

ADVC Controller Range

OPERATIONS MANUAL

Notices

SCOPE OF THIS MANUAL

This document describes the features and operation of the Advanced Controller in both Ultra & Compact configurations, using a setVUE or flexVUE O.I..

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1 Introduction

This manual details the operation of the 2008 release of the ADVC Controller (ADVC). The ADVC is designed to operate an automatic circuit recloser (ACR) or a Load Break Switch (LBS).

ADVC Applicable ACR/LBS

ADVC ULTRA	N-Series ACR
& COMPACT Models	U-Series ACR
	RL- Series LBS

The ADVC Controller reads and displays the information stored in its attached switchgear. It also trips and closes the switchgear for the primary purpose of protection.

The ADVC

■ consists of:

- ☐ an electronic switchgear controller (CAPE) that monitors the switchgear and provides protection and communications functions
- ☐ an operator interface mounted on the CAPE inside the cubicle
- ☐ a power supply which also supplies power for customer equipment
- ☐ accessories and customer equipment compartments (varies with model)

■ is powered by an auxiliary voltage supply of 110, 220, or 240 volts AC

■ is connected to the switchgear via a detachable control cable.

The ADVC Controller cubicle is constructed of stainless steel¹ and is insulated and designed to minimise any temperature rise resulting from solar heating.

The Operator Interface is located on the CAPE inside the cubicle door. The cubicle door is sealed with a rubber extrusion and the cubicle vents are screened against the entry of vermin. If installed, a hatch provides access to the O.I. without opening the cubicle door.

The controller electronics incorporate the functions of:

- an overcurrent and earth/ground fault protection relay,
- an auto reclose relay, and
- a remote terminal unit.

Additionally, the electronics can measure line current, voltage, real and reactive power, fault currents, and harmonics and perform waveform capture. This data is stored for transmission or off-line analysis.

The ADVC contains a built-in microprocessor controlled power supply which provides uninterrupted operation of not only the switchgear and protection relay, but also the communications radio or modem.

The ADVC reads and displays the switchgear-related information that is stored in the switch to which it is connected. Therefore, if the ADVC is moved to another switch, it reads the data from that switch.

The ADVC customer compartment provides room for other equipment. Standard communications cables can be used for connection to the communications ports on the CAPE and power is readily accessible from the power terminal block located on the customer compartment. The **COMPACT** cubicle has one customer compartment while the **ULTRA** cubicle has two.

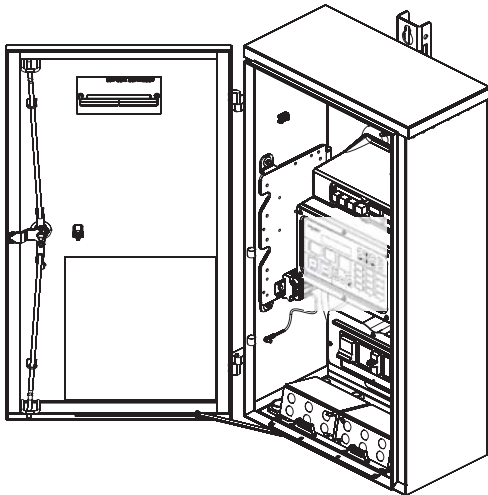


Figure 1. ADVC **ULTRA** (with flexVUE O.I.)

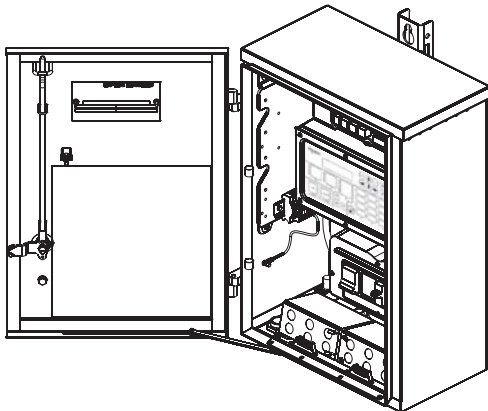


Figure 2. ADVC **COMPACT** (with flexVUE O.I.)

ABBREVIATIONS

The following abbreviations are used in this document:

ACO	Auto Changeover
ACR	Automatic Circuit Recloser
ADGS	Automatic Detection Group Selection
ADVC	ADVC Controller
APGS	Automatic Protection Group Selection
CAPE	Control And Protection Enclosure
CTRL	Controller
DT	Definite Time
EF	Earth (Ground) Fault
GND	Ground, synonymous with earth
IDMT	Inverse Definite Minimum Time
INST	Instantaneous
LA	Loop Automation
LBS	Load Break Switch
LCD	Liquid Crystal Display
LOP	Loss of Phase Protection
NPS	Negative Phase Sequence
NWRK	Network
OC	Phase Overcurrent
OF	Over Frequency Protection
O.I.	Operator Interface
OV	Over Voltage Protection
PRTN	Protection
PSSM	Power Supply and Switchgear Module
PSU	Power supply unit
PTCL	Protocol
SEF	Sensitive Earth (Sensitive Ground) Fault
SWGR	Switchgear
UF	Under Frequency Protection
UV	Under Voltage Protection
VIB	Voltage Imbalance
WSOS5	Windows Switchgear Operating System

SYMBOL MEANINGS



The bushing symbol indicates that the adjacent information applies only to the specified Switchgear.



