GE
Digital Energy

350
Feeder Protection System
Feeder protection and control

Instruction manual

350 revision: 1.6x
Manual P/N: 1601-9086-AG
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GE Multilin Inc. 350 Feeder Protection System instruction manual for revision 1.6x.

Part number: 1601-9086-AG (August 2014)

⚠CAUTION

GENERAL SAFETY PRECAUTIONS - 350

- Failure to observe and follow the instructions provided in the equipment manual(s) could cause irreversible damage to the equipment and could lead to property damage, personal injury and/or death.
- Before attempting to use the equipment, it is important that all danger and caution indicators are reviewed.
- If the equipment is used in a manner not specified by the manufacturer or functions abnormally, proceed with caution. Otherwise, the protection provided by the equipment may be impaired and can result in Impaired operation and injury.
- Caution: Hazardous voltages can cause shock, burns or death.
- Installation/service personnel must be familiar with general device test practices, electrical awareness and safety precautions must be followed.
- Before performing visual inspections, tests, or periodic maintenance on this device or associated circuits, isolate or disconnect all hazardous live circuits and sources of electric power.
- Failure to shut equipment off prior to removing the power connections could expose you to dangerous voltages causing injury or death.
- All recommended equipment that should be grounded and must have a reliable and un-compromised grounding path for safety purposes, protection against electromagnetic interference and proper device operation.
- Equipment grounds should be bonded together and connected to the facility's main ground system for primary power.
- Keep all ground leads as short as possible.
- At all times, equipment ground terminal must be grounded during device operation and service.
- In addition to the safety precautions mentioned all electrical connections made must respect the applicable local jurisdiction electrical code.
- Before working on CTs, they must be short-circuited.

This product cannot be disposed of as unsorted municipal waste in the European Union. For proper recycling return this product to your supplier or a designated collection point. For more information go to www.recyclethis.info.

Safety words and definitions

The following symbols used in this document indicate the following conditions

⚠DANGER	**Indicates a hazardous situation which, if not avoided, will result in death or serious injury.**
⚠WARNING	**Indicates a hazardous situation which, if not avoided, could result in death or serious injury.**
⚠CAUTION	**Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.**
NOTICE	**Indicates practices not related to personal injury.**

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350 Feeder Protection System

Chapter 1: Introduction

Overview

The 350 is a microprocessor-based relay for primary and backup over-current protection of medium and low voltage distribution feeders. The relay is also suitable for providing over-current protection for small and medium size motors, transformers, generators, and distribution bus-bars. The small footprint and the withdrawable option make the 350 relay ideal for panel mounting on either new or retrofit installations. The combination of proven hardware, a variety of protection and control features, and communications, makes the relay ideal for total feeder protection and control. Equipped with serial (RS485), USB, and Ethernet ports, and a wide selection of protocols such as Modbus, DNP3.0, IEC 60870-5-103, 60870-5-104, GOOSE, the 350 relay is the best-in-class for MCCs, SCADA and inter-relay communications. The 350 relay provides excellent transparency with respect to power system conditions and events, through its four-line 20-character display, as well as the EnerVista SR3 Setupprogram. Conveniently located LEDs provide indication of relay operation, alarm, and pickup, as well as breaker, and relay status.

The 350 relay provides the following key benefits:

- Withdrawable small footprint – saves on rewiring and space.
- Multiple protection groups with the added flexibility of switching through a wide selection of overcurrent protection and control features.
- Fast setup (Quick Setup) menu for power-system setup and a simple overcurrent protection configuration.
- Large four-line LCD display, LEDs, and an easy-to-navigate keypad.
- Multiple communication protocols for simultaneous access when integrated into monitoring and control systems.

Description of the 350 Feeder Protection System

CPU

Relay functions are controlled by two processors: a Freescale MPC5554 32-bit microprocessor measures all analog signals and digital inputs and controls all output relays; a Freescale MPC520B 32-bit microprocessor controls all the Ethernet communication protocols.

Analog Input Waveform Capture

Magnetic transformers are used to scale-down the incoming analog signals from the source instrument transformers. The analog signals are then passed through a 960 Hz low pass anti-aliasing filter. All signals are then simultaneously captured by sample and hold buffers to ensure there are no phase shifts. The signals are converted to digital values by a 12-bit A/D converter before finally being passed on to the CPU for analysis.

Both current and voltage are sampled thirty-two times per power frequency cycle. These 'raw' samples are scaled in software, then placed into the waveform capture buffer, thus emulating a fault recorder. The waveforms can be retrieved from the relay via the EnerVista SR3 Setup software for display and diagnostics.

Frequency

Frequency measurement is accomplished by measuring the time between zero crossings of the Bus VT phase A voltage . The signals are passed through a low pass filter to prevent false zero crossings. Sampling is synchronized to the Va-x voltage zero crossing which results in better co-ordination for multiple 350 relays on the same bus.

Phasors, Transients, and Harmonics

Current waveforms are processed four times every cycle with a DC Offset Filter and a Discrete Fourier Transform (DFT). The resulting phasors have fault current transients and all harmonics removed. This results in an overcurrent relay that is extremely secure and reliable; one that will not overreach.

Processing of AC Current Inputs

The DC Offset Filter is an infinite impulse response (IIR) digital filter, which removes the DC component from the asymmetrical current present at the moment a fault occurs. This is done for all current signals used for overcurrent protection; voltage signals bypass the DC Offset Filter. This filter ensures no overreach of the overcurrent protection.

The Discrete Fourier Transform (DFT) uses exactly one sample cycle to calculate a phasor quantity which represents the signal at the fundamental frequency; all harmonic components are removed. All subsequent calculations (e.g. RMS, power, etc.) are based upon the current and voltage phasors, such that the resulting values have no harmonic components.

Protection Elements

All protection elements are processed four times every cycle to determine if a pickup has occurred or a timer has expired. The protection elements use RMS current/voltage, based on the magnitude of the phasor. Hence, protection is impervious to both harmonics and DC transients.

Figure 1: Single line diagram

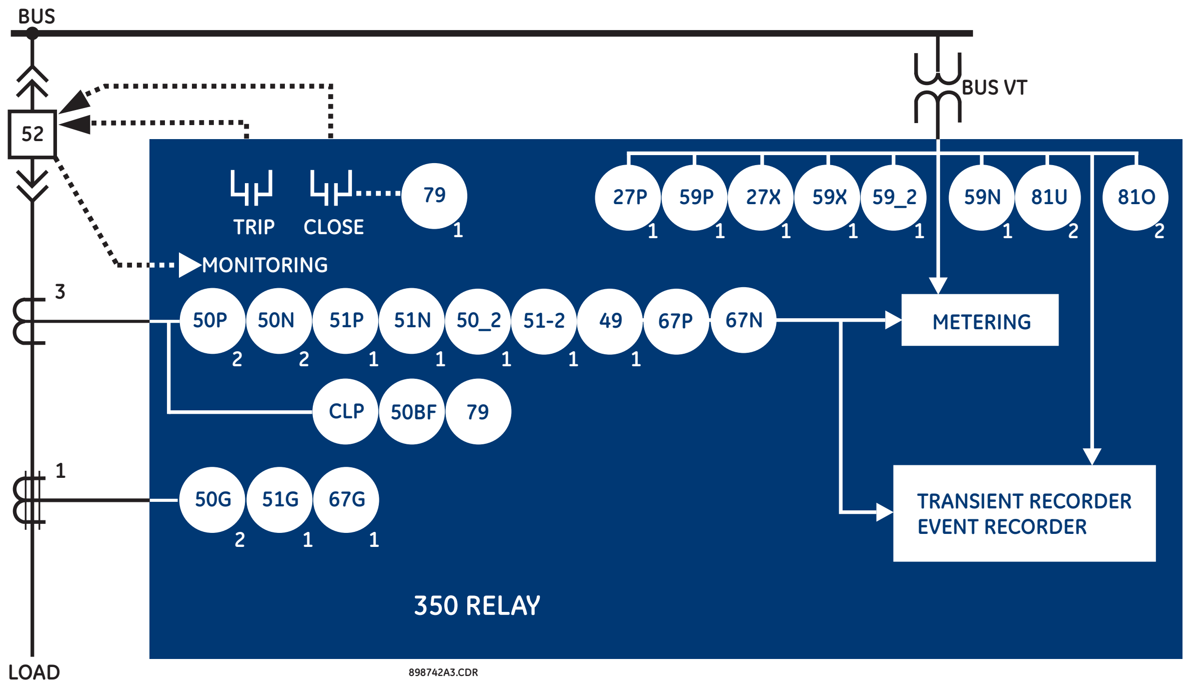
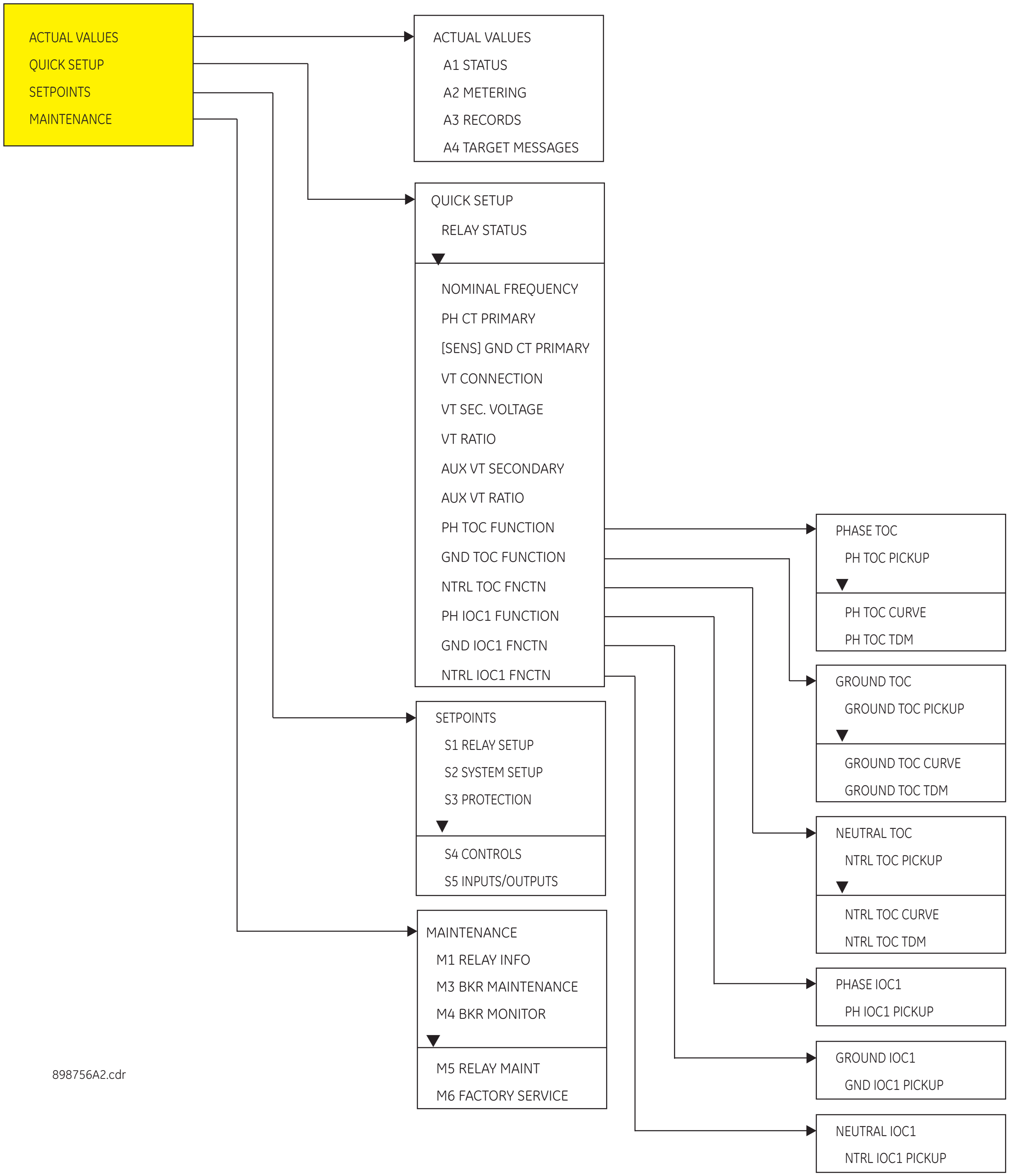


Table 1: Protection functions

ANSI Device	Description
27P	Phase Undervoltage
27X	Auxiliary Undervoltage
49	Thermal Model
50P	Phase Instantaneous Overcurrent
50N	Neutral Instantaneous Overcurrent
50G	Ground/Sensitive Ground Instantaneous Overcurrent
50BF	Breaker Failure
50_2	Negative Sequence Overcurrent
51P	Phase Timed Overcurrent
51G	Ground Timed Overcurrent
51N	Neutral Timed Overcurrent
59P	Phase Overvoltage
59X	Auxiliary Overvoltage
59N	Neutral Overvoltage
59_2	Negative Sequence Overvoltage
67G	Ground Directional Element
67N	Neutral Directional Element
67P	Phase DIrectional Element
79	Autoreclose
81U	Underfrequency
81O	Overfrequency
CLP	Cold Load Pickup

Figure 2: Main Menu structure



350 order codes

The information to specify a 350 relay is provided in the following order code figure.

Figure 3: Order Codes

	350 – * * * * * * * * * * *	
Interface	350	350 Feeder Protection System
Language	E	English
	L	English with programmable LEDs
Phase Currents	P1	1 A 3-phase current inputs
	P5	5 A 3-phase current inputs
Ground Currents[a]	G1	1 A ground current input
	G5	5 A ground current input
	S1	1 A sensitive ground current input
	S5	5 A sensitive ground current input
Power Supply	L	24 to 48 V DC
	H	110 to 250 V DC/110 to 230 V AC
Input/Output	S	8 Inputs, 7 Outputs (2 Form A, 5 Form C)
	E	10 Inputs, 7 Outputs (2 Form A, 5 Form C)
Current Protection	S	Standard configuration: 50P(1), 50G(1), 50N(1), 51P(1), 51G(1), 51N(1)
	E	Extended configuration: 49, 50P(2), 50G(2), 50N(2), 51P(1), 51G(1), 51N(1)
	M	Advanced configuration: 49, 50P(2), 50G(2), 50N(2), 51P(1), 51G(1), 51N(1), 50_2 (1), 51_2(1)
Control	N	No selection
	C	CLP, 50BF, Autoreclose (79)
Other Options	N	No selection
	D	Neutral and Ground Directional Elements: 67N(1), 67G(1)
	M	Voltage Metering
	R	Phase, Neutral and Ground Directional Elements: 67P(1), 67N(1), 67G(1) + Voltage Metering
	P	Voltage Protection, Phase, Neutral and Ground Directional elements - 27P(1), 27X(1), 59P(1), 59N(1), 59X(1), 59_2(1), 81O(2), 81U(2), 67P(1), 67N(1), 67G(1), VTFF(1)
Communications	S N	Standard: Front USB, Rear RS485: Modbus RTU, DNP3.0, IEC60870-5-103
	1 E	Standard + Ethernet (Copper & Fiber - MTRJ), Modbus TCP/IP, DNP3.0, IEC 60870-5-104
	2 E	Standard + Ethernet (Copper & Fiber - MTRJ), Modbus TCP/IP, DNP3.0, IEC 60870-5-104, IEC 61850 GOOSE
	3 E	Standard + Ethernet (Copper & Fiber - MTRJ), Modbus TCP/IP, DNP3.0, IEC 60870-5-104, IEC 61850
Case Design	D	Protection Relay with drawout design
	N	Protection Relay with non-drawout design
Harsh Environment	N	None
	H	Harsh Environment Conformal Coating

a. The ground input CT rating must match the phase input CTs

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Specifications

NOTE: Specifications are subject to change without notice.

NOTE: To obtain the total element operating time, i.e. from the presence of a trip condition to initiation of a trip, add 8 ms output relay time to the operate times listed below.

Password security

PASSWORD SECURITY

Master Reset Password: .... 8 to 10 alpha-numeric characters
Settings Password:.. 3 to 10 alpha-numeric characters for local and remote access
Control Password:.. 3 to 10 alpha-numeric characters for local and remote access

Protection

PHASE/NEUTRAL/GROUND TIME OVERCURRENT (51P/51N/51G)

Pickup Level:.. 0.05 to 20.00 × CT in steps of 0.01 × CT
Dropout Level: .... 97 to 99% of Pickup @ I > 1 × CT
Pickup - 0.02 × CT @ I < 1 × CT
Curve Shape:... ANSI Extremely/Very/Moderately/Normally Inverse
Definite Time (0.1 s base curve)
IEC Curve A/B/C/ShortIAC Extreme/Very/Inverse/Short
User Curve, FlexCurve A/B (programmable curves)
Curve Multiplier:... 0.05 to 50.00 in steps of 0.01
Reset Time: .... Instantaneous, Linear
Curve Timing Accuracy:................................ ±3% of expected inverse time or 1 cycle, whichever is greater, from pickup to operate
Level Accuracy:... per CT input

PHASE/NEUTRAL/GROUND/NEGATIVE SEQUENCE TIME OVERCURRENT (51P/51N/51G)

Pickup Level:.. 0.05 to 20.00 × CT in steps of 0.01 × CT
Dropout Level: .... 97 to 99% of Pickup @ I > 1 × CT
Pickup - 0.02 × CT @ I < 1 × CT
Curve Shape:... ANSI Extremely/Very/Moderately/Normally Inverse
Definite Time (0.1 s base curve)
IEC Curve A/B/C/Short
IAC Extreme/Very/Inverse/Short
User Curve, FlexCurve A/B (programmable curves)
Curve Multiplier:... 0.05 to 50.00 in steps of 0.01
Reset Time: .... Instantaneous, Linear
Curve Timing Accuracy:................................ ±3% of expected inverse time or 1 cycle, whichever is greater, from pickup to operate
Level Accuracy:... per CT input

SENSITIVE GROUND TIME OVERCURRENT (51SG)

Pickup Level:	0.005 to 3 x CT in steps of 0.001 x CT
Dropout Level:	97 to 99% of Pickup @ I > 0.1 x CT Pickup - 0.002 x CT @ I < 0.1 x CT
Curve Shape:	ANSI Extremely/Very/Moderately/Normally Inverse Definite Time (0.1 s base curve) IEC Curve A/B/C/Short Inverse IAC Extreme/Very/Inverse/Short Inverse User Curve, FlexCurve A/B
Curve Multiplier:	0.05 to 50.00 in steps of 0.01
Reset Time:	Instantaneous, Linear
Curve Timing Accuracy:	±3% of expected inverse time or 1 cycle, whichever is greater, from pickup to operate
Level Accuracy:	per CT input

PHASE/NEUTRAL/GROUND/NEGATIVE SEQUENCE INSTANTANEOUS OVERCURRENT (50P/50N/50G/50_2)

Pickup Level:	0.05 to 20 x CT in steps of 0.01 x CT
Dropout Level:	97 to 99% of Pickup @ I > 1 x CT Pickup - 0.02 x CT @ I <1 x CT
Time Delay:	0.00 to 300.00 sec in steps of 0.01
Operate Time:	<30 ms @ 60Hz (I > 2.0 x PKP, No time delay) <35 ms @ 50Hz (I > 2.0 x PKP, No time delay)
Time Delay Accuracy:	0 to 1 cycle (Time Delay selected)
Level Accuracy:	per CT input

SENSITIVE GROUND INSTANTANEOUS OVERCURRENT (50SG)

Pickup Level (Gnd IOC):	0.005 to 3 x CT in steps of 0.001 x CT
Dropout Level:	97 to 99% of Pickup @ I > 0.1 x CT Pickup - 0.002 x CT @ I < 0.1 x CT
Time Delay:	0.00 to 300.00 sec in steps of 0.01
Operate Time:	<30 ms @ 60Hz (I > 2.0 x PKP, No time delay) <35 ms @ 50Hz (I > 2.0 x PKP, No time delay)
Time Delay Accuracy:	0 to 1 cycle (Time Delay selected)
Level Accuracy:	per CT input

PHASE DIRECTIONAL

Directionality:	Co-existing forward and reverse
Operating:	Phase Current (Ia, Ib, Ic)
Polarizing Voltage:	Quadrature Voltage (ABC phase sequence: Vbc, Vca, Vab) (CBA phase sequence: Vcb, Vac, Vba)
Polarizing voltage threshold:	0.05 to 1.25 x VT in steps of 0.01
MTA:	From 0 to 359 in steps of 1°
Angle Accuracy:	±4
Operational Delay:	20 to 30 ms

NOTE

The selection of the “P” or “R” option from “350 OTHER OPTIONS” in the order code table, will enable the Phase directional element. The polarizing voltage used for this element is the line voltage.

GROUND DIRECTIONAL

Directionality:	Co-existing forward and reverse
Operating:	Ground Current (Ig)
Polarizing Voltage:	$-V_0$ calculated using phase voltages (VTs must be connected in “Wye”) $-3V_0$ measured from Vaux input. ($3V_0$ provided by an external open delta connection).
MTA:	From 0 to 359 in steps of 1°
Angle Accuracy:	±4
Operational Delay:	20 to 30 ms

NOTE

The selection of the “D” option from “350 OTHER OPTIONS” in the Order Code table, will enable the Ground Directional element with voltage polarizing 3V0 measured from the Vaux voltage input.

NOTE

The selection of the “P” or “R” option from “350 OTHER OPTIONS” in the order code table, will enable the Ground directional element. The polarizing voltage used for this element is the computed V_0 from the measured phase voltage inputs.

NEUTRAL DIRECTIONAL

Directionality:	Forward and reverse
Polarizing:	Voltage, Current, Dual
Polarizing Voltage:	- V_0 calculated using phase voltages (VTs must be connected in “Wye”) -$3V_0$ measured from Vaux input ($3V_0$ provided by an external open delta connection).
Polarizing Current:	I_G
MTA:	From 0 to 359 in steps of 1°
Angle Accuracy:	±4
Operational Delay:	20 to 30 ms

NOTE

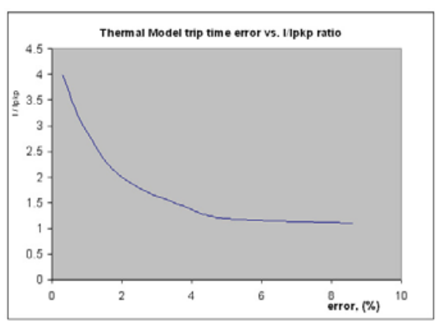
The selection of the “D” option from “350 OTHER OPTIONS” in the Order Code table, will enable the Neutral Directional element with voltage polarizing $3V_0$ measured from the Vaux voltage input.

The selection of “P,” or “R” option from “350 OTHER OPTIONS” in the Order Code table, will enable the Neutral Directional elements with voltage polarizing V_0 computed from the measured phase voltage inputs.

The ground polarizing current, IG, is available for selection in both cases.

CABLE THERMAL MODEL (49)

Current:	Fundamental phasor
Pickup Accuracy:	per current inputs
Timing Accuracy:	See graph below



The graph shows the trip time error with respect to the ratio of cable load and thermal model pickup setting. With a smaller I/Ipkp ratio, the time error tends to be higher, as accumulated through the logarithmic formula, the measurement error, and the time of measurement. For higher I/Ipkp ratios, the time to trip is substantially more accurate. Each point on the graph represents a trip time error, with the I/Ipkp ratio kept constant during the test.

PHASE/AUXILIARY UNDERVOLTAGE (27P, 27X)

Minimum Voltage: .... Programmable from 0.00 to 1.25 x VT in steps of 0.01
Pickup Level: .... 0.00 to 1.25 x VT in steps of 0.01
Dropout Level: .... 101 to 104% of pickup
Curve: .... Definite Time, Inverse Time
Time Delay: .... 0.1 to 600.0 s in steps of 0.1
Operate Time: .... Time delay ±30 ms @ 60Hz (V < 0.85 x PKP)Time delay ±40 ms @ 50Hz (V < 0.85 x PKP)
Curve Timing Accuracy: .... ±3% of expected time or 1 cycle, whichever is greater, from pickup to operate
Level Accuracy: .... Per voltage input

PHASE/AUXILIARY/NEUTRAL/NEGATIVE SEQUENCE OVERVOLTAGE (59P, 59X, 59N, 59_2)

Pickup Level: .... 0.00 to 1.25 x VT in steps of 0.01
Dropout Level: .... 96 to 99% of pickup
Time Delay: .... 0.1 to 600.0 s in steps of 0.1
Operate Time: .... Time delay ±35 ms @ 60Hz (V > 1.1 x PKP)Time delay ±40 ms @ 50Hz (V > 1.1 x PKP)
Time Delay Accuracy: .... 0 to 1 cycle
Level Accuracy: .... Per voltage input

UNDERFREQUENCY (81U)

Minimum Voltage: .... 0.00 to 1.25 x VT in steps of 0.01
Pickup Level: .... 40.00 to 70.00 Hz in steps of 0.01
Dropout Level: .... Pickup +0.03 Hz
Time Delay: .... 0.1 to 600.0 s in steps of 0.1
Time Delay Accuracy: .... 0 to 6 cycles (Time Delay selected)
Operate Time: .... Typically 10 cycles @ 0.1Hz/s change
Level Accuracy: .... ±0.01 Hz

OVERFREQUENCY (81O)

Minimum Voltage: .... 0.3 x VT
Pickup Level: .... 40.00 to 70.00 Hz in steps of 0.01
Dropout Level: .... Pickup -0.03 Hz
Time Delay: .... 0.1 to 600.0 s in steps of 0.1
Time Delay Accuracy: .... 0 to 6 cycles (Time Delay selected)
Operate Time: .... Typically 10 cycles @ 0.1Hz/s change
Level Accuracy: .... ±0.01 Hz

FUSE FAIL

Time Delay: .... 1 s
Timing Accuracy: .... ±0.5 s
Elements: .... Trip or Alarm

Metering

PARAMETER	ACCURACY	RESOLUTION	RANGE
3-Phase Real Power (MW)	±1% of full scale	0.1 MW	±100 MW
3-Phase Reactive Power (Mvar)	±1% of full scale	0.1 Mvar	±100 Mvar
3-Phase Apparent Power (MVA)	±1% of full scale	0.1 MVA	100 MVA
Power Factor	±0.05	0.01	-0.99 to 1.00
Frequency	±0.05 Hz	0.01 Hz	40.00 to 70.00 Hz

NOTE

Full scale for CT Input is 3 x CT

Data capture

TRANSIENT RECORDER

Buffer size:.......... 3 s
No. of buffers:.......... 1x192, 3x64, 6x32
No. of channels:.......... 14
Sampling rate:.......... 32 samples per cycle
Triggers:.......... Manual Command
Contact Input
Virtual Input
Logic Element
Element Pickup/Trip/Dropout/Alarm
Data:.......... AC input channels
Contact input state
Contact output state
Virtual input state
Logic element state
Data storage:.......... RAM - battery backed-up

EVENT RECORDER

Number of events:.......... 256
Header:.......... relay name, order code, firmware revision
Content:.......... event number, date of event, cause of event, per-phase current, ground current, sensitive ground current, neutral current, per-phase voltage (VTs connected in “Wye”), or phase-phase voltages (VTs connected in “Delta”), system frequency, power, power factor, thermal capacity
Data Storage:.......... Retained for 3 days

CLOCK

Setup:.......... Date and time Daylight Saving Time
IRIG-B:.......... Auto-detect (DC shift or Amplitude Modulated)
Amplitude modulated: 1 to 10 V pk-pk
DC shift: 1 to 10 V DC
Input impedance: 40 kOhm ± 10%
RTC Accuracy: ± 1 min / month at 25°C

Control

LOGIC ELEMENTS

Number of logic elements:.......... 16
Trigger source inputs per element:.......... 3
Block inputs per element:.......... 3
Supported operations:.......... AND, OR, NOT, Pickup / Dropout timers
Pickup timer:.......... 0 to 60000 ms in steps of 1 ms
Dropout timer:.......... 0 to 60000 ms in steps of 1 ms

BREAKER CONTROL

Operation:.......... Asserted Contact Input, Logic Element, Virtual Input, Manual Command
Function:.......... Opens / closes the feeder breaker

AUTORECLOSE

Reclose attempts:.......... Up to 4 shots
Time Delay Accuracy:.......... 0 to 3 cycles (AR Dead Time selected)
Elements:.......... Inputs, Outputs, Breaker Status (52 status)

BREAKER FAILURE

Pickup Level:.......... 0.05 to 20.00 x CT in steps of 0.01
Dropout Level:.......... 97 to 98% of pickup
Time Delay Accuracy:.......... 0 to 1 cycle (Timer 1, Timer 2)
Level Accuracy:.......... per CT input

BREAKER TRIP COUNTER

Trip Counter Limit (Pickup): 1 to 10000 in steps of 1

COLD LOAD PICKUP BLOCKING

Operation: Automatically (current level), or by command (asserted input)

Function: Block IOC functions, raise TOC pickup, for selected period of time

Time Delay Accuracy: 0 to 1 cycle (block Time) ±50 ms (outage time 5 min) ±1 s (outage time > 5 min)

AMBIENT TEMPERATURE

High Temperature Pickup: 20°C to 80°C in steps of 1°C

Low Temperature Pickup: -40°C to 20°C in steps of 1°C

Time Delay: 1 to 60 min in steps of 1 min

Temperature Dropout: Configurable 90 to 98% of pickup

Temperature Accuracy: ±10°C

Timing Accuracy: ±1 second

Inputs

CONTACT INPUTS

Inputs: 10

Selectable thresholds: 17, 33, 84, 166 VDC

Recognition time: 1/2 cycle

Debounce time: 1 to 64 ms, selectable, in steps of 1 ms

Maximum input voltage & continuous current draw: 300 VDC, 2 mA, connected to Class 2 source

Type: opto-isolated inputs

External switch: wet contact

PHASE & GROUND CURRENT INPUTS

CT Primary: 1 to 6000 A

Range: 0.02 to 20 × CT

Input type: 1 A or 5 A (must be specified with order)

Nominal frequency: 50/60 Hz

Burden: <0.1 VA at rated load

Accuracy: ±1% of reading at 1× CT
±3% of reading from 0.2 to 20 × CT
±20% of reading from 0.02 to 0.19 × CT

CT withstand: 1 second at 100 × rated current
2 seconds at 40 × rated current
continuous at 3 × rated current

SENSITIVE GROUND CURRENT INPUT

CT Primary: 1 to 600 A

Range: 0.002 to 3 × CT

Input type: 1 A or 5 A (must be specified with order)

Nominal frequency: 50/60 Hz

Burden: <0.1 VA at rated load

Accuracy: ±1% of reading at 0.1× CT
±3% of reading from 0.02 to 3 × CT
±20% of reading from 0.002 to 0.019 × CT

CT withstand: 1 second at 100 × rated current
2 seconds at 40 × rated current
continuous at 3 × rated current

PHASE/AUX VOLTAGE INPUTS

Source VT: 0.12 to 65 kV / 50 to 220 V
VT secondary range: 50 to 240 V
VT ratio: 1 to 1500 in steps of 1
Nominal frequency: 50/60 Hz
Relay burden: <0.25 VA at 120 V
Accuracy: ±1.0% throughout range
Voltage withstand: 260 VAC continuous

Outputs

FORM-A RELAYS

Configuration: 2 (two) electromechanical
Contact material: silver-alloy
Operate time: <8 ms
Continuous current: 10 A
Make and carry for 0.2s: 30 A per ANSI C37.90
Break (DC inductive, L/R=40 ms): 24 V / 1 A 48 V / 0.5 A 125 V / 0.3 A 250 V / 0.2 A
Break (DC resistive): 24 V / 10 A 48 V / 6 A 125 V / 0.5 A 250 V / 0.3 A
Break (AC inductive): 720 VA @ 250 VAC Pilot duty A300
Break (AC resistive): 277 VAC / 10 A

FORM-A VOLTAGE MONITOR

Applicable voltage: 20 to 250 VDC
Trickle current: 1 to 2.5 mA

FORM-C RELAYS

Configuration: 5 (five) electromechanical
Contact material: silver-alloy
Operate time: <8 ms
Continuous current: 10 A
Make and carry for 0.2s: 30 A per ANSI C37.90
Break (DC inductive, L/R=40 ms): 24 V / 1 A 48 V / 0.5 A 125 V / 0.3 A 250 V / 0.2 A
Break (DC resistive): 24 V / 10 A 48 V / 6 A 125 V / 0.5 A 250 V / 0.3 A
Break (AC inductive): 720 VA @ 250 VAC Pilot duty A300
Break (AC resistive): 277 VAC / 10 A

TRIP / CLOSE SEAL-IN

Relay 1 trip seal-in: 0.00 to 9.99 s in steps of 0.01
Relay 2 close seal-in: 0.00 to 9.99 s in steps of 0.01

Power supply

HIGH RANGE POWER SUPPLY

Nominal: 120 to 240 VAC 125 to 250 VDC
Range: 60 to 300 VAC (50 and 60 Hz) 84 to 300 VDC
Ride-through time: 35 ms

LOW RANGE POWER SUPPLY

Nominal: 24 to 48 VDC
Range: 20 to 60 VDC

ALL RANGES

Voltage withstand: 2 × highest nominal voltage for 10 ms
Power consumption: 15 W nominal, 20 W maximum 20 VA nominal, 28 VA maximum

Communications

SERIAL

RS485 port:	Opto-coupled
Baud rates:	up to 115 kbps
Response time:	1 ms typical
Parity:	None, Odd, Even
Protocol:	Modbus RTU, DNP 3.0, IEC 60870-5-103
Maximum distance:	1200 m (4000 feet)
Isolation:	2 kV

ETHERNET (COPPER)

Modes:	10/100 MB (auto-detect)
Connector:	RJ-45
Protocol:	Modbus TCP, DNP3.0, iec 60870-5-104, IEC 61850 GOOSE

ETHERNET (FIBER)

Fiber type:	100 MB Multi-mode
Wavelength:	1300 nm
Connector:	MTRJ
Protocol:	Modbus TCP, DNP3.0, iec 60870-5-104, IEC 61850 GOOSE
Transmit power:	-20 dBm
Receiver sensitivity:	-31 dBm
Power budget:	9 dB
Maximum input power:	-11.8 dBm
Typical distance:	2 km (1.25 miles)
Duplex:	half/full

USB

Standard specification:	Compliant with USB 2.0
Data transfer rate:	115 kbps

Testing and certification

APPROVALS

	Applicable Council Directive	According to
	Low voltage directive	EN60255-5 / EN60255-27 / EN61010-1
CE compliance	EMC Directive	EN60255-26 / EN50263
		EN61000-6-2
		UL508
North America	cULus	UL1053
		C22.2.No 14
ISO	Manufactured under a registered quality program	ISO9001

TYPE TESTS

Test	Reference Standard	Test Level
Dielectric voltage withstand		
(high voltage power supply*)		2.3KV
(low voltage power supply*)		500V
* Test level is based on basic insulation principle (Power supply I/P terminals tested to Chassisground).		
Impulse voltage withstand	EN60255-5	5KV
Damped Oscillatory	IEC61000-4-18IEC60255-22-1	2.5KV CM, 1KV DM
Electrostatic Discharge	EN61000-4-2/IEC60255-22-2	Level 4
RF immunity	EN61000-4-3/IEC60255-22-3	Level 3
Fast Transient Disturbance	EN61000-4-4/IEC60255-22-4	Class A and B
Surge Immunity	EN61000-4-5/IEC60255-22-5	Level 3 & 4
Conducted RF Immunity	EN61000-4-6/IEC60255-22-6	Level 3
Power Frequency Immunity	EN61000-4-7/IEC60255-22-7	Class A & B
Voltage interruptionand Ripple DC	IEC60255-11	15% ripple, 200ms interupts
Radiated & Conducted Emissions	CISPR11 /CISPR22/ IEC60255-25	Class A
Sinusoidal Vibration	IEC60255-21-1	Class 1
Shock & Bump	IEC60255-21-2	Class 1
Siesmic	IEC60255-21-3	Class 2
Power magnetic Immunity	IEC61000-4-8	Level 5
Pulse Magnetic Immunity	IEC61000-4-9	Level 4
Damped Magnetic Immunity	IEC61000-4-10	Level 4
Voltage Dip & interruption	IEC61000-4-11	0, 40, 70, 80% dips, 250/ 300 cycle interrupts
Damped Oscillatory	IEC61000-4-12	2.5KV CM, 1KV DM
Conducted RF Immunity 0-150khz	IEC61000-4-16	Level 4
Voltage Ripple	IEC61000-4-17	15% ripple
Ingress Protection	IEC60529	IP40 front , IP10 Back
Environmental (Cold)	IEC60068-2-1	-40C 16 hrs
Environmental (Dry heat)	IEC60068-2-2	85C 16hrs
Relative Humidity Cyclic	IEC60068-2-30	6day variant 2
EFT	IEEE/ANSI C37.90.1	4KV, 2.5Khz
Damped Oscillatrory	IEEE/ANSI C37.90.1	2.5KV,1Mhz
RF Immunity	IEEE/ANSIC37.90.2	35V/m (max field), (80MHz-1GHz with 1KHz sine and80% AM modulation)
ESD	IEEE/ANSIC37.90.3	8KV CD/ 15KV AD
	UL508	e83849 NKCR
Safety	UL C22.2-14	e83849 NKCR7
	UL1053	e83849 NKCR

Physical

DIMENSIONS

Size: ....*Refer to Chapter 2*
Weight:.. 4.1 kg [9.0 lb]

Environmental

Ambient temperatures:	
Storage/Shipping:	- 40C to 85C
Operating:	-40C to 60C
Humidity:	Operating up to 95% (non condensing) @ 55C (As per IEC60068-2-30 Variant 2, 6days)
Altitude:	2000m (max)
Pollution Degree:	II
Overvoltage Category:	III
Ingress Protection:	IP40 Front , IP10 back

GE
Digital Energy

350 Feeder Protection System

Chapter 2: Installation

Mechanical installation

This section describes the mechanical installation of the 350 system, including dimensions for mounting and information on module withdrawal and insertion.

Dimensions

The dimensions of the 350 are shown below. Additional dimensions for mounting and panel cutouts are shown in the following sections.

Figure 1: 350 dimensions - Drawout unit

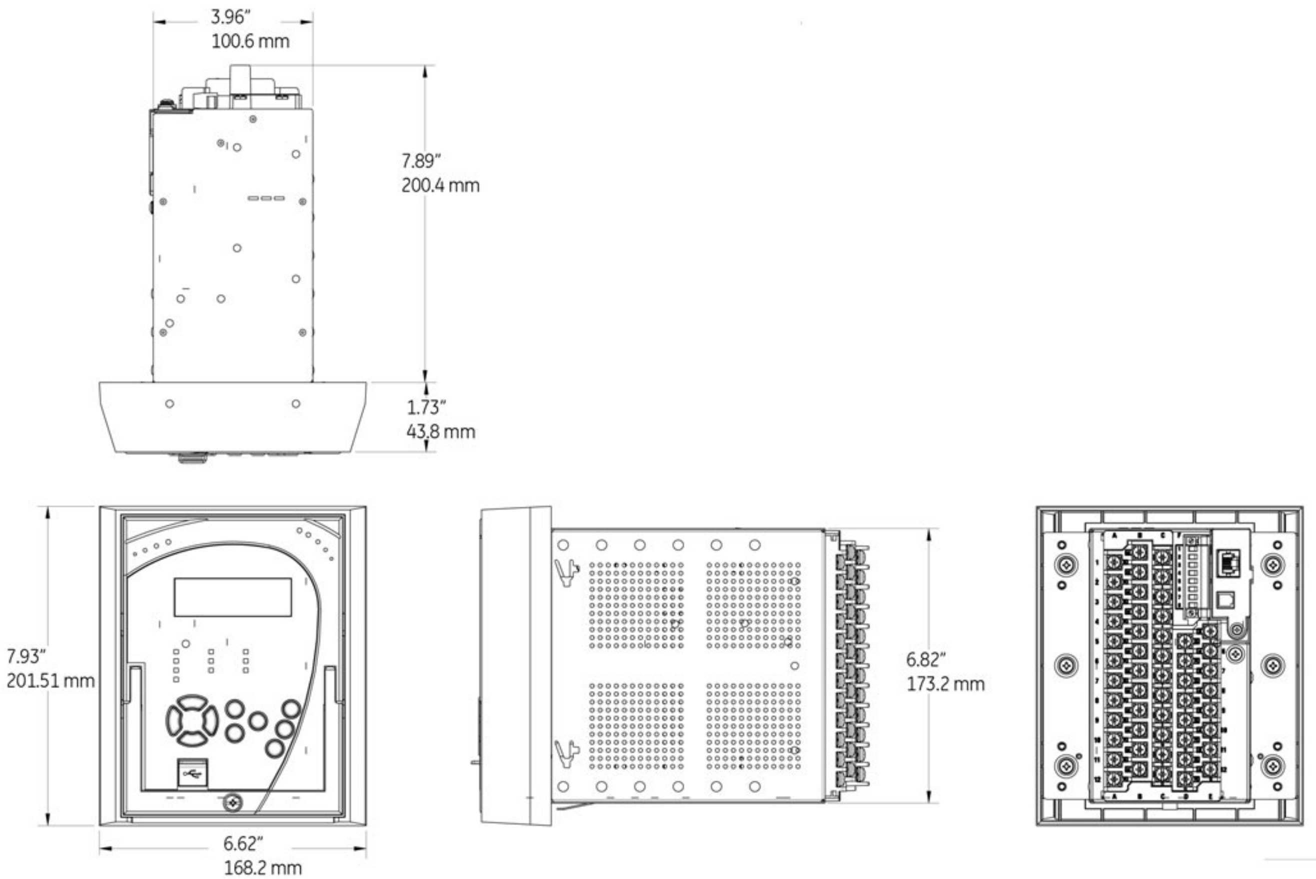
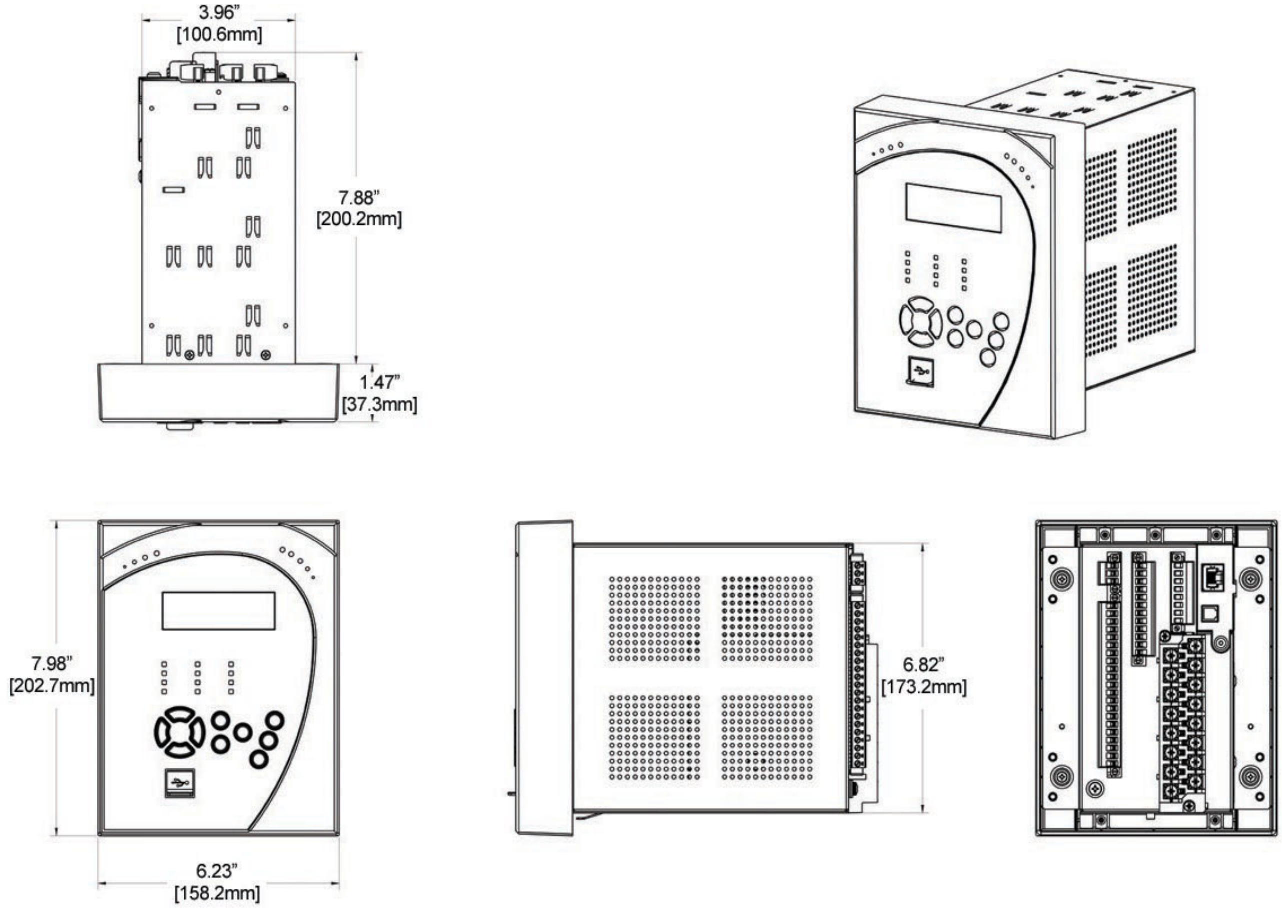


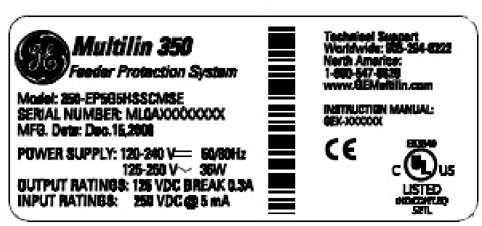
Figure 2: 350 dimensions - Non-drawout unit



Product identification

The product identification label is located on the side panel of the 350 . This label indicates the product model, serial number, firmware revision, and date of manufacture.

Figure 3: 350 label



Mounting

Standard panel mount

The standard panel mount and cutout dimensions are illustrated below.

⚠CAUTION

To avoid the potential for personal injury due to fire hazards, ensure the unit is mounted in a safe location and/or within an appropriate enclosure.

Figure 4: Standard panel mounting - Drawout

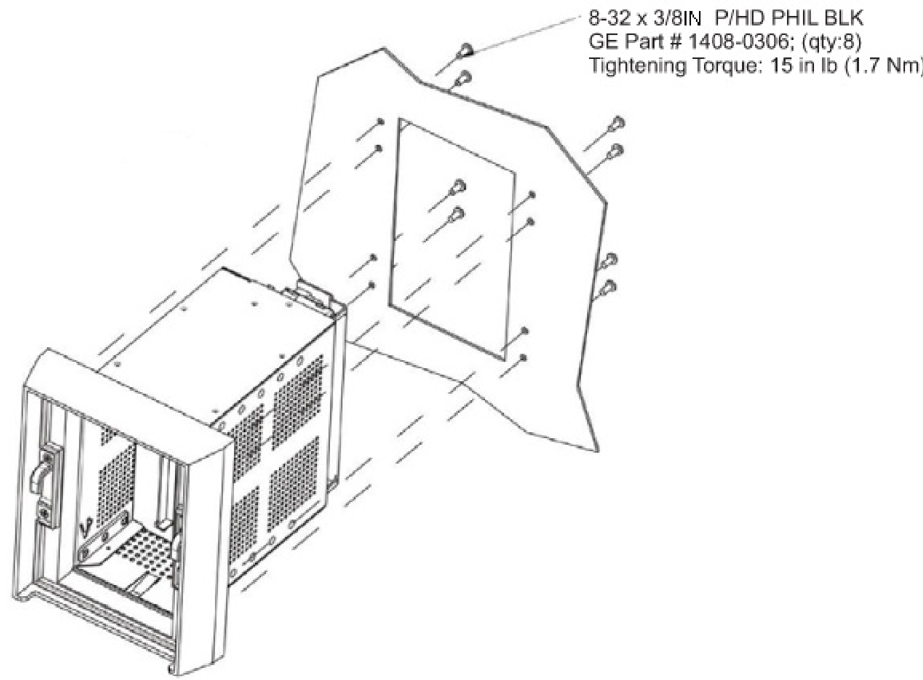


Figure 5: Standard Panel mounting - Non-drawout

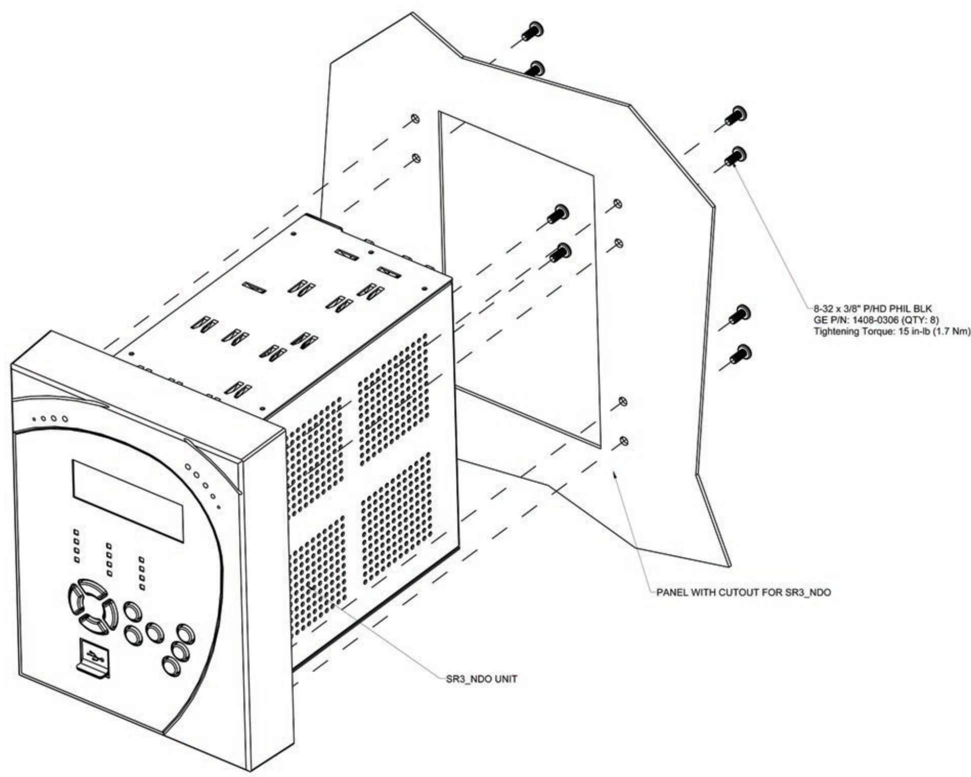
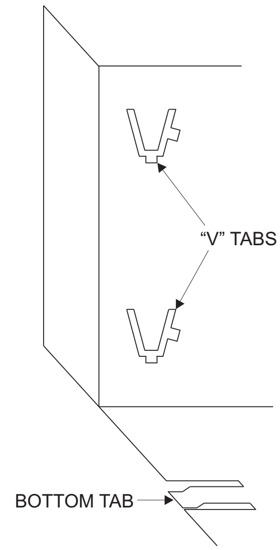


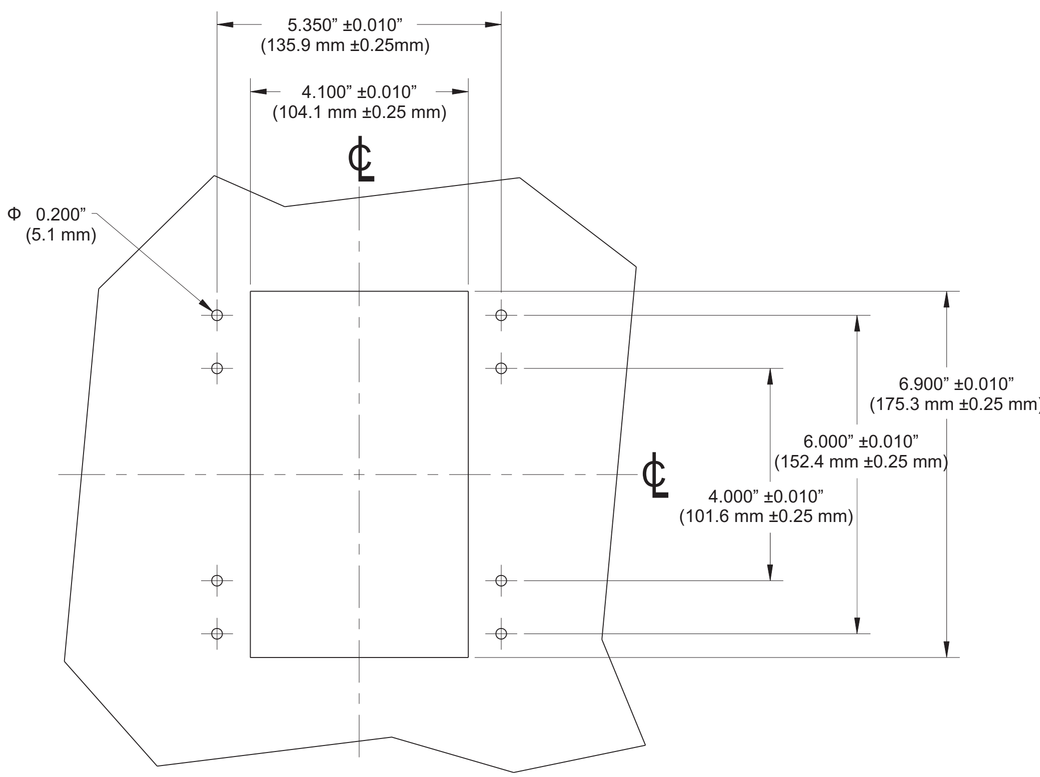
Figure 6: Mounting tabs (optional)



1. From the front of the panel, slide the empty case into the cutout until the bottom tab clicks into place (see above).
2. From the rear of the panel screw the case into the panel at the 8 screw positions shown above.
3. If added security is required, bend the retaining "V"tabs outward, to about 90°. These tabs are located on the sides of the case and appear as shown above.

The relay can now be inserted and can be panel wired.

Figure 7: Panel cutout dimensions



Mounting using the S1/S2/MDP/IAC or SR735 adapter plate

⚠CAUTION

To avoid the potential for personal injury due to fire hazards, ensure the unit is mounted in a safe location and/or within an appropriate enclosure.

The adaptor plate for mounting the 350 directly over the existing S1/S2/MDP/IAC or SR735 mounting plate, is shown below:

Figure 8: Adaptor Plate mounting - Drawout case

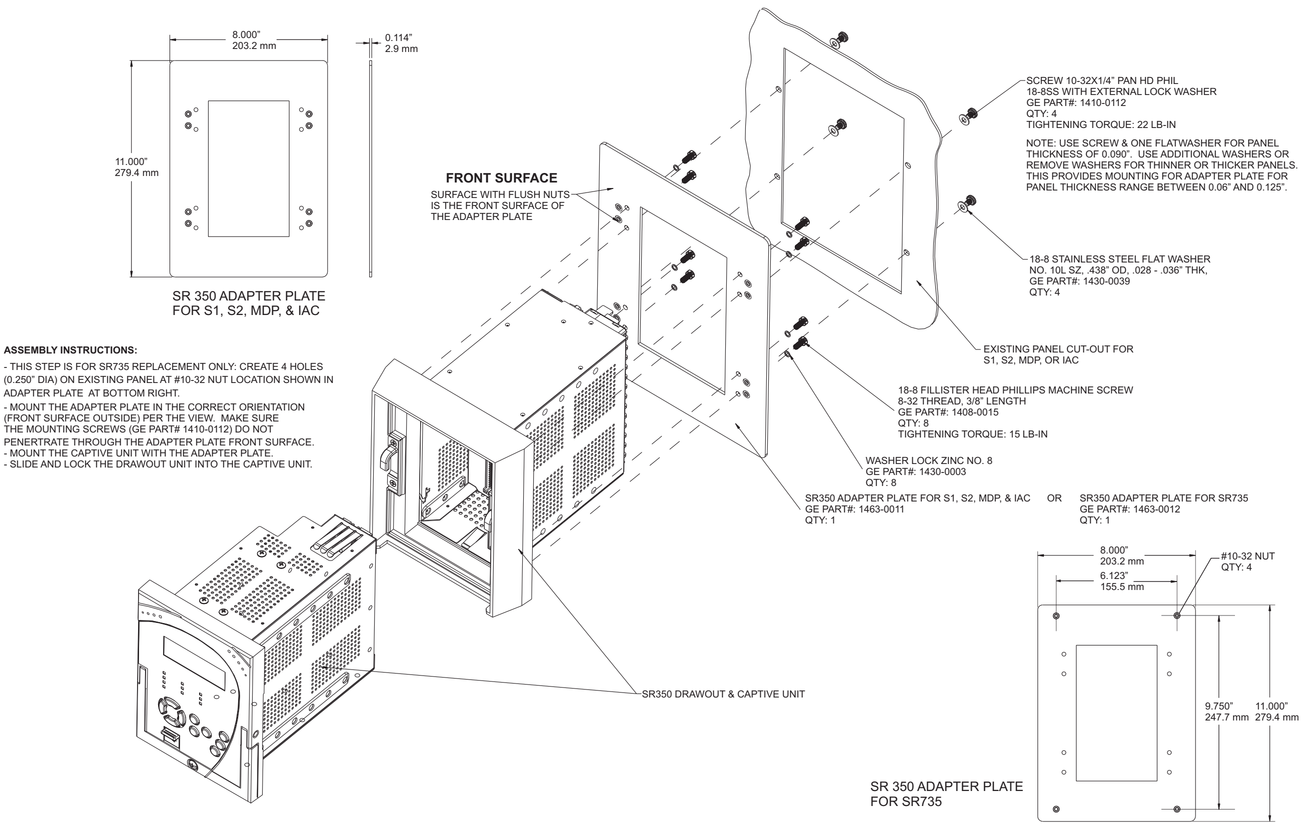


Figure 9: Non-drawout - Adapter plate mounting

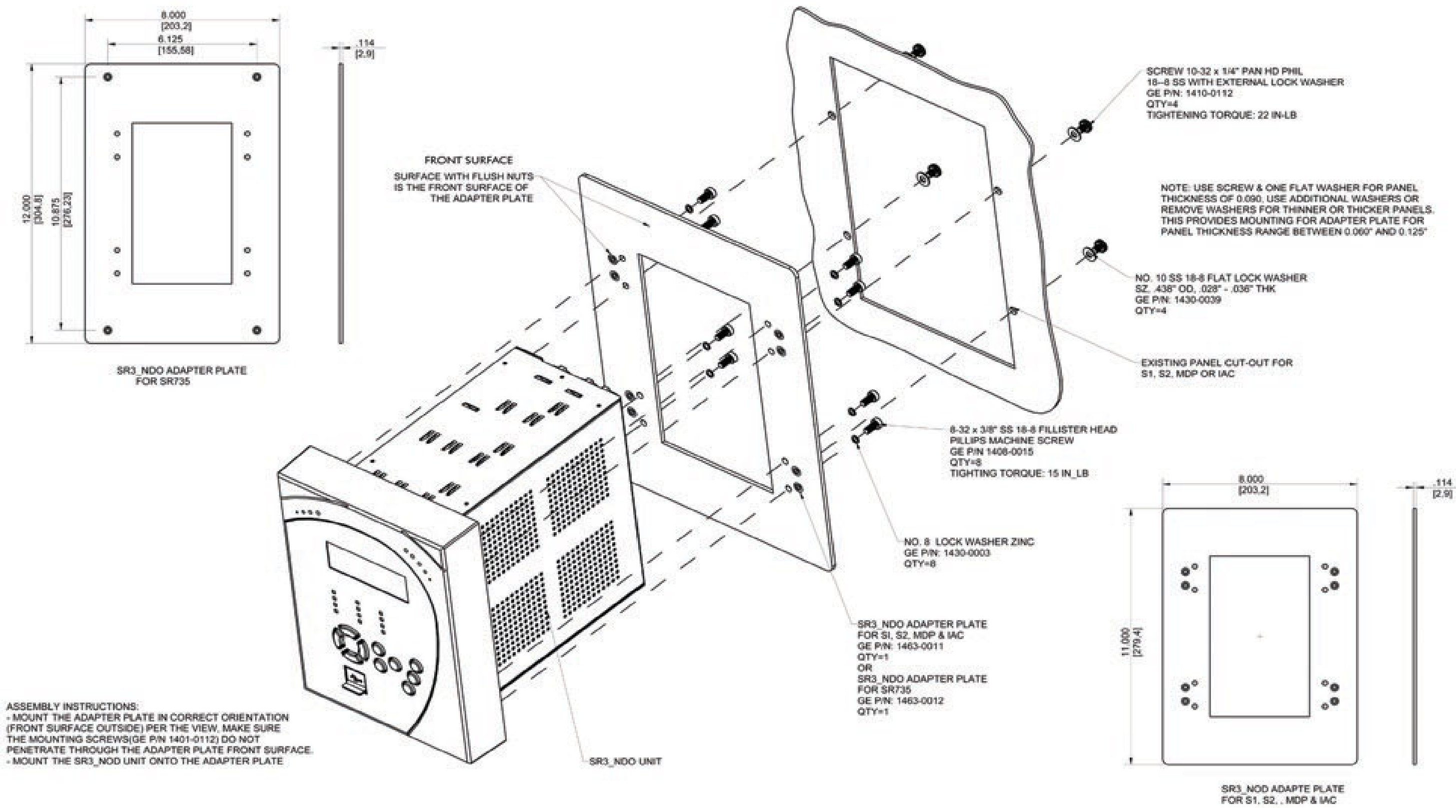
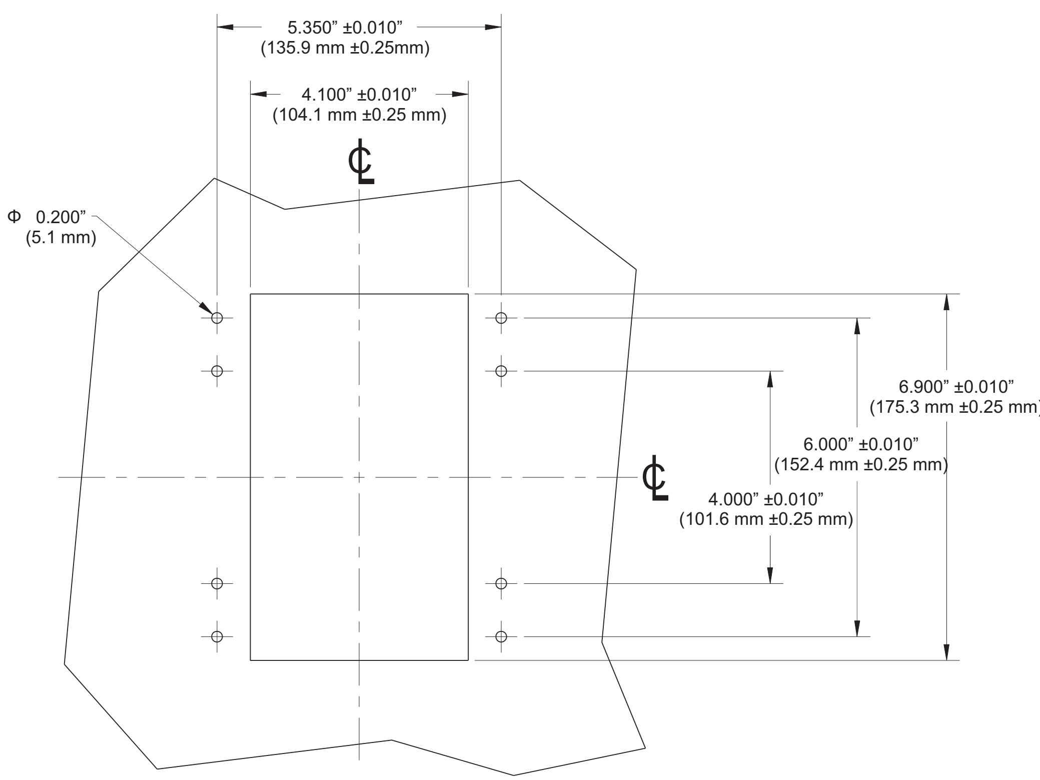
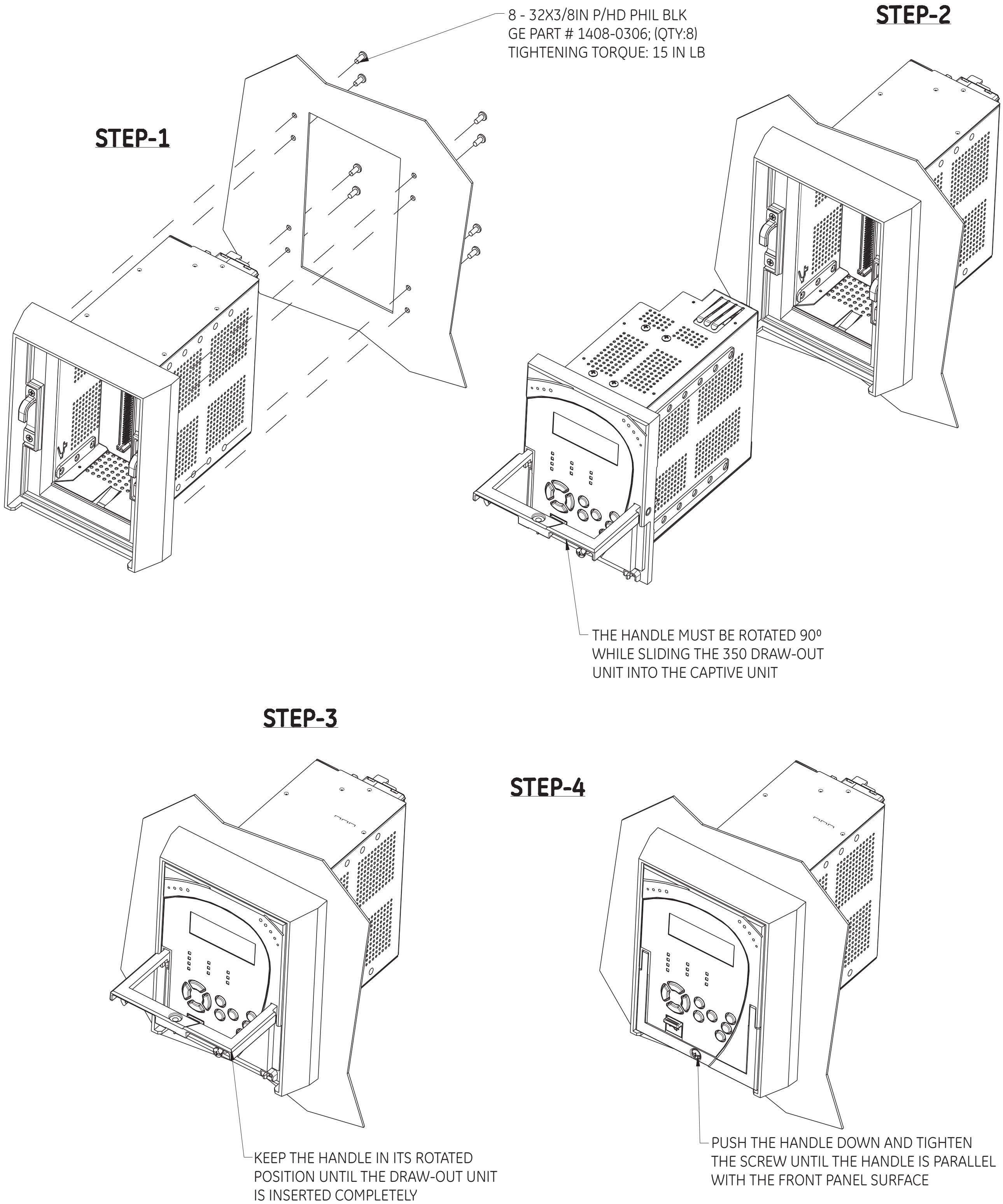


Figure 10: Panel cutout dimensions



Drawout unit withdrawal and insertion

Figure 11: Unit withdrawal and insertion diagram



Electrical installation

Figure 12: Typical wiring diagram - Drawout

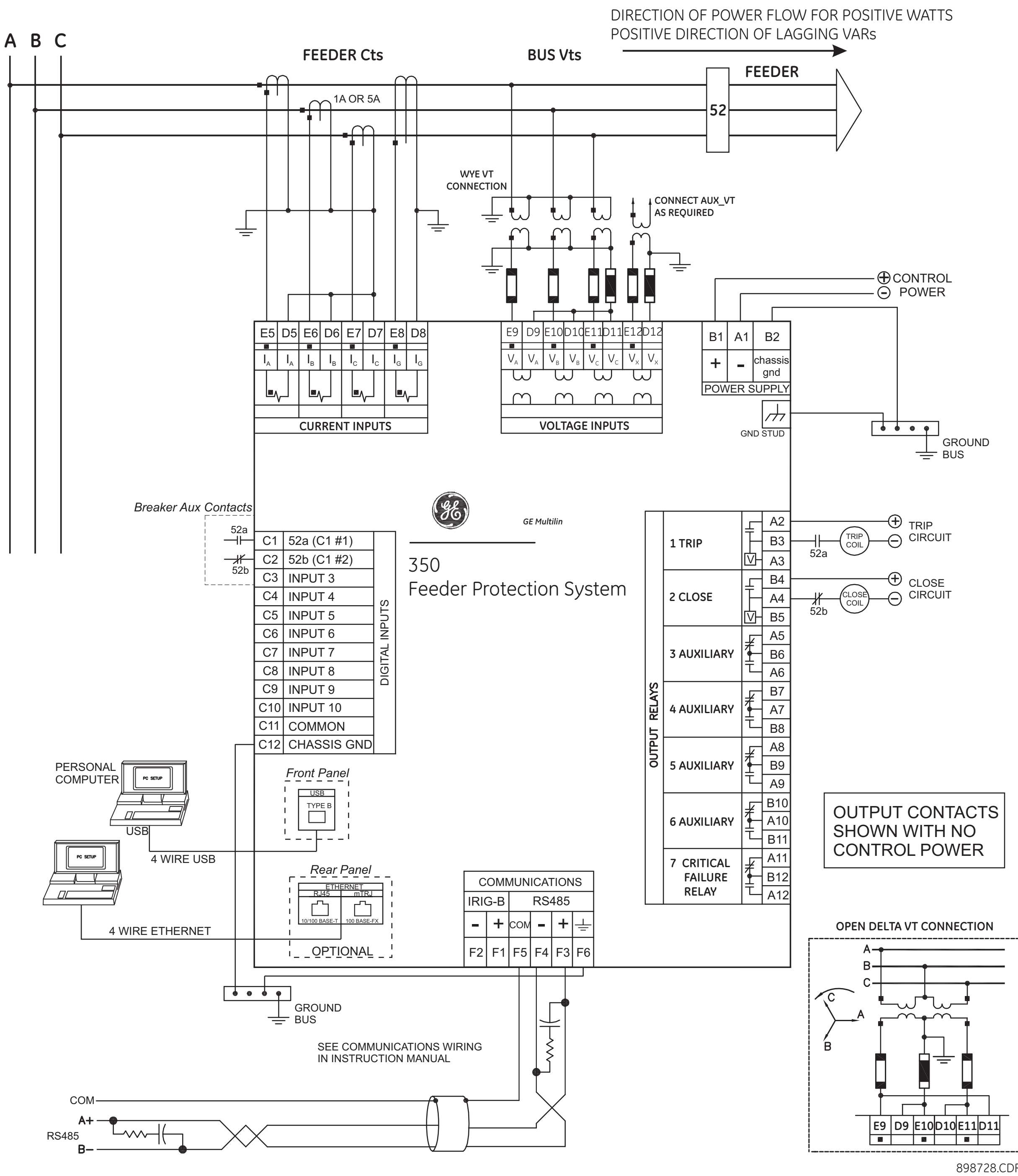
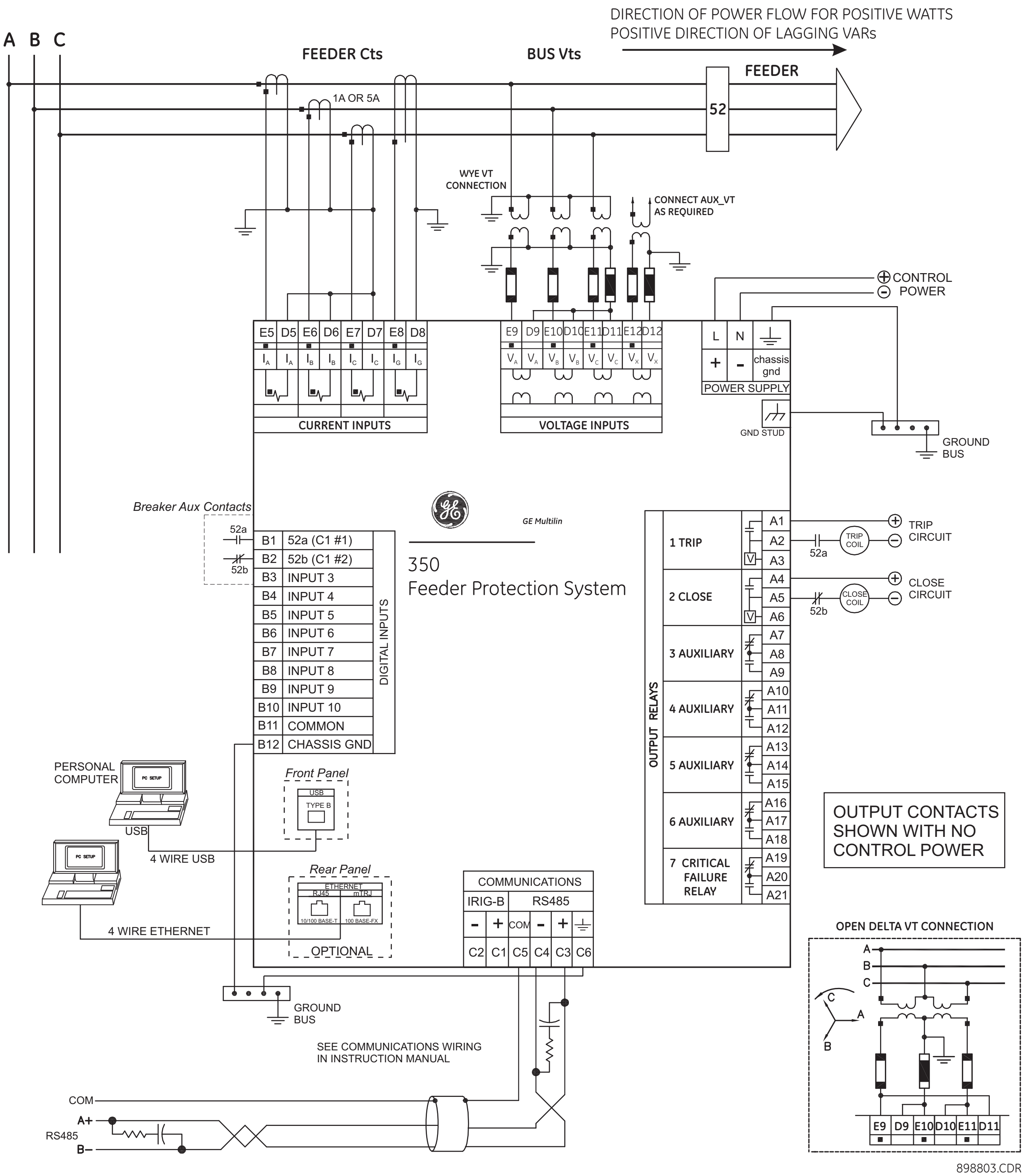


Figure 13: Typical wiring diagram - Non-drawout



Terminal identification

NOTE

When installing two lugs on one terminal, both lugs should be "right side up" as shown in the picture below. This is to ensure the adjacent lower terminal block does not interfere with the lug body.

Figure 14: Orient the Lugs correctly...

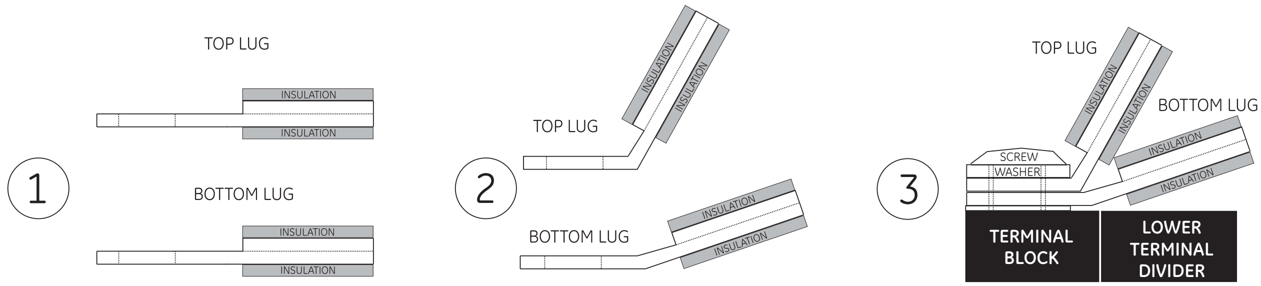


Figure 15: CORRECT INSTALLATION METHOD

Figure 16: INCORRECT INSTALLATION METHOD (lower lug reversed)

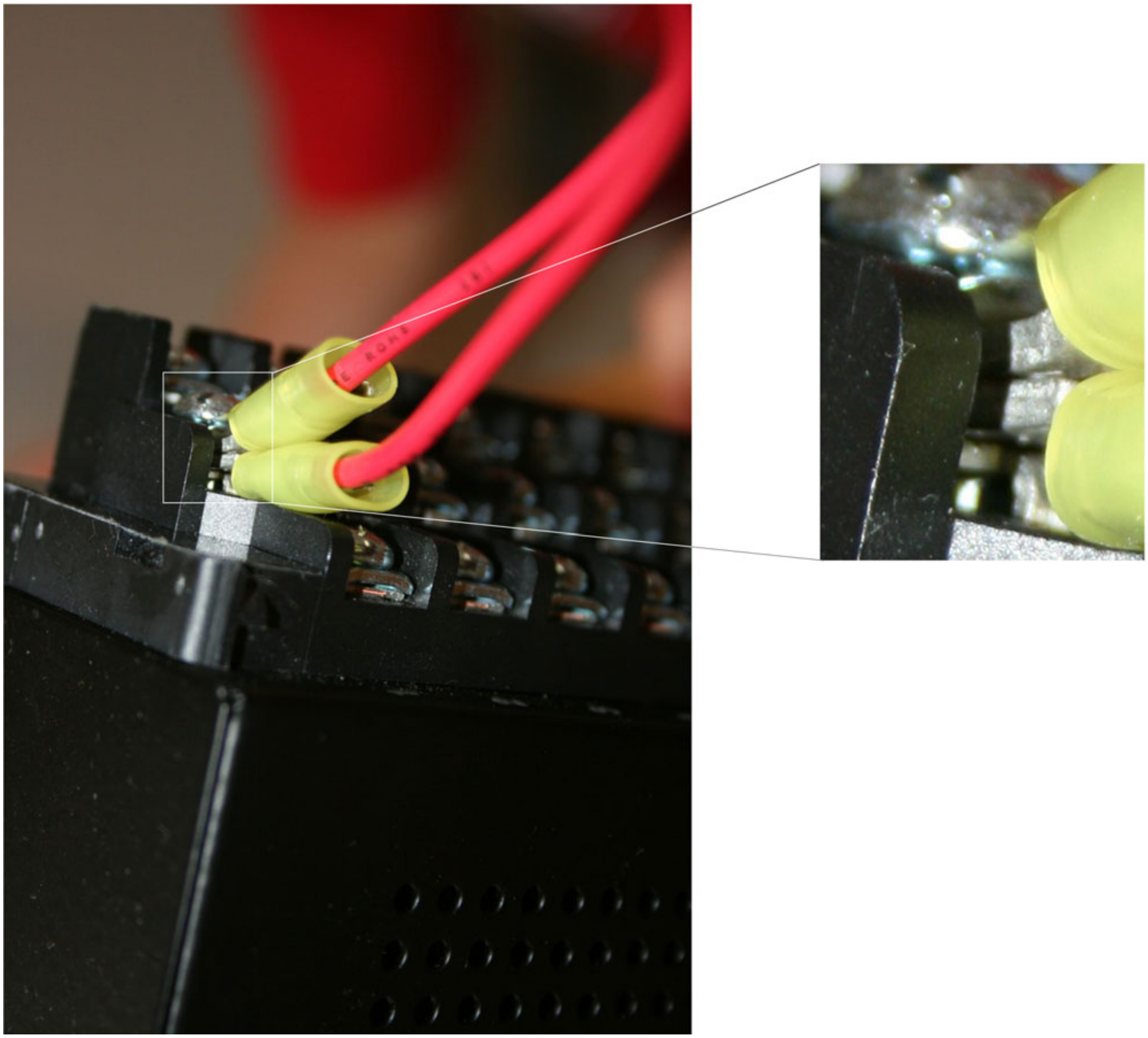


Figure 17: 350 Terminal Identification - standard

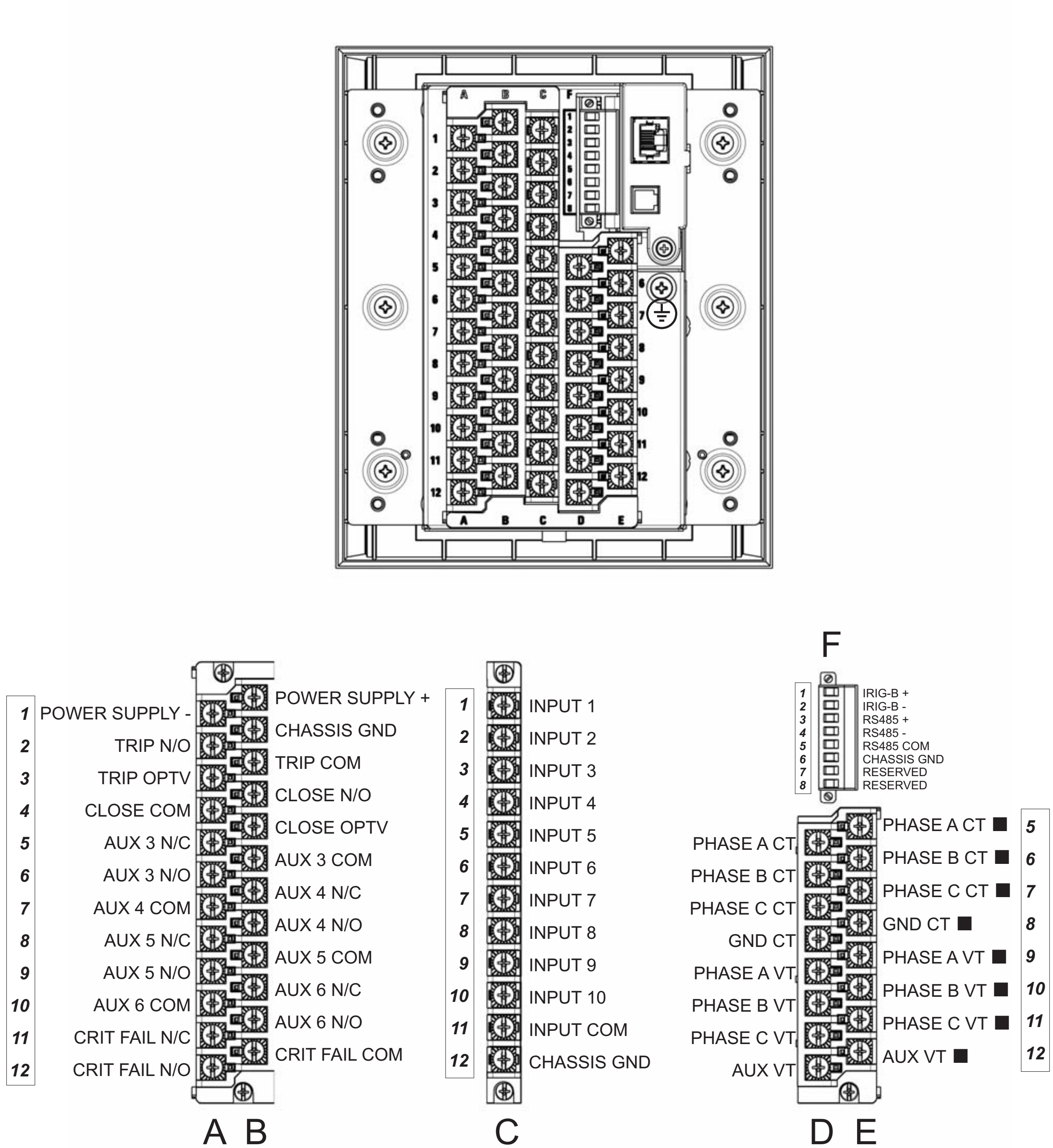
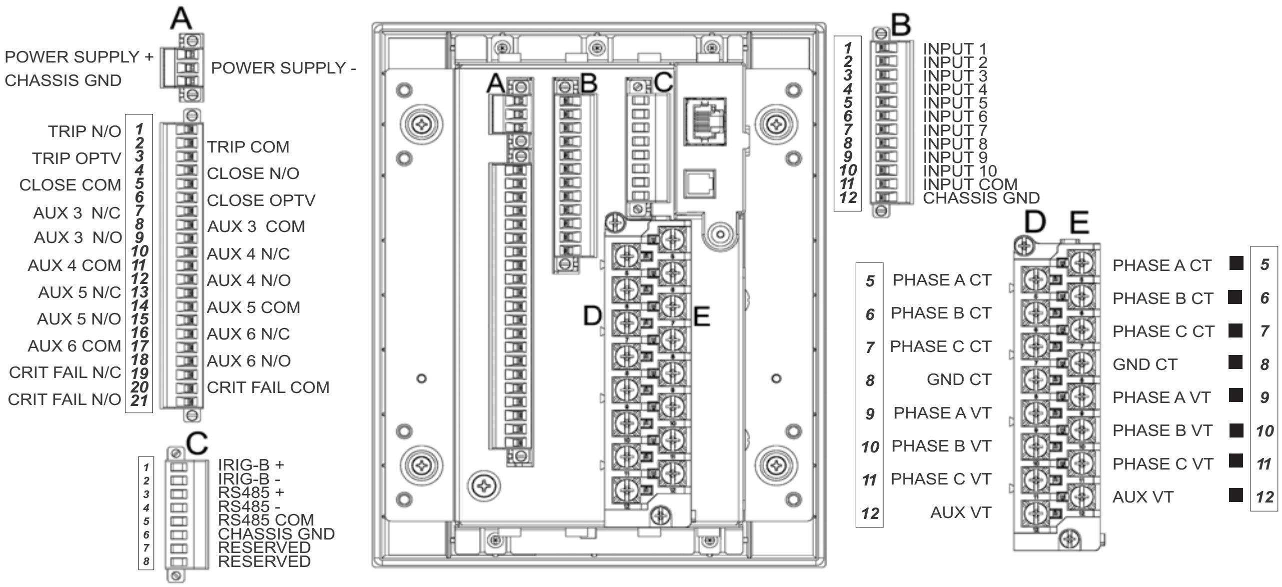


Figure 18: 350 Terminal Identification - Non-drawout



Wire range

Use the following guideline when selecting wires or lugs to connect to terminal blocks A,B,C,D,E (Drawout case design), and terminal blocks D,E (Non-drawout case design):

- 12 AWG to 22 AWG (3.3 mm^2 to 0.3 mm^2): Single wire termination with/without 9.53 mm (0.375") maximum diameter ring terminals.
- 14 AWG to 22 AWG (2.1 mm^2 to 0.3 mm^2): Multiple wire termination with matching wire sizes and stranding. Two wires maximum per circuit.
- 14 AWG to 22 AWG (2.1 mm^2 to 0.3 mm^2): Multiple wire termination with 9.53 mm (0.375") maximum diameter ring terminals. Two ring terminals maximum per circuit.
- Suggested wiring screw tightening torque, tighten to 12 in-lb (1.35 N-m).

Phase sequence and transformer polarity

For correct operation of the relay features, the user must follow the instrument transformer polarities, shown in the Typical Wiring Diagram. Note the solid square markings shown with all instrument transformer connections. When the connections adhere to this drawing, the arrow shows the direction of power flow for positive watts and the positive direction of lagging vars. The phase sequence is user programmable for either ABC or ACB rotation.

Current inputs

The 350 relay has four (4) channels for AC current inputs, each with an isolating transformer. There are no internal ground connections on the current inputs. Current transformers with 1 to 6000 A primaries may be used.

⚠CAUTION

Verify that the relay's nominal input current of 1 A or 5 A matches the secondary rating of the connected CTs. Unmatched CTs may result in equipment damage or inadequate protection.

⚠CAUTION

IMPORTANT: The phase and ground current inputs will correctly measure up to 20 times the current input's nominal rating. Time overcurrent curves become horizontal lines for currents above the 20 × CT rating. This becomes apparent if the pickup level is set above the nominal CT rating.

CAUTION **Before working on CTs, they MUST be short circuited.**

Ground and sensitive ground CT inputs

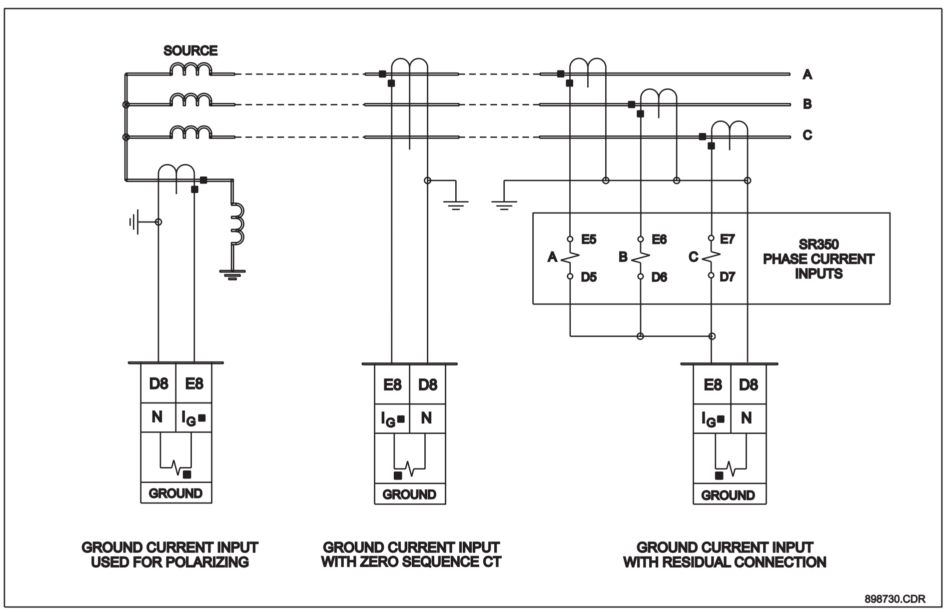
One dedicated ground input is referred to throughout this manual as the **Ground Current** or **Sensitive Ground Current** input. Before making ground connections, consider that the relay automatically calculates the neutral (residual) current from the sum of the three phase current phasors. The following figures show three possible ground connections (or three possible sensitive ground connections).

The ground input (Terminals D8 and E8) is used in conjunction with a Zero Sequence CT as source, or in the neutral of wye-connected source CTs. The ground current input can be used to polarize the neutral directional element. When using the residual connection set the GROUND CT PRIMARY setpoint to a value equal to the PHASE CT PRIMARY setpoint.

In cases where the relay is equipped with sensitive ground CT (terminals D8 and E8) the sensitive ground current input is intended for use either with a CT in a source neutral of a high-impedance grounded system, or on ungrounded systems. On ungrounded systems it is connected residually with the phase current inputs. In this case, the SENSTV GND CT PRIMARY setpoint should be programmed to a value equal to the PHASE CT PRIMARY setpoint. The sensitive ground current input can be connected to a Zero Sequence CT for increased sensitivity and accuracy when physically possible in the system.

NOTE: The Sensitive Ground input must only be used on systems where the maximum ground current does not exceed 100 times the rated current for 1 second.

