR03	Circuit Breaker 03 breaker failure trip
236	SBFTR02	Circuit Breaker 02 breaker failure trip
236	SBFTR01	Circuit Breaker 01 breaker failure trip
237	SBFTR16	Circuit Breaker 16 breaker failure trip
237	SBFTR15	Circuit Breaker 15 breaker failure trip
237	SBFTR14	Circuit Breaker 14 breaker failure trip
237	SBFTR13	Circuit Breaker 13 breaker failure trip
237	SBFTR12	Circuit Breaker 12 breaker failure trip
237	SBFTR11	Circuit Breaker 11 breaker failure trip
237	SBFTR10	Circuit Breaker 10 breaker failure trip
237	SBFTR09	Circuit Breaker 09 breaker failure trip
238	*	Reserved
238	*	Reserved
238	*	Reserved
238	SBFTR21	Circuit Breaker 21 breaker failure trip

**Table 11.2 Row List of Relay Word Bits (Sheet 44 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
238	SBFTR20	Circuit Breaker 20 breaker failure trip
238	SBFTR19	Circuit Breaker 19 breaker failure trip
238	SBFTR18	Circuit Breaker 18 breaker failure trip
238	SBFTR17	Circuit Breaker 17 breaker failure trip
239	*	Reserved
239	SBFTR	Any circuit breaker failure trip
240	*	Reserved
240	*	Reserved
240	BFZ6	Zone 6 breaker failure
240	BFZ5	Zone 5 breaker failure
240	BFZ4	Zone 4 breaker failure
240	BFZ3	Zone 3 breaker failure
240	BFZ2	Zone 2 breaker failure
240	BFZ1	Zone 1 breaker failure
<b>Miscellaneous Logic Elements</b>		
241	ER	Event report trigger equation (SELOGIC control equation)
241	EVELOCK	Event summary lock period
241	*	Reserved
<b>Trip and Unlatch</b>		
242	TRIP08	Terminal 08 trip output
242	TRIP07	Terminal 07 trip output
242	TRIP06	Terminal 06 trip output
242	TRIP05	Terminal 05 trip output
242	TRIP04	Terminal 04 trip output
242	TRIP03	Terminal 03 trip output
242	TRIP02	Terminal 02 trip output
242	TRIP01	Terminal 01 trip output
243	TRIP16	Terminal 16 trip output
243	TRIP15	Terminal 15 trip output
243	TRIP14	Terminal 14 trip output

**Table 11.2 Row List of Relay Word Bits (Sheet 45 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
243	TRIP13	Terminal 13 trip output
243	TRIP12	Terminal 12 trip output
243	TRIP11	Terminal 11 trip output
243	TRIP10	Terminal 10 trip output
243	TRIP09	Terminal 09 trip output
244	*	Reserved
244	*	Reserved
244	*	Reserved
244	TRIP21	Terminal 21 trip output
244	TRIP20	Terminal 20 trip output
244	TRIP19	Terminal 19 trip output
244	TRIP18	Terminal 18 trip output
244	TRIP17	Terminal 17 trip output
245	*	Reserved
245	TRIP	Any terminal trip output
246	ULTR08	Terminal 08 unlatch trip
246	ULTR07	Terminal 07 unlatch trip
246	ULTR06	Terminal 06 unlatch trip
246	ULTR05	Terminal 05 unlatch trip
246	ULTR04	Terminal 04 unlatch trip
246	ULTR03	Terminal 03 unlatch trip
246	ULTR02	Terminal 02 unlatch trip
246	ULTR01	Terminal 01 unlatch trip
247	ULTR16	Terminal 16 unlatch trip
247	ULTR15	Terminal 15 unlatch trip
247	ULTR14	Terminal 14 unlatch trip
247	ULTR13	Terminal 13 unlatch trip
247	ULTR12	Terminal 12 unlatch trip
247	ULTR11	Terminal 11 unlatch trip
247	ULTR10	Terminal 10 unlatch trip
247	ULTR09	Terminal 09 unlatch trip
248	*	Reserved
248	*	Reserved
248	*	Reserved
248	ULTR21	Terminal 21 unlatch trip

**Table 11.2 Row List of Relay Word Bits (Sheet 46 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
248	ULTR20	Terminal 20 unlatch trip
248	ULTR19	Terminal 19 unlatch trip
248	ULTR18	Terminal 18 unlatch trip
248	ULTR17	Terminal 17 unlatch trip
<b>Breaker Open Controls</b>		
249	OC08	Circuit Breaker 08 open command
249	OC07	Circuit Breaker 07 open command
249	OC06	Circuit Breaker 06 open command
249	OC05	Circuit Breaker 05 open command
249	OC04	Circuit Breaker 04 open command
249	OC03	Circuit Breaker 03 open command
249	OC02	Circuit Breaker 02 open command
249	OC01	Circuit Breaker 01 open command
250	OC16	Circuit Breaker 16 open command
250	OC15	Circuit Breaker 15 open command
250	OC14	Circuit Breaker 14 open command
250	OC13	Circuit Breaker 13 open command
250	OC12	Circuit Breaker 12 open command
250	OC11	Circuit Breaker 11 open command
250	OC10	Circuit Breaker 10 open command
250	OC09	Circuit Breaker 09 open command
251	*	Reserved
251	*	Reserved
251	*	Reserved
251	OC21	Circuit Breaker 21 open command
251	OC20	Circuit Breaker 20 open command
251	OC19	Circuit Breaker 19 open command
251	OC18	Circuit Breaker 18 open command
251	OC17	Circuit Breaker 17 open command
<b>Inverse-Time Overcurrent Elements</b>		
252	*	Reserved
252	51MM21	Inverse-time Element 21 pickup setting outside of specified limits
252	51TM21	Inverse-time Element 21 time-dial setting outside of specified limits
253	51R16	Inverse-time Element 16 reset
253	51R15	Inverse-time Element 15 reset
253	51R14	Inverse-time Element 14 reset

**Table 11.2 Row List of Relay Word Bits (Sheet 47 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
253	51R13	Inverse-time Element 13 reset
253	51R12	Inverse-time Element 12 reset
253	51R11	Inverse-time Element 11 reset
253	51R10	Inverse-time Element 10 reset
253	51R09	Inverse-time Element 09 reset
254	51R08	Inverse-time Element 08 reset
254	51R07	Inverse-time Element 07 reset
254	51R06	Inverse-time Element 06 reset
254	51R05	Inverse-time Element 05 reset
254	51R04	Inverse-time Element 04 reset
254	51R03	Inverse-time Element 03 reset
254	51R02	Inverse-time Element 02 reset
254	51R01	Inverse-time Element 01 reset
<b>Setting Group Bits</b>		
255	SG6	Settings Group 6 active
255	SG5	Settings Group 5 active
255	SG4	Settings Group 4 active
255	SG3	Settings Group 3 active
255	SG2	Settings Group 2 active
255	SG1	Settings Group 1 active
255	CHSG	Asserted during settings group change
255	*	Reserved
<b>Local Bits</b>		
256	LB08	Local Bit 08
256	LB07	Local Bit 07
256	LB06	Local Bit 06
256	LB05	Local Bit 05
256	LB04	Local Bit 04
256	LB03	Local Bit 03
256	LB02	Local Bit 02
256	LB01	Local Bit 01
257	LB16	Local Bit 16
257	LB15	Local Bit 15
257	LB14	Local Bit 14
257	LB13	Local Bit 13
257	LB12	Local Bit 12
257	LB11	Local Bit 11
257	LB10	Local Bit 10
257	LB09	Local Bit 09
258	LB24	Local Bit 24
258	LB23	Local Bit 23

**Table 11.2 Row List of Relay Word Bits (Sheet 48 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
258	LB22	Local Bit 22
258	LB21	Local Bit 21
258	LB20	Local Bit 20
258	LB19	Local Bit 19
258	LB18	Local Bit 18
258	LB17	Local Bit 17
259	LB32	Local Bit 32
259	LB31	Local Bit 31
259	LB30	Local Bit 30
259	LB29	Local Bit 29
259	LB28	Local Bit 28
259	LB27	Local Bit 27
259	LB26	Local Bit 26
259	LB25	Local Bit 25
<b>Remote Bits</b>		
260	RB89	Remote Bit 89
260	RB90	Remote Bit 90
260	RB91	Remote Bit 91
260	RB92	Remote Bit 92
260	RB93	Remote Bit 93
260	RB94	Remote Bit 94
260	RB95	Remote Bit 95
260	RB96	Remote Bit 96
261	RB81	Remote Bit 81
261	RB82	Remote Bit 82
261	RB83	Remote Bit 83
261	RB84	Remote Bit 84
261	RB85	Remote Bit 85
261	RB86	Remote Bit 86
261	RB87	Remote Bit 87
261	RB88	Remote Bit 88
262	RB73	Remote Bit 73
262	RB74	Remote Bit 74
262	RB75	Remote Bit 75
262	RB76	Remote Bit 76
262	RB77	Remote Bit 77
262	RB78	Remote Bit 78
262	RB79	Remote Bit 79
262	RB80	Remote Bit 80
263	RB65	Remote Bit 65
263	RB66	Remote Bit 66

**Table 11.2 Row List of Relay Word Bits (Sheet 49 of 97)**

Row	Name	Bit Description
263	RB67	Remote Bit 67
263	RB68	Remote Bit 68
263	RB69	Remote Bit 69
263	RB70	Remote Bit 70
263	RB71	Remote Bit 71
263	RB72	Remote Bit 72
264	RB57	Remote Bit 57
264	RB58	Remote Bit 58
264	RB59	Remote Bit 59
264	RB60	Remote Bit 60
264	RB61	Remote Bit 61
264	RB62	Remote Bit 62
264	RB63	Remote Bit 63
264	RB64	Remote Bit 64
265	RB49	Remote Bit 49
265	RB50	Remote Bit 50
265	RB51	Remote Bit 51
265	RB52	Remote Bit 52
265	RB53	Remote Bit 53
265	RB54	Remote Bit 54
265	RB55	Remote Bit 55
265	RB56	Remote Bit 56
266	RB41	Remote Bit 41
266	RB42	Remote Bit 42
266	RB43	Remote Bit 43
266	RB44	Remote Bit 44
266	RB45	Remote Bit 45
266	RB46	Remote Bit 46
266	RB47	Remote Bit 47
266	RB48	Remote Bit 48
267	RB33	Remote Bit 33
267	RB34	Remote Bit 34
267	RB35	Remote Bit 35
267	RB36	Remote Bit 36
267	RB37	Remote Bit 37
267	RB38	Remote Bit 38
267	RB39	Remote Bit 39
267	RB40	Remote Bit 40
268	RB25	Remote Bit 25
268	RB26	Remote Bit 26
268	RB27	Remote Bit 27

**Table 11.2 Row List of Relay Word Bits (Sheet 50 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
268	RB28	Remote Bit 28
268	RB29	Remote Bit 29
268	RB30	Remote Bit 30
268	RB31	Remote Bit 31
268	RB32	Remote Bit 32
269	RB17	Remote Bit 17
269	RB18	Remote Bit 18
269	RB19	Remote Bit 19
269	RB20	Remote Bit 20
269	RB21	Remote Bit 21
269	RB22	Remote Bit 22
269	RB23	Remote Bit 23
269	RB24	Remote Bit 24
270	RB09	Remote Bit 09
270	RB10	Remote Bit 10
270	RB11	Remote Bit 11
270	RB12	Remote Bit 12
270	RB13	Remote Bit 13
270	RB14	Remote Bit 14
270	RB15	Remote Bit 15
270	RB16	Remote Bit 16
271	RB01	Remote Bit 01
271	RB02	Remote Bit 02
271	RB03	Remote Bit 03
271	RB04	Remote Bit 04
271	RB05	Remote Bit 05
271	RB06	Remote Bit 06
271	RB07	Remote Bit 07
271	RB08	Remote Bit 08
<b>Contact Inputs</b>		
272	*	Reserved
273	*	Reserved
274	*	Reserved
275	*	Reserved
276	IN208	Optional I/O Board 1 Input 08
276	IN207	Optional I/O Board 1 Input 07
276	IN206	Optional I/O Board 1 Input 06
276	IN205	Optional I/O Board 1 Input 05
276	IN204	Optional I/O Board 1 Input 04
276	IN203	Optional I/O Board 1 Input 03
276	IN202	Optional I/O Board 1 Input 02

**Table 11.2 Row List of Relay Word Bits (Sheet 51 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
276	IN201	Optional I/O Board 1 Input 01
277	IN216	Optional I/O Board 1 Input 16
277	IN215	Optional I/O Board 1 Input 15
277	IN214	Optional I/O Board 1 Input 14
277	IN213	Optional I/O Board 1 Input 13
277	IN212	Optional I/O Board 1 Input 12
277	IN211	Optional I/O Board 1 Input 11
277	IN210	Optional I/O Board 1 Input 10
277	IN209	Optional I/O Board 1 Input 09
278	IN224	Optional I/O Board 1 Input 24
278	IN223	Optional I/O Board 1 Input 23
278	IN222	Optional I/O Board 1 Input 22
278	IN221	Optional I/O Board 1 Input 21
278	IN220	Optional I/O Board 1 Input 20
278	IN219	Optional I/O Board 1 Input 19
278	IN218	Optional I/O Board 1 Input 18
278	IN217	Optional I/O Board 1 Input 17
279	*	Reserved
280	*	Reserved
281	*	Reserved
282	*	Reserved
283	*	Reserved
284	*	Reserved
285	*	Reserved
286	*	Reserved
287	*	Reserved
288	*	Reserved
289	*	Reserved
290	*	Reserved
291	*	Reserved
<b>Protection SELOGIC Variables</b>		
292	PSV08	Protection SELOGIC control equation Variable 08
292	PSV07	Protection SELOGIC control equation Variable 07
292	PSV06	Protection SELOGIC control equation Variable 06
292	PSV05	Protection SELOGIC control equation Variable 05
292	PSV04	Protection SELOGIC control equation Variable 04
292	PSV03	Protection SELOGIC control equation Variable 03
292	PSV02	Protection SELOGIC control equation Variable 02
292	PSV01	Protection SELOGIC control equation Variable 01
293	PSV16	Protection SELOGIC control equation Variable 16
293	PSV15	Protection SELOGIC control equation Variable 15

**Table 11.2 Row List of Relay Word Bits (Sheet 52 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
293	PSV14	Protection SELOGIC control equation Variable 14
293	PSV13	Protection SELOGIC control equation Variable 13
293	PSV12	Protection SELOGIC control equation Variable 12
293	PSV11	Protection SELOGIC control equation Variable 11
293	PSV10	Protection SELOGIC control equation Variable 10
293	PSV09	Protection SELOGIC control equation Variable 09
294	PSV24	Protection SELOGIC control equation Variable 24
294	PSV23	Protection SELOGIC control equation Variable 23
294	PSV22	Protection SELOGIC control equation Variable 22
294	PSV21	Protection SELOGIC control equation Variable 21
294	PSV20	Protection SELOGIC control equation Variable 20
294	PSV19	Protection SELOGIC control equation Variable 19
294	PSV18	Protection SELOGIC control equation Variable 18
294	PSV17	Protection SELOGIC control equation Variable 17
295	PSV32	Protection SELOGIC control equation Variable 32
295	PSV31	Protection SELOGIC control equation Variable 31
295	PSV30	Protection SELOGIC control equation Variable 30
295	PSV29	Protection SELOGIC control equation Variable 29
295	PSV28	Protection SELOGIC control equation Variable 28
295	PSV27	Protection SELOGIC control equation Variable 27
295	PSV26	Protection SELOGIC control equation Variable 26
295	PSV25	Protection SELOGIC control equation Variable 25
296	PSV40	Protection SELOGIC control equation Variable 40
296	PSV39	Protection SELOGIC control equation Variable 39
296	PSV38	Protection SELOGIC control equation Variable 38
296	PSV37	Protection SELOGIC control equation Variable 37
296	PSV36	Protection SELOGIC control equation Variable 36
296	PSV35	Protection SELOGIC control equation Variable 35
296	PSV34	Protection SELOGIC control equation Variable 34
296	PSV33	Protection SELOGIC control equation Variable 33
297	PSV48	Protection SELOGIC control equation Variable 48
297	PSV47	Protection SELOGIC control equation Variable 47
297	PSV46	Protection SELOGIC control equation Variable 46
297	PSV45	Protection SELOGIC control equation Variable 45
297	PSV44	Protection SELOGIC control equation Variable 44
297	PSV43	Protection SELOGIC control equation Variable 43
297	PSV42	Protection SELOGIC control equation Variable 42
297	PSV41	Protection SELOGIC control equation Variable 41
298	PSV56	Protection SELOGIC control equation Variable 56
298	PSV55	Protection SELOGIC control equation Variable 55
298	PSV54	Protection SELOGIC control equation Variable 54

**Table 11.2 Row List of Relay Word Bits (Sheet 53 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
298	PSV53	Protection SELOGIC control equation Variable 53
298	PSV52	Protection SELOGIC control equation Variable 52
298	PSV51	Protection SELOGIC control equation Variable 51
298	PSV50	Protection SELOGIC control equation Variable 50
298	PSV49	Protection SELOGIC control equation Variable 49
299	PSV64	Protection SELOGIC control equation Variable 64
299	PSV63	Protection SELOGIC control equation Variable 63
299	PSV62	Protection SELOGIC control equation Variable 62
299	PSV61	Protection SELOGIC control equation Variable 61
299	PSV60	Protection SELOGIC control equation Variable 60
299	PSV59	Protection SELOGIC control equation Variable 59
299	PSV58	Protection SELOGIC control equation Variable 58
299	PSV57	Protection SELOGIC control equation Variable 57
<b>Protection SELOGIC Latches</b>		
300	PLT08	Protection Latch 08
300	PLT07	Protection Latch 07
300	PLT06	Protection Latch 06
300	PLT05	Protection Latch 05
300	PLT04	Protection Latch 04
300	PLT03	Protection Latch 03
300	PLT02	Protection Latch 02
300	PLT01	Protection Latch 01
301	PLT16	Protection Latch 16
301	PLT15	Protection Latch 15
301	PLT14	Protection Latch 14
301	PLT13	Protection Latch 13
301	PLT12	Protection Latch 12
301	PLT11	Protection Latch 11
301	PLT10	Protection Latch 10
301	PLT09	Protection Latch 09
302	PLT24	Protection Latch 24
302	PLT23	Protection Latch 23
302	PLT22	Protection Latch 22
302	PLT21	Protection Latch 21
302	PLT20	Protection Latch 20
302	PLT19	Protection Latch 19
302	PLT18	Protection Latch 18
302	PLT17	Protection Latch 17
303	PLT32	Protection Latch 32
303	PLT31	Protection Latch 31
303	PLT30	Protection Latch 30

**Table 11.2 Row List of Relay Word Bits (Sheet 54 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
303	PLT29	Protection Latch 29
303	PLT28	Protection Latch 28
303	PLT27	Protection Latch 27
303	PLT26	Protection Latch 26
303	PLT25	Protection Latch 25
<b>Protection SELogic Conditioning Timers</b>		
304	PCT08Q	Protection conditioning timer Output 08
304	PCT07Q	Protection conditioning timer Output 07
304	PCT06Q	Protection conditioning timer Output 06
304	PCT05Q	Protection conditioning timer Output 05
304	PCT04Q	Protection conditioning timer Output 04
304	PCT03Q	Protection conditioning timer Output 03
304	PCT02Q	Protection conditioning timer Output 02
304	PCT01Q	Protection conditioning timer Output 01
305	PCT16Q	Protection conditioning timer Output 16
305	PCT15Q	Protection conditioning timer Output 15
305	PCT14Q	Protection conditioning timer Output 14
305	PCT13Q	Protection conditioning timer Output 13
305	PCT12Q	Protection conditioning timer Output 12
305	PCT11Q	Protection conditioning timer Output 11
305	PCT10Q	Protection conditioning timer Output 10
305	PCT09Q	Protection conditioning timer Output 09
<b>Protection SELogic Sequencing Timers</b>		
306	PST08Q	Protection sequencing timer Output 08
306	PST07Q	Protection sequencing timer Output 07
306	PST06Q	Protection sequencing timer Output 06
306	PST05Q	Protection sequencing timer Output 05
306	PST04Q	Protection sequencing timer Output 04
306	PST03Q	Protection sequencing timer Output 03
306	PST02Q	Protection sequencing timer Output 02
306	PST01Q	Protection sequencing timer Output 01
307	PST16Q	Protection sequencing timer Output 16
307	PST15Q	Protection sequencing timer Output 15
307	PST14Q	Protection sequencing timer Output 14
307	PST13Q	Protection sequencing timer Output 13
307	PST12Q	Protection sequencing timer Output 12
307	PST11Q	Protection sequencing timer Output 11
307	PST10Q	Protection sequencing timer Output 10
307	PST09Q	Protection sequencing timer Output 09
308	PST24Q	Protection sequencing timer Output 24
308	PST23Q	Protection sequencing timer Output 23