The grey box symbol indicates that the adjacent information does not apply to all products.



The note symbol indicates that the adjacent text contains information for your particular attention.



The warning symbol indicates that the adjacent text contains a warning.



The caution symbol indicates that the adjacent text details a situation in which care should be taken.



The following information only relates to the **setVUE** Operator Interface.



The following information only relates to the **flexVUE** Operator Interface.

HOW TO USE THIS MANUAL

This manual is designed to give you a working knowledge of the operations, settings and their implementation and features of the ADVC Controller hardware.

While reading this manual, please consider the following:

MENU NAVIGATION

The ADVC Controller is available with 2 different Operator Interfaces, **setVUE** and **flexVUE**. Menu navigation shown in this manual is usually given with both **setVUE** and **flexVUE** options together. Consider the following example:

 PROTECTION – PROTECTION SETTINGS: Directional Blocking 3: Min SEF Vzps 5%

 ENGINEER MENU – PROTECTION MENU – DIRECTIONAL ELEMENTS – DIRECTIONAL BLOCKING – SEF – Minimum SEF Vzps

 In the above example, to find the setting on the **setVUE** panel you would:

- 1: Press **MENU** until the menu group you require comes on screen.
In this example:
PROTECTION
- 2: Use the **ARROW KEYS** to scroll through until you found the required menu. In this example:
PROTECTION SETTINGS: Directional Blocking 3.
- 3: On that Menu will be the setting you are looking for. In this example
Min SEF Vzps 5%
- 4: For information on changing settings see “ **setVUE Panel** (page 6-2)”

 On the **flexVUE** O.I. menu navigation, menus are shown in CAPITALS and editable settings are shown in Title Case.

In the above example, to find the setting on the **flexVUE** panel you would:

- 1: Press **MENU** to bring up the menu navigation.
- 2: Use the **UP & DOWN** arrows to find the next required menu. In this example, the first menu is: **ENGINEER MENU**
- 3: Press **SELECT** or the **RIGHT ARROW** to enter the next menu in the navigation structure. In this example PROTECTION MENU
- 4: Repeat steps 2 & 3 to continue through the indicated menu navigation. In this example: DIRECTIONAL ELEMENTS then to DIRECTIONAL BLOCKING then to SEF
- 5: Scroll through the settings (shown in Title Case) to the required setting. In this example: Minimum SEF Vzps and press **SELECT**
- 6: For information on changing settings see “ **flexVUE Panel** (page 6-6)”

2 Scope of this Manual

GENERAL

This manual describes the operation of the ADVC Controller.

Whilst every care has been taken in preparation of this manual, no responsibility is taken for loss or damage incurred by the purchaser or user due to any error or omission in the document.

Inevitably, not all details of equipment are provided nor are instructions for every variation or contingency during installation, operation or maintenance.

For additional information on specific problems or requirements, please contact the manufacturer or your distributor.

Controller versions covered by this manual

This Manual applies to the following controller versions:

ADVC Controller - COMPACT flexVUE Control Cubicle
ADVC Controller - COMPACT setVUE Control Cubicle
ADVC Controller - ULTRA flexVUE Control Cubicle
ADVC Controller - ULTRA setVUE Control Cubicle

Software Identification System

The software loaded into the ADVC is identified by its version which has the form:

AXX-XX.XX

This precisely identifies the software loaded into the program memory on the controller.

In order to obtain effective technical support from the manufacturer or your distributor it is vital to record the software version and to quote these when making your inquiry.

Without this information it is impossible for our customer service department to identify the software and provide correct support.

The software version is shown on the Operator pages. You can find this by navigating to the following point on the ADVC.

 Switchgear Wear7/ General Details

or

 OPERATOR MENU – SWITCHGEAR STATUS – SWITCHGEAR INFO
– App. Ver AXX-XX.XX

Software Version Covered by this manual

The software version and configuration determine the functionality of the controller. This manual applies to Software Version 44.

PRODUCT DOCUMENTATION

- The CD which contains this manual also contains the additional manuals:
- DNP3 communications protocol manual - contains information on the telemetry protocol for communication with remote control systems
- MITS communication protocol manual
- IEC 60870-101 and IEC 60870-104 communications protocols manual
- Loop Automation manual.

An Installation and Maintenance manual is provided for the ADVC in combination with each of the manufacturer's ACRs.

A Service Procedures Manual describes how to perform the customer test procedures and how to remove and replace ADVC modules. The Service Procedures Manual is available from your local distributor or the manufacturer's Service Department.

3 Software Version 44

New Features

Version 44 is the fourth major release of the ADVC Controller software. Features included in version 42, 43 & 44 are shown below.