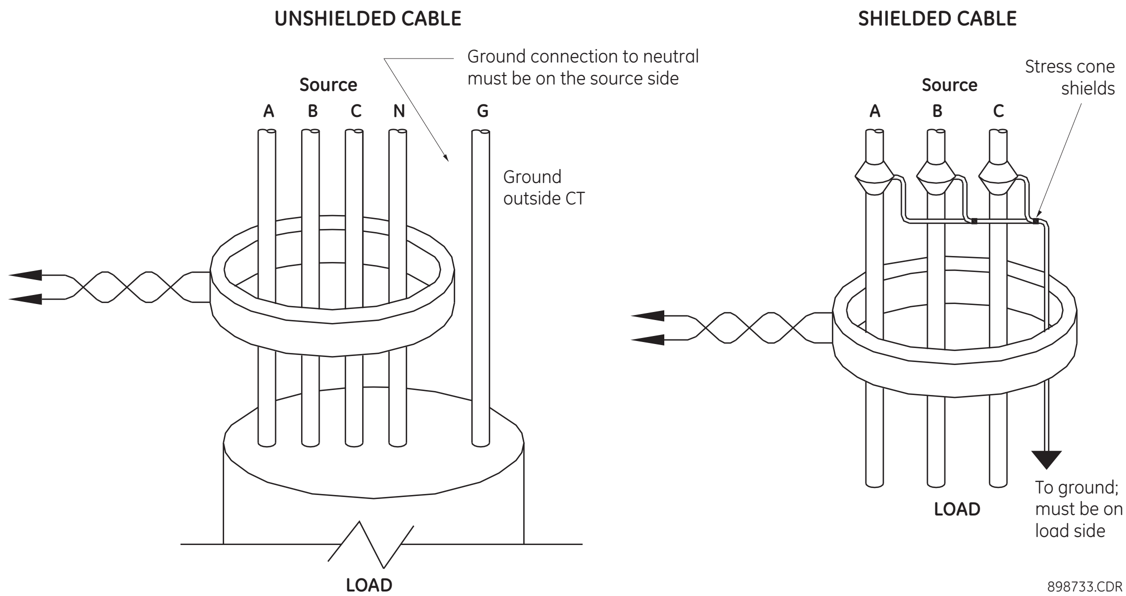
Figure 19: Ground/Sensitive Ground wiring



Zero sequence CT installation

The various CT connections and the exact placement of a Zero Sequence CT, for ground fault current detection, are shown in the figure below. Twisted pair cabling on the Zero Sequence CT is recommended.

Figure 20: Zero sequence core balance (CT) installation



Voltage inputs

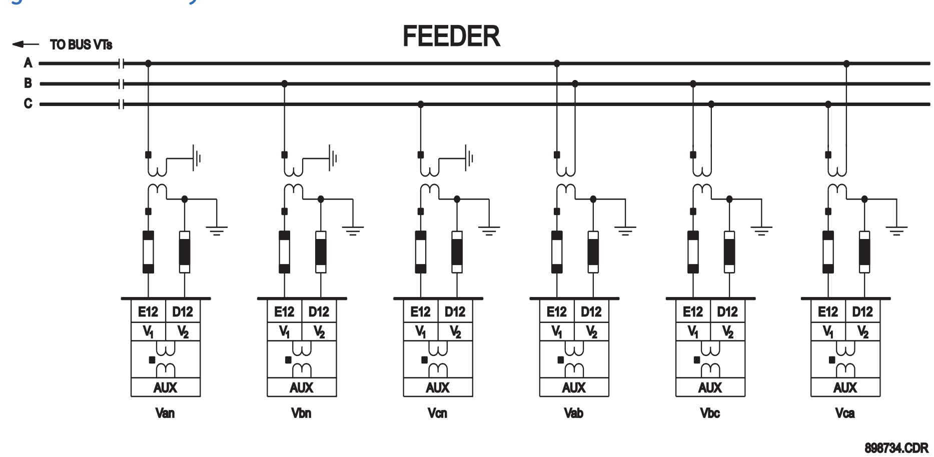
The 350 relay has four channels for AC voltage inputs, each with an isolating transformer. Voltage transformers up to a maximum 1500:1 ratio may be used. The nominal secondary voltage must be in the 50 to 240 V range.The three phase inputs are designated as the “bus voltage”. The Bus VT connections most commonly used, wye and delta (or open delta), are shown in the typical wiring diagram.

NOTE: If Delta VTs are used, the zero sequence voltage (V0) and neutral/sensitive ground polarizing voltage (–V0) will be zero. Also, with the Delta VT connection, the phase-neutral voltage cannot be measured and will not be displayed.

NOTE: The 350 relay can be applied to both metering and protection feeders with up to 65 kV phase-to-phase voltage. Please ensure that the selected VT ratio and VT secondary do not result in a primary voltage exceeding 65 kV.

The single phase input is designated as the “Aux VT Input”. The Aux VT input channel can be connected for either phase-neutral voltage Van, Vbn, Vcn, or for phase-phase voltage Vab, Vbc, Vca as shown below.

Figure 21: Auxiliary VT connections



Control power

CAUTION **Control power supplied to the relay must match the installed power supply range. If the applied voltage does not match, damage to the unit may occur. All grounds MUST be connected for safe, normal operation regardless of control power supply type.**

The label found on the relay specifies its order code or model number. The installed power supply's operating range will be one of the following:

LO: 24 to 48 V DC (Range: 20 to 60 V DC)

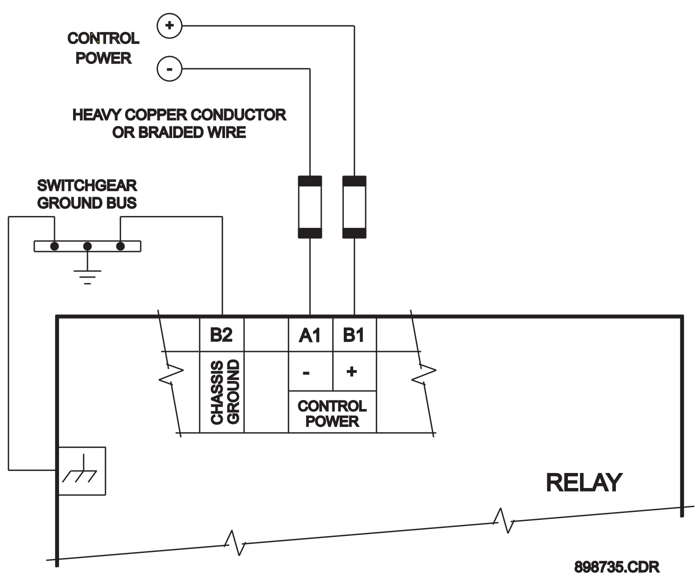
HI: 125 to 250 V DC/120 to 240 V AC (Range: 84 to 250 V DC/66 to 265 V AC)

CAUTION **The relay should be connected directly to the ground bus, using the shortest practical path. A tinned copper, braided, shielding and bonding cable should be used. As a minimum, 96 strands of number 34 AWG should be used. Belden catalog number 8660 is suitable.**

CAUTION **Isolate power prior to servicing.**

NOTE An external switch, circuit breaker, or other protective device **must** be connected near to the equipment.

Figure 22: Control power connection



Contact inputs

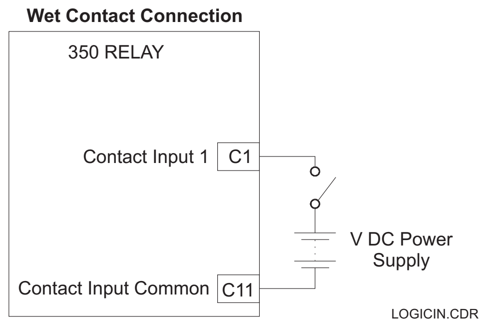
External contacts can be connected to the relay's ten (10) digital inputs. These contacts are wet only.

The inputs can be programmed to different thresholds depending on the DC voltage (17, 33, 84, 166).

CAUTION **Ensure correct polarity on contact input connections and do not connect any contact input circuits to ground or else relay hardware may be damaged.**

A wet contact has one side connected to the positive terminal of an external DC power supply. The other side of this contact is connected to the required contact input terminal. In addition, the negative side of the external source must be connected to the relay's DC negative rail at Terminal C11. The maximum external source voltage for this arrangement is 300 V DC.

Figure 23: Wet contact connections



Trip and Close output relays

The 350 relay is equipped with seven electromechanical output relays: two special relays designed for Breaker trip and close (Relay 1 "Trip", Relay 2 "Close"), four general purpose relays (Auxiliary Relays 3 to 6), and a Critical Failure relay. The special purpose relays have fixed operating characteristics and the general purpose relays can be configured by the user.

Operation of the Trip and Close output relays is designed to be controlled by the state of the circuit breaker as monitored by a 52a or 52b contact.

- The Trip and Close relays reset after the breaker is detected in a state corresponding to the command. When a relay feature sends a command to one of these special relays, it will remain operational until the requested change of breaker state is confirmed by a breaker auxiliary contact and the initiating condition has reset.
- If the initiating feature resets, but the breaker does not change state, the output relay will be reset after a default interval of 2 seconds.
- If neither of the breaker auxiliary contacts, 52a nor 52b, is programmed to a contact input, the Trip Relay is de-energized after either the delay programmed in the Breaker Failure feature, or a default interval of 100 ms after the initiating input resets. The Close Relay is de-energized after 200 ms.
- If a delay is programmed for the Trip or Close contact seal-in time, then this delay is added to the reset time. Note that the default setting for the seal-in time is 40 ms.

52a Contact Configured	52b Contact Configured	Relay Operation
Yes	Yes	Trip Relay remains operational until 52b indicates an open breaker. Close Relay remains operational until 52a indicates a closed breaker.
Yes	No	Trip Relay remains operational until 52a indicates an open breaker. Close Relay remains operational until 52a indicates a closed breaker.
No	Yes	Trip Relay remains operational until 52b indicates an open breaker. Close Relay remains operational until 52b indicates a closed breaker.
No	No	Trip Relay operates until either the Breaker Failure delay expires (if the Breaker Failure element is enabled), or 100 ms after the feature causing the trip resets. Close Relay operates for 200 ms.

Breaker monitoring (Trip and Close coil monitoring) is performed by a built-in voltage monitor on Form A output relays: #1 Trip, and #2 Close. The voltage monitor is connected across each of the two Form A contacts, and the relay effectively detects healthy current through the circuit. In order to do this, an external jumper must be connected between terminals A2 and A3 for Trip coil monitoring, or/and B4, and B5 for Close coil monitoring.

As long as the current through the Voltage Monitor is above the threshold of the trickle currents (see Technical Specification for Form A output relays), the circuit integrity for the Trip (Close) coil is effectively normal. If the Trip (Close) coil circuit gets disconnected, or if in general a high resistance is detected in the circuitry, a Trip (Close) alarm will be set and the “ALARM” and “MAINTENANCE” LEDs will be on.

Example 1: The figures below show the two different connections of the breaker trip (close) coil to the relay’s trip output #1 terminals (output #2 Close coil monitoring) for both no voltage monitoring and voltage monitoring of the trip (close) circuit integrity.

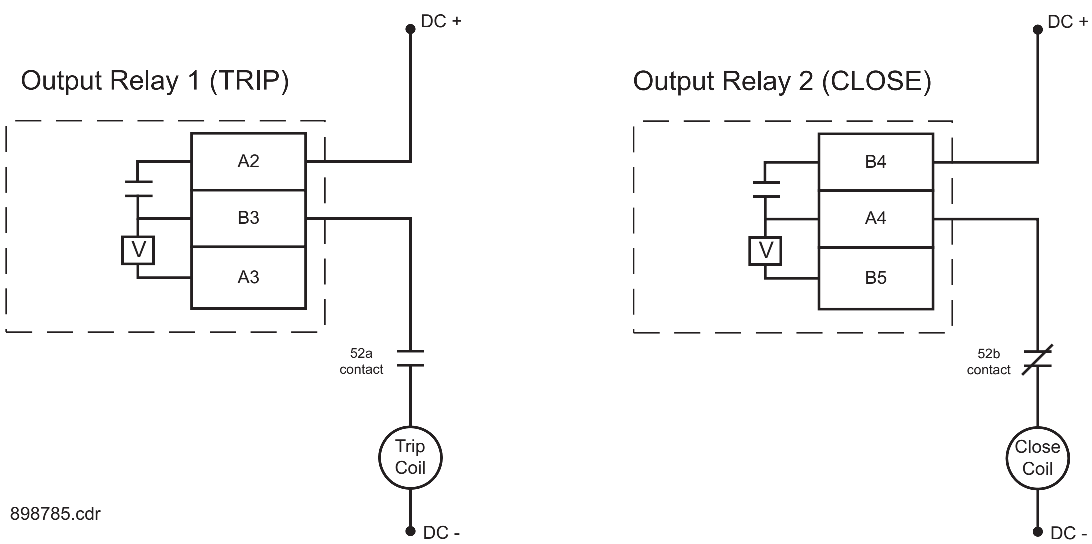
NOTE

To monitor the trip coil circuit integrity, use the relay terminals A2 and B3 to connect the Trip coil, and provide a jumper between terminals A2 (optional voltage) and A3.

NOTE

To monitor the close coil circuit integrity, use the relay terminals B4 and A4 to connect the Close coil, and provide a jumper between terminals B4 (optional voltage) and B5.

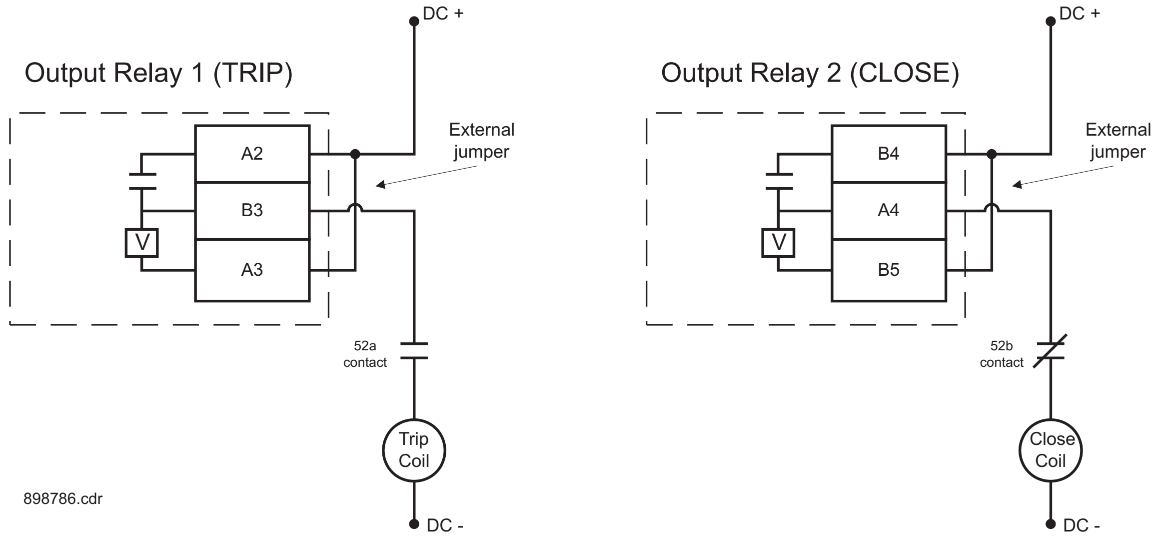
Figure 24: Trip and Close circuits with no voltage monitoring



NOTE

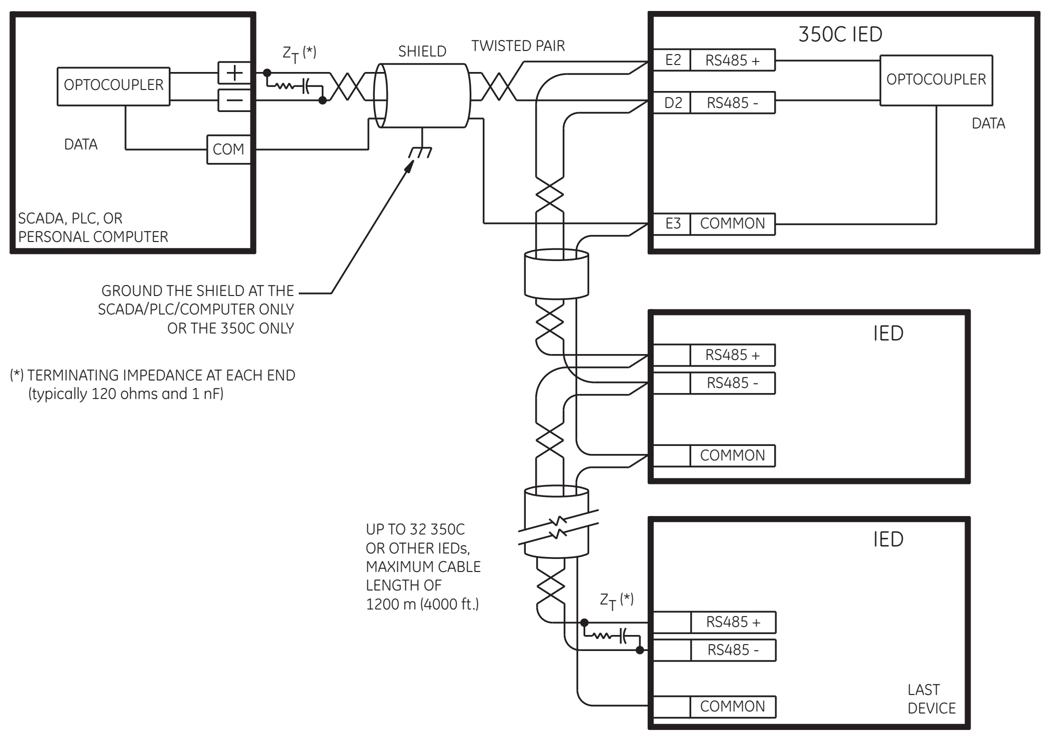
All AUX contacts are shown when the breaker is open.

Figure 25: Trip and close circuits with voltage monitoring



Serial communications

Figure 26: RS485 wiring diagram



One two-wire RS485 port is provided. Up to 32 350 IEDs can be daisy-chained together on a communication channel without exceeding the driver capability. For larger systems, additional serial channels must be added. Commercially available repeaters can also be used to add more than 32 relays on a single channel. Suitable cable should have a characteristic impedance of 120 ohms (for example, Belden #9841) and total wire length should not exceed 1200 meters (4000 ft.). Commercially available repeaters will allow for transmission distances greater than 1200 meters.

Voltage differences between remote ends of the communication link are not uncommon. For this reason, surge protection devices are internally installed across all RS485 terminals. Internally, an isolated power supply with an optocoupled data interface is used to prevent noise coupling.

⚠CAUTION

To ensure that all devices in a daisy-chain are at the same potential, it is imperative that the common terminals of each RS485 port are tied together and grounded only once, at the master or at the 350 . Failure to do so may result in intermittent or failed communications.

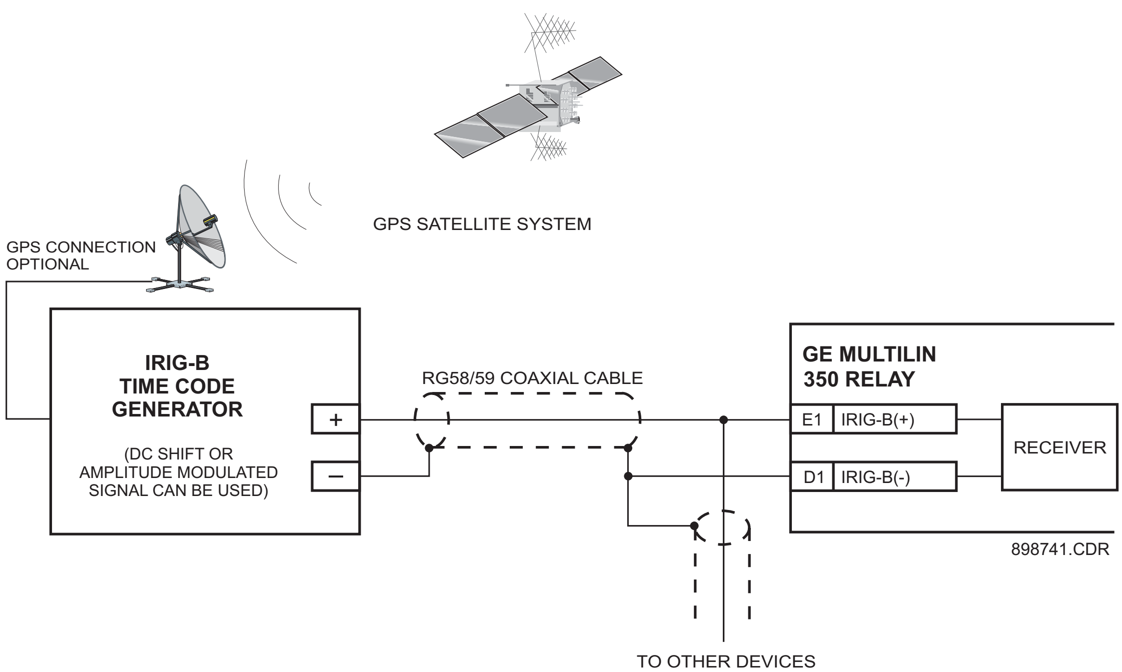
The source computer/PLC/SCADA system should have similar transient protection devices installed, either internally or externally. Ground the shield at one point only, as shown in the figure above, to avoid ground loops.

Correct polarity is also essential. The 350 IEDs must be wired with all the positive (+) terminals connected together and all the negative (–) terminals connected together. Each relay must be daisy-chained to the next one. Avoid star or stub connected configurations. The last device at each end of the daisy-chain should be terminated with a 120 ohm ¼ watt resistor in series with a 1 nF capacitor across the positive and negative terminals. Observing these guidelines will ensure a reliable communication system immune to system transients.

IRIG-B

IRIG-B is a standard time code format that allows time stamping of events to be synchronized among connected devices within 1 millisecond. The IRIG time code formats are serial, width-modulated codes which can be either DC level shift or amplitude modulated (AM) form. The type of form is auto-detected by the 350 relay. Third party equipment is available for generating the IRIG-B signal; this equipment may use a GPS satellite system to obtain the time reference so that devices at different geographic locations can also be synchronized.

Figure 27: IRIG-B connection



350 Feeder Protection System

Chapter 3: Interfaces

There are two methods of interfacing with the 350 Feeder Protection System.

- Interfacing via the relay keypad and display.
- Interfacing via the EnerVista SR3 Setup software.

This section provides an overview of the interfacing methods available with the 350 using the relay control panels and EnerVista SR3 Setup software. For additional details on interface parameters (for example, settings, actual values, etc.), refer to the individual chapters.

Front control panel interface

Figure 1: 350 Feeder Protection System Front Panel - Non-programmable LEDs

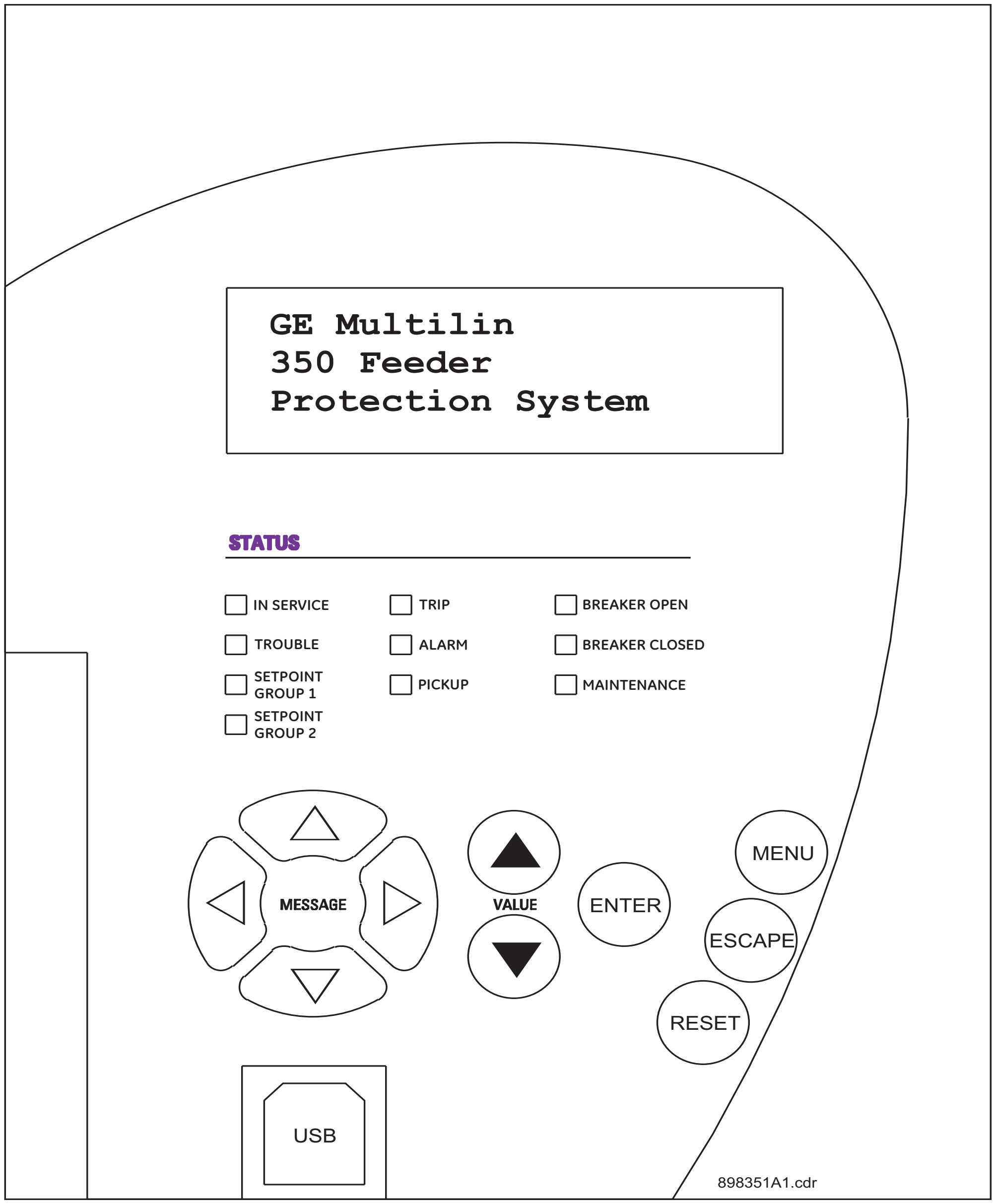
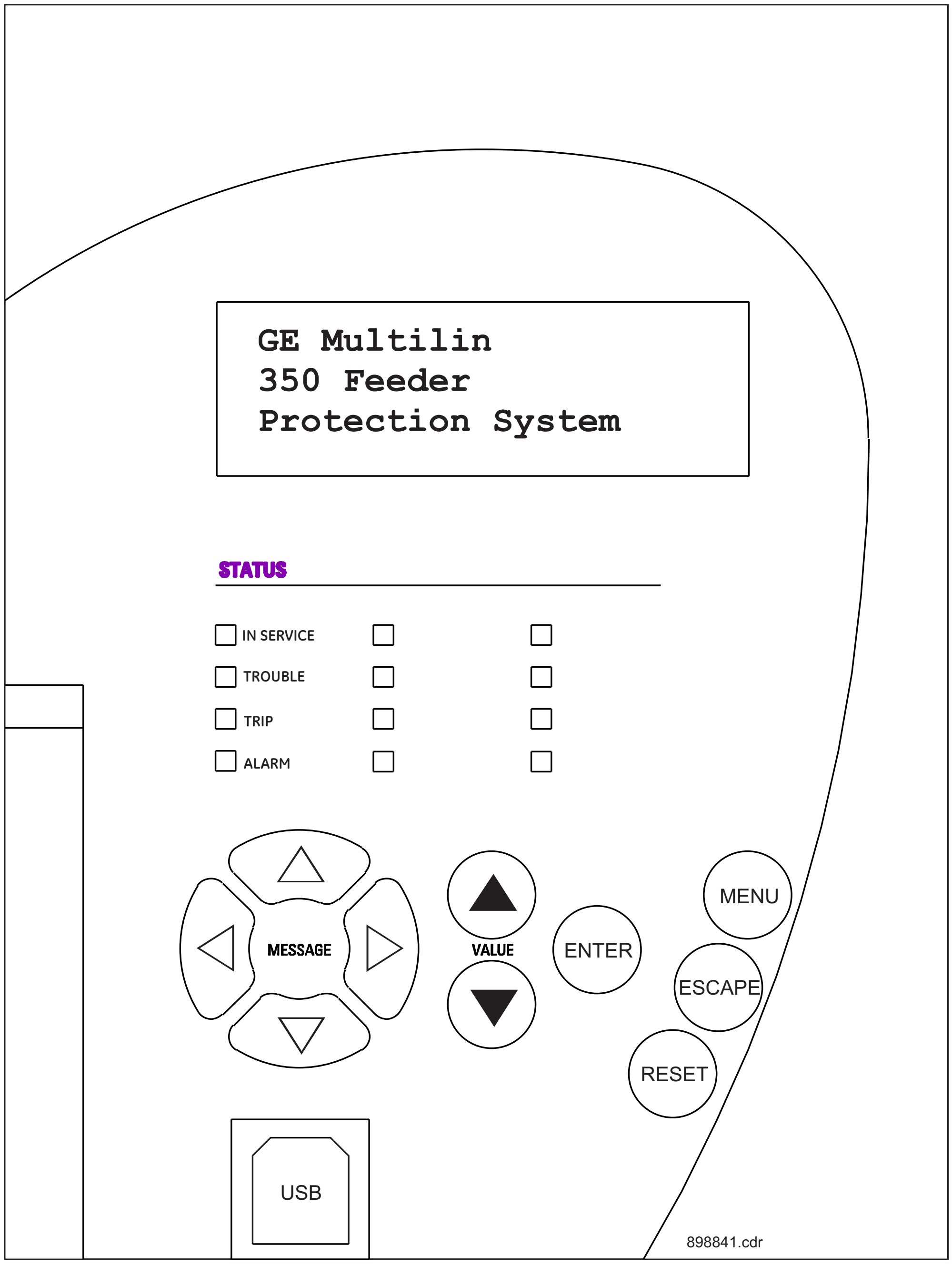


Figure 2: 350 Feeder Protection System Front Panel - Programmable LEDs



Description

The relay front panel provides an interface with a liquid crystal display, LED status indicators, control keys, and a USB program port. The display and status indicators show the relay information automatically. The control keys are used to select the appropriate message for entering setpoints or displaying measured values. The USB program port is also provided for connection with a computer running the EnerVista SR3 Setup software.

Display

The 80-character liquid crystal display (LCD) allows visibility under varied lighting conditions. When the keypad and display are not being used, system information is displayed after a user-defined period of inactivity. Pressing the Menu key during the display of default message returns the display to the last message shown before the default message appeared. Any trip, alarm, or pickup is displayed immediately, automatically overriding the default message.

Working with the Keypad

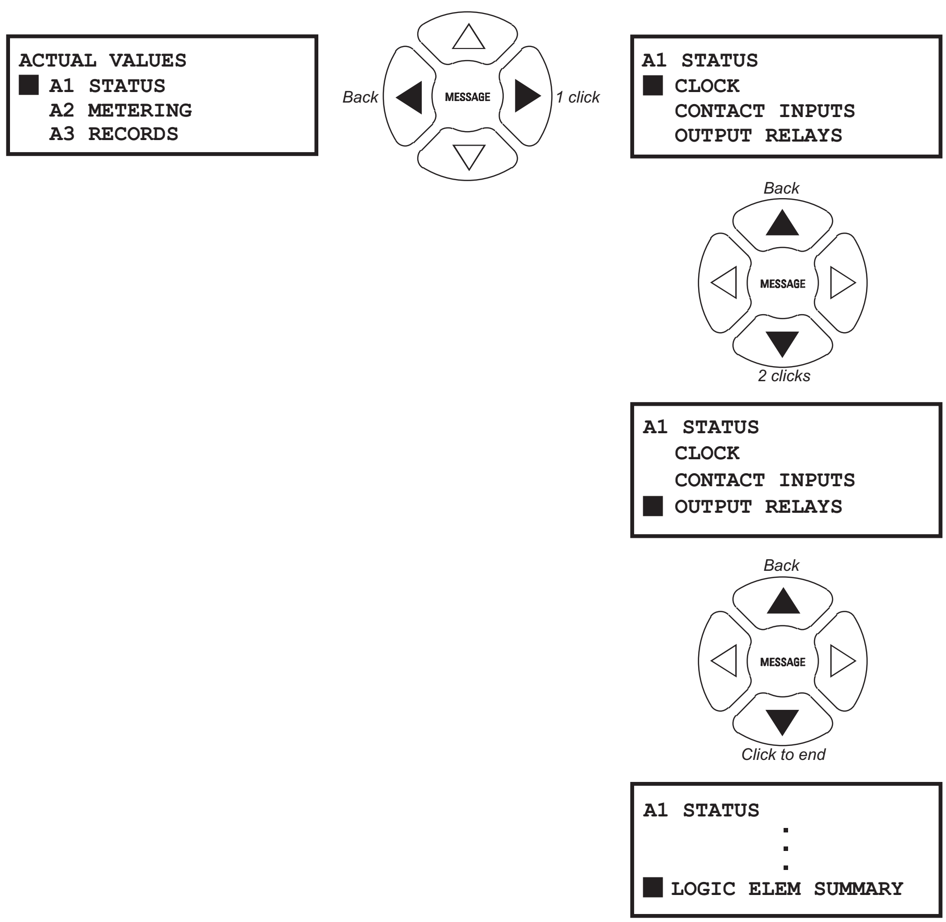
The 350 display messages are organized into a Main Menu, pages, and sub-pages. There are four main menus labeled Actual Values, Quick Setup, Setpoints, and Maintenance. Pressing the MENU key followed by the MESSAGE key scrolls through the four Main Menu headers, which appear in sequence as follows:

Figure 3: The four Main Menu headers

```
■ ACTUAL VALUES
  QUICK SETUP
  SETPOINTS
  MAINTENANCE
```

Pressing the **MESSAGE** ► key or the **ENTER** key from these Main Menu pages will display the corresponding menu Page. Use the MESSAGE ▲ and MESSAGE ▼ keys to scroll through the Page headers.

Figure 4: Typical paging operation from Main Menu selection



When the display shows **SETPOINTS**, pressing the **MESSAGE** ► key or the **ENTER** key will display the page headers of programmable parameters (referred to as setpoints in the manual). When the display shows **ACTUAL VALUES**, pressing the **MESSAGE** ► key or the **ENTER** key displays the page headers of measured parameters (referred to as actual values in the manual).

Each page is broken down further into logical sub-pages of messages. The **MESSAGE** ▲ and **MESSAGE** ▼ keys are used to navigate through the sub-pages. A summary of the setpoints and actual values pages can be found in the Chapters : Setpoints and Actual Values, respectively.

The **ENTER** key is dual purpose. It is used to enter the sub-pages and to store altered setpoint values into memory to complete the change. The **MESSAGE** ► key can also be used to enter sub-pages but not to store altered setpoints.

The **ESCAPE** key is also dual purpose. It is used to exit the sub-pages and to cancel a setpoint change. The **MESSAGE** ◄ key can also be used to exit sub-pages and to cancel setpoint changes.

The **VALUE** keys are used to scroll through the possible choices of an enumerated setpoint. They also decrement and increment numerical setpoints.

The **RESET** key resets any latched conditions that are not currently active. This includes resetting latched output relays, latched Trip LEDs, breaker operation failure, and trip / close coil failures. The Autoreclose Scheme is also reset with the shot counter being returned to zero and the lockout condition being cleared.

The **MESSAGE** ▲ and **MESSAGE** ▼ keys scroll through any active conditions in the relay. Diagnostic messages are displayed indicating the state of protection and monitoring elements that are picked up, operating, or latched.

LED status indicators - Front panel with non-programmable LEDs

- **IN SERVICE: Green**

  This LED will be continuously “ON”, when the relay is set to “Ready” under S1 RELAY SETUP/INSTALLATION/RELAY STATUS, and no major self-test errors have been detected.

- **TROUBLE: Orange**

  This LED will turn “ON”, when the relay is not programmed (Not Ready) state under S1 RELAY SETUP/INSTALLATION/RELAY STATUS, or upon detection of a major self-test error. The relay will turn back to “IN-SERVICE” if no major self-test error is present.

- **SETPOINT GROUP 1, 2: Green**

  These LEDs indicate the group of active protection elements. If setpoint group 1 is lit green, only the protection elements under group 1 will be active. The protection elements from group 2 will be inactive. The settings for each protection element can be edited and displayed regardless of the active group.

- **TRIP: Red**

  This indicator turns on when the relay detects a fault and sends a trip command to the trip output relay. The LED will reset by initiating a reset command from either the RESET pushbutton Breaker Control, or communications; in all cases after the fault condition has cleared.

- **ALARM: Orange**

  This LED will flash upon detection of an alarm condition, with element functions selected as “alarm”. The LED will automatically turn off if the alarm condition clears. The LED will remain steady “ON”, if the function of the operated protection was selected as "latched alarm".

- **PICKUP: Orange**

This indicator will light ON upon pickup condition generated by any of the relay features. The indicator will turn off if no pickup condition is detected.

- **BREAKER OPEN: Red/Green – programmable in color**

  When the breaker is open, this indicator will be on continuously.

- **BREAKER CLOSED: Red/Green – programmable in color**

  When the breaker is closed, this indicator will be on continuously.

  Breaker status indication is based on the breaker's 52a and 52b contacts. With both contacts wired to the relay, closed breaker status is determined by closed 52a contact and opened 52b contact. Visa-versa the open breaker status is determined by opened 52a contact and closed 52b contact. If both 52a and 52b contacts are open, due to a breaker being racked out from the switchgear, both the Breaker Open and Breaker Closed LED Indicators will be off.

NOTE

It is strongly recommended to detect the breaker status by using both 52a and 52b contacts.

The 350 provides also detecting the breaker status by using only one contact: either 52a or 52b. However, one should be aware that in such cases, it would be impossible to distinguish between a breaker open state and breaker racked out state, unless another contact from the breaker is wired to the relay.

To clarify this ambiguity, the BKR CONNECTED function under SETPOINTS/S2 SYSTEM SETUP/S2 BREAKER should be programmed to an additional contact input. When this additional input is closed, a single 52a or 52b contact will show both breaker states. When the breaker is racked out, this additional breaker connected input should be open. In this case, both breaker status indicators will be off.

- **MAINTENANCE: Orange**

  This LED may indicate both breaker or relay maintenance depending on the programmed maintenance elements. The LED will turn on upon operation of a maintenance element.

LED status indicators - Front panel with programmable LEDs

- **IN SERVICE: Green**

  This LED will be continuously "ON", when the relay is set to "Ready" under S1 RELAY SETUP/INSTALLATION/RELAY STATUS, and no major self-test errors have been detected.

- **TROUBLE: Orange**

  This LED will turn "ON", when the relay is not programmed (Not Ready) state under S1 RELAY SETUP/INSTALLATION/RELAY STATUS, or upon detection of a major self-test error. The relay will turn back to "IN-SERVICE" if no major self-test error is present.

- **TRIP: Red**

  This indicator turns on when the relay detects a fault and sends a trip command to the trip output relay. The LED will reset by initiating a reset command from either the RESET pushbutton Breaker Control, or communications; in all cases after the fault condition has cleared.

- **ALARM: Orange**

  This LED will flash upon detection of an alarm condition, with element functions selected as "alarm". The LED will automatically turn off if the alarm condition clears. The LED will remain steady "ON", if the function of the operated protection was selected as "latched alarm".

- **LED 1: Red - programmable in the source signal**
- **LED 2: Orange - programmable in the source signal**

- **LED 3: Orange - programmable in the source signal**
- **LED 4: Orange - programmable in the source signal**
- **LED 5: Red/Orange/Green - programmable in the source signal and in color**
- **LED 6: Red/Orange/Green - programmable in the source signal and in color**
- **LED 7: Red/Orange/Green - programmable in the source signal and in color**
- **LED 8: Red/Orange/Green - programmable in the source signal and in color**

Relay messages

Target messages

Target messages are automatically displayed for any active condition on the relay such as pickups, trips, or alarms.

The relay displays the most recent event first, and after 5 seconds will start rolling up the other target messages until the conditions clear and/or the RESET command is initiated. The Target Messages can be reviewed by pressing either the MESSAGE UP or MESSAGE DOWN key. If a RESET command is not performed but any of the other faceplate pushbuttons is pressed, the display will not show the target messages unless the user navigates to **ACTUAL VALUES > A4 TARGET MESSAGES**, where they can be reviewed. If the target messages have not been cleared before the user presses a pushbutton different from "RESET", they will reappear on the screen after the time specified under the **SETPOINTS > S1 RELAY SETUP > S1 FRONT PANEL > MESSAGE TIMEOUT** setting, that will start timing out from the last pressed pushbutton. The following shows the format of a typical Target Message:

Figure 5: Typical target message

```
A4 TARGET MESSAGES
  Cause <function>
  State: Operate
 ▼ Phase:
```

Example of a Phase IOC1 operation - phase A:

Phase IOC1 function: Trip

```
A4 TARGET MESSAGES
  Ph IOC1 Trip
  State: Operate
 ▼ Phase:A
```

Cause <Function>

The first line contains information of the cause of operation (the name of the operated element), and the element function.

State: Operate

This line from the display shows the state of the element: Pickup, Operated, Alarm.

Phase: A

The last line from the display shows the phase that picked up or operated.

Self-test errors

The relay performs self diagnostics at initialization (after power up), and continuously as a background task to ensure that the hardware and software are functioning correctly. There are two types of self-test warnings indicating either a minor or major problem. Minor problems indicate a problem with the relay that does not compromise protection of the power system. Major errors indicate a problem with the relay which takes it out of service.

⚠CAUTION

Self-Test Warnings may indicate a serious problem with the relay hardware!

Upon detection of a **minor** problem, the relay will:

- Turn on the "TROUBLE" LED at the same time as the "IN SERVICE" LED is on.
- Display the error on the relay display.
- Record the minor self-test error in the Event Recorder.

Upon detection of a **major** problem, the relay will:

- De-energize critical failure relay (Output Relay 7).
- Inhibit operation of all other output relays (1 to 6).
- Turn off the "IN SERVICE" LED; turn on the "TROUBLE" LED.
- Flash the "ALARM" LED.
- Display the cause of major self-test failure.
- Record the major self-test failure in the Event Recorder.

Figure 6: Typical Self-test warning

```
A4 TARGET MESSAGES
   UNIT FAILURE:
   Contact Factory:
   Error code:1
```

Table 1: Minor Self-test Errors

Self-test Error Message	Latched Target Message?	Description of Problem	How Often the Test is Performed	What to do
MAINTENANCE ALERT: IRIG-B Failure	No	A bad IRIG-B input signal has been detected.	Every 5 seconds*	Ensure IRIG-B cable is connected, check cable functionality (i.e. physical damage or perform continuity test), ensure IRIG-B receiver is functioning, and check input signal level (it may be less than specification). If none of these apply, contact the factory.
MAINTENANCE ALERT: Clock Not Set	No	Clock time is the same as the default time.	Every 5 seconds*	Set the date and time in PRODUCT SETUP.
MAINTENANCE ALERT: Comm Alert 1, 2, or 3	No	Communication error between CPU and Comms board.	Every 5 seconds*	If alert doesn't self-reset, then contact factory. Otherwise monitor reccurences as errors are detected and self-reset.
MAINTENANCE ALERT : Ethernet Link Fail	No	Communication error between 350 and Network.	Detected Instantaneously	Check Ethernet cable and Ethernet connection. Check health of the network. Check status of external routers and switches.

Table 2: Major Self-test Errors

Self-test Error Message	Latched Target Message?	Description of Problem	How Often the Test is Performed	What to do
UNIT FAILURE: `Contact Factory (XXXX)`	Yes	This warning is caused by a unit hardware failure. Failure code (XXXX) is shown.	Every 5 seconds[1]	Contact the factory and provide the failure code.
RELAY NOT READY: Check Settings	No	PRODUCT SETUP INSTALLATION setting indicates that relay is not in a programmed state.	On power up and whenever the PRODUCT SETUP INSTALLATION setting is altered.	Program all required settings then set the PRODUCT SETUP INSTALLATION setting to "Programmed".

1.Failure is logged after the detection of 5 consecutive failures - that is, after 25 seconds.

Flash messages

Flash messages are warning, error, or general information messages displayed in response to pressing certain keys. The factory default flash message time is 4 seconds.

Figure 7: Typical Flash message

```
S3 PHASE IOC
  BLOCK 1
  Logic Element 8
  <SETPOINT STORED>
```

SETPOINT STORED

This flash message is displayed in response to the **ENTER** key while on any setpoint message (see example above). The edited value was stored as entered.

COMMAND EXECUTED

This flash message is displayed in response to executing a command: ON, OFF, YES, NO, etc.

INVALID PASSWORD

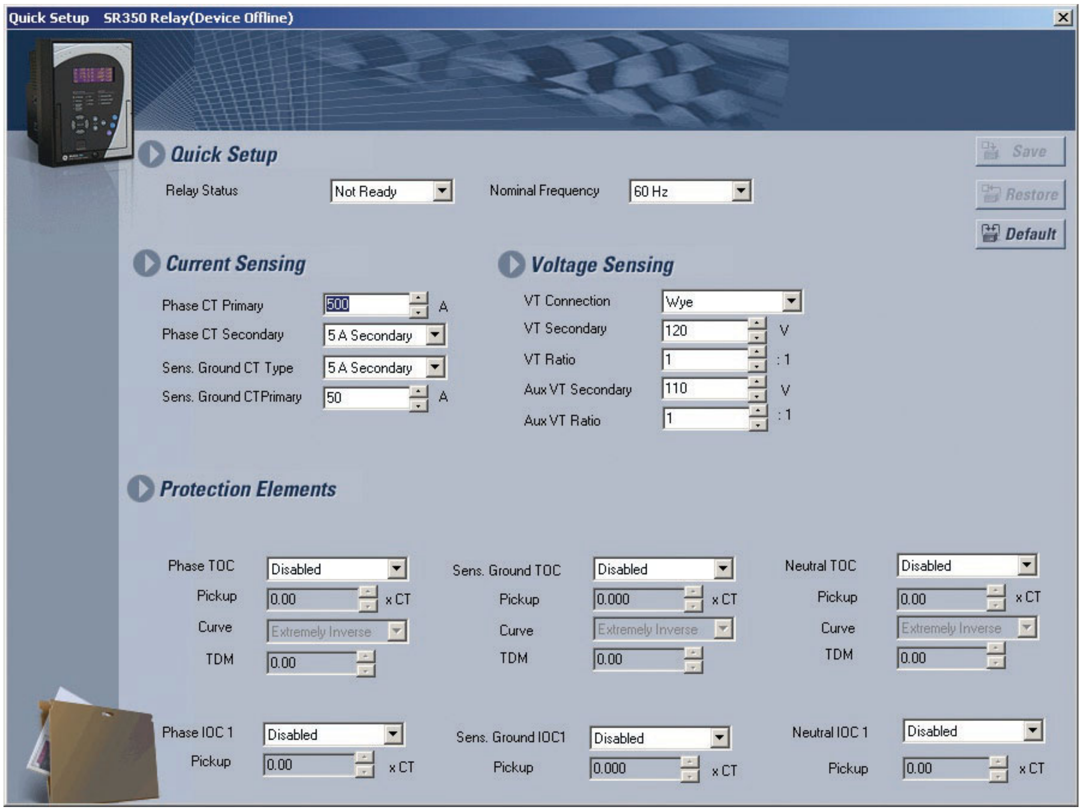
This flash message appears upon an attempt to enter an incorrect password, as part of password security.

AR IN PROGRESS

This flash message appears when the Autoreclosure is in progress performing the configured sequence.

Software setup

Quick setup - Software interface



- **The Quick Setup** window allows you to configure important settings from different screens in the relay by adding them to a common window.
- **Quick Setup** window options are available for a single device or a file.
- **The Quick Setup** Window option is accessed from the "Tree" which launches on clicking.

EnerVista SR3 Setup Software

Although settings can be entered manually using the control panel keys, a PC can be used to download setpoints through the communications port. The EnerVista SR3 Setup software is available from GE Multilin to make this as convenient as possible. With EnerVista SR3 Setup running, it is possible to:

- Program and modify settings
- Load and save setting files to and from a disk
- Read actual values
- Monitor status
- Read pre-trip data and event records
- Get help on any topic

- Upgrade the 350 firmware

The EnerVista SR3 Setup software allows immediate access to all 350 features with easy to use pull down menus in the familiar Windows environment. This section provides the necessary information to install EnerVista SR3 Setup, upgrade the relay firmware, and write and edit setting files.

The EnerVista SR3 Setup software can run without a 350 connected to the computer. In this case, settings may be saved to a file for future use. If a 350 is connected to a PC and communications are enabled, the 350 can be programmed from the setting screens. In addition, measured values, status and trip messages can be displayed with the actual value screens.

Hardware and software requirements

The following requirements must be met for the EnerVista SR3 Setupsoftware.

- Windows 7 (32-bit or 64-bit) or Windows 8.1 (32-bit or 64-bit)

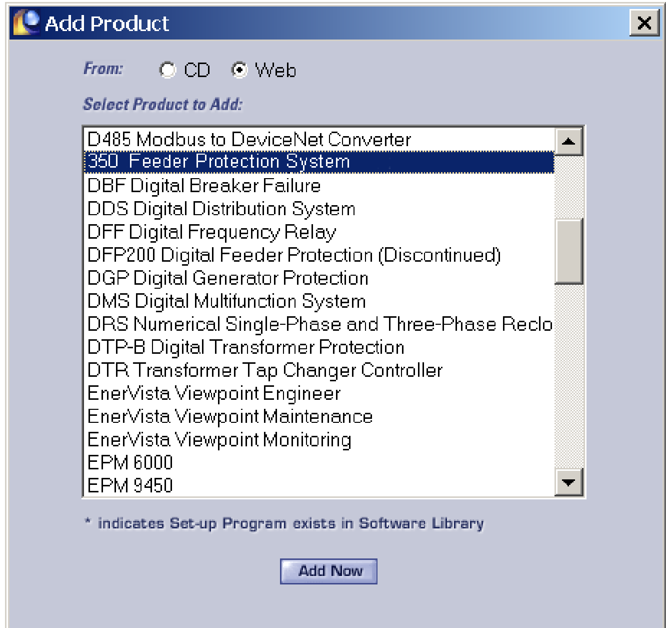
The EnerVista SR3 Setup software can be installed from either the GE EnerVista CD or the GE Multilin website at http://www.gedigitalenergy.com/multilin.

Installing the EnerVista SR3 Setup software

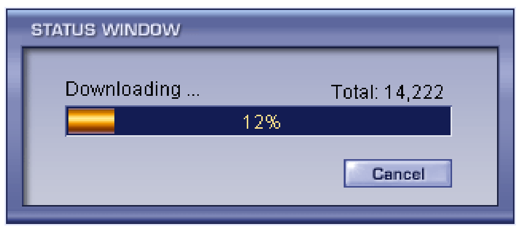
After ensuring the minimum requirements indicated earlier, use the following procedure to install the EnerVista SR3 Setup software from the enclosed GE EnerVista CD.

1. Insert the GE EnerVista CD into your CD-ROM drive.
2. Click the **Install Now** button and follow the installation instructions to install the no-charge EnerVista software on the local PC.
3. When installation is complete, start the EnerVista Launchpad application.
4. Click the **IED Setup** section of the LaunchPad toolbar.

5. In the EnerVista Launchpad window, click the **Add Product** button and select the 350 Feeder Protection System as shown below. Select the Web option to ensure the most recent software release, or select CD if you do not have a web connection, then click the **Add Now** button to list software items for the 350 .



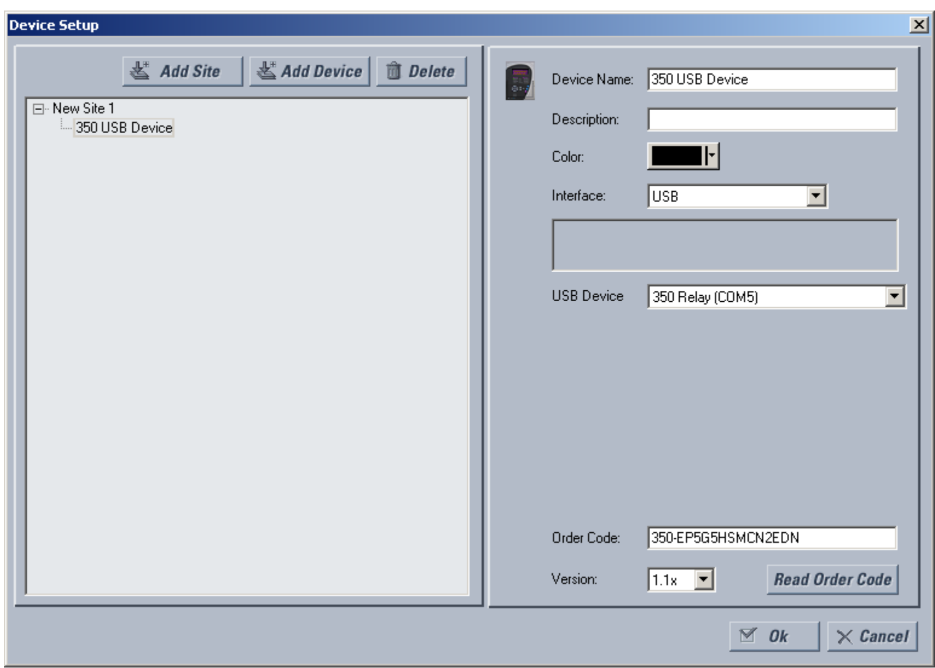
6. EnerVista Launchpad will obtain the latest installation software from the Web or CD and automatically start the installation process. A status window with a progress bar will be shown during the downloading process.



7. Select the complete path, including the new directory name, where the EnerVista SR3 Setup software will be installed.
8. Click on **Next** to begin the installation. The files will be installed in the directory indicated, the USB driver will be loaded into the computer, and the installation program will automatically create icons and add EnerVista SR3 Setups oftware to the Windows start menu.
9. The 350 device will be added to the list of installed IEDs in the EnerVista Launchpad window, as shown below.

If you are going to communicate from your computer to the 350 Relay using the USB port:

10. Plug the USB cable into the USB port on the 350 Relay then into the USB port on your computer.
11. Launch EnerVista SR3 Setup from LaunchPad.
12. In **EnerVista > Device Setup**:



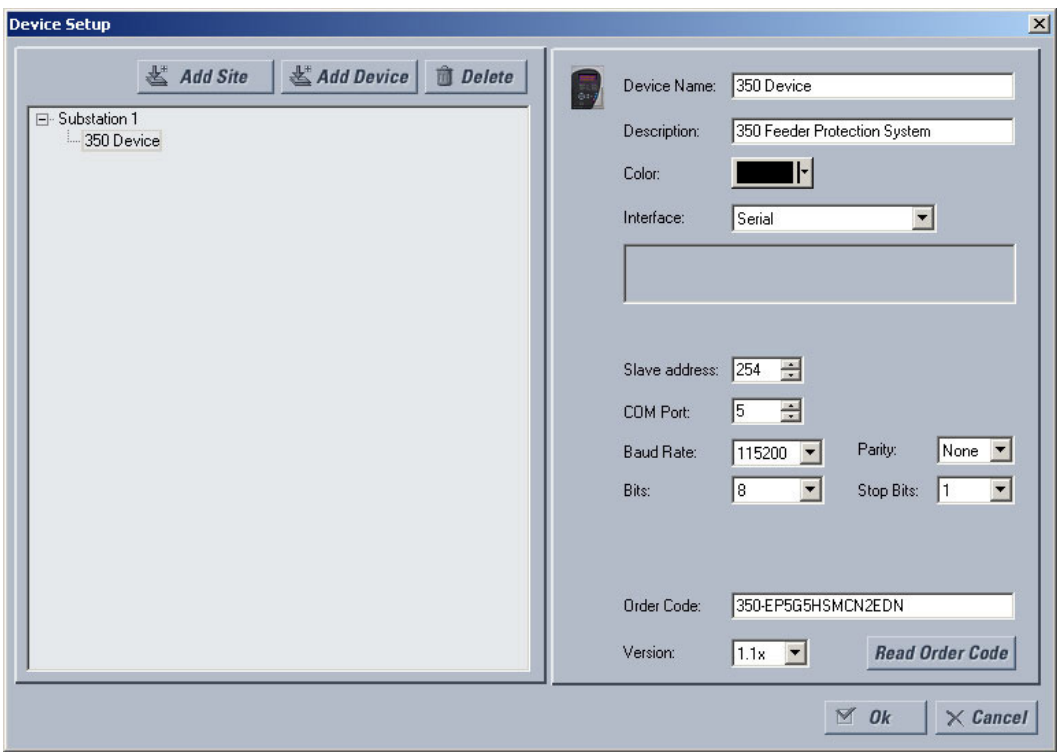
13. Select **USB** as the Interface type.
14. Select **350 Relay** as the USB device.

Connecting EnerVista SR3 Setup to the relay

Configuring serial communications

Before starting, verify that the cable is properly connected to either the USB port on the front panel of the device (for USB communications) or to the RS485 terminals on the back of the device (for RS485 communications). This example demonstrates an USB connection. For RS485 communications, the GE Multilin F485 converter will be required. Refer to the F485 manual for additional details. To configure the relay for Ethernet communications, see *Configuring Ethernet Communications* below.

1. Install and start the latest version of the EnerVista SR3 Setup software (available from the GE Multilin web site). See the previous section for the installation procedure.
2. Click on the **Device Setup** button to open the Device Setup window and click the **Add Site** button to define a new site.
3. Enter the desired site name in the "Site Name" field. If desired, a short description of the site can also be entered. In this example, we will use “Substation 1” as the site name.
4. The new site will appear in the upper-left list in the EnerVista SR3 Setup window.
5. Click the **Add Device** button to define the new device.
6. Enter the desired name in the "Device Name" field and a description (optional) of the device.
7. Select “Serial” from the Interface drop-down list.

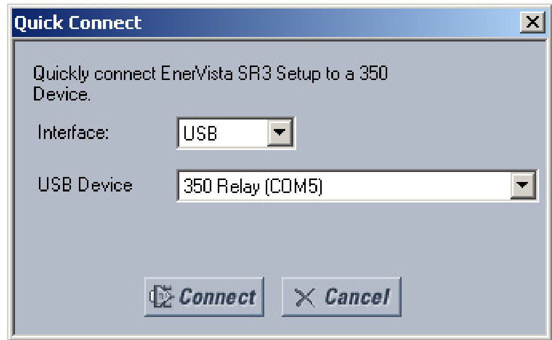


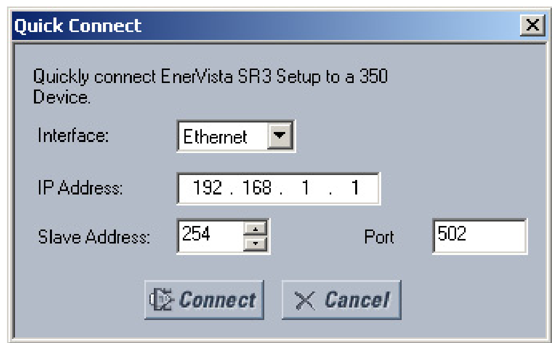
8. Click the **Read Order Code** button to connect to the 350 device and upload the order code.
9. Click **OK** when the relay order code has been received. The new device will be added to the Site List window (or Online window) located in the top left corner of the main EnerVista SR3 Setup window.

The 350 Site Device has now been configured for USB communications. Proceed to *Connecting to the Relay* below, to begin communications.

Using the Quick Connect feature

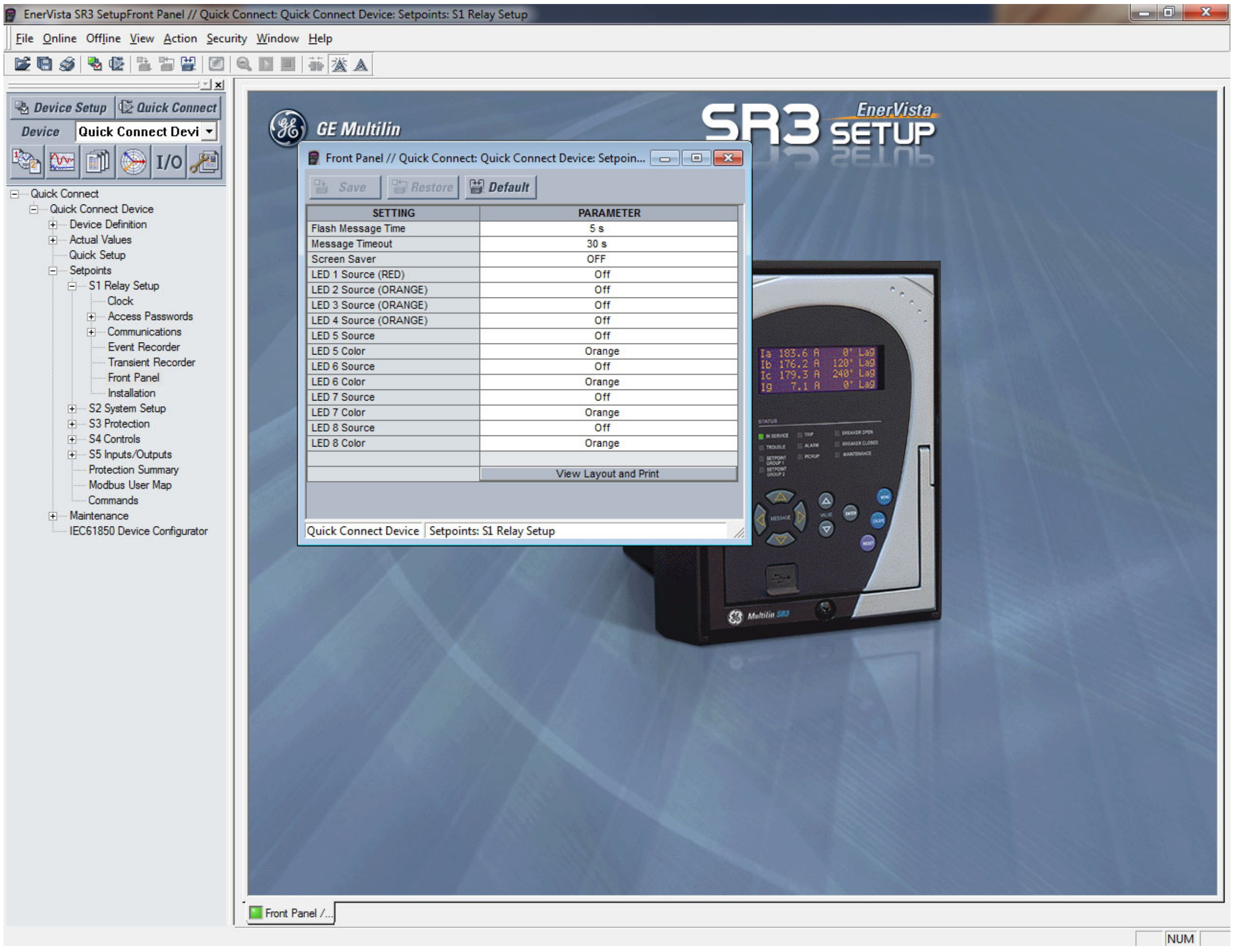
The **Quick Connect** button can be used to establish a fast connection through the front panel USB port of a 350 relay, or through the Ethernet port. The following window will appear when the **QuickConnect** button is pressed:





As indicated by the window, the "Quick Connect" feature can quickly connect the EnerVista SR3 Setup software to a 350 front port if the USB is selected in the interface drop-down list. Select "350 Relay" and press the **Connect** button. Ethernet can also be used as the interface for Quick Connect as shown above.

When connected, a new Site called “Quick Connect” will appear in the Site List window.



The 350 Site Device has now been configured via the Quick Connect feature for either USB or Ethernet communications. Proceed to *Connecting to the Relay* below, to begin communications.

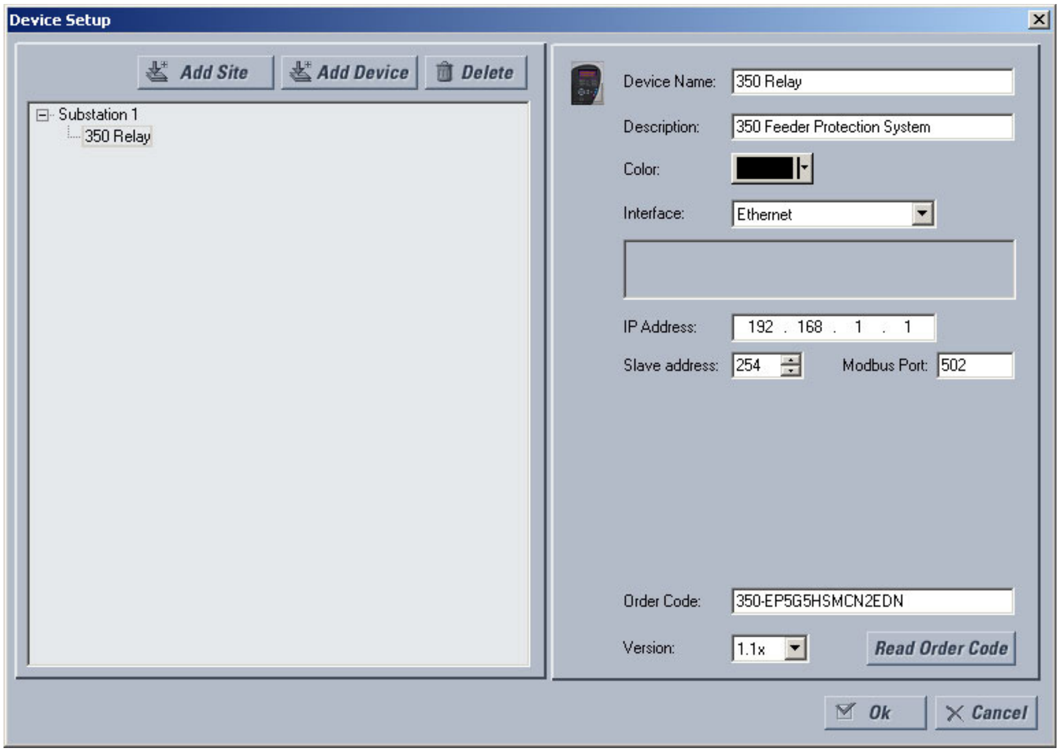
Configuring Ethernet communications

Before starting, verify that the Ethernet cable is properly connected to the RJ-45 Ethernet port.

NOTE

350 supports a maximum of 3 TCP/IP sessions.

1. Install and start the latest version of the EnerVista SR3 Setup software (available from the GE EnerVista CD). See the previous section for the installation procedure.
2. Click on the **Device Setup** button to open the Device Setup window and click the **Add Site** button to define a new site.
3. Enter the desired site name in the "Site Name" field. If desired, a short description of the site can also be entered. In this example, we will use “Substation 1” as the site name.
4. The new site will appear in the upper-left list.
5. Click the **Add Device** button to define the new device.
6. Enter the desired name in the "Device Name" field, and a description (optional).
7. Select “Ethernet” from the Interface drop-down list. This will display a number of interface parameters that must be entered for proper Ethernet functionality.



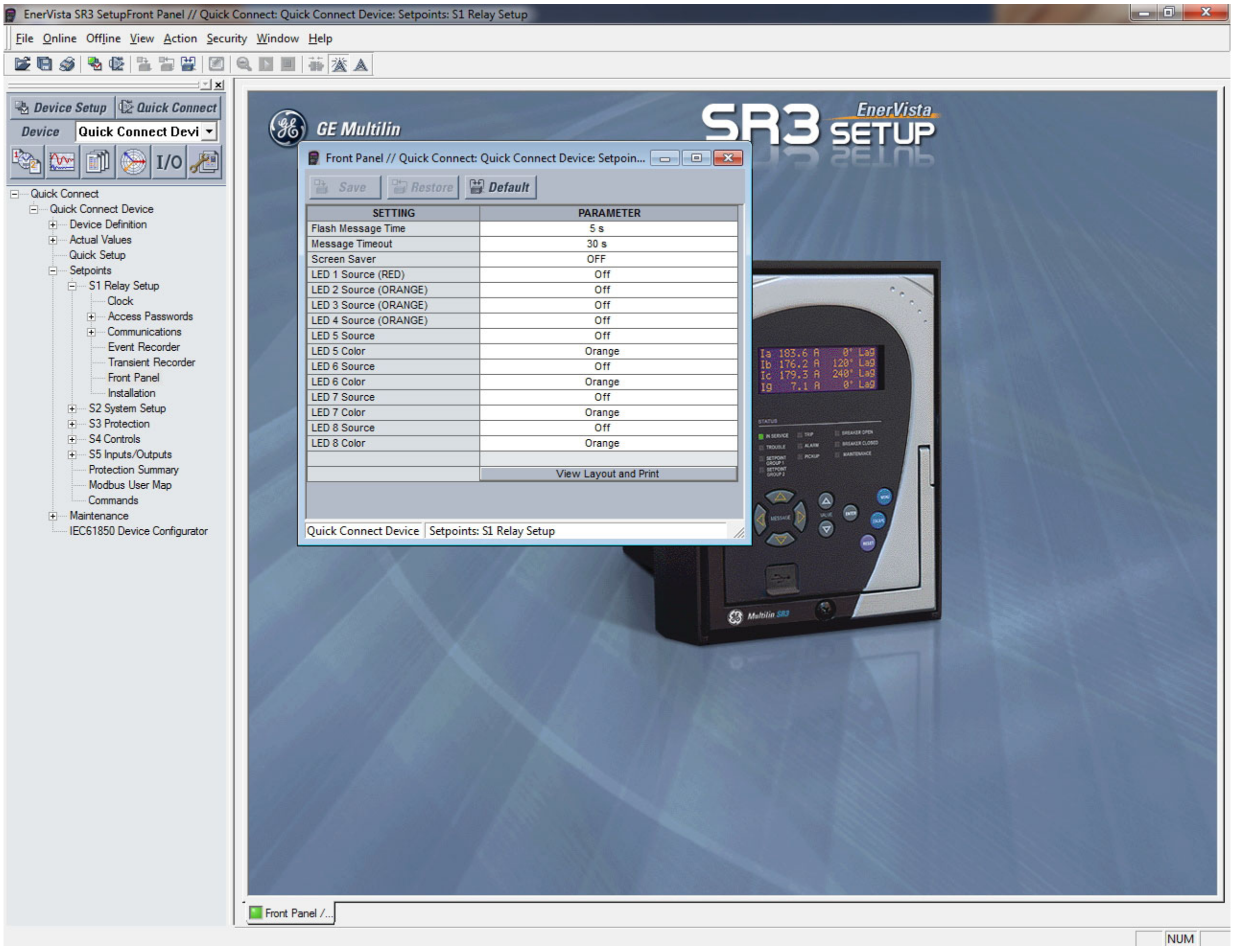
8. Enter the IP address, slave address, and Modbus port values assigned to the 350 relay (from the S1 RELAY SETUP > COMMUNICATIONS > ETHERNET menu).
9. Click the **Read Order Code** button to connect to the 350 and upload the order code. If a communications error occurs, ensure that the Ethernet communication values correspond to the relay setting values.
10. Click **OK** when the relay order code has been received. The new device will be added to the Site List window (or Online window) located in the top left corner of the main EnerVista SR3 Setup window.

The 350 Site Device has now been configured for Ethernet communications. Proceed to the following section to begin communications.

Connecting to the relay

Now that the communications parameters have been properly configured, the user can easily communicate with the relay.

1. Expand the Site list by double clicking on the site name or clicking on the «**+**» box to list the available devices for the given site.
2. Desired device trees can be expanded by clicking the «**+**» box. The following list of headers is shown for each device:
   Device Definition
   Actual Values
   Quick Setup
   Setpoints
   Maintenance.
3. Expand the SETTINGS > RELAY SETUP list item and double click on **Front Panel** to open the Front Panel settings window as shown:



4. The Front Panel settings window opens with a corresponding status indicator on the lower left of the EnerVista SR3 Setup window.
5. If the status indicator is red, verify that the serial, USB, or Ethernet cable is properly connected to the relay, and that the relay has been properly configured for communications (steps described earlier).

The Front Panel settings can now be edited, printed, or changed. Other setpoint and command windows can be displayed and edited in a similar manner. "Actual Values" windows are also available for display. These windows can be arranged, and resized at will.

Working with setpoints and setpoint files

Engaging a device

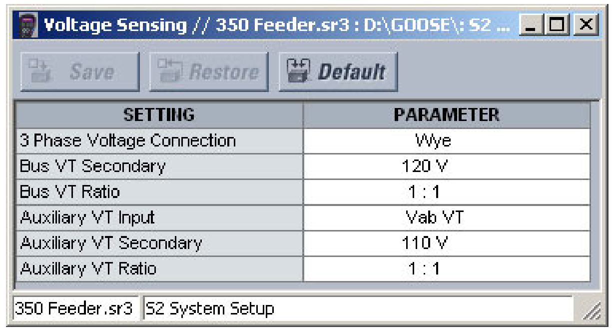
The EnerVista SR3 Setups oftware may be used in on-line mode (relay connected) to directly communicate with a relay. Communicating relays are organized and grouped by communication interfaces and into sites. Sites may contain any number of relays selected from the product series.

Entering setpoints

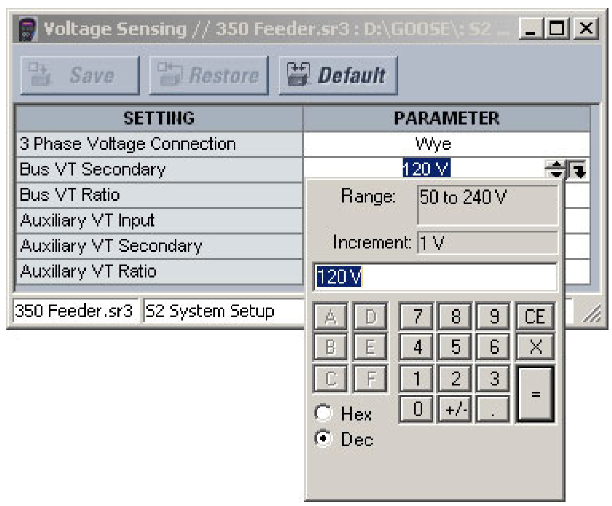
The System Setup page will be used as an example to illustrate the entering of setpoints. In this example, we will be changing the voltage sensing setpoints.

1. Establish communications with the relay.
2. Select the **Setpoint > System Setup > Voltage Sensing** menu item.

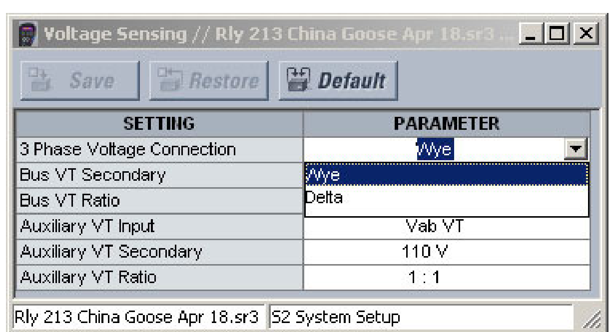
3. Select the Bus VT Secondary setpoint by clicking anywhere in the parameter box. This will display three arrows: two to increment/decrement the value and another to launch the numerical keypad.



4. Clicking the arrow at the end of the box displays a numerical keypad interface that allows the user to enter a value within the setpoint range displayed near the top of the keypad: Click **=** to exit from the keypad and keep the new value. Click on **X** to exit from the keypad and retain the old value.



5. For setpoints requiring non-numerical pre-set values (e.g. **3-Phase voltage connection** below), clicking anywhere within the setpoint value box displays a drop-down selection menu arrow. Select the desired value from this list.



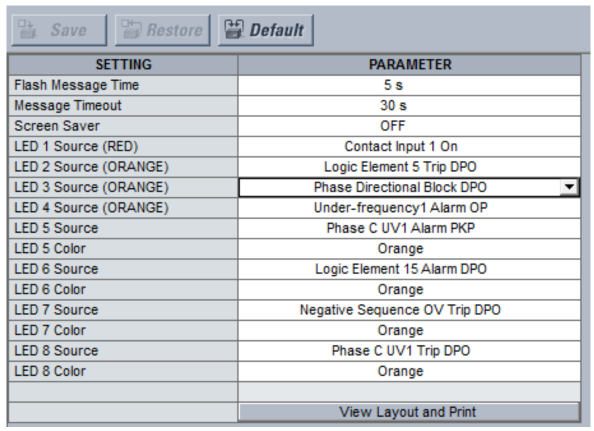
6. For setpoints requiring an alphanumeric text string (e.g. "relay name"), the value may be entered directly within the setpoint value box.

7. In the **Setpoint > System Setup > Voltage Sensing** dialog box, click on **Save** to save the values into the 350 . Click **YES** to accept any changes and exit the window. Click **Restore** to retain previous values. Click **Default** to restore Default values.

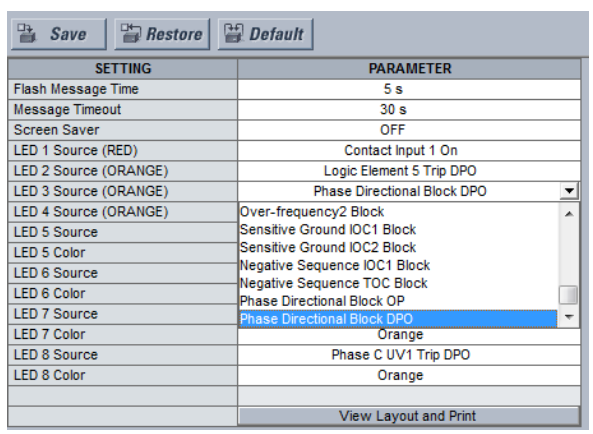
Setting programmable LEDs

Front panels with programmable LEDs have eight LEDs that are off by default, and must be set to a source signal. Four of these LEDs can also be set to different colors.

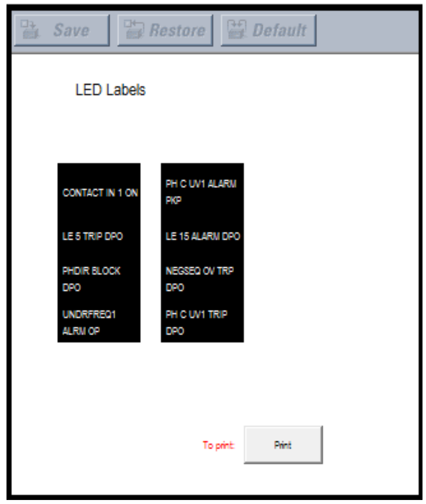
1. Establish communications with the relay.
2. Select the **Setpoint > S1 Relay Setup > Front Panel** menu item.
3. Select an LED Source setpoint by clicking anywhere in the parameter box beside an LED Source label. This displays an arrow indicating the LED source can be changed.



4. Clicking the arrow at the end of the box displays a drop-down list of available source signals. Select a source, and then repeat this process for all programmable LED source and color parameters.



5. In the **Setpoint > S1 Relay Setup > Front Panel** dialog box, click **Save** to save the values into the 350 . Click **YES** to accept any changes. Click **Restore** to retain previous values. Click **Default** to restore Default values (all LEDs Off and colors Orange).
6. Click **View Layout and Print** to create a printable label for the front panel showing the programmable LED settings. Edit LED names manually by clicking the LED label and entering up to 20 characters. (Manual edits can be printed, but are not saved.)



7. Click **Print** to print a copy of the customized front panel label.

File support

Opening any EnerVista SR3 Setup file will automatically launch the application or provide focus to the already opened application. If the file is a settings file (has a 'SR3' extension) which had been removed from the Settings List tree menu, it will be added back to the Settings List tree.

New files will be automatically added to the tree.

Using setpoints files

The EnerVista SR3 Setup software interface supports three ways of handling changes to relay settings:

- In off-line mode (relay disconnected) to create or edit relay settings files for later download to communicating relays.
- Directly modifying relay settings while connected to a communicating relay, then saving the settings when complete.
- Creating/editing settings files while connected to a communicating relay, then saving them to the relay when complete.

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

- Device Definition
- Relay Setup
- System Setup
- Protection
- Control
- Inputs/Outputs

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

The EnerVista SR3 Setupdisplays relay setpoints with the same hierarchy as the front panel display.

Downloading and saving setpoints files

Setpoints must be saved to a file on the local PC before performing any firmware upgrades. Saving setpoints is also highly recommended before making any setpoint changes or creating new setpoint files.

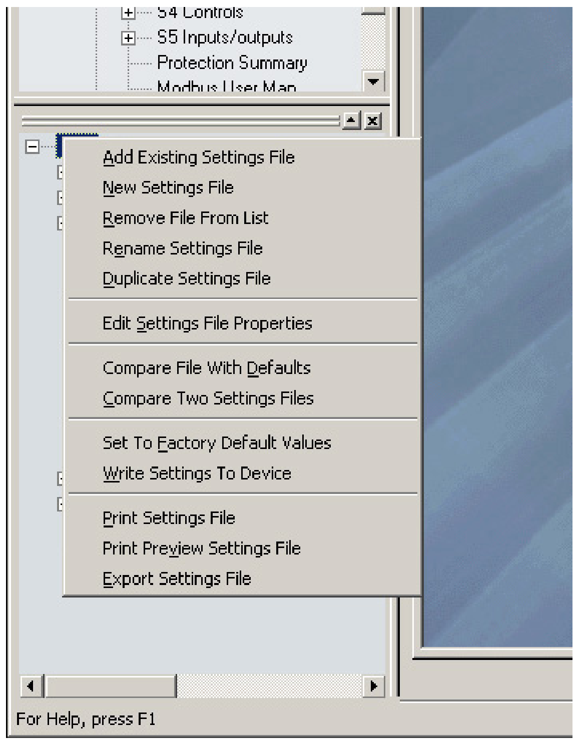
The setpoint files in the EnerVista SR3 Setup window are accessed in the Files Window. Use the following procedure to download and save setpoint files to a local PC.

1. Ensure that the site and corresponding device(s) have been properly defined and configured as shown in *Connecting EnerVista SR3 Setupto the Relay*, above.
2. Select the desired device from the site list.
3. Select the **Online > Read Device Settings** from Device menu item, or right-click on the device and select **Read Device Settings** to obtain settings information from the device.
4. After a few seconds of data retrieval, the software will request the name and destination path of the setpoint file. The corresponding file extension will be automatically assigned. Press **Receive** to complete the process. A new entry will be added to the tree, in the File pane, showing path and file name for the setpoint file.

Adding setpoints files to the environment

The EnerVista SR3 Setup software provides the capability to review and manage a large group of setpoint files. Use the following procedure to add an existing file to the list.

1. In the files pane, right-click on **Files** and select the **Add Existing Setting File** item as shown:

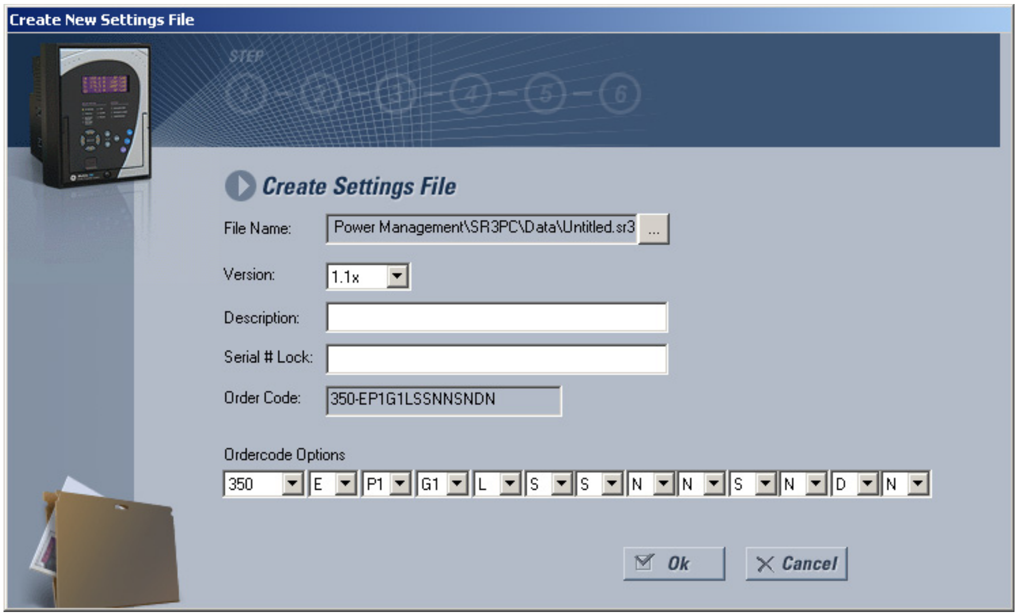


2. The Open dialog box will appear, prompting the user to select a previously saved setpoint file. As for any other MS Windows® application, browse for the file to be added then click **Open**. The new file and complete path will be added to the file list.

Creating a new setpoint file

The EnerVista SR3 Setup software allows the user to create new setpoint files independent of a connected device. These can be uploaded to a relay at a later date. The following procedure illustrates how to create new setpoint files.

1. In the File pane, right click on **File** and select the **New Settings File** item. The following box will appear, allowing for the configuration of the setpoint file for the correct firmware version. It is important to define the correct firmware version to ensure that setpoints not available in a particular version are not downloaded into the relay.



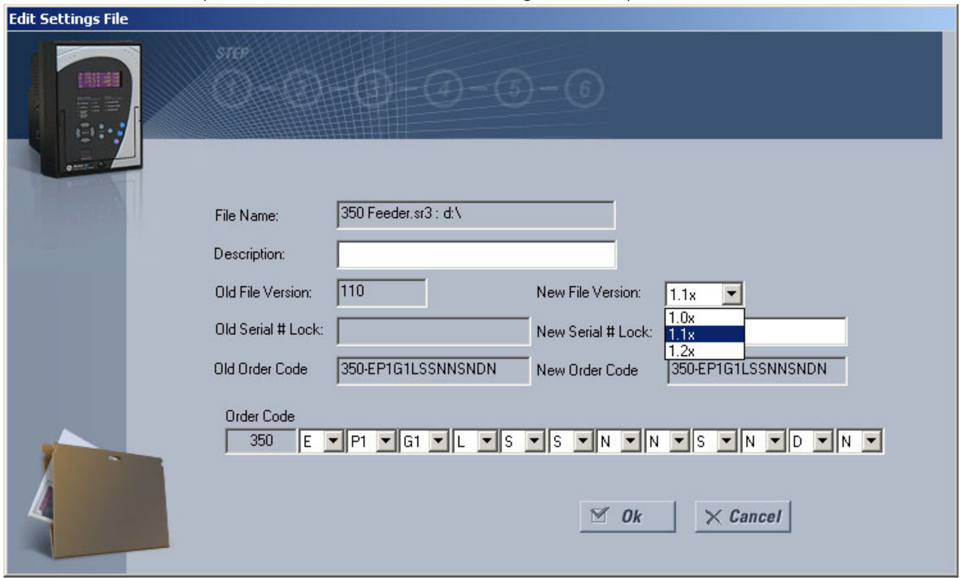
2. Select the Firmware Version, and Order Code options for the new setpoint file.
3. For future reference, enter some useful information in the **Description** box to facilitate the identification of the device and the purpose of the file.
4. To select a file name and path for the new file, click the button beside the File Name box.
5. Select the file name and path to store the file, or select any displayed file name to replace an existing file. All 350 setpoint files should have the extension 'SR3' (for example, 'feeder1.SR3').
6. Click **OK** to complete the process. Once this step is completed, the new file, with a complete path, will be added to the EnerVista SR3 Setup software environment.

Upgrading setpoint files to a new revision

It is often necessary to upgrade the revision for a previously saved setpoint file after the 350 firmware has been upgraded. This is illustrated in the following procedure:

1. Establish communications with the 350 relay.
2. Select the **Maintenance > M1 Relay Info** menu item and record the Firmware Revision.
3. Load the setpoint file to be upgraded into the EnerVista SR3 Setup environment as described in the section, *Adding Setpoints Files to the Environment.*
4. In the File pane, select the saved setpoint file.
5. From the main window menu bar, select the **Offline > Edit Settings File Properties** menu item and note the File Version of the setpoint file. If this version is different from the Firmware Revision noted in step 2, select a New File Version that matches the Firmware Revision from the pull-down menu.

6. For example, if the firmware revision is L0L01MA140.000 (Firmware Revision 1.40) and the current setpoint file revision is 1.20, change the setpoint file revision to “1.4x”.



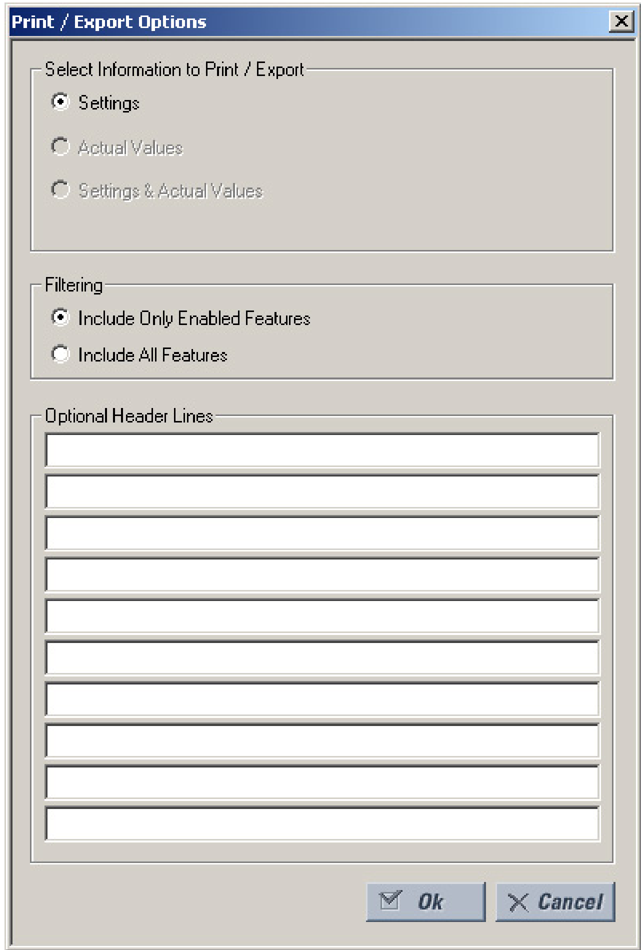
7. Enter any special comments about the setpoint file in the "Description" field.
8. Select the desired firmware version from the "New File Version" field.
9. When complete, click **OK** to convert the setpoint file to the desired revision. See *Loading Setpoints from a File* below, for instructions on loading this setpoint file into the 350 .

Printing setpoints and actual values

The EnerVista SR3 Setup software allows the user to print partial or complete lists of setpoints and actual values. Use the following procedure to print a list of setpoints:

1. Select a previously saved setpoints file in the File pane or establish communications with a 350 device.
2. From the main window, select the **Offline > Export Settings File** menu item.

3. The Print/Export Options dialog box will appear. Select **Settings** in the upper section and select either **Include All Features** (for a complete list) or **Include Only Enabled Features** (for a list of only those features which are currently used) in the filtering section and click **OK**.



4. The process for **Offline > Print Preview Settings File** is identical to the steps above.
5. Setpoint lists can be printed in the same manner by right clicking on the desired file (in the file list) or device (in the device list) and selecting the **Print Device Information** or **Print Settings File** options.

Printing actual values from a connected device

A complete list of actual values can also be printed from a connected device with the following procedure:

1. Establish communications with the desired 350 device.
2. From the main window, select the **Online > Print Device Information** menu item
3. The Print/Export Options dialog box will appear. Select **Actual Values** in the upper section and select either **Include All Features** (for a complete list) or **Include Only Enabled Features** (for a list of only those features which are currently used) in the filtering section and click **OK**.

Actual values lists can be printed in the same manner by right clicking on the desired device (in the device list) and selecting the **Print Device Information** option

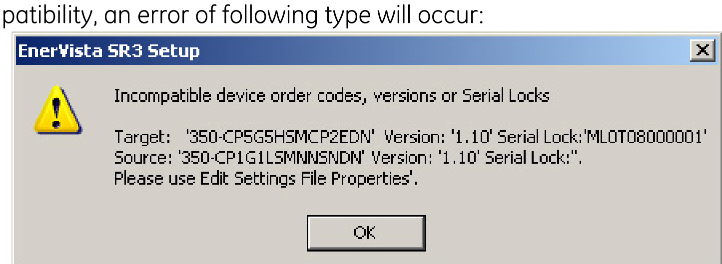
Loading setpoints from a file

CAUTION

An error message will occur when attempting to download a setpoint file with a revision number that does not match the relay firmware. If the firmware has been upgraded since saving the setpoint file, see for instructions on changing the revision number of a setpoint file.

The following procedure illustrates how to load setpoints from a file. Before loading a setpoints file, it must first be added to the EnerVista SR3 Setupenvironment as described in the section, *Adding Setpoints Files to the Environment*.

1. Select the previously saved setpoints file from the File pane of the EnerVista SR3 Setup software main window.
2. Select the **Offline > Edit Settings File Properties** menu item and verify that the corresponding file is fully compatible with the hardware and firmware version of the target relay. If the versions are not identical, see *Upgrading Setpoint Files to a New Revision* for details on changing the setpoints file version.
3. Right-click on the selected file and select the **Write Settings File to Device** item.
4. Select the target relay from the list of devices shown and click **Send**. If there is an incompatibility, an error of following type will occur:



If there are no incompatibilities between the target device and the settings file, the data will be transferred to the relay. An indication of the percentage completed will be shown in the bottom of the main window.