**Table 11.2 Row List of Relay Word Bits (Sheet 55 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
308	PST22Q	Protection sequencing timer Output 22
308	PST21Q	Protection sequencing timer Output 21
308	PST20Q	Protection sequencing timer Output 20
308	PST19Q	Protection sequencing timer Output 19
308	PST18Q	Protection sequencing timer Output 18
308	PST17Q	Protection sequencing timer Output 17
309	PST32Q	Protection sequencing timer Output 32
309	PST31Q	Protection sequencing timer Output 31
309	PST30Q	Protection sequencing timer Output 30
309	PST29Q	Protection sequencing timer Output 29
309	PST28Q	Protection sequencing timer Output 28
309	PST27Q	Protection sequencing timer Output 27
309	PST26Q	Protection sequencing timer Output 26
309	PST25Q	Protection sequencing timer Output 25
310	PST08R	Protection sequencing timer Reset 08
310	PST07R	Protection sequencing timer Reset 07
310	PST06R	Protection sequencing timer Reset 06
310	PST05R	Protection sequencing timer Reset 05
310	PST04R	Protection sequencing timer Reset 04
310	PST03R	Protection sequencing timer Reset 03
310	PST02R	Protection sequencing timer Reset 02
310	PST01R	Protection sequencing timer Reset 01
311	PST16R	Protection sequencing timer Reset 16
311	PST15R	Protection sequencing timer Reset 15
311	PST14R	Protection sequencing timer Reset 14
311	PST13R	Protection sequencing timer Reset 13
311	PST12R	Protection sequencing timer Reset 12
311	PST11R	Protection sequencing timer Reset 11
311	PST10R	Protection sequencing timer Reset 10
311	PST09R	Protection sequencing timer Reset 09
312	PST24R	Protection sequencing timer Reset 24
312	PST23R	Protection sequencing timer Reset 23
312	PST22R	Protection sequencing timer Reset 22
312	PST21R	Protection sequencing timer Reset 21
312	PST20R	Protection sequencing timer Reset 20
312	PST19R	Protection sequencing timer Reset 19
312	PST18R	Protection sequencing timer Reset 18
312	PST17R	Protection sequencing timer Reset 17
313	PST32R	Protection sequencing timer Reset 32
313	PST31R	Protection sequencing timer Reset 31
313	PST30R	Protection sequencing timer Reset 30

**Table 11.2 Row List of Relay Word Bits (Sheet 56 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
313	PST29R	Protection sequencing timer Reset 29
313	PST28R	Protection sequencing timer Reset 28
313	PST27R	Protection sequencing timer Reset 27
313	PST26R	Protection sequencing timer Reset 26
313	PST25R	Protection sequencing timer Reset 25
<b>Protection SELOGIC Counters</b>		
314	PCN08Q	Protection counter Output 08
314	PCN07Q	Protection counter Output 07
314	PCN06Q	Protection counter Output 06
314	PCN05Q	Protection counter Output 05
314	PCN04Q	Protection counter Output 04
314	PCN03Q	Protection counter Output 03
314	PCN02Q	Protection counter Output 02
314	PCN01Q	Protection counter Output 01
315	PCN16Q	Protection counter Output 16
315	PCN15Q	Protection counter Output 15
315	PCN14Q	Protection counter Output 14
315	PCN13Q	Protection counter Output 13
315	PCN12Q	Protection counter Output 12
315	PCN11Q	Protection counter Output 11
315	PCN10Q	Protection counter Output 10
315	PCN09Q	Protection counter Output 09
316	PCN24Q	Protection counter Output 24
316	PCN23Q	Protection counter Output 23
316	PCN22Q	Protection counter Output 22
316	PCN21Q	Protection counter Output 21
316	PCN20Q	Protection counter Output 20
316	PCN19Q	Protection counter Output 19
316	PCN18Q	Protection counter Output 18
316	PCN17Q	Protection counter Output 17
317	PCN32Q	Protection counter Output 32
317	PCN31Q	Protection counter Output 31
317	PCN30Q	Protection counter Output 30
317	PCN29Q	Protection counter Output 29
317	PCN28Q	Protection counter Output 28
317	PCN27Q	Protection counter Output 27
317	PCN26Q	Protection counter Output 26
317	PCN25Q	Protection counter Output 25
318	PCN08R	Protection counter reset 08
318	PCN07R	Protection counter reset 07
318	PCN06R	Protection counter reset 06

**Table 11.2 Row List of Relay Word Bits (Sheet 57 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
318	PCN05R	Protection counter reset 05
318	PCN04R	Protection counter reset 04
318	PCN03R	Protection counter reset 03
318	PCN02R	Protection counter reset 02
318	PCN01R	Protection counter reset 01
319	PCN16R	Protection counter reset 16
319	PCN15R	Protection counter reset 15
319	PCN14R	Protection counter reset 14
319	PCN13R	Protection counter reset 13
319	PCN12R	Protection counter reset 12
319	PCN11R	Protection counter reset 11
319	PCN10R	Protection counter reset 10
319	PCN09R	Protection counter reset 09
320	PCN24R	Protection counter reset 24
320	PCN23R	Protection counter reset 23
320	PCN22R	Protection counter reset 22
320	PCN21R	Protection counter reset 21
320	PCN20R	Protection counter reset 20
320	PCN19R	Protection counter reset 19
320	PCN18R	Protection counter reset 18
320	PCN17R	Protection counter reset 17
321	PCN32R	Protection counter reset 32
321	PCN31R	Protection counter reset 31
321	PCN30R	Protection counter reset 30
321	PCN29R	Protection counter reset 29
321	PCN28R	Protection counter reset 28
321	PCN27R	Protection counter reset 27
321	PCN26R	Protection counter reset 26
321	PCN25R	Protection counter reset 25

**Automation SELOGIC Variables**

322	ASV008	Automation SELOGIC control equation Variable 8
322	ASV007	Automation SELOGIC control equation Variable 7
322	ASV006	Automation SELOGIC control equation Variable 6
322	ASV005	Automation SELOGIC control equation Variable 5
322	ASV004	Automation SELOGIC control equation Variable 4
322	ASV003	Automation SELOGIC control equation Variable 3
322	ASV002	Automation SELOGIC control equation Variable 2
322	ASV001	Automation SELOGIC control equation Variable 1
323	ASV016	Automation SELOGIC control equation Variable 16
323	ASV015	Automation SELOGIC control equation Variable 15
323	ASV014	Automation SELOGIC control equation Variable 14

**Table 11.2 Row List of Relay Word Bits (Sheet 58 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
323	ASV013	Automation SELOGIC control equation Variable 13
323	ASV012	Automation SELOGIC control equation Variable 12
323	ASV011	Automation SELOGIC control equation Variable 11
323	ASV010	Automation SELOGIC control equation Variable 10
323	ASV009	Automation SELOGIC control equation Variable 09
324	ASV024	Automation SELOGIC control equation Variable 24
324	ASV023	Automation SELOGIC control equation Variable 23
324	ASV022	Automation SELOGIC control equation Variable 22
324	ASV021	Automation SELOGIC control equation Variable 21
324	ASV020	Automation SELOGIC control equation Variable 20
324	ASV019	Automation SELOGIC control equation Variable 19
324	ASV018	Automation SELOGIC control equation Variable 18
324	ASV017	Automation SELOGIC control equation Variable 17
325	ASV032	Automation SELOGIC control equation Variable 32
325	ASV031	Automation SELOGIC control equation Variable 31
325	ASV030	Automation SELOGIC control equation Variable 30
325	ASV029	Automation SELOGIC control equation Variable 29
325	ASV028	Automation SELOGIC control equation Variable 28
325	ASV027	Automation SELOGIC control equation Variable 27
325	ASV026	Automation SELOGIC control equation Variable 26
325	ASV025	Automation SELOGIC control equation Variable 25
326	ASV040	Automation SELOGIC control equation Variable 40
326	ASV039	Automation SELOGIC control equation Variable 39
326	ASV038	Automation SELOGIC control equation Variable 38
326	ASV037	Automation SELOGIC control equation Variable 37
326	ASV036	Automation SELOGIC control equation Variable 36
326	ASV035	Automation SELOGIC control equation Variable 35
326	ASV034	Automation SELOGIC control equation Variable 34
326	ASV033	Automation SELOGIC control equation Variable 33
327	ASV048	Automation SELOGIC control equation Variable 48
327	ASV047	Automation SELOGIC control equation Variable 47
327	ASV046	Automation SELOGIC control equation Variable 46
327	ASV045	Automation SELOGIC control equation Variable 45
327	ASV044	Automation SELOGIC control equation Variable 44
327	ASV043	Automation SELOGIC control equation Variable 43
327	ASV042	Automation SELOGIC control equation Variable 42
327	ASV041	Automation SELOGIC control equation Variable 41
328	ASV056	Automation SELOGIC control equation Variable 56
328	ASV055	Automation SELOGIC control equation Variable 55
328	ASV054	Automation SELOGIC control equation Variable 54
328	ASV053	Automation SELOGIC control equation Variable 53

**Table 11.2 Row List of Relay Word Bits (Sheet 59 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
328	ASV052	Automation SELOGIC control equation Variable 52
328	ASV051	Automation SELOGIC control equation Variable 51
328	ASV050	Automation SELOGIC control equation Variable 50
328	ASV049	Automation SELOGIC control equation Variable 49
329	ASV064	Automation SELOGIC control equation Variable 64
329	ASV063	Automation SELOGIC control equation Variable 63
329	ASV062	Automation SELOGIC control equation Variable 62
329	ASV061	Automation SELOGIC control equation Variable 61
329	ASV060	Automation SELOGIC control equation Variable 60
329	ASV059	Automation SELOGIC control equation Variable 59
329	ASV058	Automation SELOGIC control equation Variable 58
329	ASV057	Automation SELOGIC control equation Variable 57
330	ASV072	Automation SELOGIC control equation Variable 72
330	ASV071	Automation SELOGIC control equation Variable 71
330	ASV070	Automation SELOGIC control equation Variable 70
330	ASV069	Automation SELOGIC control equation Variable 69
330	ASV068	Automation SELOGIC control equation Variable 68
330	ASV067	Automation SELOGIC control equation Variable 67
330	ASV066	Automation SELOGIC control equation Variable 66
330	ASV065	Automation SELOGIC control equation Variable 65
331	ASV080	Automation SELOGIC control equation Variable 80
331	ASV079	Automation SELOGIC control equation Variable 79
331	ASV078	Automation SELOGIC control equation Variable 78
331	ASV077	Automation SELOGIC control equation Variable 77
331	ASV076	Automation SELOGIC control equation Variable 76
331	ASV075	Automation SELOGIC control equation Variable 75
331	ASV074	Automation SELOGIC control equation Variable 74
331	ASV073	Automation SELOGIC control equation Variable 73
332	ASV088	Automation SELOGIC control equation Variable 88
332	ASV087	Automation SELOGIC control equation Variable 87
332	ASV086	Automation SELOGIC control equation Variable 86
332	ASV085	Automation SELOGIC control equation Variable 85
332	ASV084	Automation SELOGIC control equation Variable 84
332	ASV083	Automation SELOGIC control equation Variable 83
332	ASV082	Automation SELOGIC control equation Variable 82
332	ASV081	Automation SELOGIC control equation Variable 81
333	ASV096	Automation SELOGIC control equation Variable 96
333	ASV095	Automation SELOGIC control equation Variable 95
333	ASV094	Automation SELOGIC control equation Variable 94
333	ASV093	Automation SELOGIC control equation Variable 93
333	ASV092	Automation SELOGIC control equation Variable 92

**Table 11.2 Row List of Relay Word Bits (Sheet 60 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
333	ASV091	Automation SELOGIC control equation Variable 91
333	ASV090	Automation SELOGIC control equation Variable 90
333	ASV089	Automation SELOGIC control equation Variable 89
334	ASV104	Automation SELOGIC control equation Variable 104
334	ASV103	Automation SELOGIC control equation Variable 103
334	ASV102	Automation SELOGIC control equation Variable 102
334	ASV101	Automation SELOGIC control equation Variable 101
334	ASV100	Automation SELOGIC control equation Variable 100
334	ASV099	Automation SELOGIC control equation Variable 099
334	ASV098	Automation SELOGIC control equation Variable 098
334	ASV097	Automation SELOGIC control equation Variable 097
335	ASV112	Automation SELOGIC control equation Variable 112
335	ASV111	Automation SELOGIC control equation Variable 111
335	ASV110	Automation SELOGIC control equation Variable 110
335	ASV109	Automation SELOGIC control equation Variable 109
335	ASV108	Automation SELOGIC control equation Variable 108
335	ASV107	Automation SELOGIC control equation Variable 107
335	ASV106	Automation SELOGIC control equation Variable 106
335	ASV105	Automation SELOGIC control equation Variable 105
336	ASV120	Automation SELOGIC control equation Variable 120
336	ASV119	Automation SELOGIC control equation Variable 119
336	ASV118	Automation SELOGIC control equation Variable 118
336	ASV117	Automation SELOGIC control equation Variable 117
336	ASV116	Automation SELOGIC control equation Variable 116
336	ASV115	Automation SELOGIC control equation Variable 115
336	ASV114	Automation SELOGIC control equation Variable 114
336	ASV113	Automation SELOGIC control equation Variable 113
337	ASV128	Automation SELOGIC control equation Variable 128
337	ASV127	Automation SELOGIC control equation Variable 127
337	ASV126	Automation SELOGIC control equation Variable 126
337	ASV125	Automation SELOGIC control equation Variable 125
337	ASV124	Automation SELOGIC control equation Variable 124
337	ASV123	Automation SELOGIC control equation Variable 123
337	ASV122	Automation SELOGIC control equation Variable 122
337	ASV121	Automation SELOGIC control equation Variable 121
338	ASV136	Automation SELOGIC control equation Variable 136
338	ASV135	Automation SELOGIC control equation Variable 135
338	ASV134	Automation SELOGIC control equation Variable 134
338	ASV133	Automation SELOGIC control equation Variable 133
338	ASV132	Automation SELOGIC control equation Variable 132
338	ASV131	Automation SELOGIC control equation Variable 131

**Table 11.2 Row List of Relay Word Bits (Sheet 61 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
338	ASV130	Automation SELOGIC control equation Variable 130
338	ASV129	Automation SELOGIC control equation Variable 129
339	ASV144	Automation SELOGIC control equation Variable 144
339	ASV143	Automation SELOGIC control equation Variable 143
339	ASV142	Automation SELOGIC control equation Variable 142
339	ASV141	Automation SELOGIC control equation Variable 141
339	ASV140	Automation SELOGIC control equation Variable 140
339	ASV139	Automation SELOGIC control equation Variable 139
339	ASV138	Automation SELOGIC control equation Variable 138
339	ASV137	Automation SELOGIC control equation Variable 137
340	ASV152	Automation SELOGIC control equation Variable 152
340	ASV151	Automation SELOGIC control equation Variable 151
340	ASV150	Automation SELOGIC control equation Variable 150
340	ASV149	Automation SELOGIC control equation Variable 149
340	ASV148	Automation SELOGIC control equation Variable 148
340	ASV147	Automation SELOGIC control equation Variable 147
340	ASV146	Automation SELOGIC control equation Variable 146
340	ASV145	Automation SELOGIC control equation Variable 145
341	ASV160	Automation SELOGIC control equation Variable 160
341	ASV159	Automation SELOGIC control equation Variable 159
341	ASV158	Automation SELOGIC control equation Variable 158
341	ASV157	Automation SELOGIC control equation Variable 157
341	ASV156	Automation SELOGIC control equation Variable 156
341	ASV155	Automation SELOGIC control equation Variable 155
341	ASV154	Automation SELOGIC control equation Variable 154
341	ASV153	Automation SELOGIC control equation Variable 153
342	ASV168	Automation SELOGIC control equation Variable 168
342	ASV167	Automation SELOGIC control equation Variable 167
342	ASV166	Automation SELOGIC control equation Variable 166
342	ASV165	Automation SELOGIC control equation Variable 165
342	ASV164	Automation SELOGIC control equation Variable 164
342	ASV163	Automation SELOGIC control equation Variable 163
342	ASV162	Automation SELOGIC control equation Variable 162
342	ASV161	Automation SELOGIC control equation Variable 161
343	ASV176	Automation SELOGIC control equation Variable 176
343	ASV175	Automation SELOGIC control equation Variable 175
343	ASV174	Automation SELOGIC control equation Variable 174
343	ASV173	Automation SELOGIC control equation Variable 173
343	ASV172	Automation SELOGIC control equation Variable 172
343	ASV171	Automation SELOGIC control equation Variable 171
343	ASV170	Automation SELOGIC control equation Variable 170

**Table 11.2 Row List of Relay Word Bits (Sheet 62 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
343	ASV169	Automation SELOGIC control equation Variable 169
344	ASV184	Automation SELOGIC control equation Variable 184
344	ASV183	Automation SELOGIC control equation Variable 183
344	ASV182	Automation SELOGIC control equation Variable 182
344	ASV181	Automation SELOGIC control equation Variable 181
344	ASV180	Automation SELOGIC control equation Variable 180
344	ASV179	Automation SELOGIC control equation Variable 179
344	ASV178	Automation SELOGIC control equation Variable 178
344	ASV177	Automation SELOGIC control equation Variable 177
345	ASV192	Automation SELOGIC control equation Variable 192
345	ASV191	Automation SELOGIC control equation Variable 191
345	ASV190	Automation SELOGIC control equation Variable 190
345	ASV189	Automation SELOGIC control equation Variable 189
345	ASV188	Automation SELOGIC control equation Variable 188
345	ASV187	Automation SELOGIC control equation Variable 187
345	ASV186	Automation SELOGIC control equation Variable 186
345	ASV185	Automation SELOGIC control equation Variable 185
346	ASV200	Automation SELOGIC control equation Variable 200
346	ASV199	Automation SELOGIC control equation Variable 199
346	ASV198	Automation SELOGIC control equation Variable 198
346	ASV197	Automation SELOGIC control equation Variable 197
346	ASV196	Automation SELOGIC control equation Variable 196
346	ASV195	Automation SELOGIC control equation Variable 195
346	ASV194	Automation SELOGIC control equation Variable 194
346	ASV193	Automation SELOGIC control equation Variable 193
347	ASV208	Automation SELOGIC control equation Variable 208
347	ASV207	Automation SELOGIC control equation Variable 207
347	ASV206	Automation SELOGIC control equation Variable 206
347	ASV205	Automation SELOGIC control equation Variable 205
347	ASV204	Automation SELOGIC control equation Variable 204
347	ASV203	Automation SELOGIC control equation Variable 203
347	ASV202	Automation SELOGIC control equation Variable 202
347	ASV201	Automation SELOGIC control equation Variable 201
348	ASV216	Automation SELOGIC control equation Variable 216
348	ASV215	Automation SELOGIC control equation Variable 215
348	ASV214	Automation SELOGIC control equation Variable 214
348	ASV213	Automation SELOGIC control equation Variable 213
348	ASV212	Automation SELOGIC control equation Variable 212
348	ASV211	Automation SELOGIC control equation Variable 211
348	ASV210	Automation SELOGIC control equation Variable 210
348	ASV209	Automation SELOGIC control equation Variable 209

**Table 11.2 Row List of Relay Word Bits (Sheet 63 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
349	ASV224	Automation SELOGIC control equation Variable 224
349	ASV223	Automation SELOGIC control equation Variable 223
349	ASV222	Automation SELOGIC control equation Variable 222
349	ASV221	Automation SELOGIC control equation Variable 221
349	ASV220	Automation SELOGIC control equation Variable 220
349	ASV219	Automation SELOGIC control equation Variable 219
349	ASV218	Automation SELOGIC control equation Variable 218
349	ASV217	Automation SELOGIC control equation Variable 217
350	ASV232	Automation SELOGIC control equation Variable 232
350	ASV231	Automation SELOGIC control equation Variable 231
350	ASV230	Automation SELOGIC control equation Variable 230
350	ASV229	Automation SELOGIC control equation Variable 229
350	ASV228	Automation SELOGIC control equation Variable 228
350	ASV227	Automation SELOGIC control equation Variable 227
350	ASV226	Automation SELOGIC control equation Variable 226
350	ASV225	Automation SELOGIC control equation Variable 225
351	ASV240	Automation SELOGIC control equation Variable 240
351	ASV239	Automation SELOGIC control equation Variable 239
351	ASV238	Automation SELOGIC control equation Variable 238
351	ASV237	Automation SELOGIC control equation Variable 237
351	ASV236	Automation SELOGIC control equation Variable 236
351	ASV235	Automation SELOGIC control equation Variable 235
351	ASV234	Automation SELOGIC control equation Variable 234
351	ASV233	Automation SELOGIC control equation Variable 233
352	ASV248	Automation SELOGIC control equation Variable 248
352	ASV247	Automation SELOGIC control equation Variable 247
352	ASV246	Automation SELOGIC control equation Variable 246
352	ASV245	Automation SELOGIC control equation Variable 245
352	ASV244	Automation SELOGIC control equation Variable 244
352	ASV243	Automation SELOGIC control equation Variable 243
352	ASV242	Automation SELOGIC control equation Variable 242
352	ASV241	Automation SELOGIC control equation Variable 241
353	ASV256	Automation SELOGIC control equation Variable 256
353	ASV255	Automation SELOGIC control equation Variable 255
353	ASV254	Automation SELOGIC control equation Variable 254
353	ASV253	Automation SELOGIC control equation Variable 253
353	ASV252	Automation SELOGIC control equation Variable 252
353	ASV251	Automation SELOGIC control equation Variable 251
353	ASV250	Automation SELOGIC control equation Variable 250
353	ASV249	Automation SELOGIC control equation Variable 249