VERSION 44

Feature	Described in:
Support for setVUE & flexVUE Operator Interface	See " 6 Operator Interfaces (page 6-1)"
Portuguese Language Support	Portuguese Manual

VERSION 43

Feature	Described in:
Support for RL-Series Loadbreak Switch/Sectionalizer	See " 10 Sectionalizer Fault Detection (page 10-1)" for information about Sectionalizers/LBS

VERSION 42

Feature	Described in:
Hayes messaging support for PSTN/GSM modems	See " Hayes compatible modem support (page 13-6)"
Voltage sag and swell measurement	See " Sag and Swell Monitoring (page 12-6)"
Automatic data retrieval	See " 15 Windows Switchgear Operating System (page 15-1)"
DNP3 virtual terminal objects (VTO) support	See " Communications Protocols (page 13-5)"
MITS protocol	See " Communications Protocols (page 13-5)"
Under/Over voltage protection	See " Under and Over Voltage Protection Settings/Specifications (page 9-5)"
SOS Multidrop protocol	See " SOS Multidrop (page 13-8)"
Configurable protocols tool (WSOS5 tool)	See " 15 Windows Switchgear Operating System (page 15-1)"
Curve editor (WSOS5 tool)	See " 15 Windows Switchgear Operating System (page 15-1)"
IEC 60870-101 protocol including balanced mode	See " Communications Protocols (page 13-5)"
IEC 60870-104	See " Communications Protocols (page 13-5)"

4 Ratings and Specifications

DUTY CYCLE

Maximum allowable duty cycle at full short circuit current rating:

- Open-0.5s-Close. (N-Series) Open-0.3s-Close (U Series)
- Open-2s-Close.
- Open-2s-Close.
- Open followed by 300 second recovery time.

CURRENT TRANSFORMERS

There is no access to current transformer connections on the equipment. This data is supplied for information only.



Note that this data is relevant to the base model only.

Ratio	2000:1
Accuracy 10 Amp - 800 Amp	±0.5%
Accuracy 800 Amp - 12500 Amp	±2.5%

GENERAL SPECIFICATIONS

Cubicle material (ULTRA)	316 stainless steel
Cubicle material (COMPACT)	306 Stainless Steel
Cubicle shell sealing	IP 44
Electronic enclosure sealing	IP 65
Wind loading resistance of structure	>160km/hr
Wind loading on door when latched in open position	>60km/hr
Angle of door opening	135°
Operating temperature range	-10°C to 50°C
Extended operating temperature range (optional battery heater required)	-40°C to 50°C
Maximum radiation	1.1kW/m ²
Humidity	0 to 100%
Standard control cable length ^a	7m (23')
 Maximum vertical separation from Nu-Lec ACRs with standard (7m) control cable.	5m (16.4')
Maintenance interval ^b	5 years
Auxiliary supply voltage (LV AC mains supply)	As Ordered +10 -20%
Required auxiliary supply rating	100 VA
Battery (12 Ah batteries are supplied with the battery heater.)	2 x 12V 7.2 Ah, or 2 x 12 V 12 Ah
Battery hold up time from fully charged at 25°C	26 hours with 7 Ah 44 hours with 12 Ah
Battery replacement interval ^b .	5 years
Battery Low Voltage at 0 C ^c	23 V
Battery High Voltage at 0 C ^c .	32 V
Earthing	10mm earth stud
Battery heater power (where fitted)	10 W
Battery heater element life	30,000 hrs ^d
Radio/Modem	
A radio or modem may be fitted by the manufacturer or by the utility, for remote communications. Space, power and data interfaces are provided within the control cubicle.	
Radio/Modem Power Supply Voltage (set by user)	5 - 15 V DC
Radio/Modem Power Supply Continuous Current ^e	3 Amp

Radio/Modem Power Supply Max Current	8 Amp for 30 sec with 10% duty cycle
Radio/Modem Power Supply continuous power	45 W
Radio/Modem Power Supply peak power	120 W for 15 mins at 10% duty cycle
Radio/Modem Space - Side compartment	250 x 70 x 185 mm
Radio/Modem Space - Upper compartment (ULTRA only)	185 x 300 x 215 mm
Radio/Modem Interface	V23, RS232, RS485
Radio/Modem Power Shutdown Time (user configurable)	1 - 1440 min
Shutdown time increment	10 sec
Secondary Injection Ratings	
Continuous secondary current	0.8 Amp
Short time secondary current	12 Amp for 3 sec
Short time current recovery time	60 sec

- a. Other control cable lengths available-4, 11 and 20 metres.
b. Battery replacement interval is influenced by environmental temperature.
c. Temperature compensated at 48 mV/°C.
d. If the heater is required for 6 months at say an average of 10 hours per day, it would be required for approximately 2,000 hours running time per year, thus giving 15 years life.
e. For an external VT, the maximum continuous current drawn from the radio supply should be limited to 0.5 amps.