Upgrading relay firmware

To upgrade the 350 firmware, follow the procedures listed in this section. Upon successful completion of this procedure, the 350 will have new firmware installed with the factory default setpoints.The latest firmware files are available from the GE Multilin website at http:// www.GEmultilin.com.

NOTE

EnerVista SR3 Setup software prevents incompatible firmware from being loaded into a 350 relay.

NOTE

Before upgrading firmware, it is very important to save the current 350 settings to a file on your PC. After the firmware has been upgraded, it will be necessary to load this file back into the 350 . Refer to *Downloading and Saving Setpoints Files* for details on saving relay setpoints to a file.

Loading new relay firmware

Loading new firmware into the 350 flash memory is accomplished as follows:

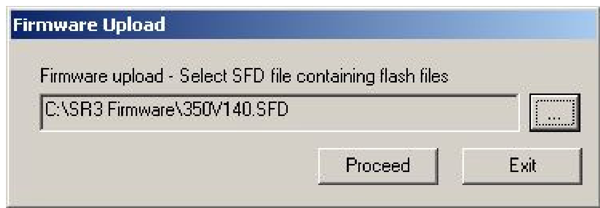
1. Connect the relay to the local PC and save the setpoints to a file as shown in *Downloading and Saving Setpoints Files*.
2. Select the **Maintenance > Update Firmware** menu item.

3. The EnerVista SR3 Setupsoftware will request the new firmware file. Locate the folder that contains the firmware files to load into the 350 . The firmware filename has the following format:

L0 L01 M A 140 . 000

- **Modification Number (000 = none)**
- **Firmware Rev #**
- **Board Assembly Rev #**
- **Code Type in Memory Device**
- **PCB Code Number**
- **Product Reference Code (L0 = 350)**

4. EnerVista SR3 Setup software now prepares the 350 to receive the new firmware file. The 350 front panel will momentarily display "SR BOOT PROGRAM Waiting for Message," indicating that it is in upload mode.
5. While the file is being loaded into the 350 , a status box appears showing how much of the new firmware file has been transferred and the upgrade status. The entire transfer process takes approximately 10 minutes.



6. The EnerVista SR3 Setupsoftware will notify the user when the 350 has finished loading the file. Carefully read any displayed messages and click **OK** to return the main screen. **Cycling power to the relay is recommended after a firmware upgrade.**

After successfully updating the 350 firmware, the relay will not be in service and will require setpoint programming. To communicate with the relay, the communication settings may have to be manually reprogrammed.

When communications is established, the saved setpoints must be reloaded back into the relay. See *Loading Setpoints from a File* for details.

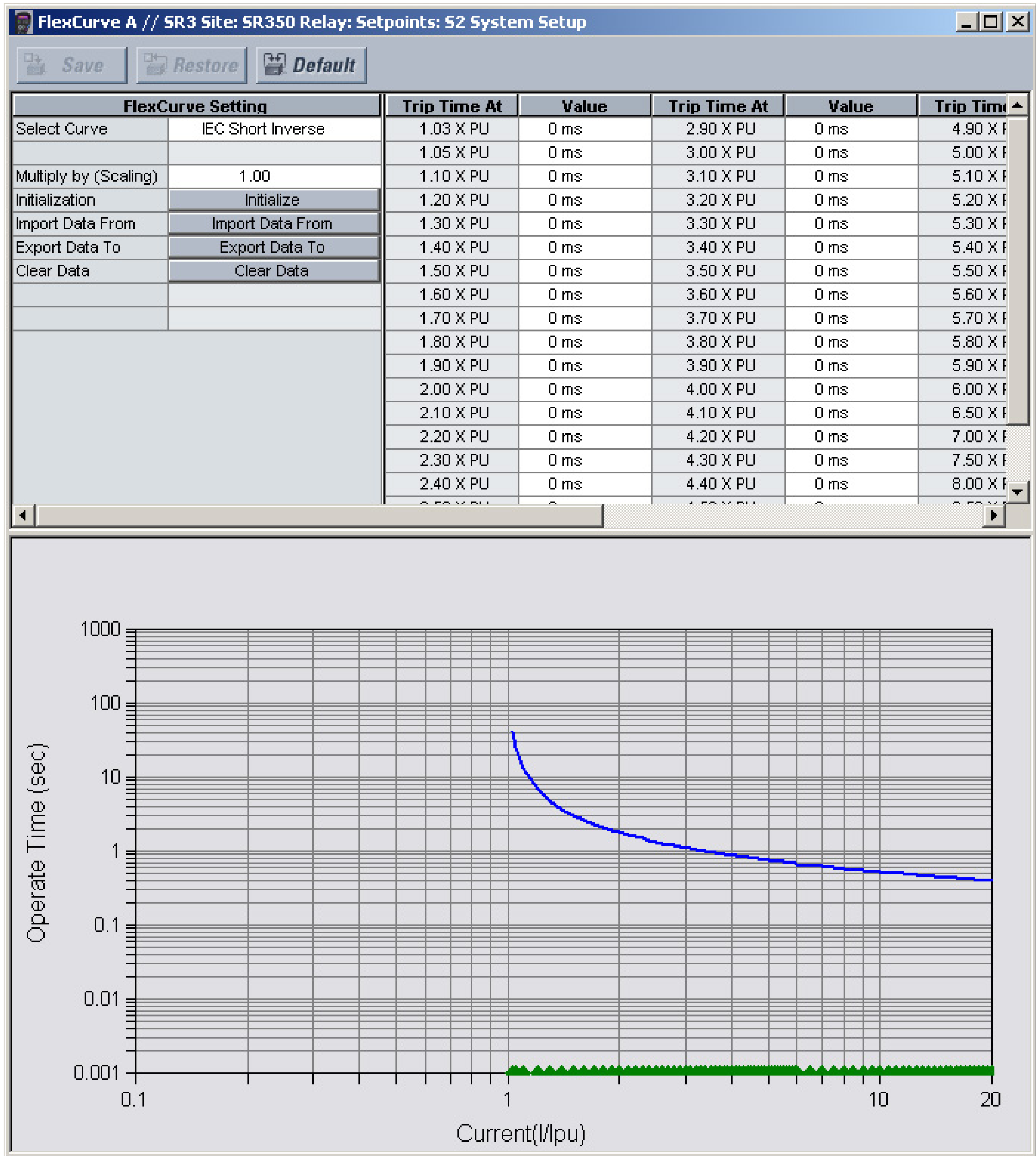
Modbus addresses assigned to firmware modules, features, settings, and corresponding data items (i.e. default values, min/max values, data type, and item size) may change slightly from version to version of firmware.

The addresses are rearranged when new features are added or existing features are enhanced or modified.

Advanced EnerVista SR3 Setup features

Flexcurve editor

The FlexCurve Editor is designed to allow the user to graphically view and edit the FlexCurve. The Flexcurve Editor screen is shown below:

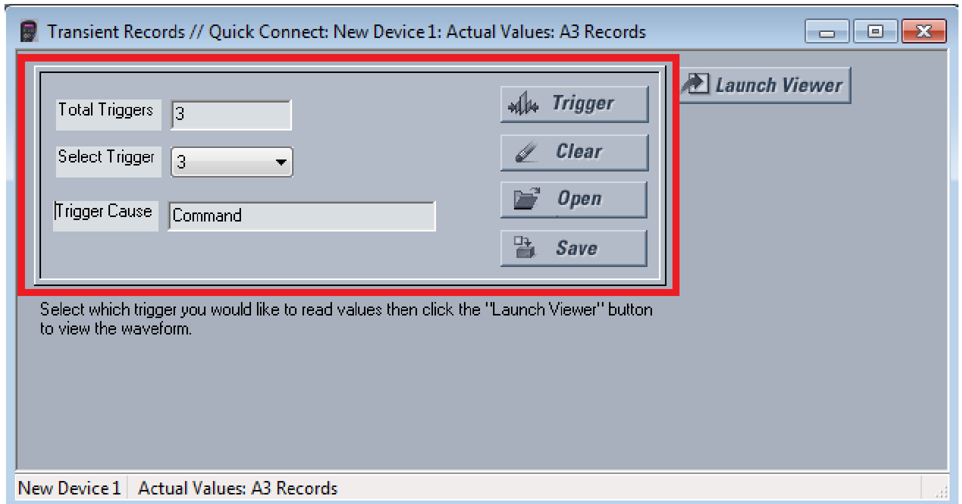


- The Operate Curves are displayed, which can be edited by dragging the tips of the curves
- A Base curve can be plotted for reference, to customize the operating curve. The Blue colored curve in the picture (in both curves) is a reference curve. It can be Extremely Inverse, Definite Time, etc.
- The Trip Times in the tables and curves work interactively i.e., changing the table value will affect the curve shape and vice versa.
- The user can save Configured Trip Times.
- The user can export Configured Trip Times to a CSV file
- The user can load Trip Times from a CSV File
- The screen above shows the model followed by 350 for viewing Flexcurves. Select **Initialize** to copy the trip times from the selected curve to the FlexCurve.

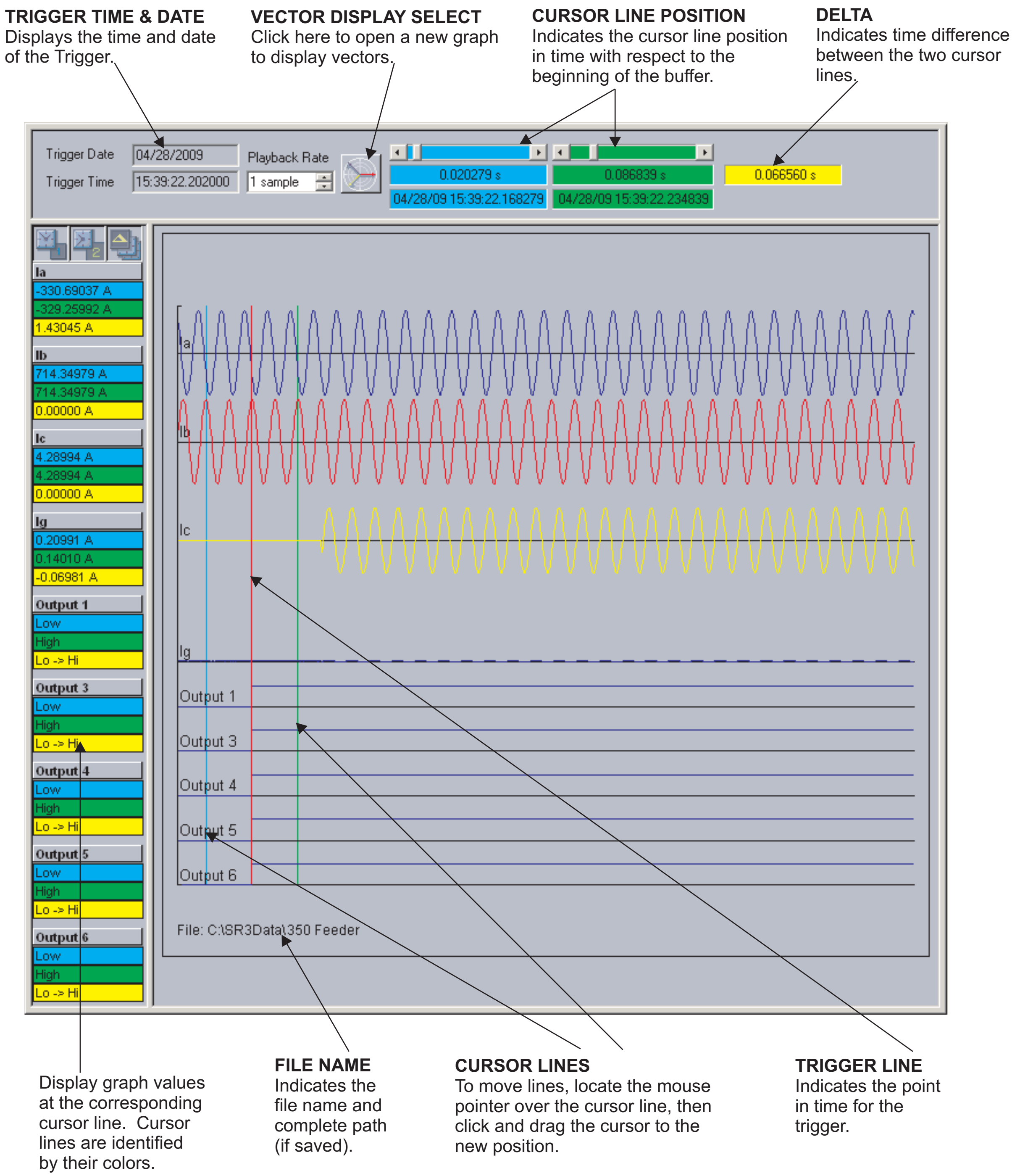
Transient recorder (Waveform capture)

The EnerVista SR3 Setupsoftware can be used to capture waveforms (or view trace memory) from the relay at the instance of a pickup, trip, alarm, or other condition.

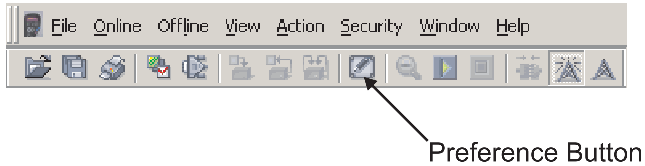
- With EnerVista SR3 Setupsoftware running and communications established, select the **Actual Values > A3 Records > Transient Records** menu item to open the Transient Recorder Viewer window.



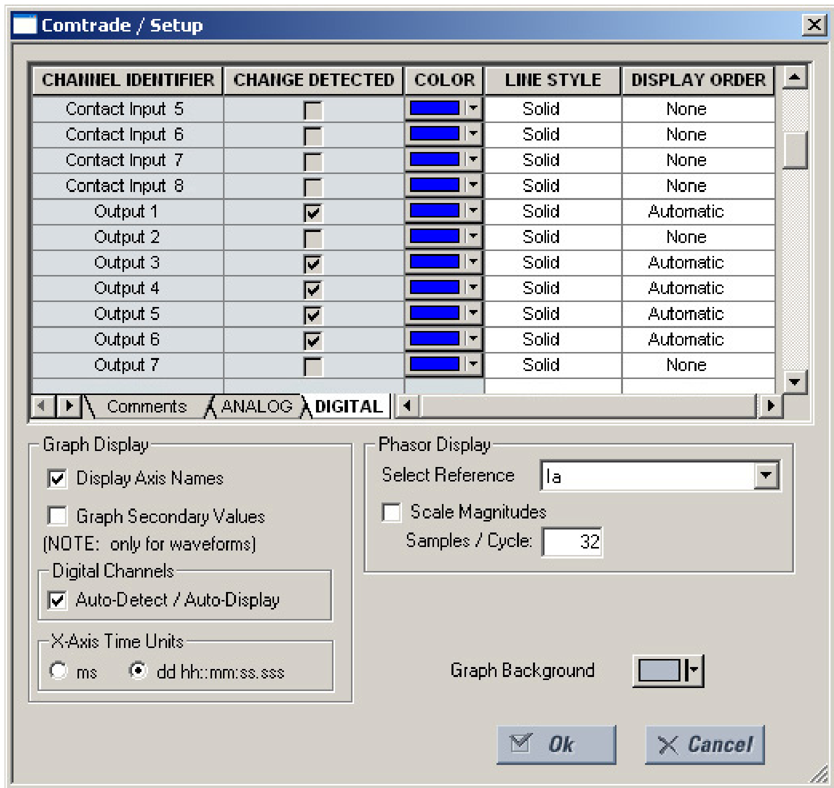
- Click on **Trigger Waveform** to trigger a waveform capture. Waveform file numbering starts with the number zero in the 350 , so that the maximum trigger number will always be one less than the total number of triggers available.
- Click on the **Save to File** button to save the selected waveform to the local PC. A new window will appear, requesting the file name and path. One file is saved as a COMTRADE file, with the extension "CFG." The other file is a "DAT" file, required by the COMTRADE file for proper display of waveforms.
- To view a previously saved COMTRADE file, click the **Open** button and select the corresponding COMTRADE file.
- To view the captured waveforms, click on the **Launch Viewer** button. A detailed Waveform Capture window will appear as shown below.



- The red vertical line indicates the trigger point.
- The date and time of the trigger are displayed at the top left corner of the window. To match the captured waveform with the event that triggered it, make note of the time and date shown in the graph, then find the event that matches the same time in the event recorder. The event record will provide additional information on the cause and system conditions at the time of the event.
- From the window main menu bar, press the **Preference** button to open the COMTRADE Setup page, in order to change the graph attributes.

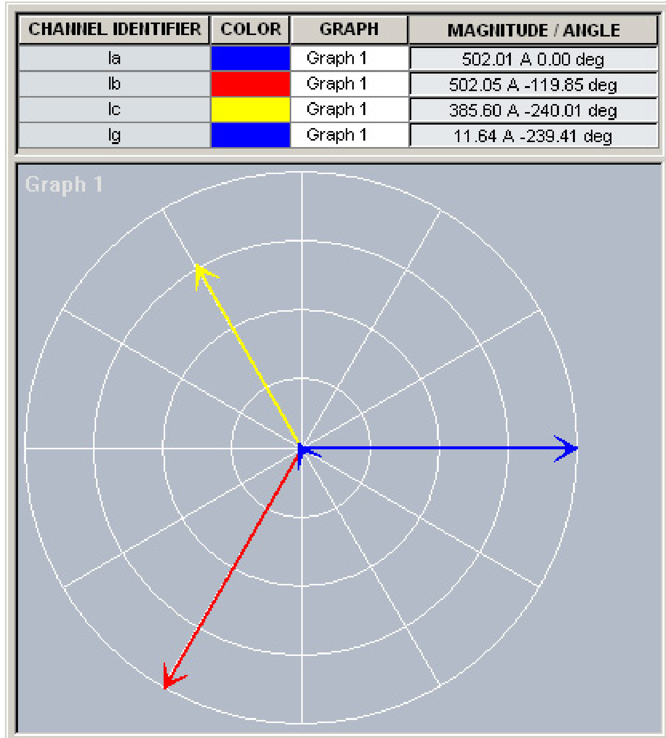


The following window will appear:



Change the color of each graph as desired, and select other options as required, by checking the appropriate boxes. Click **OK** to store these graph attributes, and to close the window. The Waveform Capture window will reappear based on the selected graph attributes.

To view a vector graph of the quantities contained in the waveform capture, press the **Vector Display** button to display the following window:



CHANNEL IDENTIFIER	COLOR	GRAPH	MAGNITUDE / ANGLE
Ia		Graph 1	502.01 A 0.00 deg
Ib		Graph 1	502.05 A -119.85 deg
Ic		Graph 1	385.60 A -240.01 deg
Ig		Graph 1	11.64 A -239.41 deg

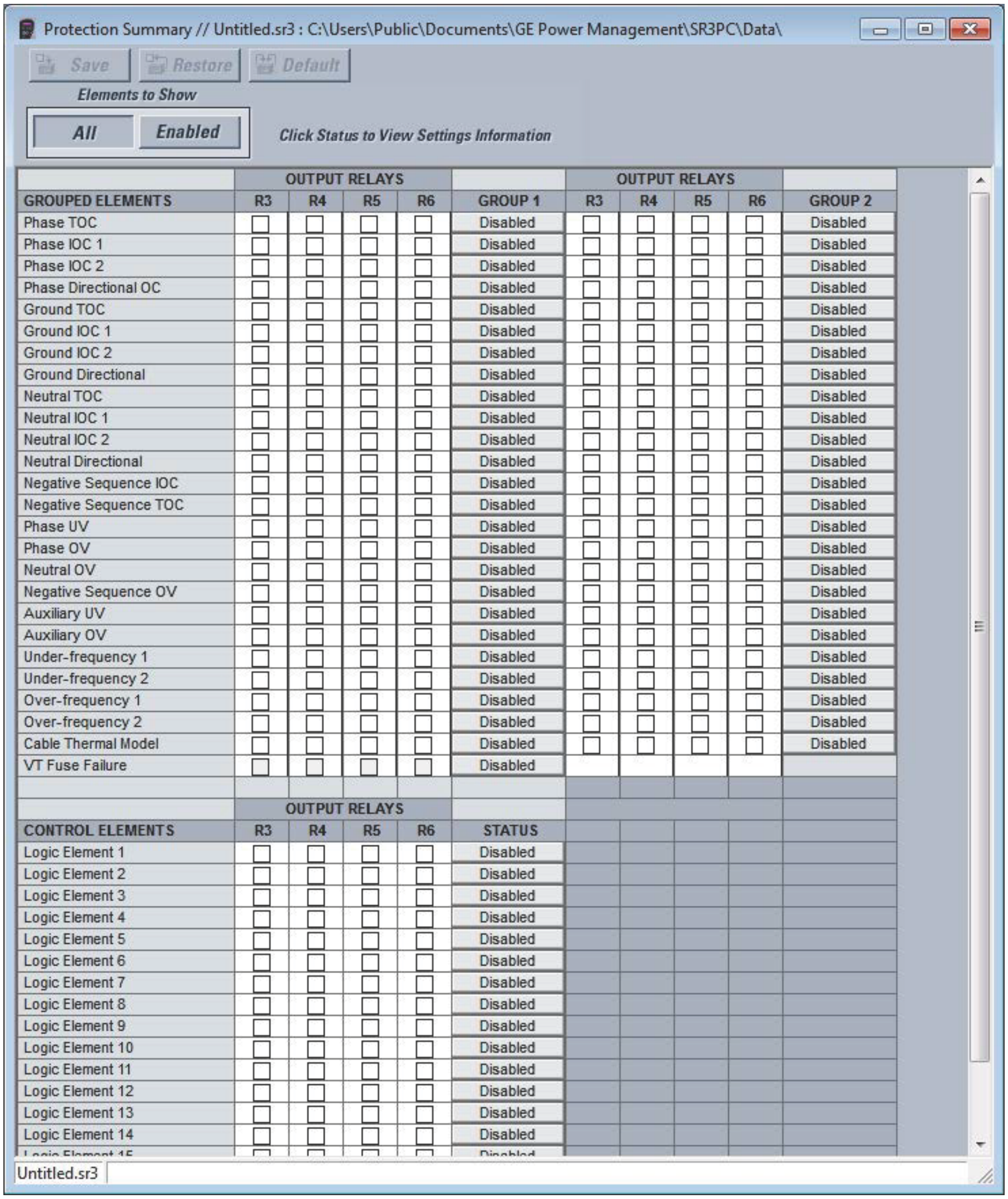
Protection summary

Protection Summary is a single screen which holds the summarized information of different settings from Grouped Elements, Control Elements and Maintenance screens.

Protection Summary Screen allows the user to:

- view the output relay assignments for the elements
- modify the output relay assignments for the elements
- view the enable/disable status of Control Elements
- navigate to the respected Protection Element screen on a button click.

The Protection Summary screen is as follows:

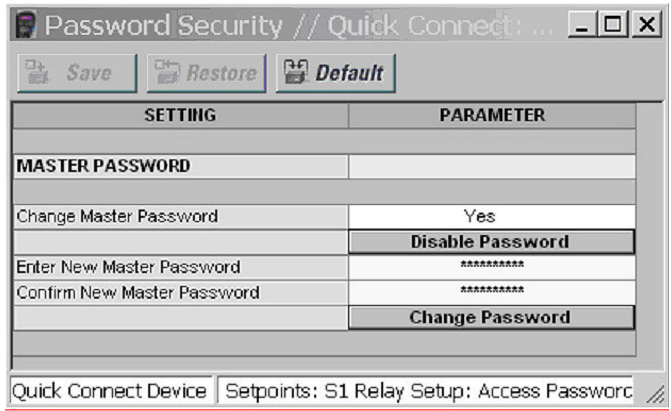


Password security

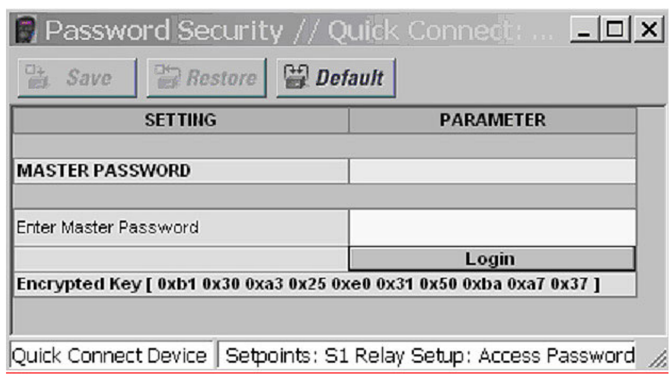
Password security is an optional feature of the 350 which can be setup using the SR3 EnerVista Setup software. The password system has been designed to facilitate a hierarchy for centralized management. This is accomplished through a Master level access password which can be used for resetting lower level access passwords and higher level privileged operations. In cases where operational security is required as well as a central administrative authority then the use of the password system is highly encouraged. The feature robustness of this system requires it to be managed exclusively through the EnerVista setup software. This section describes how to perform the initial setup. For more details on the password security feature, refer to *Chapter 6 - Password Security*.

1. 350 devices shipped from the factory are initially set with security disabled. If the password security feature is to be used, the user must first change the Master Reset Password from the initial Null setting, this can only be done over communications, not

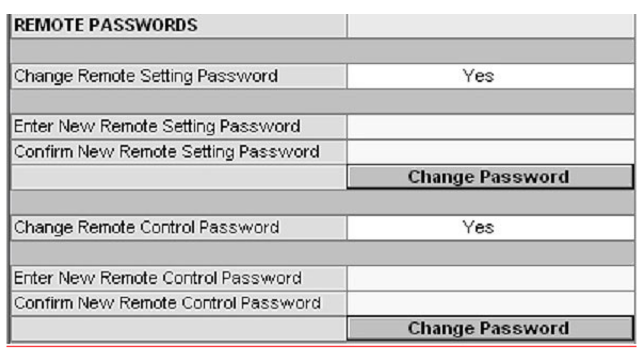
from the front panel keypad. The new Master Reset Password must be 8 to 10 characters in length, and must have minimum 2 letters and 2 numbers. The letters are case sensitive. After entering a valid Master Reset Password, enter the new Master Reset Password again to confirm, then select **Change Password**.



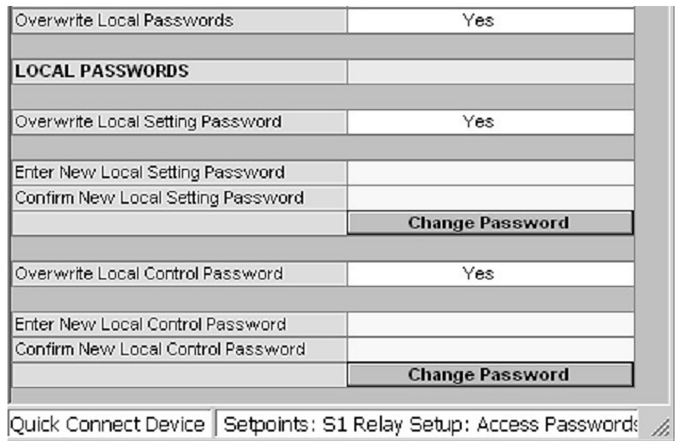
2. Now that the Master Reset Password has been programmed, enter it again to log in to the Master Access level. The Master Level permits setup of the Remote and Local Passwords. If the Master Reset Password has been lost, record the Encrypted Key and contact the factory to have it decrypted.



3. With Master Level access, the user may disable password security altogether, or change the Master Reset Password.
4. The Master Access level allows programming of the Remote Setpoint and Remote Control passwords. These passwords are initially set to a Null value, and can only be set or changed from a remote user over RS485 or Ethernet communications. Remote Passwords must be 3 to 10 characters in length.



5. Initial setup of the Local Setpoint and Local Control passwords requires the Master Access level. If Overwrite Local Passwords is set to YES, Local passwords can be changed remotely only (over RS485 or Ethernet). If Overwrite Local Passwords is set to NO, Local passwords can be changed locally only (over USB or keypad). If changing Local Passwords is permitted locally, the keypad user can only change the Local Passwords if they have been changed from the initial NULL value to a valid one. Local Passwords must be 3 to 10 characters in length.



6. If any Remote password has never been set, that level will not be attainable except when logged in as the Master Level. The same logic applies to the Local passwords.
7. When passwords have been set, the user will be prompted to enter the appropriate password depending on the interface being used (remote or local), and the nature of the change being made (setpoint or control). If the correct password is entered, the user is now logged into that access level over that interface only. The access level turns off after a period of 5 minutes of inactivity, if control power is cycled, or if the user enters an incorrect password.

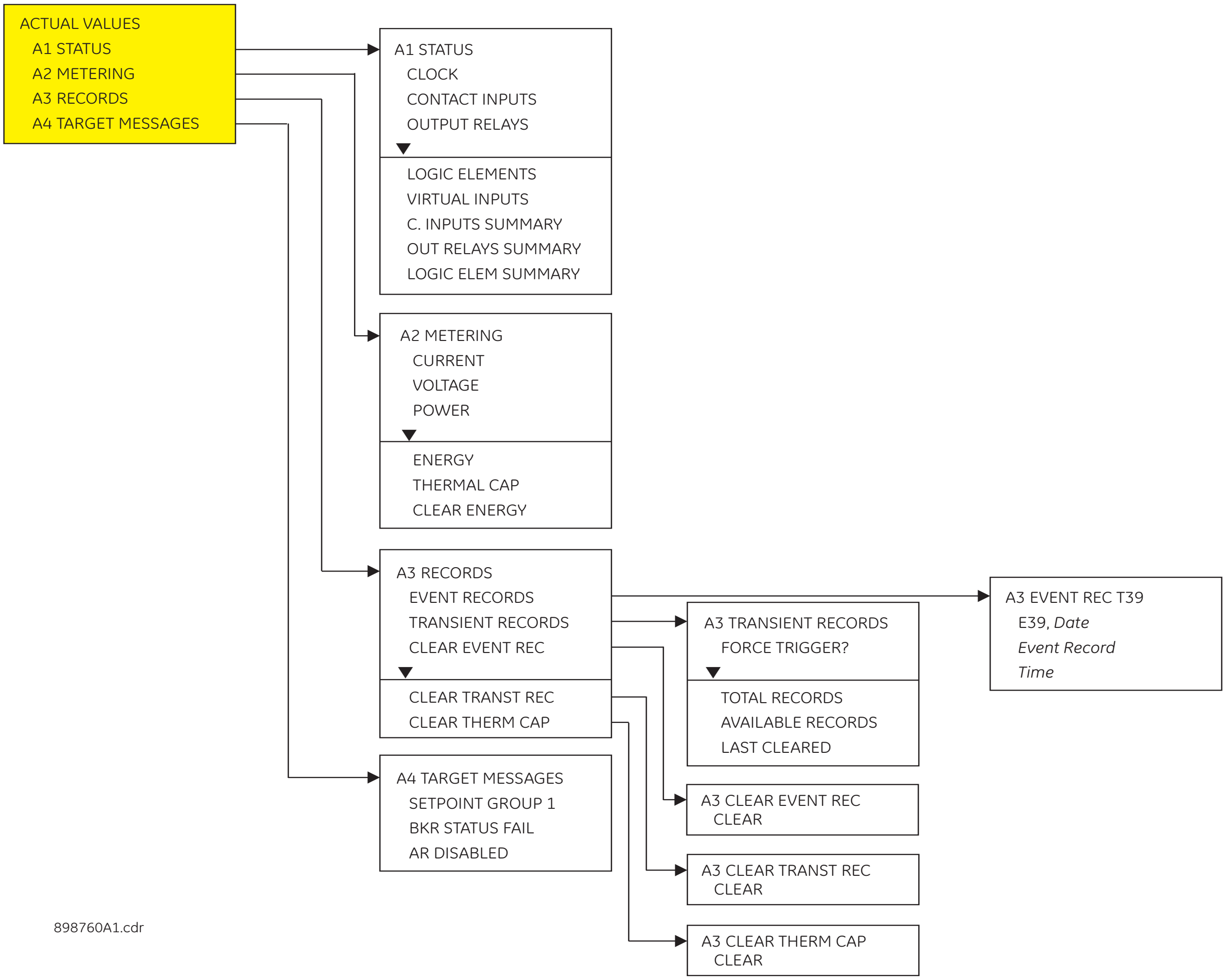
350 Feeder Protection System

Chapter 4: Actual values

Actual values overview

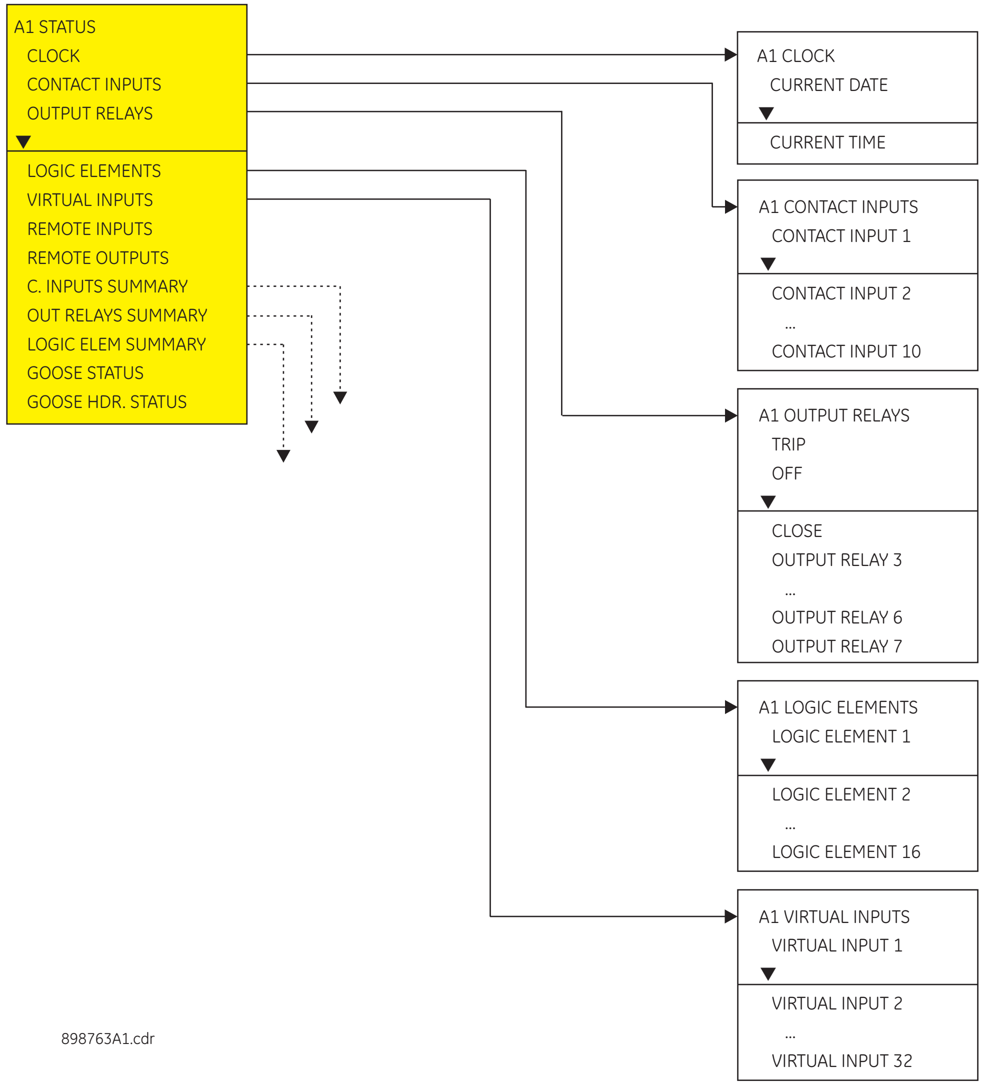
All measured values, the status of digital inputs and outputs, and fault analysis information are accessed in Actual Values mode. Actual value messages are organized into logical groups for easy reference as shown below.

Figure 1: Main Actual Values menu



A1 Status

Figure 2: Status menu



Clock

PATH: ACTUAL VALUES > A1 STATUS > CLOCK

CURRENT DATE
Feb 12 2009

Range: Date in format shown

Indicates today's date.

CURRENT TIME
09:17:12

Range: Time in format shown

Indicates the current time of day.

Contact inputs

PATH: ACTUAL VALUES > A1 STATUS > CONTACT INPUTS

CI #1 (52a) (Contact Input 1)
OFF

Range: Off, On

The status of this contact shows the breaker close/open state, when wired to a 52a breaker auxiliary contact.

CI #2 (52b) (Contact Input 2)
OFF

Range: Off, On

The status of this contact shows the breaker close/open state, when wired to a 52b breaker auxiliary contact.

CONTACT INPUT 3 to 10
OFF

Range: Off, On

Message displays the state of the contact input. The message “ON” indicates that the contact input is energized, and message “OFF” indicates a de-energized contact.

Output relays

PATH: ACTUAL VALUES > A1 STATUS > OUTPUT RELAYS

TRIP (Output Relay #1)
OFF

Range: Off, On

The “ON” state of Output Relay #1 (TRIP) shows that a TRIP command has been sent to the breaker.

CLOSE (Output Relay #2)
OFF

Range: Off, On

The “ON” state of Output Relay #2 (CLOSE) shows that a close command has been sent to the breaker.

OUTPUT RELAY 3 to 6 (Auxiliary Output Relays)
OFF

Range: Off, On

OUTPUT RELAY 7 (Critical Failure Relay)

Range: Off, On

The "ON" state indicates that the relay is in-service.

Logic elements

PATH: ACTUAL VALUES > A1 STATUS > LOGIC ELEMENTS

LOGIC ELEMENT 1 to 16
OFF

Range: Off, On

The state “ON” or “OFF” for each logic element depends on its programmed logic: triggering inputs, blocking inputs, plus any pickup, and/or reset time delay.

Virtual inputs

The state of all active virtual inputs is displayed here.

PATH: ACTUAL VALUES > A1 STATUS > VIRTUAL INPUTS

VIRTUAL INPUTS 1 to 32
OFF

Range: Off, On

Remote inputs

The state of all active remote inputs is displayed here.

PATH: ACTUAL VALUES > A1 STATUS > REMOTE INPUTS

REMOTE INPUTS 1 to 32
OFF

Range: Off, On

Remote outputs

The state of all active remote outputs is displayed here.

PATH: ACTUAL VALUES > A1 STATUS > REMOTE OUTPUTS

REMOTE OUTPUTS 1 to 32
OFF

Range: Off, On

Contact inputs summary

C. INPUTS SUMMARY

52a	OFF	CI#6	OFF
52b	OFF	CI#7	OFF
CI#3	OFF	CI#8	OFF
CI#4	OFF	CI#9	OFF
CI#5	OFF	CI#10	OFF

The display shows a summary of the states of all contact inputs.

Output relays summary

PATH: ACTUAL VALUES > A1 STATUS > OUT RELAYS SUMMARY

OUTPUT RELAYS SUMMARY

TRIP	OFF	RLY#5	OFF
CLOSE	OFF	RLY#6	OFF
RLY#3	OFF	RLY#7	ON
RLY#4	OFF		

This display shows a summary of the states of all output relays.

NOTE

Output relay #7 is the Critical Failure relay, used to indicate the correct functioning of the 350 relay. This output relay shows the status "ON" when the 350 relay is powered up and set to "Ready" and no self-test alarms are active, under **SETPOINTS > S1 RELAY SETUP > S1 INSTALLATION > RELAY STATUS.**

Logic elements summary

PATH: **ACTUAL VALUES > A1 STATUS > LOGIC ELEM SUMMARY**

LOGIC ELEM SUMMARY

LE#1	OFF	LE#9	OFF
LE#2	OFF	LE#10	OFF
LE#3	OFF	LE#11	OFF
LE#4	OFF	LE#12	OFF
LE#5	OFF	LE#13	OFF
LE#6	OFF	LE#14	OFF
LE#7	OFF	LE#15	OFF
LE#8	OFF	LE#16	OFF

This display shows a summary of the states of all logic elements.

GOOSE status

PATH: **ACTUAL VALUES > A1 STATUS > GOOSE STATUS**

GOOSE 1 TO 8 STATUS

Range: OFF, ON
Default: OFF

GOOSE HDR status

PATH: **ACTUAL VALUES > A1 STATUS > GOOSE HDR STATUS**

GOOSE 1 TO 8 H.STATUS

Range: OFF, ON
Default: OFF

A2 Metering

The relay measures all RMS currents and voltages, frequency, and all auxiliary analog inputs. Other values like neutral current, symmetrical components, power factor, power (real, reactive, apparent), are derived. All quantities are recalculated every power system cycle and perform protection and monitoring functions. Displayed metered quantities are updated approximately three (3) times a second for readability. All phasors and symmetrical components are referenced to the A-N voltage phasor for wye-connected VTs; to the A-B voltage phasor for delta connected VTs; or to the phase A current phasor when no voltage signals are present.

By scrolling the Up/Down keys the relay shows one-by-one, all metered values as follows:

Current

PH A CURRENT
0.0 A   0^o lag

Range: 0.0 to 30000 A, 0 to 359^o lag

PH B CURRENT
0.0 A   0^o lag

Range: 0.0 to 30000 A, 0 to 359^o lag

PH C CURRENT
0.0 A   0^o lag

Range: 0.0 to 30000 A, 0 to 359^o lag

NTRL CURRENT
0.0 A   0^o lag

Range: 0.0 to 30000 A, 0 to 359^o lag

GND CURRENT
0.0 A   0^o lag

Range: 0.0 to 30000 A, 0 to 359^o lag

GND CURRENT is shown when the GROUND CT TYPE is set to "1A Secondary" or "5A Secondary".

SENS GND CURRENT
0.00 A   0^o lag

Range: 0.00 to 15.00 A, 0 to 359^o lag

SENS GND CURRENT is shown when the GROUND CT TYPE is set to "50:0.025".

NEG SEQ CURRENT
0.0 A 0^o lag
Range: 0.0 to 30000 A, 0 to 359^o lag

Voltage

AN VOLTAGE
0 V 0^o lag
Range: 0 to 65535 V

BN VOLTAGE
0 V 0^o lag
Range: 0 to 65535 V

CN VOLTAGE
0 V 0^o lag
Range: 0 to 65535 V

AB VOLTAGE
0 V 0^o lag
Range: 0 to 65535 V

BC VOLTAGE
0 V 0^o lag
Range: 0 to 65535 V

CA VOLTAGE
0 V 0^o lag
Range: 0 to 65535 V

NTRL VOLTAGE
0 V 0^o lag
Range: 0 to 65535 V

NEG SEQ VOLTAGE
0 V 0^o lag
Range: 0 to 65535 V

ZERO SEQ VOLTAGE
0 V 0^o lag
Range: 0 to 65535 V

AUX VOLTAGE
0 V 0^o lag
Range: 0 to 65535 V

FREQUENCY
0.00 Hz
Range: 40 to 70 Hz

Power

3 ph REAL POWER
0.0 kV
Range: -100000.0 to 100000.0 kW

3 ph REACTIVE POWER
0.0 kVAR
Range: -100000.0 to 100000.0 kVAR

3 ph APPARENT POWER

0.0 kVA

Range: 0 to 100000.0 kVA

POWER FACTOR
0.00

Range: -0.99 to 1.00

Energy

POSITIVE WATTHOUR
0.000 MWh

Range: 0.000 to 50000.000 MWh

NEGATIVE WATTHOUR
0.000 MWh

Range: 0.000 to 50000.000 MWh

POSITIVE VARHOUR
0.000 MVarh

Range: 0.000 to 50000.000 MVarh

NEGATIVE VARHOUR
0.000 MVarh

Range: 0.000 to 50000.000 MVarh

Thermal capacity

THERMAL CAP PH A
0%

THERMAL CAP PH B
0%

THERMAL CAP PH C
0%

Clear energy

CLEAR ENERGY
NO

Range: No, Yes

When set to "YES," pressing the ENTER key will clear all energy data.

A3 Records

The 350 has an event recorder which runs continuously. All event records are stored in memory such that information is maintained for up to 3 days even after losing relay control power. The events are displayed from newest to oldest event. Each event has a header message containing a summary of the event that occurred, and is assigned an event number equal to the number of events that have occured since the recorder was cleared. The event number is incremented for each new event.

Event records

The Event Recorder runs continuously, capturing and storing the last 256 events. All events are stored in non-volatile memory where the information is maintained, even in the case where relay control power is lost.

Shown below is an example of an event record caused by a Breaker Open operation, and the recorded information at the time of this record.

PATH: **ACTUAL VALUES > A3 RECORDS > EVENT RECORDS**

Table 1: Example of Event Record

A3 EVENT REC T:778 E778 Jan 30,2009 BKR Stat Open 16:30:23.324		E778, CONTROL BKR Stat Open PHASE A CURRENT: 0.0 A 0° Lag
		E778, CONTROL BKR Stat Open PHASE B CURRENT: 0.0 A 0° Lag
		E778, CONTROL BKR Stat Open PHASE C CURRENT: 0.0 A 0° Lag
		E778, CONTROL BKR Stat Open GROUND CURRENT: 0.0 A 0° Lag
		E778, CONTROL BKR Stat Open NTRL GND CURRENT: 0.0 A
		E778, CONTROL BKR Stat Open PHASE A-B VOLTAGE 0 V 0°
		E778, CONTROL BKR Stat Open PHASE B-C VOLTAGE 0 V 0°
		E778, CONTROL BKR Stat Open PHASE C-A VOLTAGE 0 V 0°
		E778, CONTROL BKR Stat Open FREQUENCY 0.00 Hz
		E778, CONTROL BKR Stat Open 3ph REAL POWER 0.0 kW
		E778, CONTROL BKR Stat Open 3ph REACTIVE POWER 0.0 kvar

		E778, CONTROL BKR Stat Open 3ph APPARENT POWER 0.0 kVA
		E778, CONTROL BKR Stat Open POWER FACTOR 0.00
		E778, CONTROL BKR Stat Open THERM CAP PH A 0.0%
		E778, CONTROL BKR Stat Open THERM CAP PH B 0.0%
		E778, CONTROL BKR Stat Open THERM CAP PH C 0.0%

Each event is saved with event number, date and time, and contains information such as per phase current, ground current, either phase-phase voltages (VTs connected in Delta), or phase-neutral voltages (VTs connected in Wye), and system frequency. The Event Recorder can be cleared from **ACTUAL VALUES > A3 RECORDS > CLEAR EVENT REC** setpoint. The following tables provide lists of the event types and event causes:

Table 2: Event type

Event Type	Display	Description
General Events	None	Events that occur when specific operation takes place
Pickup Events	PICKUP:	These are events that occur when a protection element picks up
Trip Events	TRIP:	These are events that occur when a breaker trip is initiated
Alarm and Latched Alarm Events	ALARM:	These are events that occur when an alarm is initiated
Control Events	CONTROL:	These are events that occur when a control element is activated
Dropout Events	DROPOUT:	These are events that occur when a protection element drops out after a corresponding pickup event
Contact Input Events	C. INPUT:	These are events that occur when a contact input changes its state
Virtual Input Events	V. INPUT	These are events that occur when a virtual input changes its state
Remote Input Events	R. INPUT	These are events that occur when a remote input changes its state
Logic Element Events	L. ELEMENT	These are events that occur when a logic element changes its state
Self-Test Warning Events	SELF-TEST WARNING	These are events that occur when a self-test warning is detected.

The following table, from the *350 Communications Guide*, shows the list of Event Causes.

Code	Type	Definition
FC134	unsigned 16 bits	Cause of Event
0		No Evnt/Trp ToDate
1		Ctrl. Pwr Lost
2		Ctrl. Pwr Applied
3		Date or Time Set
4		Reset

Code	Type	Definition
6		Factory Reload
7		Clock Not Set
8		IRIG-B Failure
9		Reset Trip Counter
10		BKR Status Unknown
11		Clear Event Rec
12		Clear Transt Rec
13		Clear Therm Cap
14		Comm. Alert 1
15		Comm. Alert 2
16		Comm. Alert 3
17		Ethernet Link Fail
18		High ENET Traffic
19		Ambient Temp. >80C
23		Trace Mem. Trigger
24		Rx Goose 1 ON
25		Rx Goose 1 OFF
26		Rx Goose 2 ON
27		Rx Goose 2 OFF
28		Rx Goose 3 ON
29		Rx Goose 3 OFF
30		Rx Goose 4 ON
31		Rx Goose 4 OFF
32		Rx Goose 5 ON
33		Rx Goose 5 OFF
34		Rx Goose 6 ON
35		Rx Goose 6 OFF
36		Rx Goose 7 ON
37		Rx Goose 7 OFF
38		Rx Goose 8 ON
39		Rx Goose 8 OFF
0x0040		Contact IN 1 On
0x0041		Contact IN 2 On
0x0042		Contact IN 3 On
0x0043		Contact IN 4 On
0x0044		Contact IN 5 On
0x0045		Contact IN 6 On
0x0046		Contact IN 7 On
0x0047		Contact IN 8 On
0x0048		Contact IN 9 On
0x0049		Contact IN 10 On
0x0060		Contact IN 1 Off
0x0061		Contact IN 2 Off
0x0062		Contact IN 3 Off
0x0063		Contact IN 4 Off
0x0064		Contact IN 5 Off
0x0065		Contact IN 6 Off

Code	Type	Definition
0x0066		Contact IN 7 Off
0x0067		Contact IN 8 Off
0x0068		Contact IN 9 Off
0x0069		Contact IN 10 Off
0x0080		Virtual IN 1 On
0x0081		Virtual IN 2 On
0x0082		Virtual IN 3 On
0x0083		Virtual IN 4 On
0x0084		Virtual IN 5 On
0x0085		Virtual IN 6 On
0x0086		Virtual IN 7 On
0x0087		Virtual IN 8 On
0x0088		Virtual IN 9 On
0x0089		Virtual IN 10 On
0x008A		Virtual IN 11 On
0x008B		Virtual IN 12 On
0x008C		Virtual IN 13 On
0x008D		Virtual IN 14 On
0x008E		Virtual IN 15 On
0x008F		Virtual IN 16 On
0x0090		Virtual IN 17 On
0x0091		Virtual IN 18 On
0x0092		Virtual IN 19 On
0x0093		Virtual IN 20 On
0x0094		Virtual IN 21 On
0x0095		Virtual IN 22 On
0x0096		Virtual IN 23 On
0x0097		Virtual IN 24 On
0x0098		Virtual IN 25 On
0x0099		Virtual IN 26 On
0x009A		Virtual IN 27 On
0x009B		Virtual IN 28 On
0x009C		Virtual IN 29 On
0x009D		Virtual IN 30 On
0x009E		Virtual IN 31 On
0x009F		Virtual IN 32 On
0x00A0		Virtual IN 1 Off
0x00A1		Virtual IN 2 Off
0x00A2		Virtual IN 3 Off
0x00A3		Virtual IN 4 Off
0x00A4		Virtual IN 5 Off
0x00A5		Virtual IN 6 Off
0x00A6		Virtual IN 7 Off
0x00A7		Virtual IN 8 Off
0x00A8		Virtual IN 9 Off
0x00A9		Virtual IN 10 Off
0x00AA		Virtual IN 11 Off

Code	Type	Definition
0x00AB		Virtual IN 12 Off
0x00AC		Virtual IN 13 Off
0x00AD		Virtual IN 14 Off
0x00AE		Virtual IN 15 Off
0x00AF		Virtual IN 16 Off
0x00B0		Virtual IN 17 Off
0x00B1		Virtual IN 18 Off
0x00B2		Virtual IN 19 Off
0x00B3		Virtual IN 20 Off
0x00B4		Virtual IN 21 Off
0x00B5		Virtual IN 22 Off
0x00B6		Virtual IN 23 Off
0x00B7		Virtual IN 24 Off
0x00B8		Virtual IN 25 Off
0x00B9		Virtual IN 26 Off
0x00BA		Virtual IN 27 Off
0x00BB		Virtual IN 28 Off
0x00BC		Virtual IN 29 Off
0x00BD		Virtual IN 30 Off
0x00BE		Virtual IN 31 Off
0x00BF		Virtual IN 32 Off
0x01C0		Remote IN 1 On
0x01C1		Remote IN 2 On
0x01C2		Remote IN 3 On
0x01C3		Remote IN 4 On
0x01C4		Remote IN 5 On
0x01C5		Remote IN 6 On
0x01C6		Remote IN 7 On
0x01C7		Remote IN 8 On
0x01C8		Remote IN 9 On
0x01C9		Remote IN 10 On
0x01CA		Remote IN 11 On
0x01CB		Remote IN 12 On
0x01CC		Remote IN 13 On
0x01CD		Remote IN 14 On
0x01CE		Remote IN 15 On
0x01CF		Remote IN 16 On
0x01D0		Remote IN 17 On
0x01D1		Remote IN 18 On
0x01D2		Remote IN 19 On
0x01D3		Remote IN 20 On
0x01D4		Remote IN 21 On
0x01D5		Remote IN 22 On
0x01D6		Remote IN 23 On
0x01D7		Remote IN 24 On
0x01D8		Remote IN 25 On
0x01D9		Remote IN 26 On

Code	Type	Definition
0x01DA		Remote IN 27 On
0x01DB		Remote IN 28 On
0x01DC		Remote IN 29 On
0x01DD		Remote IN 30 On
0x01DE		Remote IN 31 On
0x01DF		Remote IN 32 On
0x01E0		Remote IN 1 Off
0x01E1		Remote IN 2 Off
0x01E2		Remote IN 3 Off
0x01E3		Remote IN 4 Off
0x01E4		Remote IN 5 Off
0x01E5		Remote IN 6 Off
0x01E6		Remote IN 7 Off
0x01E7		Remote IN 8 Off
0x01E8		Remote IN 9 Off
0x01E9		Remote IN 10 Off
0x01EA		Remote IN 11 Off
0x01EB		Remote IN 12 Off
0x01EC		Remote IN 13 Off
0x01ED		Remote IN 14 Off
0x01EE		Remote IN 15 Off
0x01EF		Remote IN 16 Off
0x01F0		Remote IN 17 Off
0x01F1		Remote IN 18 Off
0x01F2		Remote IN 19 Off
0x01F3		Remote IN 20 Off
0x01F4		Remote IN 21 Off
0x01F5		Remote IN 22 Off
0x01F6		Remote IN 23 Off
0x01F7		Remote IN 24 Off
0x01F8		Remote IN 25 Off
0x01F9		Remote IN 26 Off
0x01FA		Remote IN 27 Off
0x01FB		Remote IN 28 Off
0x01FC		Remote IN 29 Off
0x01FD		Remote IN 30 Off
0x01FE		Remote IN 31 Off
0x01FF		Remote IN 32 Off
0x8041		Therm O/L Trip PKP
0x8042		Therm O/L Trip OP
0x8044		Therm O/L Trip DPO
0x8049		Therm PhA Trip PKP
0x804A		Therm PhA Trip OP
0x804C		Therm PhA Trip DPO
0x8051		Therm PhB Trip PKP
0x8052		Therm PhB Trip OP
0x8054		Therm PhB Trip DPO

Code	Type	Definition
0x8061		Therm PhC Trip PKP
0x8062		Therm PhC Trip OP
0x8064		Therm PhC Trip DPO
0x84C1		LE 1 Trip PKP
0x84C2		LE 1 Trip OP
0x84C4		LE 1 Trip DPO
0x8501		LE 2 Trip PKP
0x8502		LE 2 Trip OP
0x8504		LE 2 Trip DPO
0x8541		LE 3 Trip PKP
0x8542		LE 3 Trip OP
0x8544		LE 3 Trip DPO
0x8581		LE 4 Trip PKP
0x8582		LE 4 Trip OP
0x8584		LE 4 Trip DPO
0x85C1		LE 5 Trip PKP
0x85C2		LE 5 Trip OP
0x85C4		LE 5 Trip DPO
0x8601		LE 6 Trip PKP
0x8602		LE 6 Trip OP
0x8604		LE 6 Trip DPO
0x8641		LE 7 Trip PKP
0x8642		LE 7 Trip OP
0x8644		LE 7 Trip DPO
0x8681		LE 8 Trip PKP
0x8682		LE 8 Trip OP
0x8684		LE 8 Trip DPO
0x8F81		Fuse Fail Trip PKP
0x8F82		Fuse Fail Trip OP
0x8F84		Fuse Fail Trip DPO
0x9001		Ph IOC1 Trip PKP
0x9002		Ph IOC1 Trip OP
0x9004		Ph IOC1 Trip DPO
0x9009		Ph A IOC1 Trip PKP
0x900A		Ph A IOC1 Trip OP
0x900C		Ph A IOC1 Trip DPO
0x9011		Ph B IOC1 Trip PKP
0x9012		Ph B IOC1 Trip OP
0x9014		Ph B IOC1 Trip DPO
0x9021		Ph C IOC1 Trip PKP
0x9022		Ph C IOC1 Trip OP
0x9024		Ph C IOC1 Trip DPO
0x9041		Ntrl IOC1 Trip PKP
0x9042		Ntrl IOC1 Trip OP
0x9044		Ntrl IOC1 Trip DPO
0x9081		Gnd IOC1 Trip PKP
0x9082		Gnd IOC1 Trip OP

Code	Type	Definition
0x9084		Gnd IOC1 Trip DPO
0x90C1		Ph TOC1 Trip PKP
0x90C2		Ph TOC1 Trip OP
0x90C4		Ph TOC1 Trip DPO
0x90C9		Ph A TOC1 Trip PKP
0x90CA		Ph A TOC1 Trip OP
0x90CC		Ph A TOC1 Trip DPO
0x90D1		Ph B TOC1 Trip PKP
0x90D2		Ph B TOC1 Trip OP
0x90D4		Ph B TOC1 Trip DPO
0x90E1		Ph C TOC1 Trip PKP
0x90E2		Ph C TOC1 Trip OP
0x90E4		Ph C TOC1 Trip DPO
0x9101		Ntrl TOC1 Trip PKP
0x9102		Ntrl TOC1 Trip OP
0x9104		Ntrl TOC1 Trip DPO
0x9141		Gnd TOC1 Trip PKP
0x9142		Gnd TOC1 Trip OP
0x9144		Gnd TOC1 Trip DPO
0x9181		Ph IOC2 Trip PKP
0x9182		Ph IOC2 Trip OP
0x9184		Ph IOC2 Trip DPO
0x9189		Ph A IOC2 Trip PKP
0x918A		Ph A IOC2 Trip OP
0x918C		Ph A IOC2 Trip DPO
0x9191		Ph B IOC2 Trip PKP
0x9192		Ph B IOC2 Trip OP
0x9194		Ph B IOC2 Trip DPO
0x91A1		Ph C IOC2 Trip PKP
0x91A2		Ph C IOC2 Trip OP
0x91A4		Ph C IOC2 Trip DPO
0x91C1		Ntrl IOC2 Trip PKP
0x91C2		Ntrl IOC2 Trip OP
0x91C4		Ntrl IOC2 Trip DPO
0x9201		Gnd IOC2 Trip PKP
0x9202		Gnd IOC2 Trip OP
0x9204		Gnd IOC2 Trip DPO
0x9301		SGnd TOC1 Trip PKP
0x9302		SGnd TOC1 Trip OP
0x9304		SGnd TOC1 Trip DPO
0x93C1		NegSeq OV Trp PKP
0x93C2		NegSeq OV Trp OP
0x93C4		NegSeq OV Trp DPO
0x9401		Ntrl OV Trip PKP
0x9402		Ntrl OV Trp OP
0x9404		Ntrl OV Trip DPO
0x9441		Ph OV1 Trip PKP

Code	Type	Definition
0x9442		Ph OV1 Trip OP
0x9444		Ph OV1 Trip DPO
0x9449		Ph A OV1 Trip PKP
0x944A		Ph A OV1 Trip OP
0x944C		Ph A OV1 Trip DPO
0x9451		Ph B OV1 Trip PKP
0x9452		Ph B OV1 Trip OP
0x9454		Ph B OV1 Trip DPO
0x9461		Ph C OV1 Trip PKP
0x9462		Ph C OV1 Trip OP
0x9464		Ph C OV1 Trip DPO
0x9481		Ph UV1 Trip PKP
0x9482		Ph UV1 Trip OP
0x9484		Ph UV1 Trip DPO
0x9489		Ph A UV1 Trip PKP
0x948A		Ph A UV1 Trip OP
0x948C		Ph A UV1 Trip DPO
0x9491		Ph B UV1 Trip PKP
0x9492		Ph B UV1 Trip OP
0x9494		Ph B UV1 Trip DPO
0x94A1		Ph C UV1 Trip PKP
0x94A2		Ph C UV1 Trip OP
0x94A4		Ph C UV1 Trip DPO
0x94C1		Aux OV Trip PKP
0x94C2		Aux OV Trip OP
0x94C4		Aux OV Trip DPO
0x9501		Aux UV Trip PKP
0x9502		Aux UV Trip Op
0x9504		Aux UV Trip DPO
0x9541		UndrFreq1 Trip PKP
0x9542		UndrFreq1 Trip OP
0x9544		UndrFreq1 Trip DPO
0x9581		UndrFreq2 Trip PKP
0x9582		UndrFreq2 Trip OP
0x9584		UndrFreq2 Trip DPO
0x95C1		OverFreq1 Trip PKP
0x95C2		OverFreq1 Trip OP
0x95C4		OverFreq1 Trip DPO
0x9601		OverFreq2 Trip PKP
0x9602		OverFreq2 Trip OP
0x9604		OverFreq2 Trip DPO
0x9641		SGnd IOC1 Trip PKP
0x9642		SGnd IOC1 Trip OP
0x9644		SGnd IOC1 Trip DPO
0x9681		SGnd IOC2 Trip PKP
0x9682		SGnd IOC2 Trip OP
0x9684		SGnd IOC2 Trip DPO

Code	Type	Definition
0x96C1		NegSeq IOC Trp PKP
0x96C2		NegSeq IOC Trp OP
0x96C4		NegSeq IOC Trp DPO
0x9C01		LE 9 Trip PKP
0x9C02		LE 9 Trip OP
0x9C04		LE 9 Trip DPO
0x9C41		LE 10 Trip PKP
0x9C42		LE 10 Trip OP
0x9C44		LE 10 Trip DPO
0x9C81		LE 11 Trip PKP
0x9C82		LE 11 Trip OP
0x9C84		LE 11 Trip DPO
0x9CC1		LE 12 Trip PKP
0x9CC2		LE 12 Trip OP
0x9CC4		LE 12 Trip DPO
0x9D01		LE 13 Trip PKP
0x9D02		LE 13 Trip OP
0x9D04		LE 13 Trip DPO
0x9D41		LE 14 Trip PKP
0x9D42		LE 14 Trip OP
0x9D44		LE 14 Trip DPO
0x9D81		LE 15 Trip PKP
0x9D82		LE 15 Trip OP
0x9D84		LE 15 Trip DPO
0x9DC1		LE 16 Trip PKP
0x9DC2		LE 16 Trip OP
0x9DC4		LE 16 Trip DPO
0xA049		Therm PhA Alrm PKP
0xA04A		Therm PhA Alrm OP
0xA04C		Therm PhA Alrm DPO
0xA051		Therm PhB Alrm PKP
0xA052		Therm PhB Alrm OP
0xA054		Therm PhB Alrm DPO
0xA061		Therm PhC Alrm PKP
0xA062		Therm PhC Alrm OP
0xA064		Therm PhC Alrm DPO
0xA482		Relay Not Ready
0xA4C1		LE 1 Alarm PKP
0xA4C2		LE 1 Alarm OP
0xA4C4		LE 1 Alarm DPO
0xA501		LE 2 Alarm PKP
0xA502		LE 2 Alarm OP
0xA504		LE 2 Alarm DPO
0xA541		LE 3 Alarm PKP
0xA542		LE 3 Alarm OP
0xA544		LE 3 Alarm DPO
0xA581		LE 4 Alarm PKP

Code	Type	Definition
0xA582		LE 4 Alarm OP
0xA584		LE 4 Alarm DPO
0xA5C1		LE 5 Alarm PKP
0xA5C2		LE 5 Alarm OP
0xA5C4		LE 5 Alarm DPO
0xA601		LE 6 Alarm PKP
0xA602		LE 6 Alarm OP
0xA604		LE 6 Alarm DPO
0xA641		LE 7 Alarm PKP
0xA642		LE 7 Alarm OP
0xA644		LE 7 Alarm DPO
0xA681		LE 8 Alarm PKP
0xA682		LE 8 Alarm OP
0xA684		LE 8 Alarm DPO
0xABC1		HI Amb Temp PKP
0xABC2		HI Amb Temp OP
0xABC4		HI Amb Temp DPO
0xAC01		LO Amb Temp PKP
0xAC02		LO Amb Temp OP
0xAC04		LO Amb Temp DPO
0xAC42		Self Test Alarm OP
0xACC2		BKRTrpCntrAlrm OP
0xAD01		R1 CoilMonAlrm PKP
0xAD02		R1 CoilMonAlrm OP
0xAD04		R1 CoilMonAlrm DPO
0xAD41		R2 CoilMonAlrm PKP
0xAD42		R2 CoilMonAlrm OP
0xAD44		R2 CoilMonAlrm DPO
0xAD81		BKR1 Fail Alrm PKP
0xAD82		BKR1 Fail Alrm OP
0xAD84		BKR1 Fail Alrm DPO
0xADC2		BKR Stat Fail OP
0xAE41		CLP Alarm PKP
0xAE42		CLP Alarm OP
0xAE44		CLP Alarm DPO
0xAF81		Fuse Fail Alrm PKP
0xAF82		Fuse Fail Alrm OP
0xAF84		Fuse Fail Alrm DPO
0xB001		Ph IOC1 Alarm PKP
0xB002		Ph IOC1 Alarm OP
0xB004		Ph IOC1 Alarm DPO
0xB009		Ph A IOC1 Alrm PKP
0xB00A		Ph A IOC1 Alrm OP
0xB00C		Ph A IOC1 Alrm DPO
0xB011		Ph B IOC1 Alrm PKP
0xB012		Ph B IOC1 Alrm OP
0xB014		Ph B IOC1 Alrm DPO

Code	Type	Definition
0xB021		Ph C IOC1 Alrm PKP
0xB022		Ph C IOC1 Alrm OP
0xB024		Ph C IOC1 Alrm DPO
0xB041		Ntrl IOC1 Alrm PKP
0xB042		Ntrl IOC1 Alrm OP
0xB044		Ntrl IOC1 Alrm DPO
0xB081		Gnd IOC1 Alarm PKP
0xB082		Gnd IOC1 Alarm OP
0xB084		Gnd IOC1 Alarm DPO
0xB0C1		Ph TOC1 Alarm PKP
0xB0C2		Ph TOC1 Alarm OP
0xB0C4		Ph TOC1 Alarm DPO
0xB0C9		Ph A TOC1 Alrm PKP
0xB0CA		Ph A TOC1 Alrm OP
0xB0CC		Ph A TOC1 Alrm DPO
0xB0D1		Ph B TOC1 Alrm PKP
0xB0D2		Ph B TOC1 Alrm OP
0xB0D4		Ph B TOC1 Alrm DPO
0xB0E1		Ph C TOC1 Alrm PKP
0xB0E2		Ph C TOC1 Alrm OP
0xB0E4		Ph C TOC1 Alrm DPO
0xB101		Ntrl TOC1 Alrm PKP
0xB102		Ntrl TOC1 Alrm OP
0xB104		Ntrl TOC1 Alrm DPO
0xB141		Gnd TOC1 Alarm PKP
0xB142		Gnd TOC1 Alarm OP
0xB144		Gnd TOC1 Alarm DPO
0xB181		Ph IOC2 Alarm PKP
0xB182		Ph IOC2 Alarm OP
0xB184		Ph IOC2 Alarm DPO
0xB189		Ph A IOC2 Alrm PKP
0xB18A		Ph A IOC2 Alrm OP
0xB18C		Ph A IOC2 Alrm DPO
0xB191		Ph B IOC2 Alrm PKP
0xB192		Ph B IOC2 Alrm OP
0xB194		Ph B IOC2 Alrm DPO
0xB1A1		Ph C IOC2 Alrm PKP
0xB1A2		Ph C IOC2 Alrm OP
0xB1A4		Ph C IOC2 Alrm DPO
0xB1C1		Ntrl IOC2 Alrm PKP
0xB1C2		Ntrl IOC2 Alrm OP
0xB1C4		Ntrl IOC2 Alrm DPO
0xB201		Gnd IOC2 Alarm PKP
0xB202		Gnd IOC2 Alarm OP
0xB204		Gnd IOC2 Alarm DPO
0xB301		SGnd TOC1 Alrm PKP
0xB302		SGnd TOC1 Alrm OP

Code	Type	Definition
0xB304		SGnd TOC1 Alrm DPO
0xB342		NtrlDir RevAlm OP
0xB344		NtrlDir RevAlmDPO
0xB382		GndDir RevAlm OP
0xB384		GndDir RevAlm DPO
0xB3C1		NegSeq OV Alrm PKP
0xB3C2		NegSeq OV Alrm OP
0xB3C4		NegSeq OV Alrm DPO
0xB401		Ntrl OV Alrm PKP
0xB402		Ntrl OV Alrm OP
0xB404		Ntrl OV Alrm DPO
0xB441		Ph OV1 Alarm PKP
0xB442		Ph OV1 Alarm OP
0xB444		Ph OV1 Alarm DPO
0xB449		Ph A OV1 Alarm PKP
0xB44A		Ph A OV1 Alarm OP
0xB44C		Ph A OV1 Alarm DPO
0xB451		Ph B OV1 Alarm PKP
0xB452		Ph B OV1 Alarm OP
0xB454		Ph B OV1 Alarm DPO
0xB461		Ph C OV1 Alarm PKP
0xB462		Ph C OV1 Alarm OP
0xB464		Ph C OV1 Alarm DPO
0xB481		Ph UV1 Alarm PKP
0xB482		Ph UV1 Alarm OP
0xB484		Ph UV1 Alarm DPO
0xB489		Ph A UV1 Alarm PKP
0xB48A		Ph A UV1 Alarm OP
0xB48C		Ph A UV1 Alarm DPO
0xB491		Ph B UV1 Alarm PKP
0xB492		Ph B UV1 Alarm OP
0xB494		Ph B UV1 Alarm DPO
0xB4A1		Ph C UV1 Alarm PKP
0xB4A2		Ph C UV1 Alarm OP
0xB4A4		Ph C UV1 Alarm DPO
0xB4C1		Aux OV Alarm PKP
0xB4C2		Aux OV Alarm OP
0xB4C4		Aux OV Alarm DPO
0xB501		Aux UV Alarm PKP
0xB502		Aux UV Alarm OP
0xB504		Aux UV Alarm DPO
0xB541		UndrFreq1 Alrm PKP
0xB542		UndrFreq1 Alrm OP
0xB544		UndrFreq1 Alrm DPO
0xB581		UndrFreq2 Alrm PKP
0xB582		UndrFreq2 Alrm OP
0xB584		UndrFreq2 Alrm DPO

Code	Type	Definition
0xB5C1		OverFreq1 Alrm PKP
0xB5C2		OverFreq1 Alrm OP
0xB5C4		OverFreq1 Alrm DPO
0xB601		OverFreq2 Alrm PKP
0xB602		OverFreq2 Alrm OP
0xB604		OverFreq2 Alrm DPO
0xB641		SGnd IOC1 Alrm PKP
0xB642		SGnd IOC1 Alrm OP
0xB644		SGnd IOC1 Alrm DPO
0xB681		SGnd IOC2 Alrm PKP
0xB682		SGnd IOC2 Alrm OP
0xB684		SGnd IOC2 Alrm DPO
0xB6C1		NSeq IOC Alrm PKP
0xB6C2		NSeq IOC Alrm OP
0xB6C4		NSeq IOC Alrm DPO
0xB889		Ph A OV2 Alarm PKP
0xBC01		LE 9 Alarm PKP
0xBC02		LE 9 Alarm OP
0xBC04		LE 9 Alarm DPO
0xBC41		LE 10 Alarm PKP
0xBC42		LE 10 Alarm OP
0xBC44		LE 10 Alarm DPO
0xBC81		LE 11 Alarm PKP
0xBC82		LE 11 Alarm OP
0xBC84		LE 11 Alarm DPO
0xBCC1		LE 12 Alarm PKP
0xBCC2		LE 12 Alarm OP
0xBCC4		LE 12 Alarm DPO
0xBD01		LE 13 Alarm PKP
0xBD02		LE 13 Alarm OP
0xBD04		LE 13 Alarm DPO
0xBD41		LE 14 Alarm PKP
0xBD42		LE 14 Alarm OP
0xBD44		LE 14 Alarm DPO
0xBD81		LE 15 Alarm PKP
0xBD82		LE 15 Alarm OP
0xBD84		LE 15 Alarm DPO
0xBDC1		LE 16 Alarm PKP
0xBDC2		LE 16 Alarm OP
0xBDC4		LE 16 Alarm DPO
0xBE01		PhDir RevAlm PKP
0xBE02		PhDir RevAlm OP
0xBE04		PhDir RevAlm DPO
0xBE09		PhADir RevAlm PKP
0xBE0A		PhADir RevAlm OP
0xBE0C		PhADir RevAlm DPO
0xBE11		PhBDir RevAlm PKP

Code	Type	Definition
0xBE12		PhBDir RevAlm OP
0xBE14		PhBDir RevAlm DPO
0xBE21		PhCDir RevAlm PKP
0xBE22		PhCDir RevAlm OP
0xBE24		PhCDir RevAlm DPO
0xBE41		PhDir UndAlm PKP
0xBE42		PhDir UndAlm OP
0xBE44		PhDir UndAlm DPO
0xBE49		PhADir UndAlm PKP
0xBE4A		PhADir UndAlm OP
0xBE4C		PhADir UndAlm DPO
0xBE51		PhBDir UndAlm PKP
0xBE52		PhBDir UndAlm OP
0xBE54		PhBDir UndAlm DPO
0xBE61		PhCDir UndAlm PKP
0xBE62		PhCDir UndAlm OP
0xBE64		PhCDir UndAlm DPO
0xBE81		GndDir UndAlm PKP
0xBE82		GndDir UndAlm OP
0xBE84		GndDir UndAlm DPO
0xBEC1		NtrlDir UndAlm PKP
0xBEC2		NtrlDir UndAlm OP
0xBEC4		NtrlDir UndAlm DPO
0xC042		Output Relay 3 On
0xC082		Output Relay 4 On
0xC0C2		Output Relay 5 On
0xC102		Output Relay 6 On
0xC142		Self-Test Rly 7 On
0xC182		Output Relay 1 On
0xC184		Output Relay 1 Off
0xC1C2		Output Relay 2 On
0xC1C4		Output Relay 2 Off
0xC202		BKR Connected
0xC4C1		LE 1 PKP
0xC4C2		LE 1 OP
0xC4C4		LE 1 DPO
0xC501		LE 2 PKP
0xC502		LE 2 OP
0xC504		LE 2 DPO
0xC541		LE 3 PKP
0xC542		LE 3 OP
0xC544		LE 3 DPO
0xC581		LE 4 PKP
0xC582		LE 4 OP
0xC584		LE 4 DPO
0xC5C1		LE 5 PKP
0xC5C2		LE 5 OP

Code	Type	Definition
0xC5C4		LE 5 DPO
0xC601		LE 6 PKP
0xC602		LE 6 OP
0xC604		LE 6 DPO
0xC641		LE 7 PKP
0xC642		LE 7 OP
0xC644		LE 7 DPO
0xC681		LE 8 PKP
0xC682		LE 8 OP
0xC684		LE 8 DPO
0xC882		Setpoint Group2 On
0xC902		Open Breaker
0xC942		Close Breaker
0xC982		Maint. Req. OP
0xCA02		52a Contact OP
0xCA42		52b Contact OP
0xCA44		52b Contact DPO
0xCA82		Reset OK
0xCB01		AR Close PKP
0xCB02		AR Close
0xCB04		AR Close DPO
0xCB42		AR N/Ready
0xCB44		AR N/Ready DPO
0xCB82		AR In Progress
0xCBC2		AR Disabled
0xCC02		AR Ext. Init
0xCC42		AR Ready
0xCCC2		BKR Stat Open
0xCD02		BKR Stat Clsd
0xCD42		Setpoint Group1 On
0xCE41		CLP PKP
0xCE42		CLP Op
0xCE44		CLP DPO
0xCF81		Fuse Fail InhibPKP
0xCF82		Fuse Fail Inhib OP
0xD041		Ntrl IOC1 PKP
0xD042		Ntrl IOC1 OP
0xD044		Ntrl IOC1 DPO
0xD081		Gnd IOC1 PKP
0xD082		Gnd IOC1 OP
0xD084		Gnd IOC1 DPO
0xD0C1		Ph TOC1 PKP
0xD0C2		Ph TOC1 OP
0xD0C4		Ph TOC1 DPO
0xD101		Ntrl TOC1 PKP
0xD102		Ntrl TOC1 OP
0xD104		Ntrl TOC1 DPO

Code	Type	Definition
0xD141		Gnd TOC1 PKP
0xD142		Gnd TOC1 OP
0xD144		Gnd TOC1 DPO
0xD181		Ph IOC2 PKP
0xD184		Ph IOC2 DPO
0xD1C1		Ntrl IOC2 PKP
0xD1C2		Ntrl IOC2 OP
0xD1C4		Ntrl IOC2 DPO
0xD201		Gnd IOC2 PKP
0xD202		Gnd IOC2 OP
0xD204		Gnd IOC2 DPO
0xD342		Ntrl Dir Rev OP
0xD344		Ntrl Dir Rev DPO
0xD382		Gnd Dir Rev OP
0xD384		Gnd Dir Rev DPO
0xD3C1		NegSeq OV PKP
0xD3C2		NegSeq OV OP
0xD3C4		NegSeq OV DPO
0xD401		Ntrl OV PKP
0xD402		Ntrl OV OP
0xD404		Ntrl OV DPO
0xD441		Ph OV1 PKP
0xD442		Ph OV1 OP
0xD444		Ph OV1 DPO
0xD481		Ph UV1 PKP
0xD482		Ph UV1 OP
0xD484		Ph UV1 DPO
0xD801		NSeq TOC1 PKP
0xD802		NSeq TOC1 OP
0xD804		NSeq TOC1 DPO
0xDC01		LE 9 PKP
0xDC02		LE 9 OP
0xDC04		LE 9 DPO
0xDC41		LE 10 PKP
0xDC42		LE 10 OP
0xDC44		LE 10 DPO
0xDC81		LE 11 PKP
0xDC82		LE 11 OP
0xDC84		LE 11 DPO
0xDCC1		LE 12 PKP
0xDCC2		LE 12 OP
0xDCC4		LE 12 DPO
0xDD01		LE 13 PKP
0xDD02		LE 13 OP
0xDD04		LE 13 DPO
0xDD41		LE 14 PKP
0xDD42		LE 14 OP

Code	Type	Definition
0xDD44		LE 14 DPO
0xDD81		LE 15 PKP
0xDD82		LE 15 OP
0xDD84		LE 15 DPO
0xDDC1		LE 16 PKP
0xDDC2		LE 16 OP
0xDDC4		LE 16 DPO
0xDE01		PhDir Rev PKP
0xDE02		PhDir Rev OP
0xDE04		PhDir Rev DPO
0xDE09		PhADir Rev PKP
0xDE0A		PhADir Rev OP
0xDE0C		PhADir Rev DPO
0xDE11		PhBDir Rev PKP
0xDE12		PhBDir Rev OP
0xDE14		PhBDir Rev DPO
0xDE21		PhCDir Rev PKP
0xDE22		PhCDir Rev OP
0xDE24		PhCDir Rev DPO
0xDE41		PhDir Und PKP
0xDE42		PhDir Und OP
0xDE44		PhDir Und DPO
0xDE49		PhADir Und PKP
0xDE4A		PhADir Und OP
0xDE4C		PhADir Und DPO
0xDE51		PhBDir Und PKP
0xDE52		PhBDir Und OP
0xDE54		PhBDir Und DPO
0xDE61		PhCDir Und PKP
0xDE62		PhCDir Und OP
0xDE64		PhCDir Und DPO
0xDE81		GndDir Und PKP
0xDE82		GndDir Und OP
0xDE84		GndDir Und DPO
0xDEC1		NtrlDir Und PKP
0xDEC2		NtrlDir Und OP
0xDEC4		NtrlDir Und DPO
0xE042		Therm O/L Blck OP
0xE044		Therm O/L Blck Off
0xE182		Output Relay 1 BLK
0xE184		Relay 1 BLK Off
0xE1C2		Output Relay 2 BLK
0xE1C4		Relay 2 BLK Off
0xE882		Group Change Blk
0xE884		Grp Change Blk DPO
0xEB02		AR Block
0xEB04		AR Block DPO

Code	Type	Definition
0xEE82		CLP Ph IOC1 BLK
0xEE84		CLP Ph IOC1 BLKDPO
0xEEC2		CLP Ph IOC2 BLK
0xEEC4		CLP Ph IOC2 BLKDPO
0xEF02		CLPNtrlIOC1 BLK
0xEF04		CLPNtrlIOC1 BLKDPO
0xEF42		CLPNtrlIOC2 BLK
0xEF44		CLPNtrlIOC2 BLKDPO
0xEF82		CLP GndIOC1 BLK
0xEF84		CLP GndIOC1 BLKDPO
0xEFC2		CLP GndIOC2 BLK
0xEFC4		CLP GndIOC2 BLKDPO
0xF002		Ph IOC1 Block
0xF004		Ph IOC1 Block DPO
0xF042		Ntrl IOC1 Block
0xF044		Ntrl IOC1 Blk DPO
0xF082		Gnd IOC1 Block
0xF084		Gnd IOC1 Block DPO
0xF0C2		Ph TOC1 Block
0xF0C4		Ph TOC1 Block DPO
0xF102		Ntrl TOC1 Block
0xF104		Ntrl TOC1 BlockDPO
0xF142		Gnd TOC1 Block
0xF144		Gnd TOC1 Block DPO
0xF182		Ph IOC2 Block
0xF184		Ph IOC2 Block DPO
0xF1C2		Ntrl IOC2 Block
0xF1C4		Ntrl IOC2 Blk DPO
0xF202		Gnd IOC2 Block
0xF204		Gnd IOC2 Block DPO
0xF302		SGnd TOC1 Block
0xF304		SGnd TOC1 BlockDPO
0xF342		NTRL DIR Rev Block
0xF344		NTRL DIR Block DPO
0xF382		Gnd Dir Block
0xF384		Gnd Dir Block DPO
0xF3C2		NegSeq OV Block
0xF3C4		NSeq OV Blk DPO
0xF402		Ntrl OV Block
0xF404		Ntrl OV Block DPO
0xF442		Ph OV1 Block
0xF444		Ph OV1 Block DPO
0xF482		Ph UV1 Block
0xF484		Ph UV1 Block DPO
0xF4C2		Aux OV Block
0xF4C4		Aux OV Block DPO
0xF502		Aux UV Block

Code	Type	Definition
0xF504		Aux UV Block DPO
0xF542		UndrFreq1 Block
0xF544		UndrFreq1 BlockDPO
0xF582		UndrFreq2 Block
0xF584		UndrFreq2 BlockDPO
0xF5C2		OverFreq1 Block
0xF5C4		OverFreq1 Blk DPO
0xF602		OverFreq2 Block
0xF604		OverFreq2 BlockDPO
0xF642		SGnd IOC1 Block
0xF644		SGnd IOC1 Blk DPO
0xF682		SGnd IOC2 Block
0xF684		SGnd IOC2 Blk DPO
0xF6C2		NSeq IOC Block
0xF6C4		NSeq IOC Block DPO
0xFE01		PhDir Block PKP
0xFE02		PhDir Block OP
0xFE04		PhDir Block DPO
0xFE41		PhDir Und Blk PKP
0xFE42		PhDir Und Blk OP
0xFE44		PhDir Und Blk DPO
0xFE81		GndDir Und Blk PKP
0xFE82		GndDir Und Blk OP
0xFE84		GndDir Und Blk DPO
0xFEC1		NtrlDir Und Blk PKP
0xFEC2		NtrlDir Und Blk OP
0xFEC4		NtrlDir Und Blk DPO

Transient records

PATH: ACTUAL VALUES > A3 RECORDS > TRANSIENT RECORDS

FORCE TRIGGER?
No

Range: No, Yes

TOTAL RECORDS
1

Range: N/A

AVAILABLE RECORDS
1

Range: N/A

LAST CLEARED
Feb 08 2009

Range: N/A

Clear event record

PATH: ACTUAL VALUES > A3 RECORDS > CLEAR EVENT REC

CLEAR
No

Range: No, Yes

When set to "Yes," pressing the ENTER key will clear all event records.

Clear transient record

PATH: ACTUAL VALUES > A3 RECORDS > CLEAR TRANST REC

CLEAR
No

Range: No, Yes

When set to "Yes," pressing the ENTER key will clear all transient records.

Clear thermal capacity record

PATH: ACTUAL VALUES > A3 RECORDS > CLEAR THERM CAP

CLEAR
No

Range: No, Yes

When set to "Yes," pressing the ENTER key will clear all thermal capacity records.

A4 Target messages

Target messages are automatically displayed for any active condition on the relay such as pickups, trips, alarms, or asserted input. The target messages shown in the table below are displayed as necessary.

The relay displays the most recent event first, and after 5 seconds starts rolling up the other target messages, until the Reset command is initiated. If the Reset command is not performed, but any of the other faceplate pushbuttons is pressed, the display will not show the target messages, unless the user navigates to **ACTUAL VALUES > A4 TARGET MESSAGES**, where they can be reviewed.

The target messages can be reviewed by pressing **Up** and **Down** message pushbuttons from the relay keypad.

The following table, from the *350 Communications Guide*, shows the list of Active Targets.

Code	Type	Definition
FC134A	unsigned 16 bits	Active Targets
0		No Active Targets
7		Clock Not Set
8		IRIG-B Failure
14		Comm. Alert 1
15		Comm. Alert 2
16		Comm. Alert 3
17		Ethernet Link Fail
18		High ENET Traffic
19		Ambient Temp. >80C
0x8040		Therm O/L Trip
0x8480		Relay Not Config
0x84C0		LE 1 Trip
0x8500		LE 2 Trip
0x8540		LE 3 Trip
0x8580		LE 4 Trip
0x85C0		LE 5 Trip
0x8600		LE 6 Trip
0x8640		LE 7 Trip
0x8680		LE 8 Trip
0x8F80		Fuse Fail Trip
0x9000		Ph IOC1 Trip
0x9040		Ntrl IOC1 Trip
0x9080		Gnd IOC1 Trip
0x90C0		Ph TOC1 Trip
0x9100		Ntrl TOC1 Trip
0x9140		Gnd TOC1 Trip
0x9180		Ph IOC2 Trip
0x91C0		Ntrl IOC2 Trip
0x9200		Gnd IOC2 Trip
0x9240		Ph TOC2 Trip
0x9280		Ntrl TOC2 Trip

Code	Type	Definition
0x92C0		Gnd TOC2 Trip
0x9300		SGnd TOC1 Trip
0x93C0		NegSeq OV Trip
0x9400		Ntrl OV Trip
0x9440		Ph OV1 Trip
0x9480		Ph UV1 Trip
0x94C0		Aux OV Trip
0x9500		Aux UV Trip
0x9540		UndrFreq1 Trip
0x9580		UndrFreq2 Trip
0x95C0		OverFreq1 Trip
0x9600		OverFreq2 Trip
0x9640		SGnd IOC1 Trip
0x9680		SGnd IOC2 Trip
0x96C0		NegSeq IOC Trip
0x9800		NSeq TOC1 Trip
0x9840		NSeq TOC2 Trip
0x99C0		SGnd TOC2 Trip
0x9C00		LE 9 Trip
0x9C40		LE 10 Trip
0x9C80		LE 11 Trip
0x9CC0		LE 12 Trip
0x9D00		LE 13 Trip
0x9D40		LE 14 Trip
0x9D80		LE 15 Trip
0x9DC0		LE 16 Trip
0xA040		Therm Lvl Alrm
0xA480		Not Configured
0xA4C0		LE 1 Alarm
0xA500		LE 2 Alarm
0xA540		LE 3 Alarm
0xA580		LE 4 Alarm
0xA5C0		LE 5 Alarm
0xA600		LE 6 Alarm
0xA640		LE 7 Alarm
0xA680		LE 8 Alarm
0xABC0		HI Ambient Temp
0xAC00		LO Ambient Temp
0xAC40		Self Test Alarm
0xACC0		BKRTrpCntrAlrm
0xAD00		Rly1 Coil Mn Alrm
0xAD40		Rly2 Coil Mn Alrm
0xAD80		BKR Fail Alrm
0xADC0		BKRStatus Fail
0xAE40		CLP Alarm
0xAF80		Fuse Fail Alrm
0xB000		Ph IOC1 Alarm

Code	Type	Definition
0xB040		Ntrl IOC1 Alarm
0xB080		Gnd IOC1 Alarm
0xB0C0		Ph TOC1 Alarm
0xB100		Ntrl TOC1 Alrm
0xB140		Gnd TOC1 Alarm
0xB180		Ph IOC2 Alarm
0xB1C0		Ntrl IOC2 Alarm
0xB200		Gnd IOC2 Alarm
0xB240		Ph TOC2 Alarm
0xB280		Ntrl TOC2 Alrm
0xB2C0		Gnd TOC2 Alarm
0xB300		SGnd TOC1 Alarm
0xB340		NtrlDir RevAlm
0xB3C0		NegSeq OV Alarm
0xB400		Ntrl OV Alarm
0xB440		Ph OV1 Alarm
0xB480		Ph UV1 Alarm
0xB4C0		Aux OV Alarm
0xB500		Aux UV Alarm
0xB540		UndrFreq1 Alarm
0xB580		UndrFreq2 Alarm
0xB5C0		OverFreq1 Alrm
0xB600		OverFreq2 Alrm
0xB640		SGnd IOC1 Alarm
0xB680		SGnd IOC2 Alarm
0xB6C0		NegSeq IOC Alrm
0xB800		NSeq TOC1 Alarm
0xB840		NSeq TOC2 Alarm
0xB9C0		SGnd TOC2 Alarm
0xBC00		LE 9 Alarm
0xBC40		LE 10 Alarm
0xBC80		LE 11 Alarm
0xBCC0		LE 12 Alarm
0xBD00		LE 13 Alarm
0xBD40		LE 14 Alarm
0xBD80		LE 15 Alarm
0xBDC0		LE 16 Alarm
0xBE00		PhDir RevAlm
0xBE40		PhDir UndAlm
0xBE80		GndDir UndAlm
0xBEC0		NtrlDir UndAlm
0xC4C0		LE 1
0xC500		LE 2
0xC540		LE 3
0xC580		LE 4
0xC5C0		LE 5
0xC600		LE 6

Code	Type	Definition
0xC640		LE 7
0xC680		LE 8
0xC880		Setpoint Group2
0xC900		Open Breaker
0xC940		Close Breaker
0xC980		Maint Required
0xCA00		52a Contact
0xCA40		52b Contact
0xCA80		Reset OK
0xCB00		AR Close
0xCB40		AR N/Ready
0xCB80		AR In Progress
0xCBC0		AR Disabled
0xCC00		AR Ext. Init
0xCC40		AR Ready
0xCCC0		BKR Stat Open
0xCD00		BKR Stat Clsd
0xCD40		Setpoint Group1
0xCE40		CLP Op
0xCF80		Fuse Fail Inhib
0xD340		Ntrl Dir Rev
0xD380		Gnd Dir
0xD440		Ph OV1
0xD480		Ph UV1
0xDC00		LE 9
0xDC40		LE 10
0xDC80		LE 11
0xDCC0		LE 12
0xDD00		LE 13
0xDD40		LE 14
0xDD80		LE 15
0xDDC0		LE 16
0xDE00		PhDir Rev
0xDE40		PhDir Und
0xDE80		GndDir Und
0xDEC0		NtrlDir Und
0xE040		Therm O/L Blck
0xE180		Output Relay 1 BLK
0xE1C0		Output Relay 2 BLK
0xE880		Group Change Blk
0xEB00		AR Block
0xEE80		CLP Ph IOC1 BLK
0xEEC0		CLP Ph IOC2 BLK
0xEF00		CLPNtrlIOC1 BLK
0xEF40		CLPNtrlIOC2 BLK
0xEF80		CLP GndIOC1 BLK
0xEFC0		CLP GndIOC2 BLK

Code	Type	Definition
0xF000		Ph IOC1 Block
0xF040		Ntrl IOC1 Block
0xF080		Gnd IOC1 Block
0xF0C0		Ph TOC1 Block
0xF100		Ntrl TOC1 Block
0xF140		Gnd TOC1 Block
0xF180		Ph IOC2 Block
0xF1C0		Ntrl IOC2 Block
0xF200		Gnd IOC2 Block
0xF240		Ph TOC2 Block
0xF280		Ntrl TOC2 Block
0xF2C0		Gnd TOC2 Block
0xF300		SGnd TOC1 Block
0xF340		NTRL DIR Rev Block
0xF380		Gnd Dir Block
0xF3C0		NegSeq OV Block
0xF400		Ntrl OV Block
0xF440		Ph OV1 Block
0xF480		Ph UV1 Block
0xF4C0		Aux OV Block
0xF500		Aux UV Block
0xF540		UndrFreq1 Block
0xF580		UndrFreq2 Block
0xF5C0		OverFreq1 Block
0xF600		OverFreq2 Block
0xF640		SGnd IOC1 Block
0xF680		SGnd IOC2 Block
0xF6C0		NegSeq IOC Block
0xF800		NSeq TOC1 Block
0xF840		NSeq TOC2 Block
0xF9C0		SGnd TOC2 Block
0xFE00		PhDir Block
0xFE40		PhDir Und Block
0xFE80		GndDir Und Block
0xFEC0		NtrlDir Und Block

- The PKP messages will appear on the relay display as long as their respective flags are active. The messages will disappear from the display, when either the protection element drops out before operation, such as when the condition clears before reaching operation, or when the protection element operates.
- The OP and BKR Status messages will appear on the relay display, when the respective element operates, with the element function set to “TRIP”, or “LATCHED ALARM”. The message will stay on the display after the condition clears, and will disappear upon Reset command. If the element function is selected to “ALARM”, or “CONTROL”, the message will disappear from the display, when the condition causing operation clears.
- The Breaker Open and Breaker Close messages will appear on the display and stay for 5 seconds only, unless the reset command is initiated, or the element changes its state. For example, if the breaker is detected “Open”, the message “Breaker Open OK”

will appear on the display and will stay for 5 seconds, unless the breaker status changes to “Close”. If the breaker status changes to "Close" within 5 seconds after the breaker has been detected open, the message “Breaker Open OK” will disappear, and the message “Breaker Close OK” will appear and stay for 5 seconds.