**Table 11.2 Row List of Relay Word Bits (Sheet 64 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
<b>Automation SELogic Latches</b>		
354	ALT08	Automation Latch 8
354	ALT07	Automation Latch 7
354	ALT06	Automation Latch 6
354	ALT05	Automation Latch 5
354	ALT04	Automation Latch 4
354	ALT03	Automation Latch 3
354	ALT02	Automation Latch 2
354	ALT01	Automation Latch 1
355	ALT16	Automation Latch 16
355	ALT15	Automation Latch 15
355	ALT14	Automation Latch 14
355	ALT13	Automation Latch 13
355	ALT12	Automation Latch 12
355	ALT11	Automation Latch 11
355	ALT10	Automation Latch 10
355	ALT09	Automation Latch 9
356	ALT24	Automation Latch 24
356	ALT23	Automation Latch 23
356	ALT22	Automation Latch 22
356	ALT21	Automation Latch 21
356	ALT20	Automation Latch 20
356	ALT19	Automation Latch 19
356	ALT18	Automation Latch 18
356	ALT17	Automation Latch 17
357	ALT32	Automation Latch 32
357	ALT31	Automation Latch 31
357	ALT30	Automation Latch 30
357	ALT29	Automation Latch 29
357	ALT28	Automation Latch 28
357	ALT27	Automation Latch 27
357	ALT26	Automation Latch 26
357	ALT25	Automation Latch 25
<b>Automation SELogic Sequencing Timers</b>		
358	AST08Q	Automation sequencing timer Output 8
358	AST07Q	Automation sequencing timer Output 7
358	AST06Q	Automation sequencing timer Output 6
358	AST05Q	Automation sequencing timer Output 5
358	AST04Q	Automation sequencing timer Output 4
358	AST03Q	Automation sequencing timer Output 3
358	AST02Q	Automation sequencing timer Output 2

**Table 11.2 Row List of Relay Word Bits (Sheet 65 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
358	AST01Q	Automation sequencing timer Output 1
359	AST16Q	Automation sequencing timer Output 16
359	AST15Q	Automation sequencing timer Output 15
359	AST14Q	Automation sequencing timer Output 14
359	AST13Q	Automation sequencing timer Output 13
359	AST12Q	Automation sequencing timer Output 12
359	AST11Q	Automation sequencing timer Output 11
359	AST10Q	Automation sequencing timer Output 10
359	AST09Q	Automation sequencing timer Output 9
360	AST24Q	Automation sequencing timer Output 24
360	AST23Q	Automation sequencing timer Output 23
360	AST22Q	Automation sequencing timer Output 22
360	AST21Q	Automation sequencing timer Output 21
360	AST20Q	Automation sequencing timer Output 20
360	AST19Q	Automation sequencing timer Output 19
360	AST18Q	Automation sequencing timer Output 18
360	AST17Q	Automation sequencing timer Output 17
361	AST32Q	Automation sequencing timer Output 32
361	AST31Q	Automation sequencing timer Output 31
361	AST30Q	Automation sequencing timer Output 30
361	AST29Q	Automation sequencing timer Output 29
361	AST28Q	Automation sequencing timer Output 28
361	AST27Q	Automation sequencing timer Output 27
361	AST26Q	Automation sequencing timer Output 26
361	AST25Q	Automation sequencing timer Output 25
362	AST08R	Automation sequencing timer Reset 8
362	AST07R	Automation sequencing timer Reset 7
362	AST06R	Automation sequencing timer Reset 6
362	AST05R	Automation sequencing timer Reset 5
362	AST04R	Automation sequencing timer Reset 4
362	AST03R	Automation sequencing timer Reset 3
362	AST02R	Automation sequencing timer Reset 2
362	AST01R	Automation sequencing timer Reset 1
363	AST16R	Automation sequencing timer Reset 16
363	AST15R	Automation sequencing timer Reset 15
363	AST14R	Automation sequencing timer Reset 14
363	AST13R	Automation sequencing timer Reset 13
363	AST12R	Automation sequencing timer Reset 12
363	AST11R	Automation sequencing timer Reset 11
363	AST10R	Automation sequencing timer Reset 10
363	AST09R	Automation sequencing timer Reset 9

**Table 11.2 Row List of Relay Word Bits (Sheet 66 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
364	AST24R	Automation sequencing timer Reset 24
364	AST23R	Automation sequencing timer Reset 23
364	AST22R	Automation sequencing timer Reset 22
364	AST21R	Automation sequencing timer Reset 21
364	AST20R	Automation sequencing timer Reset 20
364	AST19R	Automation sequencing timer Reset 19
364	AST18R	Automation sequencing timer Reset 18
364	AST17R	Automation sequencing timer Reset 17
365	AST32R	Automation sequencing timer Reset 32
365	AST31R	Automation sequencing timer Reset 31
365	AST30R	Automation sequencing timer Reset 30
365	AST29R	Automation sequencing timer Reset 29
365	AST28R	Automation sequencing timer Reset 28
365	AST27R	Automation sequencing timer Reset 27
365	AST26R	Automation sequencing timer Reset 26
365	AST25R	Automation sequencing timer Reset 25

**Automation SELogic Counters**

366	ACN08Q	Automation counter Output 8
366	ACN07Q	Automation counter Output 7
366	ACN06Q	Automation counter Output 6
366	ACN05Q	Automation counter Output 5
366	ACN04Q	Automation counter Output 4
366	ACN03Q	Automation counter Output 3
366	ACN02Q	Automation counter Output 2
366	ACN01Q	Automation counter Output 1
367	ACN16Q	Automation counter Output 16
367	ACN15Q	Automation counter Output 15
367	ACN14Q	Automation counter Output 14
367	ACN13Q	Automation counter Output 13
367	ACN12Q	Automation counter Output 12
367	ACN11Q	Automation counter Output 11
367	ACN10Q	Automation counter Output 10
367	ACN09Q	Automation counter Output 9
368	ACN24Q	Automation counter Output 24
368	ACN23Q	Automation counter Output 23
368	ACN22Q	Automation counter Output 22
368	ACN21Q	Automation counter Output 21
368	ACN20Q	Automation counter Output 20
368	ACN19Q	Automation counter Output 19
368	ACN18Q	Automation counter Output 18
368	ACN17Q	Automation counter Output 17

**Table 11.2 Row List of Relay Word Bits (Sheet 67 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
369	ACN32Q	Automation counter Output 32
369	ACN31Q	Automation counter Output 31
369	ACN30Q	Automation counter Output 30
369	ACN29Q	Automation counter Output 29
369	ACN28Q	Automation counter Output 28
369	ACN27Q	Automation counter Output 27
369	ACN26Q	Automation counter Output 26
369	ACN25Q	Automation counter Output 25
370	ACN08R	Automation counter Reset 8
370	ACN07R	Automation counter Reset 7
370	ACN06R	Automation counter Reset 6
370	ACN05R	Automation counter Reset 5
370	ACN04R	Automation counter Reset 4
370	ACN03R	Automation counter Reset 3
370	ACN02R	Automation counter Reset 2
370	ACN01R	Automation counter Reset 1
371	ACN16R	Automation counter Reset 16
371	ACN15R	Automation counter Reset 15
371	ACN14R	Automation counter Reset 14
371	ACN13R	Automation counter Reset 13
371	ACN12R	Automation counter Reset 12
371	ACN11R	Automation counter Reset 11
371	ACN10R	Automation counter Reset 10
371	ACN09R	Automation counter Reset 9
372	ACN24R	Automation counter Reset 24
372	ACN23R	Automation counter Reset 23
372	ACN22R	Automation counter Reset 22
372	ACN21R	Automation counter Reset 21
372	ACN20R	Automation counter Reset 20
372	ACN19R	Automation counter Reset 19
372	ACN18R	Automation counter Reset 18
372	ACN17R	Automation counter Reset 17
373	ACN32R	Automation counter Reset 32
373	ACN31R	Automation counter Reset 31
373	ACN30R	Automation counter Reset 30
373	ACN29R	Automation counter Reset 29
373	ACN28R	Automation counter Reset 28
373	ACN27R	Automation counter Reset 27
373	ACN26R	Automation counter Reset 26
373	ACN25R	Automation counter Reset 25

**Table 11.2 Row List of Relay Word Bits (Sheet 68 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
<b>SELOGIC Error and Status Reporting</b>		
374	PUNRLBL	Protection SELOGIC control equation unresolved label
374	PFRTEX	Protection SELOGIC control equation first execution
374	MATHERR	SELOGIC control equation math error
374	*	Reserved
375	AUNRLBL	Automation SELOGIC control equation unresolved label
375	AFRTEXP	Automation SELOGIC control equation first execution protection
375	AFRTEXA	Automation SELOGIC control equation first execution automation
375	*	Reserved
<b>Alarms</b>		
376	SALARM	Non-diagnostic alarm pulse
376	HALARM	Relay diagnostic failure or warning
376	BADPASS	Pulsed when user enters three successive bad passwords
376	HALARML	Latching relay failure alarm
376	HALARMP	Relay warning alarm pulse
376	HALARMA	Relay warning periodic alarm
376	SETCHG	Pulsed when settings change
376	GRPSW	Pulsed when settings group changes
377	ACCESS	A user is connected at Access Level B or higher
377	ACCESSP	Pulsed when higher level access achieved
377	EACC	Enable Level 1 access (SELOGIC control equation)
377	E2AC	Enable Levels 1–2 access (SELOGIC control equation)
377	*	
377	*	
377	PASSDIS	Asserts to indicate password disable jumper is installed
377	BRKENAB	Asserts to indicate breaker control enable jumper is installed
<b>Time and Date Management</b>		
378	TBNC	The active relay time source is BNC IRIG
378	TPTP	The active relay time source is PTP
378	TIRIG	Assert while time is based on IRIG for both mark and value
378	TUPDH	Assert if the update source is a high-priority time source
378	TSYNCA	Assert while the time mark from time source or fixed internal source is not synchronized
378	TSOK	Assert if current time-source accuracy is sufficient for synchronized phasor measurements

**Table 11.2 Row List of Relay Word Bits (Sheet 69 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
378	TSER	The active relay time source is serial IRIG
378	UPD_EN	Enable updating internal clock with a selected external time source
379	TSYNC	Assert when ADC sampling is synchronized to a valid high-priority time source
379	BLKLPTS	Block low-priority source from updating relay time
379	TLOCAL	Relay calendar clock and ADC sampling synchronized to a high-priority local time source
379	TPLLEXT	Update PLL using external signal
379	TSSW	High priority time source switching
379	TGLOBAL	Relay calendar clock and ADC sampling synchronized to a high-priority Global time source
379	TSNTPP	Asserts if time was synchronized with primary NTP server before SNTP time-out period expired
379	TSNTPB	Asserts if time was synchronized with backup NTP server before SNTP time-out period expired
380	*	Reserved
<b>Inverse-Time Overcurrent Elements</b>		
381	*	Reserved
381	*	Reserved
381	*	Reserved
381	51R21	Inverse-time Element 21 reset
381	51R20	Inverse-time Element 20 reset
381	51R19	Inverse-time Element 19 reset
381	51R18	Inverse-time Element 18 reset
381	51R17	Inverse-time Element 17 reset
<b>Pushbuttons</b>		
382	PB1	Pushbutton 1
382	PB2	Pushbutton 2
382	PB3	Pushbutton 3
382	PB4	Pushbutton 4
382	PB5	Pushbutton 5
382	PB6	Pushbutton 6
382	PB7	Pushbutton 7
382	PB8	Pushbutton 8
383	PB9	Pushbutton 9
383	PB10	Pushbutton 10
383	PB11	Pushbutton 11
383	PB12	Pushbutton 12
383	*	Reserved
<b>Contact Outputs</b>		
388	OUT201–OUT208	Optional I/O Board 1 Output 1–8
389	OUT209–OUT216	Optional I/O Board 1 Output 9–16
390	OUT301–OUT308	Optional I/O Board 2 Output 1–8

**Table 11.2 Row List of Relay Word Bits (Sheet 70 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
391	OUT309–OUT316	Optional I/O Board 2 Output 9–16
392	OUT401–OUT408	Optional I/O Board 3 Output 1–8
393	OUT409–OUT416	Optional I/O Board 3 Output 9–16
394	OUT501–OUT508	Optional I/O Board 4 Output 1–8
395	OUT509–OUT516	Optional I/O Board 4 Output 9–16
<b>Pushbuttons Pulse Inputs</b>		
396	PB1_PUL	Pushbutton 1 pulse input
396	PB2_PUL	Pushbutton 2 pulse input
396	PB3_PUL	Pushbutton 3 pulse input
396	PB4_PUL	Pushbutton 4 pulse input
396	PB5_PUL	Pushbutton 5 pulse input
396	PB6_PUL	Pushbutton 6 pulse input
396	PB7_PUL	Pushbutton 7 pulse input
396	PB8_PUL	Pushbutton 8 pulse input
397	PB9_PUL	Pushbutton 9 pulse input
397	PB10PUL	Pushbutton 10 pulse input
397	PB11PUL	Pushbutton 11 pulse input
397	PB12PUL	Pushbutton 12 pulse input
397	*	Reserved
<b>Pushbutton LED Bits</b>		
398	PB1_LED	Pushbutton 1 LED
398	PB2_LED	Pushbutton 2 LED
398	PB3_LED	Pushbutton 3 LED
398	PB4_LED	Pushbutton 4 LED
398	PB5_LED	Pushbutton 5 LED
398	PB6_LED	Pushbutton 6 LED
398	PB7_LED	Pushbutton 7 LED
398	PB8_LED	Pushbutton 8 LED
399	PB9_LED	Pushbutton 9 LED
399	PB10LED	Pushbutton 10 LED
399	PB11LED	Pushbutton 11 LED
399	PB12LED	Pushbutton 12 LED
399	*	Reserved

**Table 11.2 Row List of Relay Word Bits (Sheet 71 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
<b>MIRRORED BITS</b>		
400	RMB8A	Channel A receive MIRRORED BIT 8
400	RMB7A	Channel A receive MIRRORED BIT 7
400	RMB6A	Channel A receive MIRRORED BIT 6
400	RMB5A	Channel A receive MIRRORED BIT 5
400	RMB4A	Channel A receive MIRRORED BIT 4
400	RMB3A	Channel A receive MIRRORED BIT 3
400	RMB2A	Channel A receive MIRRORED BIT 2
400	RMB1A	Channel A receive MIRRORED BIT 1
401	TMB8A	Channel A transmit MIRRORED BIT 8
401	TMB7A	Channel A transmit MIRRORED BIT 7
401	TMB6A	Channel A transmit MIRRORED BIT 6
401	TMB5A	Channel A transmit MIRRORED BIT 5
401	TMB4A	Channel A transmit MIRRORED BIT 4
401	TMB3A	Channel A transmit MIRRORED BIT 3
401	TMB2A	Channel A transmit MIRRORED BIT 2
401	TMB1A	Channel A transmit MIRRORED BIT 1
402	RMB8B	Channel B receive MIRRORED BIT 8
402	RMB7B	Channel B receive MIRRORED BIT 7
402	RMB6B	Channel B receive MIRRORED BIT 6
402	RMB5B	Channel B receive MIRRORED BIT 5
402	RMB4B	Channel B receive MIRRORED BIT 4
402	RMB3B	Channel B receive MIRRORED BIT 3
402	RMB2B	Channel B receive MIRRORED BIT 2
402	RMB1B	Channel B receive MIRRORED BIT 1
403	TMB8B	Channel B transmit MIRRORED BIT 8
403	TMB7B	Channel B transmit MIRRORED BIT 7
403	TMB6B	Channel B transmit MIRRORED BIT 6
403	TMB5B	Channel B transmit MIRRORED BIT 5
403	TMB4B	Channel B transmit MIRRORED BIT 4
403	TMB3B	Channel B transmit MIRRORED BIT 3
403	TMB2B	Channel B transmit MIRRORED BIT 2
403	TMB1B	Channel B transmit MIRRORED BIT 1
404	ROKA	Channel A MIRRORED BITS normal status (non-loopback)
404	RBADA	Channel A MIRRORED BITS outage too long
404	CBADA	Channel A MIRRORED BITS unavailability
404	LBOKA	Channel A MIRRORED BITS normal status (loopback)
404	ANOKA	Channel A MIRRORED BITS analog transfer OK
404	DOKA	Channel A MIRRORED BITS communications normal status
404	*	Reserved
404	*	Reserved

**Table 11.2 Row List of Relay Word Bits (Sheet 72 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
405	ROKB	Channel B MIRRORED BITS normal status (non-loopback mode)
405	RBADB	Channel B MIRRORED BITS outage too long
405	CBADB	Channel B MIRRORED BITS unavailability
405	LBOKB	Channel B MIRRORED BITS normal status (loopback mode)
405	ANOKB	Channel B MIRRORED BITS analog transfer OK
405	DOKB	Channel B MIRRORED BITS communications normal status
405	*	Reserved
405	*	Reserved
<b>Test Bits</b>		
406	TESTDB2	DNP test bit
406	TESTDB	Communications card database test bit
406	TESTFM	Fast Meter test bit
406	TESTPUL	Pulse test bit
406	LPHDSIM	IEC 61850 Logical Node for physical device simulation
406	*	Reserved
406	*	Reserved
406	*	Reserved
<b>Advanced Check Zone Bits</b>		
407	CZ24R	Include Bus Coupler 4 in Check Zone 2
407	CZ23R	Include Bus Coupler 3 in Check Zone 2
407	CZ22R	Include Bus Coupler 2 in Check Zone 2
407	CZ21R	Include Bus Coupler 1 in Check Zone 2
407	CZ14R	Include Bus Coupler 4 in Check Zone 1
407	CZ13R	Include Bus Coupler 3 in Check Zone 1
407	CZ12R	Include Bus Coupler 2 in Check Zone 1
407	CZ11R	Include Bus Coupler 1 in Check Zone 1
<b>Virtual Bits</b>		
408	VB249	Virtual Bit 249
408	VB250	Virtual Bit 250
408	VB251	Virtual Bit 251
408	VB252	Virtual Bit 252
408	VB253	Virtual Bit 253
408	VB254	Virtual Bit 254
408	VB255	Virtual Bit 255
408	VB256	Virtual Bit 256
409	VB241	Virtual Bit 241
409	VB242	Virtual Bit 242
409	VB243	Virtual Bit 243
409	VB244	Virtual Bit 244
409	VB245	Virtual Bit 245
409	VB246	Virtual Bit 246

**Table 11.2 Row List of Relay Word Bits (Sheet 73 of 97)**

Row	Name	Bit Description
409	VB247	Virtual Bit 247
409	VB248	Virtual Bit 248
410	VB233	Virtual Bit 233
410	VB234	Virtual Bit 234
410	VB235	Virtual Bit 235
410	VB236	Virtual Bit 236
410	VB237	Virtual Bit 237
410	VB238	Virtual Bit 238
410	VB239	Virtual Bit 239
410	VB240	Virtual Bit 240
411	VB225	Virtual Bit 225
411	VB226	Virtual Bit 226
411	VB227	Virtual Bit 227
411	VB228	Virtual Bit 228
411	VB229	Virtual Bit 229
411	VB230	Virtual Bit 230
411	VB231	Virtual Bit 231
411	VB232	Virtual Bit 232
412	VB217	Virtual Bit 217
412	VB218	Virtual Bit 218
412	VB219	Virtual Bit 219
412	VB220	Virtual Bit 220
412	VB221	Virtual Bit 221
412	VB222	Virtual Bit 222
412	VB223	Virtual Bit 223
412	VB224	Virtual Bit 224
413	VB209	Virtual Bit 209
413	VB210	Virtual Bit 210
413	VB211	Virtual Bit 211
413	VB212	Virtual Bit 212
413	VB213	Virtual Bit 213
413	VB214	Virtual Bit 214
413	VB215	Virtual Bit 215
413	VB216	Virtual Bit 216
414	VB201	Virtual Bit 201
414	VB202	Virtual Bit 202
414	VB203	Virtual Bit 203
414	VB204	Virtual Bit 204
414	VB205	Virtual Bit 205
414	VB206	Virtual Bit 206
414	VB207	Virtual Bit 207

**Table 11.2 Row List of Relay Word Bits (Sheet 74 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
414	VB208	Virtual Bit 208
415	VB193	Virtual Bit 193
415	VB194	Virtual Bit 194
415	VB195	Virtual Bit 195
415	VB196	Virtual Bit 196
415	VB197	Virtual Bit 197
415	VB198	Virtual Bit 198
415	VB199	Virtual Bit 199
415	VB200	Virtual Bit 200
416	VB185	Virtual Bit 185
416	VB186	Virtual Bit 186
416	VB187	Virtual Bit 187
416	VB188	Virtual Bit 188
416	VB189	Virtual Bit 189
416	VB190	Virtual Bit 190
416	VB191	Virtual Bit 191
416	VB192	Virtual Bit 192
417	VB177	Virtual Bit 177
417	VB178	Virtual Bit 178
417	VB179	Virtual Bit 179
417	VB180	Virtual Bit 180
417	VB181	Virtual Bit 181
417	VB182	Virtual Bit 182
417	VB183	Virtual Bit 183
417	VB184	Virtual Bit 184
418	VB169	Virtual Bit 169
418	VB170	Virtual Bit 170
418	VB171	Virtual Bit 171
418	VB172	Virtual Bit 172
418	VB173	Virtual Bit 173
418	VB174	Virtual Bit 174
418	VB175	Virtual Bit 175
418	VB176	Virtual Bit 176
419	VB161	Virtual Bit 161
419	VB162	Virtual Bit 162
419	VB163	Virtual Bit 163
419	VB164	Virtual Bit 164
419	VB165	Virtual Bit 165
419	VB166	Virtual Bit 166
419	VB167	Virtual Bit 167
419	VB168	Virtual Bit 168