POWER SYSTEM MEASUREMENTS

HV line measurements on all three phases are made as follows

 Voltage Range (RMS Phase/Earth) N15/N27/U27	2 - 15 kV
 Voltage Range (RMS Phase/Earth) N38	2 - 25 kV
Voltage Resolution	1 V
Voltage Accuracy ^a	2.5% ±25 V
Live Terminal Threshold Voltage range ^b	2 - 15 kV
Live Terminal Threshold Voltage setting resolution ^b	1 V
Live Terminal Threshold Voltage accuracy ^{a b}	5% ±250 V

Ratings and Specifications

Live Terminal Threshold Hysteresis	-20%
Phase Current Range (True RMS)	1.5 - 800 Amp
Earth Current Range (True RMS)	1 - 800 Amp
Current Resolution	1 Amp
Phase Current Accuracy ^a	±1.0% ±1 Amp over range 10 - 800 Amp
Earth Current Accuracy ^a	±1.0% ±1 Amp over range 1 - 800 Amp
 Apparent Power Range	0 - 54 MVA: N-Series 0 - 36 MVA: U-Series
Apparent Power Resolution	1 kVA
Apparent Power Accuracy ^a	±3% over range 20 - 800 Amp
 Real Power Range ^{c d}	-54 - +54 MW: N-Series -36 - +36 MW: U-Series
Real Power Accuracy ^{a c d}	±3% at PF > 0.9
Real Power Resolution	1 kW
 Reactive Power Range ^c	0 - 54 MVAR: N-Series 0 - 36 MVAR: U-Series
Reactive Power Resolution	1 kVAR
Reactive Power Accuracy ^a	±4% at PF = 0.5
Unsigned Power Factor	0.5 - 1.0
Power Factor Resolution	0.01

Ratings and Specifications (Cont)

 Power Factor Accuracy	±0.05
Measurement Filter Time Constant (Step Response)	2 sec
Measurement Update Rate	0.5 sec

- a. Includes accuracy of switchgear current and voltage transformers.
b. Used for Live/Dead display, Live Load Blocking and Loss Of Supply detection.
c. In database for transmission by a protocol.
d. Used to accumulate kWh reading for weekly maximum demand data.

SF6 GAS PRESSURE MEASUREMENT

Gas pressure measurement is only available from an ADV C controlling an N-Series ACR and RL-Series LBS where SF6 is the switch insulating medium.

	N-SERIES	RL-SERIES
Nominal Pressure at 20°C	35 kPa Gauge @ 20°C	105 kPa Gauge @ 25°C
Gas Pressure Display Resolution	1 kPa	1 kPa
Gas Pressure Display Accuracy	±5 kPa	+/- 10kPa
Gas Low Alarm Setting	15 kPa Gauge @ 20°C	65 kPa Gauge @ 25°C
Gas Low Alarm Accuracy	±5 kPa	+/- 10kPa

The ADVC is designed for outdoor pole mounted operation. Both the **ULTRA** and **COMPACT** cubicles are vented and insulated to minimise internal temperature variation and maximise battery life. Cubicle dimensions are given in "**Appendix B - Dimensions** (page **B-1**)"

SEALING & CONDENSATION

All cubicle vents are screened against vermin entry and the cubicle door is sealed with replaceable foam tape.

Complete sealing against water entry under all conditions is not expected e.g. during operation in the rain. Instead, the design is such that if any water does enter, it will drain out of the bottom without affecting the electrical or electronic parts. A rain shield on the PSU will protect MCBs if the door is open during driving rain. The extensive use of stainless steel and other corrosion proof materials ensures that the presence of moisture has no detrimental effects.

Condensation can be expected to form under some atmospheric conditions such as tropical storms. However, condensation will be on metal surfaces where it is of no consequence. The water runs out in the same way as any other water entering the cubicle. Condensation will run out of the bottom or be dried by ventilation and self heating.

All electronic modules are fully sealed to IP65 and are self heating.

AUXILIARY POWER SOURCE

The auxiliary supply is used to maintain charge on the sealed lead-acid batteries that provide stand-by power when auxiliary power is lost. The controller monitors the status of both the auxiliary and battery supplies.

A low power mode is activated when the batteries are nearly exhausted due to loss of the auxiliary supply. This mode minimises power consumption while still maintaining basic functionality.

Controller

The controller consists of three modules. (See **Figure 3.** (page **5-3**) and **Figure 4.** (page **5-3**):

- Power supply unit (PSU)
- Control and protection enclosure (CAPE) with Operating Interface
- Customer Compartment

The ADVC block diagram is given in **Figure 5.** (page **5-4**).

PSU Module

The PSU module supplies power to the CAPE, and controls the supply from external auxiliary sources

The power supply module encloses all 115/230 Vac mains connections. Internally it provides terminals for auxiliary power supply connection. Cable-tie points are provided to secure the auxiliary supply cables. Circuit breakers are used to protect and switch the battery and auxiliary power supplies on/off. A durable cover is used to enclose all the terminations.

CAPE Module

The main module of control electronics is the Control and Protection Enclosure (CAPE).

The CAPE digitises the current transformer (CT) signals and capacitive voltage transformer (CVT) signals from the recloser. These are used to provide a variety of data for the operator.

The CAPE module contains the PCOM board, PSSM board, trip/close capacitors and HMI assembled into a housing that provides protection from the environment, sealing and EMC shielding.

The CAPE performs the following functions:

- Holding & operating the Operator Interface (O.I.)