- The Contact Input ON/OFF, Virtual Input ON/OFF, and Remote Input ON/OFF messages will not appear as target messages upon change of state. The state change, however, will be logged in the Event recorder.

Autoreclose target messages

AR Ready	Appears on the display when the AR is Ready, i.e. breaker closed, AR function enabled, and no AR initiation.	The message appears on the display for 5 seconds, when the AR is detected Ready.
AR IN-PROGRESS	Appears on the display when the AR is in progress	Self-Reset message
AR LOCKOUT	Appears on the display when the AR is in lockout mode	Latched message. The message disappears upon Reset command

Examples of how the messages appear on the display:

Example 1:

Phase IOC1 Settings:

- PH IOC1 FUNCTION = Trip
- PH IOC1 PICKUP = 1.00 x CT
- PH IOC1 DELAY = 0.20 s

When current greater than the IOC1 pickup level is applied, the 3350 50 display shows the following target message:

A4 TARGET MESSAGES
Ph IOC1 Trip
STATE: PKP

After the 200 ms time delay expires, the display shows the following message only:

A4 TARGET MESSAGES
Ph IOC1 Trip
STATE: OP

Example 2:

Phase IOC1 Settings:

- PH IOC1 FUNCTION = Latched Alarm
- PH IOC1 PICKUP = 1.00 x CT
- PH IOC1 DELAY = 0.20 s

When current greater than the IOC1 pickup level is applied, the 350 display shows the following target message:

A4 TARGET MESSAGES
Ph IOC1 Alarm
STATE: PKP

After the 200 ms time delay expires, the display shows the following message only:

A4 TARGET MESSAGES
Ph IOC1 Alarm
STATE: OP

Example 3:

Phase IOC1 Settings:

- PH IOC1 FUNCTION = Alarm
- PH IOC1 PICKUP = 1.00 x CT

- PH IOC1 DELAY = 0.20 s

When current greater than the IOC1 pickup level is applied, the 350 display shows the following target message:

A4 TARGET MESSAGES
Ph IOC1 Alarm
STATE: PKP

After the 200 ms time delay expires, the display shows the following message only:

A4 TARGET MESSAGES
Ph IOC1 Alarm
STATE: OP

NOTE

Once the condition clears, the target message will disappear.

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Chapter 5: Quick setup - Front control panel

The “Quick Setup” utility is part of the 350 relay main menu, and can be used for quick and easy programming. Power system parameters, and settings for some simple over-current elements can be easily set. Use the “Quick Setup” utility to program the following:

Power System Data:

- Phase CT Primary
- Ground CT Primary
- VT Secondary voltage
- Aux VT Secondary Voltage
- Aux VT Ratio

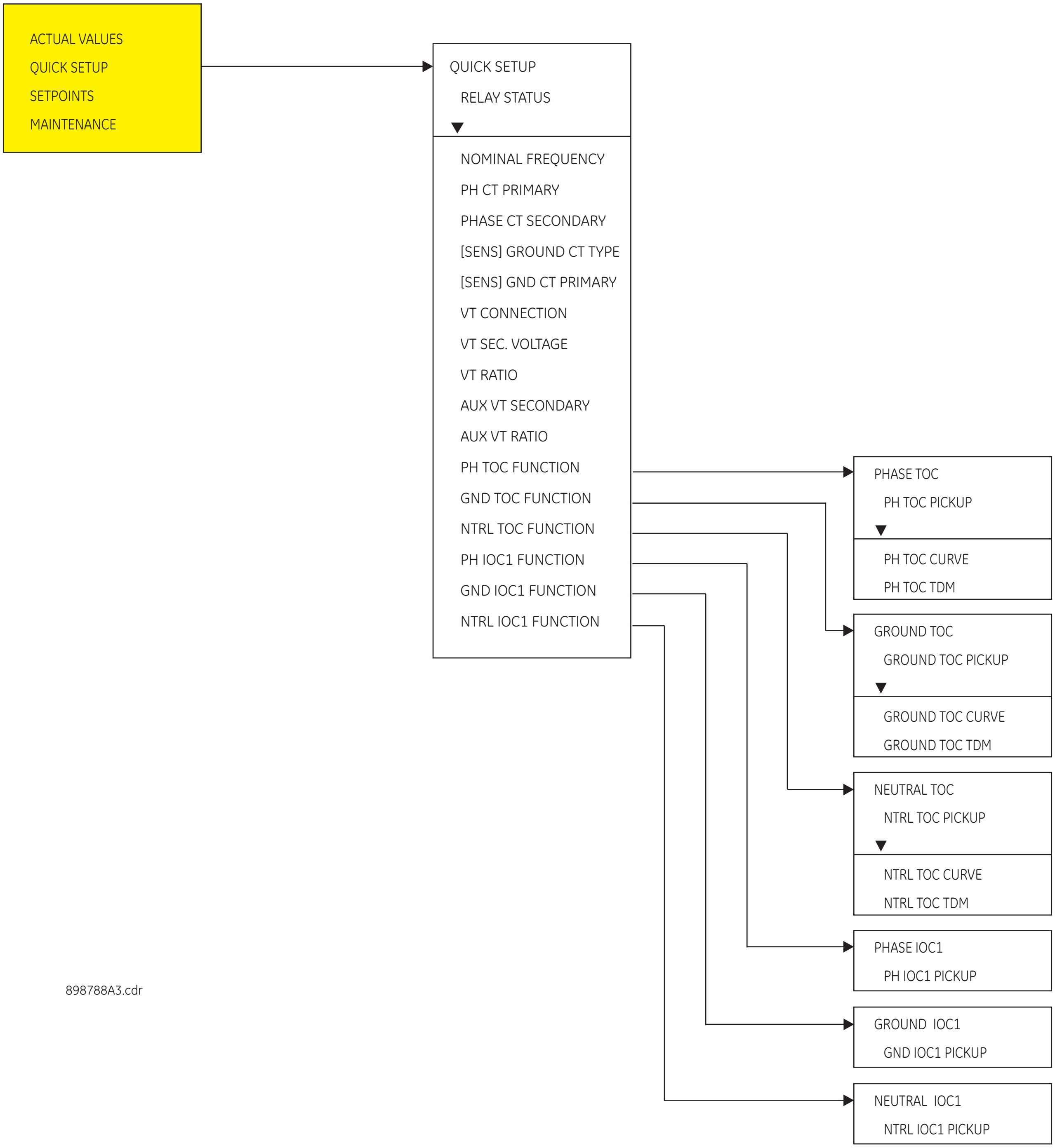
Overcurrent Protection:

- Phase TOC
- Ground TOC
- Neutral TOC
- Phase IOC
- Ground IOC
- Neutral IOC

NOTE

Ensure the relay is in "Relay Ready" state before using Quick Setup.

Figure 1: Quick Setup menu



Quick Setup settings

The setpoints below can be programmed under the "Quick Setup" menu.

Note that monitoring of Breaker Status via 52a, 52b, or both of these contacts,, should be programmed under **SETPOINTS > SYSTEM SETUP > BREAKER**.

PATH: **QUICK SETUP >**

PH CT PRIMARY

Range: 1 A to 6000 A in steps of 1
Default: 500 A

GND CT PRIMARY

Range: 1 A to 6000 A in steps of 1
Default: 50 A

VT CONNECTION

Range: Wye, Delta
Default: Wye

VT SEC VOLTAGE

Range: 50 V to 240 V in steps of 1
Default: 120 V

VT RATIO

Range: 1:1 to 1500:1 in steps of 1
Default: 1:1

AUX VT SECONDARY

Range: 50 V to 240 V in steps of 1
Default: 110 V

AUX VT RATIO

Range: 1:1 to 1500:1 in steps of 1
Default: 1:1

PH TOC FUNCTION

Range: Trip, Disabled, Latched Alarm, Alarm
Default: Trip

PH TOC PICKUP

Range: 0.04 to 20.00 x CT
Default: 1.00 x CT

PH TOC CURVE

Range: ANSI Extremely/Very/Moderately/Normally Inverse, Definite Time, IEC Curve A/B/C and Short, IAC Extreme/Very/Inverse/Short, User Curve, FlexCurve™ A/B (programmable curves)
Default: Extremely Inverse

PH TOC TDM

Range: 0.05 to 50.00
Default: 1.00

GND TOC FUNCTION

Range: Disabled, Trip, Latched Alarm, Alarm
Default: Disabled

GND TOC PICKUP
Range: 0.04 to 20 x CT
Default: 1.00 x CT

GND TOC CURVE
Range: ANSI Extremely/Very/Moderately/Normally Inverse; Definite Time; IEC Curve A/B/C /Short Inverse; IAC Extreme/Very/Inverse/Short Inverse; User Curve, FlexCurve™ A/B (programmable curves)
Default: Extremely Inverse

GND TOC TDM
Range: 0.05 to 50.00
Default: 1.00

SENS GND TOC FUNCTION [WHEN SPECIFICALLY ORDERED]
Range: Disabled, Trip, Latched Alarm, Alarm
Default: Disabled

SENS GND TOC PICKUP
Range: 0.005 to 3.000 x CT
Default: 1.000 x CT

SENS GND TOC CURVE
Range: ANSI Extremely/Very/Moderately/Normally Inverse; Definite Time; IEC Curve A/B/C /Short Inverse; IAC Extreme/Very/Inverse/Short Inverse; User Curve, FlexCurve™ A/B (programmable curves)
Default: Extremely Inverse

SENS GND TOC TDM
Range: 0.05 to 50.00
Default: 1.0

NTRL TOC FUNCTION
Range: Disabled, Trip, Latched Alarm, Alarm
Default: Disabled

NTRL TOC PICKUP
Range: 0.04 to 20.00 x CT
Default: 1.00 x CT

NTRL TOC CURVE
Range: ANSI Extremely/Very/Moderately/Normally Inverse, Definite Time, IEC Curve A/B/C and Short, IAC Extreme/Very/Inverse/Short, User Curve, FlexCurve™ A/B (programmable curves)
Default: Extremely Inverse

NTRL TOC TDM
Range: 0.05 to 50.00
Default: 1.00

PH IOC1 FUNCTION
Range: Disabled, Trip, Latched Alarm, Alarm
Default: Disabled

PH IOC1 PICKUP

Range: 0.05 to 20.00 x CT

Default: 1.00 x CT

GND IOC1 FUNCTION

Range: Disabled, Trip, Latched Alarm, Alarm

Default: Disabled

GND IOC1 PICKUP

Range: 0.05 to 20.00 x CT

Default: 1.00 x CT

SENS GND IOC1 FUNCTION [WHEN SPECIFICALLY ORDERED]

Range: Disabled, Trip, Latched Alarm, Alarm

Default: Disabled

SENS GND IOC1 PICKUP

Range: 0.005 to 3.000 x CT

Default: 1.000 x CT

NTRL IOC1 FUNCTION

Range: Disabled, Trip, Latched Alarm, Alarm

Default: Disabled

NTRL IOC1 PICKUP

Range: 0.05 to 20.00 x CT

Default: 1.00 x CT

NOTE

The settings changed using the Quick Setup menu, are available for review and modification by navigating through **S2 SYSTEM SETUP** and **S3 PROTECTION > SETPOINT GROUP 1** in the **SETPOINTS** main menu.

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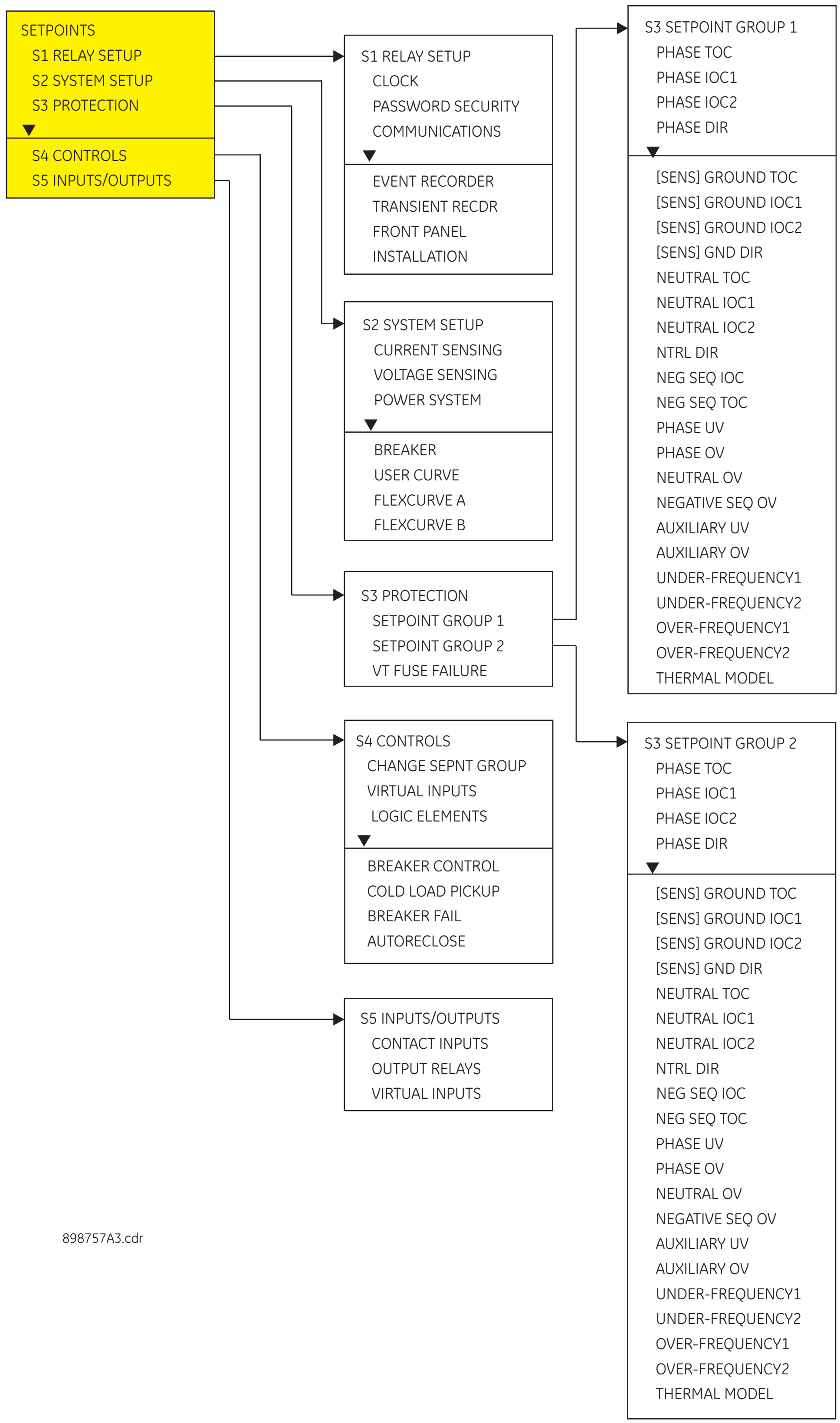
Chapter 6: Setpoints

Setpoints Main Menu

The 350 has a considerable number of programmable setpoints, all of which make the relay extremely flexible. These setpoints have been grouped into a variety of pages and subpages as shown below. Each setpoints menu has a section that describes in detail the setpoints found on that menu.

Figure 1: Main Setpoints menu



Setpoint entry methods

Before placing the relay into "**IN SERVICE**" mode, setpoints defining system characteristics, inputs, relay outputs, and protection settings must be entered using one of the following methods:

- Front panel, using the keypad and the display.
- Front USB port, or rear RS485, Ethernet 100 FX, Ethernet 10/100 BaseT (optional) port, and a computer running the EnerVista SR3 Setup software supplied with the relay.
- Rear serial RS485, and a SCADA system running user-written software.

Any of these methods can be used to enter the same information. A computer, however, makes entry much easier. Files can be stored and downloaded for fast, error free entry when a computer is used. To facilitate this process, the GE EnerVista CD with the EnerVista SR3 Setup software is supplied with the relay.

The relay leaves the factory with setpoints programmed to default values, and these values are shown throughout the setpoint message illustrations. Some of these factory default values can be left unchanged whenever they satisfy the application.

At a minimum, the **S2 SYSTEM SETUP** setpoints must be entered for the system to function correctly. To safeguard against the installation of a relay into which setpoints have not been entered, the **Relay Not Ready** self-test warning is displayed. In addition, the critical failure relay will be de-energized. Once the relay has been programmed for the intended application, the **S1 RELAY SETUP/ INSTALLATION/ RELAY STATUS** setpoint should be changed from "**Not Ready**" (the default) to "**Ready**".

Common setpoints

To make the application of this device as simple as possible, similar methods of operation and similar types of setpoints are incorporated in various features. Rather than repeat operation descriptions for this class of setpoint throughout the manual, a general description is presented in this overview. Details that are specific to a particular feature are included in the discussion of the feature. The form and nature of these setpoints is described below.

- **FUNCTION setpoint**: The **<ELEMENT_NAME> FUNCTION** setpoint determines the operational characteristic of each feature. The range for these setpoints is two or more of: "Disabled", "Enabled", "Trip", "Alarm", "Latched Alarm", and "Control".

  If **<ELEMENT_NAME > FUNCTION**: "Disabled", the feature is not operational.

  If **<ELEMENT_NAME > FUNCTION**: "Enabled", the feature is operational.

  If **<ELEMENT_NAME > FUNCTION**: "Trip", then the feature is operational. When an output is generated, the feature declares a Trip condition, and operates the Trip relay (output relay 1), any other selected aux. output relays, and displays the appropriate trip message.

  If **<ELEMENT_NAME> FUNCTION**: "Alarm" or "Latched Alarm", then the feature is operational. When an output is generated, the feature declares an "Alarm" condition which operates any selected aux.output relays and displays the appropriate alarm message.

  If **<ELEMENT_NAME> FUNCTION**: "Control" the feature is operational. When an output is generated, the feature operates any selected output relays. The "Trip", "Alarm", and "Control" function setpoint values are also used to select those operations that will be stored in the Event Recorder.
- **RELAYS (3–6) setpoint**: The **<ELEMENT_NAME> RELAYS (3-6)** setpoint selects the relays required to operate when the feature generates an output. The range is any combination of the Auxiliary relays (Auxiliary Relays 3 to 6).
- **PICKUP setpoint**: The **<ELEMENT_NAME> PICKUP** setpoint selects the threshold above which the measured parameter causes an output from the measuring element.

- **DELAY setpoint**: The **<ELEMENT_NAME> DELAY** setpoint selects a fixed time interval to delay an input signal from appearing at the output. The time from a contact input change of state or an AC parameter input level change to a contact closure of the 1 Trip relay, is the time selected as time delay in this setpoint plus approximately up to 2 power frequency periods.
- **DIRECTION setpoint**: The **<ELEMENT_NAME> DIRECTION** setpoint is available for overcurrent features which are subject to control from a directional element. The range is “Disabled”, “Forward”, and “Reverse”. If set to “Disabled”, the element is allowed to operate for current flow in any direction. There is no supervision from the directional element. If set to “Forward”, the element is allowed to operate for current flow in the forward direction only, as determined by the directional element. If set to “Reverse”, the element is allowed to operate for current flow in the reverse direction only, as determined by the directional element.

Logic diagrams

The logic diagrams provide a complete comprehensive understanding of the operation of each feature. These sequential logic diagrams illustrate how each setpoint, input parameter, and internal logic is used in the feature to obtain an output. In addition to these logic diagrams, written descriptions are provided in the setpoints chapter which includes each feature.

- **Setpoints**: Shown as a block with a heading labeled ‘**SETPOINT**’. The exact wording of the displayed setpoint message identifies the setpoint. Major functional setpoint selections are listed below the name and are incorporated in the logic.
- **Compensator Blocks**: Shown as a block with an inset box labeled ‘**RUN**’ with the associated pickup/dropout setpoint shown directly above. Element operation of the detector is controlled by the signal entering the ‘RUN’ inset. The measurement/ comparison can only be performed if a logic ‘1’ is provided at the ‘**RUN**’ input. The relationship between setpoint and input parameter is indicated by the following symbols: “**<**” (less than) " **>**” (greater than), etc.
- **Time Delays**: Shown as a block with either pickup, drop-out, or both; times in milliseconds or seconds. If the delay is adjustable, associated delay setpoint is shown with block **SETPOINT** on the top of the delay block.
- **LED Indicators**: Shown as the following schematic symbol, . The exact wording of the front panel label identifies the indicator.
- **Logic**: Described with basic logic gates (**AND, OR, XOR, NAND, NOR**). The inverter (**logical NOT**), is shown as a circle: .

Setting text abbreviations

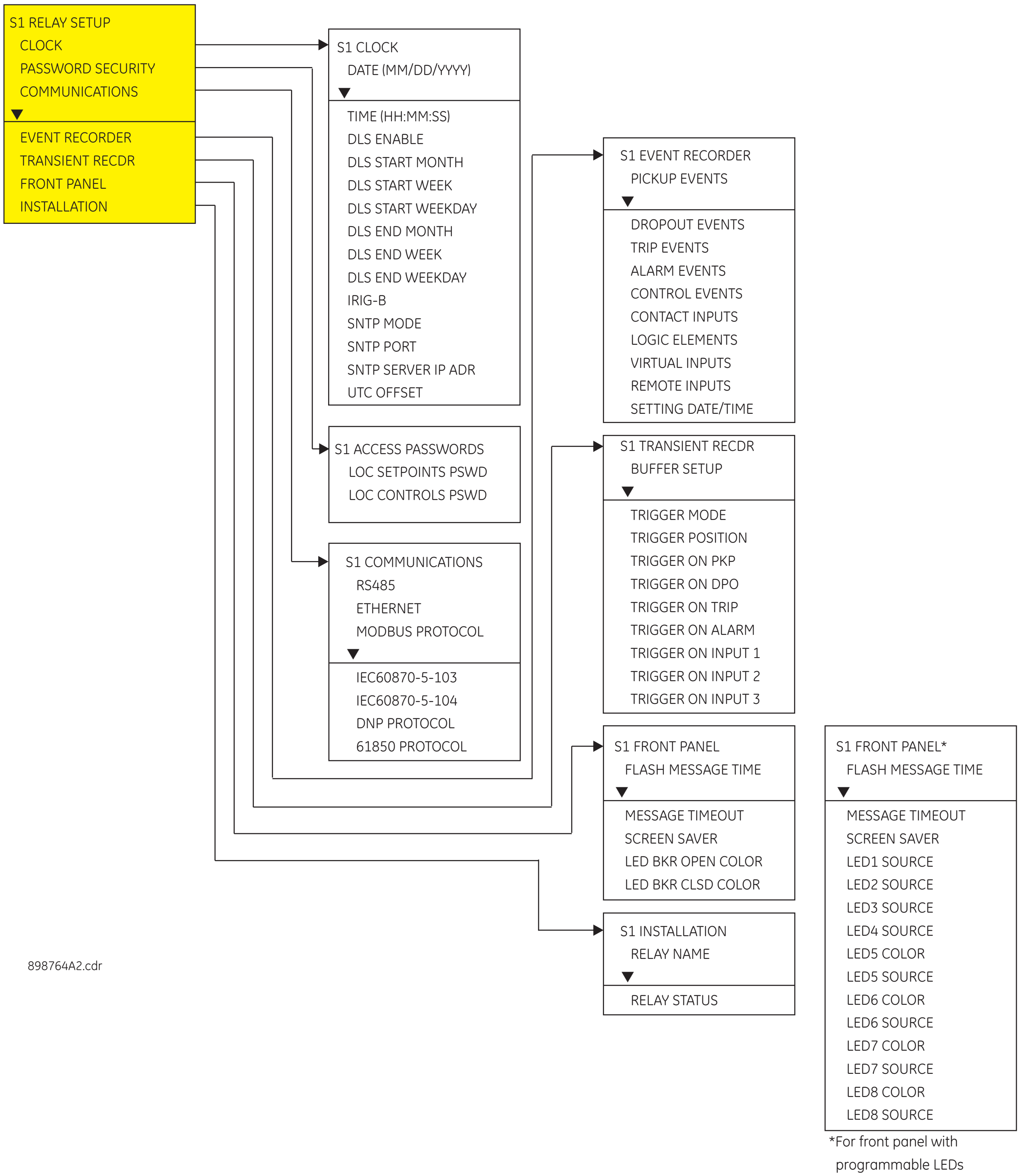
The following abbreviations are used in the setpoints pages.

- A: amperes
- kA: kiloamperes
- V: volts
- kV: kilovolts
- kW: kilowatts
- kVar: kilovars
- kVA: kilo-volt-amperes
- AUX: auxiliary
- COM, Comms: communications
- CT: current transformer

- GND: ground
- Hz: Hertz
- MAX: maximum
- MIN: minimum
- SEC, s: seconds
- UV: undervoltage
- OV: overvoltage
- VT: voltage transformer
- Ctrl: control
- Hr & hr: hour
- O/L: overload

S1 Relay setup

Figure 2: Relay Setup menu



Clock

The 350 relay has an internal real time clock that performs time stamping for various features such as the event and transient recorders. Time stamping on the relay is also available with the IRIG-B signal connected to the relay terminals and set to “Enabled”. When an IRIG-B device is connected to the relay terminals, the relay detects the DC shift or the Amplitude Modulated signal automatically. Time stamping on multiple relays can be synchronized to ± 1.0 ms with the use of IRIG-B input.

The following path is available using the keypad. For instructions on how to use the keypad, please refer to *Chapter 3 - Working with the Keypad*.

PATH: **SETPOINTS > S1 RELAY SETUP > CLOCK**

DATE: (MM/DD/YYYY)

Range: Month: Jan, Feb, Mar, Apr, May, Jun, Jul, Aug, Sep, Oct, Nov, Dec Day: 1 to 31 Year: 2009 to 2099
Default: Jan 15 2009

This setting sets the date in the specified format.

TIME: (HH:MM:SS)

Range: 0 to 23: 0 to 59: 0 to59
Default: 03:15:50

This setting sets the time in the specified format.

DLS ENABLE

Range: Disabled, Enabled
Default: Disabled

PATH: **SETPOINTS > S1 RELAY SETUP > CLOCK > DLS ENABLE [ENABLED]**

DLS START MONTH:

Range: Not Set, January, February, March, April, May, June, July, August, September, October, November, December
Default: Not Set

This setting sets the month for the DLS start time.

DLS START WEEK:

Range: Not Set, 1^{st}, 2^{nd}, 3^{rd}, 4^{th}, Last
Default: Not Set

This setting sets the week of the month for the DLS start time.

DLS START WEEKDAY:

Range: Not Set, Mon, Tue, Wed, Thu, Fri, Sat, Sun
Default: Not Set

This setting sets the weekday for the DLS start time.

DLS END MONTH:

Range: Not Set, January, February, March, April, May, June, July, August, September, October, November, December
Default: Not Set

This setting sets the month for the end of the DLS time.

DLS END WEEK:

Range: Not Set, 1^{st}, 2^{nd}, 3^{rd}, 4^{th}, Last
Default: Not Set

This setting sets the week of the month for the end of the DLS time.

DLS END WEEKDAY:

Range: Not Set, Mon, Tue, Wed, Thu, Fri, Sat, Sun

Default: Not Set

This setting sets the weekday for the end of the DLS time.

PATH: **SETPOINTS > S1 RELAY SETUP > CLOCK**

IRIG-B:

Range: Disabled, Enabled

Default: Disabled

This setting enables the IRIG-B signal for time stamp synchronization.

1. Set the IRIG-B to “Enabled” if the IRIG-B device is connected to the relay IRIG-B terminals. The relay will display the message “IRIG-B failure” in the case of either no IRIG-B signal from the connected IRIG-B device, or when the signal cannot be decoded.
2. Set the date and time per the specified date and time format.
3. Set the start time of the Daylight Saving (DLS) time, by selecting the Month, the Week of the month, and the Weekday defining the beginning of the Daylight Saving time.
4. Set the end of the Daylight Saving time, by selecting the Month, the Week of the month, and the Weekday defining the end of the Daylight Saving time.

The clock has a super-capacitor back-up, so that time, date, and events will be kept for up to 3 days in cases of loss of relay control power.

Password security

Password security features are designed into the relay to provide protection against unauthorized setpoint changes and control. The relay has programmable passwords for both Local and Remote access, which can be used to allow setpoint changes and command execution from both the front panel and the communications ports. These passwords consist of 3 to 10 alphanumeric characters. The Local and the Remote passwords are initially set after entering in a Master Reset Password (MRP). The Master Reset Password (MRP) is set to “NULL” when the relay is shipped from the factory. When the MRP is programmed to “NULL” all password security is disabled. The remote user may choose to allow the local user to change the local passwords.

Each interface (RS485, Ethernet, USB, and front panel keypad) is independent of one another, meaning that enabling setpoint access on one interface does not enable access for any of the other interfaces (i.e., the password must be explicitly entered via the interface from which access is desired).

The EnerVista SR3 Setup software incorporates a facility for programming the relay’s passwords as well as enabling/disabling setpoint access. For example, when an attempt is made to modify a setpoint but access is restricted, the program will prompt the user to enter the password and send it to the relay before the setpoint can actually be written to the relay. If a SCADA system is used for relay programming, it is up to the programmer to incorporate appropriate security for the application.

Aside from being logged out of security, which allows the user to read setpoints and actual values only, three levels of security access are provided: Setpoint Level, Control Level, and Master Level. The Setpoint and Control Levels can be attained either locally using the Local passwords (USB port and keypad), or remotely using the Remote passwords (RS485 and Ethernet ports). The user can have either Setpoint or Control Level active, but not both simultaneously from the same interface. The Master Level is used for setting and resetting of passwords, and includes all Setpoint and Control Level access rights. The Master Level cannot be attained from the keypad. The Master Reset Password must be 8 to 10 characters in length, and must contain at least 2 letters and 2 numbers. The Master Level can define whether the local user is permitted to change Local Passwords without having to enter the Master Level. The Master Reset Password is encrypted, and is not viewable from the keypad. If the Master Reset Password is lost, the user should contact the factory to decrypt the Master Reset Password.

After password entry, the access level is maintained until a period of 5 minutes of inactivity has elapsed, after which the password must be re-entered. A power-loss or entering in the wrong password will log the user out of security.

Further definition of the access levels is described as follows:

SETPOINT LEVEL

- Changing settings under QUICK SETUP menu
- Changing settings under the SETPOINTS menu except the features requiring control access listed below
- Changing any setting under MAINTENANCE such as trip and close coil monitoring and breaker maintenance settings, except the features requiring control access listed below
- Changing the Local or Remote Setpoint Password, depending on the interface being accessed

CONTROL LEVEL

- Reset command
- Open and Close Breaker commands
- Virtual Input commands
- Clearing of event records, transient records, and other data
- Uploading new firmware
- Changing the Local or Remote Control Password, depending on the interface being accessed

MASTER LEVEL

- Setting and changing of all passwords including the Master Reset Password
- Disabling password security
- All Setpoint and Control Level access rights

For details on Password Security setup and handling using the EnerVista Setup software, refer to Chapter 3.

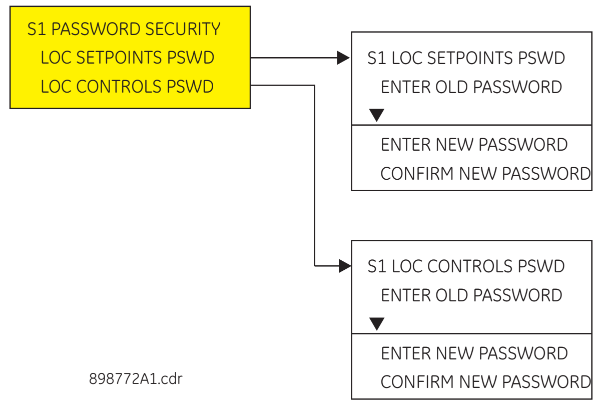
Access passwords

This section allows the user to change the Local Setpoint and Local Control Passwords. The local user may change a local password from the keypad if all of the following are true:

- Security is enabled
- A valid local setpoint (or local control) password has initially been set
- The remote user has the Overwrite Local Passwords setpoint set to **NO**
- The local user knows the current local password.

For more details on the Password Security feature, refer to Chapter 3.

Figure 3: Menu for handling password security using keypad



The following steps describe how to change the Local Setpoints Password from the keypad. Similar steps are followed to change the Local Control Password.

ENTER OLD PASSWORD

The user is prompted to enter the current Local Setpoints Password. User the value up/down keys to select characters, and use the message left/right keys to move the cursor. Press the Enter key when done. An INVALID PASSWORD message will appear if a wrong password is entered, security is disabled, the password has not been originally set, or the local user does not have the rights to change the password. In addition, the user will be automatically logged out of security from the keypad. If the correct password was entered, the user is now logged in to the Setpoints Level from the keypad, and will be prompted to enter a new password.

ENTER NEW PASSWORD

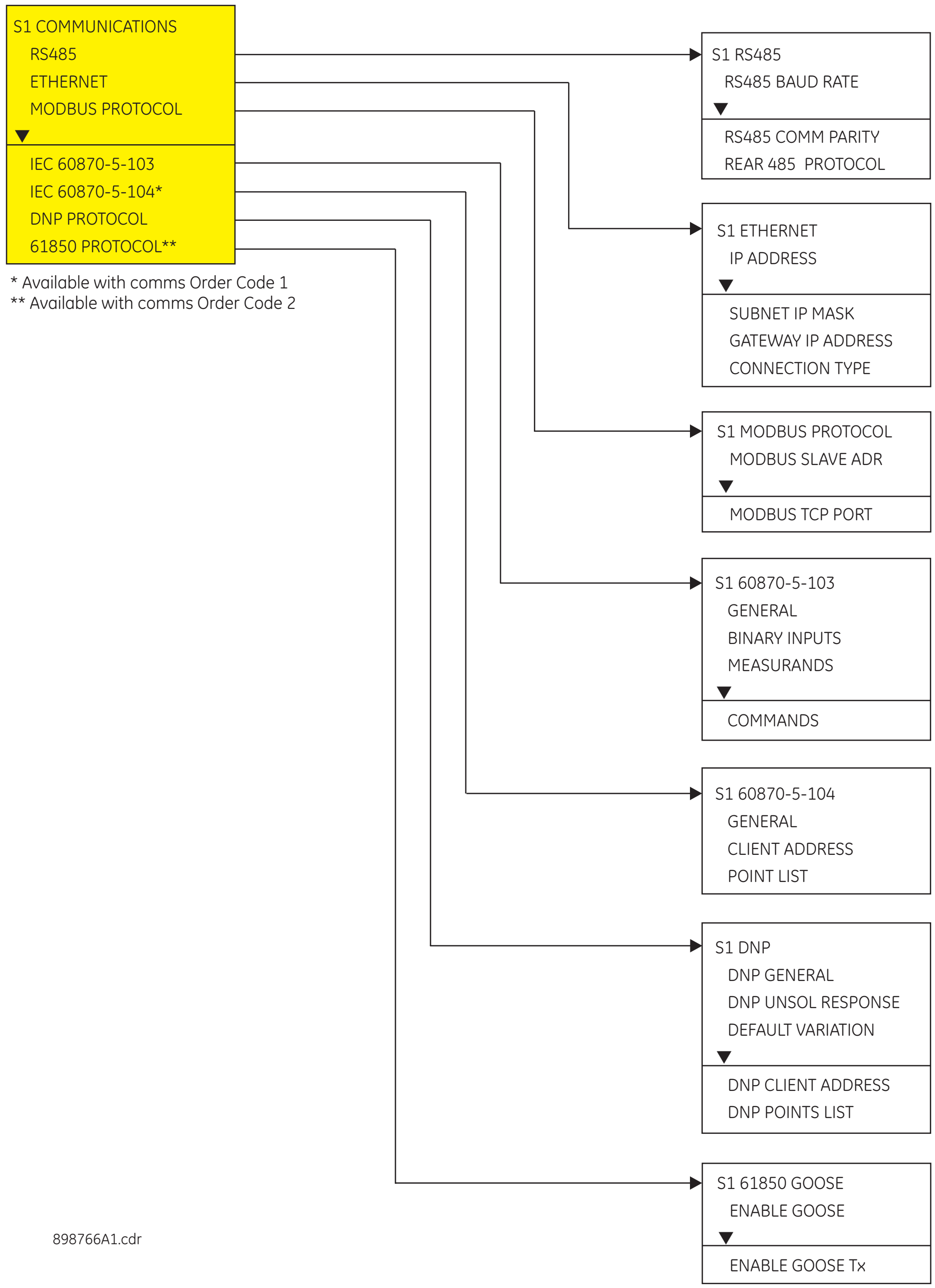
The user is prompted to enter a new Local Setpoints Password. A valid password is alphanumeric, and is 3 to 10 characters in length. An INVALID PASSWORD message will appear if the new password does not meet the password requirements. If a valid password was entered, the user will be prompted to re-enter the new password.

CONFIRM PASSWORD

The user is prompted to re-enter the new Local Setpoints Password. If the passwords do not match, an ENTRY MISMATCH message will appear, the password will remain unchanged, and the user will be returned to the Enter New Password page. If the passwords match, a PASSWORD CHANGED message will appear indicating the Local Setpoints Password has successfully been updated.

Communications

Figure 4: Main communications menu

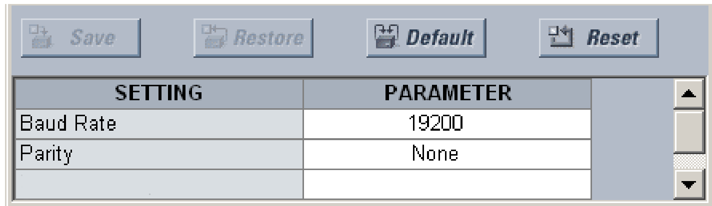


RS485 interface

The 350 is equipped with one serial RS485 communication port. The RS485 port has settings for baud rate and parity. It is important that these parameters agree with the settings used on the computer or other equipment that is connected to these ports. This port may be connected to a computer running the EnerVista SR3 Setup software. This software can download and upload setting files, view measured parameters, and upgrade the device firmware. A maximum of 32 350 -series devices can be daisy-chained and connected to a DCS, PLC, or PC using the RS485 port.

Select the **Settings > Communications > Serial Ports** menu item in the EnerVista SR3 Setupprogram, or the **SETPOINTS > S1 RELAY SETUP > COMMUNICATIONS > RS485** path on the display, to configure the serial port.

Figure 5: Serial port configuration settings



The following settings are available to configure the RS485 port.

BAUD RATE

Range: 9600, 19200, 38400, 57600, 115200

Default: 115200

This setting specifies the baud rate (bits per second) for the RS485 port.

PARITY

Range: None, Odd, Even

Default: None

This setting specifies the parity for the RS485 port.

Ethernet

Select the **Setpoints > S1 Relay Setup > Communications > Ethernet** menu item in the EnerVista SR3 Setupprogram, or the **SETPOINTS > S1 RELAY SETUP > COMMUNICATIONS > ETHERNET** path on the display, to configure the Ethernet port.

The following settings are available to configure the Ethernet port.

IP Address

Range: Standard IP Address format

Default: 000.000.000.000

This setting specifies the IP Address for the Ethernet port.

Subnet IP Mask

Range: Standard IP Address format

Default: 255.255.255.000

This setting specifies the Subnet IP Mask setting for the Ethernet port.

Gateway IP Address

Range: Standard IP Address format

Default: 000.000.000.000

This setting specifies the Gateway IP Address for the Ethernet port.

Connection Type

Range: Copper, fiber

Default: Copper

This setting specifies the connection type (Copper or Fiber) used for Ethernet communication.

NOTE

When changing Ethernet settings, power to the relay must be cycled in order for the new settings to become active.

Modbus

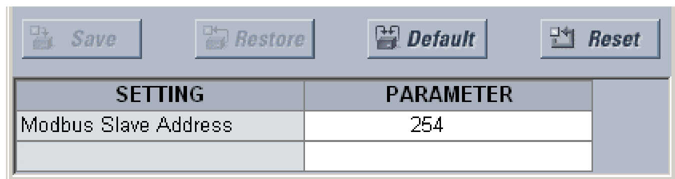
The Modicon Modbus protocol is supported by the 350 . Modbus is available via the RS485 serial link (Modbus RTU). The 350 always acts as a slave device, meaning that it never initiates communications; it only listens and responds to requests issued by a master device. A subset of the Modbus protocol format is supported that allows extensive monitoring, programming, and control functions using read and write register commands.Refer to the *350 Feeder Protection System Communications Guide* for additional details on the Modbus protocol and the Modbus memory map.

The Modbus server can simultaneously support two clients over serial RS485. The server is capable of reporting any indication or measurement and operating any output present in the device. A user-configurable input and output map is also implemented.

The 350 operates as a Modbus slave device only

Select the **Settings > Communications > Modbus > Protocol** menu item in EnerVista SR3 Setupsoftware, or the **SETPOINTS > S1 RELAY SETUP > COMMUNICATIONS > MODBUS PROTOCOL** path to set up the modbus protocol as shown below.

Figure 6: Modbus protocol configuration settings



The following Modbus settings are available:

MODBUS SLAVE ADDRESS

Range: 1 to 254 in steps of 1

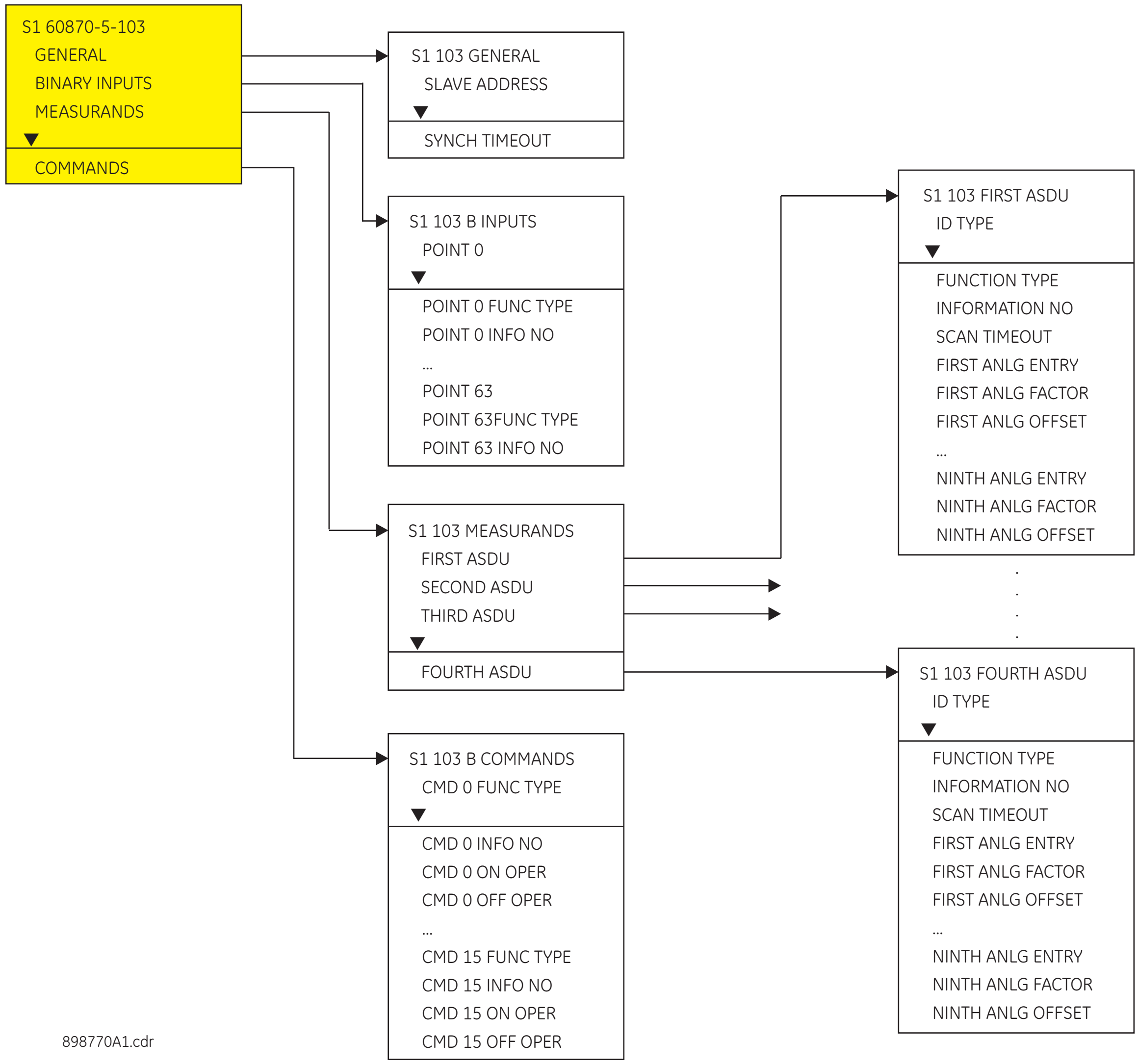
Default: 254

This setting specifies the Modbus slave address . Each device must have a unique address from 1 to 254. Address 0 is the broadcast address to which all Modbus slave devices listen. Addresses do not have to be sequential, but no two devices can have the same address or conflicts resulting in errors will occur. Generally, each device added to the link should use the next higher address starting at 1.

Please refer to the *350 Communications Guide* for details on how to set up the Modbus communications protocol.

IEC 60870-5-103 serial communication

Figure 7: IEC 60870-5-103 serial communication menu



PATH: **SETPOINTS > S1 RELAY SETUP > COMMUNICATIONS > IEC61870-5-103**

The following table, from the *350 Communications Guide*, shows the list of Binary Inputs.

Code	Type	Definition
FC134B	unsigned 16 bits	DNP Binary Inputs
0		Off
0x0040		Contact IN 1 On
0x0041		Contact IN 2 On
0x0042		Contact IN 3 On
0x0043		Contact IN 4 On
0x0044		Contact IN 5 On
0x0045		Contact IN 6 On
0x0046		Contact IN 7 On
0x0047		Contact IN 8 On
0x0048		Contact IN 9 On

Code	Type	Definition
0x0049		Contact IN 10 On
0x0060		Contact IN 1 Off
0x0061		Contact IN 2 Off
0x0062		Contact IN 3 Off
0x0063		Contact IN 4 Off
0x0064		Contact IN 5 Off
0x0065		Contact IN 6 Off
0x0066		Contact IN 7 Off
0x0067		Contact IN 8 Off
0x0068		Contact IN 9 Off
0x0069		Contact IN 10 Off
0x0080		Virtual IN 1 On
0x0081		Virtual IN 2 On
0x0082		Virtual IN 3 On
0x0083		Virtual IN 4 On
0x0084		Virtual IN 5 On
0x0085		Virtual IN 6 On
0x0086		Virtual IN 7 On
0x0087		Virtual IN 8 On
0x0088		Virtual IN 9 On
0x0089		Virtual IN 10 On
0x008A		Virtual IN 11 On
0x008B		Virtual IN 12 On
0x008C		Virtual IN 13 On
0x008D		Virtual IN 14 On
0x008E		Virtual IN 15 On
0x008F		Virtual IN 16 On
0x0090		Virtual IN 17 On
0x0091		Virtual IN 18 On
0x0092		Virtual IN 19 On
0x0093		Virtual IN 20 On
0x0094		Virtual IN 21 On
0x0095		Virtual IN 22 On
0x0096		Virtual IN 23 On
0x0097		Virtual IN 24 On
0x0098		Virtual IN 25 On
0x0099		Virtual IN 26 On
0x009A		Virtual IN 27 On
0x009B		Virtual IN 28 On
0x009C		Virtual IN 29 On
0x009D		Virtual IN 30 On
0x009E		Virtual IN 31 On
0x009F		Virtual IN 32 On
0x01C0		Remote IN 1 On
0x01C1		Remote IN 2 On
0x01C2		Remote IN 3 On
0x01C3		Remote IN 4 On

Code	Type	Definition
0x01C4		Remote IN 5 On
0x01C5		Remote IN 6 On
0x01C6		Remote IN 7 On
0x01C7		Remote IN 8 On
0x01C8		Remote IN 9 On
0x01C9		Remote IN 10 On
0x01CA		Remote IN 11 On
0x01CB		Remote IN 12 On
0x01CC		Remote IN 13 On
0x01CD		Remote IN 14 On
0x01CE		Remote IN 15 On
0x01CF		Remote IN 16 On
0x01D0		Remote IN 17 On
0x01D1		Remote IN 18 On
0x01D2		Remote IN 19 On
0x01D3		Remote IN 20 On
0x01D4		Remote IN 21 On
0x01D5		Remote IN 22 On
0x01D6		Remote IN 23 On
0x01D7		Remote IN 24 On
0x01D8		Remote IN 25 On
0x01D9		Remote IN 26 On
0x01DA		Remote IN 27 On
0x01DB		Remote IN 28 On
0x01DC		Remote IN 29 On
0x01DD		Remote IN 30 On
0x01DE		Remote IN 31 On
0x01DF		Remote IN 32 On
0x01E0		Remote IN 1 Off
0x01E1		Remote IN 2 Off
0x01E2		Remote IN 3 Off
0x01E3		Remote IN 4 Off
0x01E4		Remote IN 5 Off
0x01E5		Remote IN 6 Off
0x01E6		Remote IN 7 Off
0x01E7		Remote IN 8 Off
0x01E8		Remote IN 9 Off
0x01E9		Remote IN 10 Off
0x01EA		Remote IN 11 Off
0x01EB		Remote IN 12 Off
0x01EC		Remote IN 13 Off
0x01ED		Remote IN 14 Off
0x01EE		Remote IN 15 Off
0x01EF		Remote IN 16 Off
0x01F0		Remote IN 17 Off
0x01F1		Remote IN 18 Off
0x01F2		Remote IN 19 Off

Code	Type	Definition
0x01F3		Remote IN 20 Off
0x01F4		Remote IN 21 Off
0x01F5		Remote IN 22 Off
0x01F6		Remote IN 23 Off
0x01F7		Remote IN 24 Off
0x01F8		Remote IN 25 Off
0x01F9		Remote IN 26 Off
0x01FA		Remote IN 27 Off
0x01FB		Remote IN 28 Off
0x01FC		Remote IN 29 Off
0x01FD		Remote IN 30 Off
0x01FE		Remote IN 31 Off
0x01FF		Remote IN 32 Off
0x8002		Any Trip
0x8042		Therm O/L Trip OP
0x8044		Therm O/L Trip DPO
0x804A		Therm PhA Trip OP
0x804C		Therm PhA Trip DPO
0x8052		Therm PhB Trip OP
0x8054		Therm PhB Trip DPO
0x8062		Therm PhC Trip OP
0x8064		Therm PhC Trip DPO
0x84C1		LE 1 Trip PKP
0x84C2		LE 1 Trip OP
0x84C4		LE 1 Trip DPO
0x8501		LE 2 Trip PKP
0x8502		LE 2 Trip OP
0x8504		LE 2 Trip DPO
0x8541		LE 3 Trip PKP
0x8542		LE 3 Trip OP
0x8544		LE 3 Trip DPO
0x8581		LE 4 Trip PKP
0x8582		LE 4 Trip OP
0x8584		LE 4 Trip DPO
0x85C1		LE 5 Trip PKP
0x85C2		LE 5 Trip OP
0x85C4		LE 5 Trip DPO
0x8601		LE 6 Trip PKP
0x8602		LE 6 Trip OP
0x8604		LE 6 Trip DPO
0x8641		LE 7 Trip PKP
0x8642		LE 7 Trip OP
0x8644		LE 7 Trip DPO
0x8681		LE 8 Trip PKP
0x8682		LE 8 Trip OP
0x8684		LE 8 Trip DPO
0x8F82		Fuse Fail Trip OP

Code	Type	Definition
0x8F84		Fuse Fail Trip DPO
0x9001		Ph IOC1 Trip PKP
0x9002		Ph IOC1 Trip OP
0x9004		Ph IOC1 Trip DPO
0x9009		Ph A IOC1 Trip PKP
0x900A		Ph A IOC1 Trip OP
0x900C		Ph A IOC1 Trip DPO
0x9011		Ph B IOC1 Trip PKP
0x9012		Ph B IOC1 Trip OP
0x9014		Ph B IOC1 Trip DPO
0x9021		Ph C IOC1 Trip PKP
0x9022		Ph C IOC1 Trip OP
0x9024		Ph C IOC1 Trip DPO
0x9041		Ntrl IOC1 Trip PKP
0x9042		Ntrl IOC1 Trip OP
0x9044		Ntrl IOC1 Trip DPO
0x9081		Gnd IOC1 Trip PKP
0x9082		Gnd IOC1 Trip OP
0x9084		Gnd IOC1 Trip DPO
0x90C1		Ph TOC1 Trip PKP
0x90C2		Ph TOC1 Trip OP
0x90C4		Ph TOC1 Trip DPO
0x90C9		Ph A TOC1 Trip PKP
0x90CA		Ph A TOC1 Trip OP
0x90CC		Ph A TOC1 Trip DPO
0x90D1		Ph B TOC1 Trip PKP
0x90D2		Ph B TOC1 Trip OP
0x90D4		Ph B TOC1 Trip DPO
0x90E1		Ph C TOC1 Trip PKP
0x90E2		Ph C TOC1 Trip OP
0x90E4		Ph C TOC1 Trip DPO
0x9101		Ntrl TOC1 Trip PKP
0x9102		Ntrl TOC1 Trip OP
0x9104		Ntrl TOC1 Trip DPO
0x9141		Gnd TOC1 Trip PKP
0x9142		Gnd TOC1 Trip OP
0x9144		Gnd TOC1 Trip DPO
0x9181		Ph IOC2 Trip PKP
0x9182		Ph IOC2 Trip OP
0x9184		Ph IOC2 Trip DPO
0x9189		Ph A IOC2 Trip PKP
0x918A		Ph A IOC2 Trip OP
0x918C		Ph A IOC2 Trip DPO
0x9191		Ph B IOC2 Trip PKP
0x9192		Ph B IOC2 Trip OP
0x9194		Ph B IOC2 Trip DPO
0x91A1		Ph C IOC2 Trip PKP

Code	Type	Definition
0x91A2		Ph C IOC2 Trip OP
0x91A4		Ph C IOC2 Trip DPO
0x91C1		Ntrl IOC2 Trip PKP
0x91C2		Ntrl IOC2 Trip OP
0x91C4		Ntrl IOC2 Trip DPO
0x9201		Gnd IOC2 Trip PKP
0x9202		Gnd IOC2 Trip OP
0x9204		Gnd IOC2 Trip DPO
0x9301		SGnd TOC1 Trip PKP
0x9302		SGnd TOC1 Trip OP
0x9304		SGnd TOC1 Trip DPO
0x93C1		NegSeq OV Trp PKP
0x93C2		NegSeq OV Trp OP
0x93C4		NegSeq OV Trp DPO
0x9401		Ntrl OV Trip PKP
0x9402		Ntrl OV Trp OP
0x9404		Ntrl OV Trip DPO
0x9441		Ph OV1 Trip PKP
0x9442		Ph OV1 Trip OP
0x9444		Ph OV1 Trip DPO
0x9449		Ph A OV1 Trip PKP
0x944A		Ph A OV1 Trip OP
0x944C		Ph A OV1 Trip DPO
0x9451		Ph B OV1 Trip PKP
0x9452		Ph B OV1 Trip OP
0x9454		Ph B OV1 Trip DPO
0x9461		Ph C OV1 Trip PKP
0x9462		Ph C OV1 Trip OP
0x9464		Ph C OV1 Trip DPO
0x9481		Ph UV1 Trip PKP
0x9482		Ph UV1 Trip OP
0x9484		Ph UV1 Trip DPO
0x9489		Ph A UV1 Trip PKP
0x948A		Ph A UV1 Trip OP
0x948C		Ph A UV1 Trip DPO
0x9491		Ph B UV1 Trip PKP
0x9492		Ph B UV1 Trip OP
0x9494		Ph B UV1 Trip DPO
0x94A1		Ph C UV1 Trip PKP
0x94A2		Ph C UV1 Trip OP
0x94A4		Ph C UV1 Trip DPO
0x94C1		Aux OV Trip PKP
0x94C2		Aux OV Trip OP
0x94C4		Aux OV Trip DPO
0x9501		Aux UV Trip PKP
0x9502		Aux UV Trip OP
0x9504		Aux UV Trip DPO

Code	Type	Definition
0x9541		UndrFreq1 Trip PKP
0x9542		UndrFreq1 Trip OP
0x9544		UndrFreq1 Trip DPO
0x9581		UndrFreq2 Trip PKP
0x9582		UndrFreq2 Trip OP
0x9584		UndrFreq2 Trip DPO
0x95C1		OverFreq1 Trip PKP
0x95C2		OverFreq1 Trip OP
0x95C4		OverFreq1 Trip DPO
0x9601		OverFreq2 Trip PKP
0x9602		OverFreq2 Trip OP
0x9604		OverFreq2 Trip DPO
0x9641		SGnd IOC1 Trip PKP
0x9642		SGnd IOC1 Trip OP
0x9644		SGnd IOC1 Trip DPO
0x9681		SGnd IOC2 Trip PKP
0x9682		SGnd IOC2 Trip OP
0x9684		SGnd IOC2 Trip DPO
0x96C1		NegSeq IOC Trp PKP
0x96C2		NegSeq IOC Trp OP
0x96C4		NegSeq IOC Trp DPO
0x98D2		Ph B UV2 Trip OP
0x9C01		LE 9 Trip PKP
0x9C02		LE 9 Trip OP
0x9C04		LE 9 Trip DPO
0x9C41		LE 10 Trip PKP
0x9C42		LE 10 Trip OP
0x9C44		LE 10 Trip DPO
0x9C81		LE 11 Trip PKP
0x9C82		LE 11 Trip OP
0x9C84		LE 11 Trip DPO
0x9CC1		LE 12 Trip PKP
0x9CC2		LE 12 Trip OP
0x9CC4		LE 12 Trip DPO
0x9D01		LE 13 Trip PKP
0x9D02		LE 13 Trip OP
0x9D04		LE 13 Trip DPO
0x9D41		LE 14 Trip PKP
0x9D42		LE 14 Trip OP
0x9D44		LE 14 Trip DPO
0x9D81		LE 15 Trip PKP
0x9D82		LE 15 Trip OP
0x9D84		LE 15 Trip DPO
0x9DC1		LE 16 Trip PKP
0x9DC2		LE 16 Trip OP
0x9DC4		LE 16 Trip DPO
0xA002		Any Alarm

Code	Type	Definition
0xA042		Therm Lvl Alrm OP
0xA044		Therm Lvl Alrm DPO
0xA04A		Therm PhA Alrm OP
0xA04C		Therm PhA Alrm DPO
0xA052		Therm PhB Alrm OP
0xA054		Therm PhB Alrm DPO
0xA062		Therm PhC Alrm OP
0xA064		Therm PhC Alrm DPO
0xA4C1		LE 1 Alarm PKP
0xA4C2		LE 1 Alarm OP
0xA4C4		LE 1 Alarm DPO
0xA501		LE 2 Alarm PKP
0xA502		LE 2 Alarm OP
0xA504		LE 2 Alarm DPO
0xA541		LE 3 Alarm PKP
0xA542		LE 3 Alarm OP
0xA544		LE 3 Alarm DPO
0xA581		LE 4 Alarm PKP
0xA582		LE 4 Alarm OP
0xA584		LE 4 Alarm DPO
0xA5C1		LE 5 Alarm PKP
0xA5C2		LE 5 Alarm OP
0xA5C4		LE 5 Alarm DPO
0xA601		LE 6 Alarm PKP
0xA602		LE 6 Alarm OP
0xA604		LE 6 Alarm DPO
0xA641		LE 7 Alarm PKP
0xA642		LE 7 Alarm OP
0xA644		LE 7 Alarm DPO
0xA681		LE 8 Alarm PKP
0xA682		LE 8 Alarm OP
0xA684		LE 8 Alarm DPO
0xABC1		HI Amb Temp PKP
0xABC2		HI Amb Temp OP
0xABC4		HI Amb Temp DPO
0xAC01		LO Amb Temp PKP
0xAC02		LO Amb Temp OP
0xAC04		LO Amb Temp DPO
0xAC42		Self Test Alarm OP
0xACC2		BKRTrpCntrAlrm OP
0xAD02		R1 CoilMonAlrm OP
0xAD42		R2 CoilMonAlrm OP
0xAD81		BKR1 Fail Alrm PKP
0xAD82		BKR1 Fail Alrm OP
0xAD84		BKR1 Fail Alrm DPO
0xADC2		BKR Stat Fail OP
0xAE41		CLP Alarm PKP

Code	Type	Definition
0xAE42		CLP Alarm OP
0xAF81		Fuse Fail Alrm PKP
0xAF82		Fuse Fail Alrm OP
0xAF84		Fuse Fail Alrm DPO
0xB001		Ph IOC1 Alarm PKP
0xB002		Ph IOC1 Alarm OP
0xB004		Ph IOC1 Alarm DPO
0xB009		Ph A IOC1 Alrm PKP
0xB00A		Ph A IOC1 Alrm OP
0xB00C		Ph A IOC1 Alrm DPO
0xB011		Ph B IOC1 Alrm PKP
0xB012		Ph B IOC1 Alrm OP
0xB014		Ph B IOC1 Alrm DPO
0xB021		Ph C IOC1 Alrm PKP
0xB022		Ph C IOC1 Alrm OP
0xB024		Ph C IOC1 Alrm DPO
0xB041		Ntrl IOC1 Alrm PKP
0xB042		Ntrl IOC1 Alrm OP
0xB044		Ntrl IOC1 Alrm DPO
0xB081		Gnd IOC1 Alarm PKP
0xB082		Gnd IOC1 Alarm OP
0xB084		Gnd IOC1 Alarm DPO
0xB0C1		Ph TOC1 Alarm PKP
0xB0C2		Ph TOC1 Alarm OP
0xB0C4		Ph TOC1 Alarm DPO
0xB0C9		Ph A TOC1 Alrm PKP
0xB0CA		Ph A TOC1 Alrm OP
0xB0CC		Ph A TOC1 Alrm DPO
0xB0D1		Ph B TOC1 Alrm PKP
0xB0D2		Ph B TOC1 Alrm OP
0xB0D4		Ph B TOC1 Alrm DPO
0xB0E1		Ph C TOC1 Alrm PKP
0xB0E2		Ph C TOC1 Alrm OP
0xB0E4		Ph C TOC1 Alrm DPO
0xB101		Ntrl TOC1 Alrm PKP
0xB102		Ntrl TOC1 Alrm OP
0xB104		Ntrl TOC1 Alrm DPO
0xB141		Gnd TOC1 Alarm PKP
0xB142		Gnd TOC1 Alarm OP
0xB144		Gnd TOC1 Alarm DPO
0xB181		Ph IOC2 Alarm PKP
0xB182		Ph IOC2 Alarm OP
0xB184		Ph IOC2 Alarm DPO
0xB189		Ph A IOC2 Alrm PKP
0xB18A		Ph A IOC2 Alrm OP
0xB18C		Ph A IOC2 Alrm DPO
0xB191		Ph B IOC2 Alrm PKP

Code	Type	Definition
0xB192		Ph B IOC2 Alrm OP
0xB194		Ph B IOC2 Alrm DPO
0xB1A1		Ph C IOC2 Alrm PKP
0xB1A2		Ph C IOC2 Alrm OP
0xB1A4		Ph C IOC2 Alrm DPO
0xB1C1		Ntrl IOC2 Alrm PKP
0xB1C2		Ntrl IOC2 Alrm OP
0xB1C4		Ntrl IOC2 Alrm DPO
0xB201		Gnd IOC2 Alarm PKP
0xB202		Gnd IOC2 Alarm OP
0xB204		Gnd IOC2 Alarm DPO
0xB301		SGnd TOC1 Alrm PKP
0xB302		SGnd TOC1 Alrm OP
0xB304		SGnd TOC1 Alrm DPO
0xB342		NtrlDir RevAlm OP
0xB344		NtrlDir RevAlmDPO
0xB382		GndDir RevAlm OP
0xB384		GndDir RevAlm DPO
0xB3C1		NegSeq OV Alrm PKP
0xB3C2		NegSeq OV Alrm OP
0xB3C4		NegSeq OV Alrm DPO
0xB401		Ntrl OV Alrm PKP
0xB402		Ntrl OV Alrm OP
0xB404		Ntrl OV Alrm DPO
0xB441		Ph OV1 Alarm PKP
0xB442		Ph OV1 Alarm OP
0xB444		Ph OV1 Alarm DPO
0xB449		Ph A OV1 Alarm PKP
0xB44A		Ph A OV1 Alarm OP
0xB44C		Ph A OV1 Alarm DPO
0xB451		Ph B OV1 Alarm PKP
0xB452		Ph B OV1 Alarm OP
0xB454		Ph B OV1 Alarm DPO
0xB461		Ph C OV1 Alarm PKP
0xB462		Ph C OV1 Alarm OP
0xB464		Ph C OV1 Alarm DPO
0xB481		Ph UV1 Alarm PKP
0xB482		Ph UV1 Alarm OP
0xB484		Ph UV1 Alarm DPO
0xB489		Ph A UV1 Alarm PKP
0xB48A		Ph A UV1 Alarm OP
0xB48C		Ph A UV1 Alarm DPO
0xB491		Ph B UV1 Alarm PKP
0xB492		Ph B UV1 Alarm OP
0xB494		Ph B UV1 Alarm DPO
0xB4A1		Ph C UV1 Alarm PKP
0xB4A2		Ph C UV1 Alarm OP

Code	Type	Definition
0xB4A4		Ph C UV1 Alarm DPO
0xB4C1		Aux OV Alarm PKP
0xB4C2		Aux OV Alarm OP
0xB4C4		Aux OV Alarm DPO
0xB501		Aux UV Alarm PKP
0xB502		Aux UV Alarm OP
0xB504		Aux UV Alarm DPO
0xB541		UndrFreq1 Alrm PKP
0xB542		UndrFreq1 Alrm OP
0xB544		UndrFreq1 Alrm DPO
0xB581		UndrFreq2 Alrm PKP
0xB582		UndrFreq2 Alrm OP
0xB584		UndrFreq2 Alrm DPO
0xB5C1		OverFreq1 Alrm PKP
0xB5C2		OverFreq1 Alrm OP
0xB5C4		OverFreq1 Alrm DPO
0xB601		OverFreq2 Alrm PKP
0xB602		OverFreq2 Alrm OP
0xB604		OverFreq2 Alrm DPO
0xB641		SGnd IOC1 Alrm PKP
0xB642		SGnd IOC1 Alrm OP
0xB644		SGnd IOC1 Alrm DPO
0xB681		SGnd IOC2 Alrm PKP
0xB682		SGnd IOC2 Alrm OP
0xB684		SGnd IOC2 Alrm DPO
0xB6C1		NSeq IOC Alrm PKP
0xB6C2		NSeq IOC Alrm OP
0xB6C4		NSeq IOC Alrm DPO
0xBC01		LE 9 Alarm PKP
0xBC02		LE 9 Alarm OP
0xBC04		LE 9 Alarm DPO
0xBC41		LE 10 Alarm PKP
0xBC42		LE 10 Alarm OP
0xBC44		LE 10 Alarm DPO
0xBC81		LE 11 Alarm PKP
0xBC82		LE 11 Alarm OP
0xBC84		LE 11 Alarm DPO
0xBCC1		LE 12 Alarm PKP
0xBCC2		LE 12 Alarm OP
0xBCC4		LE 12 Alarm DPO
0xBD01		LE 13 Alarm PKP
0xBD02		LE 13 Alarm OP
0xBD04		LE 13 Alarm DPO
0xBD41		LE 14 Alarm PKP
0xBD42		LE 14 Alarm OP
0xBD44		LE 14 Alarm DPO
0xBD81		LE 15 Alarm PKP

Code	Type	Definition
0xBD82		LE 15 Alarm OP
0xBD84		LE 15 Alarm DPO
0xBDC1		LE 16 Alarm PKP
0xBDC2		LE 16 Alarm OP
0xBDC4		LE 16 Alarm DPO
0xBE01		PhDir RevAlm PKP
0xBE02		PhDir RevAlm OP
0xBE04		PhDir RevAlm DPO
0xBE09		PhADir RevAlm PKP
0xBE0A		PhADir RevAlm OP
0xBE0C		PhADir RevAlm DPO
0xBE11		PhBDir RevAlm PKP
0xBE12		PhBDir RevAlm OP
0xBE14		PhBDir RevAlm DPO
0xBE21		PhCDir RevAlm PKP
0xBE22		PhCDir RevAlm OP
0xBE24		PhCDir RevAlm DPO
0xBE41		PhDir UndAlm PKP
0xBE42		PhDir UndAlm OP
0xBE44		PhDir UndAlm DPO
0xBE49		PhADir UndAlm PKP
0xBE4A		PhADir UndAlm OP
0xBE4C		PhADir UndAlm DPO
0xBE51		PhBDir UndAlm PKP
0xBE52		PhBDir UndAlm OP
0xBE54		PhBDir UndAlm DPO
0xBE61		PhCDir UndAlm PKP
0xBE62		PhCDir UndAlm OP
0xBE64		PhCDir UndAlm DPO
0xBE81		GndDir UndAlm PKP
0xBE82		GndDir UndAlm OP
0xBE84		GndDir UndAlm DPO
0xBEC1		NtrlDir UndAlm PKP
0xBEC2		NtrlDir UndAlm OP
0xBEC4		NtrlDir UndAlm DPO
0xC042		Output Relay 3 On
0xC082		Output Relay 4 On
0xC0C2		Output Relay 5 On
0xC102		Output Relay 6 On
0xC142		Self-Test Rly 7 On
0xC182		Output Relay 1 On
0xC1C2		Output Relay 2 On
0xC202		BKR Connected
0xC4C1		LE 1 PKP
0xC4C2		LE 1 OP
0xC4C4		LE 1 DPO
0xC501		LE 2 PKP

Code	Type	Definition
0xC502		LE 2 OP
0xC504		LE 2 DPO
0xC541		LE 3 PKP
0xC542		LE 3 OP
0xC544		LE 3 DPO
0xC581		LE 4 PKP
0xC582		LE 4 OP
0xC584		LE 4 DPO
0xC5C1		LE 5 PKP
0xC5C2		LE 5 OP
0xC5C4		LE 5 DPO
0xC601		LE 6 PKP
0xC602		LE 6 OP
0xC604		LE 6 DPO
0xC641		LE 7 PKP
0xC642		LE 7 OP
0xC644		LE 7 DPO
0xC681		LE 8 PKP
0xC682		LE 8 OP
0xC684		LE 8 DPO
0xC882		Setpoint Group2 On
0xC902		Open Breaker
0xC942		Close Breaker
0xC982		Maint. Req. OP
0xCA02		52a Contact OP
0xCA42		52b Contact OP
0xCA44		52b Contact DPO
0xCA82		Reset OK
0xCB01		AR Close PKP
0xCB02		AR Close
0xCB04		AR Close DPO
0xCB42		AR N/Ready
0xCB81		AR In Progress PKP
0xCB82		AR In Progress
0xCB84		AR In Progress DPO
0xCBC1		AR Disabled PKP
0xCBC2		AR Disabled
0xCBC4		AR Disabled DPO
0xCC02		AR Ext. Init
0xCC41		AR Ready PKP
0xCC42		AR Ready
0xCC44		AR Ready DPO
0xCCC2		BKR Stat Open
0xCD02		BKR Stat Clsd
0xCD42		Setpoint Group1 On
0xCE41		CLP PKP
0xCE42		CLP Op

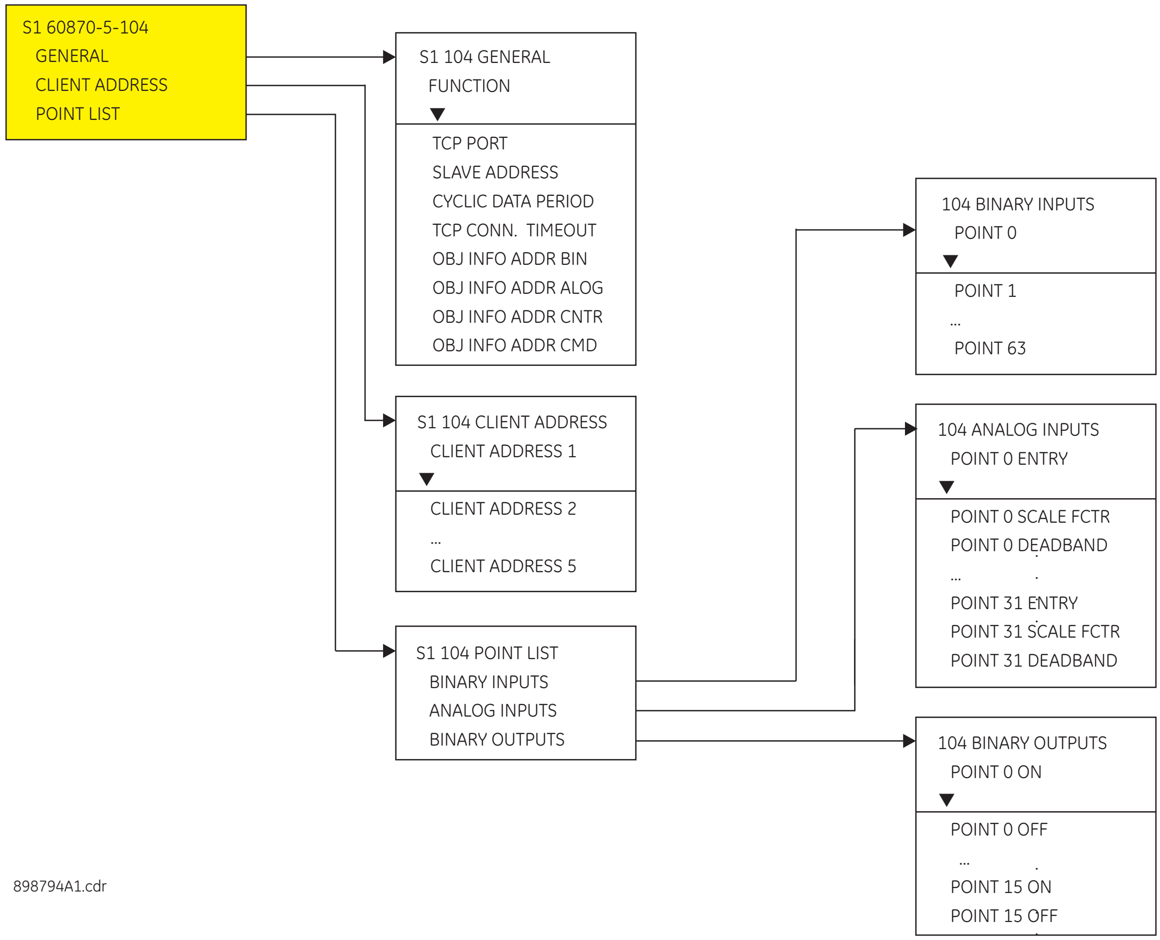
Code	Type	Definition
0xCE44		CLP DPO
0xCF81		Fuse Fail InhibPKP
0xCF82		Fuse Fail Inhib OP
0xD342		Ntrl Dir Rev OP
0xD344		Ntrl Dir Rev DPO
0xD382		Gnd Dir Rev OP
0xD384		Gnd Dir Rev DPO
0xD801		NSeq TOC1 PKP
0xD802		NSeq TOC1 OP
0xD804		NSeq TOC1 DPO
0xDC01		LE 9 PKP
0xDC02		LE 9 OP
0xDC04		LE 9 DPO
0xDC41		LE 10 PKP
0xDC42		LE 10 OP
0xDC44		LE 10 DPO
0xDC81		LE 11 PKP
0xDC82		LE 11 OP
0xDC84		LE 11 DPO
0xDCC1		LE 12 PKP
0xDCC2		LE 12 OP
0xDCC4		LE 12 DPO
0xDD01		LE 13 PKP
0xDD02		LE 13 OP
0xDD04		LE 13 DPO
0xDD41		LE 14 PKP
0xDD42		LE 14 OP
0xDD44		LE 14 DPO
0xDD81		LE 15 PKP
0xDD82		LE 15 OP
0xDD84		LE 15 DPO
0xDDC1		LE 16 PKP
0xDDC2		LE 16 OP
0xDDC4		LE 16 DPO
0xDE01		PhDir Rev PKP
0xDE02		PhDir Rev OP
0xDE04		PhDir Rev DPO
0xDE09		PhADir Rev PKP
0xDE0A		PhADir Rev OP
0xDE0C		PhADir Rev DPO
0xDE11		PhBDir Rev PKP
0xDE12		PhBDir Rev OP
0xDE14		PhBDir Rev DPO
0xDE21		PhCDir Rev PKP
0xDE22		PhCDir Rev OP
0xDE24		PhCDir Rev DPO
0xDE41		PhDir Und PKP

Code	Type	Definition
0xDE42		PhDir Und OP
0xDE44		PhDir Und DPO
0xDE49		PhADir Und PKP
0xDE4A		PhADir Und OP
0xDE4C		PhADir Und DPO
0xDE51		PhBDir Und PKP
0xDE52		PhBDir Und OP
0xDE54		PhBDir Und DPO
0xDE61		PhCDir Und PKP
0xDE62		PhCDir Und OP
0xDE64		PhCDir Und DPO
0xDE81		GndDir Und PKP
0xDE82		GndDir Und OP
0xDE84		GndDir Und DPO
0xDEC1		NtrlDir Und PKP
0xDEC2		NtrlDir Und OP
0xDEC4		NtrlDir Und DPO
0xE002		Any Block
0xE042		Therm O/L Blck
0xE182		Output Relay 1 BLK
0xE1C2		Output Relay 2 BLK
0xE882		Group Change Blk
0xEB02		AR Block
0xEE82		CLP Ph IOC1 BLK
0xEEC2		CLP Ph IOC2 BLK
0xEF02		CLPNtrlIOC1 BLK
0xEF42		CLPNtrlIOC2 BLK
0xEF82		CLP GndIOC1 BLK
0xEFC2		CLP GndIOC2 BLK
0xF002		Ph IOC1 Block
0xF042		Ntrl IOC1 Block
0xF082		Gnd IOC1 Block
0xF0C2		Ph TOC1 Block
0xF102		Ntrl TOC1 Block
0xF142		Gnd TOC1 Block
0xF182		Ph IOC2 Block
0xF1C2		Ntrl IOC2 Block
0xF202		Gnd IOC2 Block
0xF302		SGnd TOC1 Block
0xF342		NTRL DIR Rev Block
0xF382		Gnd Dir Block
0xF3C2		NegSeq OV Block
0xF402		Ntrl OV Block
0xF442		Ph OV1 Block
0xF482		Ph UV1 Block
0xF4C2		Aux OV Block
0xF502		Aux UV Block

Code	Type	Definition
0xF542		UndrFreq1 Block
0xF582		UndrFreq2 Block
0xF5C2		OverFreq1 Block
0xF602		OverFreq2 Block
0xF642		SGnd IOC1 Block
0xF682		SGnd IOC2 Block
0xF6C2		NSeq IOC Block
0xFE01		PhDir Block PKP
0xFE02		PhDir Block OP
0xFE04		PhDir Block DPO
0xFE41		PhDir Und Blk PKP
0xFE42		PhDir Und Blk OP
0xFE44		PhDir Und Blk DPO
0xFE81		GndDir Und Blk PKP
0xFE82		GndDir Und Blk OP
0xFE84		GndDir Und Blk DPO
0xFEC1		NtrlDir Und Blk PKP
0xFEC2		NtrlDir Und Blk OP
0xFEC4		NtrlDir Und Blk DPO

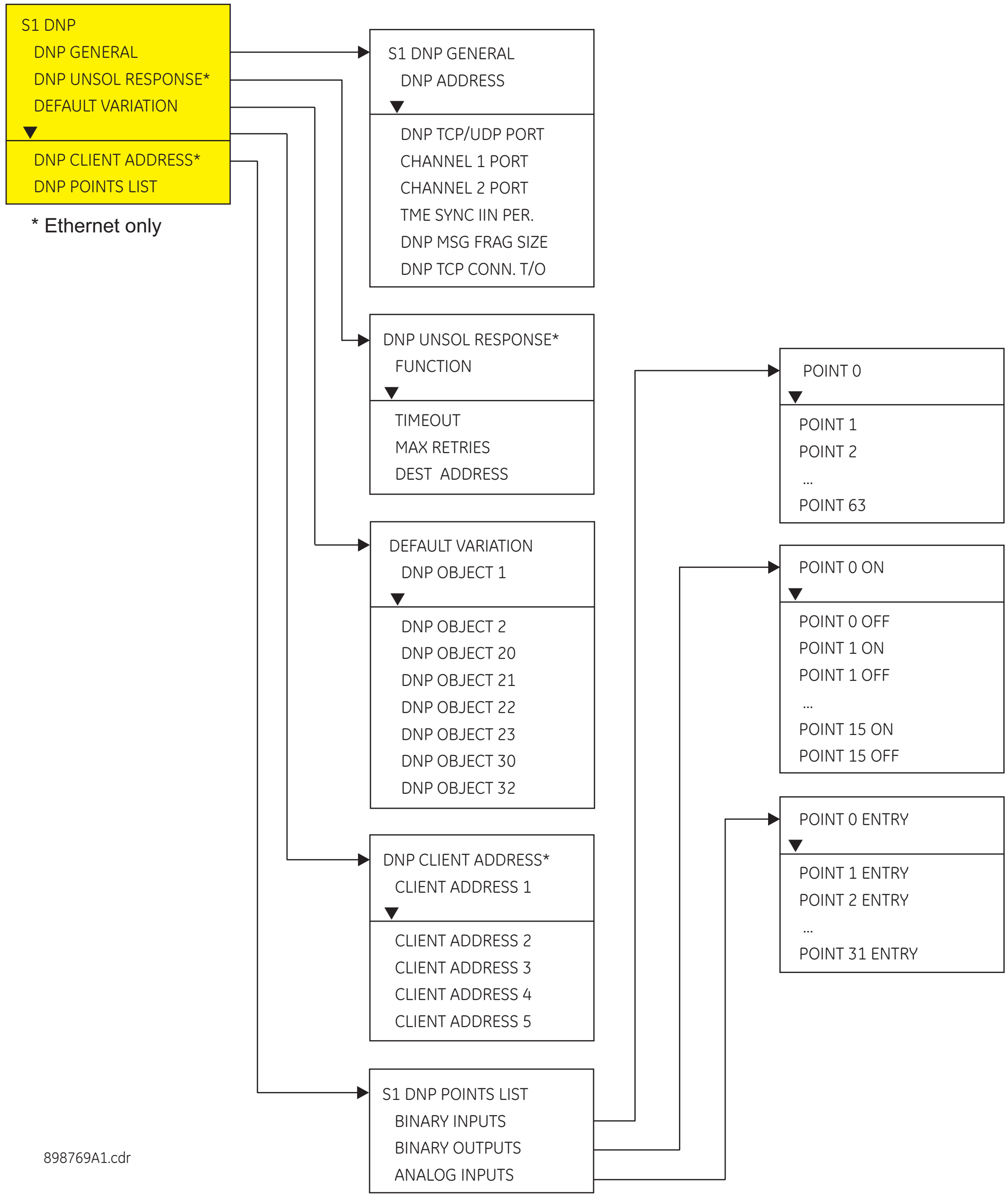
IEC60870-5-104 protocol

Figure 8: IEC 60870-5-104 protocol menu



DNP communication

Figure 9: DNP communication menu



The following path is available using the keypad. For instructions on how to use the keypad, please refer to *Chapter 3 - Working with the Keypad*.

PATH: **SETPOINTS > RELAY SETUP > COMMUNICATIONS > DNP PROTOCOL > DNP GENERAL**

The following table, from the *350 Communications Guide*, shows the list of DNP Binary Inputs.