**Table 11.2 Row List of Relay Word Bits (Sheet 75 of 97)**

Row	Name	Bit Description
420	VB153	Virtual Bit 153
420	VB154	Virtual Bit 154
420	VB155	Virtual Bit 155
420	VB156	Virtual Bit 156
420	VB157	Virtual Bit 157
420	VB158	Virtual Bit 158
420	VB159	Virtual Bit 159
420	VB160	Virtual Bit 160
421	VB145	Virtual Bit 145
421	VB146	Virtual Bit 146
421	VB147	Virtual Bit 147
421	VB148	Virtual Bit 148
421	VB149	Virtual Bit 149
421	VB150	Virtual Bit 150
421	VB151	Virtual Bit 151
421	VB152	Virtual Bit 152
422	VB137	Virtual Bit 137
422	VB138	Virtual Bit 138
422	VB139	Virtual Bit 139
422	VB140	Virtual Bit 140
422	VB141	Virtual Bit 141
422	VB142	Virtual Bit 142
422	VB143	Virtual Bit 143
422	VB144	Virtual Bit 144
423	VB129	Virtual Bit 129
423	VB130	Virtual Bit 130
423	VB131	Virtual Bit 131
423	VB132	Virtual Bit 132
423	VB133	Virtual Bit 133
423	VB134	Virtual Bit 134
423	VB135	Virtual Bit 135
423	VB136	Virtual Bit 136
424	VB121	Virtual Bit 121
424	VB122	Virtual Bit 122
424	VB123	Virtual Bit 123
424	VB124	Virtual Bit 124
424	VB125	Virtual Bit 125
424	VB126	Virtual Bit 126
424	VB127	Virtual Bit 127
424	VB128	Virtual Bit 128
425	VB113	Virtual Bit 113

**Table 11.2 Row List of Relay Word Bits (Sheet 76 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
425	VB114	Virtual Bit 114
425	VB115	Virtual Bit 115
425	VB116	Virtual Bit 116
425	VB117	Virtual Bit 117
425	VB118	Virtual Bit 118
425	VB119	Virtual Bit 119
425	VB120	Virtual Bit 120
426	VB105	Virtual Bit 105
426	VB106	Virtual Bit 106
426	VB107	Virtual Bit 107
426	VB108	Virtual Bit 108
426	VB109	Virtual Bit 109
426	VB110	Virtual Bit 110
426	VB111	Virtual Bit 111
426	VB112	Virtual Bit 112
427	VB097	Virtual Bit 097
427	VB098	Virtual Bit 098
427	VB099	Virtual Bit 099
427	VB100	Virtual Bit 100
427	VB101	Virtual Bit 101
427	VB102	Virtual Bit 102
427	VB103	Virtual Bit 103
427	VB104	Virtual Bit 104
428	VB089	Virtual Bit 089
428	VB090	Virtual Bit 090
428	VB091	Virtual Bit 091
428	VB092	Virtual Bit 092
428	VB093	Virtual Bit 093
428	VB094	Virtual Bit 094
428	VB095	Virtual Bit 095
428	VB096	Virtual Bit 096
429	VB081	Virtual Bit 081
429	VB082	Virtual Bit 082
429	VB083	Virtual Bit 083
429	VB084	Virtual Bit 084
429	VB085	Virtual Bit 085
429	VB086	Virtual Bit 086
429	VB087	Virtual Bit 087
429	VB088	Virtual Bit 088
430	VB073	Virtual Bit 073
430	VB074	Virtual Bit 074

**Table 11.2 Row List of Relay Word Bits (Sheet 77 of 97)**

Row	Name	Bit Description
430	VB075	Virtual Bit 075
430	VB076	Virtual Bit 076
430	VB077	Virtual Bit 077
430	VB078	Virtual Bit 078
430	VB079	Virtual Bit 079
430	VB080	Virtual Bit 080
431	VB065	Virtual Bit 065
431	VB066	Virtual Bit 066
431	VB067	Virtual Bit 067
431	VB068	Virtual Bit 068
431	VB069	Virtual Bit 069
431	VB070	Virtual Bit 070
431	VB071	Virtual Bit 071
431	VB072	Virtual Bit 072
432	VB057	Virtual Bit 057
432	VB058	Virtual Bit 058
432	VB059	Virtual Bit 059
432	VB060	Virtual Bit 060
432	VB061	Virtual Bit 061
432	VB062	Virtual Bit 062
432	VB063	Virtual Bit 063
432	VB064	Virtual Bit 064
433	VB049	Virtual Bit 049
433	VB050	Virtual Bit 050
433	VB051	Virtual Bit 051
433	VB052	Virtual Bit 052
433	VB053	Virtual Bit 053
433	VB054	Virtual Bit 054
433	VB055	Virtual Bit 055
433	VB056	Virtual Bit 056
434	VB041	Virtual Bit 041
434	VB042	Virtual Bit 042
434	VB043	Virtual Bit 043
434	VB044	Virtual Bit 044
434	VB045	Virtual Bit 045
434	VB046	Virtual Bit 046
434	VB047	Virtual Bit 047
434	VB048	Virtual Bit 048
435	VB033	Virtual Bit 033
435	VB034	Virtual Bit 034
435	VB035	Virtual Bit 035

**Table 11.2 Row List of Relay Word Bits (Sheet 78 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
435	VB036	Virtual Bit 036
435	VB037	Virtual Bit 037
435	VB038	Virtual Bit 038
435	VB039	Virtual Bit 039
435	VB040	Virtual Bit 040
436	VB025	Virtual Bit 025
436	VB026	Virtual Bit 026
436	VB027	Virtual Bit 027
436	VB028	Virtual Bit 028
436	VB029	Virtual Bit 029
436	VB030	Virtual Bit 030
436	VB031	Virtual Bit 031
436	VB032	Virtual Bit 032
437	VB017	Virtual Bit 017
437	VB018	Virtual Bit 018
437	VB019	Virtual Bit 019
437	VB020	Virtual Bit 020
437	VB021	Virtual Bit 021
437	VB022	Virtual Bit 022
437	VB023	Virtual Bit 023
437	VB024	Virtual Bit 024
438	VB009	Virtual Bit 009
438	VB010	Virtual Bit 010
438	VB011	Virtual Bit 011
438	VB012	Virtual Bit 012
438	VB013	Virtual Bit 013
438	VB014	Virtual Bit 014
438	VB015	Virtual Bit 015
438	VB016	Virtual Bit 016
439	VB001	Virtual Bit 001
439	VB002	Virtual Bit 002
439	VB003	Virtual Bit 003
439	VB004	Virtual Bit 004
439	VB005	Virtual Bit 005
439	VB006	Virtual Bit 006
439	VB007	Virtual Bit 007
439	VB008	Virtual Bit 008
<b>Data Reset Bits</b>		
440	RST_BAT	Reset battery monitoring
440	RSTTRGT	Target reset (SELOGIC control equation)
440	RSTDNP	Reset DNP fault summary data

Table 11.2 Row List of Relay Word Bits (Sheet 79 of 97)

Row	Name	Bit Description
440	RST_HAL	Reset HALARMA
440	*	Reserved
<b>Ethernet Switch</b>		
441	LINK5A	Link status of <b>PORT 5A</b> connection
441	LINK5B	Link status of <b>PORT 5B</b> connection
441	LINK5C	Link status of <b>PORT 5C</b> connection
441	LINK5D	Link status of <b>PORT 5D</b> connection
441	LNKFAIL	Link status of the active station bus port
441	LNKFL2	Link status of the active process bus port
441	LINK5E	Link status of <b>PORT 5E</b> connection
441	*	Reserved
442	P5ASEL	<b>PORT 5A</b> active/inactive
442	P5BSEL	<b>PORT 5B</b> active/inactive
442	P5CSEL	<b>PORT 5C</b> active/inactive
442	P5DSEL	<b>PORT 5D</b> active/inactive
442	P5ESEL	<b>PORT 5E</b> active/inactive
442	*	Reserved
442	*	Reserved
442	*	Reserved
<b>Advanced Check Zone Bits</b>		
443	*	Reserved
443	CZ34R	Include Bus Coupler 4 in Check Zone 3
443	CZ33R	Include Bus Coupler 3 in Check Zone 3
443	CZ32R	Include Bus Coupler 2 in Check Zone 3
443	CZ31R	Include Bus Coupler 1 in Check Zone 3
<b>Fast SER Enable Bits</b>		
444	FSERP1	Fast SER enabled for serial <b>PORT 1</b>
444	FSERP2	Fast SER enabled for serial <b>PORT 2</b>
444	FSERP3	Fast SER enabled for serial <b>PORT 3</b>
444	FSERPF	Fast SER enabled for serial <b>PORT F</b>
444	FSERP5	Fast SER enabled for serial <b>PORT 5</b>
444	*	Reserved
444	*	Reserved
444	*	Reserved

**Table 11.2 Row List of Relay Word Bits (Sheet 80 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
<b>Check Zone Activation</b>		
445	*	Reserved
445	CZONE3	Check Zone 3 is active
445	CZONE2	Check Zone 2 is active
445	CZONE1	Check Zone 1 is active
<b>Check Zone Supervision</b>		
446	*	Reserved
446	CZ3S	Check Zone 3 supervision asserted
446	CZ2S	Check Zone 2 supervision asserted
446	CZ1S	Check Zone 1 supervision asserted
<b>Check Zone Trip</b>		
447	*	Reserved
447	87CZ3	Check Zone 3 differential-element trip
447	87CZ2	Check Zone 2 differential-element trip
447	87CZ1	Check Zone 1 differential-element trip
<b>Check Zone Elements</b>		
448	*	Reserved
448	87SCZ3	Check Zone 3 sensitive differential element picked up
448	87SCZ2	Check Zone 2 sensitive differential element picked up
448	87SCZ1	Check Zone 1 sensitive differential element picked up
449	*	Reserved

**Table 11.2 Row List of Relay Word Bits (Sheet 81 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
449	87STCZ3	Check Zone 3 sensitive differential element timed out
449	87STCZ2	Check Zone 2 sensitive differential element timed out
449	87STCZ1	Check Zone 1 sensitive differential element timed out
450	87RCZ1	Check Zone 1 restraint differential element picked up
450	P87RCZ1	Check Zone 1 instantaneous differential element picked up
450	87OCZ1	Check Zone 1 restraint differential operating current above CZO87P
450	FLTCZ1	Check Zone 1 fault detector picked up
450	CONCZ1	Check Zone 1 in high-security mode
450	EXTCZ1	Check Zone 1 external fault declaration
450	DOPCZ1	Check Zone 1 incremental operating current picked up
450	DRTCZ1	Check Zone 1 incremental restraint current picked up
451	*	Reserved
451	FDIFCZ1	Check Zone 1 filtered restrained differential element picked up
451	RDIFCZ1	Check Zone 1 unfiltered restrained differential element picked up
451	IFLTCZ1	Check Zone 1 fault detection
451	GFLTCZ1	Check Zone 1 fast fault detection
452	87RCZ2	Check Zone 2 restraint differential element picked up
452	P87RCZ2	Check Zone 2 instantaneous differential element picked up
452	87OCZ2	Check Zone 2 restraint differential operating current above CZO87P
452	FLTCZ2	Check Zone 2 fault detector picked up
452	CONCZ2	Check Zone 2 in high-security mode
452	EXTCZ2	Check Zone 2 external fault declaration
452	DOPCZ2	Check Zone 2 incremental operating current picked up
452	DRTCZ2	Check Zone 2 incremental restraint current picked up
453	*	Reserved
453	FDIFCZ2	Check Zone 2 filtered restrained differential element picked up
453	RDIFCZ2	Check Zone 2 unfiltered restrained differential element picked up
453	IFLTCZ2	Check Zone 2 fault detection
453	GFLTCZ2	Check Zone 2 fast fault detection
454	87RCZ3	Check Zone 3 restraint differential element picked up
454	P87RCZ3	Check Zone 3 instantaneous differential element picked up
454	87OCZ3	Check Zone 3 restraint differential operating current above CZO87P
454	FLTCZ3	Check Zone 3 fault detector picked up
454	CONCZ3	Check Zone 3 in high-security mode
454	EXTCZ3	Check Zone 3 external fault declaration

**Table 11.2 Row List of Relay Word Bits (Sheet 82 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
454	DOPCZ3	Check Zone 3 incremental operating current picked up
454	DRTCZ3	Check Zone 3 incremental restraint current picked up
455	*	Reserved
455	FDIFCZ3	Check Zone 3 filtered restrained differential element picked up
455	RDIFCZ3	Check Zone 3 unfiltered restrained differential element picked up
455	IFLTCZ3	Check Zone 3 fault detection
455	GFLTCZ3	Check Zone 3 fast fault detection
456	*	Reserved
456	DECZ3F	Check Zone 3 forward directional element picked up
456	DECZ2F	Check Zone 2 forward directional element picked up
456	DECZ1F	Check Zone 1 forward directional element picked up
<b>Local Bit Supervision</b>		
457	LB_SP08	Local Bit 08 supervision (SELOGIC control equation)
457	LB_SP07	Local Bit 07 supervision (SELOGIC control equation)
457	LB_SP06	Local Bit 06 supervision (SELOGIC control equation)
457	LB_SP05	Local Bit 05 supervision (SELOGIC control equation)
457	LB_SP04	Local Bit 04 supervision (SELOGIC control equation)
457	LB_SP03	Local Bit 03 supervision (SELOGIC control equation)
457	LB_SP02	Local Bit 02 supervision (SELOGIC control equation)
457	LB_SP01	Local Bit 01 supervision (SELOGIC control equation)
458	LB_SP16	Local Bit 16 supervision (SELOGIC control equation)
458	LB_SP15	Local Bit 15 supervision (SELOGIC control equation)
458	LB_SP14	Local Bit 14 supervision (SELOGIC control equation)
458	LB_SP13	Local Bit 13 supervision (SELOGIC control equation)
458	LB_SP12	Local Bit 12 supervision (SELOGIC control equation)
458	LB_SP11	Local Bit 11 supervision (SELOGIC control equation)
458	LB_SP10	Local Bit 10 supervision (SELOGIC control equation)
458	LB_SP09	Local Bit 09 supervision (SELOGIC control equation)
459	LB_SP24	Local Bit 24 supervision (SELOGIC control equation)
459	LB_SP23	Local Bit 23 supervision (SELOGIC control equation)
459	LB_SP22	Local Bit 22 supervision (SELOGIC control equation)
459	LB_SP21	Local Bit 21 supervision (SELOGIC control equation)
459	LB_SP20	Local Bit 20 supervision (SELOGIC control equation)
459	LB_SP19	Local Bit 19 supervision (SELOGIC control equation)

**Table 11.2 Row List of Relay Word Bits (Sheet 83 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
459	LB_SP18	Local Bit 18 supervision (SELOGIC control equation)
459	LB_SP17	Local Bit 17 supervision (SELOGIC control equation)
460	LB_SP32	Local Bit 32 supervision (SELOGIC control equation)
460	LB_SP31	Local Bit 31 supervision (SELOGIC control equation)
460	LB_SP30	Local Bit 30 supervision (SELOGIC control equation)
460	LB_SP29	Local Bit 29 supervision (SELOGIC control equation)
460	LB_SP28	Local Bit 28 supervision (SELOGIC control equation)
460	LB_SP27	Local Bit 27 supervision (SELOGIC control equation)
460	LB_SP26	Local Bit 26 supervision (SELOGIC control equation)
460	LB_SP25	Local Bit 25 supervision (SELOGIC control equation)
<b>Local Bit Status</b>		
461	LB_DP08	Local Bit 08 status display (SELOGIC control equation)
461	LB_DP07	Local Bit 07 status display (SELOGIC control equation)
461	LB_DP06	Local Bit 06 status display (SELOGIC control equation)
461	LB_DP05	Local Bit 05 status display (SELOGIC control equation)
461	LB_DP04	Local Bit 04 status display (SELOGIC control equation)
461	LB_DP03	Local Bit 03 status display (SELOGIC control equation)
461	LB_DP02	Local Bit 02 status display (SELOGIC control equation)
461	LB_DP01	Local Bit 01 status display (SELOGIC control equation)
462	LB_DP16	Local Bit 16 status display (SELOGIC control equation)
462	LB_DP15	Local Bit 15 status display (SELOGIC control equation)
462	LB_DP14	Local Bit 14 status display (SELOGIC control equation)
462	LB_DP13	Local Bit 13 status display (SELOGIC control equation)
462	LB_DP12	Local Bit 12 status display (SELOGIC control equation)
462	LB_DP11	Local Bit 11 status display (SELOGIC control equation)
462	LB_DP10	Local Bit 10 status display (SELOGIC control equation)
462	LB_DP09	Local Bit 09 status display (SELOGIC control equation)
463	LB_DP24	Local Bit 24 status display (SELOGIC control equation)
463	LB_DP23	Local Bit 23 status display (SELOGIC control equation)
463	LB_DP22	Local Bit 22 status display (SELOGIC control equation)
463	LB_DP21	Local Bit 21 status display (SELOGIC control equation)
463	LB_DP20	Local Bit 20 status display (SELOGIC control equation)
463	LB_DP19	Local Bit 19 status display (SELOGIC control equation)
463	LB_DP18	Local Bit 18 status display (SELOGIC control equation)
463	LB_DP17	Local Bit 17 status display (SELOGIC control equation)
464	LB_DP32	Local Bit 32 status display (SELOGIC control equation)
464	LB_DP31	Local Bit 31 status display (SELOGIC control equation)
464	LB_DP30	Local Bit 30 status display (SELOGIC control equation)
464	LB_DP29	Local Bit 29 status display (SELOGIC control equation)
464	LB_DP28	Local Bit 28 status display (SELOGIC control equation)
464	LB_DP27	Local Bit 27 status display (SELOGIC control equation)

**Table 11.2 Row List of Relay Word Bits (Sheet 84 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
464	LB_DP26	Local Bit 26 status display (SELOGIC control equation)
464	LB_DP25	Local Bit 25 status display (SELOGIC control equation)
465	*	Reserved
<b>Target Logic Bits</b>		
466	TRGTR	Reset all active target Relay Words
466	*	Reserved
<b>Signal Profiling</b>		
467	SPEN	Signal profiling enabled
467	*	Reserved
<b>IRIG-B Control Bits</b>		
468	YEAR80	IRIG-B year information, binary-coded-decimal, add 80 if asserted
468	YEAR40	IRIG-B year information, binary-coded-decimal, add 40 if asserted
468	YEAR20	IRIG-B year information, binary-coded-decimal, add 20 if asserted
468	YEAR10	IRIG-B year information, binary-coded-decimal, add 10 if asserted
468	YEAR8	IRIG-B year information, binary-coded-decimal, add 8 if asserted
468	YEAR4	IRIG-B year information, binary-coded-decimal, add 4 if asserted
468	YEAR2	IRIG-B year information, binary-coded-decimal, add 2 if asserted
468	YEAR1	IRIG-B year information, binary-coded-decimal, add 1 if asserted
469	*	Reserved
469	*	Reserved
469	TUTCH	IRIG-B offset half-hour from UTC time, binary, add 0.5 if asserted
469	TUTC8	IRIG-B offset hours from UTC time, binary, add 8 if asserted
469	TUTC4	IRIG-B offset hours from UTC time, binary, add 4 if asserted
469	TUTC2	IRIG-B offset hours from UTC time, binary, add 2 if asserted
469	TUTC1	IRIG-B offset hours from UTC time, binary, add 1 if asserted
469	TUTCS	IRIG-B offset hours sign from UTC time, subtract the UTC offset if TUTCS is asserted, add otherwise
470	DST	Daylight-saving time
470	DSTP	IRIG-B daylight-saving time pending

**Table 11.2 Row List of Relay Word Bits (Sheet 85 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
470	LPSEC	Direction of the upcoming leap second. During the time that LPSECP is asserted, if LPSEC is asserted, the upcoming leap second is deleted; otherwise, the leap second is added.
470	LPSECP	Leap second pending
470	TQUAL8	Time quality, binary, add 8 when asserted
470	TQUAL4	Time quality, binary, add 4 when asserted
470	TQUAL2	Time quality, binary, add 2 when asserted
470	TQUAL1	Time quality, binary, add 1 when asserted
471	*	Reserved
<b>Time and Date Management</b>		
472	SER_SET	Qualify serial IRIG-B time source
472	SER_RST	Disqualify serial IRIG-B time source
472	BNC_SET	Qualify BNC IRIG-B time source
472	BNC_RST	Disqualify BNC IRIG-B time source
472	BNC_OK	IRIG-B signal from BNC port is available and has sufficient quality
472	SER_OK	IRIG-B signal from serial PORT 1 is available and has sufficient quality
472	UPD_BLK	Block updating internal clock period and master time
472	BNC_BNP	Bad jitter on BNC port and the IRIG-B signal is lost afterward
473	SER_BNP	Bad jitter on the serial port and the IRIG-B signal is lost afterward
473	BNC_TIM	A valid IRIG-B time source is detected on BNC port
473	SER_TIM	A valid IRIG-B time source is detected on serial port
473	PTP_TIM	A valid PTP time source is detected
473	PTP_SET	Qualify PTP time source
473	PTP_RST	Disqualify PTP time source
473	PTP_OK	PTP is available and has sufficient quality
473	P5ABSW	PORT 5A or 5B has just become active
474	PTPSYNC	Synchronized to a high-quality PTP source
474	PTP_BNP	Bad jitter on PTP signals and the PTP signal is lost afterward
474	SERSYNC	Synchronized to a high-quality serial IRIG source
474	BNCSYNC	Synchronized to a high-quality BNC IRIG source
474	P5CDSW	PORT 5C or 5D has just become active
474	*	Reserved
474	*	Reserved
474	*	Reserved
<b>Sampled Values (SV) Subscription</b>		
476	*	Reserved
476	SVS07OK	Subscription 07 is valid
476	SVS06OK	Subscription 06 is valid
476	SVS05OK	Subscription 05 is valid
476	SVS04OK	Subscription 04 is valid
476	SVS03OK	Subscription 03 is valid
476	SVS02OK	Subscription 02 is valid