- Operating the external communications interface to allow monitoring and control from a remote computer or operator over a communications link.
- Switchgear Monitoring and Control
- Controlling WSOS5 over an RS232 link. RS232 Port A is by default configured for WSOS connection. A USB socket is currently located on the CAPE. This port is reserved for future USB connectivity.
- Supply power to all electronic circuits and the customer compartment

PROTECTION AND COMMUNICATION SUBMODULE (PCOM)

The PCOM submodule contains a digital signal processor (DSP) which samples the current and voltage signals from the switchgear and processes them to derive the basic power system information such as current/ voltage/frequency/real power/ reactive power etc. This is then used by the general-purpose processor (GPP) to provide protection and communications functions e.g. over-current protection. It also presents this data to the outside world via various communications protocols.

Results of surge protection tests on the communications interfaces are described below:

RS232 PORT A, B, C and D were all tested in accordance with:

- IEC61000-4-3: Radiated, radio frequency, electromagnetic field immunity test,
- IEC61000-4-4: Electrical fast transient / burst immunity test,
- IEC61000-4-5: Surge immunity test.

All tests passed to Level IV,



Please note: These tests were completed using 20m shielded cables. If shielded cables are not used there is a risk of damage to the ports or the switchgear.

Ports	Protection
V23	Tested to 1 kA, 15 kV, MOVs to ground
RS485	Tested to 1 kA, 15 kV, MOVs to ground
10BaseT	Tested to 1 kA, 15 kV, MOVs to ground

OPERATOR INTERFACE/ DOOR ASSEMBLY

The O.I. is mounted on the CAPE and is accessed by opening the cubicle door. Operators can view switchgear and system data, control and configure the system via the O.I. The O.I. has its own electronic processing and driver circuit, and operator control panel with LCD, membrane keyboard and status lamps.

WSOS5 Interface

To use WSOS5 to upload or download data, connect your PC serial port to Port A located above the operator interface. Use an RS232, DB9 female to DB9 female, Crossover (also known as Null Modem).

ACCESSORY COMPARTMENT(S)

The **COMPACT** cubicle compartment is fitted with an accessory tray that facilitates the mounting of your equipment e.g. a radio or modem.

The **ULTRA** cubicle has one standard, and one optional to allow for more equipment. **Figure 3.** (page 5-3) and **Figure 4.** (page 5-3). The compartments have a terminal block for the radio power supply and power for accessories such as an IOEX.

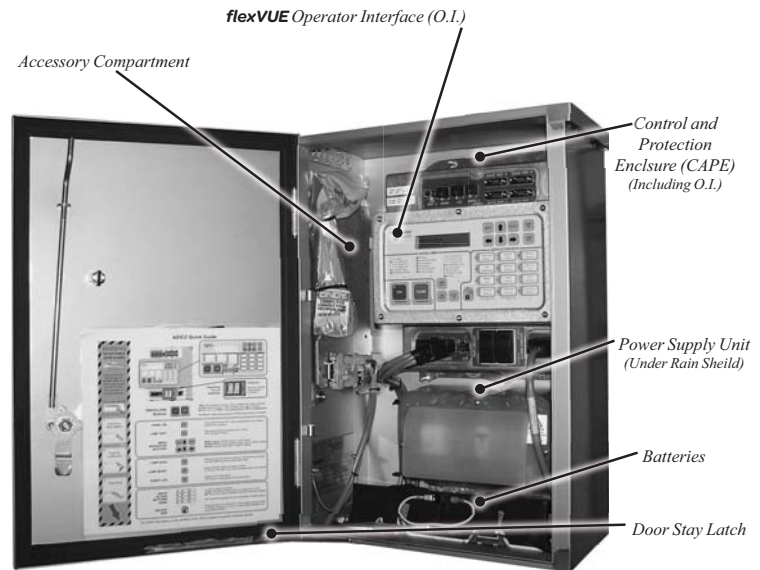


Figure 3. **COMPACT** ADV C (with flexVUE O.I.)

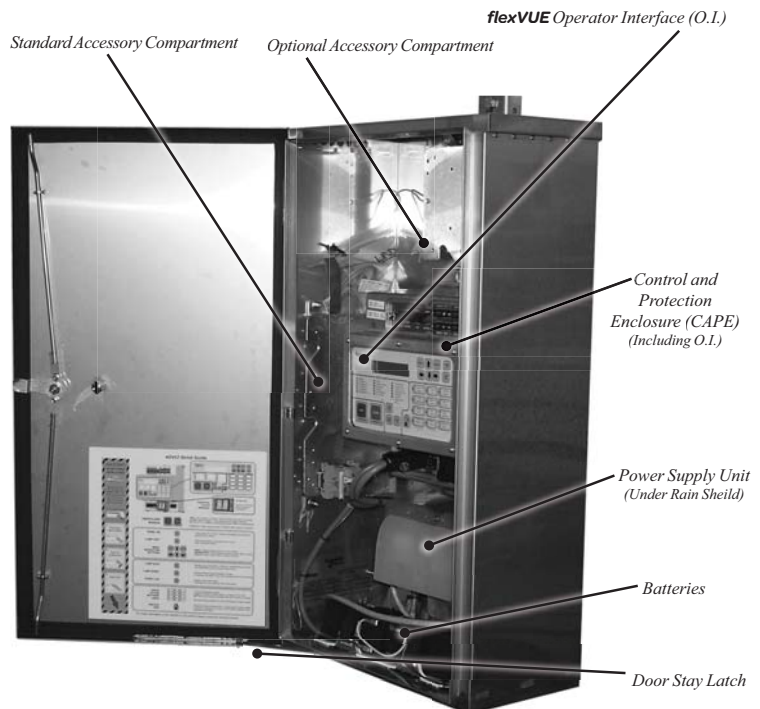


Figure 4. **ULTRA** ADV C (with flexVUE O.I.)