Code	Type	Definition
FC134B	unsigned 16 bits	DNP Binary Inputs
0		Off
0x0040		Contact IN 1 On
0x0041		Contact IN 2 On
0x0042		Contact IN 3 On
0x0043		Contact IN 4 On
0x0044		Contact IN 5 On
0x0045		Contact IN 6 On
0x0046		Contact IN 7 On
0x0047		Contact IN 8 On
0x0048		Contact IN 9 On
0x0049		Contact IN 10 On
0x0060		Contact IN 1 Off
0x0061		Contact IN 2 Off
0x0062		Contact IN 3 Off
0x0063		Contact IN 4 Off
0x0064		Contact IN 5 Off
0x0065		Contact IN 6 Off
0x0066		Contact IN 7 Off
0x0067		Contact IN 8 Off
0x0068		Contact IN 9 Off
0x0069		Contact IN 10 Off
0x0080		Virtual IN 1 On
0x0081		Virtual IN 2 On
0x0082		Virtual IN 3 On
0x0083		Virtual IN 4 On
0x0084		Virtual IN 5 On
0x0085		Virtual IN 6 On
0x0086		Virtual IN 7 On
0x0087		Virtual IN 8 On
0x0088		Virtual IN 9 On
0x0089		Virtual IN 10 On
0x008A		Virtual IN 11 On
0x008B		Virtual IN 12 On
0x008C		Virtual IN 13 On
0x008D		Virtual IN 14 On
0x008E		Virtual IN 15 On
0x008F		Virtual IN 16 On
0x0090		Virtual IN 17 On
0x0091		Virtual IN 18 On
0x0092		Virtual IN 19 On
0x0093		Virtual IN 20 On
0x0094		Virtual IN 21 On
0x0095		Virtual IN 22 On
0x0096		Virtual IN 23 On
0x0097		Virtual IN 24 On

Code	Type	Definition
0x0098		Virtual IN 25 On
0x0099		Virtual IN 26 On
0x009A		Virtual IN 27 On
0x009B		Virtual IN 28 On
0x009C		Virtual IN 29 On
0x009D		Virtual IN 30 On
0x009E		Virtual IN 31 On
0x009F		Virtual IN 32 On
0x01C0		Remote IN 1 On
0x01C1		Remote IN 2 On
0x01C2		Remote IN 3 On
0x01C3		Remote IN 4 On
0x01C4		Remote IN 5 On
0x01C5		Remote IN 6 On
0x01C6		Remote IN 7 On
0x01C7		Remote IN 8 On
0x01C8		Remote IN 9 On
0x01C9		Remote IN 10 On
0x01CA		Remote IN 11 On
0x01CB		Remote IN 12 On
0x01CC		Remote IN 13 On
0x01CD		Remote IN 14 On
0x01CE		Remote IN 15 On
0x01CF		Remote IN 16 On
0x01D0		Remote IN 17 On
0x01D1		Remote IN 18 On
0x01D2		Remote IN 19 On
0x01D3		Remote IN 20 On
0x01D4		Remote IN 21 On
0x01D5		Remote IN 22 On
0x01D6		Remote IN 23 On
0x01D7		Remote IN 24 On
0x01D8		Remote IN 25 On
0x01D9		Remote IN 26 On
0x01DA		Remote IN 27 On
0x01DB		Remote IN 28 On
0x01DC		Remote IN 29 On
0x01DD		Remote IN 30 On
0x01DE		Remote IN 31 On
0x01DF		Remote IN 32 On
0x01E0		Remote IN 1 Off
0x01E1		Remote IN 2 Off
0x01E2		Remote IN 3 Off
0x01E3		Remote IN 4 Off
0x01E4		Remote IN 5 Off
0x01E5		Remote IN 6 Off
0x01E6		Remote IN 7 Off

Code	Type	Definition
0x01E7		Remote IN 8 Off
0x01E8		Remote IN 9 Off
0x01E9		Remote IN 10 Off
0x01EA		Remote IN 11 Off
0x01EB		Remote IN 12 Off
0x01EC		Remote IN 13 Off
0x01ED		Remote IN 14 Off
0x01EE		Remote IN 15 Off
0x01EF		Remote IN 16 Off
0x01F0		Remote IN 17 Off
0x01F1		Remote IN 18 Off
0x01F2		Remote IN 19 Off
0x01F3		Remote IN 20 Off
0x01F4		Remote IN 21 Off
0x01F5		Remote IN 22 Off
0x01F6		Remote IN 23 Off
0x01F7		Remote IN 24 Off
0x01F8		Remote IN 25 Off
0x01F9		Remote IN 26 Off
0x01FA		Remote IN 27 Off
0x01FB		Remote IN 28 Off
0x01FC		Remote IN 29 Off
0x01FD		Remote IN 30 Off
0x01FE		Remote IN 31 Off
0x01FF		Remote IN 32 Off
0x8002		Any Trip
0x8042		Therm O/L Trip OP
0x8044		Therm O/L Trip DPO
0x804A		Therm PhA Trip OP
0x804C		Therm PhA Trip DPO
0x8052		Therm PhB Trip OP
0x8054		Therm PhB Trip DPO
0x8062		Therm PhC Trip OP
0x8064		Therm PhC Trip DPO
0x84C1		LE 1 Trip PKP
0x84C2		LE 1 Trip OP
0x84C4		LE 1 Trip DPO
0x8501		LE 2 Trip PKP
0x8502		LE 2 Trip OP
0x8504		LE 2 Trip DPO
0x8541		LE 3 Trip PKP
0x8542		LE 3 Trip OP
0x8544		LE 3 Trip DPO
0x8581		LE 4 Trip PKP
0x8582		LE 4 Trip OP
0x8584		LE 4 Trip DPO
0x85C1		LE 5 Trip PKP

Code	Type	Definition
0x85C2		LE 5 Trip OP
0x85C4		LE 5 Trip DPO
0x8601		LE 6 Trip PKP
0x8602		LE 6 Trip OP
0x8604		LE 6 Trip DPO
0x8641		LE 7 Trip PKP
0x8642		LE 7 Trip OP
0x8644		LE 7 Trip DPO
0x8681		LE 8 Trip PKP
0x8682		LE 8 Trip OP
0x8684		LE 8 Trip DPO
0x8F82		Fuse Fail Trip OP
0x8F84		Fuse Fail Trip DPO
0x9001		Ph IOC1 Trip PKP
0x9002		Ph IOC1 Trip OP
0x9004		Ph IOC1 Trip DPO
0x9009		Ph A IOC1 Trip PKP
0x900A		Ph A IOC1 Trip OP
0x900C		Ph A IOC1 Trip DPO
0x9011		Ph B IOC1 Trip PKP
0x9012		Ph B IOC1 Trip OP
0x9014		Ph B IOC1 Trip DPO
0x9021		Ph C IOC1 Trip PKP
0x9022		Ph C IOC1 Trip OP
0x9024		Ph C IOC1 Trip DPO
0x9041		Ntrl IOC1 Trip PKP
0x9042		Ntrl IOC1 Trip OP
0x9044		Ntrl IOC1 Trip DPO
0x9081		Gnd IOC1 Trip PKP
0x9082		Gnd IOC1 Trip OP
0x9084		Gnd IOC1 Trip DPO
0x90C1		Ph TOC1 Trip PKP
0x90C2		Ph TOC1 Trip OP
0x90C4		Ph TOC1 Trip DPO
0x90C9		Ph A TOC1 Trip PKP
0x90CA		Ph A TOC1 Trip OP
0x90CC		Ph A TOC1 Trip DPO
0x90D1		Ph B TOC1 Trip PKP
0x90D2		Ph B TOC1 Trip OP
0x90D4		Ph B TOC1 Trip DPO
0x90E1		Ph C TOC1 Trip PKP
0x90E2		Ph C TOC1 Trip OP
0x90E4		Ph C TOC1 Trip DPO
0x9101		Ntrl TOC1 Trip PKP
0x9102		Ntrl TOC1 Trip OP
0x9104		Ntrl TOC1 Trip DPO
0x9141		Gnd TOC1 Trip PKP

Code	Type	Definition
0x9142		Gnd TOC1 Trip OP
0x9144		Gnd TOC1 Trip DPO
0x9181		Ph IOC2 Trip PKP
0x9182		Ph IOC2 Trip OP
0x9184		Ph IOC2 Trip DPO
0x9189		Ph A IOC2 Trip PKP
0x918A		Ph A IOC2 Trip OP
0x918C		Ph A IOC2 Trip DPO
0x9191		Ph B IOC2 Trip PKP
0x9192		Ph B IOC2 Trip OP
0x9194		Ph B IOC2 Trip DPO
0x91A1		Ph C IOC2 Trip PKP
0x91A2		Ph C IOC2 Trip OP
0x91A4		Ph C IOC2 Trip DPO
0x91C1		Ntrl IOC2 Trip PKP
0x91C2		Ntrl IOC2 Trip OP
0x91C4		Ntrl IOC2 Trip DPO
0x9201		Gnd IOC2 Trip PKP
0x9202		Gnd IOC2 Trip OP
0x9204		Gnd IOC2 Trip DPO
0x9301		SGnd TOC1 Trip PKP
0x9302		SGnd TOC1 Trip OP
0x9304		SGnd TOC1 Trip DPO
0x93C1		NegSeq OV Trp PKP
0x93C2		NegSeq OV Trp OP
0x93C4		NegSeq OV Trp DPO
0x9401		Ntrl OV Trip PKP
0x9402		Ntrl OV Trp OP
0x9404		Ntrl OV Trip DPO
0x9441		Ph OV1 Trip PKP
0x9442		Ph OV1 Trip OP
0x9444		Ph OV1 Trip DPO
0x9449		Ph A OV1 Trip PKP
0x944A		Ph A OV1 Trip OP
0x944C		Ph A OV1 Trip DPO
0x9451		Ph B OV1 Trip PKP
0x9452		Ph B OV1 Trip OP
0x9454		Ph B OV1 Trip DPO
0x9461		Ph C OV1 Trip PKP
0x9462		Ph C OV1 Trip OP
0x9464		Ph C OV1 Trip DPO
0x9481		Ph UV1 Trip PKP
0x9482		Ph UV1 Trip OP
0x9484		Ph UV1 Trip DPO
0x9489		Ph A UV1 Trip PKP
0x948A		Ph A UV1 Trip OP
0x948C		Ph A UV1 Trip DPO

Code	Type	Definition
0x9491		Ph B UV1 Trip PKP
0x9492		Ph B UV1 Trip OP
0x9494		Ph B UV1 Trip DPO
0x94A1		Ph C UV1 Trip PKP
0x94A2		Ph C UV1 Trip OP
0x94A4		Ph C UV1 Trip DPO
0x94C1		Aux OV Trip PKP
0x94C2		Aux OV Trip OP
0x94C4		Aux OV Trip DPO
0x9501		Aux UV Trip PKP
0x9502		Aux UV Trip OP
0x9504		Aux UV Trip DPO
0x9541		UndrFreq1 Trip PKP
0x9542		UndrFreq1 Trip OP
0x9544		UndrFreq1 Trip DPO
0x9581		UndrFreq2 Trip PKP
0x9582		UndrFreq2 Trip OP
0x9584		UndrFreq2 Trip DPO
0x95C1		OverFreq1 Trip PKP
0x95C2		OverFreq1 Trip OP
0x95C4		OverFreq1 Trip DPO
0x9601		OverFreq2 Trip PKP
0x9602		OverFreq2 Trip OP
0x9604		OverFreq2 Trip DPO
0x9641		SGnd IOC1 Trip PKP
0x9642		SGnd IOC1 Trip OP
0x9644		SGnd IOC1 Trip DPO
0x9681		SGnd IOC2 Trip PKP
0x9682		SGnd IOC2 Trip OP
0x9684		SGnd IOC2 Trip DPO
0x96C1		NegSeq IOC Trp PKP
0x96C2		NegSeq IOC Trp OP
0x96C4		NegSeq IOC Trp DPO
0x98D2		Ph B UV2 Trip OP
0x9C01		LE 9 Trip PKP
0x9C02		LE 9 Trip OP
0x9C04		LE 9 Trip DPO
0x9C41		LE 10 Trip PKP
0x9C42		LE 10 Trip OP
0x9C44		LE 10 Trip DPO
0x9C81		LE 11 Trip PKP
0x9C82		LE 11 Trip OP
0x9C84		LE 11 Trip DPO
0x9CC1		LE 12 Trip PKP
0x9CC2		LE 12 Trip OP
0x9CC4		LE 12 Trip DPO
0x9D01		LE 13 Trip PKP

Code	Type	Definition
0x9D02		LE 13 Trip OP
0x9D04		LE 13 Trip DPO
0x9D41		LE 14 Trip PKP
0x9D42		LE 14 Trip OP
0x9D44		LE 14 Trip DPO
0x9D81		LE 15 Trip PKP
0x9D82		LE 15 Trip OP
0x9D84		LE 15 Trip DPO
0x9DC1		LE 16 Trip PKP
0x9DC2		LE 16 Trip OP
0x9DC4		LE 16 Trip DPO
0xA002		Any Alarm
0xA042		Therm Lvl Alrm OP
0xA044		Therm Lvl Alrm DPO
0xA04A		Therm PhA Alrm OP
0xA04C		Therm PhA Alrm DPO
0xA052		Therm PhB Alrm OP
0xA054		Therm PhB Alrm DPO
0xA062		Therm PhC Alrm OP
0xA064		Therm PhC Alrm DPO
0xA4C1		LE 1 Alarm PKP
0xA4C2		LE 1 Alarm OP
0xA4C4		LE 1 Alarm DPO
0xA501		LE 2 Alarm PKP
0xA502		LE 2 Alarm OP
0xA504		LE 2 Alarm DPO
0xA541		LE 3 Alarm PKP
0xA542		LE 3 Alarm OP
0xA544		LE 3 Alarm DPO
0xA581		LE 4 Alarm PKP
0xA582		LE 4 Alarm OP
0xA584		LE 4 Alarm DPO
0xA5C1		LE 5 Alarm PKP
0xA5C2		LE 5 Alarm OP
0xA5C4		LE 5 Alarm DPO
0xA601		LE 6 Alarm PKP
0xA602		LE 6 Alarm OP
0xA604		LE 6 Alarm DPO
0xA641		LE 7 Alarm PKP
0xA642		LE 7 Alarm OP
0xA644		LE 7 Alarm DPO
0xA681		LE 8 Alarm PKP
0xA682		LE 8 Alarm OP
0xA684		LE 8 Alarm DPO
0xABC1		HI Amb Temp PKP
0xABC2		HI Amb Temp OP
0xABC4		HI Amb Temp DPO

Code	Type	Definition
0xAC01		LO Amb Temp PKP
0xAC02		LO Amb Temp OP
0xAC04		LO Amb Temp DPO
0xAC42		Self Test Alarm OP
0xACC2		BKRTrpCntrAlrm OP
0xAD02		R1 CoilMonAlrm OP
0xAD42		R2 CoilMonAlrm OP
0xAD81		BKR1 Fail Alrm PKP
0xAD82		BKR1 Fail Alrm OP
0xAD84		BKR1 Fail Alrm DPO
0xADC2		BKR Stat Fail OP
0xAE41		CLP Alarm PKP
0xAE42		CLP Alarm OP
0xAF81		Fuse Fail Alrm PKP
0xAF82		Fuse Fail Alrm OP
0xAF84		Fuse Fail Alrm DPO
0xB001		Ph IOC1 Alarm PKP
0xB002		Ph IOC1 Alarm OP
0xB004		Ph IOC1 Alarm DPO
0xB009		Ph A IOC1 Alrm PKP
0xB00A		Ph A IOC1 Alrm OP
0xB00C		Ph A IOC1 Alrm DPO
0xB011		Ph B IOC1 Alrm PKP
0xB012		Ph B IOC1 Alrm OP
0xB014		Ph B IOC1 Alrm DPO
0xB021		Ph C IOC1 Alrm PKP
0xB022		Ph C IOC1 Alrm OP
0xB024		Ph C IOC1 Alrm DPO
0xB041		Ntrl IOC1 Alrm PKP
0xB042		Ntrl IOC1 Alrm OP
0xB044		Ntrl IOC1 Alrm DPO
0xB081		Gnd IOC1 Alarm PKP
0xB082		Gnd IOC1 Alarm OP
0xB084		Gnd IOC1 Alarm DPO
0xB0C1		Ph TOC1 Alarm PKP
0xB0C2		Ph TOC1 Alarm OP
0xB0C4		Ph TOC1 Alarm DPO
0xB0C9		Ph A TOC1 Alrm PKP
0xB0CA		Ph A TOC1 Alrm OP
0xB0CC		Ph A TOC1 Alrm DPO
0xB0D1		Ph B TOC1 Alrm PKP
0xB0D2		Ph B TOC1 Alrm OP
0xB0D4		Ph B TOC1 Alrm DPO
0xB0E1		Ph C TOC1 Alrm PKP
0xB0E2		Ph C TOC1 Alrm OP
0xB0E4		Ph C TOC1 Alrm DPO
0xB101		Ntrl TOC1 Alrm PKP

Code	Type	Definition
0xB102		Ntrl TOC1 Alrm OP
0xB104		Ntrl TOC1 Alrm DPO
0xB141		Gnd TOC1 Alarm PKP
0xB142		Gnd TOC1 Alarm OP
0xB144		Gnd TOC1 Alarm DPO
0xB181		Ph IOC2 Alarm PKP
0xB182		Ph IOC2 Alarm OP
0xB184		Ph IOC2 Alarm DPO
0xB189		Ph A IOC2 Alrm PKP
0xB18A		Ph A IOC2 Alrm OP
0xB18C		Ph A IOC2 Alrm DPO
0xB191		Ph B IOC2 Alrm PKP
0xB192		Ph B IOC2 Alrm OP
0xB194		Ph B IOC2 Alrm DPO
0xB1A1		Ph C IOC2 Alrm PKP
0xB1A2		Ph C IOC2 Alrm OP
0xB1A4		Ph C IOC2 Alrm DPO
0xB1C1		Ntrl IOC2 Alrm PKP
0xB1C2		Ntrl IOC2 Alrm OP
0xB1C4		Ntrl IOC2 Alrm DPO
0xB201		Gnd IOC2 Alarm PKP
0xB202		Gnd IOC2 Alarm OP
0xB204		Gnd IOC2 Alarm DPO
0xB301		SGnd TOC1 Alrm PKP
0xB302		SGnd TOC1 Alrm OP
0xB304		SGnd TOC1 Alrm DPO
0xB342		NtrlDir RevAlm OP
0xB344		NtrlDir RevAlmDPO
0xB382		GndDir RevAlm OP
0xB384		GndDir RevAlm DPO
0xB3C1		NegSeq OV Alrm PKP
0xB3C2		NegSeq OV Alrm OP
0xB3C4		NegSeq OV Alrm DPO
0xB401		Ntrl OV Alrm PKP
0xB402		Ntrl OV Alrm OP
0xB404		Ntrl OV Alrm DPO
0xB441		Ph OV1 Alarm PKP
0xB442		Ph OV1 Alarm OP
0xB444		Ph OV1 Alarm DPO
0xB449		Ph A OV1 Alarm PKP
0xB44A		Ph A OV1 Alarm OP
0xB44C		Ph A OV1 Alarm DPO
0xB451		Ph B OV1 Alarm PKP
0xB452		Ph B OV1 Alarm OP
0xB454		Ph B OV1 Alarm DPO
0xB461		Ph C OV1 Alarm PKP
0xB462		Ph C OV1 Alarm OP

Code	Type	Definition
0xB464		Ph C OV1 Alarm DPO
0xB481		Ph UV1 Alarm PKP
0xB482		Ph UV1 Alarm OP
0xB484		Ph UV1 Alarm DPO
0xB489		Ph A UV1 Alarm PKP
0xB48A		Ph A UV1 Alarm OP
0xB48C		Ph A UV1 Alarm DPO
0xB491		Ph B UV1 Alarm PKP
0xB492		Ph B UV1 Alarm OP
0xB494		Ph B UV1 Alarm DPO
0xB4A1		Ph C UV1 Alarm PKP
0xB4A2		Ph C UV1 Alarm OP
0xB4A4		Ph C UV1 Alarm DPO
0xB4C1		Aux OV Alarm PKP
0xB4C2		Aux OV Alarm OP
0xB4C4		Aux OV Alarm DPO
0xB501		Aux UV Alarm PKP
0xB502		Aux UV Alarm OP
0xB504		Aux UV Alarm DPO
0xB541		UndrFreq1 Alrm PKP
0xB542		UndrFreq1 Alrm OP
0xB544		UndrFreq1 Alrm DPO
0xB581		UndrFreq2 Alrm PKP
0xB582		UndrFreq2 Alrm OP
0xB584		UndrFreq2 Alrm DPO
0xB5C1		OverFreq1 Alrm PKP
0xB5C2		OverFreq1 Alrm OP
0xB5C4		OverFreq1 Alrm DPO
0xB601		OverFreq2 Alrm PKP
0xB602		OverFreq2 Alrm OP
0xB604		OverFreq2 Alrm DPO
0xB641		SGnd IOC1 Alrm PKP
0xB642		SGnd IOC1 Alrm OP
0xB644		SGnd IOC1 Alrm DPO
0xB681		SGnd IOC2 Alrm PKP
0xB682		SGnd IOC2 Alrm OP
0xB684		SGnd IOC2 Alrm DPO
0xB6C1		NSeq IOC Alrm PKP
0xB6C2		NSeq IOC Alrm OP
0xB6C4		NSeq IOC Alrm DPO
0xBC01		LE 9 Alarm PKP
0xBC02		LE 9 Alarm OP
0xBC04		LE 9 Alarm DPO
0xBC41		LE 10 Alarm PKP
0xBC42		LE 10 Alarm OP
0xBC44		LE 10 Alarm DPO
0xBC81		LE 11 Alarm PKP

Code	Type	Definition
0xBC82		LE 11 Alarm OP
0xBC84		LE 11 Alarm DPO
0xBCC1		LE 12 Alarm PKP
0xBCC2		LE 12 Alarm OP
0xBCC4		LE 12 Alarm DPO
0xBD01		LE 13 Alarm PKP
0xBD02		LE 13 Alarm OP
0xBD04		LE 13 Alarm DPO
0xBD41		LE 14 Alarm PKP
0xBD42		LE 14 Alarm OP
0xBD44		LE 14 Alarm DPO
0xBD81		LE 15 Alarm PKP
0xBD82		LE 15 Alarm OP
0xBD84		LE 15 Alarm DPO
0xBDC1		LE 16 Alarm PKP
0xBDC2		LE 16 Alarm OP
0xBDC4		LE 16 Alarm DPO
0xBE01		PhDir RevAlm PKP
0xBE02		PhDir RevAlm OP
0xBE04		PhDir RevAlm DPO
0xBE09		PhADir RevAlm PKP
0xBE0A		PhADir RevAlm OP
0xBE0C		PhADir RevAlm DPO
0xBE11		PhBDir RevAlm PKP
0xBE12		PhBDir RevAlm OP
0xBE14		PhBDir RevAlm DPO
0xBE21		PhCDir RevAlm PKP
0xBE22		PhCDir RevAlm OP
0xBE24		PhCDir RevAlm DPO
0xBE41		PhDir UndAlm PKP
0xBE42		PhDir UndAlm OP
0xBE44		PhDir UndAlm DPO
0xBE49		PhADir UndAlm PKP
0xBE4A		PhADir UndAlm OP
0xBE4C		PhADir UndAlm DPO
0xBE51		PhBDir UndAlm PKP
0xBE52		PhBDir UndAlm OP
0xBE54		PhBDir UndAlm DPO
0xBE61		PhCDir UndAlm PKP
0xBE62		PhCDir UndAlm OP
0xBE64		PhCDir UndAlm DPO
0xBE81		GndDir UndAlm PKP
0xBE82		GndDir UndAlm OP
0xBE84		GndDir UndAlm DPO
0xBEC1		NtrlDir UndAlm PKP
0xBEC2		NtrlDir UndAlm OP
0xBEC4		NtrlDir UndAlm DPO

Code	Type	Definition
0xC042		Output Relay 3 On
0xC082		Output Relay 4 On
0xC0C2		Output Relay 5 On
0xC102		Output Relay 6 On
0xC142		Self-Test Rly 7 On
0xC182		Output Relay 1 On
0xC1C2		Output Relay 2 On
0xC202		BKR Connected
0xC4C1		LE 1 PKP
0xC4C2		LE 1 OP
0xC4C4		LE 1 DPO
0xC501		LE 2 PKP
0xC502		LE 2 OP
0xC504		LE 2 DPO
0xC541		LE 3 PKP
0xC542		LE 3 OP
0xC544		LE 3 DPO
0xC581		LE 4 PKP
0xC582		LE 4 OP
0xC584		LE 4 DPO
0xC5C1		LE 5 PKP
0xC5C2		LE 5 OP
0xC5C4		LE 5 DPO
0xC601		LE 6 PKP
0xC602		LE 6 OP
0xC604		LE 6 DPO
0xC641		LE 7 PKP
0xC642		LE 7 OP
0xC644		LE 7 DPO
0xC681		LE 8 PKP
0xC682		LE 8 OP
0xC684		LE 8 DPO
0xC882		Setpoint Group2 On
0xC902		Open Breaker
0xC942		Close Breaker
0xC982		Maint. Req. OP
0xCA02		52a Contact OP
0xCA42		52b Contact OP
0xCA44		52b Contact DPO
0xCA82		Reset OK
0xCB01		AR Close PKP
0xCB02		AR Close
0xCB04		AR Close DPO
0xCB42		AR N/Ready
0xCB81		AR In Progress PKP
0xCB82		AR In Progress
0xCB84		AR In Progress DPO

Code	Type	Definition
0xCBC1		AR Disabled PKP
0xCBC2		AR Disabled
0xCBC4		AR Disabled DPO
0xCC02		AR Ext. Init
0xCC41		AR Ready PKP
0xCC42		AR Ready
0xCC44		AR Ready DPO
0xCCC2		BKR Stat Open
0xCD02		BKR Stat Clsd
0xCD42		Setpoint Group1 On
0xCE41		CLP PKP
0xCE42		CLP Op
0xCE44		CLP DPO
0xCF81		Fuse Fail InhibPKP
0xCF82		Fuse Fail Inhib OP
0xD342		Ntrl Dir Rev OP
0xD344		Ntrl Dir Rev DPO
0xD382		Gnd Dir Rev OP
0xD384		Gnd Dir Rev DPO
0xD801		NSeq TOC1 PKP
0xD802		NSeq TOC1 OP
0xD804		NSeq TOC1 DPO
0xDC01		LE 9 PKP
0xDC02		LE 9 OP
0xDC04		LE 9 DPO
0xDC41		LE 10 PKP
0xDC42		LE 10 OP
0xDC44		LE 10 DPO
0xDC81		LE 11 PKP
0xDC82		LE 11 OP
0xDC84		LE 11 DPO
0xDCC1		LE 12 PKP
0xDCC2		LE 12 OP
0xDCC4		LE 12 DPO
0xDD01		LE 13 PKP
0xDD02		LE 13 OP
0xDD04		LE 13 DPO
0xDD41		LE 14 PKP
0xDD42		LE 14 OP
0xDD44		LE 14 DPO
0xDD81		LE 15 PKP
0xDD82		LE 15 OP
0xDD84		LE 15 DPO
0xDDC1		LE 16 PKP
0xDDC2		LE 16 OP
0xDDC4		LE 16 DPO
0xDE01		PhDir Rev PKP

Code	Type	Definition
0xDE02		PhDir Rev OP
0xDE04		PhDir Rev DPO
0xDE09		PhADir Rev PKP
0xDE0A		PhADir Rev OP
0xDE0C		PhADir Rev DPO
0xDE11		PhBDir Rev PKP
0xDE12		PhBDir Rev OP
0xDE14		PhBDir Rev DPO
0xDE21		PhCDir Rev PKP
0xDE22		PhCDir Rev OP
0xDE24		PhCDir Rev DPO
0xDE41		PhDir Und PKP
0xDE42		PhDir Und OP
0xDE44		PhDir Und DPO
0xDE49		PhADir Und PKP
0xDE4A		PhADir Und OP
0xDE4C		PhADir Und DPO
0xDE51		PhBDir Und PKP
0xDE52		PhBDir Und OP
0xDE54		PhBDir Und DPO
0xDE61		PhCDir Und PKP
0xDE62		PhCDir Und OP
0xDE64		PhCDir Und DPO
0xDE81		GndDir Und PKP
0xDE82		GndDir Und OP
0xDE84		GndDir Und DPO
0xDEC1		NtrlDir Und PKP
0xDEC2		NtrlDir Und OP
0xDEC4		NtrlDir Und DPO
0xE002		Any Block
0xE042		Therm O/L Blck
0xE182		Output Relay 1 BLK
0xE1C2		Output Relay 2 BLK
0xE882		Group Change Blk
0xEB02		AR Block
0xEE82		CLP Ph IOC1 BLK
0xEEC2		CLP Ph IOC2 BLK
0xEF02		CLPNtrlIOC1 BLK
0xEF42		CLPNtrlIOC2 BLK
0xEF82		CLP GndIOC1 BLK
0xEFC2		CLP GndIOC2 BLK
0xF002		Ph IOC1 Block
0xF042		Ntrl IOC1 Block
0xF082		Gnd IOC1 Block
0xF0C2		Ph TOC1 Block
0xF102		Ntrl TOC1 Block
0xF142		Gnd TOC1 Block

Code	Type	Definition
0xF182		Ph IOC2 Block
0xF1C2		Ntrl IOC2 Block
0xF202		Gnd IOC2 Block
0xF302		SGnd TOC1 Block
0xF342		NTRL DIR Rev Block
0xF382		Gnd Dir Block
0xF3C2		NegSeq OV Block
0xF402		Ntrl OV Block
0xF442		Ph OV1 Block
0xF482		Ph UV1 Block
0xF4C2		Aux OV Block
0xF502		Aux UV Block
0xF542		UndrFreq1 Block
0xF582		UndrFreq2 Block
0xF5C2		OverFreq1 Block
0xF602		OverFreq2 Block
0xF642		SGnd IOC1 Block
0xF682		SGnd IOC2 Block
0xF6C2		NSeq IOC Block
0xFE01		PhDir Block PKP
0xFE02		PhDir Block OP
0xFE04		PhDir Block DPO
0xFE41		PhDir Und Blk PKP
0xFE42		PhDir Und Blk OP
0xFE44		PhDir Und Blk DPO
0xFE81		GndDir Und Blk PKP
0xFE82		GndDir Und Blk OP
0xFE84		GndDir Und Blk DPO
0xFEC1		NtrlDir Und Blk PKP
0xFEC2		NtrlDir Und Blk OP
0xFEC4		NtrlDir Und Blk DPO

SR3 IEC 61850 GOOSE details

The 350 firmware supports IEC61850 GOOSE communications on the optional communications daughter board.

Portions of the IEC61850 standard not pertaining to GOOSE, are not implemented in the 350 relay.

The 350 relay does not support

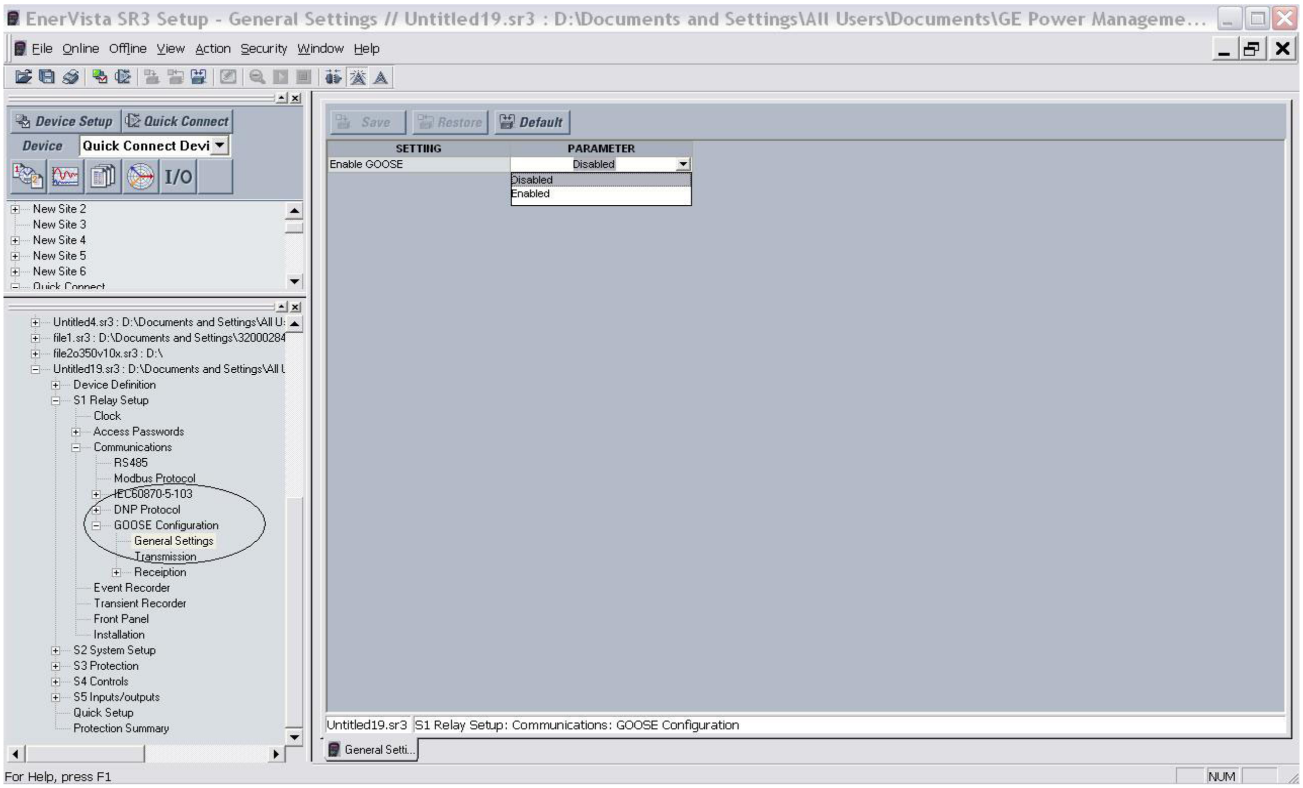
- Manufacturing Message Specification (MMS) standard ISO/IEC 9506
- the mapping of analogue values to data points in data sets in either the transmit or receive direction
- a file system to maintain SCL, ICD or CID files, for IEC61850 GOOSE. As such the implementation stores GOOSE configuration using MODBUS set points.

Configuration of transmission and reception settings for the GOOSE feature are performed using EnerVista SR3 Setup software.

The 350 firmware accepts GOOSE messages from UR, F650 and UR Plus. The interoperability with other manufacturers will be guaranteed in almost all cases, by implementing the reception side with nested structures (one level of nesting) and all the standard data types.

GOOSE settings changes will take effect only after the 350 relay is re-booted. One setting is available to Enable/Disable both Transmission and Reception. It is possible to change this setting from the Front Panel of the relay.

Figure 10: EnerVista SR3 GOOSE General Settings



Event recorder

The Event Recorder runs continuously, capturing and storing the last 256 events. All events are stored in a non-volatile memory where the information is maintained for up to 3 days in case of lost relay control power.

PATH: SETPOINTS > S1 RELAY SETUP > EVENT RECORDER

PICKUP EVENTS

Range: Disabled, Enabled

Default: Enabled

When set to “Enabled”, the event recorder records the events that occur when a protection element picks up.

DROPOUT EVENTS

Range: Disabled, Enabled

Default: Disabled

When set to “Enabled” the event recorder records the dropout state of a protection element.

TRIP EVENTS

Range: Disabled, Enabled

Default: Enabled

The trip events include all programmed relay elements set to trip the breaker. The text “TRIP” followed by the name of the operated element is recorded.

ALARM EVENTS

Range: Disabled, Enabled

Default: Enabled

These events include the elements programmed as an “ALARM” or “LATCHED ALARM” function, which detect power system conditions considered as an alarm.

CONTROL EVENTS

Range: Disabled, Enabled

Default: Enabled

If set to “Enabled”, the event recorder records events caused by the performance of the programmed control elements.

CONTACT INPUTS

Range: Disabled, Enabled

Default: Enabled

When set to “Enabled”, the event recorder will record the event, when a contact input changes its state.

LOGIC ELEMENT

Range: Disabled, Enabled

Default: Enabled

When set to “Enabled”, the event recorder records the events, which occur upon state change of any programmed remote input.

VIRTUAL INPUTS

Range: Disabled, Enabled

Default: Enabled

When set to “Enabled”, the event recorder records the events, which occur upon state changes of any logic element.

REMOTE INPUTS

Range: Disabled, Enabled

Default: Enabled

When set to “Enabled”, the event recorder records the events, which occur upon state change of any programmed remote input.

Transient recorder

The Transient Recorder contains waveforms captured at the same sampling rate as the other relay data at the point of trigger. By default, data is captured for the analog current and voltage inputs - Ia, Ib, Ic, Ig, Va, Vb, Vc, and Vx when relay is ordered with CTs and VTs, or only analog current inputs Ia, Ib, Ic, and Ig when relay is ordered without VTs. Triggering of the transient recorder occurs, when an event is detected, causing a pickup, trip, dropout, or alarm, any one of which has been "Enabled" to activate the trigger. The transient recorder trigger may also be activated when any of the selected trigger inputs 1 to 3 is detected as having “On” status.

The following path is available using the keypad. For instructions on how to use the keypad, please refer to *Chapter 3 - Working with the Keypad*.

PATH: **SETPOINTS > S1 RELAY SETUP > TRANSIENT RECDR**

BUFFER SETUP

Range: 1 x 192, 3 x 64, 6 x 32

Default: 3 x 64

Each selection from the range is expressed by two numbers; the first identifies the number of records, whereas the second stands for the number of cycles per record.

TRIGGER MODE

Range: Overwrite, Protected

Default: Overwrite

When the “Overwrite” setting is selected, the new records overwrite the old ones, meaning the relay will always keep the newest records. In “Protected” mode, the relay will keep the number of records corresponding to the selected number, only without overwriting.

TRIGGER POSITION

Range: 0 to 100% in steps of 1%

Default: 0%

This setting indicates the location of the trigger with respect to the selected length of record. For example at 20% selected trigger position, the length of each record will be split on 20% pre-trigger data, and 80% post-trigger data.

TRIGGER ON PKP

Range: Off, On

Default: Off

Selection of “Yes” setting enables triggering for the recorder upon Pickup condition detected from any protection or control element.

TRIGGER ON DPO

Range: Off, On

Default: Off

Selection of “Yes” setting enables triggering for the recorder upon a Dropout condition detected from any protection or control element.

TRIGGER ON TRIP

Range: Off, On

Default: Off

Selection of “Yes” setting enables triggering for the recorder upon Trip condition detected from any protection or control element.

TRIGGER ON ALARM

Range: Off, On

Default: Off

Selection of “Yes” setting enables triggering for the recorder upon Alarm condition detected from any protection or control element.

TRIGGER ON INPUT 1 to 3

Range: Off, Contact Input 1 to 10, Virtual Input 1 to 32, Remote Input 1 to 32, Logic Element 1 to 16

Default: Off

Selection of input or logic element from the settings range enables triggering input for the recorder. A record will be triggered if the status of the selected input changes to “On”.

Front panel with non-programmable LEDs

The user can send a message to the display, that will override any normal message by sending text through Modbus. Refer to the *350 Feeder Protection System Communications Guide* for register details.

PATH: **SETPOINTS > S1 RELAY SETUP > FRONT PANEL**

FLASH MESSAGE TIME

Range: 1 s to 65535 s

Default: 5 s

Flash messages are status, warning, error, or information messages displayed for several seconds in response to certain key presses during setting programming. These messages override any normal messages. The duration of a flash message on the display can be changed to accommodate different reading rates.

MESSAGE TIMEOUT

Range: 1 s to 65535 s

Default: 30 s

If the keypad is inactive for a period of time, the relay automatically reverts to a default message. The inactivity time is modified via this setting to ensure messages remain on the screen long enough during programming or reading of actual values.

SCREEN SAVER

Range: Off, 1 min to 10000 min

Default: Off

The life of the LCD backlight can be prolonged by enabling the Screen Saver mode.

If the keypad is inactive for the selected period of time, the relay automatically shuts off the LCD screen. Any activity (keypress, alarm, trip, or target message) will restore screen messages.

LED BKR OPEN COLOR

Range: Red, Green

Default: Green

Allows the user to select the color of the LED indicator under Breaker Open conditions.

LED BKR CLSD COLOR

Range: Red, Green

Default: Red

Allows the user to select the color of the LED indicator under Breaker Closed conditions.

Front panel with programmable LEDs

The front panel with programmable LEDs provides LEDs with programmable source (LED1 through LED4) and additional LEDs with programmable source and color (LED5 through LED8). By default these eight programmable LEDs are Off. Programmable LEDs can be configured using the keypad or the Enervista SR3 Setup software as described in Chapter 3 - Software Setup.

The following path is available using the keypad. For instructions on how to use the keypad, please refer to *Chapter 3 - Working with the Keypad*.

PATH: **SETPOINTS > S1 RELAY SETUP > FRONT PANEL**

FLASH MESSAGE TIME

Range: 1 s to 65535 s

Default: 5 s

Flash messages are status, warning, error, or information messages displayed for several seconds in response to certain key presses during setting programming. These messages override any normal messages. The duration of a flash message on the display can be changed to accommodate different reading rates.

MESSAGE TIMEOUT

Range: 1 s to 65535 s

Default: 30 s

If the keypad is inactive for a period of time, the relay automatically reverts to a default message. The inactivity time is modified via this setting to ensure messages remain on the screen long enough during programming or reading of actual values.

SCREEN SAVER

Range: Off, 1 min to 10000 min

Default: Off

The life of the LCD backlight can be prolonged by enabling the Screen Saver mode.

If the keypad is inactive for the selected period of time, the relay automatically shuts off the LCD screen. Any activity (keypress, alarm, trip, or target message) will restore screen messages.

LED1 SOURCE

Range: DNP binary input

Default: Off

Allows the user to select the signal source of the LED1.

LED2 SOURCE

Range: DNP binary input

Default: Off

Allows the user to select the signal source of the LED2.

LED3 SOURCE

Range: DNP binary input

Default: Off

Allows the user to select the signal source of the LED3.

LED4 SOURCE

Range: DNP binary input

Default: Off

Allows the user to select the signal source of the LED4.

LED5 COLOR

Range: Red, Orange, Green

Default: Orange

Allows the user to select the color of the LED5.

LED5 SOURCE

Range: DNP binary input

Default: Off

Allows the user to select the signal source of the LED5.

LED6 COLOR

Range: Red, Orange, Green

Default: Orange

Allows the user to select the color of the LED6.

LED6 SOURCE

Range: DNP binary input

Default: Off

Allows the user to select the signal source of the LED6.

LED7 COLOR

Range: Red, Orange, Green

Default: Orange

Allows the user to select the color of the LED7.

LED7 SOURCE

Range: DNP binary input

Default: Off

Allows the user to select the signal source of the LED7.

LED8 COLOR

Range: Red, Orange, Green

Default: Orange

Allows the user to select the color of the LED8.

LED8 SOURCE

Range: DNP binary input

Default: Off

Allows the user to select the signal source of the LED8.

Installation

PATH: **SETPOINTS > S1 RELAY SETUP > INSTALLATION**

RELAY NAME

Range: Feeder Name, Alpha-numeric (18 characters)

Default: Feeder Name

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

RELAY STATUS

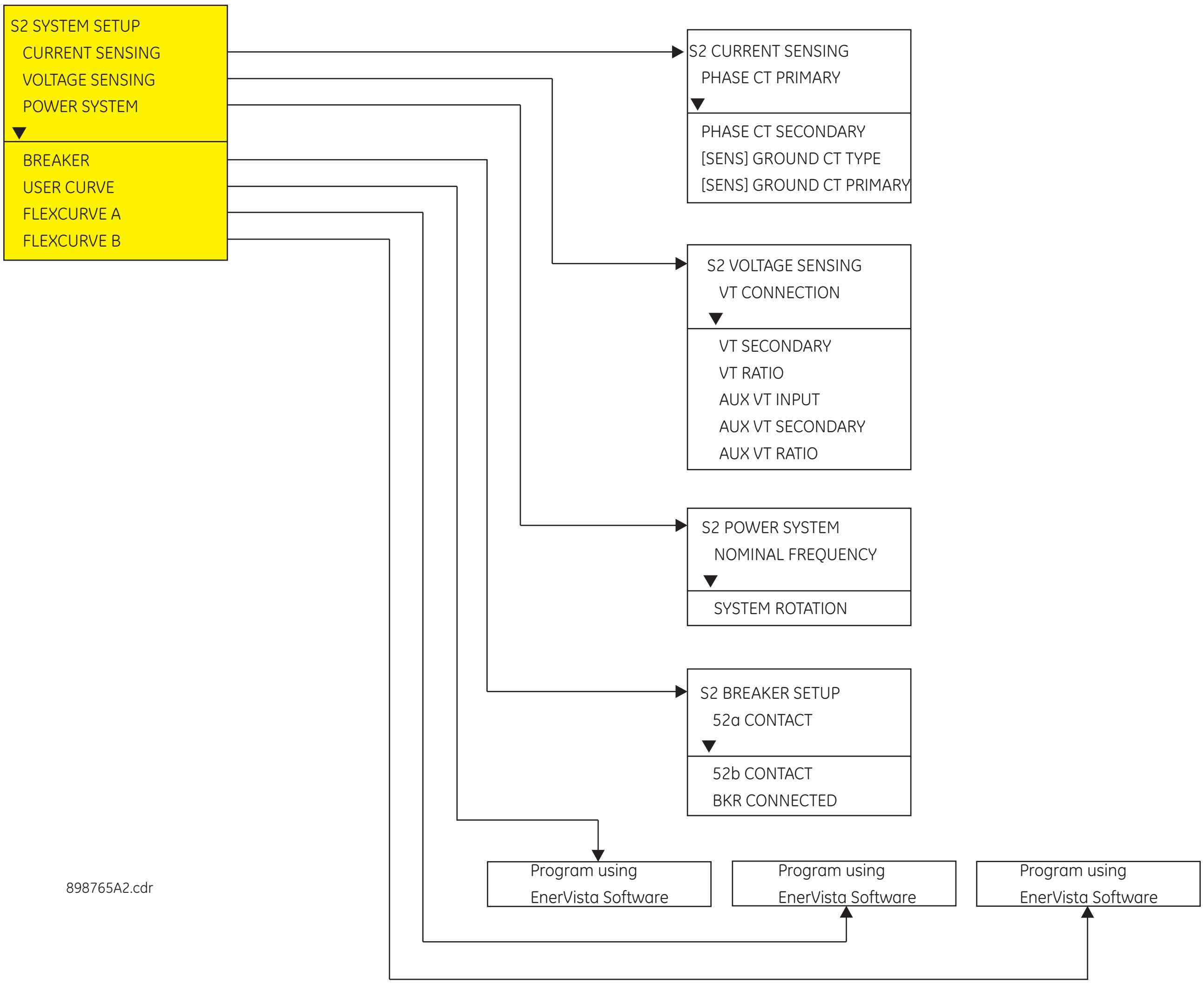
Range: Not Ready, Ready

Default: Not Ready

Allows the user to activate/deactivate the relay. The relay is not operational when set to "Not Ready."

S2 System Setup

Figure 11: Main system setup menu



Current sensing

PATH: **SETPOINTS > S2 SYSTEM SETUP > CURRENT SENSING**

PHASE CT PRIMARY

Range: 1 A to 6000 A

Default: 500 A

Enter the primary rating of the three-phase feeder CTs wired to the relay phase CT terminals (see above). For correct operation, the relay CT tap must match the feeder CT tap (5 A or 1 A).

As the phase CTs are connected in wye (star), the calculated phasor sum of the three phase currents ($Ia + Ib + Ic$ = Neutral Current = $3I_0$) is used as the input for the neutral overcurrent. In addition, a zero-sequence (core balance) CT which senses current in all of the circuit primary conductors, or a CT in a neutral grounding conductor may also be used.

PHASE CT SECONDARY

Range: 1 A or 5 A

Default: 5 A

Configurable 1 A or 5 A secondary, available with Phase Current option ‘P0’ installed. Enter the rated phase CT secondary current of the three-phase current transformers.

GROUND [SENS GND] CT PRIMARY

Range: [1 A to 600 A] 1 A to 6000 A

Default: 50 A

For the above configuration, the ground CT primary rating must be entered. To detect low level ground fault currents, the sensitive ground input may be used. In this case, the sensitive ground CT primary rating must be entered. The Sens GND CT primary range is 1 A to 600 A

The relay phase and ground CT types (5 A, 1 A) must match the feeder phase and ground CT taps.

GROUND [SENS GND] CT TYPE

Range: 1 A or 5 A

Default: 5 A

Configurable 1 A or 5 A secondary, available with Ground Current option ‘G0’ installed. Enter the rated ground CT secondary current of the ground current transformer.

Voltage sensing

PATH: **SETPOINTS > S2 SYSTEM SETUP > VOLTAGE SENSING**

VT CONNECTION

Range: Wye, Delta

Default: Wye

The 350 provides three-phase VT inputs, that can be wired to either bus VTs or feeder VTs. Select “Wye” connection, if phase-neutral voltages are wired to the relay VT terminals. Select “Delta” connection, if phase-phase voltages from either Delta or Open Delta VTs are connected to the three-phase VT terminals. See the VT connections per the Typical Wiring Diagram in Chapter 2.

VT SECONDARY

Range: 50 V to 240 V

Default: 120 V

This setting defines the voltage across the VT secondary winding when nominal voltage is applied to the primary. On a source of 13.8kV line-line voltage, with a VT ratio of 14400:120 V delta connection, the voltage to be entered is “115 V”. For a Wye connection, the voltage to be entered is 115/ 3 = 66 V.

VT RATIO

Range: 1:1 to 1500:1

Default: 1:1

This setting defines the VT primary to secondary turns ratio. For a 14400: 120 VT, the entry would be “120:1” (14400/120 = 120).

AUX VT INPUT

Range: V_{ab} *VT,* V_{bc} *VT,* V_{ca} *VT,* V_{an} *VT,* V_{bn} *VT,* V_{cn} *VT*

Default: V_{ab} *VT*

The 350 relay provides a voltage input (AUX VT INPUT), where a single feeder/line VT can be connected. The aux. VT voltage can be used for setting up auxiliary under- and over-voltage feeder protection. Select the phase-neutral, or the phase-phase voltage connected to the Aux VT input terminals

AUX VT SECONDARY

Range: 50 V to 240 V

Default: 110 V

This setting defines the voltage across the VT secondary winding when nominal voltage is applied to the primary. On a source of 13.8kV line-line voltage, with a VT ratio of 14400:120 V delta connection, the voltage to be entered is “115 V”. For a Wye connection, the voltage to be entered is 115/3 = 66 V.

AUX VT RATIO

Range: 1:1 to 1500:1

Default: 1:1

This setting defines the VT primary to secondary turns ratio. For a 14400: 120 VT, the entry would be “120:1” (14400/120 = 120).

NOTE

The 350 relay can be applied to both metering and protection feeders with up to 65 kV phase-to-phase voltage. Please ensure that the selected VT ratio and VT secondary do not result in a primary voltage exceeding 65 kV.

Power system

PATH: **SETPOINTS > S2 SYSTEM SETUP > POWER SYSTEM**

NOMINAL FREQUENCY

Range: 60 Hz, 50 Hz

Default: 60 Hz

Enter the nominal power system frequency. This value is used as a default to set the optimal digital sampling rate.

SYSTEM ROTATION

Range: ABC, ACB,

Default: ABC

Enter the phase sequence of the power system.

Breaker

The status of the feeder breaker is monitored by the 350 relay using the status of either one or two contact inputs named 52a (CI#1) and 52b (CI#2) wired to the breaker auxiliary contacts 52a and 52b respectively (see below).

The following path is available using the keypad. For instructions on how to use the keypad, please refer to *Chapter 3 - Working with the Keypad*.

PATH: **SETPOINTS > S2 SYSTEM SETUP > BREAKER**

52a CONTACT

Range: Disabled, 52a (CI#1)

Default: Disabled

Select contact input 52a (CI#1) if connected to breaker auxiliary contact 52a.

52b CONTACT

Range: Disabled, 52b (CI#2)

Default: Disabled

Select contact input 52b (CI#2) if connected to breaker auxiliary contact 52b.

BKR CONNECTED

Range: Contact Input 3 to 10, Disabled

Default: Disabled

Select a contact input to show whether the breaker is connected (Racked-in, or disconnect switches switched-on), or disconnected (racked-out, or disconnect switches switched-off) to the system.

NOTE

It is highly recommended to monitor the status of the feeder breaker using both breaker auxiliary contacts 52a, and 52b, however using only one of them is also acceptable.

The breaker status when disconnected from the main power circuit, such by drawout breaker racking mechanism, or isolated by the associated disconnect switches on a fixed circuit breaker, is provided by monitoring the contact input setting for "BKR CONNECTED".The logic for Breaker Open, and Breaker Close status is shown in the table below:

Table 1: Breaker open / Breaker closed status logic

52a contact configured	52b contact configured	Breaker status	
		Open	**Close**
Yes	Yes	52a contact open 52b contact closed	52a contact closed 52b contact open
Yes	No	52a contact open	52a contact closed
No	Yes	52b contact closed	52b contact open
No	No	Status unknown	

If the contact input selected under BKR CONNECTED setting is asserted, the breaker is considered connected to the primary system. When the breaker is determined disconnected, the breaker state is shown to be neither open, nor closed.

Table 2: Breaker status with both contacts configured

52a contact status	52b contact status	Breaker status
Off	On	open
On	Off	closed
On	On	BKR status failure
Off	Off	BKR status failure

User curve

There is one user-programmable User Curve available with the 350 system. Refer to the *S3 Protection/Current Elements/TOC Curves* section for details on how to set the User Curve. Due to the complexity of the configuration, the User Curve is available only through the EnerVista SR3 Setup program.

FlexCurves™

There are two user-programmable FlexCurves™ available with the 350 system, labeled A and B.

For details on FlexCurves™please refer to *S3 Protection/Current Elements/TOC Curves* in this manual.

NOTE

The **User Curve** and **Flexcurves A and B** are available for programming under *EnerVista SR3 Setup software*.

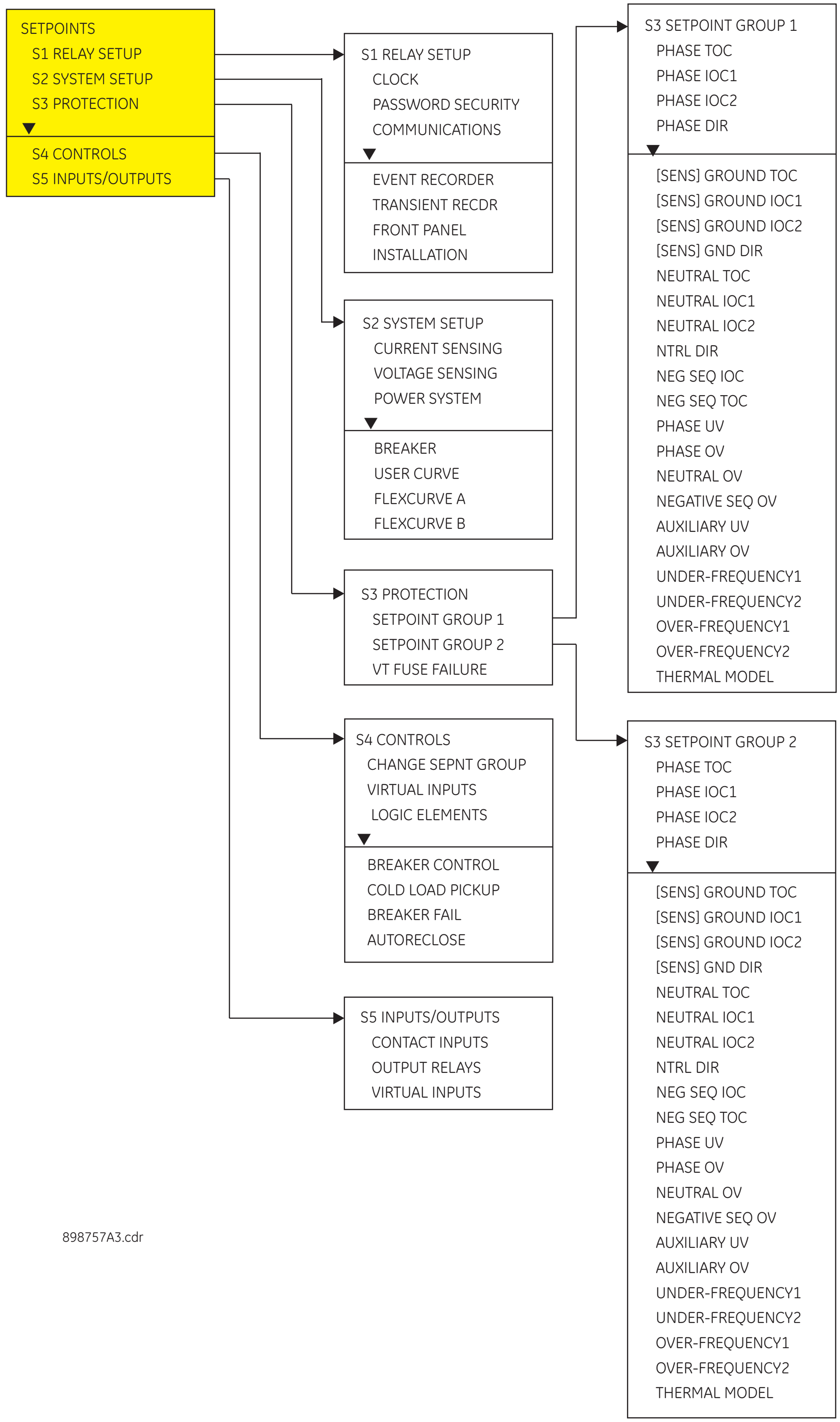
S3 Protection

The 350 protection elements are organized in two identical setpoint groups: Setpoint Group 1 and Setpoint Group 2.

Each Setpoint Group has the same protection functions, depending on the relay order code. These protection functions include:

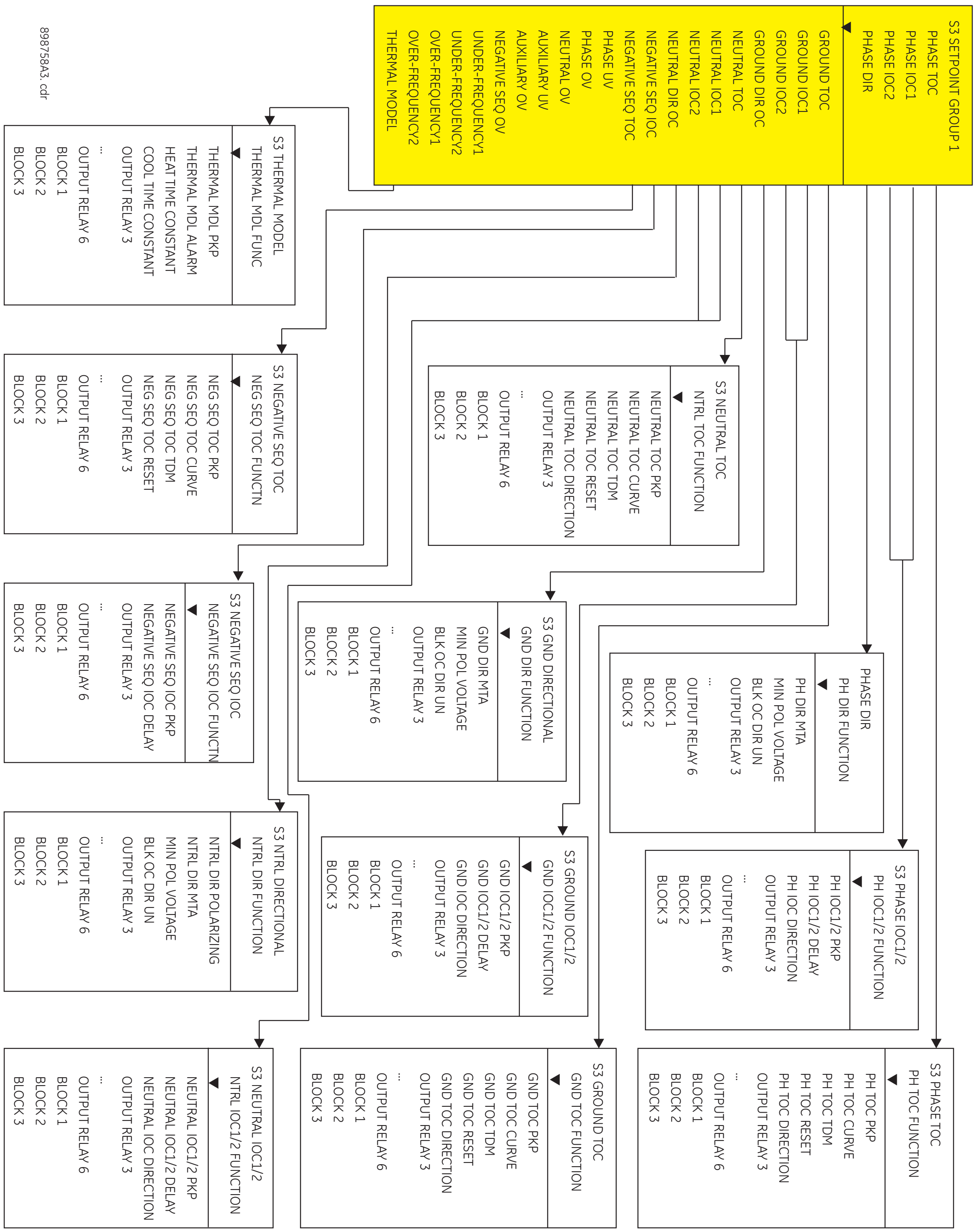
- Phase Timed Overcurrent (Phase TOC)
- Phase Instantaneous Overcurrent (Phase IOC)
- Phase Directional (Phase Dir)
- Ground Timed Overcurrent (Ground TOC)
- Ground Instantaneous Overcurrent (Ground IOC1, Ground IOC2)
- Ground Directional(Ground Dir)
- Neutral Timed Overcurrent (Neutral TOC)
- Neutral Instantaneous Overcurrent (Neutral IOC1, Neutral IOC2)
- Neutral Directional(Neutral Dir)
- Negative Sequence Overcurrent (Negative Seq OC)
- Phase Undervoltage (Phase UV)
- Phase Overvoltage (Phase OV)
- Neutral Overvoltage (Neutral OV)
- Negative Sequence Overvoltage (Negative Seq OV)
- Auxiliary Undervoltage (Auxiliary UV)
- Auxiliary Overvoltage (Auxiliary OV)
- Underfrequency 1, Underfrequency 2
- Overfrequency 1, Overfrequency 2
- Thermal Model
- VT Fuse Fail

Figure 12: Main protection menu



Current elements

Figure 13: Current Elements menu



TOC curves

DESCRIPTION

The relay has a total of two phase, two neutral, and two ground/sensitive ground time overcurrent elements. The programming of the time-current characteristics of these elements is identical in all cases and will only be covered in this section. The required curve is established by programming a Pickup Current, Curve Shape, Curve Multiplier, and Reset Time. The Curve Shape can be either a standard shape or a user-defined shape programmed with the FlexCurve™ feature.

Accurate coordination may require changing the time overcurrent characteristics of particular elements under different conditions. For picking up a cold load, a different time-current characteristic can be produced by increasing the pickup current value. The following setpoints are used to program the time-current characteristics.

- **<Element_Name> PICKUP**: The pickup current is the threshold current at which the time overcurrent element starts timing. There is no intentional 'dead band' when the current is above the pickup level. However, accuracy is only guaranteed above a 1.5 per unit pickup level. The dropout threshold is 98% of the pickup threshold. Enter the pickup current corresponding to 1 per unit on the time overcurrent curves as a multiple of the source CT. For example, if 100: 5 CTs are used and a pickup of 90 amps is required for the time overcurrent element, enter "0.9 x CT".
- **<Element_Name> CURVE**: Select the desired curve shape. If none of the standard curve shapes is appropriate, a custom FlexCurve™ can be created by entering the trip times at 80 different current values; see S2 SYSTEM SETUP > FLEXCURVE A. Curve formulas are given for use with computer based coordination programs. Calculated trip time values are only valid for I / Ipu > 1. Select the appropriate curve shape and multiplier, thus matching the appropriate curve with the protection requirements. The available curves are shown in the table below.

ANSI	GE TYPE IAC	IEC	OTHER
Extremely Inverse	Extremely Inverse	Curve A (BS142)	Definite Time
Very Inverse	Very Inverse	Curve B (BS142)	Flexcurve A™
Normally Inverse	Inverse	Curve C (BS142)	Flexcurve B™
Moderately Inverse	Short Inverse	IEC Short Inverse	User Curve

- **<Element_Name> MULTIPLIER**: A multiplier setpoint allows shifting of the selected base curve in the vertical time direction. Unlike the electromechanical time dial equivalent, trip times are directly proportional to the value of the time multiplier setpoint. For example, all trip times for a multiplier of 10 are 10 times the multiplier 1 or base curve values.

  When Timed Over-Current is programmed with Definite time, the operating time is obtained after multiplication of the selected Multiplier (TDM) by a 0.1 s base line. For example, selection of TDM = 5 would lead to a 0.5 s operating time.
- **<Element_Name> RESET**: Time overcurrent tripping time calculations are made with an internal 'energy capacity' memory variable. When this variable indicates that the energy capacity has reached 100%, a time overcurrent trip is generated. If less than 100% is accumulated in this variable and the current falls below the dropout threshold of 97 to 99% of the pickup value, the variable must be reduced. Two methods of this resetting operation are available, Instantaneous and Linear. The Instantaneous selection is intended for applications with other relays, such as most static units, which set the energy capacity directly to zero when the current falls below the reset threshold. The Linear selection can be used where the relay must coordinate with electromechanical units. With this setpoint, the energy capacity variable is decremented according to the following equation.

$$T_{RESET} = E \times M \times C_R$$

where: T_{RESET} = reset time in seconds; E = energy capacity reached (per unit); M = curve multiplier; CR = characteristic constant (5 for ANSI, IAC, Definite Time, and FlexCurves™; 8 for IEC)

TOC CURVE CHARACTERISTICS

ANSI Curves

The ANSI time overcurrent curve shapes conform to industry standards and the ANSI C37.90 curve classifications for extremely, very, normally, and moderately inverse. The ANSI curves are derived from the following formula:

$$T = M \times \left(A + \frac{B}{(I/I_{pu}) - C} + \frac{D}{((I/I_{pu}) - C)^2} + \frac{E}{((I/I_{pu}) - C)^3} \right)$$

where:T = trip time (seconds); M = multiplier value; I = input current; I_{pu} = pickup current setpoint; A, B, C, D, E = constants

Table 3: ANSI Curve Constants

ANSI Curve Shape	A	B	C	D	E
ANSI Extremely Inverse	0.0399	0.2294	0.5000	3.0094	0.7222
ANSI Very Inverse	0.0615	0.7989	0.3400	–0.2840	4.0505
ANSI Normally Inverse	0.0274	2.2614	0.3000	–4.1899	9.1272
ANSI Moderately Inverse	0.1735	0.6791	0.8000	–0.0800	0.1271

Table 4: ANSI Curve Trip Times (in seconds)

Multiplier (TDM)	Current (I/Ipickup)									
	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
ANSI Extremely Inverse										
0.5	2.000	0.872	0.330	0.184	0.124	0.093	0.075	0.063	0.055	0.049
1.0	4.001	1.744	0.659	0.368	0.247	0.185	0.149	0.126	0.110	0.098
2.0	8.002	3.489	1.319	0.736	0.495	0.371	0.298	0.251	0.219	0.196
4.0	16.004	6.977	2.638	1.472	0.990	0.742	0.596	0.503	0.439	0.393
6.0	24.005	10.466	3.956	2.208	1.484	1.113	0.894	0.754	0.658	0.589
8.0	32.007	13.955	5.275	2.944	1.979	1.483	1.192	1.006	0.878	0.786
10.0	40.009	17.443	6.594	3.680	2.474	1.854	1.491	1.257	1.097	0.982
ANSI Very Inverse										
0.5	1.567	0.663	0.268	0.171	0.130	0.108	0.094	0.085	0.078	0.073
1.0	3.134	1.325	0.537	0.341	0.260	0.216	0.189	0.170	0.156	0.146
2.0	6.268	2.650	1.074	0.682	0.520	0.432	0.378	0.340	0.312	0.291
4.0	12.537	5.301	2.148	1.365	1.040	0.864	0.755	0.680	0.625	0.583
6.0	18.805	7.951	3.221	2.047	1.559	1.297	1.133	1.020	0.937	0.874
8.0	25.073	10.602	4.295	2.730	2.079	1.729	1.510	1.360	1.250	1.165
10.0	31.341	13.252	5.369	3.412	2.599	2.161	1.888	1.700	1.562	1.457
ANSI Normally Inverse										
0.5	2.142	0.883	0.377	0.256	0.203	0.172	0.151	0.135	0.123	0.113
1.0	4.284	1.766	0.754	0.513	0.407	0.344	0.302	0.270	0.246	0.226
2.0	8.568	3.531	1.508	1.025	0.814	0.689	0.604	0.541	0.492	0.452
4.0	17.137	7.062	3.016	2.051	1.627	1.378	1.208	1.082	0.983	0.904
6.0	25.705	10.594	4.524	3.076	2.441	2.067	1.812	1.622	1.475	1.356
8.0	34.274	14.125	6.031	4.102	3.254	2.756	2.415	2.163	1.967	1.808
10.0	42.842	17.656	7.539	5.127	4.068	3.445	3.019	2.704	2.458	2.260
ANSI Moderately Inverse										

Multiplier (TDM)	Current (I/Ipickup)									
	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
0.5	0.675	0.379	0.239	0.191	0.166	0.151	0.141	0.133	0.128	0.123
1.0	1.351	0.757	0.478	0.382	0.332	0.302	0.281	0.267	0.255	0.247
2.0	2.702	1.515	0.955	0.764	0.665	0.604	0.563	0.533	0.511	0.493
4.0	5.404	3.030	1.910	1.527	1.329	1.208	1.126	1.066	1.021	0.986
6.0	8.106	4.544	2.866	2.291	1.994	1.812	1.689	1.600	1.532	1.479
8.0	10.807	6.059	3.821	3.054	2.659	2.416	2.252	2.133	2.043	1.972
10.0	13.509	7.574	4.776	3.818	3.324	3.020	2.815	2.666	2.554	2.465

IEC Curves

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

$$T = M \times \left(\frac{K}{(I/I_{pu})^{E} - 1} \right)$$

where: T = trip time (seconds), M = multiplier setpoint, I = input current, I_{pu} = pickup current setpoint, K, E = constants.

Table 5: IEC (BS) Inverse Time Curve Constants

IEC (BS) Curve Shape	K	E
IEC Curve A (BS142)	0.140	0.020
IEC Curve B (BS142)	13.500	1.000
IEC Curve C (BS142)	80.000	2.000
IEC Short Inverse	0.050	0.040

Table 6: IEC Curve Trip Times (in seconds)

Multiplier (TDM)	Current (I/Ipickup)									
	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
IEC Curve A										
0.05	0.860	0.501	0.315	0.249	0.214	0.192	0.176	0.165	0.156	0.149
0.10	1.719	1.003	0.630	0.498	0.428	0.384	0.353	0.330	0.312	0.297
0.20	3.439	2.006	1.260	0.996	0.856	0.767	0.706	0.659	0.623	0.594
0.40	6.878	4.012	2.521	1.992	1.712	1.535	1.411	1.319	1.247	1.188
0.60	10.317	6.017	3.781	2.988	2.568	2.302	2.117	1.978	1.870	1.782
0.80	13.755	8.023	5.042	3.984	3.424	3.070	2.822	2.637	2.493	2.376
1.00	17.194	10.029	6.302	4.980	4.280	3.837	3.528	3.297	3.116	2.971
IEC Curve B										
0.05	1.350	0.675	0.338	0.225	0.169	0.135	0.113	0.096	0.084	0.075
0.10	2.700	1.350	0.675	0.450	0.338	0.270	0.225	0.193	0.169	0.150
0.20	5.400	2.700	1.350	0.900	0.675	0.540	0.450	0.386	0.338	0.300
0.40	10.800	5.400	2.700	1.800	1.350	1.080	0.900	0.771	0.675	0.600
0.60	16.200	8.100	4.050	2.700	2.025	1.620	1.350	1.157	1.013	0.900
0.80	21.600	10.800	5.400	3.600	2.700	2.160	1.800	1.543	1.350	1.200
1.00	27.000	13.500	6.750	4.500	3.375	2.700	2.250	1.929	1.688	1.500
IEC Curve C										
0.05	3.200	1.333	0.500	0.267	0.167	0.114	0.083	0.063	0.050	0.040
0.10	6.400	2.667	1.000	0.533	0.333	0.229	0.167	0.127	0.100	0.081

Multiplier (TDM)	Current (I/Ipickup)									
	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
0.20	12.800	5.333	2.000	1.067	0.667	0.457	0.333	0.254	0.200	0.162
0.40	25.600	10.667	4.000	2.133	1.333	0.914	0.667	0.508	0.400	0.323
0.60	38.400	16.000	6.000	3.200	2.000	1.371	1.000	0.762	0.600	0.485
0.80	51.200	21.333	8.000	4.267	2.667	1.829	1.333	1.016	0.800	0.646
1.00	64.000	26.667	10.000	5.333	3.333	2.286	1.667	1.270	1.000	0.808
IEC Short Time										
0.05	0.153	0.089	0.056	0.044	0.038	0.034	0.031	0.029	0.027	0.026
0.10	0.306	0.178	0.111	0.088	0.075	0.067	0.062	0.058	0.054	0.052
0.20	0.612	0.356	0.223	0.175	0.150	0.135	0.124	0.115	0.109	0.104
0.40	1.223	0.711	0.445	0.351	0.301	0.269	0.247	0.231	0.218	0.207
0.60	1.835	1.067	0.668	0.526	0.451	0.404	0.371	0.346	0.327	0.311
0.80	2.446	1.423	0.890	0.702	0.602	0.538	0.494	0.461	0.435	0.415
1.00	3.058	1.778	1.113	0.877	0.752	0.673	0.618	0.576	0.544	0.518

IAC Curves

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

$$T = M \times \left(A + \frac{B}{(I/I_{pu}) - C} + \frac{D}{((I/I_{pu}) - C)^2} + \frac{E}{((I/I_{pu}) - C)^3} \right)$$

where: T = trip time (seconds), M = multiplier setpoint, I = input current, I_{pu} = pickup current setpoint, A to E = constants.

Table 7: GE Type IAC Inverse Curve Constants

IAC Curve Shape	A	B	C	D	E
IAC Extreme Inverse	0.0040	0.6379	0.6200	1.7872	0.2461
IAC Very Inverse	0.0900	0.7955	0.1000	–1.2885	7.9586
IAC Inverse	0.2078	0.8630	0.8000	–0.4180	0.1947
IAC Short Inverse	0.0428	0.0609	0.6200	–0.0010	0.0221

Table 8: IAC Curve Trip Times

Multiplier (TDM)										
	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
IAC Extremely Inverse										
0.5	1.699	0.749	0.303	0.178	0.123	0.093	0.074	0.062	0.053	0.046
1.0	3.398	1.498	0.606	0.356	0.246	0.186	0.149	0.124	0.106	0.093
2.0	6.796	2.997	1.212	0.711	0.491	0.372	0.298	0.248	0.212	0.185
4.0	13.591	5.993	2.423	1.422	0.983	0.744	0.595	0.495	0.424	0.370
6.0	20.387	8.990	3.635	2.133	1.474	1.115	0.893	0.743	0.636	0.556
8.0	27.183	11.987	4.846	2.844	1.966	1.487	1.191	0.991	0.848	0.741
10.0	33.979	14.983	6.058	3.555	2.457	1.859	1.488	1.239	1.060	0.926
IAC Very Inverse										
0.5	1.451	0.656	0.269	0.172	0.133	0.113	0.101	0.093	0.087	0.083
1.0	2.901	1.312	0.537	0.343	0.266	0.227	0.202	0.186	0.174	0.165
2.0	5.802	2.624	1.075	0.687	0.533	0.453	0.405	0.372	0.349	0.331
4.0	11.605	5.248	2.150	1.374	1.065	0.906	0.810	0.745	0.698	0.662
6.0	17.407	7.872	3.225	2.061	1.598	1.359	1.215	1.117	1.046	0.992
8.0	23.209	10.497	4.299	2.747	2.131	1.813	1.620	1.490	1.395	1.323

Multiplier (TDM)										
	1.5	**2.0**	**3.0**	**4.0**	**5.0**	**6.0**	**7.0**	**8.0**	**9.0**	**10.0**
10.0	29.012	13.121	5.374	3.434	2.663	2.266	2.025	1.862	1.744	1.654
IAC Inverse										
0.5	0.578	0.375	0.266	0.221	0.196	0.180	0.168	0.160	0.154	0.148
1.0	1.155	0.749	0.532	0.443	0.392	0.360	0.337	0.320	0.307	0.297
2.0	2.310	1.499	1.064	0.885	0.784	0.719	0.674	0.640	0.614	0.594
4.0	4.621	2.997	2.128	1.770	1.569	1.439	1.348	1.280	1.229	1.188
6.0	6.931	4.496	3.192	2.656	2.353	2.158	2.022	1.921	1.843	1.781
8.0	9.242	5.995	4.256	3.541	3.138	2.878	2.695	2.561	2.457	2.375
10.0	11.552	7.494	5.320	4.426	3.922	3.597	3.369	3.201	3.072	2.969
IAC Short Inverse										
0.5	0.072	0.047	0.035	0.031	0.028	0.027	0.026	0.026	0.025	0.025
1.0	0.143	0.095	0.070	0.061	0.057	0.054	0.052	0.051	0.050	0.049
2.0	0.286	0.190	0.140	0.123	0.114	0.108	0.105	0.102	0.100	0.099
4.0	0.573	0.379	0.279	0.245	0.228	0.217	0.210	0.204	0.200	0.197
6.0	0.859	0.569	0.419	0.368	0.341	0.325	0.314	0.307	0.301	0.296
8.0	1.145	0.759	0.559	0.490	0.455	0.434	0.419	0.409	0.401	0.394
10.0	1.431	0.948	0.699	0.613	0.569	0.542	0.524	0.511	0.501	0.493

USER Curves

The relay provides a selection of user definable curve shapes used by the time overcurrent protection. The User curve is programmed by selecting the proper parameters in the formula:

$$T = \frac{A * D}{(V^{P} - Q)} + B * D + K$$

A, P, Q, B, K - selectable curve parameters within the ranges from the table: D is the Time Dial Multiplier.

User Curve can be used on multiple elements only if the time dial multiplier is the same for each element.

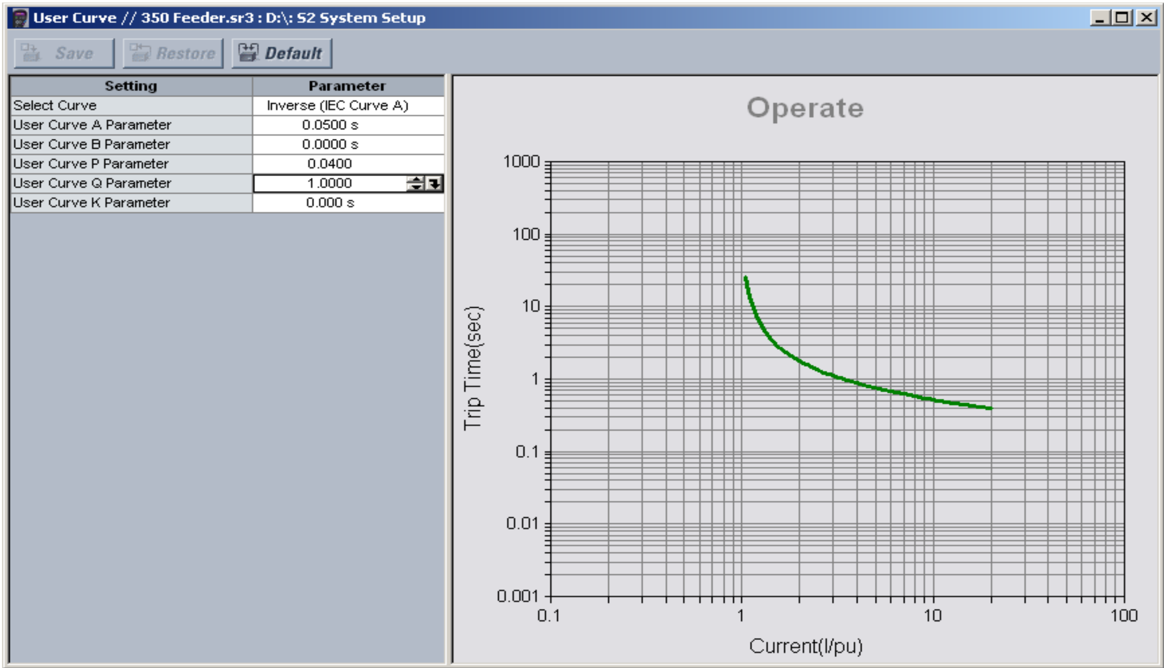
$V = I/I_{PICKUP}$ (TOC setting) is the ratio between the measured current and the pickup setting.

NOTE

The maximum trip time for the User Curve is limited to 65.535 seconds. The User Curve can be used for one protection situation only.

Parameters	A	B	P	Q	K
Range	0 to 125	0 to 3	0 to 3	0 to 2	0 to 1.999
Step	0.0001	0.0001	0.0001	0.0001	0.001
Unit	sec	sec	NA	NA	sec
Default Value	0.05	0	0.04	1.0	0

Figure 14: USER curve configuration settings



Flexcurves

Prospective FlexCurves™ can be configured from a selection of standard curves to provide the best approximate fit, then specific data points can be edited afterwards. Click the **Initialize** button to populate the pickup values with the points from the curve specified by the "Select Curve" setting and the "Multiply" value. These values can then be edited to create a custom curve. Click on the **Clear FlexCurve Data** button to reset all pickup values to zero.

Curve data can be imported from CSV (comma-separated values) files by clicking on the **Open** button. Likewise, curve data can be saved in CSV format by clicking the **Save** button. CSV is a delimited data format with fields separated by the comma character and records separated by new lines. Refer to IETF RFC 4180 for additional details.

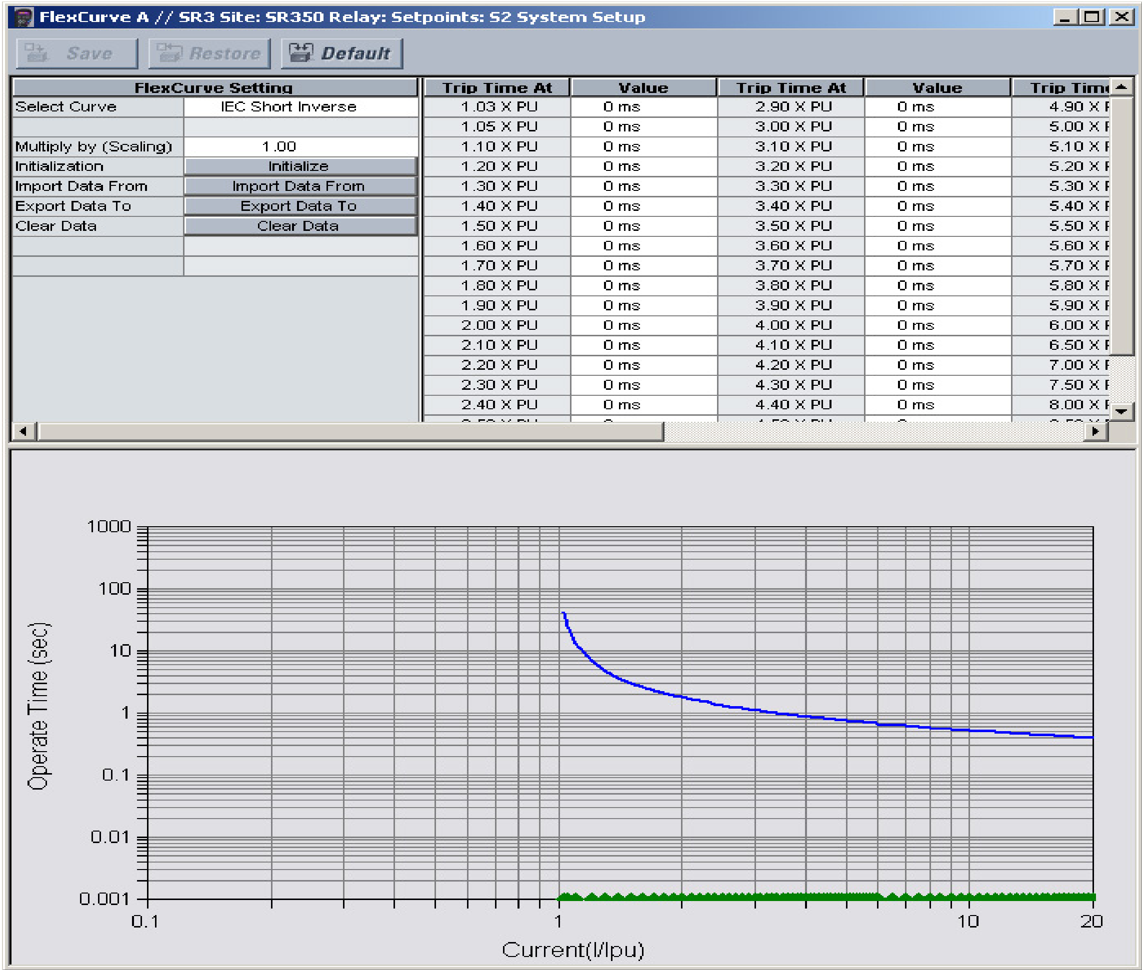
The curve shapes for the two FlexCurves are derived from the following equations.

Eq. 1

$$T_{operate} = \text{TDM} \times \left(T_{flex} \text{ at } \frac{I}{I_{pickup}} \right), \quad \text{when } \frac{I}{I_{pickup}} \geq 1.00$$

In the above equations, $T_{operate}$ represents the operate time in seconds, TDM represents the multiplier setting, I represents the input current, I_{pickup} represents the value of the pickup current setting, T_{flex} represents the FlexCurve™ time in seconds.

Figure 15: Flexcurve™ configuration settings



The following settings are available for each custom Flexcurve™.

Select Curve

Range: ANSI Moderately Inverse, ANSI Very Inverse, ANSI Extremely Inverse, IEEE Normally Inverse, IEC Curve A, IEC Curve B, IEC Curve C, IEC Short Inverse, IAC Extreme Inv, IAC Very Inverse, IAC Inverse, IAC Short Inverse, User Curve, FlexCurve B (Note: For FlexCurve A, you can select FlexCurve B as the setpoint, and vice versa for FlexCurve B.)

Default: Extremely Inverse

This setting specifies a curve to use as a base for a custom FlexCurve™. Must be used before Initialization is implemented (see **Initialization** below).

Multiply

Range: 0.01 to 30.00 in steps of 0.01

Default: 1.00

This setting provides selection for Time Dial Multiplier by which the times from the inverse curve are modified. For example if an ANSI Extremely Inverse curve is selected with TDM = 2, and the fault current was 5 times bigger than the PKP level, the operation of the element will not occur before a time elapse of 495 ms from pickup.

Initialization

Used after specifying a curve to use as a base for a custom FlexCurve™ (see **Select Curve** and **Multiply** above). When the **Initialize FlexCurve** button is clicked, the pickup settings will be populated with values specified by the curve selected in this setting.

1.03 × Pickup, ..., 20.00 × Pickup

Range: 0 to 65535 ms in steps of 1

Default: 0 ms

These settings specify the time to operate at the following pickup levels 1.03 to 20.00. This data is converted into a continuous curve by linear interpolation between data points. To enter a custom FlexCurve™, enter the operate time for each selected pickup point.

NOTE

Each FlexCurve can be configured to provide inverse time characteristic to more than one Time Overcurrent Element. However, for computation of the curve operating times, one must take into account the setting of the Time Delay Multiplier from the FlexCurve menu, and the Time Delay Multiplier setting from TOC menu. The true TDM applied to the TOC element when FlexCurve is selected is the result from the multiplication of both TDM settings. For example, for FlexCurve Multiplier = 5, and Phase TOC Multiplier = 2, the total Time Dial Multiplier will be equal to 10. To avoid confusion, it is suggested to keep the multiplier from the TOC menu equal to 1, and change only the multiplier from the selected FlexCurve. This way, one can see from the FlexCurve setup, the curve operating times as related to the multiples of pickup.

Phase timed overcurrent protection

The relay has one Phase Time Overcurrent protection element per protection group. The settings of this function are applied to each of the three phases to produce trip or pickup per phase. The TOC pickup flag is asserted, when the current on any phase is above the PKP value. The TOC trip flag is asserted if the element stays picked up for the time defined by the selected inverse curve and the magnitude of the current. The element drops from pickup without operation, if the measured current drops below 97-98% of the pickup value, before the time for operation is reached. The selection of Definite Time has a base time delay of 0.1 s, multiplied by the selected TD multiplier. For example the operating time for TOC set to Definite Time and a TDM set to 5 will result in 5*0.1 = 0.5 s.

The following path is available using the keypad. For instructions on how to use the keypad, please refer to *Chapter 3 - Working with the Keypad*.

PATH: SETPOINTS > S3 PROTECTION > SETPOINT GROUP 1(2) > PHASE TOC

PH TOC FUNCTION

Range: Disabled, Latched Alarm, Alarm, Trip

Default: Disabled

The selection of the Latched Alarm, Alarm, or Trip setting enables the Phase TOC function. The output relay #1 “Trip” will operate when the Trip setting is selected, and the Phase TOC operates. The “ALARM” LED will not turn on if the TOC operates when set to function Trip. The “ALARM” LED will flash upon phase TOC operation, with the TOC function selected as Alarm, and will self-reset, when the operation clears. If Latched Alarm is selected as a TOC function, the “ALARM” LED will flash during TOC operation, and will stay “ON” after the operation clears until the reset command is initiated. The output relay #1 “Trip” will not operate if the Latched Alarm or Alarm setting is selected.

PH TOC PKP

Range: 0.04 to 20.00 x CT in steps of 0.01 x CT

Default: 1.00 x CT

This setting sets the time overcurrent pickup level. For example, a PKP setting of 0.9 x CT with 300:5 CT translates into 270A primary current.

PH TOC CURVE

Range: ANSI Extremely/Very/Moderately/Normally Inverse, Definite Time, IEC Curve A/B/C and Short Inverse, IAC Extremely/Very/Inverse/Short, User Curve, FlexCurve A, FlexCurve B

Default: Extremely Inverse

This setting sets the shape of the selected TOC inverse curve. If none of the standard curve shapes is appropriate, a custom User curve, or FlexCurve can be created. Refer to the User curve and the FlexCurve setup for more detail on their configurations and usage.

PH TOC TDM

Range: 0.05 to 50.00 in steps of 0.01

Default: 1.00

This setting provides selection for Time Dial Multiplier by which the times from the inverse curve are modified. For example if an ANSI Extremely Inverse curve is selected with TDM = 2, and the fault current was 5 times bigger than the PKP level, the operation of the element will not occur before an elapsed time from pickup, of 495 ms.

PH TOC RESET

Range: Instantaneous, Linear

Default: Instantaneous

The “Instantaneous” reset method is intended for applications with other relays, such as most static relays, which set the energy capacity directly to zero when the current falls below the reset threshold. The “Timed” reset method can be used where the relay must coordinate with electromechanical relays.

PH TOC DIRECTION

Range: Disabled, Forward, Reverse

Default: Disabled

This setting provides control to the Phase TOC function in terms of permitting operation upon fault conditions in the selected current flow direction, and blocking it when faults occur in the opposite direction.

A special case is considered when fault direction is undefined. Then “BLK OC DIR UN” setting in Neutral Directional defines the fault direction.

OUTPUT RELAY 3 to 6

Range: Do not operate, Operate

Default: Do not operate

Any or all of the output relays 3 to 6 can be selected to operate, upon Phase TOC operation. The selection of relay outputs operation is available no matter whether Latched Alarm, Alarm, or Trip function is selected.

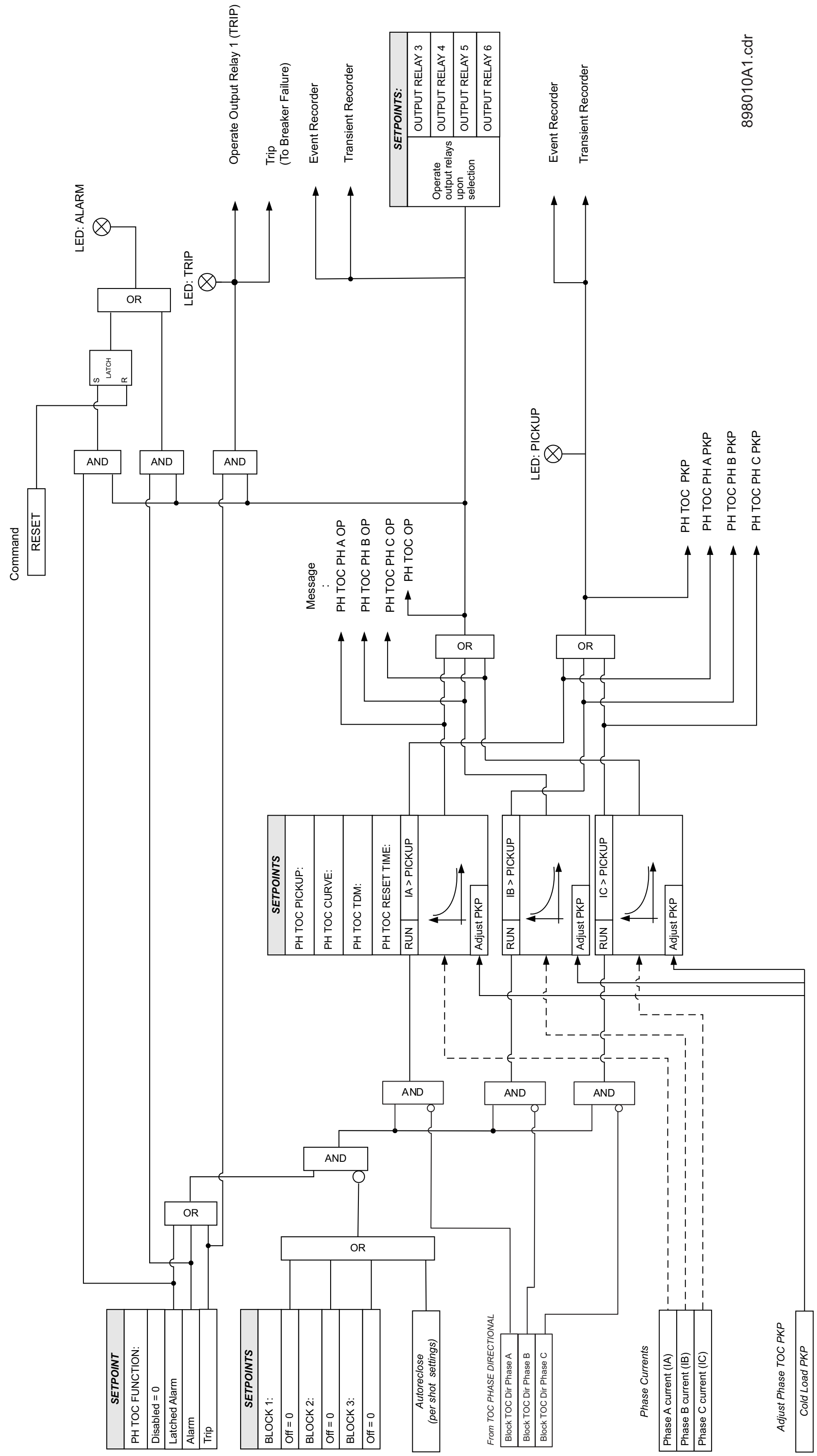
BLOCK 1/2/3

Range: Off, Contact Input 1 to 10, Virtual Input 1 to 32, Remote Input 1 to 32, Logic Elements 1 to 16

Default: Off

Three blocking inputs are provided in the Phase TOC menu. When any of the selected blocking inputs - Contact input, Virtual Input, Remote Input, or Logic Element - turns on, the phase TOC function will be blocked.

Figure 16: Phase Time Overcurrent Protection Logic Diagram



Phase instantaneous overcurrent protection

The 350 relay has two identical phase instantaneous overcurrent protection types per Setpoint Group: Phase IOC1, and Phase IOC2. Each consists of three separate instantaneous overcurrent elements; one per phase, with identical settings.

The following path is available using the keypad. For instructions on how to use the keypad, please refer to *Chapter 3 - Working with the Keypad*.

PATH: **SETPOINTS > S3 PROTECTION > SETPOINT GROUP 1(2) > PHASE IOC1(2)**

PH IOC1/2 FUNCTION

Range: Disabled, Latched Alarm, Alarm, Trip

Default: Disabled

The selection of the Latched Alarm, Alarm, or Trip setting enables the Phase IOC function. The output relay #1 "Trip" will operate when the Trip function is selected, and the Phase IOC operates. The "ALARM" LED will not turn on if the IOC operates when set to function Trip. The "ALARM" LED will flash upon phase IOC operation, and with the IOC function selected as Alarm, will self-reset when the operation clears. If Latched Alarm is selected, the "ALARM" LED will flash during IOC operation, and will stay "ON" after the operation clears, until the Reset command is initiated. The output relay #1 "Trip" will not operate if the Latched Alarm or Alarm function is selected.

PH IOC1/2 PKP

Range: 0.05 to 20.00 x CT in steps of 0.01 x CT

Default: 1.00 x CT

This setting sets the instantaneous overcurrent pickup level. For example, a PKP setting of 0.9 x CT with 300:5 CT translates into 270A primary current.

PH IOC1/2 DELAY

Range: 0.00 to 300.00 sec in steps of 0.01 sec

Default: 0.00 sec

This setting provides selection for the time used to delay the protection operation.

PH IOC DIRECTION

Range: Disabled, Forward, Reverse

Default: Disabled

This setting provides control to the Phase IOC1(2) function in terms of permitting operation upon fault conditions in the selected current flow direction, and blocking it, when faults occur in the opposite direction.

A special case is considered when fault direction is undefined. Then "BLK OC DIR UN" setting in Phase Directional defines the fault direction.

OUTPUT RELAY 3 to 6

Range: Do not operate, Operate

Default: Do not operate

Any or all of the output relays 3 to 6 can be selected to operate upon Phase IOC operation. Relay outputs operation is available no matter whether Latched Alarm, Alarm, or Trip function is selected.