**Table 11.2 Row List of Relay Word Bits (Sheet 86 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
476	SVS01OK	Subscription 01 is valid
477	*	Reserved
478	*	Reserved
479	SVSALM	General SV subscription alarm
479	SVSTST	SV subscription unit in test mode
479	SVCC	Coupled clock mode indication
479	*	Reserved
<b>SV and TiDL Subscription Mapping Bits</b>		
480	I13MAP	Terminal I13 is mapped in a subscription
480	I04MAP	Terminal I04 is mapped in a subscription
480	I12MAP	Terminal I12 is mapped in a subscription
480	I03MAP	Terminal I03 is mapped in a subscription
480	I11MAP	Terminal I11 is mapped in a subscription
480	I02MAP	Terminal I02 is mapped in a subscription
480	I10MAP	Terminal I10 is mapped in a subscription
480	I01MAP	Terminal I01 is mapped in a subscription
481	I17MAP	Terminal I17 is mapped in a subscription
481	I08MAP	Terminal I08 is mapped in a subscription
481	I16MAP	Terminal I16 is mapped in a subscription
481	I07MAP	Terminal I07 is mapped in a subscription
481	I15MAP	Terminal I15 is mapped in a subscription
481	I06MAP	Terminal I06 is mapped in a subscription
481	I14MAP	Terminal I14 is mapped in a subscription
481	I05MAP	Terminal I05 is mapped in a subscription
482	I21MAP	Terminal I21 is mapped in a subscription
482	V03MAP	Terminal V03 is mapped in a subscription
482	I20MAP	Terminal I20 is mapped in a subscription
482	V02MAP	Terminal V02 is mapped in a subscription
482	I19MAP	Terminal I19 is mapped in a subscription
482	V01MAP	Terminal V01 is mapped in a subscription
482	I18MAP	Terminal I18 is mapped in a subscription
482	I09MAP	Terminal I09 is mapped in a subscription
483	*	Reserved
<b>SV and TiDL Subscription OK Bits</b>		
484	I13OK	Terminal I13 configured channel data OK
484	I04OK	Terminal I04 configured channel data OK
484	I12OK	Terminal I12 configured channel data OK

**Table 11.2 Row List of Relay Word Bits (Sheet 87 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
484	I03OK	Terminal I03 configured channel data OK
484	I11OK	Terminal I11 configured channel data OK
484	I02OK	Terminal I02 configured channel data OK
484	I10OK	Terminal I10 configured channel data OK
484	I01OK	Terminal I01 configured channel data OK
485	I17OK	Terminal I17 configured channel data OK
485	I08OK	Terminal I08 configured channel data OK
485	I16OK	Terminal I16 configured channel data OK
485	I07OK	Terminal I07 configured channel data OK
485	I15OK	Terminal I15 configured channel data OK
485	I06OK	Terminal I06 configured channel data OK
485	I14OK	Terminal I14 configured channel data OK
485	I05OK	Terminal I05 configured channel data OK
486	I21OK	Terminal I21 configured channel data OK
486	V03OK	Terminal V03 configured channel data OK
486	I20OK	Terminal I20 configured channel data OK
486	V02OK	Terminal V02 configured channel data OK
486	I19OK	Terminal I19 configured channel data OK
486	V01OK	Terminal V01 configured channel data OK
486	I18OK	Terminal I18 configured channel data OK
486	I09OK	Terminal I09 configured channel data OK
487	*	Reserved
<b>SV and TiDL Subscription Blocking Bits</b>		
488	I13BK	Terminal I13 is not OK (use for blocking)
488	I04BK	Terminal I04 is not OK (use for blocking)
488	I12BK	Terminal I12 is not OK (use for blocking)
488	I03BK	Terminal I03 is not OK (use for blocking)
488	I11BK	Terminal I11 is not OK (use for blocking)
488	I02BK	Terminal I02 is not OK (use for blocking)
488	I10BK	Terminal I10 is not OK (use for blocking)
488	I01BK	Terminal I01 is not OK (use for blocking)
489	I17BK	Terminal I17 is not OK (use for blocking)
489	I08BK	Terminal I08 is not OK (use for blocking)
489	I16BK	Terminal I16 is not OK (use for blocking)
489	I07BK	Terminal I07 is not OK (use for blocking)
489	I15BK	Terminal I15 is not OK (use for blocking)
489	I06BK	Terminal I06 is not OK (use for blocking)
489	I14BK	Terminal I14 is not OK (use for blocking)
489	I05BK	Terminal I05 is not OK (use for blocking)
490	I21BK	Terminal I21 is not OK (use for blocking)
490	V03BK	Terminal V03 is not OK (use for blocking)

**Table 11.2 Row List of Relay Word Bits (Sheet 88 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
490	I20BK	Terminal I20 is not OK (use for blocking)
490	V02BK	Terminal V02 is not OK (use for blocking)
490	I19BK	Terminal I19 is not OK (use for blocking)
490	V01BK	Terminal V01 is not OK (use for blocking)
490	I18BK	Terminal I18 is not OK (use for blocking)
490	I09BK	Terminal I09 is not OK (use for blocking)
491	*	Reserved
<b>SV and TiDL Subscription Terminal Freeze Bits</b>		
496	I13FZ	Terminal I13 freeze bit for use in open phase logic and breaker failure logic
496	I04FZ	Terminal I04 freeze bit for use in open phase logic and breaker failure logic
496	I12FZ	Terminal I12 freeze bit for use in open phase logic and breaker failure logic
496	I03FZ	Terminal I03 freeze bit for use in open phase logic and breaker failure logic
496	I11FZ	Terminal I11 freeze bit for use in open phase logic and breaker failure logic
496	I02FZ	Terminal I02 freeze bit for use in open phase logic and breaker failure logic
496	I10FZ	Terminal I10 freeze bit for use in open phase logic and breaker failure logic
496	I01FZ	Terminal I01 freeze bit for use in open phase logic and breaker failure logic
497	I17FZ	Terminal I17 freeze bit for use in open phase logic and breaker failure logic
497	I08FZ	Terminal I08 freeze bit for use in open phase logic and breaker failure logic
497	I16FZ	Terminal I16 freeze bit for use in open phase logic and breaker failure logic
497	I07FZ	Terminal I07 freeze bit for use in open phase logic and breaker failure logic
497	I15FZ	Terminal I15 freeze bit for use in open phase logic and breaker failure logic
497	I06FZ	Terminal I06 freeze bit for use in open phase logic and breaker failure logic
497	I14FZ	Terminal I14 freeze bit for use in open phase logic and breaker failure logic
497	I05FZ	Terminal I05 freeze bit for use in open phase logic and breaker failure logic
498	I21FZ	Terminal I21 freeze bit for use in open phase logic and breaker failure logic
498	I20FZ	Terminal I20 freeze bit for use in open phase logic and breaker failure logic
498	I19FZ	Terminal I19 freeze bit for use in open phase logic and breaker failure logic
498	I18FZ	Terminal I18 freeze bit for use in open phase logic and breaker failure logic
498	I09FZ	Terminal I09 freeze bit for use in open phase logic and breaker failure logic
498	*	Reserved
498	*	Reserved
498	*	Reserved
499	*	Reserved
<b>SV and TiDL Application Freeze Bits and Blocking Bits</b>		
500	*	Reserved
500	SVBLK	General blocking bit for SV applications
500	SVBK_EX	Extended general blocking bit for SV applications

**Table 11.2 Row List of Relay Word Bits (Sheet 89 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
500	*	Reserved
501	87Z1BK	Differential Zone 1 blocking bit (because of loss of SV data)
501	87Z2BK	Differential Zone 2 blocking bit (because of loss of SV data)
501	87Z3BK	Differential Zone 3 blocking bit (because of loss of SV data)
501	87Z4BK	Differential Zone 4 blocking bit (because of loss of SV data)
501	87Z5BK	Differential Zone 5 blocking bit (because of loss of SV data)
501	87Z6BK	Differential Zone 6 blocking bit (because of loss of SV data)
501	*	Reserved
501	*	Reserved
502	87CZ1BK	Check Zone 1 blocking bit (because of loss of SV data)
502	87CZ2BK	Check Zone 2 blocking bit (because of loss of SV data)
502	87CZ3BK	Check Zone 3 blocking bit (because of loss of SV data)
502	*	Reserved
503	*	Reserved
<b>IEC 61850 Control Mode Control Bits</b>		
504	SC850TM	SELOGIC control for IEC 61850 Test Mode
504	SC850BM	SELOGIC control for IEC 61850 Block Mode
504	SC850SM	SELOGIC control for IEC 61850 Simulation Mode
504	*	Reserved
<b>TiDL Mapped Output Contact Status</b>		
506	OUT308S	Mapped OUT308 contact status
506	OUT307S	Mapped OUT307 contact status
506	OUT306S	Mapped OUT306 contact status
506	OUT305S	Mapped OUT305 contact status
506	OUT304S	Mapped OUT304 contact status
506	OUT303S	Mapped OUT303 contact status

**Table 11.2 Row List of Relay Word Bits (Sheet 90 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
506	OUT302S	Mapped OUT302 contact status
506	OUT301S	Mapped OUT301 contact status
507	OUT316S	Mapped OUT316 contact status
507	OUT315S	Mapped OUT315 contact status
507	OUT314S	Mapped OUT314 contact status
507	OUT313S	Mapped OUT313 contact status
507	OUT312S	Mapped OUT312 contact status
507	OUT311S	Mapped OUT311 contact status
507	OUT310S	Mapped OUT310 contact status
507	OUT309S	Mapped OUT309 contact status
508	OUT408S	Mapped OUT408 contact status
508	OUT407S	Mapped OUT407 contact status
508	OUT406S	Mapped OUT406 contact status
508	OUT405S	Mapped OUT405 contact status
508	OUT404S	Mapped OUT404 contact status
508	OUT403S	Mapped OUT403 contact status
508	OUT402S	Mapped OUT402 contact status
508	OUT401S	Mapped OUT401 contact status
509	OUT416S	Mapped OUT416 contact status
509	OUT415S	Mapped OUT415 contact status
509	OUT414S	Mapped OUT414 contact status
509	OUT413S	Mapped OUT413 contact status
509	OUT412S	Mapped OUT412 contact status
509	OUT411S	Mapped OUT411 contact status
509	OUT410S	Mapped OUT410 contact status
509	OUT409S	Mapped OUT409 contact status
510	OUT508S	Mapped OUT508 contact status
510	OUT507S	Mapped OUT507 contact status
510	OUT506S	Mapped OUT506 contact status
510	OUT505S	Mapped OUT505 contact status
510	OUT504S	Mapped OUT504 contact status
510	OUT503S	Mapped OUT503 contact status
510	OUT502S	Mapped OUT502 contact status
510	OUT501S	Mapped OUT501 contact status
511	OUT516S	Mapped OUT516 contact status
511	OUT515S	Mapped OUT515 contact status
511	OUT514S	Mapped OUT514 contact status
511	OUT513S	Mapped OUT513 contact status
511	OUT512S	Mapped OUT512 contact status
511	OUT511S	Mapped OUT511 contact status

**Table 11.2 Row List of Relay Word Bits (Sheet 91 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
511	OUT510S	Mapped OUT510 contact status
511	OUT509S	Mapped OUT509 contact status
<b>TiDL Port Map Bits</b>		
512	P6HMAP	PORT 6H mapped
512	P6GMAP	PORT 6G mapped
512	P6FMAP	PORT 6F mapped
512	P6EMAP	PORT 6E mapped
512	P6DMAP	PORT 6D mapped
512	P6CMAP	PORT 6C mapped
512	P6BMAP	PORT 6B mapped
512	P6AMAP	PORT 6A mapped
513	*	Reserved
514	*	Reserved
515	*	Reserved
<b>TiDL Port Status Bits</b>		
516	P6HOK	PORT 6H OK
516	P6GOK	PORT 6G OK
516	P6FOK	PORT 6F OK
516	P6EOK	PORT 6E OK
516	P6DOK	PORT 6D OK

**Table 11.2 Row List of Relay Word Bits (Sheet 92 of 97)**

**Table 11.2 Row List of Relay Word Bits (Sheet 93 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
521	*	Reserved
521	*	Reserved
522	*	Reserved
523	*	Reserved
<b>IED Local Remote Bits</b>		
524	LOC	Control authority at local (bay) level
524	SC850LS	SELOGIC control for control authority at station level
524	MLTLEV	Multi-level control authority
524	LOCSTA	Control authority at station level
524	*	Reserved
<b>Automation SELOGIC Condition Timers</b>		
528	ACT08Q	Automation SELOGIC conditioning timer Output 08
528	ACT07Q	Automation SELOGIC conditioning timer Output 07
528	ACT06Q	Automation SELOGIC conditioning timer Output 06
528	ACT05Q	Automation SELOGIC conditioning timer Output 05
528	ACT04Q	Automation SELOGIC conditioning timer Output 04
528	ACT03Q	Automation SELOGIC conditioning timer Output 03
528	ACT02Q	Automation SELOGIC conditioning timer Output 02
528	ACT01Q	Automation SELOGIC conditioning timer Output 01
529	ACT16Q	Automation SELOGIC conditioning timer Output 16
529	ACT15Q	Automation SELOGIC conditioning timer Output 15
529	ACT14Q	Automation SELOGIC conditioning timer Output 14
529	ACT13Q	Automation SELOGIC conditioning timer Output 13
529	ACT12Q	Automation SELOGIC conditioning timer Output 12

**Table 11.2 Row List of Relay Word Bits (Sheet 94 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
529	ACT11Q	Automation SELOGIC conditioning timer Output 11
529	ACT10Q	Automation SELOGIC conditioning timer Output 10
529	ACT09Q	Automation SELOGIC conditioning timer Output 09
530	ACT24Q	Automation SELOGIC conditioning timer Output 24
530	ACT23Q	Automation SELOGIC conditioning timer Output 23
530	ACT22Q	Automation SELOGIC conditioning timer Output 22
530	ACT21Q	Automation SELOGIC conditioning timer Output 21
530	ACT20Q	Automation SELOGIC conditioning timer Output 20
530	ACT19Q	Automation SELOGIC conditioning timer Output 19
530	ACT18Q	Automation SELOGIC conditioning timer Output 18
530	ACT17Q	Automation SELOGIC conditioning timer Output 17
531	ACT32Q	Automation SELOGIC conditioning timer Output 32
531	ACT31Q	Automation SELOGIC conditioning timer Output 31
531	ACT30Q	Automation SELOGIC conditioning timer Output 30
531	ACT29Q	Automation SELOGIC conditioning timer Output 29
531	ACT28Q	Automation SELOGIC conditioning timer Output 28
531	ACT27Q	Automation SELOGIC conditioning timer Output 27
531	ACT26Q	Automation SELOGIC conditioning timer Output 26
531	ACT25Q	Automation SELOGIC conditioning timer Output 25
<b>Local Bits 2</b>		
532	LB40	Local Bit 40
532	LB39	Local Bit 39
532	LB38	Local Bit 38
532	LB37	Local Bit 37
532	LB36	Local Bit 36
532	LB35	Local Bit 35
532	LB34	Local Bit 34
532	LB33	Local Bit 33
533	LB48	Local Bit 48
533	LB47	Local Bit 47
533	LB46	Local Bit 46
533	LB45	Local Bit 45
533	LB44	Local Bit 44
533	LB43	Local Bit 43
533	LB42	Local Bit 42
533	LB41	Local Bit 41
534	LB56	Local Bit 56
534	LB55	Local Bit 55
534	LB54	Local Bit 54
534	LB53	Local Bit 53
534	LB52	Local Bit 52

**Table 11.2 Row List of Relay Word Bits (Sheet 95 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
534	LB51	Local Bit 51
534	LB50	Local Bit 50
534	LB49	Local Bit 49
535	LB64	Local Bit 64
535	LB63	Local Bit 63
535	LB62	Local Bit 62
535	LB61	Local Bit 61
535	LB60	Local Bit 60
535	LB59	Local Bit 59
535	LB58	Local Bit 58
535	LB57	Local Bit 57
<b>Local Bit Supervision 2</b>		
536	LB_SP40	Local Bit 40 supervision (SELOGIC control equation)
536	LB_SP39	Local Bit 39 supervision (SELOGIC control equation)
536	LB_SP38	Local Bit 38 supervision (SELOGIC control equation)
536	LB_SP37	Local Bit 37 supervision (SELOGIC control equation)
536	LB_SP36	Local Bit 36 supervision (SELOGIC control equation)
536	LB_SP35	Local Bit 35 supervision (SELOGIC control equation)
536	LB_SP34	Local Bit 34 supervision (SELOGIC control equation)
536	LB_SP33	Local Bit 33 supervision (SELOGIC control equation)
537	LB_SP48	Local Bit 48 supervision (SELOGIC control equation)
537	LB_SP47	Local Bit 47 supervision (SELOGIC control equation)
537	LB_SP46	Local Bit 46 supervision (SELOGIC control equation)
537	LB_SP45	Local Bit 45 supervision (SELOGIC control equation)
537	LB_SP44	Local Bit 44 supervision (SELOGIC control equation)
537	LB_SP43	Local Bit 43 supervision (SELOGIC control equation)
537	LB_SP42	Local Bit 42 supervision (SELOGIC control equation)
537	LB_SP41	Local Bit 41 supervision (SELOGIC control equation)
538	LB_SP56	Local Bit 56 supervision (SELOGIC control equation)
538	LB_SP55	Local Bit 55 supervision (SELOGIC control equation)
538	LB_SP54	Local Bit 54 supervision (SELOGIC control equation)
538	LB_SP53	Local Bit 53 supervision (SELOGIC control equation)
538	LB_SP52	Local Bit 52 supervision (SELOGIC control equation)
538	LB_SP51	Local Bit 51 supervision (SELOGIC control equation)
538	LB_SP50	Local Bit 50 supervision (SELOGIC control equation)
538	LB_SP49	Local Bit 49 supervision (SELOGIC control equation)
539	LB_SP64	Local Bit 64 supervision (SELOGIC control equation)
539	LB_SP63	Local Bit 63 supervision (SELOGIC control equation)
539	LB_SP62	Local Bit 62 supervision (SELOGIC control equation)
539	LB_SP61	Local Bit 61 supervision (SELOGIC control equation)
539	LB_SP60	Local Bit 60 supervision (SELOGIC control equation)

**Table 11.2 Row List of Relay Word Bits (Sheet 96 of 97)**

<b>Row</b>	<b>Name</b>	<b>Bit Description</b>
539	LB_SP59	Local Bit 59 supervision (SELOGIC control equation)
539	LB_SP58	Local Bit 58 supervision (SELOGIC control equation)
539	LB_SP57	Local Bit 57 supervision (SELOGIC control equation)
<b>Local Bit Status 2</b>		
540	LB_DP40	Local Bit 40 status display (SELOGIC control equation)
540	LB_DP39	Local Bit 39 status display (SELOGIC control equation)
540	LB_DP38	Local Bit 38 status display (SELOGIC control equation)
540	LB_DP37	Local Bit 37 status display (SELOGIC control equation)
540	LB_DP36	Local Bit 36 status display (SELOGIC control equation)
540	LB_DP35	Local Bit 35 status display (SELOGIC control equation)
540	LB_DP34	Local Bit 34 status display (SELOGIC control equation)
540	LB_DP33	Local Bit 33 status display (SELOGIC control equation)
541	LB_DP48	Local Bit 48 status display (SELOGIC control equation)
541	LB_DP47	Local Bit 47 status display (SELOGIC control equation)
541	LB_DP46	Local Bit 46 status display (SELOGIC control equation)
541	LB_DP45	Local Bit 45 status display (SELOGIC control equation)
541	LB_DP44	Local Bit 44 status display (SELOGIC control equation)
541	LB_DP43	Local Bit 43 status display (SELOGIC control equation)
541	LB_DP42	Local Bit 42 status display (SELOGIC control equation)
541	LB_DP41	Local Bit 41 status display (SELOGIC control equation)
542	LB_DP56	Local Bit 56 status display (SELOGIC control equation)
542	LB_DP55	Local Bit 55 status display (SELOGIC control equation)
542	LB_DP54	Local Bit 54 status display (SELOGIC control equation)
542	LB_DP53	Local Bit 53 status display (SELOGIC control equation)
542	LB_DP52	Local Bit 52 status display (SELOGIC control equation)
542	LB_DP51	Local Bit 51 status display (SELOGIC control equation)
542	LB_DP50	Local Bit 50 status display (SELOGIC control equation)
542	LB_DP49	Local Bit 49 status display (SELOGIC control equation)
543	LB_DP64	Local Bit 64 status display (SELOGIC control equation)
543	LB_DP63	Local Bit 63 status display (SELOGIC control equation)
543	LB_DP62	Local Bit 62 status display (SELOGIC control equation)
543	LB_DP61	Local Bit 61 status display (SELOGIC control equation)
543	LB_DP60	Local Bit 60 status display (SELOGIC control equation)
543	LB_DP59	Local Bit 59 status display (SELOGIC control equation)
543	LB_DP58	Local Bit 58 status display (SELOGIC control equation)
543	LB_DP57	Local Bit 57 status display (SELOGIC control equation)
<b>Parallel Redundancy Protocol Supervision</b>		
544	PRPAGOK	PRP PORT 5A GOOSE status
544	PRPBGOK	PRP PORT 5B GOOSE status
544	PRPCGOK	PRP PORT 5C GOOSE status
544	PRPDGOK	PRP PORT 5D GOOSE status

**Table 11.2 Row List of Relay Word Bits (Sheet 97 of 97)**

Row	Name	Bit Description
544	PRPASOK	PRP PORT 5A SV status
544	PRPBSOK	PRP PORT 5B SV status

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## S E C T I O N   1 2

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# Analog Quantities

This section contains tables of the analog quantities available within the SEL-487B-2 Relay.