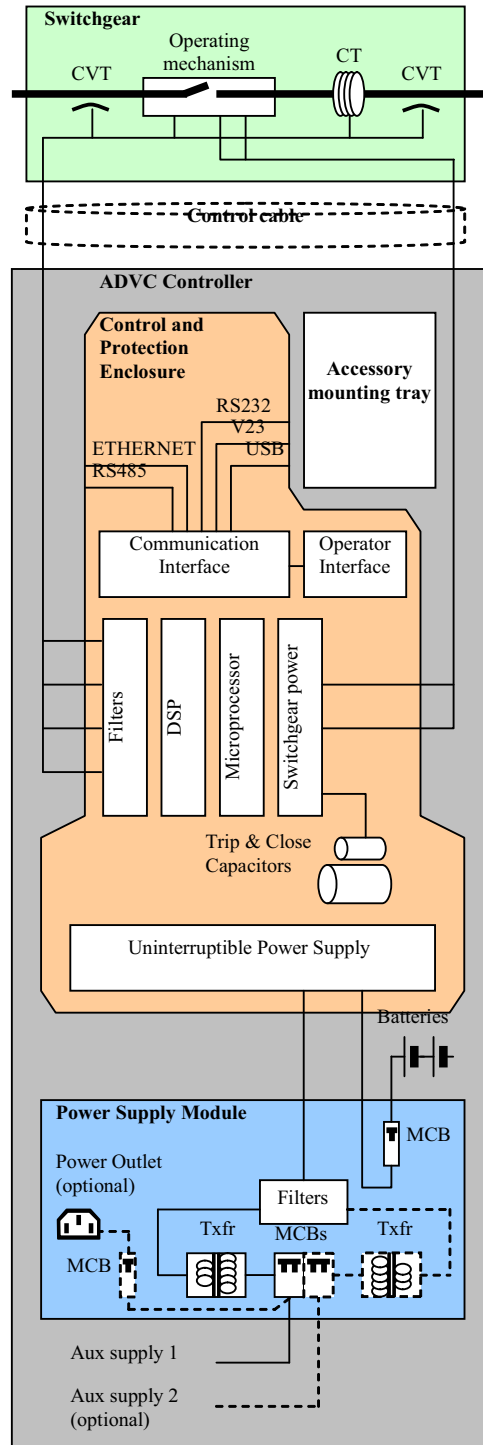


Figure 5. ADVC Block Diagram

6 Operator Interfaces

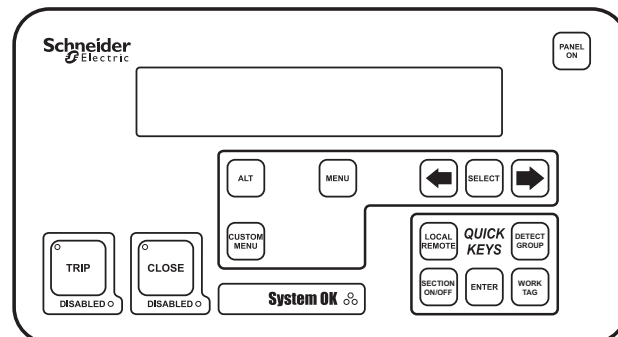
The ADVC can be remote controlled via modems or other communications devices, controlled using a laptop computer connected directly via serial or USB connections to the ADVC, or by the Operator Interface (O.I.). The O.I. offers full functionality to change settings, trip and close the switchgear or display current values or past events related to the switchgears function.

The Operator Interface (O.I.) is mounted on the CAPE inside the ADVC Controller and accessed by opening the cubicle door. The O.I. consists of a liquid crystal display (LCD) and key pad and light emitting diodes (lamps). Together these hardware features provide a user interface to monitor and control the ACR.

Two styles provide different functionality depending on the users requirements. These two styles are as follows:

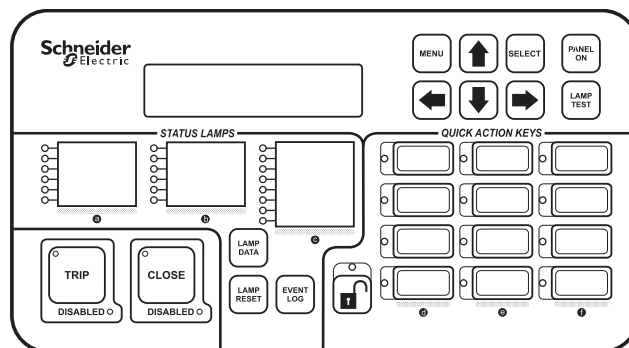
setVUE

A traditional O.I. that provides a 4 × 40 character LCD and simple navigation with four user configurable quick keys.



flexVUE

This O.I. provides the user with 20 indicator lights and 12 Quick Action Keys (Each with configurable lamps) that are totally configurable by the user through WSOS 5. This provides the user with instant feedback about the switchgear, and minimises the need to navigate through layers of menu structure.