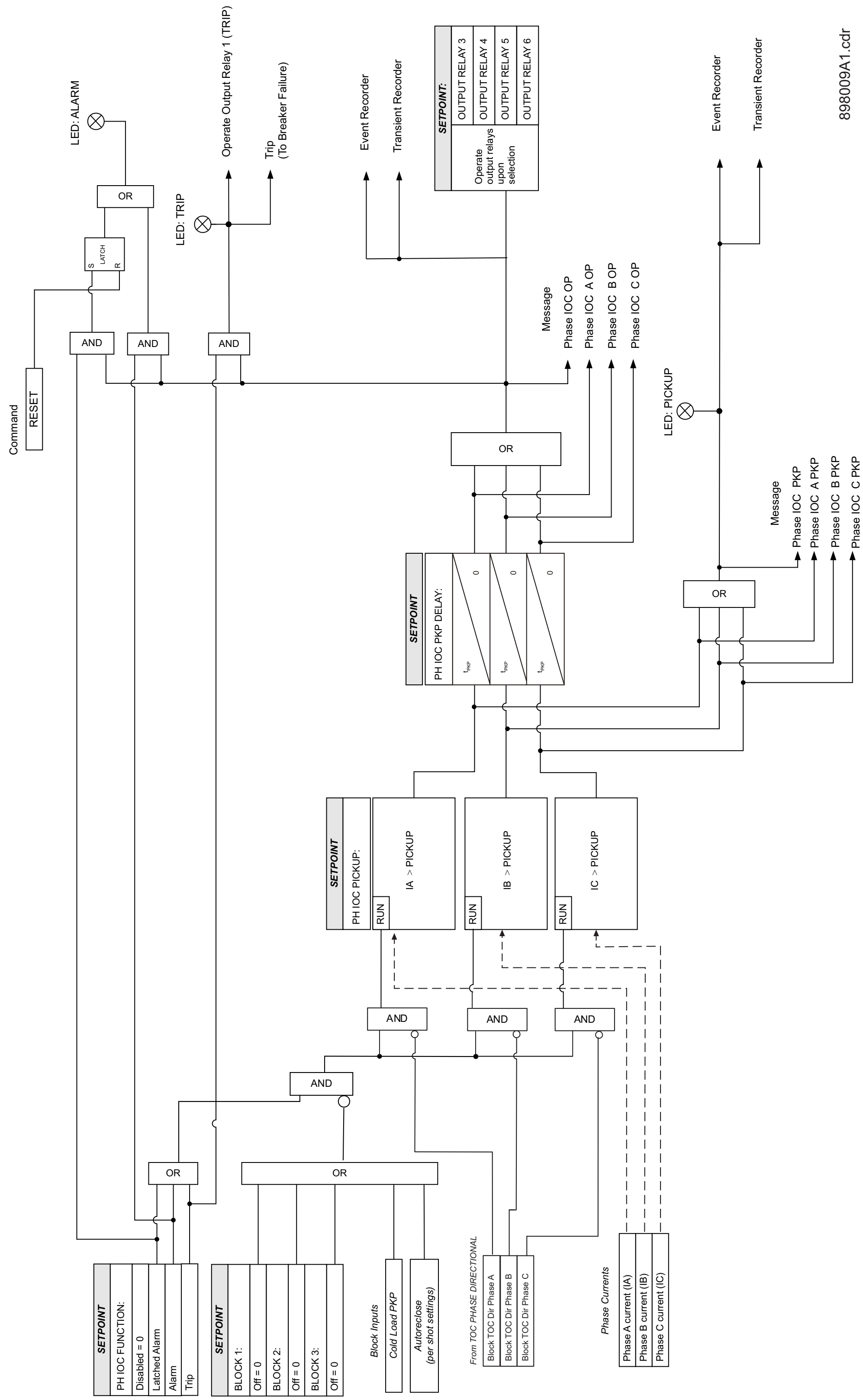
BLOCK 1/2/3

Range: Off, Contact Input 1 to 10, Virtual Input 1 to 32, Remote Input 1 to 32, Logic Elements 1 to 16

Default: Off

Three blocking inputs are provided in the Phase IOC menu. When any one of the selected blocking inputs - Contact input, Virtual Input, Remote Input, or Logic Element - is turned on, the phase IOC function will be blocked.

Figure 17: Phase instantaneous overcurrent protection logic diagram



Phase directional

The Phase Directional element (one for each of phases A, B and C) is used to discriminate between faults that occur in the forward direction, and faults that occur in the reverse direction. The Phase Directional element can be used either individually for control or alarm by energizing the auxiliary output relays, or as a part of the Phase Time, or Instantaneous, over-current elements to define the tripping direction. (See the setup for Phase TOC and Phase IOC elements.)

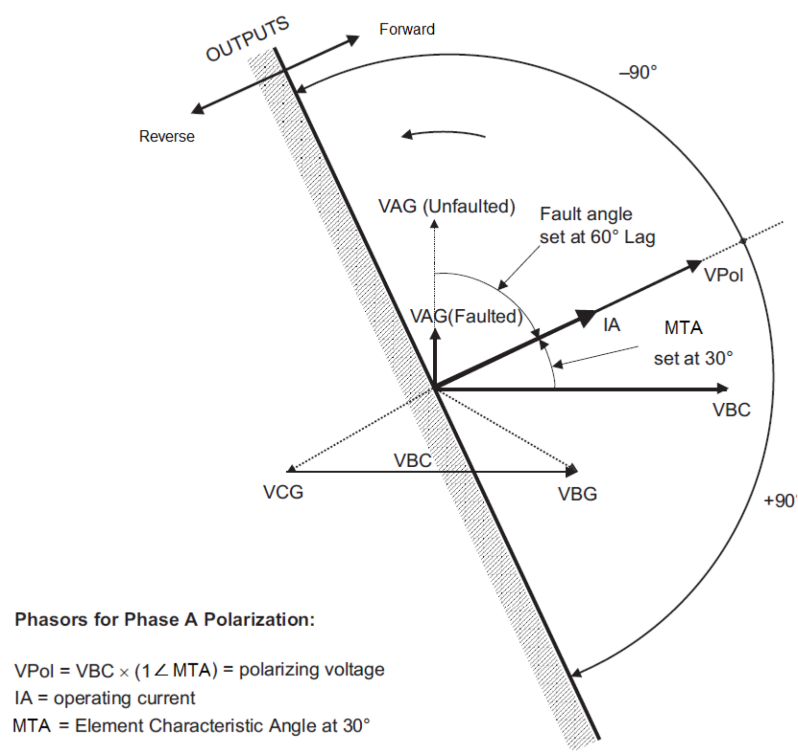
The polarizing signal for the Phase Directional element is determined by comparing the phase angle between the current from the phase CTs and the line-line voltage from the VTs, and the set MTA angle.

The following table shows the operating and polarizing signals used for phase directional control:

PHASE	OPERATING SIGNAL	POLARIZING SIGNAL Vpol	
		ABC PHASE SEQUENCE	ACB PHASE SEQUENCE
A	Angle of Ia	Angle of Vbc × (Angle of MTA)	Angle of Vcb × (Angle of MTA)
B	Angle of Ib	Angle of Vca × (Angle of MTA)	Angle of Vac × (Angle of MTA)
C	Angle of Ic	Angle of Vab × (Angle of MTA)	Angle of Vba × (Angle of MTA)

When line voltage is below the minimum polarizing voltage threshold (MIN POL VOLTAGE), the direction is undefined. In this case, phase overcurrent protection elements are blocked if “BLK OC DIR UN” setting is enabled and directional is not disabled.

Figure 18: Phase A polarization



The following path is available using the keypad. For instructions on how to use the keypad, please refer to *Chapter 3 - Working with the Keypad*.

PATH: **SETPOINTS > S3 PROTECTION > SETPOINT GROUP 1(2) > PHASE DIR**

PH DIR FUNCTION

Range: Disabled, Alarm, Latched Alarm, Control

Default: Disabled

When Alarm function is selected, the alarm LED will flash upon detection of Reverse direction for any phase, and will drop out when the direction changes to Forward for all phases. When Latched Alarm is selected, the alarm LED will flash upon detection of Reverse direction, and will stay lit (latched) after the direction for all phases is Forward. The alarm LED can be reset by issuing the reset command. Detection of Reverse direction when Control function is selected does not trigger the alarm LED.

PH DIR MTA

Range: 0° to 359° Lead in steps of 1

Default: 30°

This setting sets the Maximum Torque Angle (MTA) for the Phase Directional element to define the regions of Forward and Reverse directions. This is the angle of maximum sensitivity, i.e. maximum torque angle by which the operating current leads the polarizing voltage.

MIN POL VOLTAGE

Range: 0.00 to 1.25 x CT in steps of 0.01

Default: 0.05 x CT

This setting is used to establish the minimum level of voltage for which the phase angle measurement is reliable. The setting is based on VT accuracy.

BLOC OC DIR UN

Range: Disabled, Enabled

Default: Enabled

This setting establishes the procedure under undefined direction (voltage below threshold). If enabled, OC elements with "Forward" or "Reverse" setting are blocked; otherwise, they are not.

OUTPUT RELAY 3 to 6

Range: Do not operate, Operate

Default: Do not operate

Any or all of the output relays 3 to 6 can be selected to operate upon Phase directional operation. Relay outputs operation is available no matter whether Latched Alarm, Alarm or Trip function is selected.

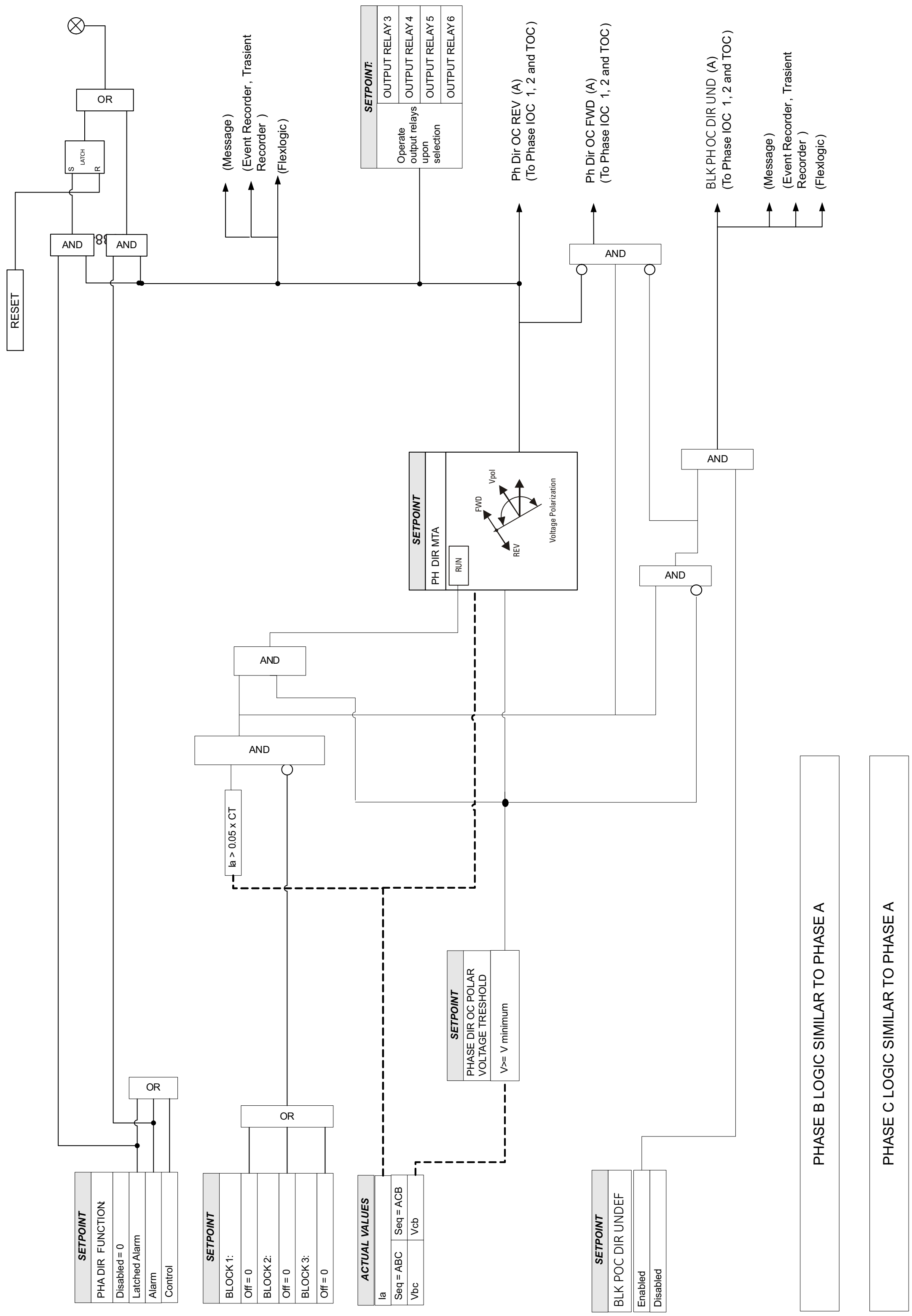
BLOCK 1/2/3

Range: Off, Contact Input 1 to 10[8], Virtual Input 1 to 32, Remote Input 1 to 32, Logic Elements 1 to 16

Default: Off

Three blocking inputs are provided in the Phase IOC menu. When any one of the selected blocking inputs - Contact input, Virtual Input, Remote Input, or Logic Element - is turned on, the phase directional function will be blocked.

Figure 19: Phase directional logic diagram



Ground/Sensitive Ground timed overcurrent protection

The relay has one Ground Time Overcurrent protection per setpoint group. The settings of this function are applied to the ground input current to produce trip or pickup flags. The Ground TOC pickup flag is asserted, when the ground current is above the PKP value. The Ground TOC operate flag is asserted if the element stays picked up for the time defined by the selected inverse curve, and the magnitude of the current. The element drops from pickup without operation if the measured current drops below 97 to 98% of the pickup value, before the time to operate is reached. The selection of Definite Time has a base time delay of 0.1 s, multiplied by the selected TD multiplier. For example the operating time for TOC set to Definite Time and a TDM set to 5 will result in 5*0.1 = 0.5 s.

The following path is available using the keypad. For instructions on how to use the keypad, please refer to *Chapter 3 - Working with the Keypad*.

PATH: **SETPOINTS > S3 PROTECTION > SETPOINT GROUP 1(2) > GROUND TOC**

NOTE

The settings from the menu for Sensitive Ground TOC, appears only upon selection of the Sensitive Ground CT when ordering the relay. Otherwise, the relay displays the menu for Ground TOC protection.

GND TOC FUNCTION

Range: Disabled, Trip, Alarm, Latched Alarm

Default: Disabled

The selection of the Latched Alarm, Alarm, or Trip setting enables the Ground/Sensitive Ground TOC function. The output relay #1 “Trip” will operate, if the Ground/Sensitive Ground TOC function is selected as Trip, and the measured ground current satisfies the operating condition set by the settings. The “ALARM” LED will not turn on if the TOC operates when set to the Trip function. The “ALARM” LED will flash upon phase TOC operation, with the TOC function selected as Alarm, and will self-reset, when this operation clears. If Latched Alarm is selected as the TOC function, the “ALARM” LED will flash during TOC operation, and will stay “ON” after the condition clears, until the reset command is initiated. The output relay #1 “Trip” will not operate if the Latched Alarm or Alarm function is selected. Any or all of output relays 3 to 6 can be selected to operate when the Ground TOC function is selected as Latched Alarm, Alarm, or Trip.

GND TOC PKP

Range: 0.04 to 20.00 x CT in steps of 0.01 x CT

Default: 1.00 x CT

SENS.GND TOC PKP

Range: 0.005 to 3.00 x CT in steps of 0.001 x CT

Default: 1.00 x CT

This setting sets the time overcurrent pickup level. For example, a PKP setting of 0.9 x CT with 300:5 CT translates into 270A primary current.

GND TOC CURVE

Range: ANSI Extremely/Very/Moderately/Normally Inverse, Definite Time, IEC Curve A/B/C and Short Inverse, IAC Extremely/Very/Inverse/Short, User Curve, FlexCurve A, FlexCurve B

Default: Extremely Inverse

This setting sets the shape of the selected over-current inverse curve. If none of the standard curve shapes is appropriate, a custom User curve, or FlexCurve can be created. Refer to the User curve and the FlexCurve setup for more detail on their configurations and usage.

GND TOC TDM

Range: 0.05 to 50.00 in steps of 0.01

Default: 1.0

This setting provides selection for Time Dial Multiplier by which the times from the inverse curve are modified. For example if an ANSI Extremely Inverse curve is selected with TDM = 2, and the fault current was 5 times bigger than the PKP level, the operation of the element will not occur before an elapsed time from pickup, of 495 ms.

GND TOC RESET

Range: Instantaneous, Linear

Default: Instantaneous

The “Instantaneous” reset method is intended for applications with other relays, such as most static relays, which set the energy capacity directly to zero when the current falls below the reset threshold. The “Timed” reset method can be used where the relay must coordinate with electromechanical relays.

GND TOC DIRECTION

Range: Disabled, Forward, Reverse

Default: Disabled

This setting provides control to the Ground TOC function in terms of permitting operation upon fault conditions in the selected current flow direction, and blocking it, when faults occur in the opposite direction.

A special case is considered when fault direction is undefined. Then “BLK OC DIR UN” setting in Ground Directional defines the fault direction.

OUTPUT RELAY 3 to 6

Range: Do not operate, Operate

Default: Do not operate

Any or all of the output relays 3 to 6 can be selected to operate upon Ground TOC operation. The selection of relay outputs operation is available no matter whether Latched Alarm, Alarm, or Trip function is selected.

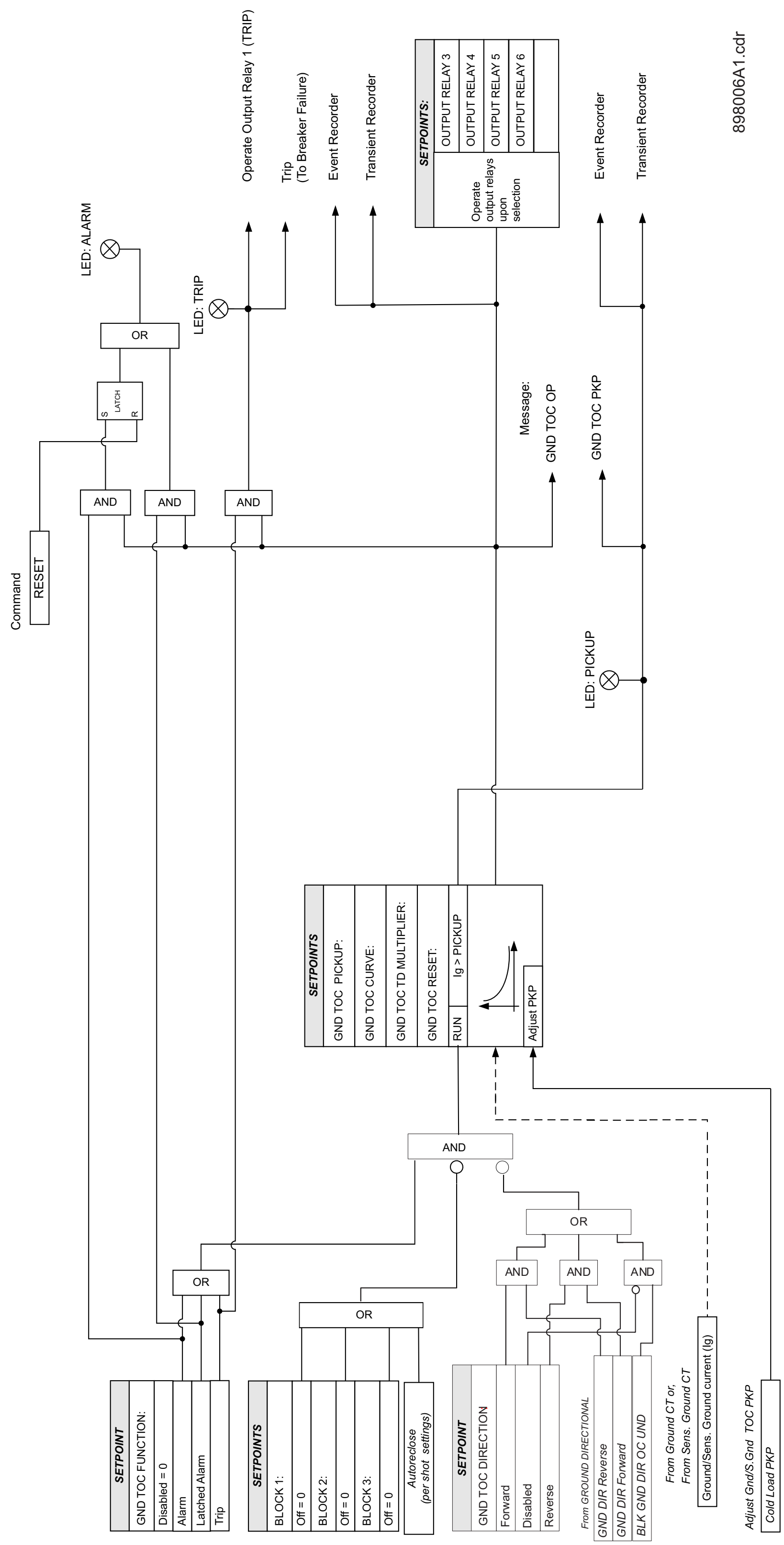
BLOCK 1/2/3

Range: Off, Contact Input 1 to 10, Virtual Input 1 to 32, Remote Input 1 to 32, Logic Elements 1 to 16

Default: Off

Three blocking inputs are provided in the Ground TOC menu. When any of the selected blocking inputs - Contact input, Virtual Input, Remote Input, or Logic Element - turn on, the ground TOC function is blocked.

Figure 20: Ground/Sensitive Ground timed overcurrent protection: Logic Diagram



Ground/Sensitive Ground instantaneous overcurrent protection

The relay has one Ground/Sensitive Ground Instantaneous Overcurrent protection element per setpoint group. The settings of these functions are applied to the gound/sensitive ground current for pickup and trip flags. The Ground IOC pickup flag is asserted, when the ground current is above the PKP value. The Ground IOC operate flag is asserted if the element stays picked up for the time defined by the Ground IOC PKP Delay setting. If the pickup time delay is set to 0.00 seconds, the pickup and operate flags will be asserted at the same time. The element drops from pickup without operation, if the ground current drops below 97-99% of the pickup value.

The following path is available using the keypad. For instructions on how to use the keypad, please refer to *Chapter 3 - Working with the Keypad*.

PATH: **SETPOINTS > S3 PROTECTION > SETPOINT GROUP 1(2) > GROUND IOC1(2)**

GND IOC FUNCTION

Range: Disabled, Trip, Alarm, Latched Alarm
Default: Disabled

The selection of the Latched Alarm, Alarm, or Trip setting enables the Ground/Sensitive Ground IOC function. The output relay #1 "Trip" will operate, if the Ground/Sensitive Ground IOC function is selected as Trip, and the measured ground current satisfies the operating condition set by the settings. The "ALARM" LED will not turn on if the element operates when set to function Trip. The "ALARM" LED will flash upon IOC operation, with the IOC function selected as Alarm, and will self-reset, when this operation clears. If Latched Alarm is selected as an IOC function, the "ALARM" LED will flash during the IOC operating condition, and will stay "ON" after the condition clears, until a reset command is initiated. The output relay #1 "Trip" will not operate if Latched Alarm or Alarm setting is selected. Any or all of the output relays 3 to 6 can be selected to operate when the Ground/S.Ground IOC function is selected as Latched Alarm, Alarm, or Trip.

GND IOC PKP

Range: Disabled, 0.05 to 20.00 x CT in steps of 0.01 x CT
Default: 1.00 x CT

SENS.GND IOC PKP

Range: 0.005 to 3.00 x CT in steps of 0.001 x CT
Default: 1.00 x CT

This setting sets the ground overcurrent pickup level specified per times CT. For example, a PKP setting of 0.9 x CT with 300:5 CT translates into 270A primary current.

GND IOC DELAY

Range: 0.00 to 300.00 sec in steps of 0.01 sec
Default: 0.00 sec

This setting provides selection for pickup time delay used to delay the operation of the protection.

GND IOC DIRECTION

Range: Disabled, Forward, Reverse
Default: Disabled

This setting provides control to the Ground IOC1(2) function in terms of permitting operation upon fault conditions in the selected current flow direction, and blocking it, when faults occur in the opposite direction.

A special case is considered when fault direction is undefined. Then "BLK OC DIR UN" setting in Ground Directional defines the fault direction.

OUTPUT RELAY 3 to 6

Range: Do not operate, Operate

Default: Do not operate

Any or all of the output relays 3 to 6 can be selected to operate upon Ground IOC operation. The selection of relay outputs operation is available no matter whether Latched Alarm, Alarm, or Trip function is selected.

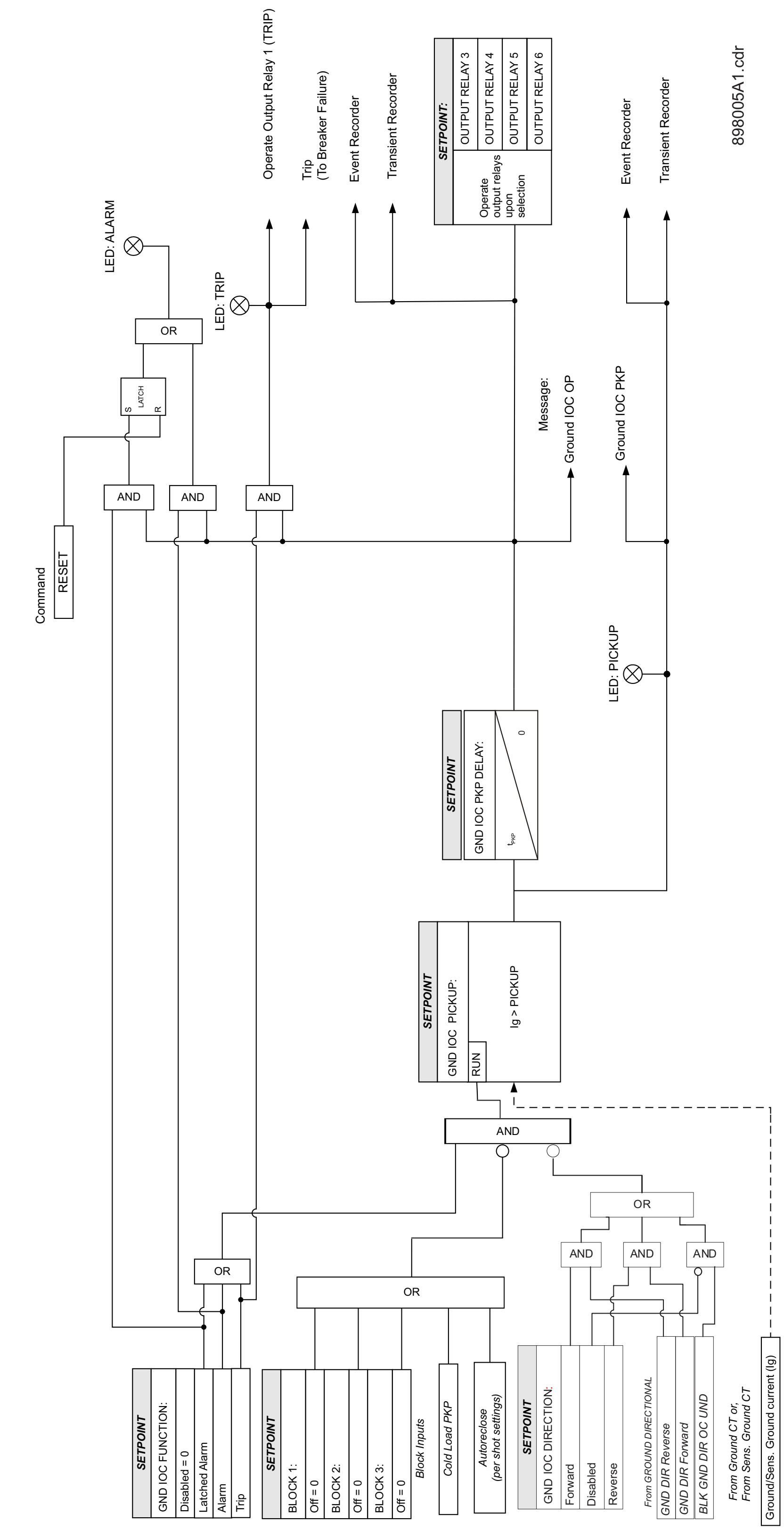
BLOCK 1/2/3

Range: Off, Contact Input 1 to 10, Virtual Input 1 to 32, Remote Input 1 to 32, Logic Element 1 to 16

Default: Off

Three blocking inputs are provided in the Ground IOC menu. When any of the selected blocking inputs - Contact input, Virtual Input, Remote Input, or Logic Element - turns on, the ground IOC function is blocked.

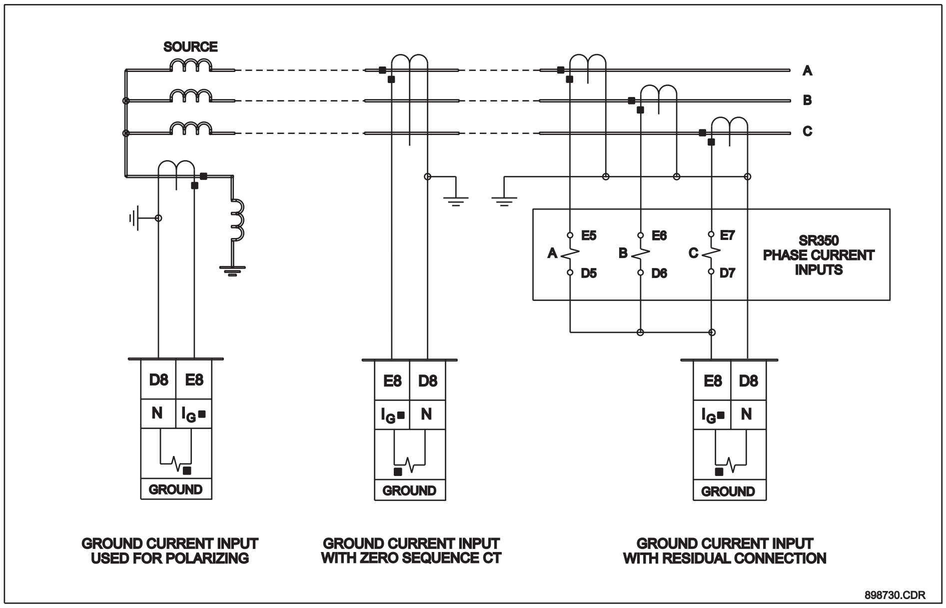
Figure 21: Ground/Sensitive Ground instantaneous overcurrent protection logic diagram



Ground directional

The Ground Directional element is used to discriminate whether a fault occurs in a forward or in a reverse direction, and it can be used either individually or as a part of the Ground Time, or Instantaneous over-current elements. (See the setup for Ground TOC, and Ground IOC elements.)

The operating current for the Ground directional element is the measured current from the ground CT input terminals. Depending on the ground CT connection, the measured current from the CT terminals can be either the current from a zero sequence CT, or the zero sequence current from a residual CT connection (see figure below).



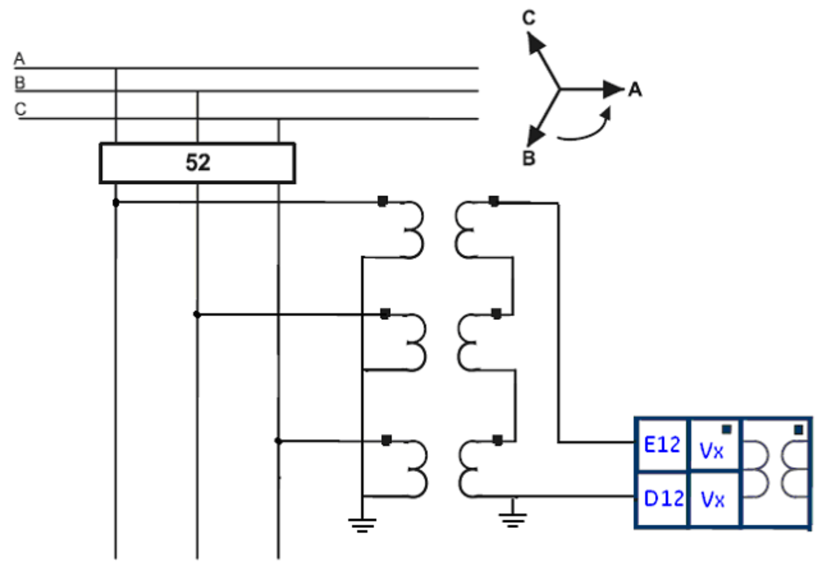
The polarizing signal for the Ground Directional element is based on the zero sequence voltage. Depending on the relay's order code, the zero sequence voltage used for the polarizing voltage, is either calculated, when three-phase voltages are available, or is measured from the auxiliary voltage input Vx when the three-phase voltages are not available. For those relays with available phase VTs, the polarizing voltage for the Neutral directional element is calculated as follows:

$$-V_0 = \frac{-(V_a + V_b + V_c)}{3} \qquad \textbf{Eq. 2}$$

Please note, that the phase VT inputs must be connected in Wye.

For those relays with available Vx auxiliary voltage input only, the polarizing voltage for the Ground directional element is three times the zero sequence voltage measured at the Vx terminals. The Vx input should be connected to measure $3V_0$ from an open delta VT configuration as shown on the figure below.

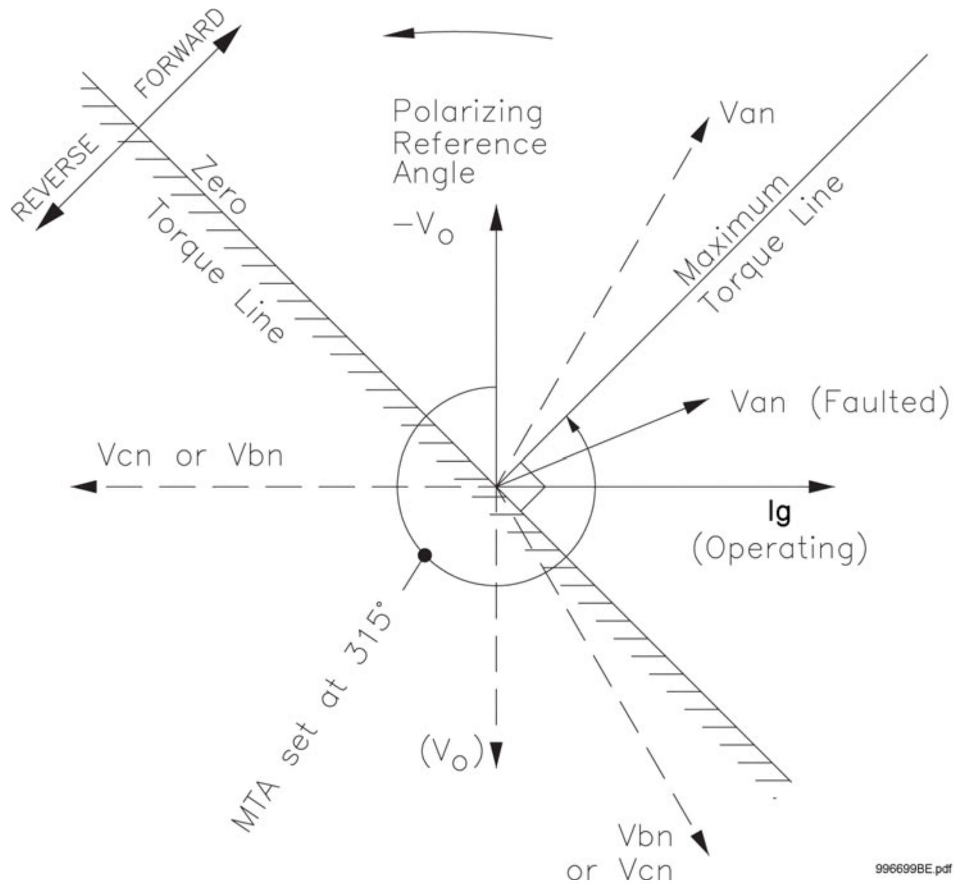
Figure 22: Open Delta VT connection



The fault is detected in the Forward direction when the direction of the operating current Ig is within ± 90° of the polarizing signal. Otherwise the direction is detected as Reverse.

In the case where the voltage drops below the setting of the minimum polarizing voltage, the ground directional element is undefined. In this case, ground overcurrent protection elements are blocked if “BLK OC DIR UN” setting is enabled and directional is not disabled.

The diagram below shows the regions for detection of ground current Forward and Reverse directions with respect to the zero sequence voltage and the selected Maximum Torque Angle (MTA).



The following path is available using the keypad. For instructions on how to use the keypad, please refer to *Chapter 3 - Working with the Keypad*.

PATH: **SETPOINTS > S3 PROTECTION > S3 SETPOINT GROUP 1(2) > NTRL DIR**

GND (S.GND) DIR FUNCTION

Range: Disabled, Latched Alarm, Alarm, Control

Default: Disabled

When the **Alarm** function is selected, the alarm LED will flash upon detection of Reverse direction, and will drop out when the direction changes to Forward. When **Latched Alarm** is selected, the alarm LED will flash upon detection of Reverse direction, and will stay lit (latched) after the direction changes to Forward. The alarm LED can be reset by issuing a Reset command. Detection of Reverse direction when the **Control** function is selected, does not trigger the alarm LED.

GND (S.GND) DIR MTA

Range: 0° to 359° lead in steps of 1°

Default: 315°

This setting sets the Maximum Torque Angle (MTA), for the Ground Directional element to define the regions of Forward and Reverse directions. For Voltage polarizing, enter the maximum torque angle by which the operating current leads the polarizing voltage. This is the angle of maximum sensitivity.

MIN POL VOLTAGE

Range: 0.05 to 1.25 x VT in steps of 0.01

Default: 0.05 x VT

The minimum zero sequence voltage level must be selected to prevent operation due to normal system unbalances, or voltage transformer errors. Set the minimum zero sequence voltage level to 2% of VT for well balanced systems, and 1% of VT accuracy. For systems with high resistance grounding or floating neutrals, this setting can be as high as 20%. The default of 5% of VT is appropriate for most solidly grounded systems. The following table shows the operating current, and the polarizing signals used for directional control:

Table 9: Ground Directional characteristics

Quantity	Operating Current	Polarizing Voltage
Ground	Ig	-Vo/-3Vo*

* Polarizing voltage will be 3Vo when voltage is measured from the auxiliary voltage channel.

BLOCK OC DIR UN

Range: Disabled, Enabled

Default: Enabled

This setting establishes the procedure under undefined direction. If enabled, ground OC elements with “Forward” or “Reverse” setting are blocked; otherwise, they are not.

OUTPUT RELAY 3 to 6

Range: Do not operate, Operate

Default: Do not operate

Any or all of the output relays 3 to 6 can be selected to operate upon Gnd (S. Gnd) Directional operation. The selection of relay outputs operation is available no matter whether Latched Alarm, Alarm, or Trip function is selected.

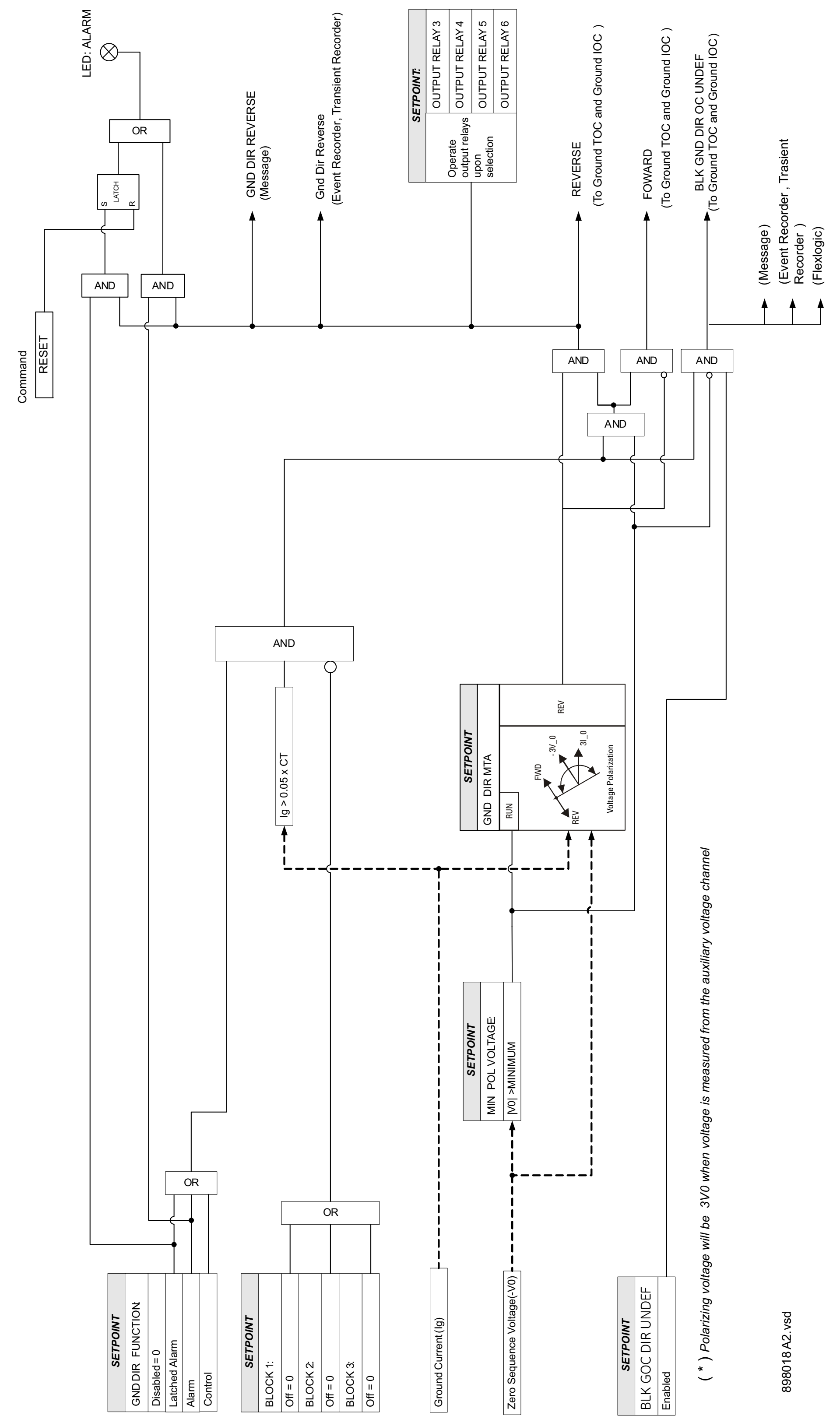
BLOCK 1/2/3

Range: Off, Contact Input 1 to 10, Virtual Input 1 to 32, Remote Input 1 to 32, Logic Element 1 to 16

Default: Off

Three blocking inputs are provided in the Ground Directional menu. One blocking input going “high” is enough to block the function. The selection for each block can be Contact input, Virtual Input, Remote Input, or Logic Element.

Figure 23: Ground directional logic diagram



Neutral timed overcurrent protection

The relay has one Neutral Time Overcurrent protection element per setpoint group. The settings of this function are applied to the calculated neutral current to produce pickup and trip flags. The Neutral TOC pickup flag is asserted, when the neutral current is above the PKP value. The Neutral TOC operate flag is asserted if the element stays picked up for the time defined by the selected inverse curve and the magnitude of the current. The element drops from pickup without operation, if the neutral current drops below 97-99% of the pickup value, before the time for operation is reached. The selection of Definite Time has a base time delay of 0.1 s, multiplied by the selected TD multiplier. For example the operating time for TOC set to Definite Time and a TDM set to 5 will result in 5*0.1 = 0.5 s.

The following path is available using the keypad. For instructions on how to use the keypad, please refer to *Chapter 3 - Working with the Keypad*.

PATH: **SETPOINTS > S3 PROTECTION > SETPOINT GROUP 1(2) > NEUTRAL TOC**

NTRL TOC FUNCTION

Range: Disabled, Latched Alarm, Alarm, Trip

Default: Disabled

The selection of the Latched Alarm, Alarm, or Trip setting enables the Neutral TOC function. The output relay #1 “Trip” will operate if the Neutral TOC function is selected as Trip, and the neutral current calculated by the relay satisfies the operating condition set by the settings. The “ALARM” LED will not turn on if the TOC operates when set to function Trip. The “ALARM” LED will flash upon Neutral TOC operating condition with the TOC function selected as Alarm, and will self-reset when the operating condition clears. If Latched Alarm is selected as a TOC function, the “ALARM” LED will flash during TOC operation, and will stay “ON” after the operation clears, until a reset command is initiated. The output relay #1 “Trip” will not operate if Latched Alarm or Alarm setting is selected. Any or all of the output relays 3 to 6 can be selected to operate when the Neutral TOC function is selected as Latched Alarm, Alarm, or Trip.

NTRL TOC PKP

Range: 0.05 to 20.00 x CT in steps of 0.01 x CT

Default: 1.00 x CT

This setting sets the time overcurrent pickup level. For example, a PKP setting of 0.9 x CT with 300:5 CT translates into 270A neutral current.

NTRL TOC CURVE

Range: ANSI Extremely/Very/Moderately/Normally Inverse, Definite Time, IEC Curve A/B/C and Short Inverse, IAC Extremely/Very/Inverse/Short, User Curve, FlexCurve A, FlexCurve B

Default: Extremely Inverse

This setting sets the shape of the selected over-current inverse curve. If none of the standard curve shapes is appropriate, a custom User curve, or FlexCurve can be created. Refer to the User curve and the FlexCurve setup for more detail on their configurations and usage.

NTRL TOC TDM

Range: 0.05 to 50.00 in steps of 0.01

Default: 1.00

This setting provides selection for Time Dial Multiplier by which the times from the selected inverse curve are modified. For example if an ANSI Extremely Inverse curve is selected with TDM = 2, and the fault current was 5 times bigger than the PKP level, operation of the element will not occur before an elapse of 495 ms from pickup.

NTRL TOC RESET

Range: Instantaneous, Linear

Default: Instantaneous

The “Instantaneous” reset method is intended for applications with other relays, such as most static relays, which set the energy capacity directly to zero when the current falls below the reset threshold. The “Timed” reset method can be used where the relay must coordinate with electromechanical relays.

NTRL TOC DIRECTION

Range: Disabled, Forward, Reverse

Default: Disabled

This setting provides control to the Neutral TOC function in terms of permitting operation under fault conditions in the selected current flow direction, and blocking it when faults occur in the opposite direction.

A special case is considered when fault direction is undefined. Then “BLK OC DIR UN” setting in Neutral Directional defines the fault direction.

OUTPUT RELAY 3 to 6

Range: Do not operate, Operate

Default: Do not operate

Any or all of the output relays 3 to 6 can be selected to operate, upon Neutral TOC operation. The selection of relay outputs operation is available no matter whether Latched Alarm, Alarm, or Trip function is selected.

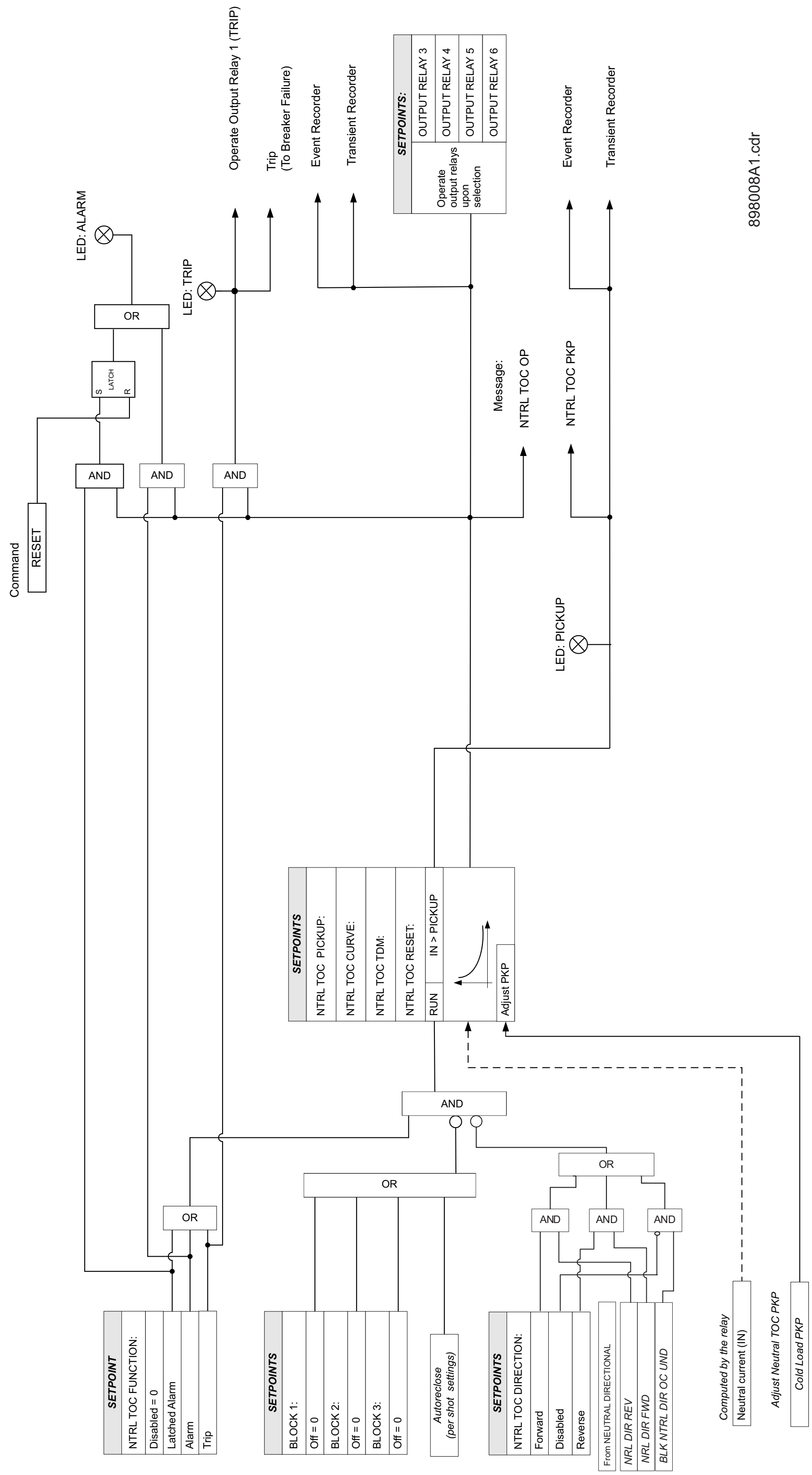
BLOCK 1/2/3

Range: Off, Contact Input 1 to 10, Virtual Input 1 to 32, Remote Input 1 to 32, Logic Element 1 to 16

Default: Off

There are three blocking inputs provided in the Neutral TOC menu. One blocking input going “high” is enough to block the function. The selection for each block can include Contact input, Virtual Input, Remote Input, or Logic Element.

Figure 24: Neutral Timed Overcurrent Protection: Logic Diagram



Negative sequence timed overcurrent protection

The SR3 relay has one Negative Sequence Overcurrent element per setpoint group. The negative sequence overcurrent protection responds to negative sequence $|I_2|$current, where it is calculated as .

$$|I_2| = \frac{1}{3} \cdot |I_A + I_B \cdot (1\angle 240) + I_C \cdot (1\angle 120)|$$

The negative sequence overcurrent elements are uniquely suited to detect phase-phase faults and are not sensitive to balanced loads. While negative sequence elements do not respond to a balanced load, they do detect the negative sequence current present in an unbalanced load. For this reason, select an element pickup setting above the maximum expected I_2 current due to load unbalance.

The Negative Sequence TOC1(2) Trip (Alarm) Pickup flag is asserted when the negative sequence current is above the PKP value. The Negative Sequence TOC1(2) Trip (Alarm) operate flag is asserted if the element stays picked-up for the time defined by the selected inverse curve and the magnitude of the current. The element drops from pickup without operation if the measured current drops below 97-99% of the pickup value, before the time for operation is reached. When Definite Time is selected, the time for Negative Sequence TOC operation is defined only by the TDM setting. The selection of Definite Time has a base time delay of 0.1s, multiplied by the selected TD multiplier. For example, the operating time for TOC set to Definite Time and a TDM set to 5 will result in 5*0.1 = 0.5s.

PATH: **SETPOINTS > S3 PROTECTION > SETPOINT GROUP 1(2) > NEG SEQ TOC1(2)**

NEG SEQ TOC FUNC

Range: Disabled, Latched Alarm, Alarm, Trip

Default: Disabled

The selection of the **Latched Alarm**, **Alarm**, or **Trip** setting enables the Negative Sequence TOC function. The output relay #1 “Trip” will operate if the function **Trip** is selected, and the negative sequence current computed by the relay, is above the NEG SEQ TOC PKP setting for a time greater than the selected time under NEG SEQ TOC DELAY. The “ALARM” LED will not turn on if the negative sequence TOC function is set to **Trip**. The “ALARM” LED will flash under the neg. sequence TOC operating condition, with the negative sequence TOC function selected as **Alarm**, and will self-reset when this operating condition clears. Until a reset command is initiated, if **Latched Alarm** is selected as a negative sequence TOC function, the “ALARM” LED will flash during the TOC condition, and will stay “ON” after the condition clears. The output relay #1 “Trip” will not operate if the **Latched Alarm** or **Alarm** setting is selected. Any or all of the output relays 3 to 6 can be selected to operate with the negative sequence TOC function selected as **Latched Alarm**, **Alarm**, or **Trip**.

NEG SEQ TOC PKP

Range: 0.05 to 20.00 x CT in steps of 0.01 x CT

Default: 1.00 x CT

This setting defines the negative sequence TOC pickup level associated with the ratings of the CTs selected under NEG SEQ CT INPUT.

NEG SEQ TOC CURVE

Range: - ANSI Extremely/Very/Moderately/Normally Inverse- Definite Time- IEC Curve A/B/C and Short Inverse- IAC Extremely/Very/Inverse/Short, User Curve, FlexCurve™ A/B

Default: Ext Inverse

This setting defines the shape of the selected overcurrent inverse curve.

NEG SEQ TOC TDM

Range: 0.05 to 50.00 in steps of 0.01

Default: 1.00

This setting provides a selection for Time Dial Multiplier, which modifies the time response of the selected curve. For example if an ANSI Extremely Inverse curve is selected with TDM = 2, and the fault current was 5 times bigger than the PKP level, the operation of the element will not occur before the elapse of 2.59 seconds from pickup.

NEG SEQ TOC RESET

Range: Instantaneous, Linear

Default: Instantaneous

The reset of the negative sequence timed overcurrent can be selected as either "Instantaneous" or "Linear". If Instantaneous reset is selected, the Negative Sequence TOC element will reset instantaneously providing that the current drops below 97-98% of the Neg. Seq. TOC PKP level, before the time for operation is reached. When Linear reset is selected, the time to reset is calculated based on the following linear equation:

$$T_{RESET} = E.M.C_R \qquad \textbf{Eq. 3}$$

where: T_{RESET} - reset time in seconds; E - energy capacity reached (per unit); M - curve multiplier; C_R - characteristic constant (5 for ANSI, IAC, Definite Time, User Curve.

The 100% "energy capacity" for the TOC element is defined by the selection of PKP, TDM and points from the inverse curve. A memory variable based on actual values currents is monitored for accumulation of energy capacity, where if it reaches a level of 100% of the set energy capacity level, the element operates, and if it goes below 97-98% of this level, the element will tend to reset. The accumulated energy capacity is used as an input for computation of the reset time, when the "Linear" reset is selected as a setting.

OUTPUT RELAY 3 to 6

Range: Do not operate, Operate

Default: Do not operate

Any or all of the output relays 3 to 6 can be selected to operate upon the negative sequence TOC condition. Relay outputs operation is available no matter whether the **Latched Alarm**, **Alarm**, or **Trip** function is selected.

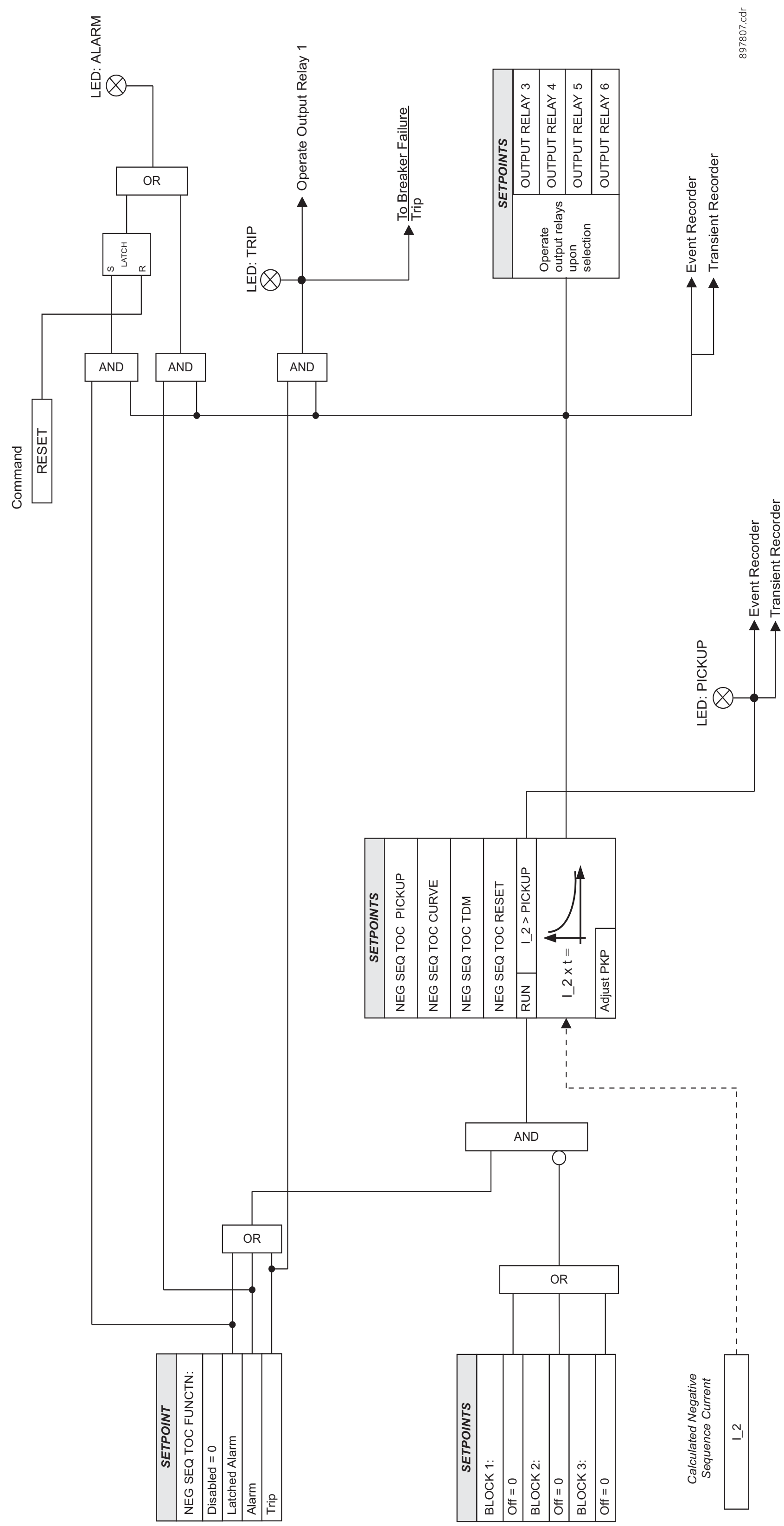
BLOCK 1/2/3

Range: Off, Contact Input 1 to 10, Virtual Input 1 to 32, Remote Input 1 to 32, Logic Element 1 to 16

Default: Off

Three blocking inputs are provided in the negative sequence TOC menu. Any one of the assigned blocking inputs can block the function. The selections for each block include Contact input, Virtual Input, Remote Input, or Logic Element.

Figure 25: Negative Sequence Timed Overcurrent logic diagram



Neutral instantaneous overcurrent protection

The relay has two Instantaneous Overcurrent protection elements per setpoint group. The settings of this function are applied to the calculated neutral current for pickup and trip flags. The Neutral IOC pickup flag is asserted, when the neutral current is above the PKP value. The Neutral IOC operate flag is asserted if the element stays picked up for the time defined by the Neutral IOC Delay setting. If the pickup time delay is set to 0.00 seconds, the pickup and operate flags will be asserted at the same time. The element drops from pickup without operation, if the neutral current drops below 97-99% of the pickup value before the time for operation is reached.

The following path is available using the keypad. For instructions on how to use the keypad, please refer to *Chapter 3 - Working with the Keypad*.

PATH: **SETPOINTS > PROTECTION > ETPOINT GROUP 1 (2) > NEUTRAL IOC1(2)**

NTRL IOC1(2) FUNCTION

Range: Disabled, Latched Alarm, Alarm, Trip

Default: Disabled

The selection of the Latched Alarm, Alarm, or Trip setting enables the Neutral IOC function. The output relay #1 “Trip” will operate if the Neutral IOC function is selected as Trip, and the neutral current calculated by the relay satisfies the operating condition set by the settings. The “ALARM” LED will not turn on if the neutral IOC operates when set to function Trip. The “ALARM” LED will flash upon Neutral IOC operation with the IOC function selected as Alarm and will self-reset when this operation clears. If Latched Alarm is selected as an IOC function, the “ALARM” LED will flash during IOC operation and will stay “ON” after the operating condition clears, until the reset command is initiated. The output relay #1 “Trip” will not operate if the Latched Alarm or Alarm setting is selected. Any or all of the output relays 3 to 6 can be selected to operate when the Neutral IOC function - Latched Alarm, Alarm, or Trip - is selected.

NTRL IOC PKP

Range: 0.05 to 20 x CT in steps of 0.01 x CT

Default: 1.00 x CT

This setting sets the neutral instantaneous overcurrent pickup level.

NTRL IOC DELAY

Range: 0.00 to 300 sec in steps of 0.01 sec

Default: 0.00 sec

This setting sets the neutral instantaneous overcurrent delay.

NTRL IOC DIRECTION

Range: Disabled, Forward, Reverse

Default: Disabled

This setting provides control to the Neutral IOC1(2) function in terms of permitting operation upon fault conditions in the selected current flow direction, and blocking it when faults occur in the opposite direction.

A special case is considered when fault direction is undefined. Then “BLK OC DIR UN” setting in Neutral Directional defines the fault direction.

OUTPUT RELAY 3 to 6

Range: Do Not Operate, Operate

Default: Do Not Operate

Any or all of the output relays 3 to 6 can be selected to operate upon a Neutral IOC condition. Relay outputs operation is available no matter whether the **Latched Alarm**, **Alarm**, or **Trip** function is selected.

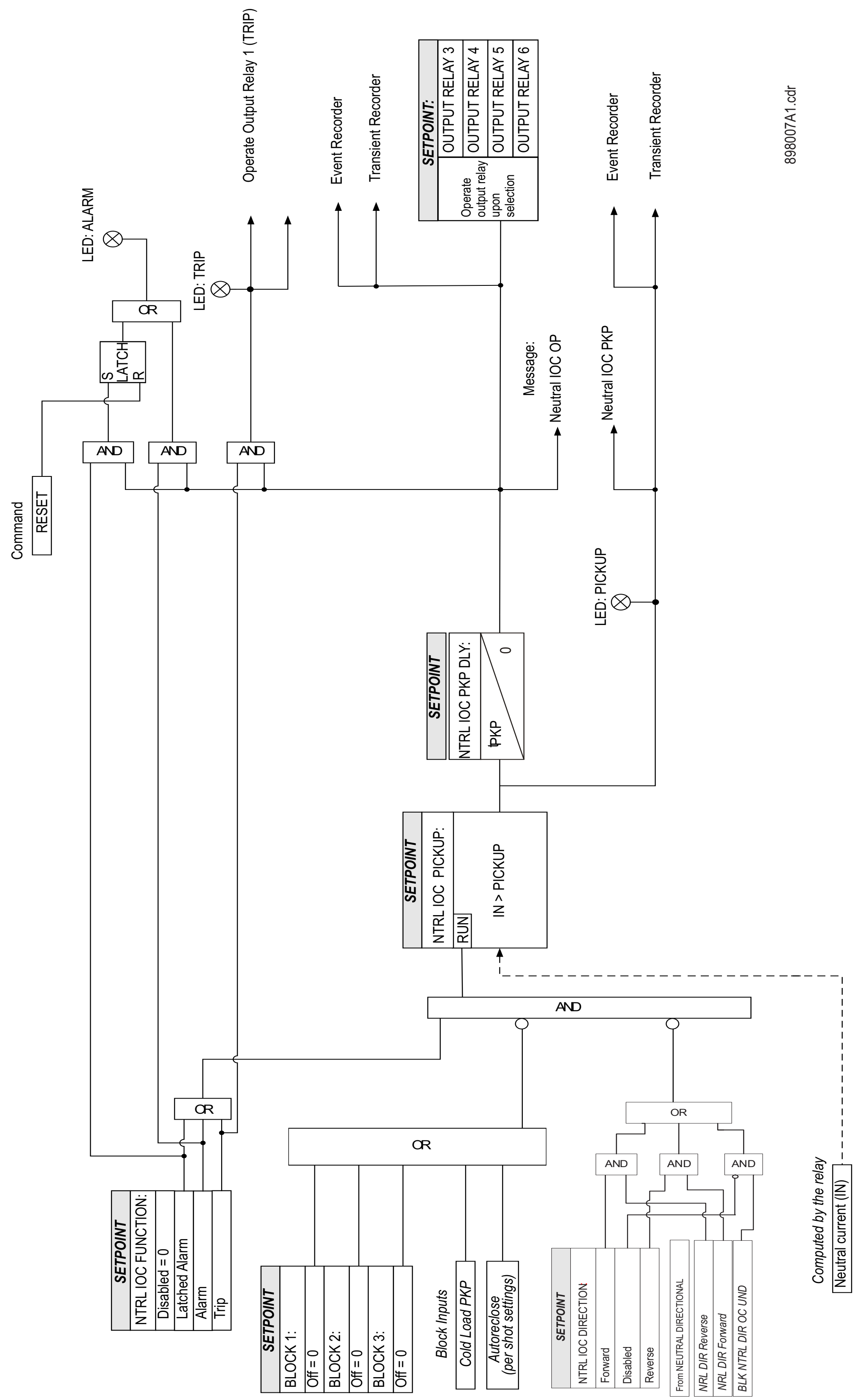
BLOCK 1/2/3

Range: Off, Contact Input 1 to 10, Virtual Input 1 to 32, Remote Input 1 to 32, Logic Element 1 to 16

Default: Off

Three blocking inputs are provided in the Neutral IOC menu. One blocking input going "high" is enough to block the function. The selection for each block can be Contact input, Virtual Input, Remote Input, or Logic Element.

Figure 26: Neutral Instantaneous Overcurrent Protection: Logic Diagram



Neutral directional

The Neutral Directional element is used to discriminate between faults that occur in the forward direction, and faults that occur in the reverse direction. The Neutral Directional element can be used either individually for control or alarm by energizing the auxiliary output relays, or as a part of the Neutral Time, or Instantaneous, over-current elements to define the tripping direction. (See the setup for Neutral TOC, and Neutral IOC elements.)

The polarizing signal for the Neutral Directional element can be set to be either voltage (zero sequence voltage), current (measured ground current), or dual (both).

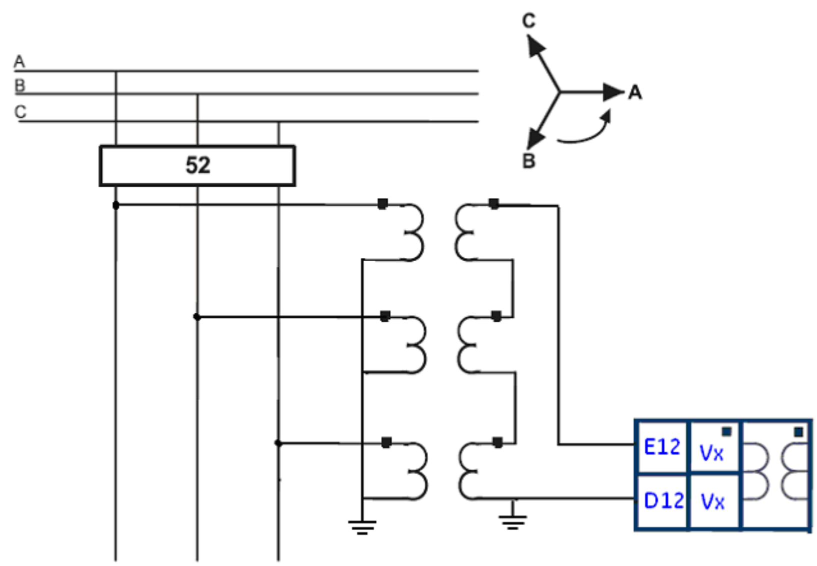
Depending on the relay's order code, the zero sequence voltage used for the Neutral Directional polarizing voltage, is calculated either when three-phase voltages are available, or is the measured voltage from the auxiliary Vx voltage input when the three-phase voltages are not available. For those relays with available phase VTs, the polarizing voltage for the Neutral directional element is calculated as follows:

$$-V_0 = \frac{-(V_a + V_b + V_c)}{3} \quad \textbf{Eq. 4}$$

Please note that the phase VT inputs must be connected in Wye.

For those relays with available Vx auxiliary voltage input only, the polarizing voltage for the Neutral directional element is three times the zero sequence voltage measured at the Vx terminals. The Vx input should be connected to measure $3V_0$ from an open delta VT configuration as shown in the figure below.

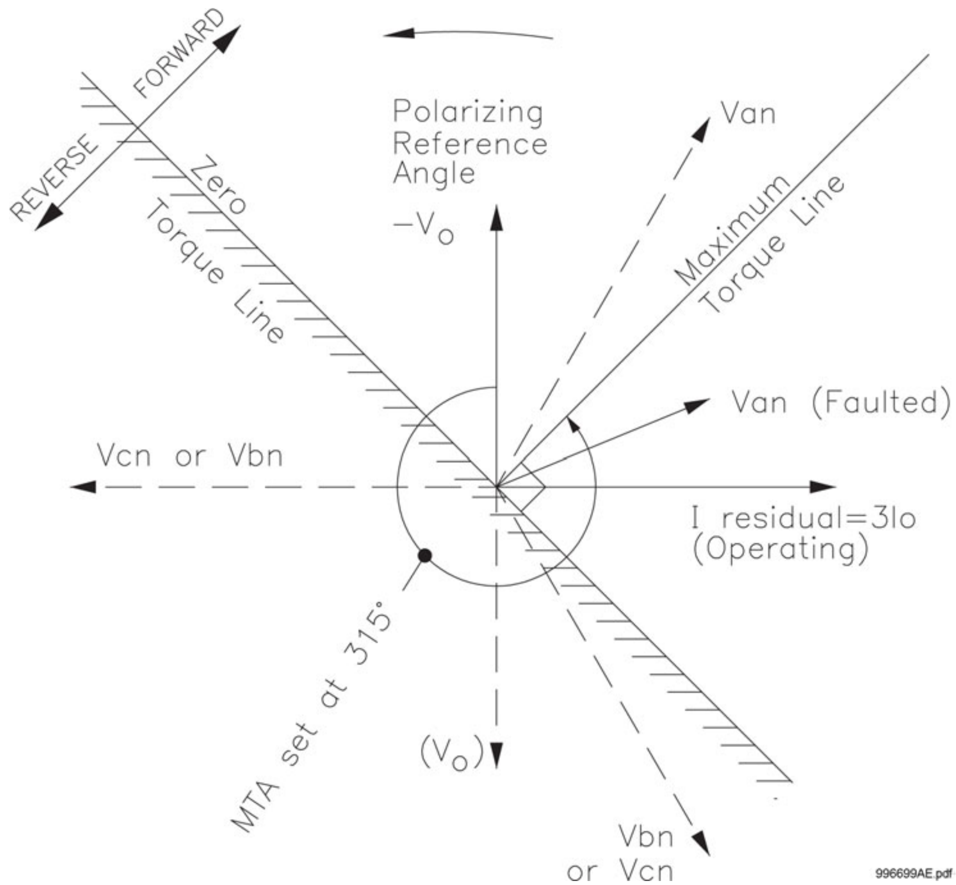
Figure 27: Open Delta VT connection



When "Voltage" polarization is selected, the direction is determined by comparing the angle between the operating current and the voltage, and the set MTA angle. In cases where the voltage drops below the setting of the minimum polarizing voltage, the neutral directional element is undefined (see following table).

When "Current" polarizing is selected, the direction of the neutral current is determined with reference to the direction of the measured ground current . The fault is detected in the Forward direction when the ground current typically flowing from the ground point into the neutral current is within ± 90° of the polarizing current. Otherwise the direction is detected as Reverse. The neutral directional element is undefined (see following table) if the polarizing ground current drops below 5% of the ground CT.

The diagram below shows the regions for detection of neutral current Forward and Reverse directions with respect to the zero sequence voltage and the selected Maximum Torque Angle (MTA).



When "Dual" polarizing is selected, the Reverse direction is declared if both directional comparators - the one based on the zero sequence polarizing voltage, and the other based on measured ground polarizing current - declare Reverse direction. If the direction from one of the comparators declares Forward direction and the other declares Reverse direction, the neutral directional element is undefined (see following table). If the polarizing voltage falls below the set minimum voltage, the direction declared depends on the polarizing ground current, assuming the measured ground current is above some 5% CTg. The same rule applies if the ground current falls below 5% CTg. In this case the direction is determined using the polarizing zero sequence voltage, assuming it is above the set minimum voltage from the settings menu.

When direction is undefined, the "BLK NOC DIR UNDEF" setting determines whether neutral overcurrent protection must be blocked (setting = Enabled) or enabled (setting= Disabled).

Table 10: Neutral directional element directions

Directional type	Current direction	Voltage direction	Result
Current	Undefined	-	Undefined
	FW		FW
	RV		RV
Voltage	-	Undefined	Undefined
		FW	FW
		RV	RV

Directional type	Current direction	Voltage direction	Result
Dual	Undefined	Undefined	Undefined
	FW	RV	Undefined
	RV	FW	Undefined
	Undefined	FW	FW
	Undefined	RV	RV
	FW	Undefined	FW
	RV	Undefined	RV

The following path is available using the keypad. For instructions on how to use the keypad, please refer to *Chapter 3 - Working with the Keypad*.

PATH: **SETPOINTS > S3 PROTECTION > S3 SETPOINT GROUP 1(2) > NTRL DIR**

NTRL DIR FUNCTION

Range: Disabled, Latched Alarm, Alarm, Control

Default: Disabled

When an **Alarm** function is selected, the alarm LED will flash upon detection of Reverse direction, and will drop out when the direction changes to Forward. When **Latched Alarm** is selected, the alarm LED will flash upon detection of Reverse direction, and will stay lit (latched) after the direction changes to Forward. The alarm LED can be reset, by issuing a Reset command. Detection of Reverse direction when the **Control** function is selected, does not trigger the alarm LED.

NTRL DIR POLARIZING

Range: Voltage, Current, Dual

Default: Voltage

This setting specifies the voltage polarizing signal for the detection of Forward and Reverse directions.

NTRL DIR MTA

Range: 0° to 359° Lead in steps of 1°

Default: 315°

This setting sets the Maximum Torque Angle (MTA), for the Neutral Directional element to define the regions of Forward and Reverse directions. For Voltage polarizing, enter the maximum torque angle by which the operating current leads the polarizing voltage. This is the angle of maximum sensitivity.

MIN POL VOLTAGE

Range: 0.05 to 1.25 x VT in steps of 0.01

Default: 0.05 x VT

This setting affects only cases where voltage or dual polarizing is selected. The minimum zero sequence voltage level must be selected to prevent operation due to normal system unbalances, or voltage transformer errors. Set the minimum zero sequence voltage level to 2% of VT for well balanced systems, and 1% of VT accuracy. For systems with high resistance grounding or floating neutrals, this setting can be as high as 20%. The default of 5% of VT is appropriate for most solidly grounded systems.

Table 11: Neutral directional characteristics

Quantity	Operating Current	Polarizing Voltage (VT connection: Wye)	Polarizing Current
Neutral	$3I_0 = I_a + I_b + I_c$	$-V_0 = -(V_a + V_b + V_c)/3$ $-3V_0$ (*)	I_g

* Polarizing voltage will be $3V_o$ when voltage is measured from the auxiliary voltage channel.

BLK OC DIR UN

Range: Disabled, Enabled

Default: Enabled

This setting establishes the procedure under undefined direction conditions. If enabled, OC elements with a “Forward” or “Reverse” setting are blocked; otherwise, they are not.

OUTPUT RELAY 3 to 6

Range: Do not operate, Operate

Default: Do not operate

Any or all of the output relays 3 to 6 can be selected to operate upon Neutral Directional operation. The selection of relay outputs operation is available no matter whether Latched Alarm, Alarm, or Trip function is selected.

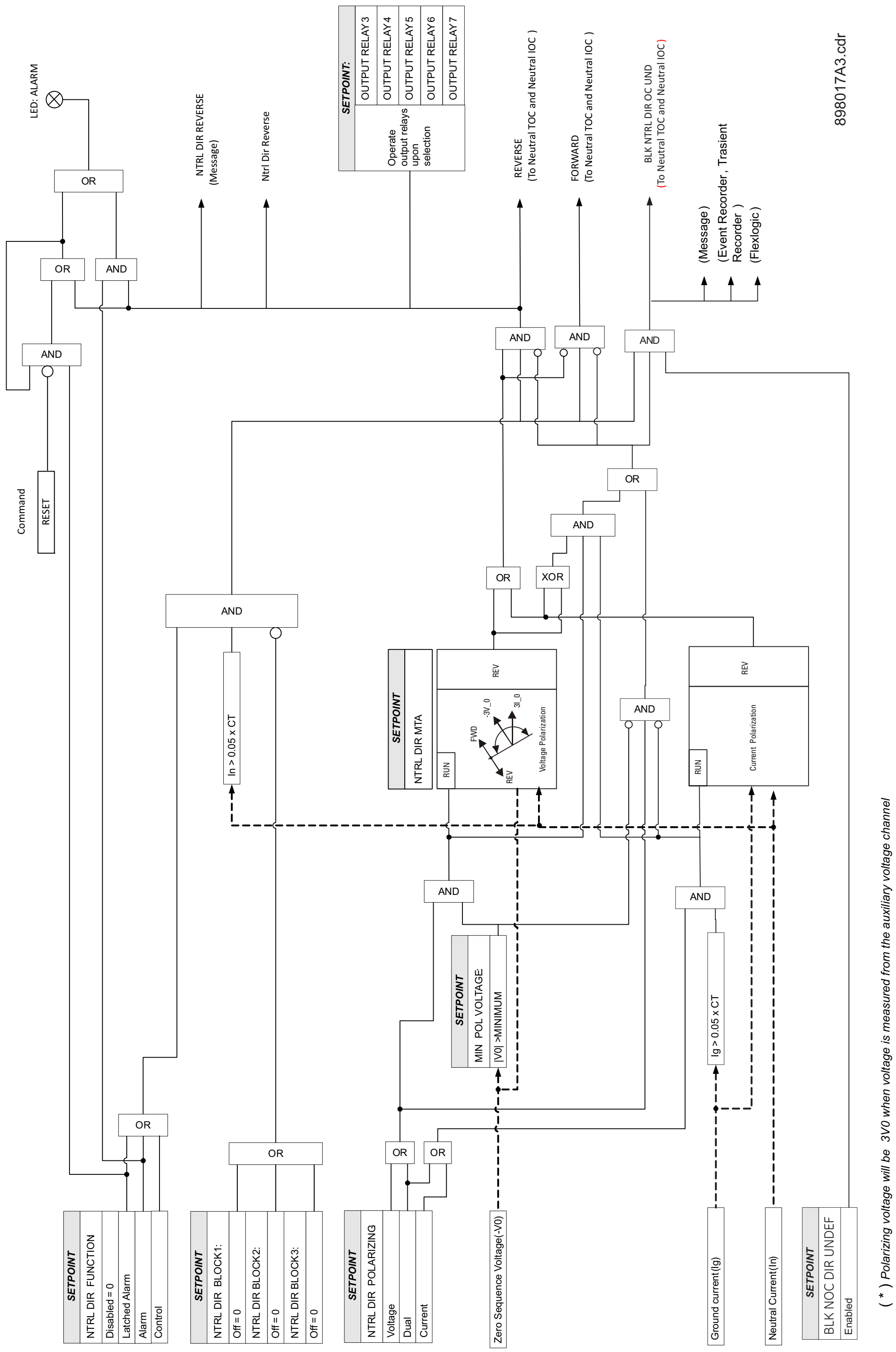
BLOCK 1/2/3

Range: Off, Contact Input 1 to 10, Virtual Input 1 to 32, Remote Input 1 to 32, Logic Element 1 to 16

Default: Off

Three blocking inputs are provided in the Neutral Directional menu. One blocking input going “high” is enough to block the function. The selection for each block can be Contact input, Virtual Input, Remote Input, or Logic Element.

Figure 28: Neutral directional logic diagram



Negative sequence instantaneous overcurrent protection

The 350 relay has one Negative Sequence Overcurrent element per protection group. The negative sequence over-current protection responds to negative sequence current, where it is calculated as .

$$|I_2| = \frac{1}{3}.|I_A + I_B.(1\angle 240) + I_C.(1\angle 120)|$$

The negative sequence over-current elements are uniquely suited to detect phase-phase faults and are not sensitive to balanced loads. While negative sequence elements do not respond to balanced load, they do detect the negative sequence current present in unbalanced load. For this reason, select an element pickup setting above the maximum expected current due to load unbalance.

PATH: **SETPOINTS > S3 PROTECTION > SETPOINT GROUP 1(2) > NEG SEQ IOC**

NEG SEQ IOC FUNCTION

Range: Disabled, Latched Alarm, Alarm, Trip

Default: Disabled

The selection of the **Latched Alarm**, **Alarm**, or **Trip** setting enables the Negative Sequence IOC function. The output relay #1 "Trip" will operate if the function **Trip** is selected, and the negative sequence current computed by the relay, is above the NEG SEQ IOC PKP setting for a time greater than the selected time under NEG SEQ IOC DELAY. The LED "ALARM" will not turn on if the neg. sequence IOC function is set to **Trip**. The LED "ALARM" will flash under the neg. sequence IOC operating condition, with the neg. sequence IOC function selected as **Alarm**, and will self-reset, when this operating condition clears. If **Latched Alarm** is selected as a neg. seq. IOC function, the LED "ALARM" will flash during the IOC condition, and will stay "ON" after the condition clears, until the reset command is initiated. The output relay #1 "Trip" will not operate if **Latched Alarm** or **Alarm** setting is selected. Any or all of the output relays 3 to 6 can be selected to operate with the neg. seq. IOC function selected as **Latched Alarm**, **Alarm**, or **Trip**.

NEG SEQ IOC PKP

Range: 0.05 to 20.00 x CT in steps of 0.01 x CT

Default: 1.00 x CT

This setting defines the negative sequence IOC pickup level.

NEG SEQ IOC DELAY

Range: 0.00 to 300.00 sec in steps of 0.01 sec

Default: 0.00 sec

This setting specifies the time delay before IOC operation. .

OUTPUT RELAY 3 to 6

Range: Do not operate, Operate

Default: Do not operate

Any or all of the output relays 3 to 6 can be selected to operate upon a Neg Seq IOC condition. Relay outputs operation is available no matter whether the **Latched Alarm**, **Alarm**, or **Trip** function is selected.

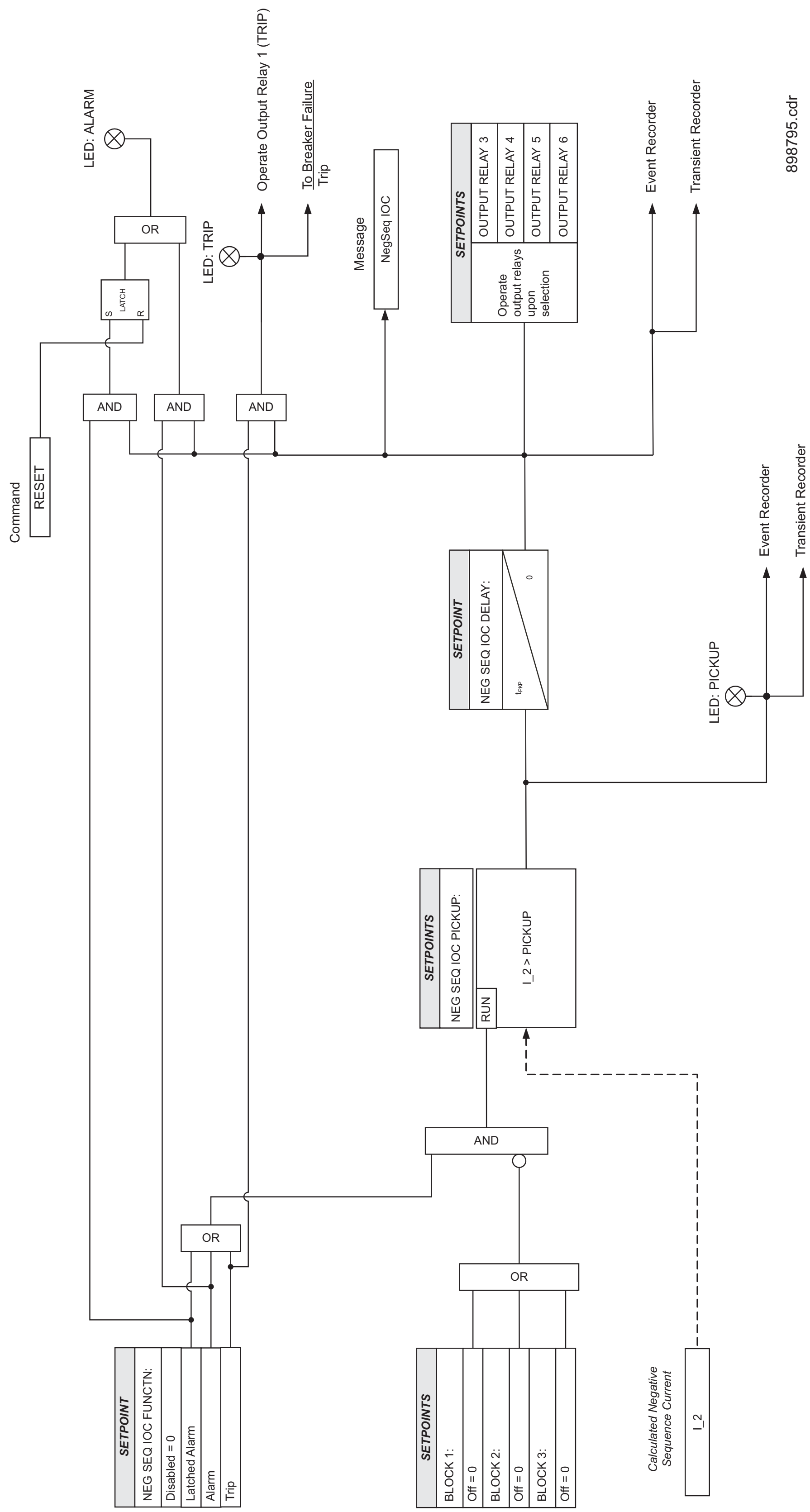
BLOCK 1/2/3

Range: Off, Contact Input 1 to 10, Virtual Input 1 to 32, Remote Input 1 to 32, Logic Elements 1 to 16

Default: Off

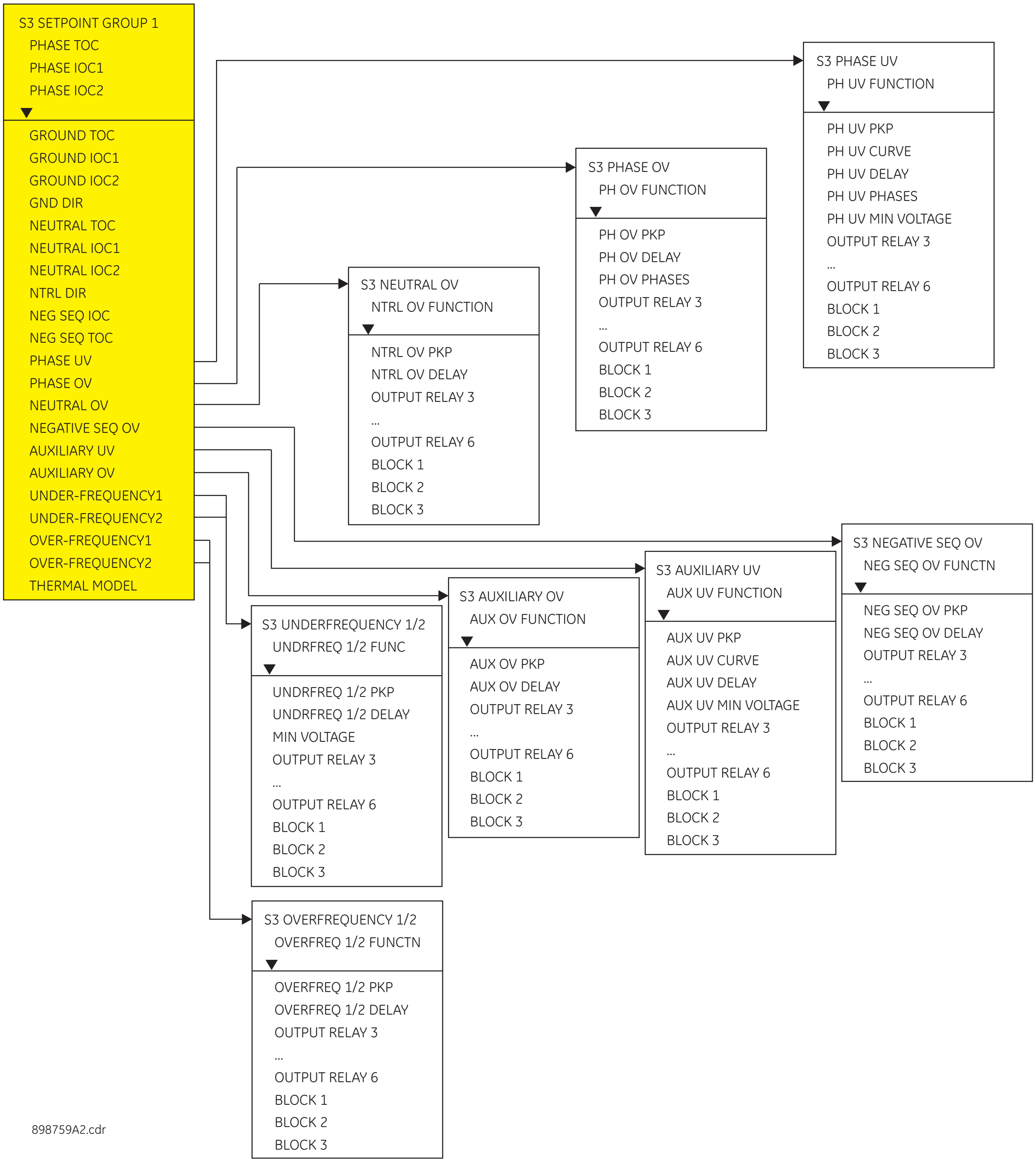
Three blocking inputs are provided in the Neg. seq. IOC menu. Any one of the assigned blocking inputs can block the function. The available selections for each block include Contact input, Virtual Input, Remote Input, or Logic Element.

Figure 29: Negative sequence instantaneous overcurrent protection logic diagram



Voltage elements

Figure 30: Voltage elements menu



Phase undervoltage

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

- **Permissive Functions**: The undervoltage feature may be used to block the functioning of external devices by operating an output relay, when the voltage falls below the specified voltage setting. Note that all internal features that are inhibited by an undervoltage condition, such as underfrequency and overfrequency, have their own inhibit functions independent of the undervoltage protection features.
- **Source Transfer Schemes**: In the event of an undervoltage, a transfer signal may be generated to transfer a load from its normal source to a standby or emergency power source.

The undervoltage elements can be programmed to have an inverse time delay characteristic. The undervoltage delay setpoint defines a family of curves as shown below. The operating time is given by:

$$T = \frac{D}{1 - V/V_{pu}} \qquad \textbf{Eq. 5}$$

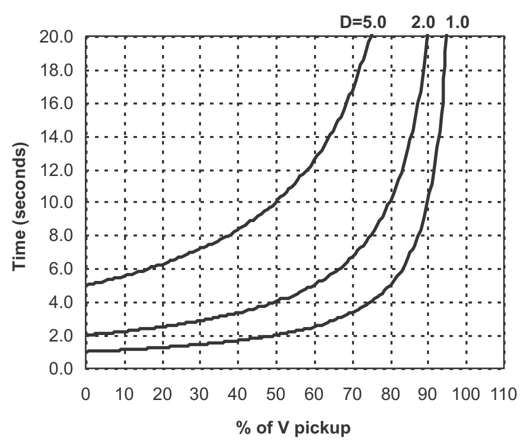
Where:

T = Operating Time
D = Undervoltage Delay setpoint
V = Voltage as a fraction of the nominal VT Secondary Voltage
V_{pu} = Pickup Level

NOTE

At 0% of pickup, the operating time equals the Undervoltage Delay setpoint.

Figure 31: Inverse time undervoltage curves



The following path is available using the keypad. For instructions on how to use the keypad, please refer to *Chapter 3 - Working with the Keypad*.