Use *Table 12.1* and *Table 12.2* as a reference for labels in this manual and as a resource for quantities you use in SELOGIC control equation relay settings.

*Table 12.1* lists the analog quantities alphabetically, and *Table 12.2* groups the analog quantities by function.

**Table 12.1 Analog Quantities Sorted Alphabetically (Sheet 1 of 3)**

Label	Description	Units
3V0FII	Filtered instantaneous zero seq. voltage (imaginary)	V (secondary)
3V0FIM	Filtered instantaneous zero seq. voltage (magnitude)	V (secondary)
3V0FIR	Filtered instantaneous zero seq. voltage (real)	V (secondary)
3V2FII	Filtered instantaneous negative seq. voltage (imaginary)	V (secondary)
3V2FIM	Filtered instantaneous negative seq. voltage (magnitude)	V (secondary)
3V2FIR	Filtered instantaneous negative seq. voltage (real)	V (secondary)
51P01–51P21	51 Element 01–21 pickup value	A (secondary)
51TD01–51TD21	51 Element 01–21 time-dial setting	—
ACN01CV–ACN32CV	Automation SELOGIC counter current value	N/A
ACN01PV–ACN32PV	Automation SELOGIC counter preset value	N/A
ACT01DO–ACT32DO	Automation SELOGIC conditioning timer dropout time	s
ACT01PU–ACT32PU	Automation SELOGIC conditioning timer pickup time	s
ACTGRP	Active group setting	N/A
AMV001–AMV256	Automation SELOGIC math variable	N/A
AST01ET–AST32ET	Automation SELOGIC math sequencing timer elapsed time	s
AST01PT–AST32PT	Automation SELOGIC sequencing timer preset time	s
BNCDSJI	BNC port 100PPS data stream jitter	µs
BNCOTJF	Fast converging BNC port ON TIME marker jitter, coarse accuracy	µs
BNCOTJS	Slow converging BNC port ON TIME marker jitter, fine accuracy	µs
BNCTBTW	Time between BNC 100PPS pulses	µs
CUR_SRC	Current high-priority time source	N/A
DC1	Station Battery 1 dc voltage	V
DC1MAX	Maximum dc 1 voltage	V
DC1MIN	Minimum dc 1 voltage	V
DC1NE	Average negative-to-ground dc 1 voltage	V
DC1PO	Average positive-to-ground dc 1 voltage	V
DC1RI	AC ripple of dc 1 voltage	V
DDOM	UTC Date, day of the month (1–31)	day

**Table 12.1 Analog Quantities Sorted Alphabetically (Sheet 2 of 3)**

<b>Label</b>	<b>Description</b>	<b>Units</b>
DDOW	UTC Date, day of the week (1-SU,.., 7-SA)	N/A
DDOY	UTC Date, day of the year (1–366)	day
DLDOM	Local date, day of the month (1–31)	day
DLDOW	Local date, day of the week (1-SU,.., 7-SA)	N/A
DLDOY	Local date, day of the year (1–366)	day
DLMON	Local date, month (1–12)	month
DLYEAR	Local date, year (2000–2200)	year
DMON	UTC date, month (1–12)	month
DYEAR	UTC date, year (2000–2200)	year
I01FA–I21FA	1-cycle average phase current (angle)	Degrees [°]
I01FIA–I21FIA	Filtered instantaneous phase current (angle)	Degrees [°]
I01FII–I21FII	Filtered instantaneous phase current (imaginary)	A (secondary)
I01FIM–I21FIM	Filtered instantaneous phase current (magnitude)	A (secondary)
I01FIR–I21FIR	Filtered instantaneous phase current (real)	A (secondary)
I01FM–I21FM	1-cycle average phase current (magnitude)	A (primary)
I850MOD	IEC 61850 Mode/Behavior status	N/A
IOPCZ1–IOPCZ3	Check Zones 1–3 operating current	pu
IOPCZ1F–IOPCZ3F	1-cycle average Check Zones 1–3 operating current	pu
IOP1–IOP6	Zones 1–6 operating current	pu
IOP1F–IOP6F	1-cycle average Zones 1–6 operating current	pu
IRTCZ1–IRTCZ3	Check Zones 1–3 Restraint current	pu
IRTCZ1F–IRTCZ3F	1-cycle average Check Zones 1–3 restraint current	pu
IRT1–IRT6	Zones 1–6 restraint current	pu
IRT1F–IRT6F	1-cycle average Zones 1–6 restraint current	pu
MB1A–MB7A	A Channel received MIRRORED BITS analog values	N/A
MB1B - MB7B	B Channel received MIRRORED BITS analog values	N/A
NEW_SRC	Selected high-priority time source	N/A
PCN01CV–PCN32CV	Protection SELOGIC counter current value	N/A
PCN01PV–PCN32PV	Protection SELOGIC counter preset value	N/A
PCT01DO–PCT16DO	Protection SELOGIC conditioning timer dropout time	cycles
PCT01PU–PCT16PU	Protection SELOGIC conditioning timer pickup time	cycles
PMV01–PMV64	Protection SELOGIC math variable	N/A
PST01ET–PST32ET	Protection SELOGIC sequencing timer elapsed time	cycles
PST01PT–PST32PT	Protection SELOGIC sequencing timer preset time	cycles
PTPDSJI	PTP 100PPS data stream jitter in $\mu$ s	$\mu$ s
PTPMCC	PTP master clock class enumerated value	N/A
PTPOFST	Raw clock offset between PTP master and relay time	ns
PTPOTJF	Fast converging PTP ON TIME marker jitter in $\mu$ s, coarse accuracy	$\mu$ s
PTPOTJS	Slow converging PTP ON TIME marker jitter in $\mu$ s, fine accuracy	$\mu$ s
PTPPORT	Active PTP port number	N/A
PTPSTEN	PTP port state enumerated value	N/A

**Table 12.1 Analog Quantities Sorted Alphabetically (Sheet 3 of 3)**

<b>Label</b>	<b>Description</b>	<b>Units</b>
PTPTBTW	Time between PTP 100PPS pulses in $\mu$ s	$\mu$ s
RA001–RA256	Remote analogs	N/A
RAO01–RAO64	Remote analog output	—
RLYTEMP	Relay temperature (temperature of the box)	°C (degrees Celsius)
SERDSJI	Serial port 100PPS data stream jitter	$\mu$ s
SEROTJF	Fast converging serial port ON TIME marker jitter, coarse accuracy	$\mu$ s
SEROTJS	Slow converging serial port ON TIME marker jitter, fine accuracy	$\mu$ s
SERTBTW	Time between serial 100PPS pulses	$\mu$ s
SMPSYNC	Locally derived SmpSync value	N/A
SQUAL	Synchronization accuracy of the selected high-priority time source	$\mu$ s
SV01SNC–SV07SNC	Incoming SmpSync value per subscribed SV stream	N/A
SVND01–SVND07	Network delay for the subscribed SV stream	ms
THR	UTC time, hour (0–23)	hr
TLHR	Local time, hour (0–23)	hr
TLMIN	Local time, minute (0–59)	min
TLMSEC	Local time, milliseconds (0–999)	ms
TLNSEC	Local time, nanoseconds (0–999999)	ns
TLODMS	Local time of day in milliseconds (0–86400000)	ms
TLSEC	Local time, seconds (0–59)	s
TMIN	UTC time, minute (0–59)	min
TMSEC	UTC time, milliseconds (0–999)	ms
TNSEC	UTC time, nanoseconds (0–999999)	ns
TODMS	UTC time of day in milliseconds (0–86400000)	ms
TQUAL	Worst-case clock time error of the selected high-priority time source	s
TSEC	UTC time, seconds (0–59)	s
TUTC	Offset from local time to UTC time	hr
V1FII	Filtered instantaneous positive-sequence voltage (imaginary)	V (secondary)
V1FIM	Filtered instantaneous positive-sequence voltage (magnitude)	V (secondary)
V1FIR	Filtered instantaneous positive-sequence voltage (real)	V (secondary)
V01FA–V03FA	1-cycle average phase voltage (angle)	Degrees [°]
V01FIA–V03FIA	Filtered instantaneous phase voltage (angle)	Degrees [°]
V01FII–F03FII	Filtered instantaneous phase voltage (imaginary)	V (secondary)
V01FIM–V03FIM	Filtered instantaneous phase voltage (magnitude)	V (secondary)
V01FIR–F03FIR	Filtered instantaneous phase voltage (real)	V (secondary)
V01FM–V03FM	1-cycle average phase voltage (magnitude)	kV (primary)

**Table 12.2 Analog Quantities Sorted by Function (Sheet 1 of 4)**

<b>Label</b>	<b>Description</b>	<b>Units</b>
<b>Current</b>		
<i>Inn</i> FIM <sup>a</sup>	Phase-filtered instantaneous current magnitude	A (secondary)
<i>Inn</i> FIA <sup>a</sup>	Phase-filtered instantaneous current angle	degrees

**Table 12.2 Analog Quantities Sorted by Function (Sheet 2 of 4)**

<b>Label</b>	<b>Description</b>	<b>Units</b>
<i>InnFIR</i> <sup>a</sup>	Phase-filtered instantaneous current (real)	A (secondary)
<i>InnFII</i> <sup>a</sup>	Phase-filtered instantaneous current (imaginary)	A (secondary)
<i>InnFM</i> <sup>a</sup>	Phase one-cycle average current magnitude	A (primary)
<i>InnFA</i> <sup>a</sup>	Phase one-cycle average current angle	degrees
<i>IOPk</i> <sup>b</sup>	Zone <i>k</i> operating current	pu
<i>IOPCZp</i> <sup>c</sup>	Check Zone <i>p</i> operating current	pu
<i>IRTk</i> <sup>b</sup>	Zone <i>k</i> restraint current	pu
<i>IRTCZp</i> <sup>c</sup>	Check Zone <i>p</i> restraint current	pu
<i>IOPkF</i> <sup>b</sup>	Zone <i>k</i> one-cycle average operating current	pu
<i>IOPCZpF</i> <sup>c</sup>	Check Zone <i>p</i> one-cycle average operating current	pu
<i>IRTkF</i> <sup>b</sup>	Zone <i>k</i> one-cycle average restraint current	pu
<i>IRTCZpF</i> <sup>c</sup>	Check Zone <i>p</i> one-cycle average restraint current	pu
<b>Voltage</b>		
<i>VmmFIM</i> <sup>d</sup>	Phase-filtered instantaneous voltage magnitude	V (secondary)
<i>VmmFIA</i> <sup>d</sup>	Phase-filtered instantaneous voltage angle	degrees
<i>VmmFIR</i> <sup>d</sup>	Phase-filtered instantaneous voltage (real)	V (secondary)
<i>VmmFII</i> <sup>d</sup>	Phase-filtered instantaneous voltage (imaginary)	V (secondary)
<i>VmmFM</i> <sup>d</sup>	Phase one-cycle average voltage magnitude	kV (primary)
<i>VmmFA</i> <sup>d</sup>	Phase one-cycle average voltage angle	degrees
<i>V1FIM</i>	Positive-sequence filtered instantaneous voltage magnitude, V1	V (secondary)
<i>V1FIR</i>	Positive-sequence filtered instantaneous voltage (real)	V (secondary)
<i>V1FII</i>	Positive-sequence filtered instantaneous voltage (imaginary)	V (secondary)
<i>3V2FIM</i>	Negative-sequence filtered instantaneous voltage magnitude, 3V2	V (secondary)
<i>3V2FIR</i>	Negative-sequence filtered instantaneous voltage (real)	V (secondary)
<i>3V2FII</i>	Negative-sequence filtered instantaneous voltage (imaginary)	V (secondary)
<i>3V0FIM</i>	Zero-sequence filtered instantaneous voltage magnitude, 3V0	V (secondary)
<i>3V0FIR</i>	Zero-sequence filtered instantaneous voltage (real)	V (secondary)
<i>3V0FII</i>	Zero-sequence filtered instantaneous voltage (imaginary)	V (secondary)
<i>DC1</i>	Filtered dc monitor voltage	V
<i>DC1PO</i>	Average positive-to-ground dc voltage	V
<i>DC1NE</i>	Average negative-to-ground dc voltage	V
<i>DC1RI</i>	AC ripple of dc voltage (peak-to-peak)	V
<i>DC1MIN</i>	Minimum dc voltage	V
<i>DC1MAX</i>	Maximum dc voltage	V
<b>Database Structure</b>		
RA001–RA256	Remote analogs from Ethernet card	N/A
<b>Output Settings</b>		
RAO001–RAO064	Remote analog output	N/A
<b>Date and Time</b>		
<i>TODMS</i>	UTC time of day in milliseconds (0–86399999)	ms
<i>THR</i>	UTC time, hour (0–23)	hr

**Table 12.2 Analog Quantities Sorted by Function (Sheet 3 of 4)**

<b>Label</b>	<b>Description</b>	<b>Units</b>
TMIN	UTC time, minute (0–59)	min
TSEC	UTC time, seconds (0–59)	s
TMSEC	UTC time, milliseconds (0–999)	ms
TNSEC	UTC time, nanoseconds (0–999999)	ns
DDOW	UTC date, day of the week (Encoded value: 1 = Sun, 2 = Mon, 3 = Tue, 4 = Wed, 5 = Thu, 6 = Fri, 7 = Sat)	N/A
DDOM	UTC date, day of the month (1–31)	day
DDOY	UTC date, day of the year (1–366)	day
DMON	UTC date, month (1–12)	month
DYEAR	UTC date, year (2000–2200)	year
TLODMS	Local time of Day in Milliseconds (0–86400000)	ms
TLHR	Local time, hour (0–23)	hr
TLMIN	Local time, minute (0–59)	min
TLSEC	Local time, seconds (0–59)	s
TLMSEC	Local time, milliseconds (0–999)	ms
TLNSEC	Local time, nanoseconds (0–999999)	ns
DLDOW	Local date, day of the week (1-SU, ..., 7-SA)	N/A
DLDOM	Local date, day of the month (1–31)	day
DLDOTY	Local date, day of the year (1–366)	day
DLMON	Local date, month (1–12)	month
DLYEAR	Local date, year (2000–2200)	year
<b>High-Priority Time Analogs</b>		
TUTC	Offset from local time to UTC time	hr
TQUAL	Worst-case clock time error of the selected high-priority time source	s
NEW_SRC	Selected high-priority time source	N/A
CUR_SRC	Current high-priority time source	N/A
SQUAL	Synchronization accuracy of the selected high-priority time source	μs
BNCDSJI	BNC port 100PPS data stream jitter	μs
BNCOTJS	Slow converging BNC port ON TIME marker jitter, fine accuracy	μs
BNCOTJF	Fast converging BNC port ON TIME marker jitter, coarse accuracy	μs
BNCTBTW	Time between BNC 100PPS pulses	μs
SERDSJI	Serial port 100PPS data stream jitter	μs
SEROTJS	Slow converging serial port ON TIME marker jitter, fine accuracy	μs
SEROTJF	Fast converging serial port ON TIME marker jitter, coarse accuracy	μs
SERTBTW	Time between serial 100PPS pulses	μs
<b>MIRRORED BITS Communications</b>		
MB1A-MB7A	MIRRORED BITS communications Channel A received analog values	N/A
MB1B-MB7B	MIRRORED BITS communications Channel B received analog values	N/A
<b>SELOGIC and Automation Elements</b>		
PMV01-PMV64	Protection SELOGIC control equation math variable	N/A
PCT01PU-PCT16PU	Protection conditioning timer pickup time	cycles

**Table 12.2 Analog Quantities Sorted by Function (Sheet 4 of 4)**

<b>Label</b>	<b>Description</b>	<b>Units</b>
PCT01DO–PCT16DO	Protection conditioning timer dropout time	cycles
PST01ET–PST32ET	Protection sequencing timer elapsed time	cycles
PST01PT–PST32PT	Protection sequencing timer preset time	cycles
PCN01CV–PCN32CV	Protection counter current value	N/A
PCN01PV–PCN32PV	Protection counter preset value	N/A
AMV001–AMV256	Automation SELOGIC control equation math variable	N/A
ACT01PU–ACT32PU	Automation SELOGIC conditioning timer pickup time	s
ACT01DO–ACT32DO	Automation SELOGIC conditioning timer dropout time	s
AST01ET–AST32ET	Automation sequencing timer elapsed time	s
AST01PT–AST32PT	Automation sequencing timer preset time	s
ACN01CV–ACN32CV	Automation counter current value	N/A
ACN01PV–ACN32PV	Automation counter preset value	N/A
<b>Setting Group</b>		
ACTGRP	Active group setting	N/A
<b>51 Elements</b>		
51P <sup>d</sup> <i>mm</i>	51 Element <i>mm</i> pickup value	A (secondary)
51TD <sup>d</sup> <i>mm</i>	51 Element <i>mm</i> time-dial setting	N/A
<b>Auxiliary Channels</b>		
RLYTEMP	Relay temperature (temperature of the box)	°C (degrees Celsius)
<b>IEEE 1588 PTP Status</b>		
PTPDSJI	PTPDSJI PTP 100PPS data stream jitter in μs	μs
PTPMCC	PTP master clock class enumerated value	N/A
PTPOTJS	PTPOTJS Slow converging PTP ON TIME marker jitter in μs, fine accuracy	μs
PTPOTJF	PTPOTJF Fast converging PTP ON TIME marker jitter in μs, coarse accuracy	μs
PTPOFST	PTPOFST Raw clock offset between PTP master and relay time	ns
PTPPORT	Active PTP port number	N/A
PTPTBTW	PTPTBTW Time between PTP 100PPS pulses in μs	μs
PTPSTEN	PTPSTEN PTP Port State enumerated value	N/A
<b>Sampled Values (SV) Analogs</b>		
SMPSYNC	Locally derived SmpSync value	N/A
SV01SNC–SV07SNC	Incoming SmpSync value per subscribed SV stream	N/A
SVND01–SVND07	Network delay for the subscribed SV stream	ms
<b>IEC 61850 Mode/Behavior</b>		
I850MOD	IEC 61850 Mode/Behavior status	N/A

<sup>a</sup> nn = 01-21.<sup>b</sup> k = 1-6.<sup>c</sup> p = 1-3.<sup>d</sup> mm = 01-03.

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## A P P E N D I X A

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# Firmware, ICD File, and Manual Versions

## Firmware

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### Determining the Firmware Version

**NOTE:** The SEL-487B-2 R4xx firmware version is incompatible with the SEL-487B-0 and SEL-487B-1 R1xx and R3xx firmware versions. Do not attempt to load firmware on incompatible hardware.

To determine the firmware version, view the status report by using the serial port **ID** command or the front-panel **LCD View Configuration** menu option. The status report displays the Firmware Identification (FID) number.

The firmware version will be either a standard release or a point release. A standard release adds new functionality to the firmware beyond the specifications of the existing version. A point release is reserved for modifying firmware functionality to conform to the specifications of the existing version.

A standard release is identified by a change in the R-number of the device FID number.

Existing firmware:

**FID=SEL-487B-2-R400-V0-Z001001-Dxxxxxxxx**

Standard release firmware:

**FID=SEL-487B-2-R401-V0-Z001001-Dxxxxxxxx**

A point release is identified by a change in the V-number of the device FID number.

Existing firmware:

**FID=SEL-487B-2-R400-V0-Z001001-Dxxxxxxxx**

Point release firmware:

**FID=SEL-487B-2-R400-V1-Z001001-Dxxxxxxxx**

The date code is after the D. For example, the following is firmware version number R400, date code October 12, 2018.

**SEL-487B-2-R400-V0-Z100100-D20181012**

Similarly, the device SELBOOT firmware version (BFID) will be reported as:

**BFID=SLBT-4XX-Rxx-Vx-Zxxxxxx-Dxxxxxxxx**

## Revision History

*Table A.1* lists the firmware versions, revision descriptions, and corresponding instruction manual date codes. The most recent firmware version is listed first.

Starting with revisions published after March 1, 2022, changes that address cybersecurity vulnerabilities are marked with “[Cybersecurity]”. Other improvements to cybersecurity functionality that should be evaluated for potential cybersecurity importance are marked with “[Cybersecurity Enhancement]”.