Both the **setVUE** and **flexVUE** O.I.'s, and their operation are described in detail on the following pages.

The O.I. turns ON automatically when the door is opened and OFF when it is closed. The O.I. also turns OFF automatically if no keys are pressed for 10 minutes. Pressing the PANEL ON key will reactivate the panel.



This manual contains examples of display interface screens. In general, the language chosen for these examples is International English. In some cases, screen text will differ if the configured language is English (USA).

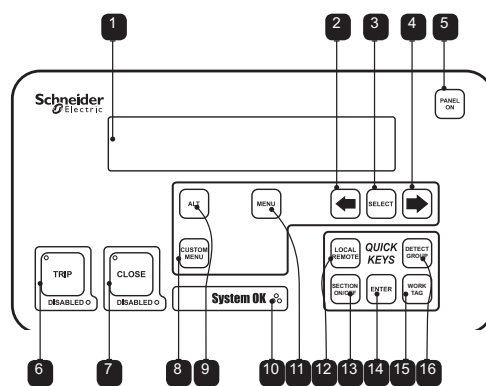


Figure 6. setVUE O.I.

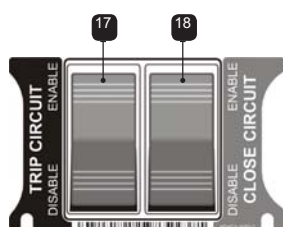


Figure 7. Trip/Close Enable Switches
Located below the O.I.

setVUE PANEL

#	Item	Description
1	Display	Back-lit LCD, 4 line with 40 characters per line.
2	LEFT scroll key	Select the previous screen in a display group or, if a setting is selected, decrease its value
3	SELECT Key	Press to SELECT a data field/setting so that it can be changed.
4	RIGHT scroll key	Select the next screen in a display group or, if a setting is selected, increase its value.
5	PANEL ON key	Turns the O.I. on. The O.I. will turn on when the cubicle door is opened.
6	Trip key	Generates a Trip request to the CAPE when the panel is active. A lamp is embedded in the key to indicate its operation. Another lamp is used to indicate whether this keys operation is DISABLED.
7	Close key	Generates a Close request to the CAPE when the panel is active. A lamp is embedded in the key to indicate its operation. Another lamp is used to indicate whether this keys operation is DISABLED.
8	Custom Menu key	Gives access to the custom menu which was configured using WSOS5. The custom menu is configured to provide a regular, updated data display by allowing a cycle of up to 12 screens. See " Custom Menu (page 16-7)"
9	ALT	The alternative function key gives access to an alternative Event Log display.
10	System OK	The 3 System OK lamps flash while the controller is operating normally.
11	MENU scroll key	Displays the first page of the next group. Pressing the MENU key after changing a setting causes the setting change to take effect.
12	Configurable Quick Key	Default linkage is to LOCAL/REMOTE. See " Quick Keys (page 6-5)"
13	Configurable Quick Key	Default linkage is to AUTO ON/OFF. See " Quick Keys (page 6-5)"
14	ENTER key	Press this key in order to commit a setting change that has been made. (Unlike the adjacent Quick Keys, the ENTER key is not configurable.)
15	Configurable Quick Key	Default linkage is to PROT. GROUP See " Quick Keys (page 6-5)"
16	Configurable Quick Key	Default linkage is to EARTH PROT. See " Quick Keys (page 6-5)"
17	Enable/ Disable TRIP switch	Disables ALL Trip Operations. When the switch is in the Disable position the trip circuit in the switchgear is electrically disconnected from the control electronics. Thus the switch provides a physical isolation point for the control circuitry. The switchgear cannot be opened, an audible alarm in the panel will sound and the DISABLED LED in the TRIP key will flash. The TRIP key operates normally when the switch is in the Enable position. <i>This switch also prevents a close operation, so that the switchgear cannot be carrying load without the ability to trip.</i>
18	Enable/ Disable CLOSE switch	Disables ALL Close Operations. When the switch is in the Disable position the close circuit in the switchgear is electrically disconnected from the control electronics. Thus the switch provides a physical isolation point for the control circuitry. The switchgear cannot be closed and an audible alarm in the panel will sound and the DISABLED LED in the CLOSE key will flash. The CLOSE key operates normally when the switch is in the Enable position.

setVUE Panel Operator Interface (cont)

DISPLAY GROUPS

The **setVUE** displays are organized into logical groups called Display Groups. Within each group is a menu of pages and some pages have sub-pages.