PATH: SETPOINTS > S3 PROTECTION > SETPOINT GROUP 1(2) > PHASE UV

PH UV FUNCTION

Range: Disabled, Alarm, Latched Alarm, Trip
Default: Disabled

The selection of the Latched Alarm, Alarm, or Trip setting enables the Phase UV function. The output relay #1 "Trip" will operate if the function is selected as a Trip, and the phase voltages from the selected "PH UV PHASES" combination are below the PH UV PKP setting for a time greater than the selected PHASE UV DELAY time. The "ALARM" LED will not turn on if the phase UV function is set to Trip. The "ALARM" LED will flash upon the UV operating condition, with the phase UV selected as Alarm, and will self-reset, when this operating condition clears. If Latched Alarm is selected as a phase UV function, the "ALARM" LED will flash during the UV condition and will stay "ON" after the condition clears, until the reset command is initiated. The output relay #1 "Trip" will not operate if the Latched Alarm or Alarm setting is selected. Any or all of the output relays 3 to 6 can be selected to operate when the phase UV function is selected as Latched Alarm, Alarm, or Trip.

PH UV PKP

Range: 0.00 to 1.25 x VT in steps of 0.01

Default: 0.75 x VT

This setting defines the phase UV pickup level, and it is usually set to a level, below which the drawn current from voltage sensitive loads, such as induction motors may cause dangerous motor overheating conditions.

PH UV CURVE

Range: Definite Time, Inverse Time

Default: Inverse Time

This setting selects the type of timing-inverse time/definite time to define the time of undervoltage operation based on the selected UV time delay, and the actual undervoltage condition with respect to the selected UV pickup.

PH UV DELAY

Range: 0.1 to 600.0 sec in steps of 0.1 sec

Default: 2.0 s

This setting specifies the time delay used by the selected “PHASE UV CURVE” type of timing, to calculate the time before UV operation.

PH UV PHASES

Range: Any One, Any Two, All Three

Default: Any One

This setting selects the combination of undervoltage conditions with respect to the number of phase voltages under the undervoltage pickup setting. Selection of the “Any Two”, or “All Three” settings would effectively rule out the case of single VT fuse failure.

PH UV MIN VOLTAGE

Range: 0.00 to 1.25 x VT in steps of 0.01

Default: 0.30 x VT

The minimum operating voltage level is programmable to prevent undesired UV operation before voltage becomes available.

OUTPUT RELAY 3 to 6

Range: Do not operate, Operate

Default: Do not operate

Any or all of the output relays 3 to 6 can be selected to operate upon a Phase UV condition. The selection of relay outputs operation is available no matter whether Latched Alarm, Alarm, or Trip function is selected.

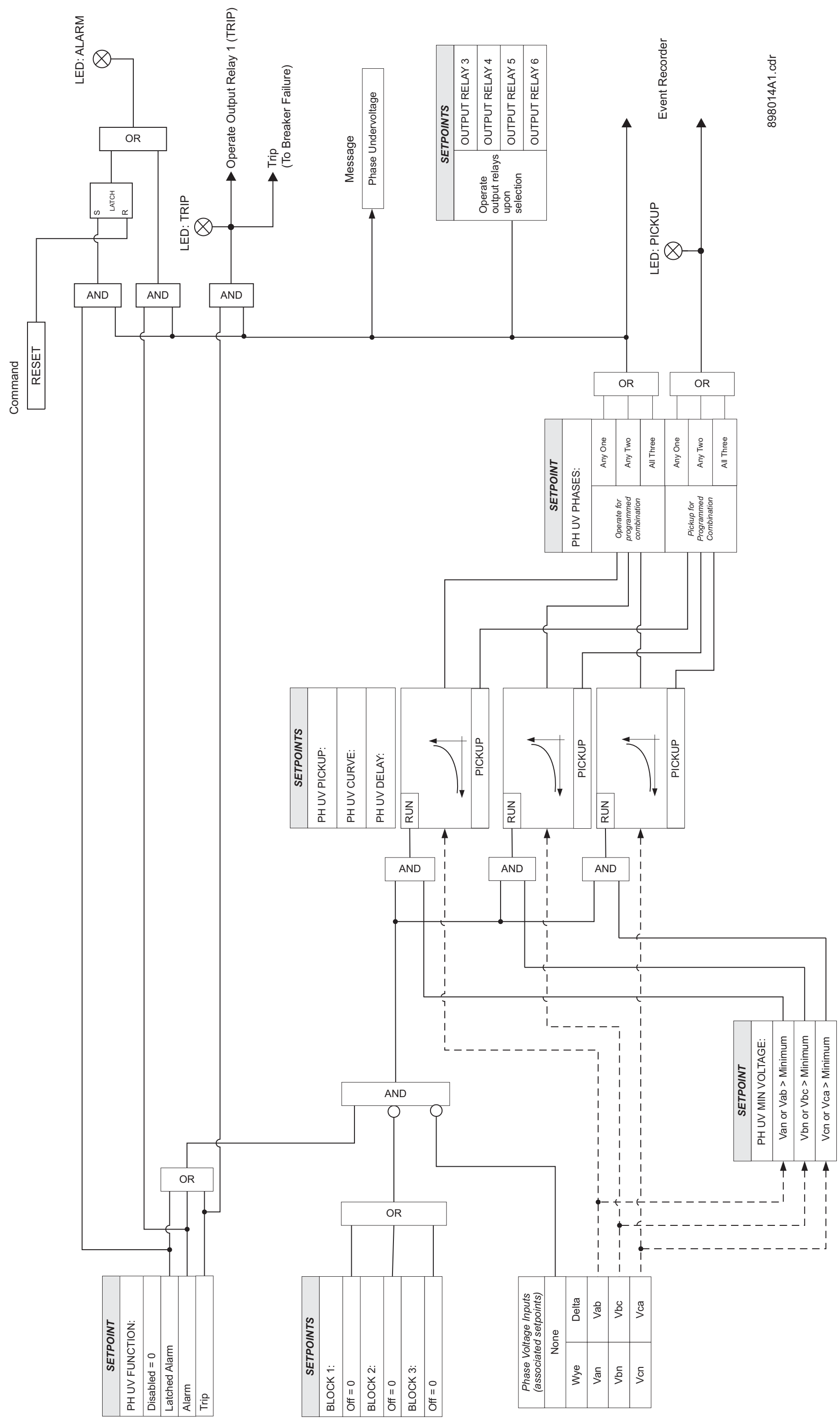
BLOCK 1/2/3

Range: Off, Contact Input 1 to 10, Virtual Input 1 to 32, Remote Input 1 to 32, Logic Element 1 to 16

Default:Off

Three blocking inputs are provided in the Phase UV menu. One blocking input “high” is enough to block the function. The available selections for each block include Contact input, Virtual Input, Remote Input, or Logic Element.

Figure 32: Phase undervoltage logic diagram



Phase overvoltage

The phase OV protection can be used to protect voltage sensitive feeder loads and circuits against sustained overvoltage conditions. The protection can be used to either cause a trip, or generate an alarm when the voltage exceeds a specified voltage value for the specified time delay.

The following path is available using the keypad. For instructions on how to use the keypad, please refer to *Chapter 3 - Working with the Keypad*.

PATH: **SETPOINTS > S3 PROTECTION > SETPOINT GROUP 1(2) > PHASE OV**

PH OV FUNCTION

Range: Disabled, Alarm, Latched Alarm, Trip

Default: Disabled

The selection of the Latched Alarm, Alarm, or Trip setting enables the Phase OV function. The output relay #1 “Trip” will operate, if the function is selected as a Trip, and the phase voltages from the selected “PH OV PHASES” combination are above the PH OV PKP setting for a time greater than the selected PHASE OV DELAY time. The “ALARM” LED will not turn on if the phase OV function is set to Trip. The “ALARM” LED will flash upon the OV operating condition, with the phase OV selected as Alarm, and will self-reset, when this operating condition clears. If Latched Alarm is selected as a phase OV function, the “ALARM” LED will flash during the OV condition and will stay “ON” after the condition clears, until the reset command is initiated. The output relay #1 “Trip” will not operate if the Latched Alarm or Alarm setting is selected. Any or all of the output relays 3 to 6 can be selected to operate when the phase OV function is selected as Latched Alarm, Alarm, or Trip.

PH OV PKP

Range: 0.00 to 1.25 x VT in steps of 0.01

Default: 1.25 x VT

This setting defines the phase OV pickup level, and it is usually set to a level above which some voltage sensitive loads and feeder components may experience overexcitation and dangerous overheating conditions.

PH OV DELAY

Range: 0.1 to 600.0 sec in steps of 0.1

Default: 2.0 s

This setting specifies the time delay before OV operation.

PH OV PHASES

Range: Any One, Any Two, All Three

Default: Any One

This setting selects the combination of overvoltage conditions with respect to the number of phase voltages over the overvoltage pickup setting.

OUTPUT RELAY 3 to 6

Range: Do not operate, Operate

Default: Do not operate

Any or all of the output relays 3 to 6 can be selected to operate upon a Phase OV condition. The selection of relay outputs operation is available no matter whether Latched Alarm, Alarm, or Trip function is selected.

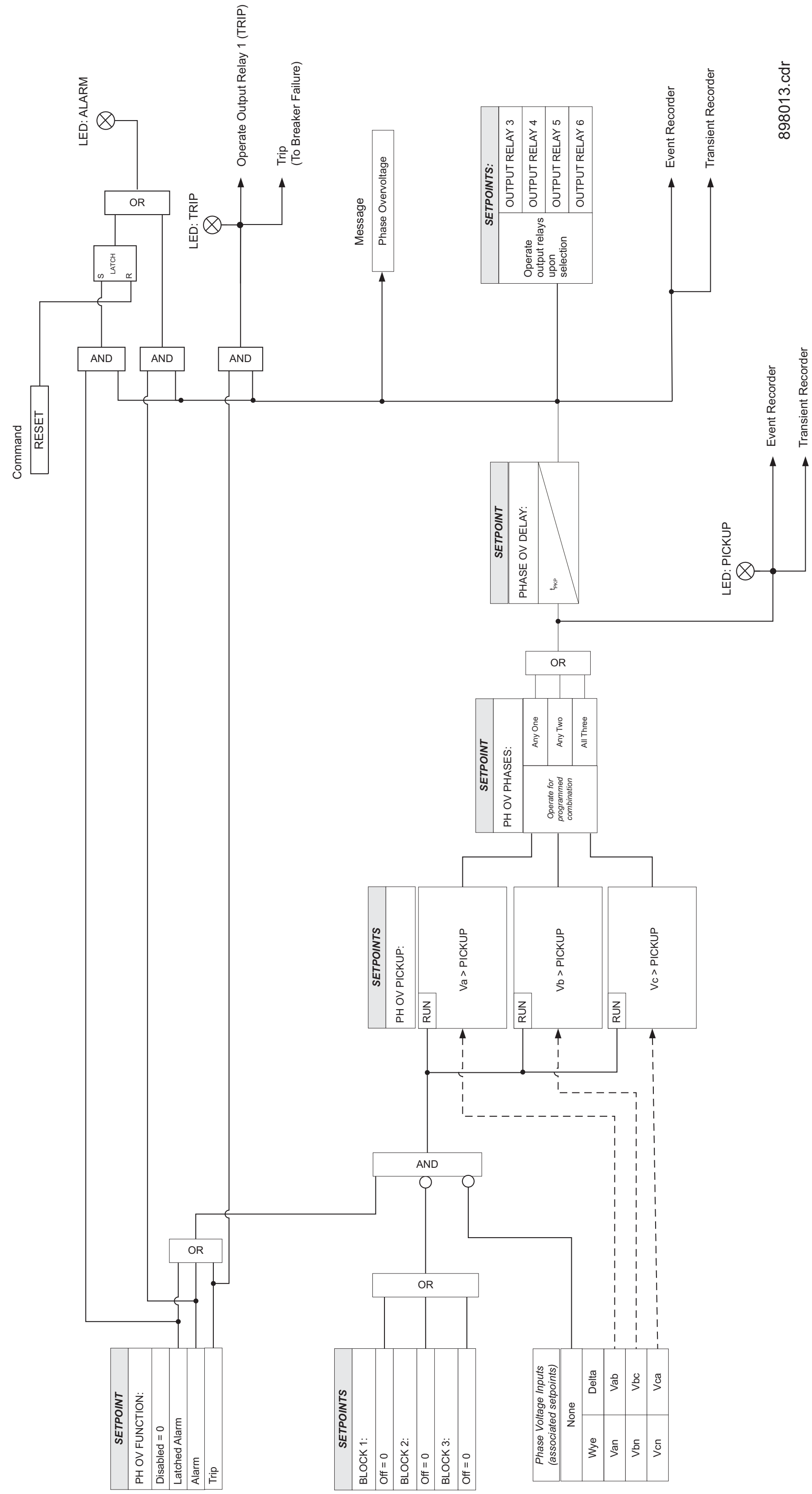
BLOCK 1/2/3

Range: Off, Contact Input 1 to 10, Virtual Input 1 to 32, Remote Input 1 to 32, Logic Element 1 to 16

Default: Off

Three blocking inputs are provided in the Phase OV menu. One blocking input “high” is enough to block the function. The available selections for each block include Contact input, Virtual Input, Remote Input, or Logic Element.

Figure 33: Phase Overvoltage logic diagram



Neutral overvoltage

The relay has one Neutral Overvoltage element per protection group. This element requires the three phase Bus VTs to be Wye connected. When setting the pickup for this element, it is important to consider the error in the VT ratio, as well as the normal voltage unbalance on the system.

NOTE

This element should be used with caution. It would normally be applied to give line to ground fault coverage on high impedance grounded or ungrounded systems, which are isolated. This constraint stems from the fact that a measurement of 3V0 cannot discriminate between a faulted circuit and an adjacent healthy circuit. Use of a time delayed back-up or an alarm mode allow other protections an opportunity to isolate the faulted element first.

The following path is available using the keypad. For instructions on how to use the keypad, please refer to *Chapter 3 - Working with the Keypad*.

PATH: **SETPOINTS > S3 PROTECTION > SETPOINT GROUP 1(2) > NEUTRAL OV**

NEUTRAL OV FUNCTION

Range: Disabled, Alarm, Latched Alarm,Trip

Default: Disabled

The selection of the Latched Alarm, Alarm, or Trip setting enables the Neutral OV function. The output relay #1 "Trip" will operate if the function is selected as a Trip and the neutral voltage is above the NTRL OV PKP setting for a time greater than the selected NTRL OV DELAY time. The "ALARM" LED will not turn on if the neutral OV function is set to Trip. The "ALARM" LED will flash upon an OV operating condition, with the neutral OV function selected as Alarm, and will self-reset, when this operating condition clears. If Latched Alarm is selected as a neutral OV function, the "ALARM" LED will flash during the OV condition, and will stay "ON" after the condition clears, until the reset command is initiated. The output relay #1 "Trip" will not operate if the Latched Alarm or Alarm setting is selected. Any or all of the output relays 3 to 6 can be selected to operate when the neutral OV function is selected as Latched Alarm, Alarm, or Trip.

NEUTRAL OV PKP

Range: 0.00 to 1.25 x VT in steps of 0.01

Default: 0.30 x VT

This setting defines the neutral OV pickup level.

NEUTRAL OV DELAY

Range: 0.1 to 600.0 sec in steps of 0.1 sec

Default: 2.0 s

This setting specifies the time delay before OV operation.

OUTPUT RELAY 3 to 6

Range: Do not operate, Operate

Default: Do not operate

Any or all of the output relays 3 to 6 can be selected to operate upon a Neutral OV condition. The selection of relay outputs operation is available no matter whether Latched Alarm, Alarm, or Trip function is selected.

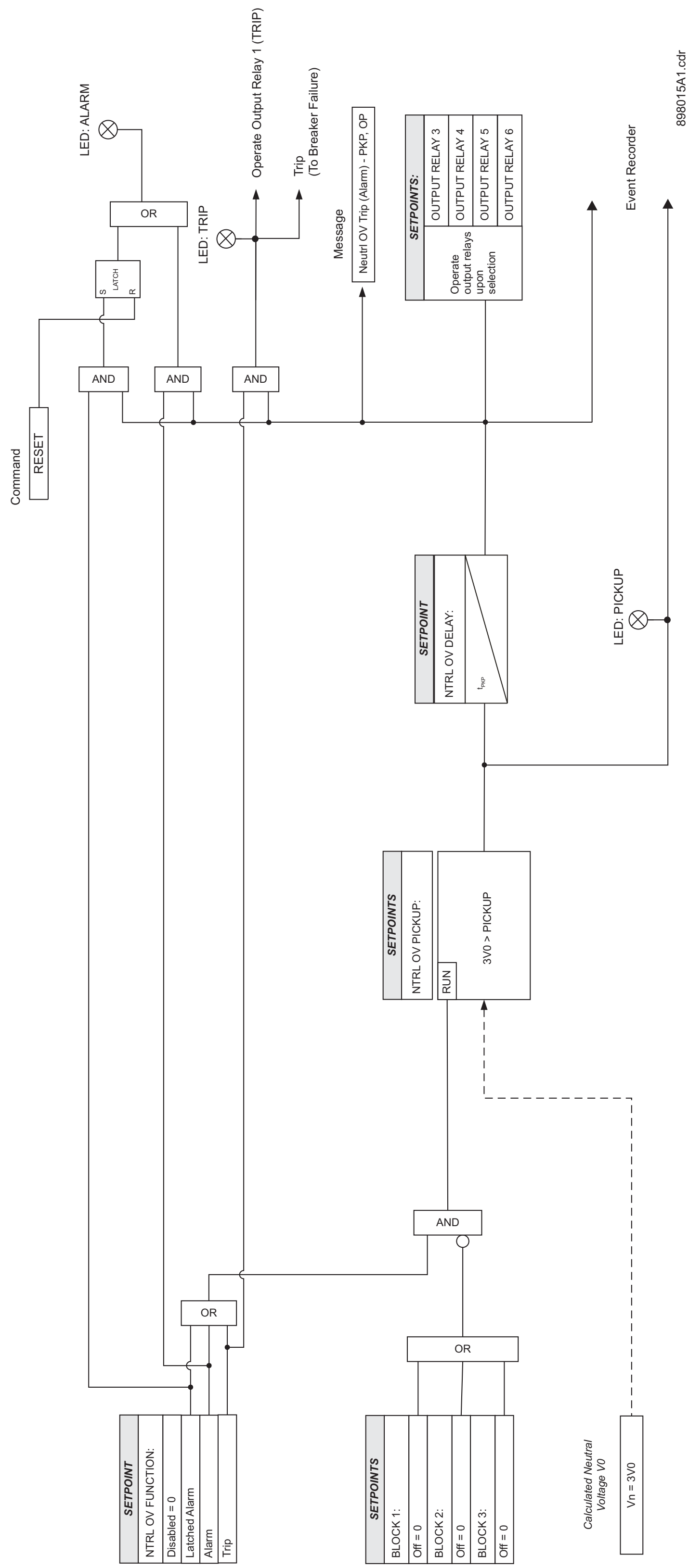
BLOCK 1/2/3

Range: Off, Contact Input 1 to 10, Virtual Input 1 to 32, Remote Input 1 to 32, Logic Element 1 to 16

Default: Off

Three blocking inputs are provided in the Neutral OV menu. One blocking input "high" is enough to block the function. The available selections for each block include Contact input, Virtual Input, Remote Input, or Logic Element.

Figure 34: Neutral Overvoltage logic diagram



Negative sequence overvoltage

The relay has one Negative Sequence Overvoltage element per protection group. The negative sequence overvoltage may be used to detect the loss of one or two phases of the source, a reversed voltage phase sequence , or non-system voltage conditions.

The following path is available using the keypad. For instructions on how to use the keypad, please refer to *Chapter 3 - Working with the Keypad*.

PATH: **SETPOINTS > S3 PROTECTION > SETPOINT GROUP 1(2) > NEGATIVE SEQ. OV**

NEG SEQ OV FUNCTION

Range: Disabled, Alarm, Latched Alarm, Trip

Default: Disabled

The selection of the Latched Alarm, Alarm, or Trip setting enables the Negative Sequence OV function. The output relay #1 "Trip" will operate, if the function is selected as a Trip and the negative sequence voltage computed by the relay is above the NEG SEQ OV PKP setting for a time greater than the selected NEG SEQ OV DELAY time. The "ALARM" LED will not turn on, if the neg. sequence OV function is set to Trip. The "ALARM" LED will flash upon an OV operating condition with the neg. sequence OV function selected as Alarm, and will self-reset, when the operating condition clears. If Latched Alarm is selected as a neg. seq. OV function, the "ALARM" LED will flash during the OV condition, and will stay "ON" after the condition clears, until the reset command is initiated. The output relay #1 "Trip" will not operate if the Latched Alarm or Alarm setting is selected. Any or all of the output relays 3 to 6 can be selected to operate when the neg. seq. OV function is selected as Latched Alarm, Alarm, or Trip.

NEG SEQ OV PKP

Range: 0.00 to 1.25 x VT in steps of 0.01

Default: 0.30 x VT

This setting defines the negative sequence OV pickup level.

NEG SEQ OV DELAY

Range: 0.1 to 600.0 sec in steps of 0.1 sec

Default: 2.0 s

This setting specifies the time delay before OV operation.

OUTPUT RELAY 3 to 6

Range: Do not operate, Operate

Default: Do not operate

Any or all of the output relays 3 to 6 can be selected to operate upon a Negative Seq. OV condition. The selection of relay outputs operation is available no matter whether Latched Alarm, Alarm, or Trip function is selected.

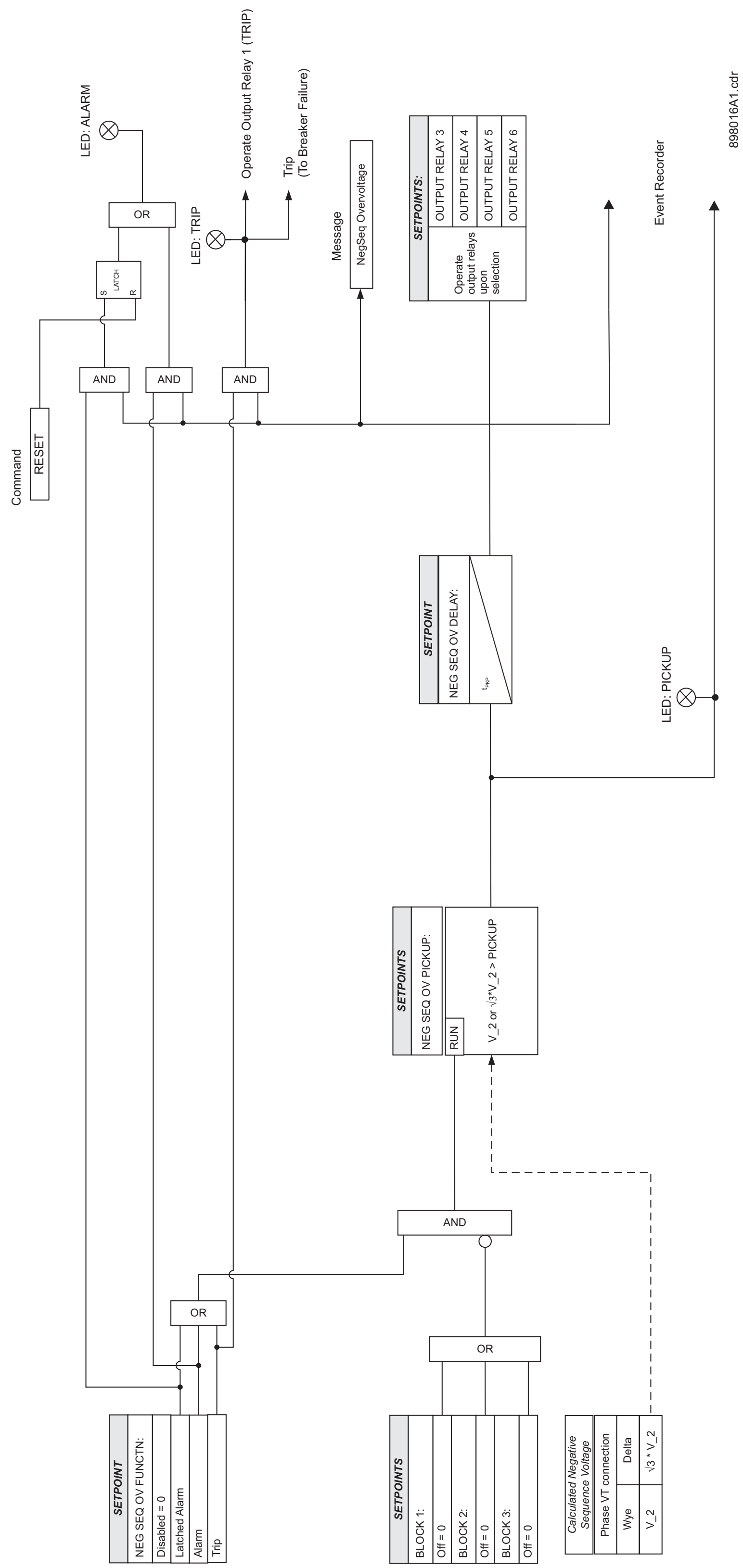
BLOCK 1/2/3

Range: Off, Contact Input 1 to 10, Virtual Input 1 to 32, Remote Input 1 to 32, Logic Element 1 to 16

Default: Off

Three blocking inputs are provided in the Neg. Seq. OV menu. One blocking input "high" is enough to block the function. The available selections for each block include Contact input, Virtual Input, Remote Input, or Logic Element.

Figure 35: Negative Sequence Overvoltage logic diagram



Auxiliary undervoltage

The relay has one Auxiliary Undervoltage element per setpoint group. The input for this element is the voltage from the auxiliary VT relay terminals, where a single voltage from the line is connected. The time delay characteristic can be programmed as either definite time or inverse time. A minimum operating voltage level is programmable to prevent undesired operation before voltage becomes available.

- **Undervoltage Protection**: For voltage sensitive loads, such as induction motors, a drop in voltage will result in an increase in the drawn current, which may cause dangerous overheating in the motor. The undervoltage protection feature can be used to either cause a trip or generate an alarm when the voltage drops below a specified voltage setting for a specified time delay.
- **Permissive Functions**: The undervoltage feature may be used to block the functioning of external devices by operating an output relay, when the voltage falls below the specified voltage setting. Note that all internal features that are inhibited by an undervoltage condition, such as underfrequency and overfrequency, have their own inhibit functions independent of the undervoltage protection features.
- **Source Transfer Schemes**: In the event of an undervoltage, a transfer signal may be generated to transfer a load from its normal source to a standby or emergency power source.

The undervoltage elements can be programmed to have an inverse time delay characteristic. The undervoltage delay setpoint defines a family of curves as shown below. The operating time is given by:

$$T = \frac{D}{1 - V/V_{pu}} \quad \textbf{Eq. 6}$$

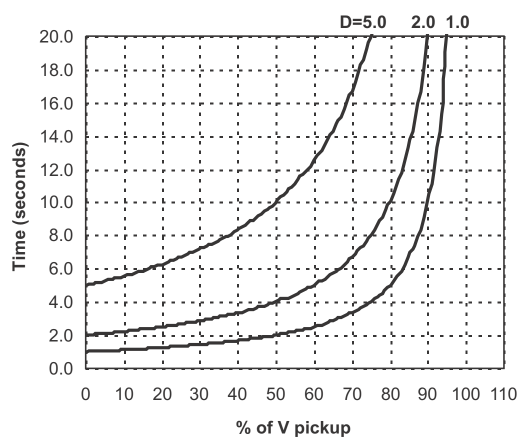
Where:

T = Operating Time
D = Undervoltage Delay setpoint
V = Voltage as a fraction of the nominal VT Secondary Voltage
V_{pu} = Pickup Level

NOTE

At 0% of pickup, the operating time equals the Undervoltage Delay setpoint.

Figure 36: Inverse time undervoltage curves



The following path is available using the keypad. For instructions on how to use the keypad, please refer to *Chapter 3 - Working with the Keypad*.

PATH: SETPOINTS > S3 PROTECTION > S3 SETPOINT GROUP 1(2) > AUXILIARY UV

AUX UV FUNCTION

Range: Disabled, Alarm, Latched Alarm, Trip

Default: Disabled

The selection of the Latched Alarm, Alarm, or Trip setting enables the Auxiliary UV function. The output relay #1 “Trip” will operate if the function is selected as a Trip, and the auxiliary voltage is below the AUX UV PKP setting for a time greater than the selected AUX UV DELAY time. The “ALARM" LED will not turn on if the auxiliary UV function is set to Trip. The “ALARM" LED will flash upon UV operation, with the aux. UV function selected as Alarm, and will self-reset when UV operation clears. If Latched Alarm is selected as a aux. UV function, the “ALARM" LED will flash during the UV condition, and will stay “ON” after the condition clears, until the reset command is initiated. The output relay #1 “Trip” will not operate if the Latched Alarm or Alarm setting is selected. Any or all of the output relays 3 to 6 can be selected to operate when the auxiliary UV function is selected as Latched Alarm, Alarm, or Trip.

AUX UV PKP

Range: 0.00 to 1.25 x VT in steps of 0,01

Default: 0.75 x VT

This setting defines the auxiliary UV pickup level.

AUX UV CURVE

Range: Definite Time, Inverse Time

Default: Inverse Time

This setting selects the type of timing-inverse time/definite time, to define the time of aux. undervoltage operation based on selected UV time delay, and the actual undervoltage condition with respect to the selected UV pickup.

AUX UV DELAY

Range: 0.1 to 600.0 sec in steps of 0.1 sec

Default: 2.0 s

This setting specifies a time delay used by the selected “AUX UV CURVE” type of timing to calculate the time before UV operation.

AUX UV MIN VOLTAGE

Range: 0.00 to 1.25 x VT in steps of 0,01

Default: 0.30 x VT

The minimum operating voltage level is programmable to prevent undesired UV operation before voltage becomes available.

OUTUT RELAY 3 to 6

Range: Do not operate, Operate

Default: Do not operate

Any or all of the output relays 3 to 6 can be selected to operate upon an Auxiliary UV condition. The selection of relay outputs operation is available no matter whether Latched Alarm, Alarm, or Trip function is selected.

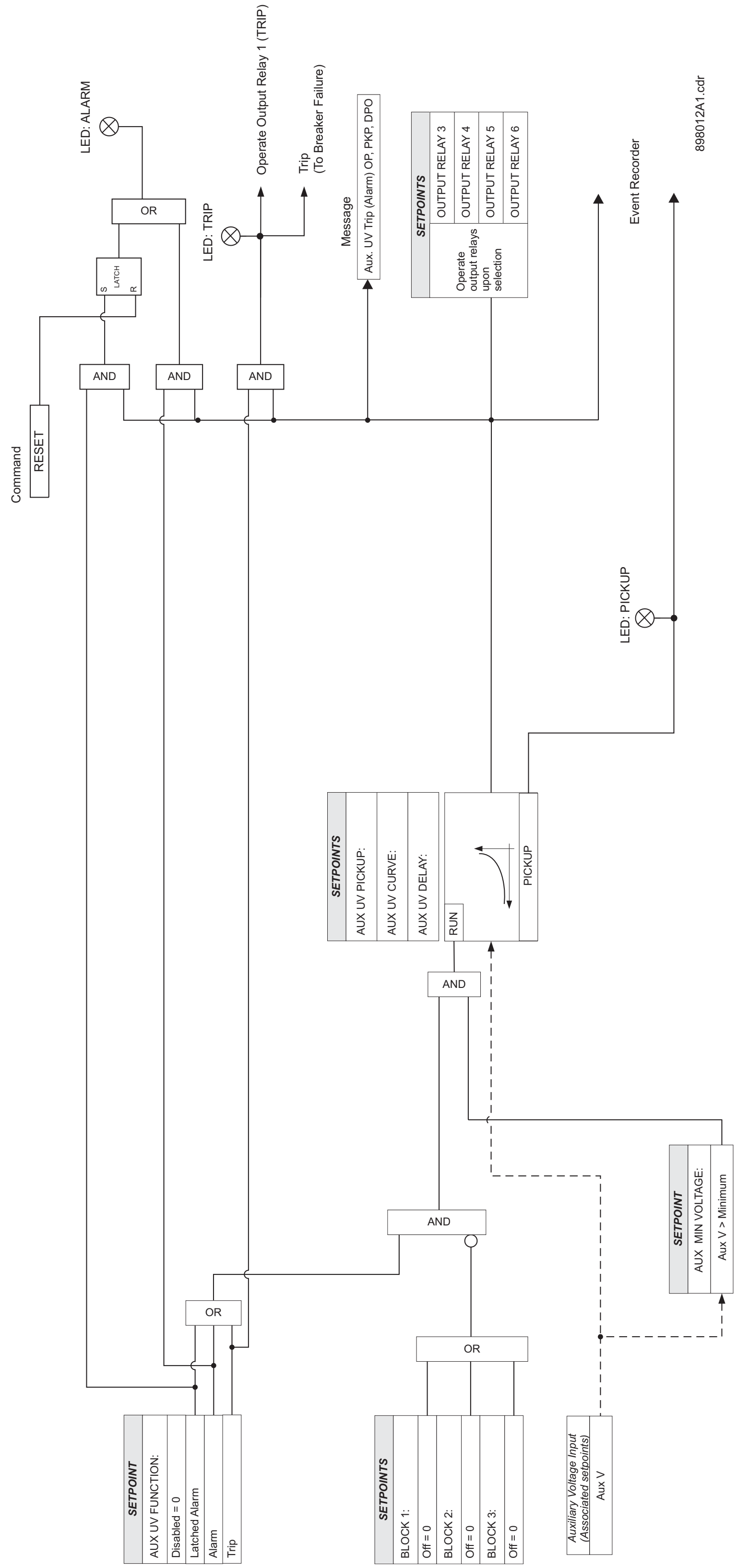
BLOCK 1/2/3

Range: Off, Contact Input 1 to 10, Virtual Input 1 to 32, Remote Input 1 to 32, Logic Element 1 to 16

Default: Off

Three blocking inputs are provided in the Auxiliary UV menu. One blocking input “high” is enough to block the function. The available selections for each block include Contact input, Virtual Input, Remote Input, or Logic Element.

Figure 37: Auxiliary Undervoltage logic diagram



Auxiliary overvoltage

The relay has one Auxiliary Overvoltage element per protection group. The element is intended for monitoring overvoltage conditions of the auxiliary voltage input. A typical application for this element is monitoring the zero sequence voltage (3V_0) from an open corner Delta VT connection. The nominal voltage for the auxiliary voltage input is set under **Setpoints > S2 System Setup > Voltage Sensing > Aux VT Secondary**.

The following path is available using the keypad. For instructions on how to use the keypad, please refer to *Chapter 3 - Working with the Keypad*.

PATH: **SETPOINTS > S3 PROTECTION > SETPOINT GROUP 1(2) > AUXILIARY OV**

AUX OV FUNCTION

Range: Disabled, Alarm, Latched Alarm, Trip
Default: Disabled

The selection of Latched Alarm, Alarm, or Trip setting enables the Auxiliary OV function. The output relay #1 "Trip" will operate, if the function is selected as a Trip, and the auxiliary voltage is above the AUX OV PKP setting for a time greater than the selected AUX OV DELAY time. The "ALARM" LED will not turn on, if the auxiliary OV function is set to Trip. The LED "ALARM" will flash upon an OV operating condition, with the aux. OV function selected as Alarm, and will self-reset, when the operating condition clears. If Latched Alarm is selected as an aux. OV function, the "ALARM" LED will flash during the OV condition, and will stay "ON" after the condition clears until the reset command is initiated. The output relay #1 "Trip" will not operate if the Latched Alarm or Alarm setting is selected. Any or all of output relays 3 to 6 can be selected to operate when the auxiliary OV function is selected as Latched Alarm, Alarm, or Trip.

AUX OV PKP

Range: 0.00 to 1.25 x VT in steps of 0.01
Default: 1.25 x VT

This setting defines the auxiliary OV pickup level.

AUX OV DELAY

Range: 0.1 to 600.0 sec in steps of 0.1
Default: 2.0 s

This setting specifies the time delay before OV operation.

OUTPUT RELAY 3 to 6

Range: Do not operate, Operate
Default: Do not operate

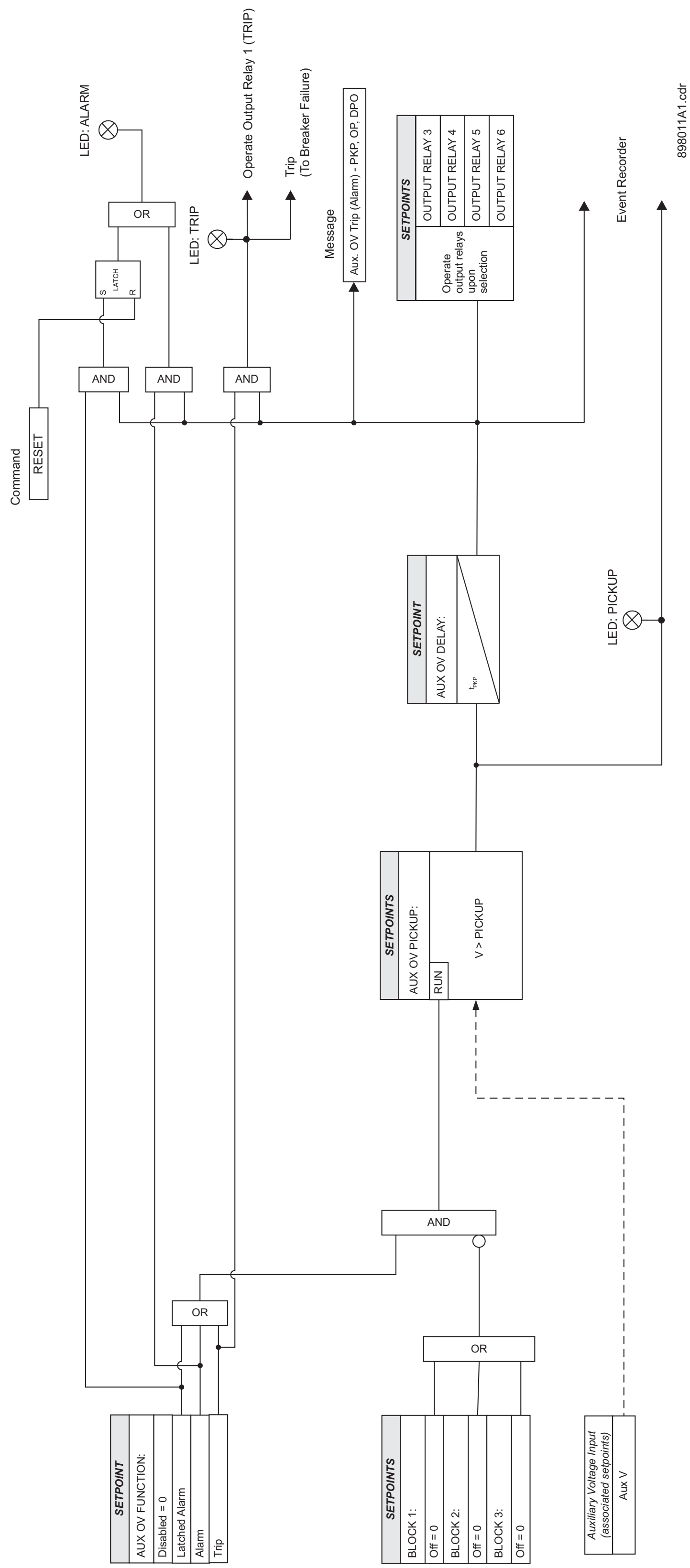
Any or all of the output relays 3 to 6 can be selected to operate upon an Auxiliary OV condition. The selection of relay outputs operation is available no matter whether Latched Alarm, Alarm, or Trip function is selected.

BLOCK 1/2/3

Range: Off, Contact Input 1 to 10, Virtual Input 1 to 32, Remote Input 1 to 32, Logic Element 1 to 16
Default: Off

Three blocking inputs are provided in the Auxiliary OV menu. One blocking input "high" is enough to block the function. The available selections for each block include Contact input, Virtual Input, Remote Input, or Logic Element.

Figure 38: Auxiliary Overvoltage logic diagram



Underfrequency

The relay is equipped with two Underfrequency elements per setpoint group. These elements can be used for detecting system underfrequency conditions, and be part of an automatic load shedding scheme. The need for such protection arises if during a system disturbance, an area becomes electrically isolated from the main system and suffers a generation deficiency due to the loss of either transmission or generation facilities. If reserve generation is not available in the area, conditions of low frequency will occur and may lead to a complete collapse. The 350 provides two underfrequency elements, which can automatically disconnect sufficient load to restore an acceptable balance between load and generation.

The following path is available using the keypad. For instructions on how to use the keypad, please refer to *Chapter 3 - Working with the Keypad*.

PATH: **SETPOINTS > S3 PROTECTION > PROTECTION GROUP 1(2) > UNDER-FREQUENCY1(2)**

UNDERFREQ 1(2) FUNCTION

Range: Disabled, Alarm, Latched Alarm, Trip

Default: Disabled

The selection of Latched Alarm, Alarm, or Trip setting enables the Underfrequency function. The output relay #1 “Trip” will operate, if the function is selected as a Trip, and the measured frequency is below the UNDERFREQ PKP setting for a time longer than the selected UNDERFREQ DELAY time. The LED “ALARM” will not turn on, if the Underfrequency function is set to Trip. The LED “ALARM” will flash upon underfrequency operating condition, with the underfreq. function selected as Alarm, and will self-reset, when the operating condition clears. If Latched Alarm is selected, the LED “ALARM” will flash during the underfrequency condition, and will stay “ON” after the condition clears, until reset command is initiated. The output relay #1 “Trip” will not operate if Latched Alarm or Alarm setting is selected. Any or all of the output relays 3 to 6 can be selected to operate when the Underfrequency function is selected as Latched Alarm, Alarm, or Trip.

UNDERFREQ 1(2) PKP

Range: 40.00 to 70.00 Hz in steps of 0.01 Hz

Default: 59.00 Hz

This setting defines the Underfrequency pickup level, and it is usually set to a frequency level considered dangerous for the stability of the system.

UNDERFREQ 1(2) DELAY

Range: 0.1 to 600.0 sec in steps of 0.1 sec

Default: 2.0 s

This setting specifies the time delay before underfrequency operation.

MIN VOLTAGE

Range: 0.00 to 1.25 x VT in steps of 0.01

Default: 0.70 x VT

The minimum operating voltage level is programmable to prevent undesired underfrequency operation before voltage becomes available, such as on faults cleared by downstream protection or fuses.

OUTPUT RELAY 3 to 6

Range: Do not operate, Operate

Default: Do not operate

Any or all of the output relays 3 to 6 can be selected to operate upon an Underfrequency condition. The selection of relay outputs operation is available no matter whether Latched Alarm, Alarm, or Trip function is selected.

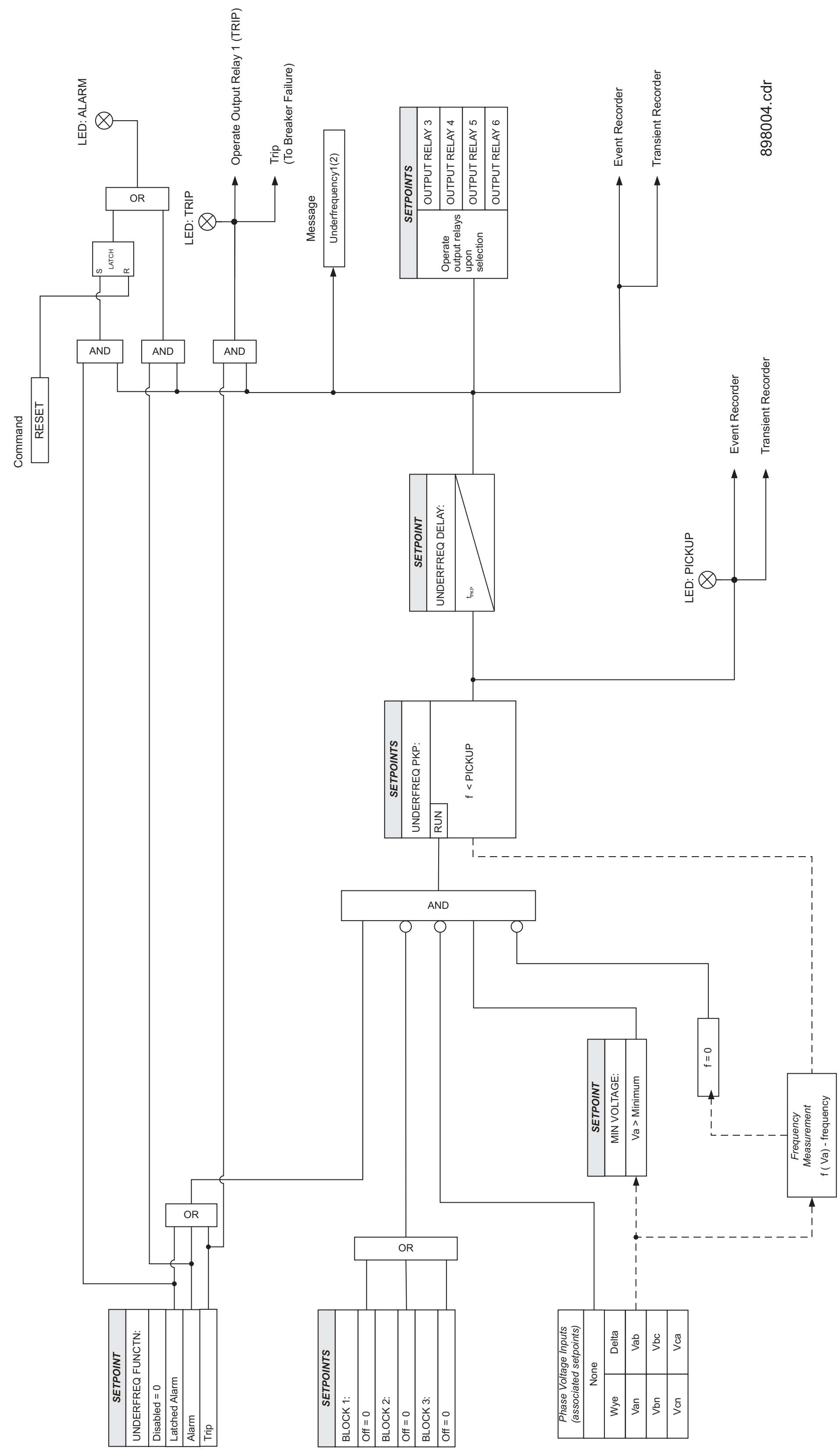
BLOCK 1/2/3

Range: Off, Contact Input 1 to 10, Virtual Input 1 to 32, Remote Input 1 to 32, Logic Element 1 to 16

Default: Off

Three blocking inputs are provided in the menu for each of the two Underfrequency elelements. One blocking input “high” is enough to block the function. The available selections for each block include Contact input, Virtual Input, Remote Input, or Logic Element.

Figure 39: Underfrequency logic diagram



Overfrequency

The relay is equipped with two Overfrequency elements per setpoint group, ANSI device number 81O-1, and 81O-2. Voltage channel phase A is used for frequency measurement.

The steady-state frequency of a power system is an indicator of the existing balance between generated power and the load. Whenever this power is disrupted through disconnection of significant load or the isolation of a part of the system that has surplus of generation, it would result in increase of frequency. If the control system of the generators do not respond fast enough to quickly ramp the turbine frequency back to normal, the overspeed can lead to turbine trip. The overfrequency elements can be used to control the turbine frequency at a generating location. This element can also be used for feeder reclosing as part of the "after load shedding restoration"

The following path is available using the keypad. For instructions on how to use the keypad, please refer to *Chapter 3 - Working with the Keypad*.

PATH: **SETPOINTS > S3 PROTECTION > SETPOINT GROUP 1(2) > OVER-FREQUENCY1(2)**

OVERFREQ 1(2) FUNCTION

Range: Disabled, Alarm, Latched Alarm, Trip
Default: Disabled

The selection of the **Latched Alarm**, **Alarm**, or **Trip** setting enables the Overfrequency function. The output relay #1 "Trip" will operate, if the function is selected as a **Trip**, and the measured frequency is above the OVERFREQ PKP setting for a time longer than the selected OVERFREQ DELAY time. The "ALARM" LED will not turn on if the Overfrequency function is set to Trip. The "ALARM" LED will flash upon Overfrequency operating condition, with the overfrequency function selected as **Alarm**, and will self-reset, when the operating condition clears. If **Latched Alarm** is selected, the "ALARM" LED will flash during the overfrequency condition, and will stay "ON" after the condition clears until reset command is initiated. The output relay #1 "Trip" will not operate if the **Latched Alarm** or **Alarm** setting is selected. Any or all of output relays 3 to 6 can be selected to operate when the Overfrequency function is selected as **Latched Alarm**, **Alarm**, or **Trip**.

OVERFREQ 1(2) PKP

Range: 40.00 to 70.00 Hz in steps of 0.01
Default: 60.50 Hz

This setting defines the Overfrequency pickup level, and it is usually set to a frequency level considered dangerous for the stability of the system.

OVERFREQ 1(2) DELAY

Range: 0.1 to 600.0 s in steps of 0.1
Default: 2.0 s

This setting specifies the time delay before overfrequency operation.

OUTPUT RELAY 3 to 6

Range: Do Not Operate, Operate
Default: Do Not Operate

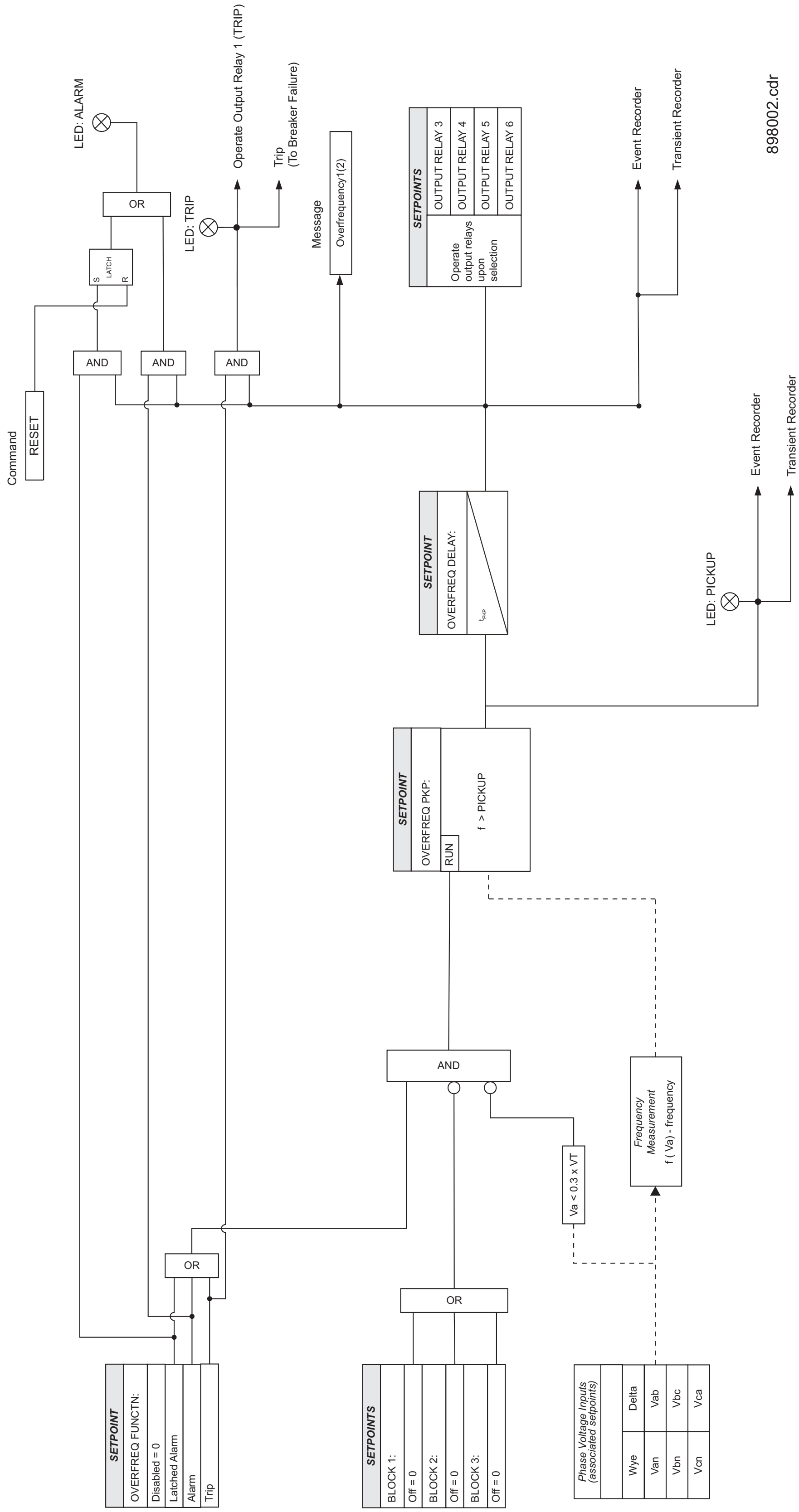
Any or all of output relays 3 to 6 can be selected to operate upon an Overfrequency condition. The selection of relay outputs operation is available no matter whether the **Latched Alarm**, **Alarm**, or **Trip** function is selected.

BLOCK 1/2/3

Range: Off, Contact Input 1 to 10, Virtual Input 1 to 32, Remote Input 1 to 32, Logic Element 1 to 16
Default: Off

Three blocking inputs are provided in the menu for each of the two Overfrequency elements. One blocking input "high" is enough to block the function. The available selections for each block include Contact input, Virtual Input, Remote Input, or Logic Element.

Figure 40: Overfrequency logic diagram



Cable Thermal Model

The thermal overload protection (Thermal Model) can be applied to prevent damage to the protected cables, dry transformers, capacitor banks, or even overhead lines. Loads exceeding the load ratings of the protected equipment can, over time, degrade the insulation, and may, in return, lead to short circuit conditions. As the heating of plant equipment such as cables or transformers is resistive (I^2R), the generated heat is directly proportional to the square of the flowing current (I^2). The relay uses a thermal time characteristic based on current squared and integrated over time.

The relay will continuously calculate the thermal capacity as a percentage of the total thermal capacity. The thermal capacity is calculated as follows:

$$\theta(t) = \left[\theta(t-1) + \frac{\Delta t}{\tau}\left[I^2 - \theta(t-1)\right]\right]$$

Where:

(t) = Cable thermal capacity (%) at time ***t***

(t-1) = Cable thermal capacity (%) at time ***t-1***

t/ = Time step **t** divided by the heating/cooling time constant

$I^2 = (I_{phase}/I_{pickup})^2$ = Squared ratio between the actual load current and the pickup setting

= Heating and cooling time constant, usually provided by the manufacturer.

The heating time constant is used when the squared load/pickup ratio is greater than the thermal capacity ***(t-1)*** estimated in the previous time step. Otherwise the formula uses the cooling time constant.

The time to trip is estimated when the load current exceeds the PKP setting, and the 49 element picks up. At the same time the thermal capacity will start to increase at a rate depending on the current amplitude and the prior loading condition of the cable. When the thermal capacity exceeds the alarm level, the element will generate an alarm signal. The thermal model alarm can be used as a warning for the start of dangerous overloading conditions, and can prevent unnecessary tripping. When the thermal capacity exceeds the trip level, the element will generate a trip signal. As per the formula below, the operate time (time to trip) is determined from when the element picks up until it trips, and depends on both the measured load over time, and the equipment heating and cooling time constants.

$$T_{TRIP} = \tau * \ln\left(\frac{I^2}{I^2 - \theta^2}\right)$$

Where:

T_{TRIP} = Time to trip in seconds

^{2} = 1 = Trip thermal state set to 100%

= Heating and cooling time constant, usually provided by the manufacturer.

I^2= Squared ratio of the actual phase current and the pickup setting.

The time to trip will start timing out once the level of the computed thermal capacity (%) becomes higher than 100 % thermal capacity (***=1***). The trip flag will dropout when the Thermal capacity falls below 97% of the pickup level.

The following path is available using the keypad. For instructions on how to use the keypad, please refer to *Chapter 3 - Working with the Keypad*.

PATH: **SETPOINTS > S3 PROTECTION > SETPOINT GROUP 1(2) > THERMAL MODEL**

THERMAL MDL FUNC

Range: Disabled, Latched Alarm, Alarm, Trip
Default: Disabled

The thermal capacity will be displayed on the relay even if the Thermal Model Function is set to “Disabled. The output relay #1 “Trip” will operate only if the function is selected as a Trip and the thermal capacity value of any phase is over 100%. The LED “ALARM” will turn on when the function is selected as a Trip or Alarm if the thermal capacity value of any phase is over the Thermal MDL Alarm setting. This LED will turn off when the thermal capacity value of all phases is below 97% of the Thermal MDL Alarm setting. If Latched Alarm is selected as a function setting, the LED “ALARM” will flash if the thermal capacity value of any phase is over the Thermal MDL Alarm setting, and will stay “ON” when the thermal capacity value of all phases is below 97% of the Thermal MDL Alarm setting, until the reset command is initiated. The output relay #1 “Trip” will not operate if the Latched Alarm or Alarm setting is selected. Any of the output relays 3 to 6 can be selected to operate when the Thermal Model Function is selected as Latched Alarm, Alarm or Trip.

The thermal capacity values are stored in memory and can be cleared either by using the "Clear Thermal Capacity" command, or by cycling relay control power.

THERMAL MDL PKP

Range: 0.05 to 20 × CT in steps of 0.01 × CT
Default: 1.00 × CT

This setting sets the level of phase current above which the thermal model starts timing out the time-to-trip per the logarithmic formula above.

THERMAL MDL ALARM

Range: 70.0 to 110.0% in steps of 0.1%
Default: 80.0%

This setting sets the alarm level for the accumulated thermal capacity above which the element generates an alarm.

HEAT TIME CONSTANT (${}_H$)

Range: 3.0 to 600.0 min in steps of 0.1 min
Default: 6.0 min

This time constant is used to compute the thermal capacity when the thermal capacity at each time-step is greater than the one computed in the previous time-step.

COOL TIME CONSTANT (${}_C$)

Range: 1.00 to 6.00 × ${}_H$ in steps of 0.01 × ${}_H$
Default: 2.00 × ${}_H$

This time constant is used to compute the thermal capacity when the thermal capacity at each time-step is less than the one computed in the previous time-step.

OUTPUT RELAY 3 to 6

Range: Do Not Operate, Operate
Default: Do Not Operate

Any or all of output relays 3 to 6 can be selected to operate upon a Thermal Model condition. The selection of relay outputs operation is available no matter whether the **Latched Alarm**, **Alarm**, or **Trip** function is selected.

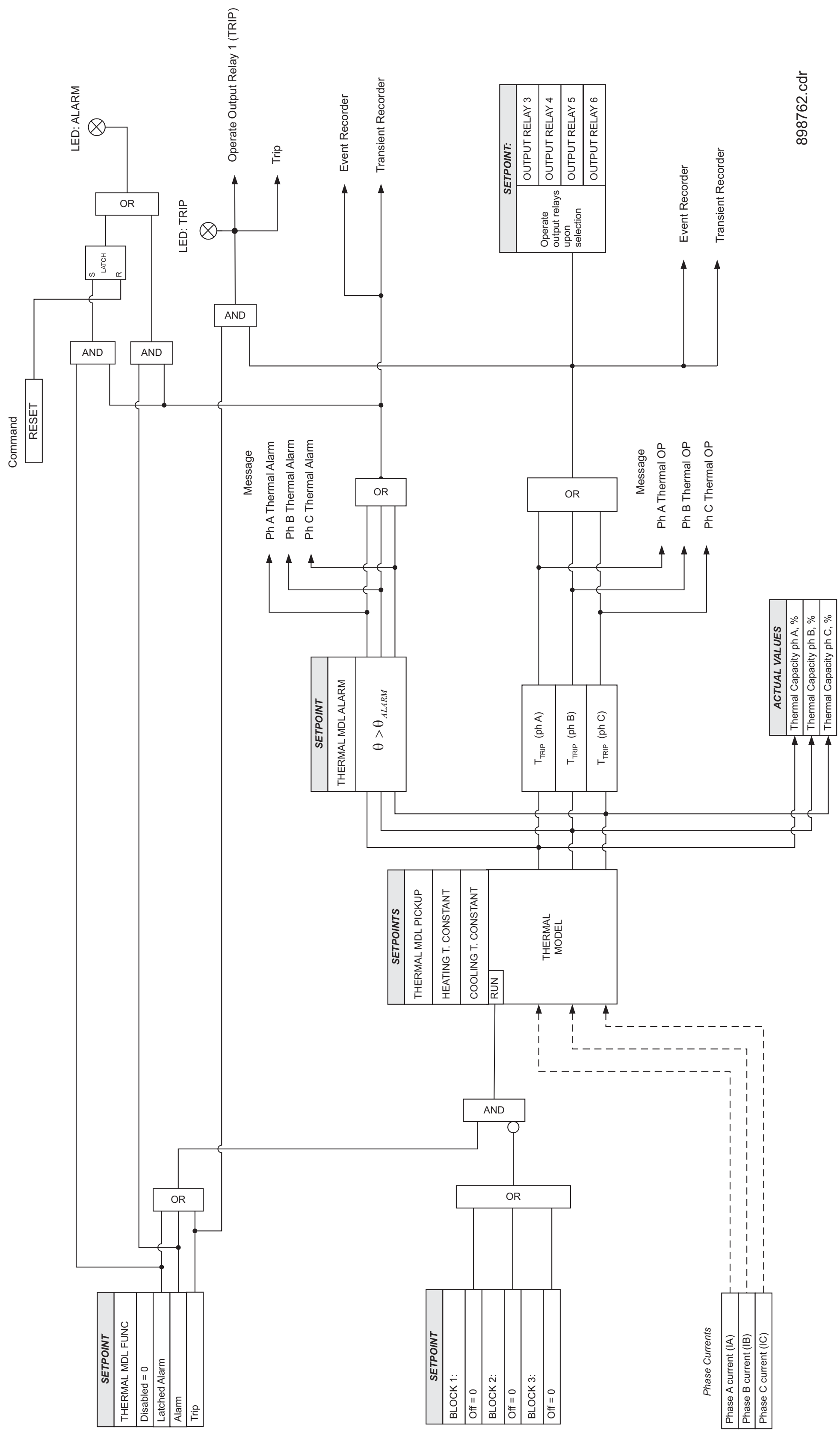
BLOCK 1/2/3

Range: Off, Contact Input 1 to 10, Virtual Input 1 to 32, Remote Input 1 to 32, Logic Element 1 to 16

Default: Off

Three blocking inputs are provided in the menu. One blocking input “high” is enough to block the function. The available selections for each block include Contact input, Virtual Input, Remote Input, or Logic Element.

Figure 41: Thermal model protection logic diagram



VT fuse fail

If one or two of the three phase to phase voltages drops to less than 70% of nominal, and at the same time any of the three voltages is greater than 85%, either an alarm or a trip will occur after a 1 second delay. The 70% threshold allows for the possibility that the voltage downstream from a blown fuse is pulled up above zero by devices connected between the open fuse and another phase.

PATH: **SETPOINTS > S3 PROTECTION > VT FUSE FAILURE**

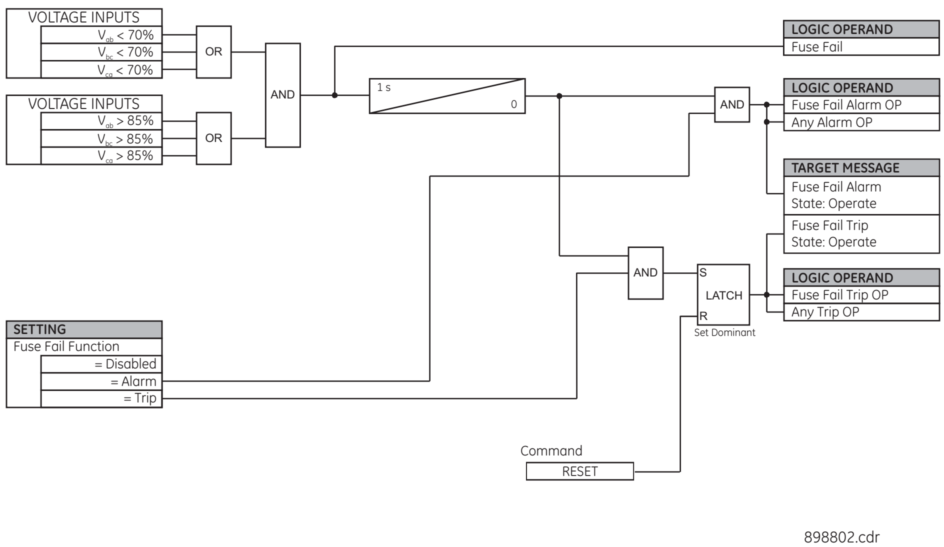
FUSE FAIL FUNCTION

Range: Disabled, Alarm, Trip

Default: Trip

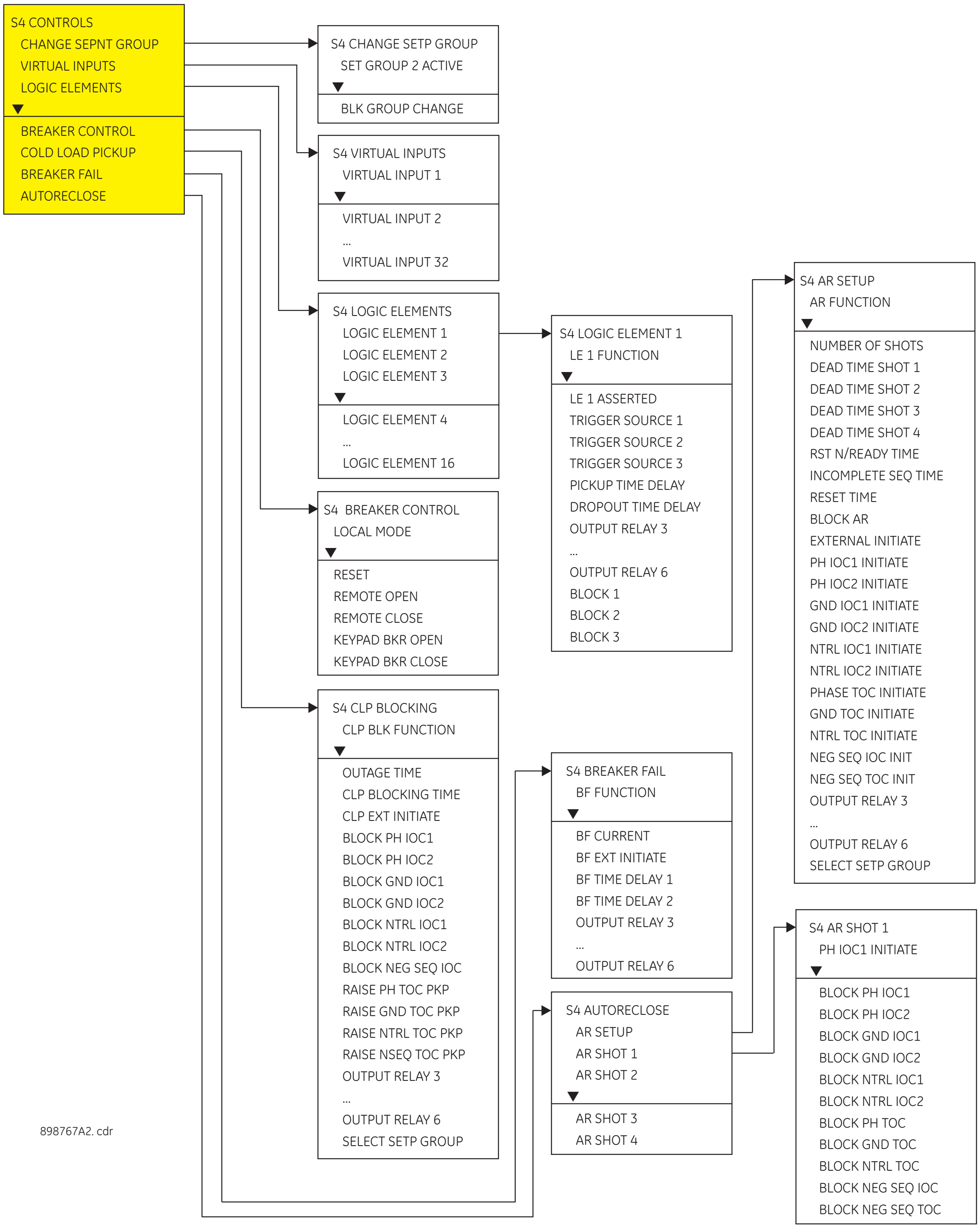
Sets the Fuse Fail action.

Figure 42: Fuse Fail Protection Logic Diagram



S4 Controls

Figure 43: Main controls menu



Change setpoint group

The 350 relay has two identical setpoint groups- Group 1 and Group 2 for all protection elements. Switching between these two groups is available automatically by assigning an input (contact, virtual, remote, logic element), or via communications.

Group 1 is the default setpoint group. The relay can automatically switch from Group 1 protections to Group 2 protections, and vice versa, by setting up the switching conditions under “Change Setpoint Group”. Under some application conditions, such as an overcurrent element pick up, it may not be desirable to change setpoint groups. A setpoint change can also be prevented if the breaker is open, so that a fault detected before a reclosure will not cause a group change while the breaker is open. In such cases, the user can set a condition under “BLK GROUP CHANGE”, where if asserted, the active setpoint group will stay active, even if the input configured to switch to the other setpoint group is asserted. For example if the active group was Group 1 at the time of a trip, the breaker opens, and the input configured under “BLK GROUP CHANGE” is asserted, the relay will maintain Setpoint Group 1, even if the input “SET GROUP 2 ACTIVE” is asserted. Vice versa, if the “BLK GROUP CHANGE” input is asserted; the relay will not switch from Group 2 to Group 1, even if the input under “SET GROUP 2 ACTIVE” is de-asserted.

The relay will default to Setpoint Group 1, if both the input “SET GROUP 2 ACTIVE” and the blocking input “BLK GROUP CHANGE” are de-asserted.

Switching from Group 1 to Group 2 can be also initiated by the Autoreclose, or the Cold Load Pickup functions. If the setpoint group selected in the Autoreclosure menu is different from the active setpoint group, then the Autoreclosure function will force the relay to apply the Autoreclosure selected setpoint group. The Autoreclosure function will then apply the AR shot settings to the corresponding protections. The relay will revert to the previous setpoint group after detecting the Autoreclosure resets.

Similarly, if “Enabled” and not blocked by the Autoreclosure, the Cold Load Pickup function will force the relay to apply the protections of the other setpoint group, if the one selected under the CLP menu is different from this, being in-service. The relay will revert to the setpoint group used originally, after the CLP blocking function resets.

PATH: **CONTROLS > CHANGE SPNT GROUP**

SET GROUP 2 ACTIVE

Range: Off, Contact Input 1 to 10, Virtual Input 1 to 32, Remote Input 1 to 32, Logic Elements 1 to 16
Default: Off

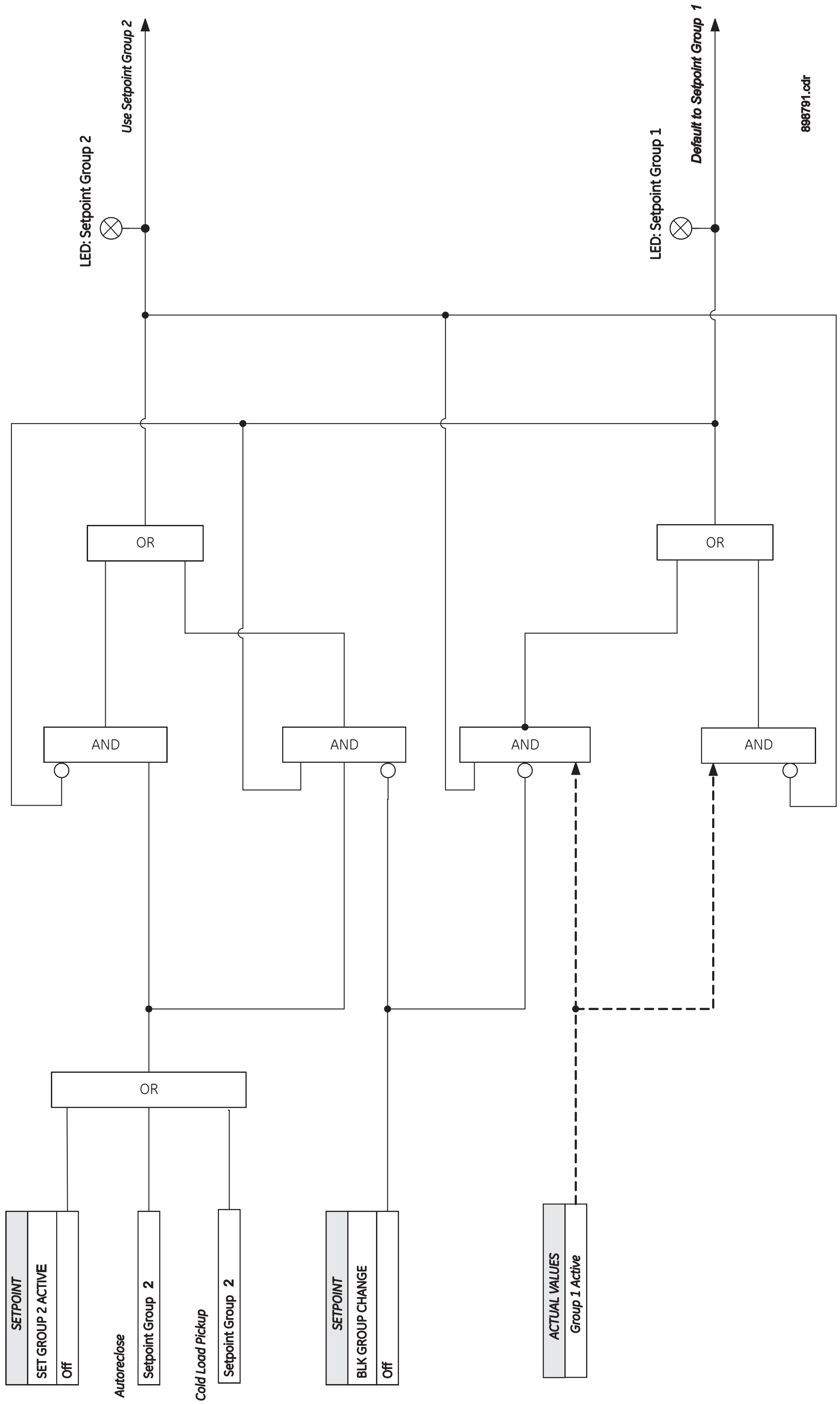
This setting selects an input used to change from Setpoint Group 1 to Setpoint Group 2, when asserted. If no group change supervision is selected, Setpoint group 2 will stay active as long as the “SET GROUP 2 ACTIVE” input is asserted, and will revert to Group 1, when this input is de-asserted.

BLOCK GROUP CHANGE

Range: Off, Contact Input 1 to 10, Virtual Input 1 to 32, Remote Input 1 to 32, Logic Elements 1 to 16
Default: Off

This setting defines an input that can be used to block changing setpoint groups. When the assigned input is asserted, changing from one setpoint group to the other one is blocked.

Figure 44: Switching setpoint groups - Logic diagram



Virtual inputs

There are 32 virtual inputs that can be individually programmed to respond to input commands entered via the relay keypad, or by using communication protocols.

PATH: **SETPOINTS > S4 CONTROLS > VIRTUAL INPUTS**.

VIRTUAL INPUT 1

Range: Off, On

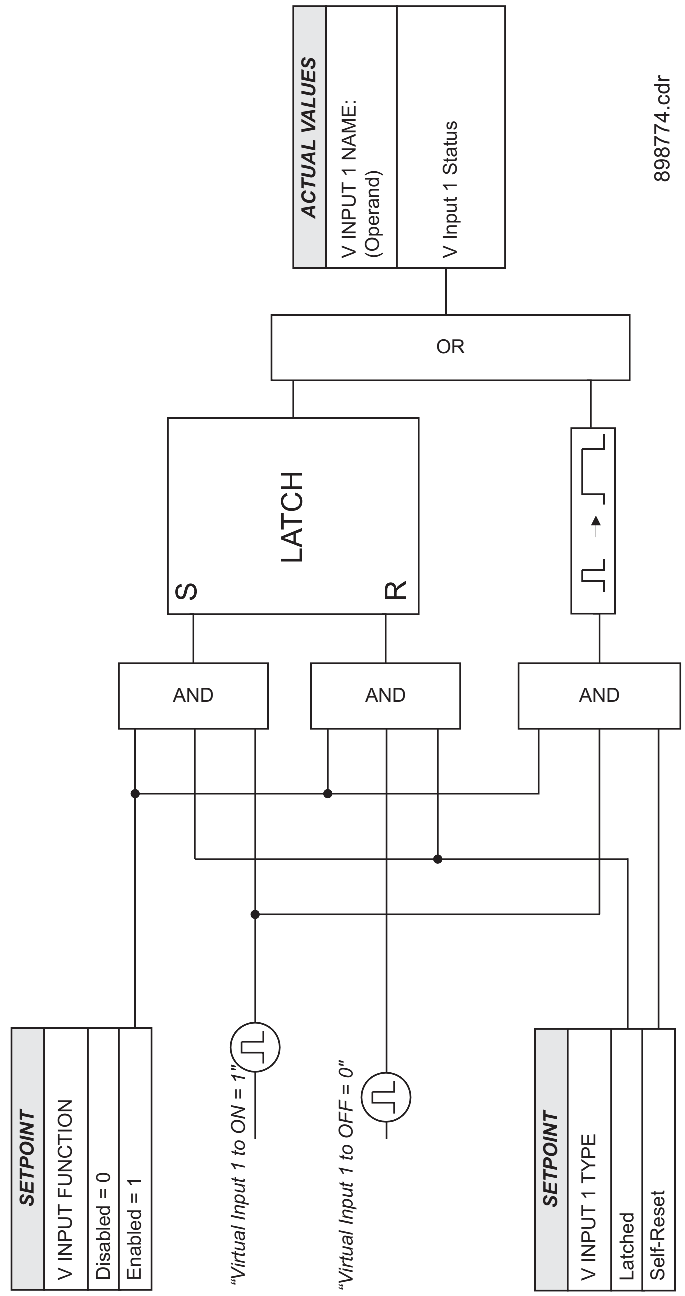
Default: Off

The state of each virtual input can be controlled under **SETPOINTS > S4 CONTROL > VIRTUAL INPUTS** menu. For this purpose, each of the virtual inputs selected for control need be “Enabled” under **SETPOINTS > S5 INPUTS/OUTPUTS > VIRTUAL INPUTS**, and its type “Self-Reset” or “Latched” specified.

If Self-Reset type was selected, entering “On” command will lead to a pulse of one protection pass. To prolong the time of the virtual input pulse, one can assign it as a trigger source to a Logic Element with a dropout timer set to the desired pulse time. If “Latched” type is selected, the state of the virtual input will be latched, upon entering “On” command.

Refer to the logic diagram in the **S5 INPUTS/OUTPUTS > VIRTUAL INPUTS** chapter for more details.

Figure 45: Virtual inputs scheme logic



Logic elements

The 350 relay has 16 Logic Elements available to build simple logic using the state of any programmed contact, virtual, or remote input, or from the output operand of a protection, or control element. Changing the state of any of the assigned inputs used as trigger sources, will change the state of the Logic Element, unless a blocking input is present. The logic provides for assigning up to three triggering inputs in an "OR" gate for Logic Element operation, and up to three blocking inputs in an "OR" gate for defining the block signal. Pickup and dropout timers are available for delaying Logic Element operation and drop-out respectively. In addition, the user can define whether to use the "ON", or "OFF" state of the programmed element by selecting ASSERTED: "On" or "Off".

Referring to the Logic Element logic diagram below, the Logic Element can be set to one of four functions: **Control**, **Alarm**, **Latched Alarm**, or **Trip**. When **Alarm** or **Latched Alarm** is selected, the output relay #1 (Trip) is not triggered during Logic Element operation. The Trip output relay will be triggered when **Trip** is selected as the function, and the Logic Element operates. The Logic Element function can be also selected as **Control**, and used with other relay elements without turning on the “ALARM” and “TRIP” LEDs.

The “PICKUP” LED will turn on upon a Logic Element pickup condition except when the Logic Element function is selected as **Control**.

The “ALARM” LED will turn on upon Logic Element operation if the Logic Element function selected is either **Alarm**, or **Latched Alarm**.

The “TRIP” LED will turn on upon Logic Element operation if the Logic Element function is selected as **Trip**.

The option to trigger auxiliary output relays is provided for any of the selected Logic Element functions.

The following path is available using the keypad. For instructions on how to use the keypad, please refer to *Chapter 3 - Working with the Keypad*.

PATH: **SETPOINTS > S4 CONTROLS > S4 LOGIC ELEMENTS**

LE1(16) FUNCTION

Range: Disabled, Control, Alarm, Latched Alarm, Trip

Default: Disabled

This setting defines the use of the Logic Element. When **Trip** is selected as a function, the Logic Element will trigger Output Relay # 1 (Trip) upon operation.

LE1(16) ASSERTED

Range: On, Off

Default: Off

This setting defines the Logic Element state “On” or “Off” to be used as an output. The asserted “On” selection provides an output “high” when the LE is "On". If asserted “Off” is selected, then the LE output will be “high”, when the LE is “Off”.

TRIGGER SOURCE 1, 2, 3

Range: Off, Any input from the list of inputs

Default: Off

Each of the three trigger sources is configurable by allowing the assigning of an input selected from a list of inputs. This input can be a contact input, a virtual input, a remote input, or an output flag from a protection, or control element. See the list of available inputs from the table below.

TRIGGER LOGIC

Range: OR, AND

Default: OR

This setting defines trigger source operation as either “OR” or “AND”. When set to “OR” any of the inputs will trigger the Logic Element. When set to “AND” all three sources must be asserted before the Logic Element is triggered.

PKP TIME DELAY

Range: 0 to 60000 ms in steps of 1 ms

Default: 0 ms

This setting specifies the pickup time delay before Logic Element operation.

DPO TIME DELAY

Range: 0 to 60000 ms in steps of 1 ms

Default: 0 ms

This setting specifies the time delay from a reset timer that starts upon expiry of the pickup time delay and prolongs the operation of the Logic Element until this time expires.

OUTPUT RELAYS 3 to 6

Range: Do not operate, Operate

Default: Do not operate

Any or all of output relays 3 to 6 can be selected to operate upon a Logic Element operating condition. The selection of auxiliary relay outputs is available no matter whether the **Control**, **Alarm**, **Latched Alarm**, or **Trip** function is selected.

BLOCK 1, 2, 3

Range: Off, Any input from the list of inputs

Default: Off

Each of the three blocks is configurable by allowing the assigning of an input selected from a list of inputs. This input can be a contact input, a virtual input, a remote input, or an output flag from a protection, or control element, as well as an input from any of the other seven logic inputs. See the list of available inputs from the table below

BLOCK LOGIC

Range: OR, AND

Default: OR

This setting defines block source operation as either "OR" or "AND". When set to "OR" any of the inputs will block the Logic Element. When set to "AND" all three sources must be asserted before the Logic Element is blocked.

Figure 46: Logic Element logic diagram

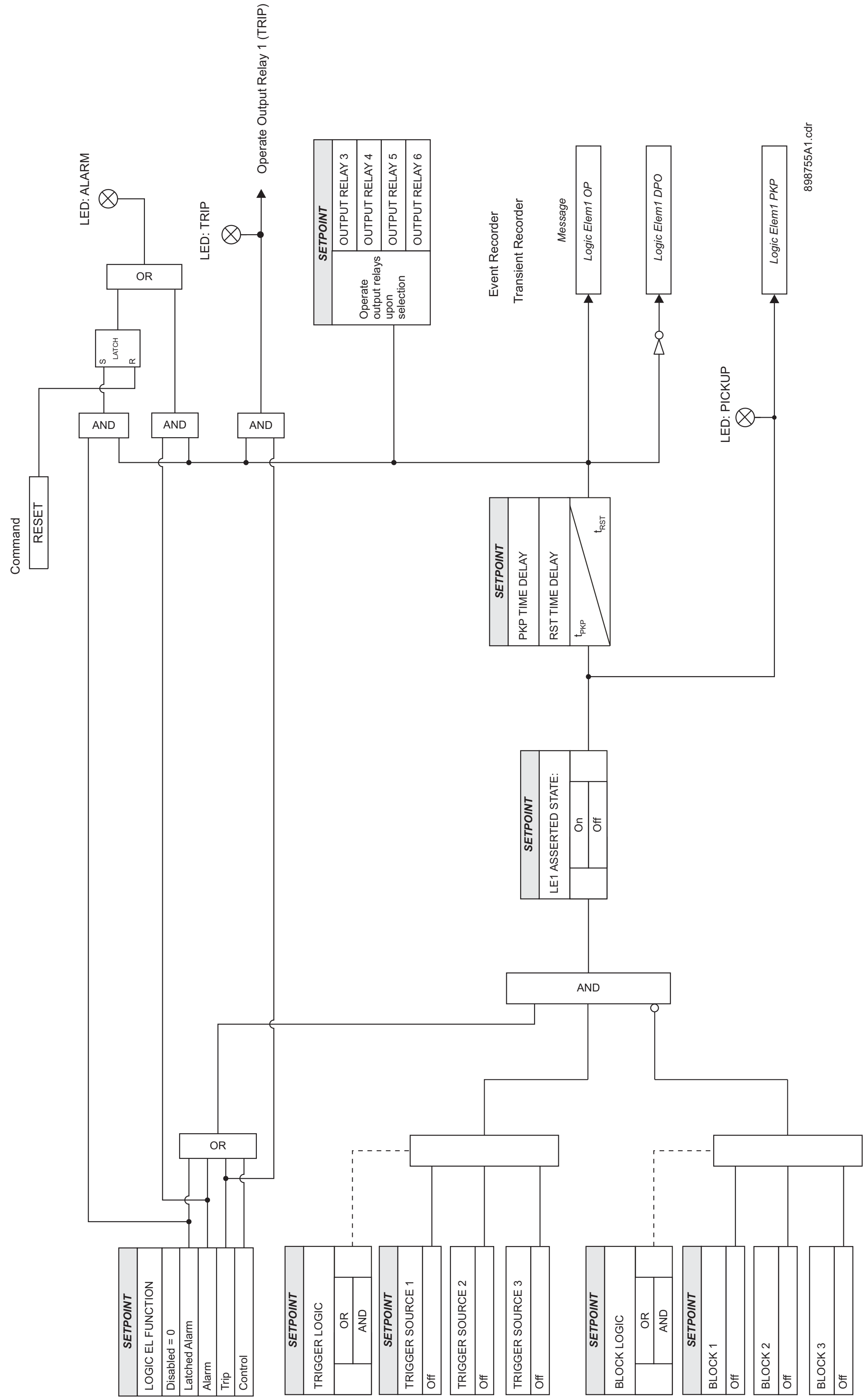


Table 12: List of logic inputs

Input Type	Input Name
Contact Inputs	BKR 52a input (CI1)
	BKR 52b input (CI2)
	Contact Input 3
	Contact Input 4
	Contact Input 5
	Contact Input 6
	Contact Input 7
	Contact Input 8
Virtual Inputs	Virtual Input 1
	Virtual Input 2
	Virtual Input 3
	Virtual Input 4
	Virtual Input 5
	Virtual Input 6
	Virtual Input 7
	Virtual Input 8
	Virtual Input 9
	Virtual Input 10
	Virtual Input 11
	Virtual Input 12
	Virtual Input 13
	Virtual Input 14
	Virtual Input 15
	Virtual Input 16
	Virtual Input 17
	Virtual Input 18
	Virtual Input 19
	Virtual Input 20
	Virtual Input 21
	Virtual Input 22
	Virtual Input 23
	Virtual Input 24
	Virtual Input 25
	Virtual Input 26
	Virtual Input 27
	Virtual Input 28
	Virtual Input 29
	Virtual Input 30
	Virtual Input 31
	Virtual Input 32
Remote Inputs	Remote Input 1
	Remote Input 2
	Remote Input 3
	Remote Input 4
	Remote Input 5
	Remote Input 6

Input Type	Input Name
	Remote Input 7
	Remote Input 8
	Remote Input 9
	Remote Input 10
	Remote Input 11
	Remote Input 12
	Remote Input 13
	Remote Input 14
	Remote Input 15
	Remote Input 16
	Remote Input 17
	Remote Input 18
	Remote Input 19
	Remote Input 20
	Remote Input 21
	Remote Input 22
	Remote Input 23
	Remote Input 24
	Remote Input 25
	Remote Input 26
	Remote Input 27
	Remote Input 28
	Remote Input 29
	Remote Input 30
	Remote Input 31
	Remote Input 32
Logic Elements	Logic Element #1
	Logic Element #2
	Logic Element #3
	Logic Element #4
	Logic Element #5
	Logic Element #6
	Logic Element #7
	Logic Element #8

Breaker control

The Breaker Control menu is designed to trip and close the breaker from the relay either remotely (LOCAL MODE setting set to "OFF," or the selected contact input deselected) or locally (the input from the LOCAL MODE setpoint asserted). While in LOCAL MODE, the REMOTE OPEN and CLOSE setpoints are not active.

The following path is available using the keypad. For instructions on how to use the keypad, please refer to *Chapter 3 - Working with the Keypad*.

PATH: **SETPOINTS > S4 CONTROLS > BREAKER CONTROL**

LOCAL MODE

Range: Off, Contact Input 1 to 10, Virtual Input 1 to 32, Remote Input 1 to 32, Logic Elements1 to 16

Default: Off

The LOCAL MODE setting places the relay in local mode. The relay is in Remote Mode, if not forced into Local Mode by this setpoint (i.e. LOCAL MODE set to "OFF," or the selected input de-asserted).

RESET

Range: Off, Contact Input 1 to 10, Virtual Input 1 to 32, Remote Input 1 to 32, Logic Elements1 to 16

Default: Off

The RESET setting resets the latched alarm or Trip LEDs, and the latched relays.

REMOTE OPEN

Range: Off, Contact Input 1 to 10, Virtual Input 1 to 32, Remote Input 1 to 32, Logic Elements1 to 16

Default: Off

This setting specifies the input which when asserted, initiates a trip (output relay #1 TRIP energized) and opens the breaker.

REMOTE CLOSE

Range: Off, Contact Input 1 to 10, Virtual Input 1 to 32, Remote Input 1 to 32, Logic Elements 1 to 16

Default: Off

This setting specifies the input which when asserted initiates a close (output relay #2 CLOSE energized) and closes the breaker.

KEYPAD BKR OPEN

Range: Yes, No

Default: No

This setting provides flexibility to the user to open the breaker from the keypad. Selecting “Yes” will introduce a pulse of 100ms to the "trip" output relay. The setting is active, when the selected input under LOCAL MODE setpoint is asserted

KEYPAD BKR CLOSE

Range: Yes, No

Default: No

This setting provides flexibility to the user to close the breaker from the keypad. Selecting “Yes” will introduce a pulse of 100ms to the "close" output relay. The setting is active, when the selected input under LOCAL MODE setpoint is asserted

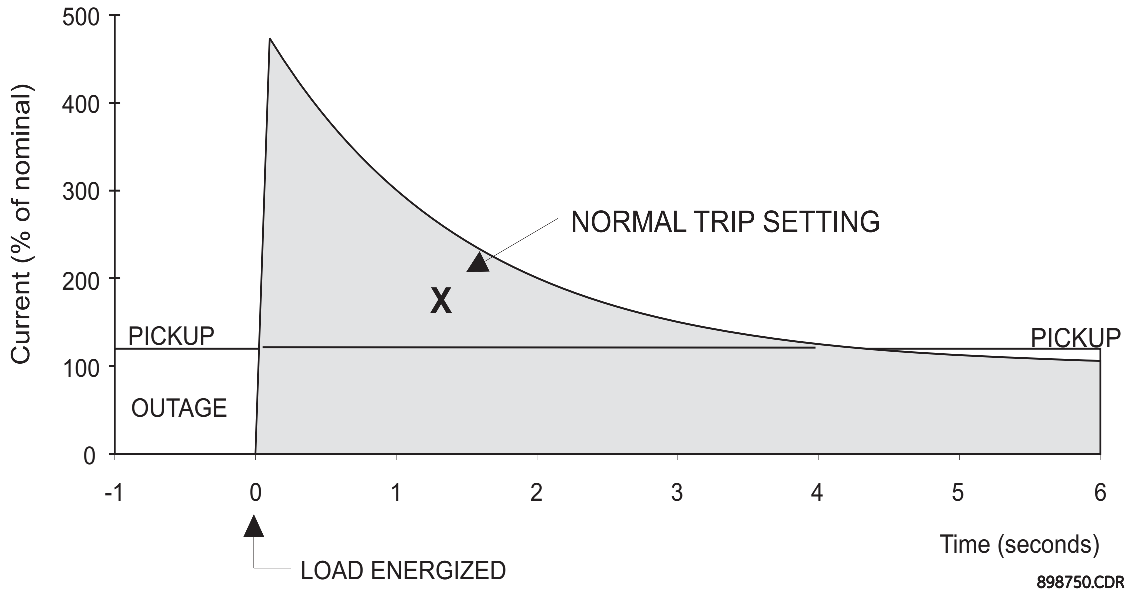
By default, the breaker control mode is set to "Remote" (LOCAL MODE set to "OFF"). In this mode, only the REMOTE OPEN and REMOTE CLOSE setpoints are active. The rest of the setpoints with exception of the RESET setpoint are deactivated, regardless of the status of their selected inputs.