**Table A.1 Firmware Revision History (Sheet 1 of 5)**

Firmware Identification (FID) Number	Summary of Revisions	Manual Date Code
SEL-487B-2-R405-V0-Z104101-D20240509	<ul style="list-style-type: none"> <li>➤ [Cybersecurity] Resolved an issue where a maliciously crafted web request sent to the relay from an unauthenticated user could cause a diagnostic restart. By design, three diagnostic restarts within 7 days cause the relay to disable. This issue can only be triggered when the Port 5 setting EHTTP is configured to Y.</li> <li>➤ Resolved an issue where the relay could indicate an incorrect time-synchronization status when the relay was transitioning between two Grandmaster clock sources and the active clock source was no longer available. This does not apply when both clocks are globally time-synchronized.</li> </ul>	20240509
SEL-487B-2-R404-V0-Z104101-D20231207	<ul style="list-style-type: none"> <li>➤ Resolved an issue where MMS time stamps do not match the SER time stamps for Relay Word bit state changes during a settings or IEC 61850 Mode/Behavior change.</li> <li>➤ Resolved an issue where a change of an stSelD (status selector) attribute may not generate an MMS buffered or unbuffered report.</li> <li>➤ Modified the default value of the settings ESERDEL, SRDLCNT, and SRDLTIM to Y, 10, and 0.5, respectively.</li> <li>➤ Modified the default value of the settings ERDIG from S to A.</li> <li>➤ Enhanced the SER to automatically include an entry when entering or exiting IEC 61850 Simulation Mode.</li> <li>➤ Resolved an issue where the relay may not synchronize to a PTP time source on one of the ports when NETMODE = PRP when using the four port Ethernet card. Only firmware version R403 is affected.</li> <li>➤ Added support for MMS buffered and unbuffered report reservation.</li> <li>➤ Added support for the TiDL communications board with SFP ports, which replaces the TiDL communications board with fixed fiber ports.</li> <li>➤ Modified the STA T and STA A command responses to include information related to the TiDL communications board with SFP ports.</li> <li>➤ Modified the firmware to report zero for the Time Quality indicator code in the IEEE C37.111-2013 COMTRADE configuration file when the relay is connected to a PTP clock that is locked to a satellite-synchronized clock source.</li> </ul>	20231207
SEL-487B-2-R403-V2-Z103101-D20231110	<p>Includes all the functions of SEL-487B-2-R403-V1-Z103101-D20230830 with the following addition:</p> <ul style="list-style-type: none"> <li>➤ [Cybersecurity] Resolved an issue where MMS file transfers will cause the relay to disable. Only firmware version R403-V1 is affected.</li> </ul>	20231110
SEL-487B-2-R403-V1-Z103101-D20230830	<p>Includes all the functions of SEL-487B-2-R403-V0-Z103101-D20230317 with the following additions:</p> <ul style="list-style-type: none"> <li>➤ [Cybersecurity] Improved web server security against session hijacking.</li> <li>➤ [Cybersecurity] Improved web server security against intentionally large files causing denial of service.</li> <li>➤ [Cybersecurity] Improved web server security against cross-site scripting and misuse of session tokens.</li> <li>➤ [Cybersecurity] Resolved a rare issue where continuous event report polling requests from a communication processor can cause the relay to disable.</li> <li>➤ Improved the firmware so that access levels defined by the MAXACC setting apply correctly for MMS setting file transfers. Previously, MMS file transfer access was controlled only by MMS authentication.</li> </ul>	20230830

**Table A.1 Firmware Revision History (Sheet 2 of 5)**

Firmware Identification (FID) Number	Summary of Revisions	Manual Date Code
	<ul style="list-style-type: none"> <li>➤ Improved the performance of protection and automation latch bits during diagnostic restart.</li> <li>➤ Resolved a rare issue that could prevent the relay from restarting after a diagnostic failure.</li> </ul>	
SEL-487B-2-R403-V0-Z103101-D20230317  <b>NOTE:</b> SELBoot R302 or later is required for this and all new firmware versions. This provides the capability to convert to the five-port Ethernet card.	<ul style="list-style-type: none"> <li>➤ Added support for the five-port Ethernet card. This card provides Parallel Redundancy Protocol (PRP) for both process bus and station bus, a dedicated Ethernet port for engineering access, and greater flexibility in configuring IEC 61850 solutions.</li> <li>➤ Added the <b>COM PRP</b> command for the five-port Ethernet card. Modified the <b>COM PTP</b>, <b>ETH</b>, <b>GOO</b>, <b>MAC</b>, <b>STA</b>, and <b>VER</b> commands to include information related to the five-port Ethernet card.</li> <li>➤ Modified the synchronization status values reported in IEC 61850 LTMS.TmSyn.stVal to accurately reflect the definitions in IEC 61850-9-2.</li> <li>➤ Modified firmware to improve the IEC 61850 time accuracy value LTMS.TmAcc.stVal.</li> <li>➤ Resolved an issue where IEC 61850 simulation mode is not retained following a relay power cycle. This is applicable when simulation mode is entered using IEC 61850 MMS.</li> <li>➤ Resolved an issue where the relay could become unresponsive after an Ethernet card hardware failure.</li> <li>➤ Resolved a file transfer issue that could result in a loss of SEL Fast Message communications.</li> <li>➤ Resolved a PTP issue where the TGLOCAL Relay Word bit could incorrectly assert during the transition from a local to global time source.</li> </ul>	20230317
SEL-487B-2-R402-V0-Z102101-D20220517	<ul style="list-style-type: none"> <li>➤ [Cybersecurity] Resolved a rare, low-risk issue where deliberately crafted Ethernet traffic could cause the relay to perform a diagnostic restart.</li> <li>➤ [Cybersecurity] Updated a third-party networking software component, which removes low-risk security vulnerabilities that could result in temporary loss of Ethernet communications.</li> <li>➤ Added support for PTP Power Utility Automation profile (IEC/IEEE 61850-9-3).</li> <li>➤ Modified the firmware to remove the 1 µs accuracy requirements to assert Relay Word Bit TLOCAL. This allows SV protection to remain operational when Global time synchronization is lost.</li> <li>➤ Modified the firmware to allow for a seamless transition from TGLOCAL to TLOCAL.</li> <li>➤ Modified the firmware to allow the Automation SELOGIC conditioning timer pickup and dropout settings values to be assigned to a display point.</li> <li>➤ Added IEC 61850 and PTP settings to COMTRADE event reports.</li> <li>➤ Resolved an issue where PTP time synchronization could be lost in PRP network applications.</li> <li>➤ Enhanced the internal fault detection logic associated with the differential element.</li> <li>➤ Improved Automation SELOGIC timer accuracy. Automation SELOGIC timer accuracy is now within ±1% or ±1 s for values up to 1 month.</li> <li>➤ Added settings EACC, E2AC, and EPAC to support port access control through the use of SELOGIC control equations.</li> </ul>	20220523

**Table A.1 Firmware Revision History (Sheet 3 of 5)**

Firmware Identification (FID) Number	Summary of Revisions	Manual Date Code
	<ul style="list-style-type: none"> <li>➤ Resolved a rare issue where the SELBOOT checksum could be reported incorrectly in the VER command response.</li> <li>➤ Reduced maximum relay automatic diagnostic restart response time.</li> <li>➤ Enhanced STA A and CST command responses to include high-accuracy PTP time status.</li> <li>➤ Modified firmware to support IEC 61850-9-2 neutral current and neutral voltage subscriptions.</li> <li>➤ Modified the firmware to address SER time-stamping accuracy and IEC 61850 mode control change following a power cycle.</li> <li>➤ Modified the firmware by adding a warm start (settings change, group switch) ride-through capability for control inputs. In this release, previously asserted control inputs do not change state during warm start.</li> <li>➤ Modified the firmware to address an issue where the Simulation mode status SimSt.stVal for the LSVS and LGOS logical nodes does not transition from TRUE to FALSE for a change in the LPHD logical node Sim.stVal.</li> </ul>	
SEL-487B-2-R401-V1-Z101101-D20211203	<p>Includes all the functions of SEL-487B-2-R401-V0-Z101101-D20210326 with the following additions:</p> <ul style="list-style-type: none"> <li>➤ Resolved an issue where an MMS client may report the relay as offline when multiple MMS clients are simultaneously accessing reports.</li> <li>➤ Resolved an issue where an MMS client may not be able to retrieve file attributes associated with IEEE C37.111-2013 COMTRADE event files.</li> </ul>	20211203
<p><b>NOTE:</b> This firmware release only supports .zds digitally signed firmware files. SELBOOT R301 or newer is required for this and all new firmware versions. See Appendix B: Firmware Upgrade Instructions in the SEL-400 Series Relays Instruction Manual for more information.</p> <p><b>NOTE:</b> You can only use SEL Grid Configurator for settings version Z101 and later.</p>	<ul style="list-style-type: none"> <li>➤ Added support for Time-Domain Link (TiDL) technology that uses SEL-TMU devices and provides support for multiple point-to-point connections and user-configurable topologies.</li> <li>➤ Enhanced selective protection disabling logic that results from remote data acquisition data loss.</li> <li>➤ Modified the <b>CFG CTNOM</b> command to use the default Global and Group settings only on a nominal secondary current configuration change.</li> <li>➤ Resolved an issue where uncommon and repetitive command line operations can cause a restart when the IEC 61850 GOOSE function is enabled.</li> <li>➤ Enhanced the relay's logic to use both the BMCA algorithm and the network time inaccuracy check to choose the best Grandmaster clock on a PRP network.</li> <li>➤ Improved received GOOSE message processing speed for relay Virtual Bits mapped to GOOSE Binary data.</li> <li>➤ Increased the number of available local bits to 64.</li> <li>➤ Increased the number of available display points to 192.</li> <li>➤ Increased the number of available DNP binary outputs to 160.</li> <li>➤ Modified the firmware to interpret Group settings RTDI, OPDI, CZRTDI, and CZOPDI as peak values instead of RMS.</li> <li>➤ Improved reference angle selection for metering.</li> <li>➤ Added IEC 61850 simulation mode indication to the <b>STA</b> and <b>GOO</b> commands.</li> <li>➤ Added SELOGIC variable SC850SM to change the relay's IEC 61850 simulation mode.</li> </ul>	20210326

**Table A.1 Firmware Revision History (Sheet 4 of 5)**

Firmware Identification (FID) Number	Summary of Revisions	Manual Date Code
	<ul style="list-style-type: none"> <li>➤ Enhanced IEC 61850 processing to indicate when the invalid quality attribute is set in received GOOSE messages.</li> <li>➤ Modified firmware to report SMPCNT RANGE ERR in the <b>COM SV</b> command when the merging unit and the SV relay have mismatched nominal frequency values.</li> <li>➤ Corrected an issue where the Mode, Beh, and Health quality.validity = good is not maintained when Mode = OFF.</li> <li>➤ Modified firmware to enable DNP and IEC 61850 breaker control only when the circuit breaker jumper is installed.</li> <li>➤ Added support for the IEC 61850 Local/Remote control feature defined in the IEC 61850-7-4 standard.</li> <li>➤ Added conditioning timers to Automation SELOGIC.</li> <li>➤ Improved processing consistency of breaker control bits in Automation SELOGIC.</li> <li>➤ Modified <b>COM SV</b> command to report PDU LENGTH ERR for an incoming message with an incorrect PDU length.</li> <li>➤ Added the ability to remotely upgrade relay firmware over an Ethernet network.</li> <li>➤ Modified Ethernet communications to automatically correct a loss of synchronization between the communications subsystem and the other relay subsystems.</li> <li>➤ Improved relay response to three consecutive failed login attempts within a one-minute interval to pulse the BADPASS and SALARM Relay Word bits for all communication interfaces.</li> <li>➤ Enhanced relay self-tests to detect current or voltage magnitudes that exceed the maximum analog-to-digital converter output and perform an automatic diagnostic restart.</li> <li>➤ Added support for new IEC 61850 control and settings common data classes.</li> <li>➤ Enhanced FTP network security.</li> <li>➤ Modified firmware to retain stored data after successful reads of SER.TXT, CSER.TXT, PRO.TXT, and CPRO.TXT over Ethernet connections.</li> <li>➤ Modified firmware to support all printable ASCII characters in the password entry HMI screen.</li> <li>➤ Modified firmware to support a default profile for Precision Time Protocol when NETMODE = PRP.</li> <li>➤ Enhanced wildcard parsing used in YMODEM file transfer operations.</li> <li>➤ Modified firmware to increment the state number (stNum) in GOOSE messages for any change of the quality attribute.</li> <li>➤ Improved error handling for Ethernet interface.</li> </ul>	
SEL-487B-2-R400-V3-Z100100-D20210428	<p>Includes all the functions of SEL-487B-2-R400-V2-Z100100-D20201009 with the following additions:</p> <ul style="list-style-type: none"> <li>➤ Resolved an issue where uncommon and repetitive command line operations can cause a relay restart when the IEC 61850 GOOSE function is enabled.</li> <li>➤ Enhanced the relay's logic to use both the BMCA algorithm and the network time inaccuracy check in power profile to choose the best Grandmaster clock on a PRP network.</li> </ul>	20210428

**Table A.1 Firmware Revision History (Sheet 5 of 5)**

Firmware Identification (FID) Number	Summary of Revisions	Manual Date Code
SEL-487B-2-R400-V2-Z100100-D20201009	<p>Includes all the functions of SEL-487B-2-R400-V1-Z100100-D20191210 with the following additions:</p> <ul style="list-style-type: none"> <li>➤ Enhanced output contact behavior following a power cycle while the relay is in IEC 61850 “Blocked” or “Test/Blocked” operating mode.</li> <li>➤ Resolved an extremely rare issue that could cause the relay to perform a diagnostic restart when configured for Parallel Redundancy Protocol (NETMODE = PRP) and the relay received abnormal Ethernet traffic.</li> </ul>	20201009
SEL-487B-2-R400-V1-Z100100-D20191210	<p>Includes all the functions of SEL-487B-2-R400-V0-Z100100-D20181012 with the following addition:</p> <ul style="list-style-type: none"> <li>➤ Modified processing of pulsed Relay Word bits.</li> </ul>	20191210
SEL-487B-2-R400-V0-Z100100-D20181012	<ul style="list-style-type: none"> <li>➤ Initial version.</li> </ul>	20181012

## SELBOOT

**NOTE:** R2xx SELBOOT versions only support serial-port firmware upgrades with .s19 or .z19 firmware upgrade files. R3xx SELBoot versions only support .zds digitally signed firmware upgrade files over a serial or Ethernet connection. If upgrading from R2xx SELBOOT to R3xx SELBOOT, load the .s19 file. Do not load a .zds file when using R2xx SELBOOT.

SELBOOT is a firmware package inside the relay that handles hardware initialization and provides the functions needed to support firmware upgrades. *Table A.5* lists the SELBOOT versions used with the SEL-487B-2 Relay and revision descriptions.

**Table A.2 SELBOOT Revision History**

SELBOOT Firmware Identification (BFID) Number	Summary of Revisions
SLBT-4XX-R302-V0-Z001002-D20230317	<ul style="list-style-type: none"> <li>➤ Modified SELBOOT to support the five-port Ethernet card.</li> </ul>
SLBT-4XX-R301-V0-Z001002-D20201204	<ul style="list-style-type: none"> <li>➤ Modified SELBOOT to support digitally signed firmware on SV and TiDL devices.</li> </ul>
SLBT-4XX-R210-V0-Z001002-D20170706	<ul style="list-style-type: none"> <li>➤ First version used with SEL-487B-2.</li> </ul>

## ICD File

**NOTE:** There are two ICD files for the SEL-487B-2. The ICD file that starts with ICD-487B-2S is exclusively for the SEL-487B-2 SV Subscriber Relay (see *Table A.3*). The ICD file that starts with ICD-487B-2 is exclusively for the SEL-487B-2 TiDL Relay (see *Table A.4*).

**NOTE:** ClassFileVersion 007 supports both the four- and five-port Ethernet cards.

To find the ICD revision number in your relay, view the configVersion by using the serial port ID command. The configVersion is the last item displayed in the information returned from the ID command.

configVersion = ICD-487B-2S-R001-V0-Z400006-D20180910

The ICD revision number is after the R (e.g., 001) and the date code is after the D. This revision number is not related to the relay firmware revision number. The configVersion revision displays the ICD file version used to create the CID file that is loaded in the relay.

The configVersion contains other useful information. The Z-number consists of six digits. The first three digits following the Z represent the minimum IED firmware required to be used with the ICD (e.g., 400). The second three digits represent the ICD ClassFileVersion (e.g., 006). The ClassFileVersion increments when there is a major addition or change to the IEC 61850 implementation of the relay.

*Table A.3* lists the ICD file versions for the SEL-487B-2 SV Subscriber Relay, a description of modifications, and the instruction manual date code that corresponds to the versions. The most recent version is listed first.

**Table A.3 SEL-487B-2 SV Subscriber Relay ICD File Revision History (Sheet 1 of 2)**

configVersion	Summary of Revisions	Minimum Relay Firmware	ClassFile Version	Manual Date Code
ICD-487B-2S-R004-V0-Z404009-D20231207  NOTE: ClassFileVersion 008 did not production release.	<ul style="list-style-type: none"> <li>➤ Updated IEC 61850 Edition 2 Conformance.</li> <li>➤ Updated ClassFileVersion to 009.</li> <li>➤ Added support for MMS buffered and unbuffered report reservation.</li> </ul>	R404	009	20231207
ICD-487B-2S-R003-V0-Z402007-D20230317	<ul style="list-style-type: none"> <li>➤ Added support for the five-port Ethernet card. Added logical nodes PRPGGIO, PBLCCH, SBLCCH, EALCCH, and an additional ETHGGIO. Added multiple access points to allow for the segregation of process bus and station bus GOOSE transmission.</li> </ul>	R402	007	20230317
ICD-487B-2S-R002-V0-Z401006-D20210222	<ul style="list-style-type: none"> <li>➤ Added FltType and FltCaus data attributes to the FLTRDRE1 logical node.</li> <li>➤ Added support for the IEC 61850 Functional Naming Feature.</li> <li>➤ Added the IEC 61850 LTRK logical node for service tracking.</li> <li>➤ Corrected the IEC 61850 Data Object number extensions according to the Ed 2 number usage.</li> <li>➤ Improved consistency in deadband units for the ICD file to use voltage in kV and power in MW.</li> <li>➤ Moved IEC 61850 mode/behavior control from logical node LPHD to LLN0.</li> <li>➤ Added ALMGGIO, ETHGGIO, and SGGGIO annunciator logical nodes.</li> <li>➤ Added support for system logical nodes LSVS, LGOS, LTIM, LTMS, and LCCH.</li> <li>➤ Added status alarms to DCZBAT metering logical node.</li> <li>➤ Resolved an issue in which the quality data attribute of the MBAGGIO and MBBGGIO logical nodes were referenced to an incorrect value.</li> <li>➤ Added PRBGGIO logical nodes to support pulsing remote bits.</li> <li>➤ Added support for the IEC 61850 Local/Remote control feature defined in the IEC 61850-7-4 standard. Control messages need to include the orCat value associated with the active control authority.</li> </ul>	R401	006	20210326

**Table A.3 SEL-487B-2 SV Subscriber Relay ICD File Revision History (Sheet 2 of 2)**

<b>configVersion</b>	<b>Summary of Revisions</b>	<b>Minimum Relay Firmware</b>	<b>ClassFileVersion</b>	<b>Manual Date Code</b>
ICD-487B-2S-R001-V0-Z400006-D20180910	► SEL-487B-2S ICD file for firmware R400 or higher.	R400	006	20180910

**configVersion Details:**

ICD-[PN]-R[RN]-V[VS]-Z[FC]-D[RD] where:

[PN] = Product name (e.g., 487E-5S)

[RN]<sup>a</sup> = Revision number (e.g., 001)

[VS] = Version specifications (e.g., 0)

[FC]<sup>b</sup> = Minimum relay firmware and class file version (e.g., 400)

[RD] = Release date code (e.g., 20180910)

<sup>a</sup> This is the ICD file revision number, not IED firmware revision number.<sup>b</sup> FC consists of six digits. The first three following the Z represent the minimum IED firmware required to be used with the ICD (e.g., 516). The second three represent the ICD ClassFileVersion (e.g., 006).

*Table A.4 lists the ICD file versions for the SEL-487B-2 TiDL Relay, a description of modifications and the instruction manual date code that corresponds to the versions. The most recent version is listed first.*

**Table A.4 SEL-487B-2 TiDL ICD File Revision History**

<b>configVersion</b>	<b>Summary of Revisions</b>	<b>Minimum Relay Firmware</b>	<b>ClassFileVersion</b>	<b>Manual Date Code</b>
ICD-487B-2-R004-V0-Z404009-D20231207	► Updated IEC 61850 Edition 2 Conformance. ► Updated ClassFileVersion to 009. ► Added support for MMS buffered and unbuffered report reservation.	R404	009	20231207
<b>NOTE:</b> ClassFileVersion 008 did not production release.				
ICD-487B-2-R003-V0-Z402007-D20230317	► Added support for the five-port Ethernet card. Added logical nodes PRPGGIO, PBLCCH, SBLCCH, EALCCH, and an additional ETHGGIO. Added multiple access points to allow for the segregation of process bus and station bus GOOSE transmission.	R402	007	20230317
ICD-487B-2-R002-V0-Z401006-D20210222	► SEL-487B-2 ICD file for firmware R401 or higher	R401	006	20210326

**configVersion Details:**

ICD-[PN]-R[RN]-V[VS]-Z[FC]-D[RD] where:

[PN] = Product name (e.g., 487B-2)

[RN]<sup>a</sup> = Revision number (e.g., 002)

[VS] = Version specifications (e.g., 0)

[FC]<sup>b</sup> = Minimum relay firmware and class file version (e.g., 401)

[RD] = Release date code (e.g., 20210222)

<sup>a</sup> This is the ICD file revision number, not IED firmware revision number.<sup>b</sup> FC consists of six digits. The first three following the Z represent the minimum IED firmware required to be used with the ICD (e.g., 516). The second three represent the ICD ClassFileVersion (e.g., 006).

# Instruction Manual

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The date code at the bottom of each page of this manual reflects the creation or revision date.

*Table A.5* lists the instruction manual versions and revision descriptions. The most recent instruction manual version is listed first.

**Table A.5 Instruction Manual Revision History (Sheet 1 of 3)**

Date Code	Summary of Revisions
20240927	<b>Section 1</b> <ul style="list-style-type: none"> <li>➤ Changed <i>Object Penetration</i> to <i>Ingress Protection</i> and updated contents in <i>Specifications</i>.</li> </ul>
20240509	<b>Appendix A</b> <ul style="list-style-type: none"> <li>➤ [Cybersecurity] Updated for firmware version R405.</li> </ul>
20231207	<b>Section 1</b> <ul style="list-style-type: none"> <li>➤ Updated <i>Figure 1.1: SEL-487B Relay Basic Functions in a Double-Bus Application</i>.</li> <li>➤ Updated <i>Models and Options</i> and <i>Specifications</i>.</li> </ul> <b>Section 2</b> <ul style="list-style-type: none"> <li>➤ Updated <i>Figure 2.4: SEL-487B-2 TiDL Relay Rear Panel</i> and <i>Figure 2.15: SEL-487B-2 TiDL Relay, 4U Rear Panel</i>.</li> </ul> <b>Section 4</b> <ul style="list-style-type: none"> <li>➤ Updated <i>Figure 4.11: Factory-Default Operator Control Pushbuttons</i>.</li> </ul> <b>Section 5</b> <ul style="list-style-type: none"> <li>➤ Updated <i>Figure 5.35: Open-Phase Detection</i>.</li> </ul> <b>Appendix A</b> <ul style="list-style-type: none"> <li>➤ Updated for firmware version R404.</li> <li>➤ Updated for ICD file version R004.</li> </ul>
20231110	<b>Appendix A</b> <ul style="list-style-type: none"> <li>➤ Updated for firmware version R403-V2.</li> </ul>
20230830	<b>Appendix A</b> <ul style="list-style-type: none"> <li>➤ Updated for firmware version R403-V1.</li> </ul>
20230317	<b>Section 1</b> <ul style="list-style-type: none"> <li>➤ Updated <i>Features, Models and Options</i>, and <i>Specifications</i>.</li> </ul> <b>Section 2</b> <ul style="list-style-type: none"> <li>➤ Updated <i>Figure 2.3: SEL-487B-2 SV Subscriber Relay Rear Panel</i>, <i>Figure 2.4: SEL-487B-2 TiDL Relay Rear Panel</i>, <i>Figure 2.14: SEL-487B-2 SV Subscriber Relay Rear Panel</i>, and <i>Figure 2.15: SEL-487B-2 TiDL Relay, 4U Rear Panel</i>.</li> <li>➤ Updated <i>Ethernet Network Connections</i>.</li> </ul> <b>Section 5</b> <ul style="list-style-type: none"> <li>➤ Updated <i>Figure 5.30: U.S. Curves U1, U2, U3, and U4</i>.</li> </ul> <b>Section 9</b> <ul style="list-style-type: none"> <li>➤ Updated <i>Table 9.1: SEL-487B List of Commands</i>.</li> </ul> <b>Section 11</b> <ul style="list-style-type: none"> <li>➤ Updated <i>Table 11.1: Alphabetic List of Relay Word Bits</i> and <i>Table 11.2: Row List of Relay Word Bits</i>.</li> </ul> <b>Appendix A</b> <ul style="list-style-type: none"> <li>➤ Updated for firmware version R403.</li> <li>➤ Updated for SELboot version R302.</li> <li>➤ Updated for ICD versions R003 in <i>Table A.3: SEL-487B-2 SV Subscriber ICD File Revision History</i> and <i>Table A.4: SEL-487B-2 TiDL ICD File Revision History</i>.</li> </ul> <b>SEL-400G Relay Command Summary</b> <ul style="list-style-type: none"> <li>➤ Added <i>COM PRP</i>.</li> </ul>

**Table A.5 Instruction Manual Revision History (Sheet 2 of 3)**

Date Code	Summary of Revisions
20220523	<p><b>Section 1</b></p> <ul style="list-style-type: none"> <li>➤ Updated <i>Table 1.9: SEL-487B Relay Characteristics.</i></li> </ul> <p><b>Section 2</b></p> <ul style="list-style-type: none"> <li>➤ Updated <i>Figure 2.6: High-Speed, High-Current Interrupting Control Output Connection, INT4.</i></li> </ul> <p><b>Section 5</b></p> <ul style="list-style-type: none"> <li>➤ Updated <i>Filtered Differential Element, Internal Fault Detection Logic, Selectable Time-Overcurrent Elements (51), 27TCk Undervoltage Element Torque Control, Coupler Security Logic, Breaker Differential, Single CT Application, Circuit Breaker Status Logic.</i></li> </ul> <p><b>Section 8</b></p> <ul style="list-style-type: none"> <li>➤ Added <i>Table 8.14: Access Control.</i></li> </ul> <p><b>Section 10</b></p> <ul style="list-style-type: none"> <li>➤ Updated <i>Table 10.4: SEL-487B Database Structure—TARGET Region.</i></li> </ul> <p><b>Section 11</b></p> <ul style="list-style-type: none"> <li>➤ Updated <i>Table 11.1: Alphabetic List of Relay Word Bits</i> and <i>Table 11.2: Row List of Relay Word Bits.</i></li> </ul> <p><b>Section 12</b></p> <ul style="list-style-type: none"> <li>➤ Updated <i>Table 12.1: Analog Quantities Sorted Alphabetically</i> and <i>Table 12.2: Analog Quantities Sorted by Function.</i></li> </ul> <p><b>Appendix A</b></p> <ul style="list-style-type: none"> <li>➤ Updated <i>Determining the Firmware Version.</i></li> <li>➤ Updated for firmware version R402-V0.</li> </ul>
20211203	<p><b>Appendix A</b></p> <ul style="list-style-type: none"> <li>➤ Updated for firmware version R401-V1.</li> <li>➤ Updated Summary of Revisions for ICD file version R002 in <i>Table A.3: SEL-487B-2 SV Subscriber Relay ICD File Revision History.</i></li> </ul>
20210708	<p><b>Section 1</b></p> <ul style="list-style-type: none"> <li>➤ Updated <i>Specifications.</i></li> </ul>
20210701	<p><b>Section 1</b></p> <ul style="list-style-type: none"> <li>➤ Updated <i>Figure 1.1: SEL-487B Relay Basic Functions in a Double-Bus Application.</i></li> <li>➤ Updated <i>Specifications.</i></li> </ul>
20210514	<p><b>Section 1</b></p> <ul style="list-style-type: none"> <li>➤ Updated <i>Specifications.</i></li> </ul> <p><b>Appendix A</b></p> <ul style="list-style-type: none"> <li>➤ Updated Summary of Revisions for R002 in <i>Table A.3: SEL-487B-2 SV Subscriber Relay ICD File Revision History.</i></li> </ul>
20210428	<p><b>Appendix A</b></p> <ul style="list-style-type: none"> <li>➤ Updated for firmware version R400-V3.</li> </ul>
20210326	<p><b>Preface</b></p> <ul style="list-style-type: none"> <li>➤ Added <i>Differentiating Between Relay Versions.</i></li> <li>➤ Updated <i>Manual Overview and General Information.</i></li> </ul> <p><b>Section 1</b></p> <ul style="list-style-type: none"> <li>➤ Updated introductory text.</li> <li>➤ Updated <i>Features, Models and Options, Applications, and Product Characteristics.</i></li> <li>➤ Updated <i>Specifications.</i></li> </ul> <p><b>Section 2</b></p> <ul style="list-style-type: none"> <li>➤ Updated <i>Relay Sizes.</i></li> <li>➤ Added <i>Figure 2.4: SEL-487B-2 TiDL Relay Rear Panel</i> and <i>Figure 2.15: SEL-487B-2 TiDL Relay Rear Panel.</i></li> <li>➤ Updated <i>Secondary Circuits, Control Outputs, Jumpers, Connection, and Merging Unit AC/DC Connections.</i></li> </ul>

**Table A.5 Instruction Manual Revision History (Sheet 3 of 3)**

Date Code	Summary of Revisions
	<p><b>Section 3</b></p> <ul style="list-style-type: none"> <li>➤ Updated <i>Relay Test Connections</i>.</li> <li>➤ Updated <i>Figure 3.13: Test Connections Using Two Current Sources</i>, <i>Figure 3.19: Test Connections for Testing the Directional Element</i>, and <i>Figure 3.24: Test Connections for Testing the Voltage Elements</i>.</li> </ul> <p><b>Section 5</b></p> <ul style="list-style-type: none"> <li>➤ Updated <i>Analog Channel Statuses and Sampled Values Alarm Logic (SEL-487B-2 SV Subscriber Relay)</i>.</li> <li>➤ Added <i>TiDL Alarm Logic (SEL-487B-2 TiDL Relay)</i> and <i>Selective Protection Disabling</i>.</li> <li>➤ Updated <i>Application Setting SVBLK and Relay Word Bit SVBK_EX</i>, <i>Differential Zone and Restricted Earth Fault Element Blocking Logic</i>, <i>Busbar Protection Elements</i>, <i>Check-Zone Protection Elements</i>, <i>Zone Supervision Logic</i>, <i>Check-Zone Selection</i>, <i>Instantaneous/Delayed Overcurrent Elements</i>, and <i>Selectable Time-Overcurrent Element (51)</i>.</li> <li>➤ Updated <i>Figure 5.34: Time-Overcurrent Logic</i>.</li> <li>➤ Updated <i>Over- and Undervoltage Elements</i>, <i>Open-Phase Detection Logic</i>, <i>Open CT Detection Logic</i>, <i>Circuit Breaker Failure Protection</i>, <i>Disconnect Monitor</i>, <i>Differential Trip Logic</i>, and <i>Circuit Breaker Status Logic</i>.</li> </ul> <p><b>Section 6</b></p> <ul style="list-style-type: none"> <li>➤ Updated <i>Figure 6.4: CT Wiring in a Single-Relay Application</i>.</li> <li>➤ Updated <i>Zone Supervision, Trip Logic, Summary, and Single Bus and Tie Breaker (Three Relays) Application</i>.</li> </ul> <p><b>Section 7</b></p> <ul style="list-style-type: none"> <li>➤ Updated <i>Metering note</i>.</li> </ul> <p><b>Section 8</b></p> <ul style="list-style-type: none"> <li>➤ Updated <i>Table 8.2: Global Settings Categories</i> and <i>Table 8.6: Control Inputs (Global)</i>.</li> <li>➤ Added <i>Table 8.8: Interface Board #n Control Inputs</i>.</li> <li>➤ Updated <i>Table 8.15: SV and TiDL Application Settings</i>, <i>Table 8.41: Undervoltage Elements</i>, <i>Table 8.43: Trip Logic</i>, and <i>Table 8.53: Undervoltage (27) Elements</i>.</li> </ul> <p><b>Section 10</b></p> <ul style="list-style-type: none"> <li>➤ Updated <i>Table 10.4: SEL-487B Database Structure—TARGET Region</i>, <i>Table 10.5: SEL-487B Database Structure—HISTORY Region</i>, <i>Table 10.12: Logical Device: PRO (Protection)</i>, and <i>Table 10.13: Logical Device: MET (Metering)</i>.</li> <li>➤ Added <i>Table 10.14: FLTYPE—Fault Type</i> and <i>Table 10.15: FLTCAUS—Fault Cause</i>.</li> </ul> <p><b>Section 11</b></p> <ul style="list-style-type: none"> <li>➤ Updated <i>Table 11.1: Alphabetic List of Relay Word Bits</i> and <i>Table 11.2: Row List of Relay Word Bits</i>.</li> </ul> <p><b>Appendix A</b></p> <ul style="list-style-type: none"> <li>➤ Updated for firmware version R401-V0.</li> <li>➤ Updated for SELBOOT version R301-V0.</li> <li>➤ Updated for ICD versions R002-V0 in <i>Table A.3: SEL-487B-2 SV Subscriber ICD File Revision History</i> and R002-V0 in <i>Table A.4: SEL-487B-2 TiDL ICD File Revision History</i>.</li> </ul>
20201204	<p><b>Preface</b></p> <ul style="list-style-type: none"> <li>➤ Updated <i>SEL-400 Series Relays Instruction Manual</i> and <i>Safety Marks</i>.</li> </ul>
20201009	<p><b>Appendix A</b></p> <ul style="list-style-type: none"> <li>➤ Updated for firmware version R400-V2.</li> </ul>
20191210	<p><b>Appendix A</b></p> <ul style="list-style-type: none"> <li>➤ Updated for firmware version R400-V1.</li> </ul>
20181012	<ul style="list-style-type: none"> <li>➤ Initial version.</li> </ul>

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# SEL-487B-2 Relay Command Summary

<b>Command<sup>a, b</sup></b>	<b>Description</b>
<b>2ACCESS</b>	Go to Access Level 2 (full control)
<b>AACCESS</b>	Go to Access Level A (automation configuration)
<b>ACCESS</b>	Go to Access Level 1 (monitor relay)
<b>BACCESS</b>	Go to Access Level B (monitor relay and control circuit breakers)
<b>BNAME</b>	ASCII names of Fast Meter status bits
<b>CASCII</b>	Generate the Compressed ASCII response configuration message
<b>CEVENT</b>	Display Compressed ASCII event report
<b>CFG CTNOM <i>i</i></b>	For DSS relays, configure the nominal CT input value <i>i</i> to 1 or 5
<b>CHISTORY</b>	Display Compressed ASCII history report
<b>COM <i>c</i></b>	Display relay-to-relay MIRRORED BITS communications data ( <i>c</i> = A is Channel A; <i>c</i> = B is Channel B; <i>c</i> = M is either enabled single channel)
<b>COM PRP</b>	Display PRP information and statistics for the five-port Ethernet card
<b>COM PTP</b>	Display a report on PTP data sets and statistics
<b>COM SV</b>	Display information and statistics for the configured SV publications or subscriptions
<b>CONTROL <i>nn</i></b>	Set, clear, or pulse an internal remote bit ( <i>nn</i> is the remote bit number from 01–96)
<b>COPY <i>m n</i></b>	Copy settings between instances in the same class ( <i>m</i> and <i>n</i> are instance numbers; for example: <i>m</i> = 1 is Group 1; <i>n</i> = 2 is Group 2)
<b>CPR</b>	Display Compressed ASCII signal profiling report
<b>CSER</b>	Display Compressed ASCII sequential events report
<b>CSTATUS</b>	Display Compressed ASCII relay status report
<b>CSUMMARY</b>	Display Compressed ASCII summary event report
<b>DATE</b>	Display and set the date
<b>DNAME X</b>	ASCII names of all relay digital points reported via Fast Meter
<b>ETHERNET</b>	Display Ethernet port (PORT 5) configuration and status
<b>EVENT</b>	Display and acknowledge event reports
<b>EXIT</b>	Terminates a Telnet session
<b>FILE</b>	Transfer files between the relay and external software
<b>GOOSE</b>	Displays transmit and receive GOOSE messaging information
<b>GROUP</b>	Display the active group number or select the active group
<b>HELP</b>	List and describe available commands at each access level
<b>HISTORY</b>	View event summaries/histories; clear event summary data
<b>ID</b>	Display the firmware ID, user ID, device code, part number, and configuration information
<b>LOOPBACK</b>	Connect MIRRORED BITS data from transmit to receive on the same port
<b>MAC</b>	Display the MAC addresses
<b>MAP 1</b>	View the relay database organization
<b>METER</b>	Display metering data and internal relay operating variables
<b>OACCESS</b>	Go to Access Level O (output configuration)
<b>OPEN <i>n</i></b>	Open the circuit breaker ( <i>n</i> = 1–21)
<b>PACCESS</b>	Go to Access Level P (protection configuration)

Command <sup>a, b</sup>	Description
<b>PASSWORD <i>n</i></b>	Change relay password for Access Level <i>n</i>
<b>PING <i>addr</i></b>	Sends an ICMP echo request message to the provided IP address to confirm connectivity
<b>PORT <i>p</i></b>	Connect to a remote relay via MIRRORED BITS virtual terminal for port number <i>p</i> ( <i>p</i> = 1–3 and F)
<b>PROFILE</b>	Display signal profile records
<b>PULSE OUT<i>nnn</i></b>	Pulse a relay control output (OUT <i>nnn</i> is a control output)
<b>QUIT</b>	Reduce access level to Access Level 0 (exit relay control)
<b>SER</b>	View Sequential Events Recorder report
<b>SET</b>	Set or modify relay settings
<b>SHOW</b>	Display relay settings
<b>SNS</b>	Display Sequential Events Recorder settings name strings (Fast SER)
<b>STATUS</b>	Report or clear relay status and SELOGIC control equation errors
<b>SUMMARY</b>	Display a summary event report
<b>TARGET</b>	Display relay elements for a row in the Relay Word table
<b>TEST DB</b>	Display or place values in the communications card database (useful for Ethernet protocol read tests)
<b>TEST DB2</b>	Test all communications protocols except Fast Message
<b>TEST FM</b>	Display or place values in metering database (Fast Meter)
<b>TEST SV</b>	For SV subscriber relays, accept SV test messages
<b>TIME</b>	Display and set the internal clock
<b>TIME Q</b>	Display detailed information on the relay internal clock
<b>TRIGGER</b>	Initiate a data capture and record an event report
<b>VERSION</b>	Display the relay hardware and software configurations
<b>VIEW 1</b>	View data from the Fast Message database
<b>ZONE</b>	Display the terminal and bus names associated with all active protective zones

<sup>a</sup> See Section 9: ASCII Command Reference.<sup>b</sup> For help on a specific command, type HELP [command] <Enter> at an ASCII terminal communicating with the relay.

# SEL-487B-2 Relay Command Summary

<b>Command<sup>a, b</sup></b>	<b>Description</b>
<b>2ACCESS</b>	Go to Access Level 2 (full control)
<b>AACCESS</b>	Go to Access Level A (automation configuration)
<b>ACCESS</b>	Go to Access Level 1 (monitor relay)
<b>BACCESS</b>	Go to Access Level B (monitor relay and control circuit breakers)
<b>BNAME</b>	ASCII names of Fast Meter status bits
<b>CASCII</b>	Generate the Compressed ASCII response configuration message
<b>CEVENT</b>	Display Compressed ASCII event report
<b>CFG CTNOM <i>i</i></b>	For DSS relays, configure the nominal CT input value <i>i</i> to 1 or 5
<b>CHISTORY</b>	Display Compressed ASCII history report
<b>COM <i>c</i></b>	Display relay-to-relay MIRRORED BITS communications data ( <i>c</i> = A is Channel A; <i>c</i> = B is Channel B; <i>c</i> = M is either enabled single channel)
<b>COM PRP</b>	Display PRP information and statistics for the five-port Ethernet card
<b>COM PTP</b>	Display a report on PTP data sets and statistics
<b>COM SV</b>	Display information and statistics for the configured SV publications or subscriptions
<b>CONTROL <i>nn</i></b>	Set, clear, or pulse an internal remote bit ( <i>nn</i> is the remote bit number from 01–96)
<b>COPY <i>m n</i></b>	Copy settings between instances in the same class ( <i>m</i> and <i>n</i> are instance numbers; for example: <i>m</i> = 1 is Group 1; <i>n</i> = 2 is Group 2)
<b>CPR</b>	Display Compressed ASCII signal profiling report
<b>CSER</b>	Display Compressed ASCII sequential events report
<b>CSTATUS</b>	Display Compressed ASCII relay status report
<b>CSUMMARY</b>	Display Compressed ASCII summary event report
<b>DATE</b>	Display and set the date
<b>DNAME X</b>	ASCII names of all relay digital points reported via Fast Meter
<b>ETHERNET</b>	Display Ethernet port (PORT 5) configuration and status
<b>EVENT</b>	Display and acknowledge event reports
<b>EXIT</b>	Terminates a Telnet session
<b>FILE</b>	Transfer files between the relay and external software
<b>GOOSE</b>	Displays transmit and receive GOOSE messaging information
<b>GROUP</b>	Display the active group number or select the active group
<b>HELP</b>	List and describe available commands at each access level
<b>HISTORY</b>	View event summaries/histories; clear event summary data
<b>ID</b>	Display the firmware ID, user ID, device code, part number, and configuration information
<b>LOOPBACK</b>	Connect MIRRORED BITS data from transmit to receive on the same port
<b>MAC</b>	Display the MAC addresses
<b>MAP 1</b>	View the relay database organization
<b>METER</b>	Display metering data and internal relay operating variables
<b>OACCESS</b>	Go to Access Level O (output configuration)
<b>OPEN <i>n</i></b>	Open the circuit breaker ( <i>n</i> = 1–21)
<b>PACCESS</b>	Go to Access Level P (protection configuration)

Command <sup>a, b</sup>	Description
<b>PASSWORD <i>n</i></b>	Change relay password for Access Level <i>n</i>
<b>PING <i>addr</i></b>	Sends an ICMP echo request message to the provided IP address to confirm connectivity
<b>PORT <i>p</i></b>	Connect to a remote relay via MIRRORED BITS virtual terminal for port number <i>p</i> ( <i>p</i> = 1–3 and F)
<b>PROFILE</b>	Display signal profile records
<b>PULSE OUT<i>nnn</i></b>	Pulse a relay control output (OUT <i>nnn</i> is a control output)
<b>QUIT</b>	Reduce access level to Access Level 0 (exit relay control)
<b>SER</b>	View Sequential Events Recorder report
<b>SET</b>	Set or modify relay settings
<b>SHOW</b>	Display relay settings
<b>SNS</b>	Display Sequential Events Recorder settings name strings (Fast SER)
<b>STATUS</b>	Report or clear relay status and SELOGIC control equation errors
<b>SUMMARY</b>	Display a summary event report
<b>TARGET</b>	Display relay elements for a row in the Relay Word table
<b>TEST DB</b>	Display or place values in the communications card database (useful for Ethernet protocol read tests)
<b>TEST DB2</b>	Test all communications protocols except Fast Message
<b>TEST FM</b>	Display or place values in metering database (Fast Meter)
<b>TEST SV</b>	For SV subscriber relays, accept SV test messages
<b>TIME</b>	Display and set the internal clock
<b>TIME Q</b>	Display detailed information on the relay internal clock
<b>TRIGGER</b>	Initiate a data capture and record an event report
<b>VERSION</b>	Display the relay hardware and software configurations
<b>VIEW 1</b>	View data from the Fast Message database
<b>ZONE</b>	Display the terminal and bus names associated with all active protective zones

<sup>a</sup> See Section 9: ASCII Command Reference.<sup>b</sup> For help on a specific command, type HELP [command] <Enter> at an ASCII terminal communicating with the relay.