Local Mode is set if the input for the LOCAL MODE setpoint is asserted. In this mode, the REMOTE OPEN and REMOTE CLOSE setpoints are deactivated, regardless of the status of their selected inputs. **Breaker Open** and **Breaker Close** commands from the KEYPAD BKR OPEN and KEYPAD BKR CLOSE setpoints will be active, if the breaker operation is set to Local Mode (i.e. the selected input under the LOCAL MODE setpoint asserted).

Cold load pickup

The 350 can be programmed to block the instantaneous over-current elements, and raise the pickup level of the time over-current elements, when a cold load condition is detected. The cold load condition is detected during closing of the breaker on a feeder that has been de-energized for a long time. The feeder inrush current and the motor accelerating current during breaker closing may be above some over-current protection settings. The diagram shows the slow decaying of the cold load current starting at about 500% of the nominal current at the time of breaker closing, decaying down to 300% after 1 second, 200% after 2 seconds, and 150% after 3 seconds.

Figure 47: Cold load pickup



The relay detects Cold Load condition (Cold Load Pickup armed), if the currents on all three phases drop below 3% of the CT nominal rating for the period of time greater, than the Outage Time Before Cold Load setting. The Cold Load condition can be immediately initiated (Outage Time Before Cold Load timer bypassed), by asserting a contact input selected for External CLP Initiate.

The second timer Cold Load Pickup Block is used to specify the time of blocking the instantaneous over-current elements, and the time of raised pickup levels of the time over-current elements, after breaker closing. The timer starts when at least one of the three phase currents is above 10% of CT nominal. Upon timer expiration, the settings return to normal.

The following path is available using the keypad. For instructions on how to use the keypad, please refer to *Chapter 3 - Working with the Keypad*.

PATH: **SETPOINTS > S4 CONTROLS > COLD LOAD PICKUP**

CLP BLK FUNCTION

Range: Disabled, Alarm, Latched Alarm
Default: Disabled

If set to Alarm, the alarm LED will flash upon detection of Cold Load Pickup condition, and will turn off upon clearing the condition. If Latched Alarm setting is selected, the alarm LED will flash during the Cold Load Pickup condition, and will remain ON, when the condition is cleared. The Alarm LED turns OFF upon manual or remote reset command.

OUTAGE TIME

Range: 1 to 1000 min in steps of 1 min
Default: 20 min

This timer starts when the feeder is de-energized (currents drop below 3% of CT nominal). The Cold Load Pickup is armed after its time expiration.

CLP BLOCKING TIME

Range: 1 to 1000 sec in steps of 1 sec

Default: 5 s

This setting sets the time of blocking for the selected instantaneous overcurrent elements, and the time of raised pickup level of the time overcurrent elements. This timer starts when currents bigger than 10% of CT nominal are detected.

CLP EXT INITIATE

Range: Off, Contact Input 1 to 10, Virtual Input 1 to 32, Remote Input 1 to 32, Logic Input 1 to 16

Default: Off

This setting allows the user to select Contact Input, Virtual Input, Remote Input, or Logic Element, and force the CLP element into the Cold Load Pickup armed state, bypassing the timer **Outage Time Before Pickup**.

BLOCK PH IOC1(2)/ BLOCK GND [S.GND] IOC1(2)/ BLOCK NTRL IOC1(2) / BLOCK NEG SEQ IOC

Range: No, Yes

Default: No

Each instantaneous over-current element from the list can be selected for block or not, upon cold load pickup condition.

RAISE PH TOC PKP/ RAISE GND [S.GND] TOC PKP/ RAISE NTRL TOC PKP/RAISE NSEQ TOC PKP

Range: 0 to 100% in steps of 1%

Default: 0%

The pickup level of each time over-current element from the list can be raised by 0 to 100%, upon cold load pickup condition.

OUTPUT RELAYS 3 to 6

Range: Do not operate, Operate

Default: Do not operate

Each of the output relays can be programmed to operate when cold load pickup function is armed.

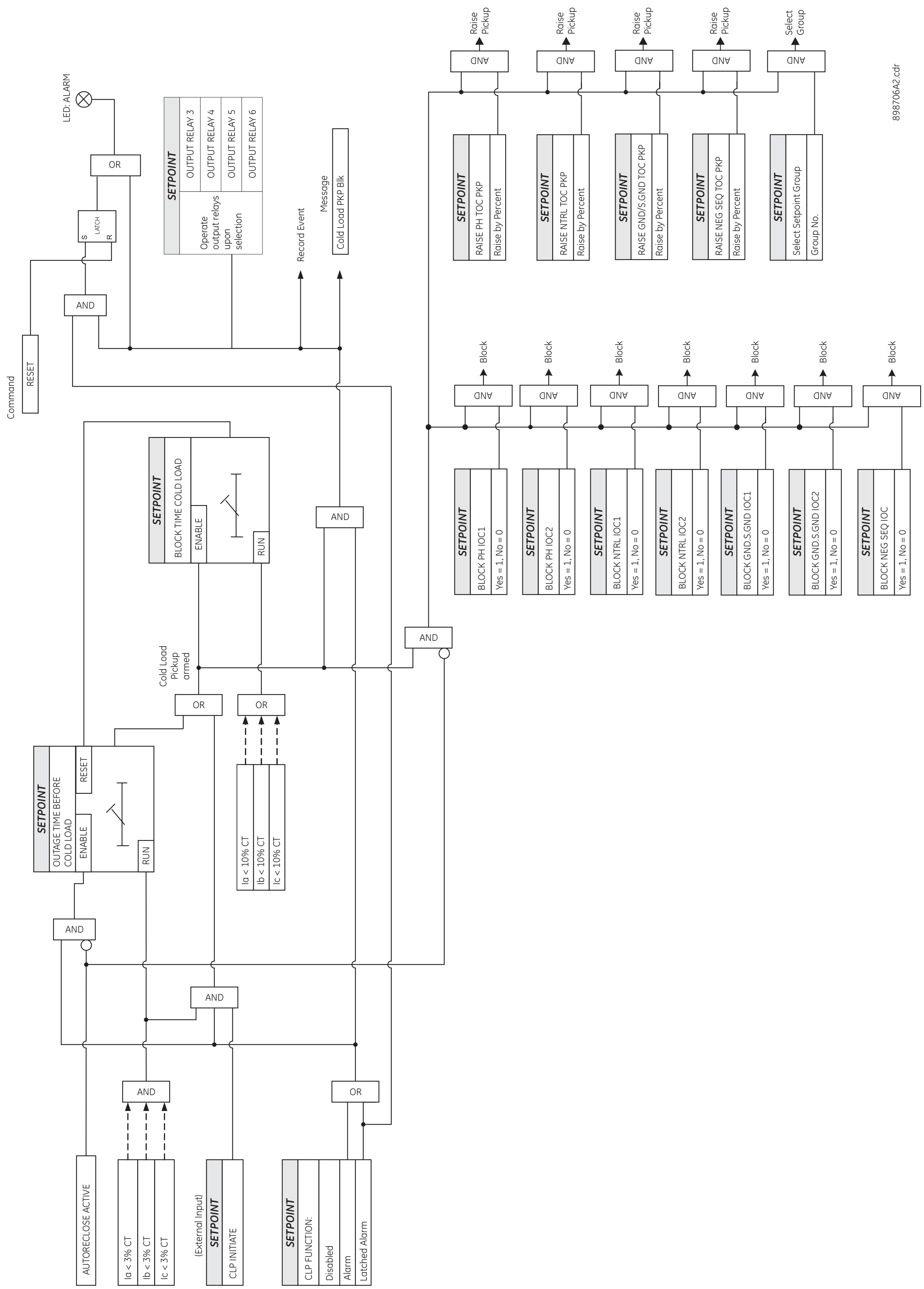
SELECT SETP GROUP

Range: Active Group, SP Group 1 Active, SP Group 2 Active

Default: Active Group

The CLP blocking function will block the IOC, and adjust the TOC pickup levels for the over-current elements from whichever Setting Group is active, if the setting Active Group is selected.

Figure 48: Cold load pickup logic diagram



Breaker failure

The Breaker Failure function monitors the phase currents, after a trip command from the protection elements is initiated. If any phase current is above the set current level after the BF DELAY time expires, a breaker failure will be declared, and will operate the selected output relays. The Breaker failure scheme provides also an external input to initiate breaker failure via Contact Input, Virtual Input, Remote Input, or Logic Element.

The following path is available using the keypad. For instructions on how to use the keypad, please refer to *Chapter 3 - Working with the Keypad*.

PATH: **SETPOINTS > S4 CONTROLS > BREAKER FAIL**

BF FUNCTION

Range: Disabled, Alarm, Latched Alarm

Default: Disabled

If set to Alarm, the alarm LED will flash upon detection of Breaker Failure condition, and will turn off upon clearing the condition. If Latched Alarm setting is selected, the alarm LED will flash during the Breaker Failure condition, and will remain ON, when the condition is cleared. The Alarm LED turns OFF upon manual or remote reset command.

BF CURRENT

Range: 0.05 to 20.00 x CT in steps of 0.01

Default: 1.00 x CT

This setting selects the current level to be monitored by the BF logic, after the programmed time delays.

BF EXT INITIATE

Range: Off, Contact Input 1 to 10, Virtual Input 1 to 32, Remote Input 1 to 32, Logic Element 1 to 16

Default: Off

This setting allows the user to select Contact Input, Virtual or Remote Input, Logic Element to initiate the Breaker Failure logic.

BF TIME DELAY 1

Range: 0.03 to 1.00 s in steps of 0.01 s

Default: 0.10 s

This timer starts when breaker trip command is issued from any of the protection elements.

BF TIME DELAY 2

Range: 0.00 to 1.00 s in steps of 0.01 s

Default: 0.00 s

This timer does not start until a trip condition is recognized, BF TIMER DELAY 1 has expired, and at least one of the phase currents is above the BF CURRENT setting.

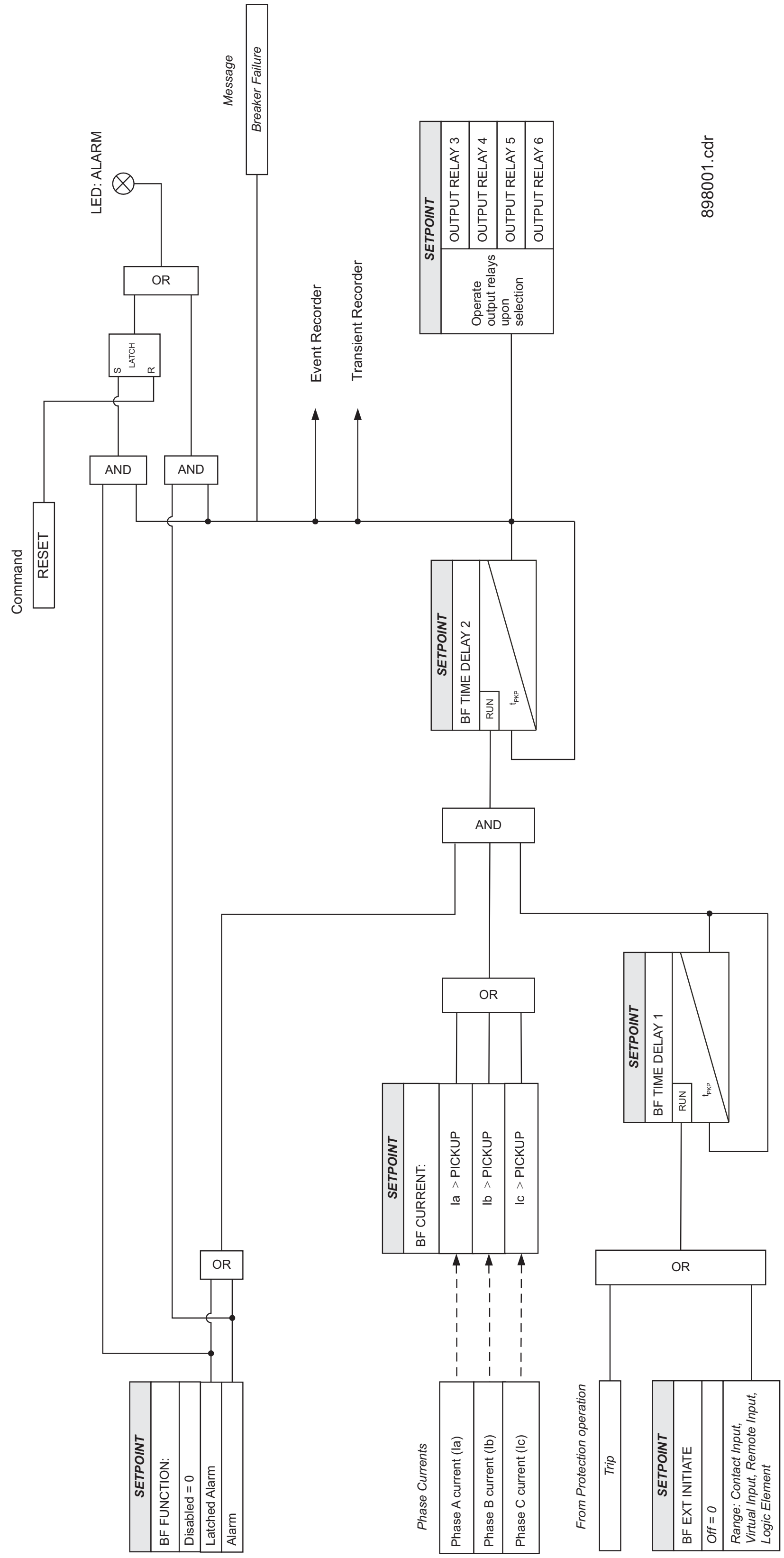
OUTPUT RELAY 3 to 6

Range: Do not operate, Operate

Default: Do not operate

Each of the output relays can be programmed to operate upon detection of breaker failure.

Figure 49: Breaker failure logic diagram



Autorecloser

The automatic recloser is intended for use on single three-pole tripping breaker applications. Up to four reclosing "shots" can be programmed with independent set of protection elements for initiation, and individual dead time prior to each subsequent shot. A typical example for selection of individual set of overcurrent protection elements for initiation is the selection of instantaneous overcurrent protections for the first AR initiation, and selection of time overcurrent protections after the first reclose. This would provide longer time before the breaker opens, and allow the fuses to burn off, if the fault is still present.

NOTE

To synchronize the Reclose function with the breaker status feedback, it is recommended that a debounce of 2 cycles is used, regardless of whether the breaker status is detected using one or both contacts.

The following path is available using the keypad. For instructions on how to use the keypad, please refer to *Chapter 3 - Working with the Keypad*.

PATH: **SETPOINTS > S4 CONTROLS > AUTORECLOSE > AR SETUP**

AR FUNCTION

Range: Disabled, Enabled
Default: Disabled

This setting enables or disables the Autorecloser function.

NUMBER OF SHOTS

Range: 1 to 4, step 1
Default: 1

The maximum number of reclosures that will be attempted before AR Not Ready.

DEAD TIME SHOT 1 to 4

Range: 0.1 to 600.0 s, step 0.1 s
Default: 1.0 s

This setting specifies the dead time delay before each reclosure. Four time delay settings are to be configured and used to time out before the first, second, third, or fourth breaker reclosure.

RST N/READY TIME

Range: 0.1 to 600.0 s, step 0.1 s
Default: 10 s

This setting specifies the reset AR Not Ready time. Upon breaker close, the timer times out, and resets the AR lockout.

INCOMP SEQ TIME

Range: 0.1 to 600.0 s, step 0.1 s
Default: 5.0 s

This timer is used to set the maximum time interval allowed for single reclosure shot. The timer starts timing out for both situations: upon AR initiate to open the breaker, where the breaker doesn't open, or whenever breaker reclose command is issued, where the breaker doesn't close. Upon incomplete sequence time expiry, the AR goes into AR Not Ready mode.

RESET TIME

Range: 0.1 to 600.0 s, step 0.1 s
Default: 5.0 s

This time is used to reset the AR into AR ready mode after successful reclosure. If no breaker tripping occurs within the reset time, the AR shot counter is reset.

BLOCK AR

Range: Off, Contact Input 1 to 10, Virtual Input1 to 32, Remote Input1 to 32, Logic Elements1 to 16
Default: Off

This setting provides selection for contact input, virtual input, remote input, or logic element to block off the AR scheme.

EXT INITIATE

Range: Off, Contact Input 1 to 10, Virtual Input 1 to 32, Remote Input 1 to 32, Logic Elements 1 to 16
Default: Off

This setting provides selection for contact input, virtual input, remote input, or logic element to initiate the AR scheme.

PH IOC1/2 INITIATE

Range: Off/On
Default: Off

When set to “On,” the operation of this element initiates the AR sequence.

GND [S.GND] IOC1/2 INITIATE

Range: Off/On
Default: Off

When set to “On,” the operation of this element initiates the AR sequence.

NTRL IOC1/2 INITIATE

Range: Off/On
Default: Off

When set to “On,” the operation of this element initiates the AR sequence.

PHASE TOC INITIATE

Range: Off/On
Default: Off

When set to “On,” the operation of this element initiates the AR sequence.

NTRL TOC INITIATE

Range: Off/On
Default: Off

When set to “On,” the operation of this element initiates the AR sequence.

GND [S.GND] TOC INITIATE

Range: Off/On
Default: Off

When set to “On,” the operation of this element initiates the AR sequence.

NSEQ TOC INITIATE

Range: Off/On
Default: Off

When set to “ON,” the operation of this element initiates the AR sequence.

AR READY - RELAY 3 to 6

Range: Do not operate, Operate
Default: Do not operate

Any or all of the output relays can be selected to operate upon Autoreclose Status detected as “AR READY”.

AR IN-PROGR - RELAY 3 to 6

Range: Do not operate, Operate

Default: Do Not Operate

Any or all of the output relays can be selected to operate upon Autoreclose Status detected as “AR IN-PROGRESS”.

AR N/READY - RELAY 3 to 6

Range: Do not operate, Operate

Default: Do Not Operate

Any or all of the output relays can be selected to operate upon Autoreclose Status detected as “AR LOCKOUT”.

SELECT SETP GROUP

Range: Active group, SP Group 1 Active, SP Group 2 Active

Default: SP Group 1 Active

The Autoreclose function will be executed in the setpoint group selected as a setting in “SELECT SETP GROUP”, or in the active setpoint group if the setting “Active Group” is selected.

The following path is available using the keypad. For instructions on how to use the keypad, please refer to *Chapter 3 - Working with the Keypad*.

PATH: **SETPOINTS > S4 CONTROLS > AUTORECLOSE > AR SHOT 1(4)**

BLOCK PH IOC1/2 Shot 1 to 4

Range: Off/On

Default: Off

If set to “On” for the selected shot, the operation of the element will initiate breaker trip after the corresponding breaker reclosing shot.

BLOCK NTRL IOC1/2 Shot 1 to 4

Range: Off/On

Default: Off

If set to “On” for the selected shot, the operation of the element will initiate breaker trip after the corresponding breaker reclosing shot.

BLOCK GND/S.GND IOC1/2 Shot 1 to 4

Range: Off/On

Default: Off

If set to “On” for the selected shot, the operation of the element will initiate breaker trip after the corresponding breaker reclosing shot.

BLOCK PH TOC Shot 1 to 4

Range: Off/On

Default: Off

If set to “On” for the selected shot, the operation of the element will initiate a breaker trip after the corresponding breaker reclosing shot.

BLOCK GND TOC Shot 1 to 4

Range: Off/On

Default: Off

If set to “On” for the selected shot, the operation of the element will initiate a breaker trip after the corresponding breaker reclosing shot.

BLOCK NSEQ TOC Shot 1 to 4

Range: Off/On

Default: Off

If set to “ON” for the selected shot, the operation of the element will initiate a breaker trip after the corresponding breaker reclosing shot.

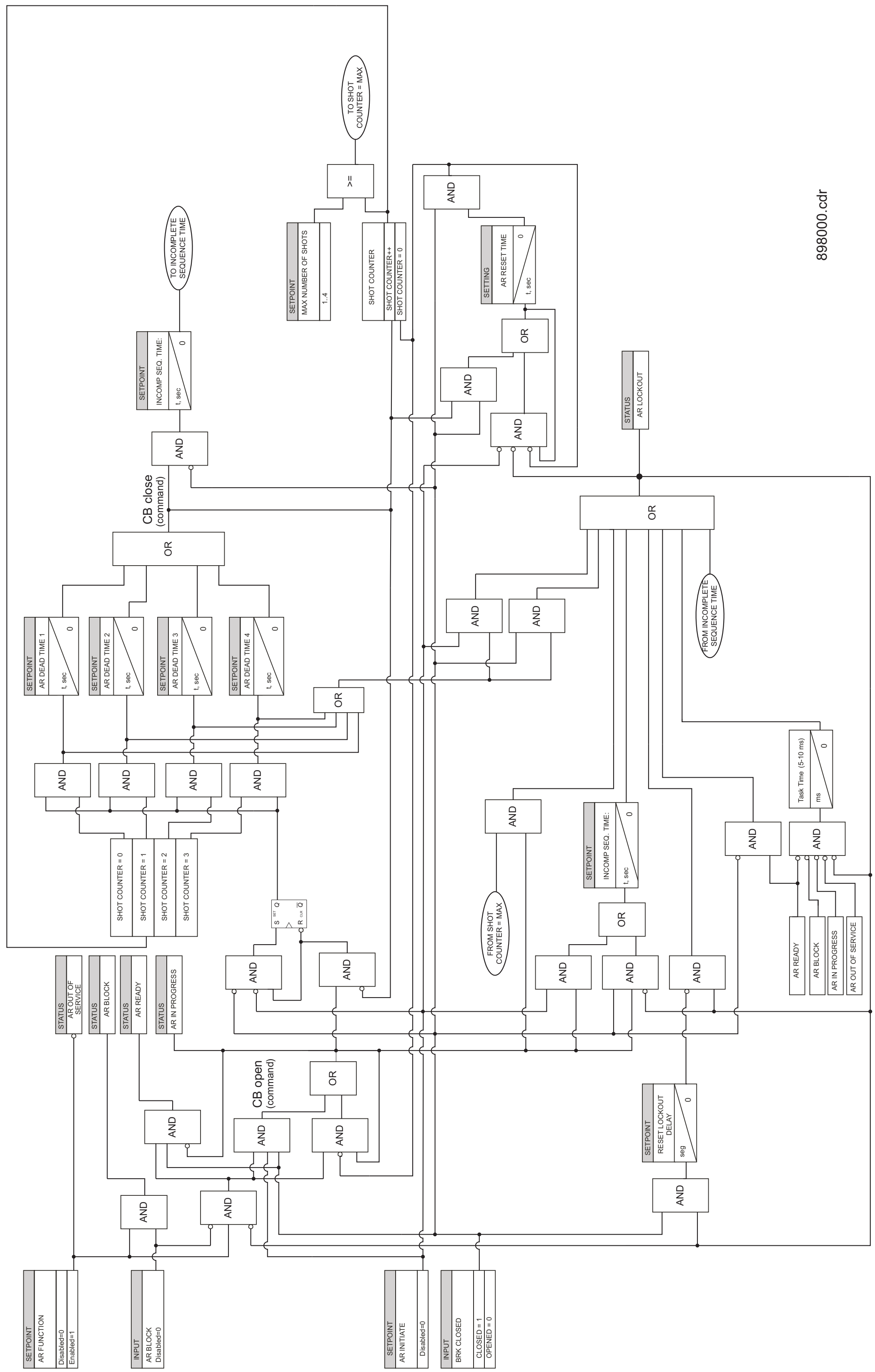
BLOCK NTRL TOC Shot 1 to 4

Range: Off/On

Default: Off

If set to “On” for the selected shot, the operation of the element will initiate a breaker trip after the corresponding breaker reclosing shot.

Figure 50: Autoreclose logic diagram



The Automatic Reclosure function is designed to perform up to four breaker autoreclosings, with a configurable dead time before each reclosing shot. Upon AR function enabled, and breaker status “closed”, the AR is set into “AR Ready” state. If an intermittent feeder fault occurs such as overhead conductor touching tree branch, one or more of the overcurrent protection elements enabled under AR initiate menu will operate and issue a breaker trip command. If the breaker opens, the dead time configured under the first AR shot will start timing out. After this time expires, the AR scheme will produce the first breaker reclosing shot. Upon breaker close and no fault conditions, the overcurrent elements set for initiation on the first AR shot will not operate, and the reclosing is declared successful. The remaining of the configured AR sequence will be executed. The AR Reset time will start timing out, where upon time expiry resets the AR counter. The AR sequence is reset with AR function into “AR Ready” state.

If the fault is permanent, the configured AR sequence will be executed in full, where the breaker opens after the last reclosing shot and the AR function goes into lockout.

The reclosure scheme passes through the following states during operation:

AR NOT READY: When in this state, the AR is blocked. The AR NOT READY occurs if any of the following conditions are present:

- The maximum shot number was reached.
- The incomplete sequence AR INCOM SEQ TIME timer times out.
- The AR BLOCK INPUT is set

AR READY: To reach this state the AR RESET NOT READY timer times out from NOT READY state or the AR RESET TIME timer times out from WAIT RST TIME state. In this state the autorecloser is waiting for reclose Initiation (RI) event to start the reclosure process.

WAIT FOR 52 OPEN: Once a Reclose Initiation event occurs the autorecloser is waiting for breaker status OPEN or otherwise the AR INCOM SEQ TIME timer will time out. If the AR INCOM SEQ TIME expires, the autorecloser will go into NOT READY state. However if the breaker opens, the AR scheme will start the configured DEAD TIME timer, and will be put into WAIT DEAD TIME state.

WAIT DEAD TIME: In this state the autorecloser is waiting for the relevant AR DEAD TIME SHOT timer to time out. If during this time out the breaker status changes to CLOSE, a Reclose Initiation or an AR BLOCK input occurs the autorecloser process ends in a NOT READY state. If not, the WAIT FOR 52 CLOSE state is reached.

WAIT FOR 52 CLOSE: In this state upon reclosing command, the autorecloser is waiting for the breaker to CLOSE. If the AR INCOM SEQ TIME timer times out or a new Reclose Initiation occurs and it’s the last shot then the autorecloser ends in a NOT READY state. If a new Reclose Initiation occurs and it is not the last from the programmed sequence, the autorecloser goes into the WAIT FOR 52 OPEN status.

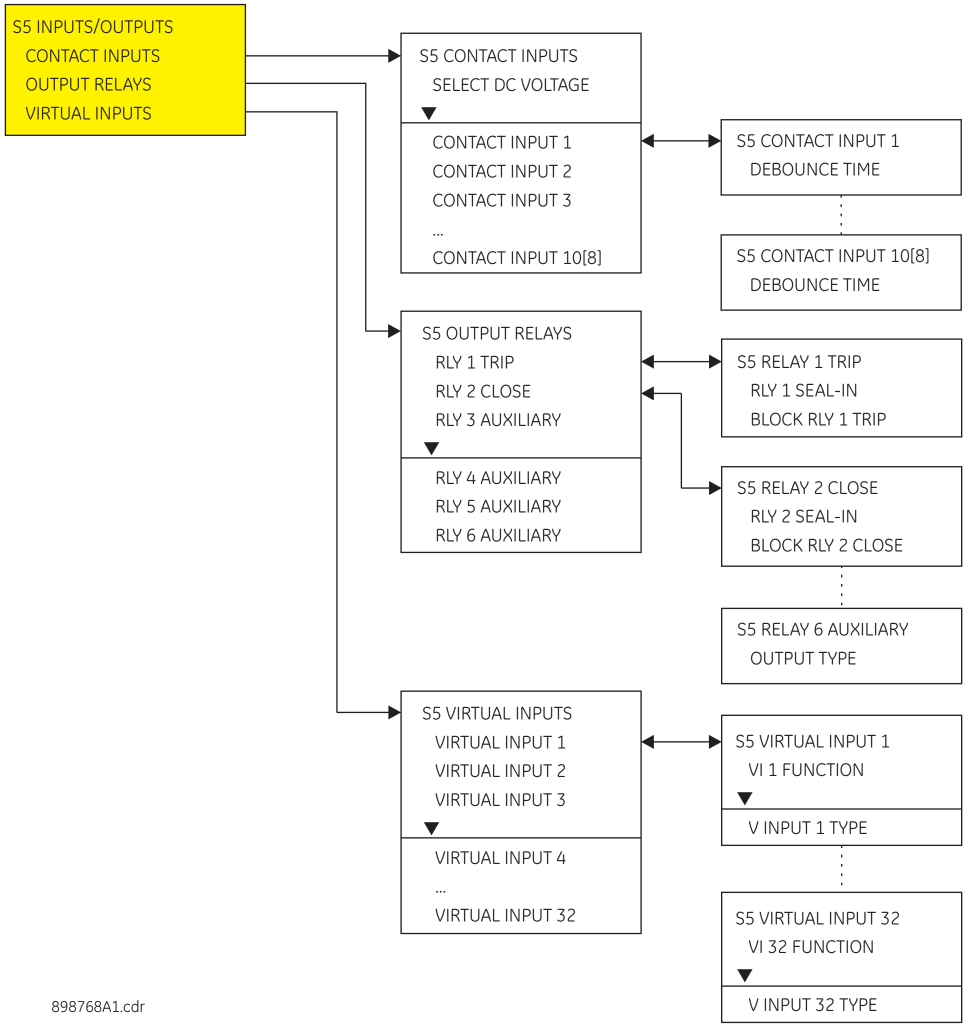
WAIT RESET TIME: In this state, when the AR RST TIME timer times out the number of shots is reset and the autorecloser goes into AR READY state waiting for a new AR execution.If the breaker status changes to OPEN or an AR BLOCK input occurs, or a new *Reclose Initiation* happens and it’s the last shot then the autorecloser ends in a NOT READY state.

If a new *Reclose Initiation* different from the last shot occurs the autorecloser goes into the WAIT FOR 52 OPEN status for the next shot.

Reclose Initiation is produced by a trip with the relevant permission enabled.

S5 Inputs/Outputs

Figure 51: Main inputs/outputs menu



Contact inputs

The 350 relay is equipped with eight (8) contact inputs, which can be used to provide a variety of functions such as for circuit breaker control, external trips, blocking of protection elements, etc. All contact inputs are wet type contacts (refer to the 350 typical wiring diagram) that require an external DC voltage source. The voltage threshold (17V, 33V, 84V, 166V) is selectable, and it applies for all eight contact inputs.

The contact inputs are either open or closed with a programmable debounce time to prevent false operation from induced voltage. Because of de-bouncing, momentary contacts must have a minimum dwell time greater than half power frequency cycle. The debounce time is adjustable by the user.

PATH: SETPOINTS > S5 INPUTS/OUTPUTS > CONTACT INPUTS

SELECT DC VOLTAGE
Range: 17 V, 33 V, 84 V, 166 V
Default: 84 V

52a BKR INPUT 1
Range: Select alpha-numeric name
Default: 52a (CI#1)

52b BKR INPUT 2
Range: Select alpha-numeric name
Default: 52b (CI#2)

CONTACT INPUT X [3 to 10]
Range: Select alpha-numeric name
Default: Input X

DEBOUNCE TIME

CONTACT INPUT X [1 TO 10]
Range: 1 to 64 ms
Default: 2 ms

Each of the contact inputs 3 to 8, can be named to reflect the function it represents within the application. Up to 18 alpha-numeric characters are available for names.

The debounce time is used to discriminate between oscillating inputs. The state will be recognized if the input is maintained for a period consisting of the protection pass plus the debounce setting.

NOTE

Contact Input 1 and Contact Input 2 are named by the factory as 52a and 52b respectively and are used for monitoring the breaker open/close state when wired to the breakers auxiliary contacts 52a and 52b.

Output relays

The 350 relay is equipped with seven electromechanical output relays: two special relays designated for Breaker Trip and Close (Relay 1 "Trip", Relay 2 "Close"), four general purpose relays (Auxiliary Relays 3 to 6), and one Critical Failure relay for fail-safe relay indication. The special purpose relays have fixed operating characteristics and the general purpose relays can be configured by the user. Logic diagrams for each output relay are provided for detailed explanation of their operation.

Operation of these breaker-control relays is designed to be controlled by the state of the circuit breaker as monitored by a 52a or 52b contact.

- The Trip and Close relays reset after the breaker is detected in a state corresponding to the command. When a relay feature sends a command to one of these special relays, it will remain operational until the requested change of breaker state is confirmed by a breaker auxiliary contact and the initiating condition has reset.
- If the initiating feature resets, but the breaker does not change state, the output relay will be reset after a default interval of 2 seconds.
- If neither of the breaker auxiliary contacts, 52a nor 52b, is programmed to a logic input, the Trip Relay is de-energized after either the delay programmed in the Breaker Failure feature, or a default interval of 100 ms after the initiating input resets. The Close Relay is de-energized after 200 ms.
- If a delay is programmed for the Trip or Close contact seal-in time, then this delay is added to the reset time. Note that the default setting for the seal-in time is 40 ms.

52a Contact Configured	52b Contact Configured	Relay Operation
Yes	Yes	Trip Relay remains operational until 52b indicates an open breaker. Close Relay remains operational until 52a indicates a closed breaker.
Yes	No	Trip Relay remains operational until 52a indicates an open breaker. Close Relay remains operational until 52a indicates a closed breaker.
No	Yes	Trip Relay remains operational until 52b indicates an open breaker. Close Relay remains operational until 52b indicates a closed breaker.
No	No	Trip Relay operates until either the Breaker Failure delay expires (if the Breaker Failure element is enabled), or 100 ms after the feature causing the trip resets. Close Relay operates for 200 ms.

Output Relay 1 "Trip"

The following path is available using the keypad. For instructions on how to use the keypad, please refer to *Chapter 3 - Working with the Keypad*.

PATH: **SETPOINTS > S5 INPUTS/OUTPUTS > OUTPUT RELAYS > RELAY 1 TRIP**

SEAL IN TIME

Range: 0.00 to 9.99 s in steps of 0.01

Default: 0.04 s

This setting defines the time to be added to the reset time of the Relay 1 Trip output, thus extending its pulse width. This is useful for those applications where the 52 contacts reporting the breaker state are faster than the 52 contacts that are responsible for interrupting the coil current.

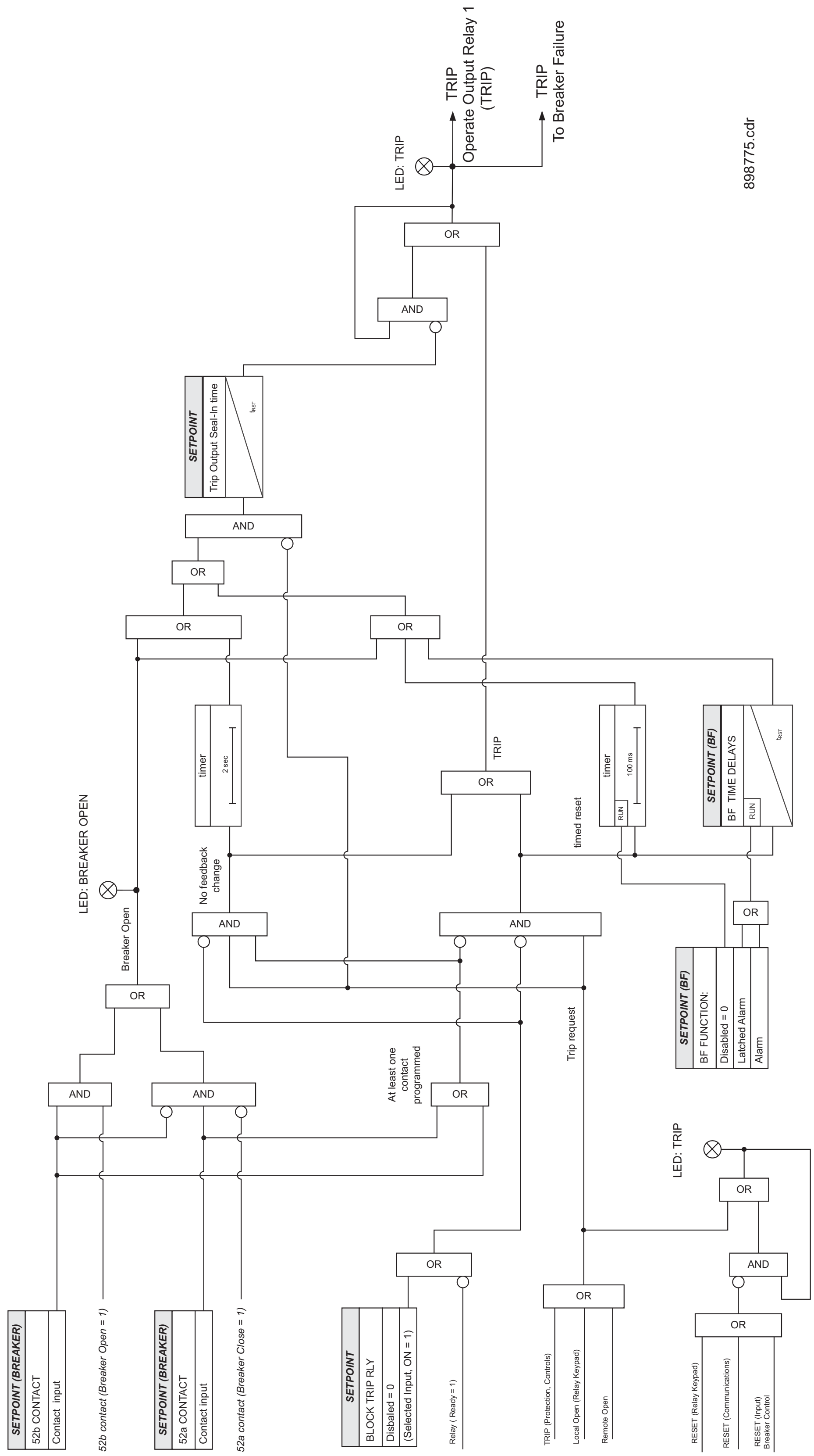
BLOCK RLY 1 TRIP

Range: Disabled, Contact Input 1 to 10, Virtual Input 1 to 32, Remote Input 1 to 32, Logic Elements 1 to 16

Default: Disabled

This setting defines a block to the Trip Output relay. When the selected input is asserted, the Trip Output relay will be blocked.

Figure 52: Relay 1 "TRIP" logic diagram



Output Relay 2 "Close"

PATH: **SETPOINTS > S5 INPUTS/OUTPUTS > OUTPUT RELAYS > RELAY 2 CLOSE**

SEAL IN TIME

Range: 0.00 to 9.99 s in steps of 0.01

Default: 0.04 s

This setting defines the time to be added to the reset time of the Relay 2 Close output, thus extending its pulse width. This is useful for those applications where the 52 contacts reporting the breaker state are faster than the 52 contacts that are responsible for interrupting the coil current.

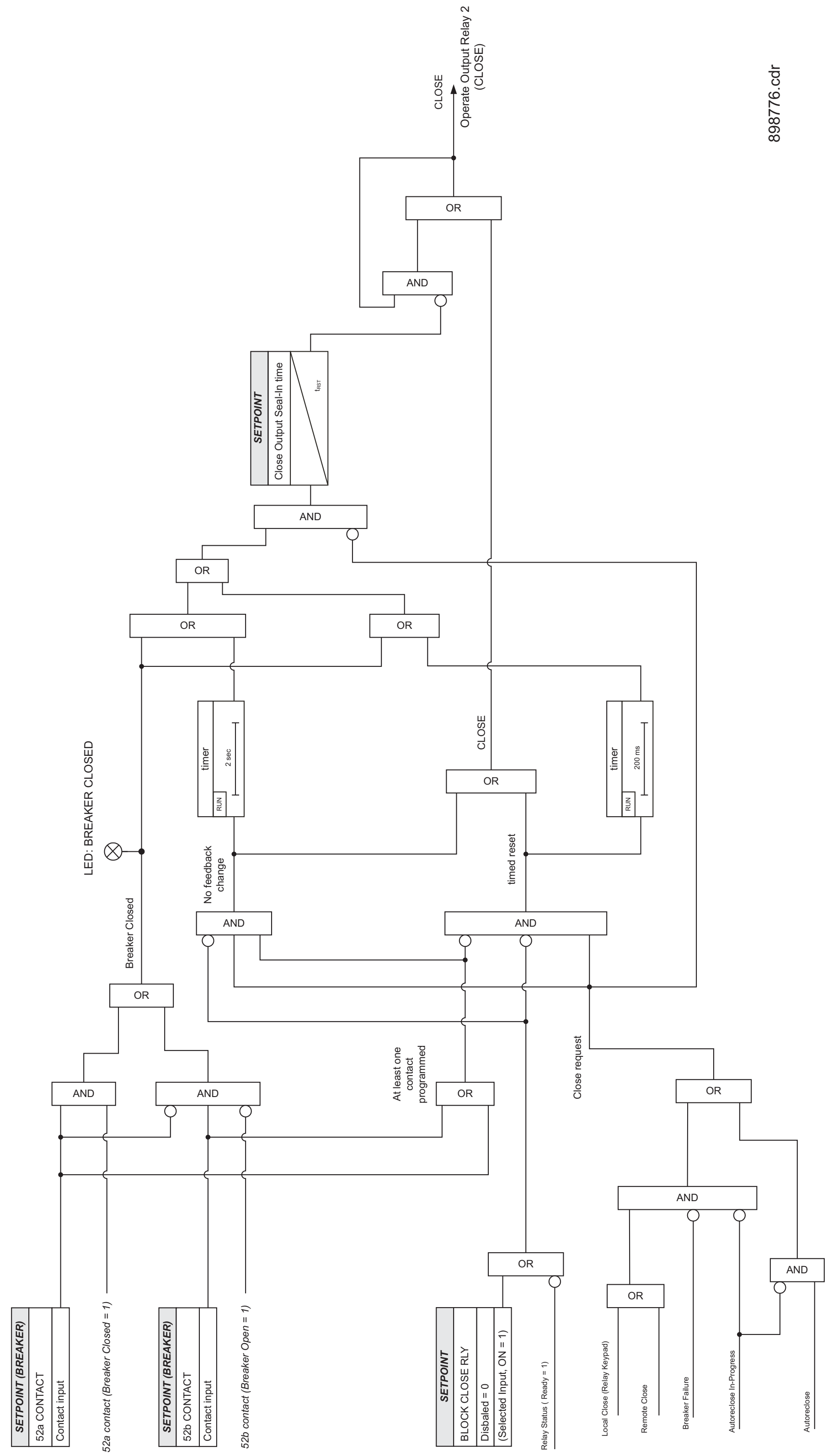
BLOCK RLY 2 CLOSE

Range: Disabled, Contact Input 1 to 10, Virtual Input 1 to 32, Remote Input 1 to 32, Logic Elements 1 to 16

Default: Disabled

This setting defines a block to the Close Output relay. When the selected input is asserted, the Close Output relay will be blocked. The block function can be useful for breaker maintenance purposes.

Figure 53: Relay 2 "CLOSE" logic diagram



Auxiliary Output Relays 3 to 6

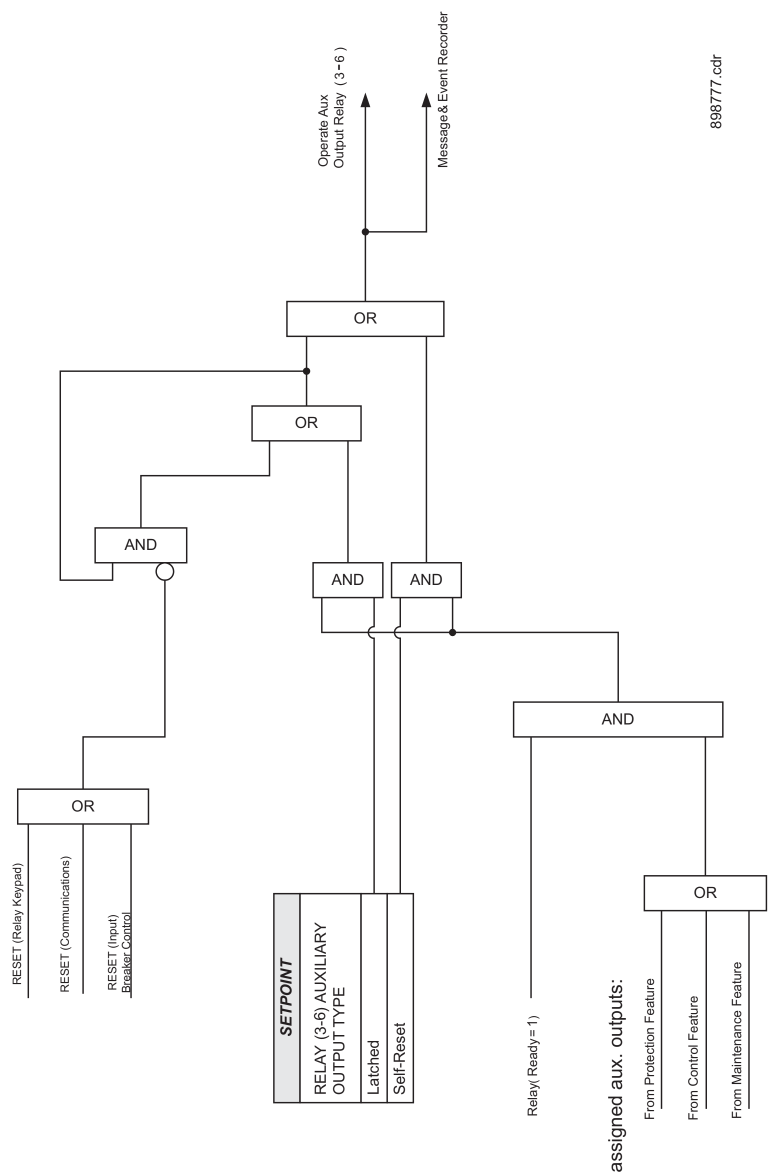
The 350 relay is equipped with four auxiliary output relays numbered from 3 to 6. All these relays are available for selection for operation of protection, control, or maintenance features. Each auxiliary relay can be selected as either **Self-Reset**, or **Latched**. If the Self-Reset type is selected, the output relay will be energized as long as the element is in operating mode and will reset when the element drops out. If the Latched type is selected, the output relay will stay energized, after the element dropout, and will be de-energized upon the reset command.

PATH: SETPOINTS > S5 INPUTS/OUTPUTS > OUTPUT RELAYS > RELAY 3(6) AUXILIARY

OUTPUT TYPE

Range: Self Reset, Latched
Default: Self Reset

Figure 54: Auxiliary relays



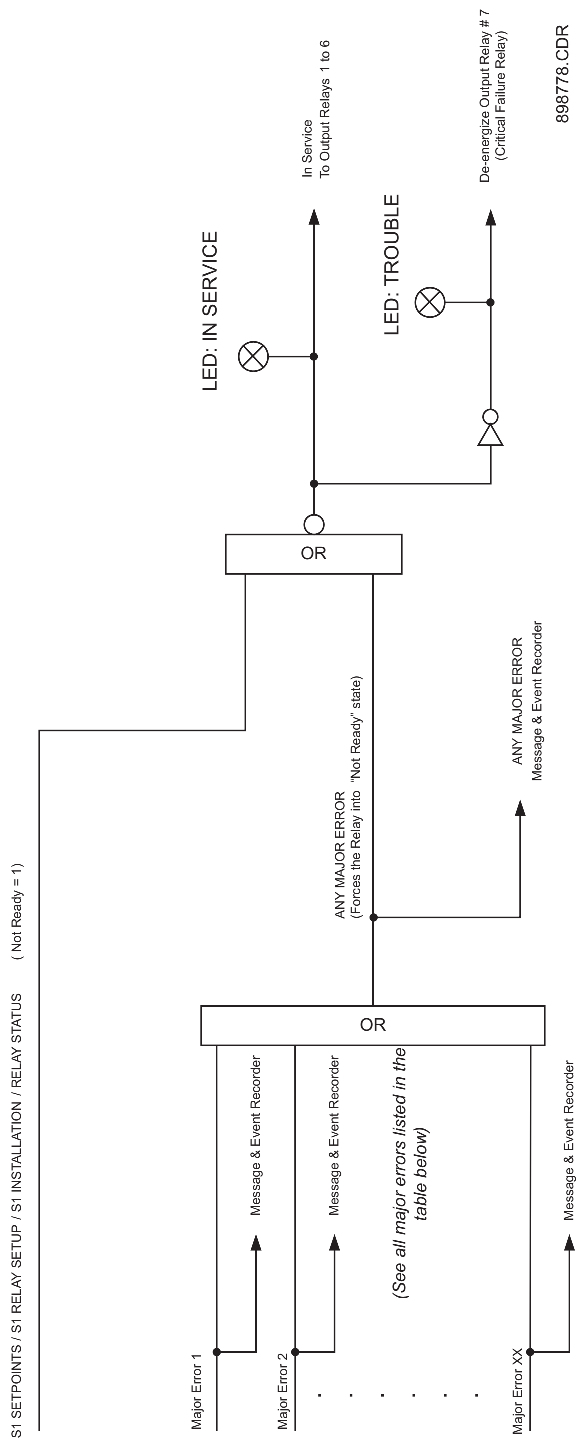
Critical Failure Relay #7

The 350 relay is also equipped with one output relay (# 7 - “Critical Failure Relay”) for fail-safe indication. There are no user-programmable setpoints associated with this output relay. The logic for this relay is shown below.

The Critical Failure Relay (Output Relay 7) is a form C contact (refer to the Typical Wiring Diagram) with one NO and one NC contacts (no control power). Output relay 7 is energized or de-energized (state change) depending on the following conditions:

1. Output Relay 7 will be **de-energized**, if the relay is not IN-SERVICE or the control power is not applied to the relay
2. Output Relay 7 will be **energized** when the control power is applied to the relay and the relay is IN-SERVICE mode.
3. Output Relay 7 will stay **de-energized**, when the control power is applied, if the relay was not programmed as “Ready”, or upon major self-test failure during relay boot up.
4. Output Relay 7 will change state from **energized** to **de-energized** if the 350 relay experiences any major self-test failure.

Figure 55: Output relay 7: Critical Failure Relay



Virtual inputs

There are 32 virtual inputs that can be individually programmed to respond to input commands entered via the relay keypad, or by using communication protocols.

The following path is available using the keypad. For instructions on how to use the keypad, please refer to *Chapter 3 - Working with the Keypad*.

PATH: **SETPOINTS > S5 INPUTS/OUTPUTS > VIRTUAL INPUTS**

VI x FUNCTION

Range: Disabled/Enabled

Default: Disabled

The Virtual Input is enabled and ready to be triggered when set to **Enabled**. All virtual inputs will appear under the **S4 CONTROLS > SETPOINTS > S4 VIRTUAL INPUTS** menu.

VI x TYPE

Range: Self-Reset, Latched

Default: Self-reset

When the **Self-Reset** type is selected, the Virtual Input will be evaluated for one protection pass only, upon “On” initiation and it will reset. When the **Latched** type is selected, the virtual input will keep the state “On” until reset command “Off” is initiated.

NOTE

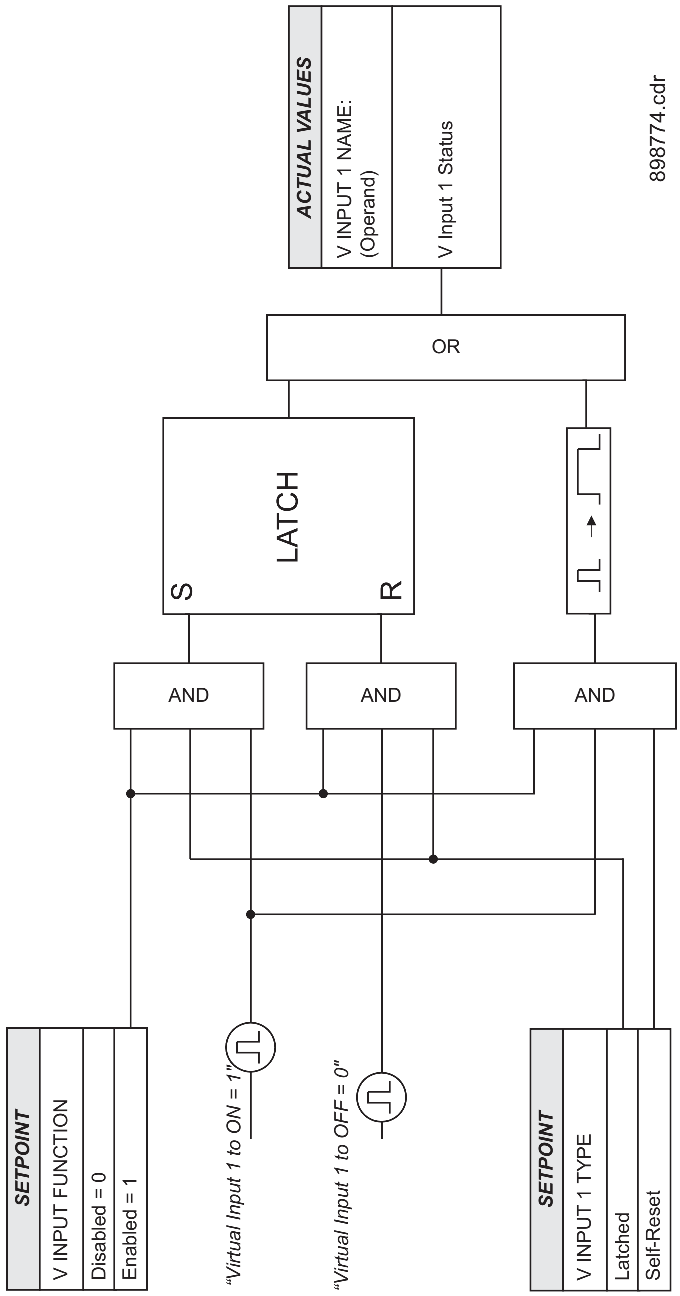
See also the Virtual Inputs section under **S4 CONTROLS**, on how to trigger a virtual input signal state.

Virtual input programming begins with enabling the Virtual Input Function, and selecting the Virtual Input Type **Self-Reset** or **Latched** under **SETPOINTS > S5 INPUTS/OUTPUTS > VIRTUAL INPUTS**. Next, the user can assign a command **On/Off** to the enabled Virtual Input under **SETPOINTS > S4 CONTROLS > S4 VIRTUAL INPUTS**. Referring to the Virtual Inputs logic diagram below, a Virtual Input type can be selected to be either **Self-Reset**, or **Latched**. When **Self-Reset** is selected and the “On” command is executed, the virtual input is evaluated as a pulse at a rate of one protection pass. To prolong the time of the virtual input pulse, one can assign it as a trigger source to a logic element with a dropout timer set to the desired pulse time. Selecting the **Latched** type, will latch the virtual input state, when the “On” command is executed.

NOTE

The "On" state of the Virtual Input will not be retained in the case of cycling of the relay control power supply.

Figure 56: Virtual inputs scheme logic



Remote inputs

Remote Inputs are available for programming under the EnerVista SR3 Setupsoftware.

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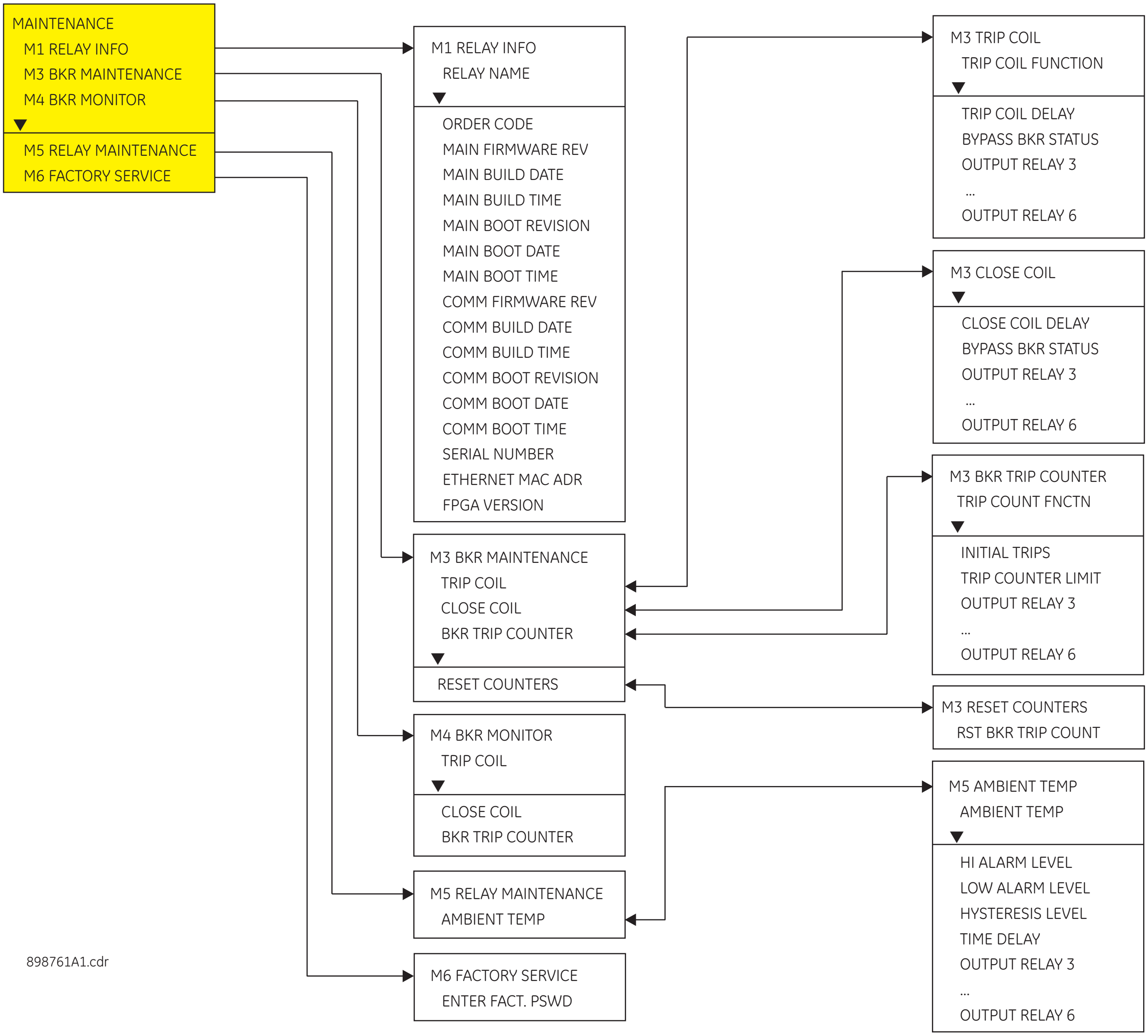
Chapter 7: Maintenance

Information about the relay and the breaker can be obtained through the features included in the Maintenance page.

Figure 1: Main maintenance menu



M1 Relay information

PATH: **MAINTENANCE > M1 RELAY INFO**

RELAY NAME

Range: alpha-numeric name of up to 18 characters
Default: Motor Name

ORDER CODE
350-EP0S0HSMCP3EDN

This screen shows the relay Order Code.

RMIO

Range: G, GG, GGG

Displays the validated RMIO. This value will be seen only if the RMIO module is installed.

MAIN FIRMWARE REVISION
1.41

This screen shows the relay Main Firmware Revision.

MAIN BUILD DATE
Aug 16 2010

This screen shows the relay Main Firmware Build Date.

MAIN BUILD TIME
15:57:46

This screen shows the relay Main Firmware Build Time.

MAIN BOOT REVISION
1.20

This screen shows the relay Main Boot Code Revision.

MAIN BOOT DATE
Dec 11 2009

This screen shows the relay Main Boot Code Build Date.

MAIN BOOT TIME
10:44:54

This screen shows the relay Main Boot Code Build Time.

COMM FIRMWARE REVISION
1.40

This screen shows the relay Comm Code Revision.

COMM BUILD DATE
Aug 16 2010

This screen shows the relay Comm Code Build Date.

COMM BUILD TIME
16:20:45

This screen shows the relay Comm Code Build Time.

COMM BOOT REVISION
1.30

This screen shows the relay Comm Boot Code Revision.

COMM BOOT TIME
16:22:41

This screen shows the relay Comm Boot Code Build Time.

SERIAL NUMBER
ML0A08999014

Each relay has a unique serial number.

ETHERNET MAC ADR
00:A0F4:00:33:00

This screen shows the Ethernet MAC Address of the relay.

FPGA VERSION
1.00

This screen shows the FPGA Version.

M3 Breaker maintenance

Trip coil

The Trip coil monitoring is performed by a built-in voltage monitor on the Form A output relay: #1 Trip. The voltage monitor is connected across the Form A contact, and effectively the relay detects healthy current through the circuit. To do that, an external jumper must be made between terminals "A2" and "A3" for Trip coil monitoring.

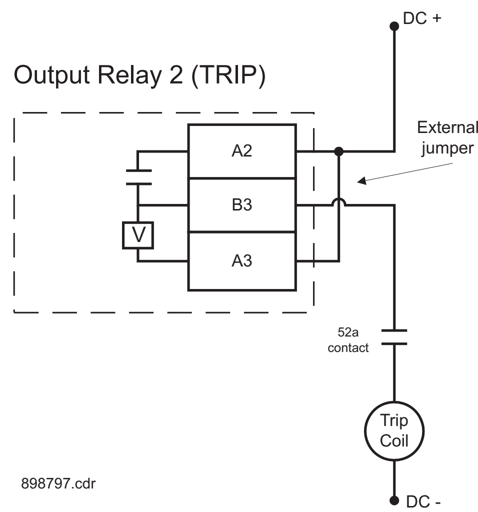
As long as the current through the Voltage Monitor is above the threshold of the trickle currents (see Technical Specification for Form A output relays), the circuit integrity for the Trip coil is effectively normal. If the Trip coil circuit gets disconnected, or if in general a high resistance is detected in the circuitry, a Trip alarm will be set and the "ALARM" and "MAINTENANCE" LEDs will be on.

Example 1: The figure below shows the connections of the breaker trip coil to the relay's trip output relay for voltage monitoring of the trip circuit.

NOTE

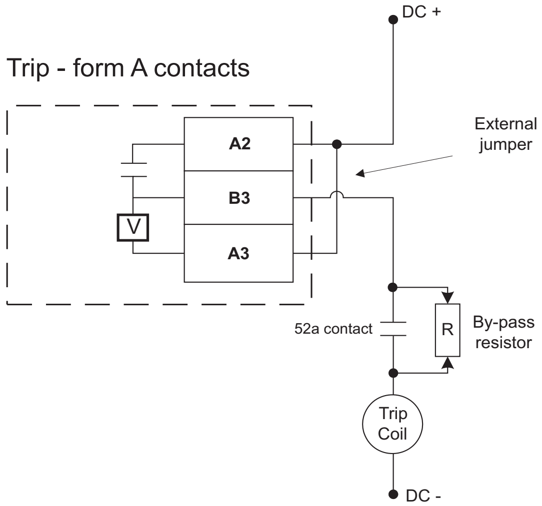
To monitor the trip coil circuit integrity, use the relay terminals "A2" and "B3" to connect the Trip coil, and provide a jumper between terminals "A2" and "A3" (voltage monitor).

Figure 2: Trip Coil circuit with voltage monitoring



Example 2: Some applications require that the Trip coil be monitored continuously, regardless of the breaker position (open or closed). This can be achieved by connecting a suitable resistor (see the table) across breaker auxiliary contact 52a in the trip circuit. With such connections, the trickle current will be maintained by the resistor when the breaker is open. For these applications the setting for "BYPASS BKR STATUS" should be set to ENABLED.

Figure 3: Trip circuit with continuous monitoring



VALUES OF RESISTOR 'R'

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

898787.cdr

The following path is available using the keypad. For instructions on how to use the keypad, please refer to *Chapter 3 - Working with the Keypad*.

PATH: **MAINTENANCE > M3 BKR MAINTENANCE**

TRIP COIL FUNCTION

Range: Disabled, Alarm, Latched Alarm

Default: Disabled

Selecting Alarm, or Latched Alarm, enables the Trip Coil Monitor monitoring function. The "ALARM" and "MAINTENANCE" LEDs will light up upon detection of a trip coil circuitry problem. The "ALARM" LED will flash upon Trip Coil Monitor operating condition, with the Trip Coil Monitor function selected as Alarm, and will self-reset, when the condition clears. If Latched Alarm is selected, the "ALARM" LED will flash during the Trip Coil Monitor condition, and will stay "ON" after the condition clears, until the reset command is initiated. Any or all of output relays 3 to 6 can be selected to operate when the Trip Coil Monitor function is selected as Alarm, or Latched Alarm.

TRIP COIL DELAY

Range: 1 to 10 sec in steps of 1 sec

Default: 5 s

This setting defines the Trip Coil Monitor Delay, before targets appear on the display, "ALARM" and "MAINTENANCE" LEDs light up on the front panel, and selected output relays operate.

BYPASS BKR STATUS

Range: Disabled, Enabled

Default: Disabled

Set the "BYPASS BKR STATE" to Enabled when a by-pass resistor is connected across the breaker auxiliary contact for continuous Trip circuit integrity monitoring. The circuits will be monitored regardless of breaker position. When "BYPASS BKR STATE" is set to Disabled, monitoring of the trip coil will be blocked when the breaker is open.

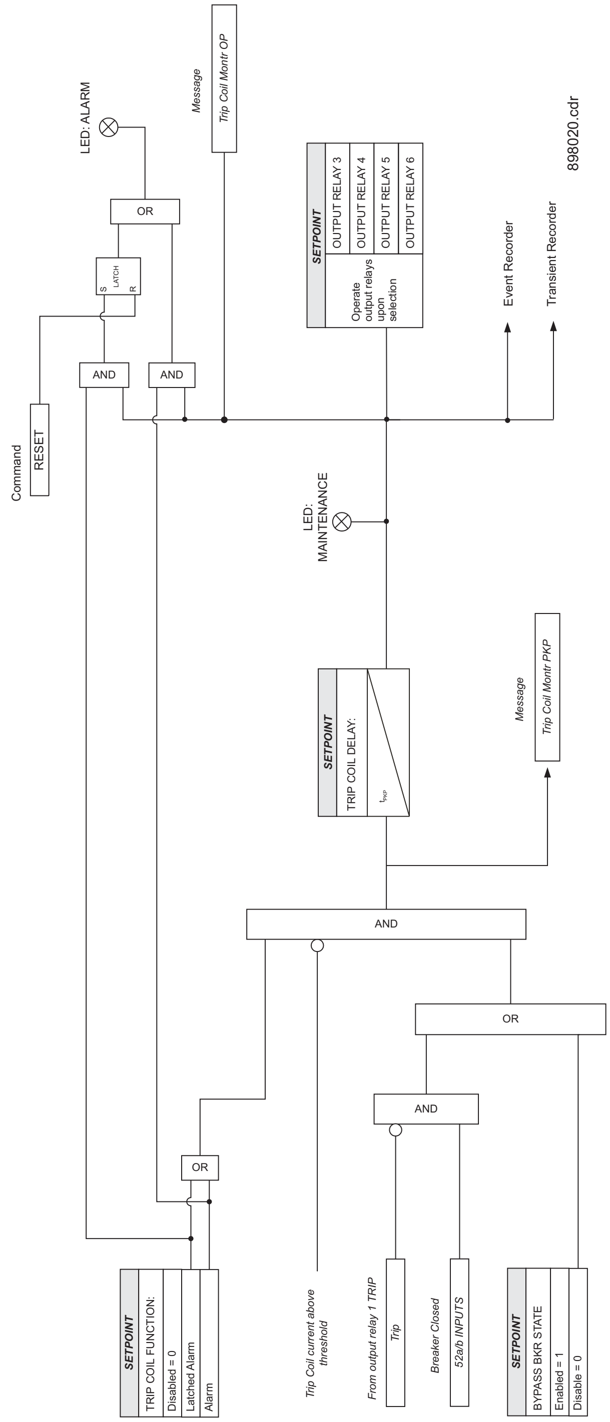
OUTPUT RELAY 3 to 6

Range: Do not operate, Operate

Default: Do not operate

Any, or all, of output relays 3 to 6 can be selected to operate upon detection of Trip Coil, or a Trip coil circuitry problem. The selection of the relay outputs operation is available no matter whether the Alarm, or Latched Alarm, function is selected.

Figure 4: Trip coil monitoring logic diagram



Close coil

Close coil monitoring is performed by a built-in voltage monitor on the Form A output relay: #2 Close. The voltage monitor is connected across the Form A contact, and effectively the relay detects healthy current through the circuit. To do that, an external jumper should be made between terminals “B4”, and “B5” for Close coil monitoring.

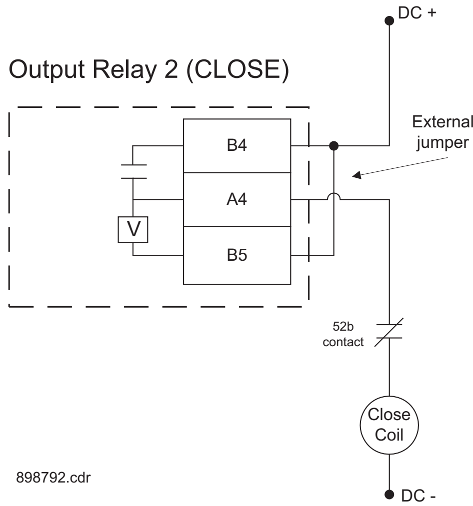
As long as the current through the Voltage Monitor is above the threshold of the trickle currents (see Technical Specification for Form A output relays), the circuit integrity for the Close coil is effectively normal. If the Close coil circuit gets disconnected, or if in general a high resistance is detected in the circuitry, a Close Coil alarm will be set and the "ALARM" and "MAINTENANCE" LEDs will be on.

Example 1: The figure below shows the connection of the breaker close coil to the relay's close output relay for voltage monitoring of the close circuit.

NOTE

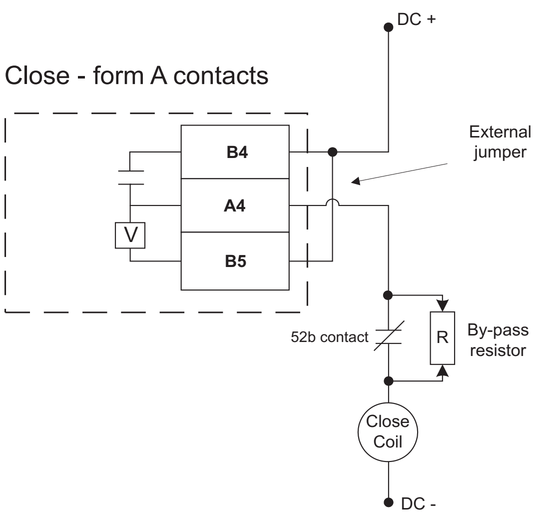
To monitor the close coil circuit integrity, use the relay terminals "B4" and "A4" to connect the Close coil, and provide a jumper between terminals "B4" and "B5" (voltage monitor).

Figure 5: Close Coil circuit with voltage monitoring



Example 2: Some applications require that the Close Coil be monitored continuously, regardless of the breaker position (open or closed). This can be achieved by connecting a suitable resistor (see the table) across breaker auxiliary contact 52b in the Close circuit. With such connections, the trickle current will be maintained by the resistor when the breaker is closed. For these applications the setting for "BYPASS BKR STATUS" should be set to ENABLED.

Figure 6: Close Coil circuit with continuous monitoring



VALUES OF RESISTOR 'R'

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

898793.cdr

The following path is available using the keypad. For instructions on how to use the keypad, please refer to *Chapter 3 - Working with the Keypad*.

PATH: **MAINTENANCE > M3 BKR MAINTENANCE**

CLOSE COIL FUNCTION

Range: Disabled, Alarm, Latched Alarm

Default: Disabled

Selecting Alarm, or Latched Alarm, enables the Close Coil Monitor monitoring function. The “ALARM” and “MAINTENANCE” LEDs will light up upon detection of a close coil circuitry problem. The “ALARM” LED will flash upon a Close Coil Monitor operating condition, with the Close Coil Monitor function selected as Alarm, and will self-reset, when the condition clears. If Latched Alarm is selected, the “ALARM” LED will flash during the Close Coil Monitor condition, and will stay “ON” after the condition clears, until the reset command is initiated. Any or all of output relays 3 to 6 can be selected to operate when the Close Coil Monitor function is selected as Alarm, or Latched Alarm.

CLOSE COIL DELAY

Range: 1 to 10 sec in steps of 1 sec

Default: 5 s

This setting defines the Close Coil Monitor Delay, before targets appear on the display, “ALARM” and “MAINTENANCE” LEDs light up on the front panel, and selected output relays operate.

BYPASS BKR STATUS

Range: Disabled, Enabled

Default: Disabled

Set the “BYPASS BKR STATE” to Enabled when a by-pass resistor is connected across the breaker auxiliary contact for continuous Close circuit integrity monitoring. The circuits will be monitored regardless of breaker position. When “BYPASS BKR STATE” is set to Disabled, monitoring of the close coil will be blocked when the breaker is closed.

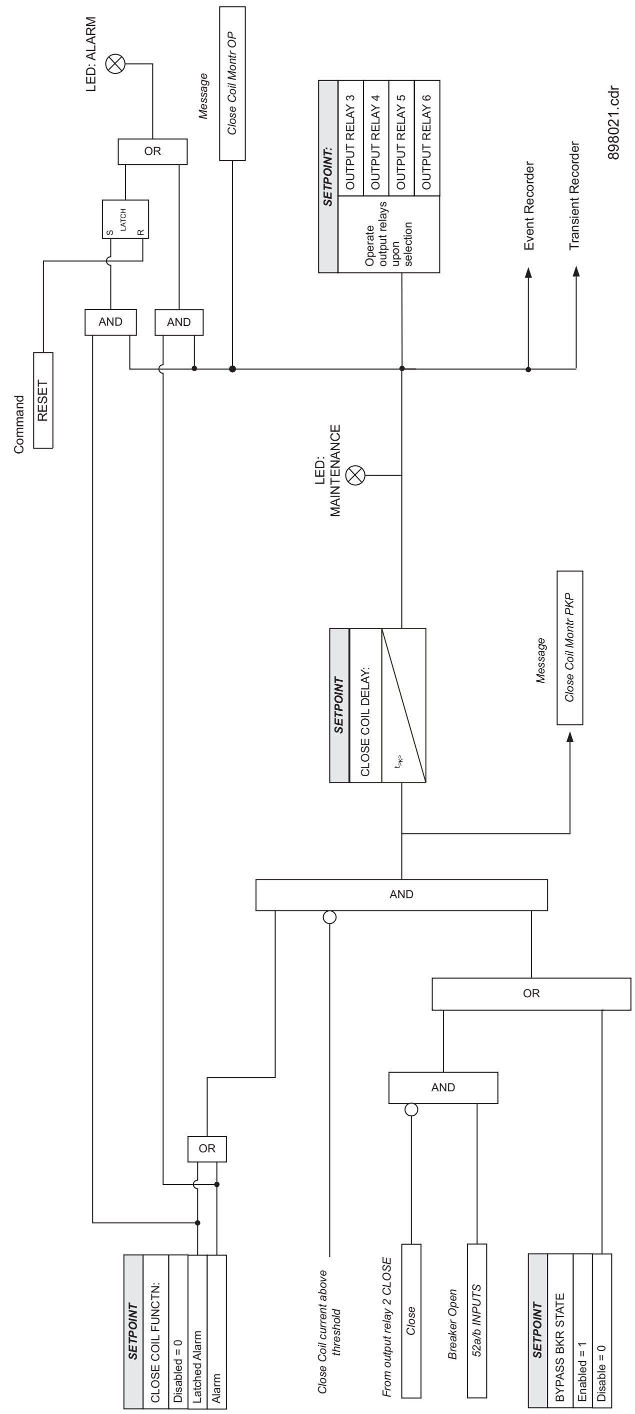
OUTPUT RELAY 3 to 6

Range: Do not operate, Operate

Default: Do not operate

Any, or all, of output relays 3 to 6 can be selected to operate upon detection of a Close coil circuitry problem. The selection of the relay outputs operation is available no matter whether the Alarm, or Latched Alarm, function is selected.

Figure 7: Close coil monitoring logic diagram



Breaker trip counter

When the total number of breaker trips detected reaches the TRIP COUNTER LIMIT setpoint, an output will occur.

The following path is available using the keypad. For instructions on how to use the keypad, please refer to *Chapter 3 - Working with the Keypad*.

PATH: **MAINTENANCE > M3 BKR MAINTENANCE > BKR TRIP COUNTER**

TRIP COUNT FUNCTN

Range: Disabled, Alarm, Latched Alarm

Default: Disabled

The selection of the **Latched Alarm**, or **Alarm** setting enables the BKR Trip Counter function. The "ALARM" LED will turn on when the Total breaker trips reaches the TRIP COUNTER LIMIT setting. The "ALARM" LED will flash when the BKR Trip Counter reaches the TRIP COUNTER LIMIT setting with function selected as **Alarm**, and will reset, when the trip counter is reset. The "ALARM" LED will latch when **Latched Alarm** is selected, until the counter is reset, and the **reset targets** command is initiated.

Any or all of output relays 3 to 6 can be selected to operate when the number of breaker trips reaches the "TRIP COUNTER LIMIT," regardless of the selected trip counter function.

INITIAL TRIPS

Range: 0 to 10000 in steps of 1

Default: 0

This setting defines the number of breaker trips, that occurred before enabling the breaker trip counter for breaker monitoring.

TRIP COUNTER LIMIT

Range: 1 to 10000 in steps of 1

Default: 1 trip

This setting defines the limit number for breaker trips. The BKR TRIP COUNTER will operate and produce an output if the number of breaker trips reaches the set limit.

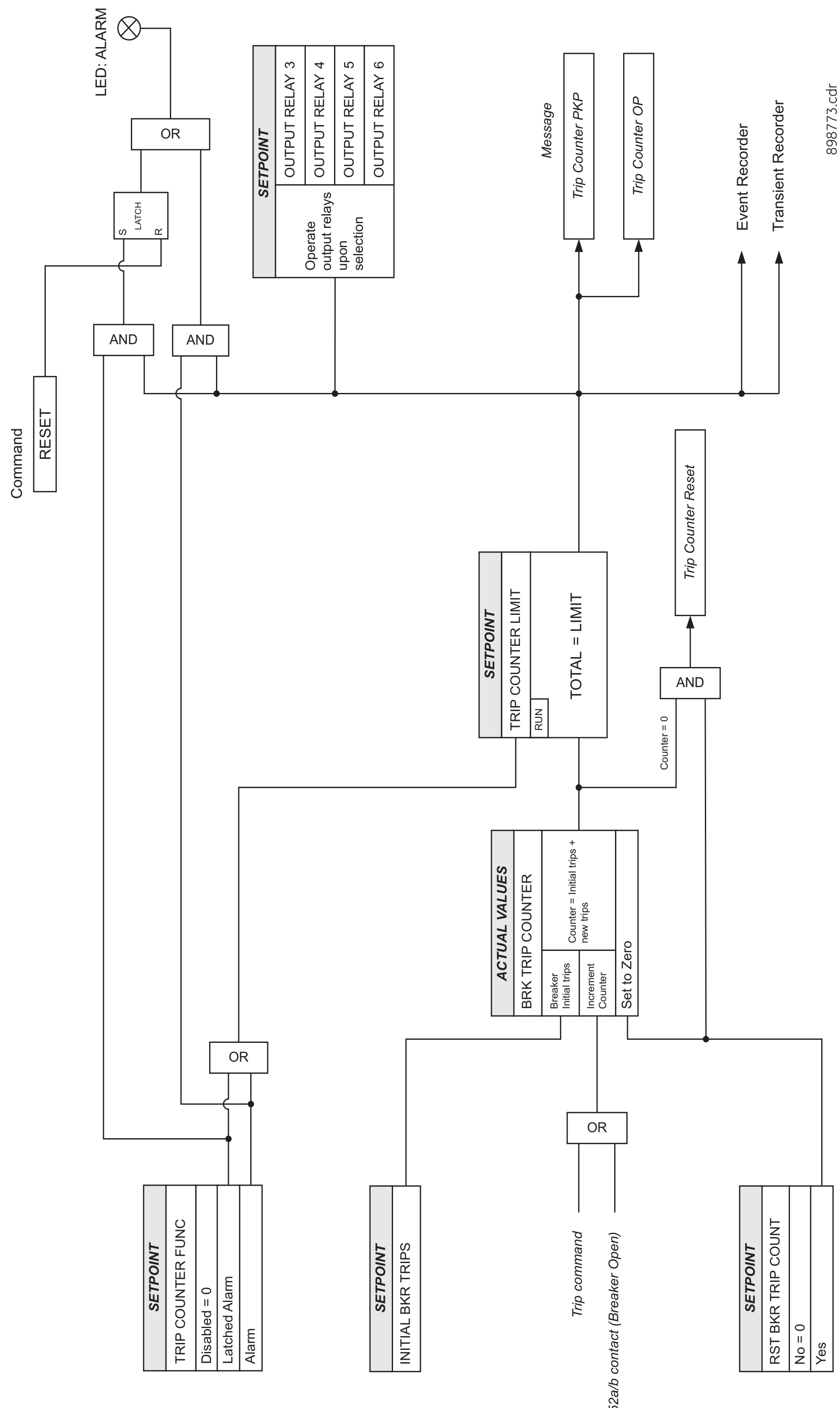
OUTPUT RELAY 3 to 6

Range: Do not operate, Operate

Default: Do not operate

Any, or all, of output relays 3 to 6 can be selected to operate, upon the BKR TRIP COUNTER condition.

Figure 8: BKR trip counter logic diagram



M4 Breaker monitor

The status of the breaker trip and close coils, as well as the trip and close circuits, can be monitored under **MAINTENANCE > M4 BKR MONITOR**. In the case where a breaker coil or circuit fails, the relay will display the message "Unhealthy" for the corresponding coil.

Further information on the breaker is provided under **BKR TRIP COUNTER**, where the 350 stores the number of trips. The counter can be reset under **M3 RESET COUNTERS > RST BKR TRIP COUNT** set to "Yes".

PATH: **MAINTENANCE > M4 BKR MONITOR**

TRIP COIL
Healthy
Range: Healthy, Unhealthy

CLOSE COIL
Healthy
Range: Healthy, Unhealthy

BKR TRIP COUNTER
5
Number of Trips

M5 Relay maintenance

Ambient temperature

The SR3 has a temperature monitor feature that measures the ambient temperature around the chassis of the relay. The relay extrapolates the ambient temperature from an internal temperature sensor inside the product. This feature can be used to signal the customer that the product is being subjected to temperatures that can degrade the product life and proper action should be initiated. For example the air conditioning, heating or ventilation system should be checked.

The purpose of the feature is to measure the immediate temperature around the product. There are several factors that can alter the measurement that need to be considered for the application of this feature.

- Any forced air flow or obstructions that can interrupt even distribution of the ambient temperature.
- Installation of the relay should be for normal operation (CT, VT, inputs, outputs).

PATH: MAINTENANCE > M5 RELAY MAINTENANCE > AMBIENT TEMP

AMBIENT TEMPERATURE

Range: Disabled, Alarm, Latched Alarm

Default: Disabled

This setting enables the ambient temperature functionality. If the operating condition is satisfied when **Alarm** is selected as the function, the "ALARM" LED will flash upon the activating condition, and will automatically reset when the condition clears. If **Latched Alarm** is selected, the LED "ALARM" will flash upon the activating condition, and will stay "ON" after the condition clears, until a reset command is initiated. Any assignable output relays can be selected to operate when this function is enabled.

HI ALARM LEVEL

Range: 20°C to 80°C in steps of 1°C

Default: 60°C

This setting specifies the temperature level monitored by the Ambient Temperature Alarm high logic. The alarm will occur when the temperature remains above this level.

LOW ALARM LEVEL

Range: -40°C to 20°C in steps of 1°C

Default: 10°C

This setting specifies the temperature level monitored by the Ambient Temperature Alarm low logic. The alarm will occur when the temperature remains below this level.

HYSTERESIS LEVEL

Range: 2°C to 10°C in steps of 1°C

Default: 2°C

This setting allows the user to select the dropout level for the feature.

TIME DELAY

Range: 1 to 60 min in steps of 1 min

Default: 1 sec

This timer starts when either the high or low level thresholds have exceeded their respective levels.

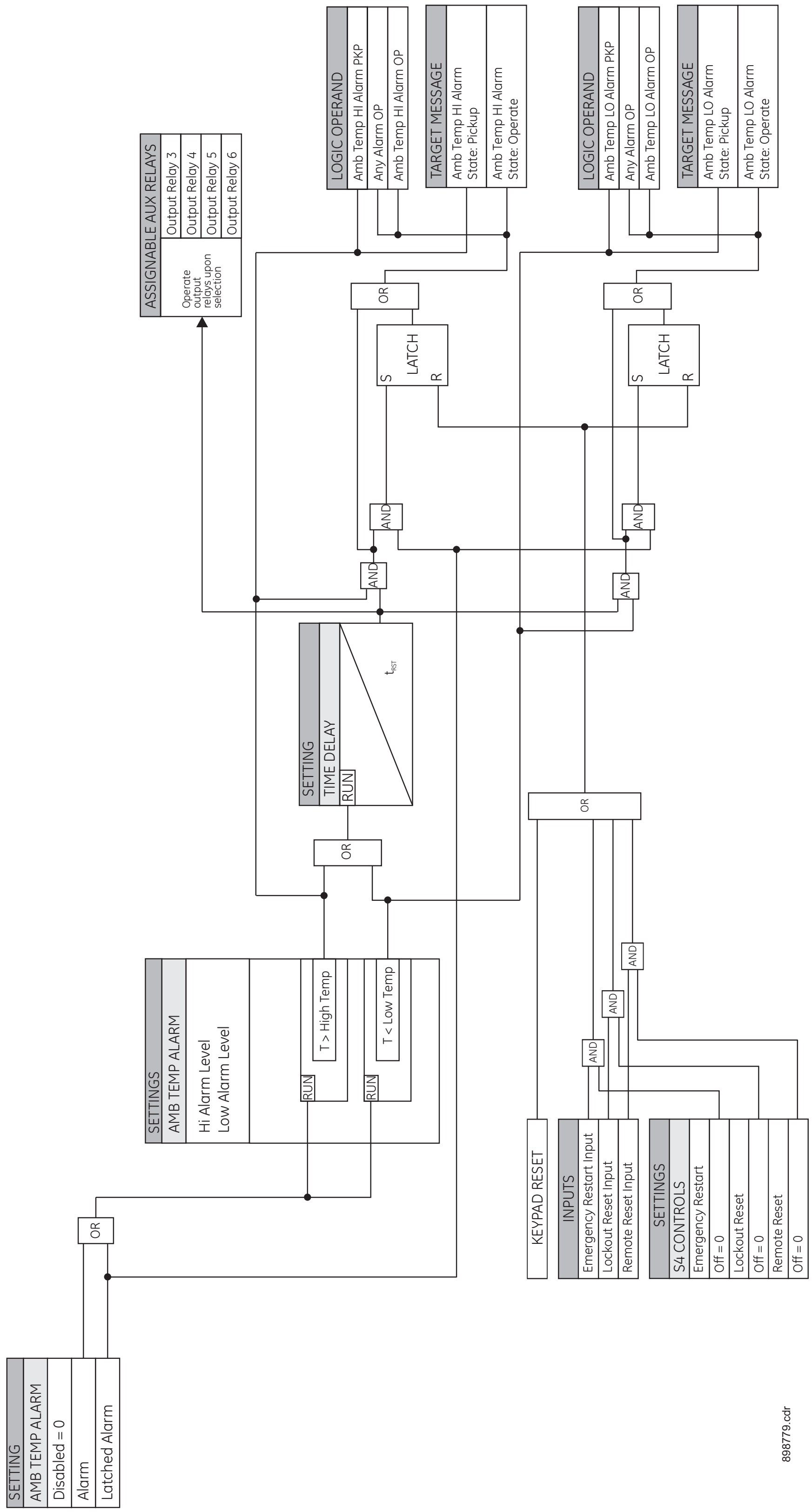
OUTPUT RELAY 3 to 6

Range: Do Not Operate, Operate

Default: Do Not Operate

Any assignable output relay can be selected to operate upon Ambient Temperature Alarm operation.

Figure 9: Ambient Temperature Alarm logic diagram



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Appendix

Warranty

For products shipped as of 1 October 2013, GE Digital Energy warrants most of its GE manufactured products for 10 years. For warranty details including any limitations and disclaimers, see the GE Digital Energy Terms and Conditions at https://www.gedigitalenergy.com/multilin/warranty.htm

For products shipped before 1 October 2013, the standard 24-month warranty applies.

Change notes

Manual Revision history

Table 1: Revision History

MANUAL P/N	RELEASE DATE
1601-9086-A1	12 May 2009
1601-9086-A2	4 June 2009
1601-9086-A3	4 June 2009
1601-9086-A4	30 June 2009
1601-9086-A5	30 June 2009
1601-9086-A6	6 December 2010
1601-9086-A7	18 January 2011
1601-9086-A8	10 May 2010
1601-9086-A9	9 December 2011

Table 1: Revision History

MANUAL P/N	RELEASE DATE
1601-9086-AA	29 February 2012
1601-9086-AB	29 September 2012
1601-9086-AC	29 February 2012
1601-9086-AD	13 June 2013
1601-9086-AE	12 July 2013
1601-9086-AF	20 August 2013
1601-9086-AG	26 August 2014

Table 2: Major Updates for 350-AG

Page Number	CHANGES
	Manual revision number from AF to AG
Chapter 1	Added note to specifications
Chapter 1	Changed Time Delay Accuracy to Curve Timing Accuracy
Chapter 3	Updated hardware and software requirements.
Chapter 3	Replaced image for Transient Recorder Viewer window with updated image.

Table 3: Major Updates for 350-AF

Page Number	CHANGES
	Manual revision number from AE to AF
	Software revision number from 1.5x to 1.60
Chapter 1	Added 67P Order Codes for models with Directional protection (Order Code Other Protection characters “P” and “R”)
Chapter 1	Updated Order Codes adding programmable LEDs option (Language character “L”) and removing Chinese option(Language character “C”)
Chapter 3, 6	Added section on programmable LEDs
General	Increased VT Ratio setting to 1500:1
Chapter 6	Added new 67N and 67G settings to define directional effect on overcurrent elements when direction cannot be calculated
General	Changed Time Delay Multiplier maximum to 50.00 and minimum to 0.05
Chapter 1, 4	Changed Power Metering maximum to 100 from 3000

Table 4: Major Updates for 350-AE

Page Number	CHANGES
	Manual revision number from AD to AE

Table 4: Major Updates for 350-AE

Page Number	CHANGES
Chapter 6	Clarify SR3 IEC 61850 GOOSE details

Table 5: Major Updates for 350-AD

Page Number	CHANGES
	Manual revision number from AC to AD
Chapter 1	Updated Type Tests table
General	Minor Corrections

Table 6: Major Updates for 350-AC

Page Number	CHANGES
	Manual revision number from AB to AC
Chapter 1	Revise time delay parameters
Chapter 2	Revise Non-drawout-Adapter plate mounting drawing
Chapter 6	Add missing setpoint titles
General	Minor Corrections

Table 7: Major Updates for 350-AB

Page Number	CHANGES
	Manual revision number from AA to AB
Chapter 1	Add Case design option N (relay with non-drawout design)
Chapter 2	Add dimensions, mounting and wiring for non-drawout unit
General	Minor Corrections

Table 8: Major Updates for 350-AA

Page Number	CHANGES
	Manual revision number from A9 to AA
Chapter 2	Revise Control Power parameters

Table 9: Major Updates for 350-A9

Page Number	CHANGES
	Manual revision number from A6 to A9
General	Add support for additional safety/protection elements

Table 10: Major Updates for 350-A6

Page Number	CHANGES
	Manual revision number from A5 to A6
Chapter 1	Add Protection Elements 67G and 67N to Protection Functions
Chapter 1	Add Comm option 3E to Order Code Table
Chapter 7	Add Ambient Temp section (Ch 7 - Maintenance)
General	Increase number of Logic Elements to 16
General	Minor Corrections

Table 11: Major Updates for 350 A1 to A5

Page Number	CHANGES
	Manual revision numbers from A1 to A5
General	Minor Corrections