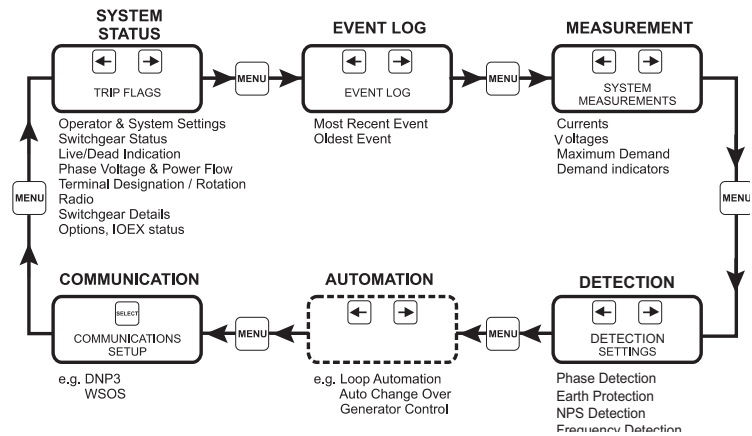


Figure 8. setVUE Display Group Navigation

Navigating the Menu Structure

Refer to the diagram inside the controller door or to the Installation and Maintenance Manual for details of Navigation within groups.

A custom menu can also be configured, refer to “**Custom Menu** (page 16-7)”. To use the custom menu, press the CUSTOM MENU button.

A detailed Menu Structure for the **setVUE** O.I. can be found in “**Appendix R setVUE Menu Structure** (page R-1)”

DISPLAY SCREEN LAYOUT

The display area consists of four lines, each forty characters long. See Figure 9

The top line of the display is the page title. To the right of the title is a letter, indicating the display group to which the page belongs:

Code	Display Group
S	System Status Display Group
P	Protection Display Group
M	Measurement Display Group
A	Automation Display Group
C	Communications Setup
E	Event Log

The next three lines are the data on display. Most displays have six data fields.

A field may contain either:

- a setting, which can be changed - ON/OFF is the most common; or
- a status.

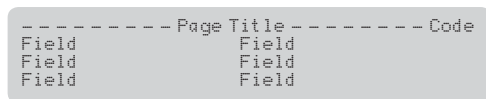


Figure 9. setVUE Display Screen Layout



Please Note: Screen sizes between **flexVUE** and **setVUE** are not to scale in this manual.

The character size is approximately the same but the **flexVUE** is shown larger in this manual for readability.



CHANGING SETTINGS

Three types of settings can be changed:

- Operator settings
- Password protected settings
- Protection settings

Operator Settings

Find the display page containing the setting to be changed:

- 1: Press the MENU key to display the group you require.
- 2: Communications Group (only) is divided into subgroups for different protocols. Press SELECT to display the subgroup you require.
- 3: Press  to display the page you require.
- 4: Press SELECT to highlight the setting. A highlighted setting "blinks". Alternatively, if a QUICK KEY is linked to the setting, you can use it to go directly to the relevant display page where you will find the highlighted setting. See "*Quick Keys* (page 6-5)".
- 5: Once you have selected the setting to be changed, use  or  to change its setting.
- 6: Press ENTER to activate the new setting.

Password Protected Settings

Some settings are password protected. You will be prompted for a password before you can change the setting. To enter the password:

- 1: Press either of the  /  keys until the first character of the password is displayed.
- 2: Press the SELECT key.
- 3: Repeat Steps 1 and 2 until the password is complete.
- 4: Press Enter.

While the operator panel is ON you will not be required to enter the password again.

The default factory password is **AAAA** but you can change it using the Windows Switchgear Operator System (WSOS5) program. The factory password does not have to be remembered - the controller prompts you for it automatically.

Protection Settings

Protection settings are password protected. To change a protection setting, follow the steps detailed in the Operator Settings section above but, in addition, enter the password when prompted. When you have completed the setting change by pressing ENTER, the following message will flash at the top of the screen:

Active Protection Setting has changed.

At this point, the changed setting will be displayed but not in service. If further setting changes are required, they can be made now.

When you have completed making all the setting changes you require, press ENTER. The following text will be displayed:

CHANGED ACTIVE PROTECTION SETTING [A]
The changed active PROTECTION SETTINGS are now in service.
Select the MENU or ENTER key to continue.

The changed settings are now in service. Press MENU or ENTER to return to the normal menu display.

QUICK KEYS

The operator settings that you will frequently change can each be linked to a QUICK KEY. You use a QUICK KEY for instant display and selection of the linked setting which, otherwise, you would have to find by navigation.

You can link operator settings to individual Quick Keys using the Operator Interface or WSOS5.

A QUICK Key can be set to Blank, if it is not required.

Otherwise, any one of the settings tabled at left can be linked to one of the four Quick Keys.

How to configure the Quick keys is described in the chapter on customising the ADV C Controller. Please refer to “**16 ADV C Customisation** (page **16-1**)”.

Setting	Default status
LOCAL/Remote / Hit & Run	Default setting, upper left key
Loop Auto ON/OFF	Configurable
Prot Group	Default setting, lower right key
Reset Flags	Configurable
Work Tag ON/OFF	Configurable
Auto ON/OFF Protection OFF	Default setting, lower left key
Cold Load ON/OFF	Configurable
Earth Prot	Default setting, upper right key
Live Block	Configurable
Negative Phase Sequence Protection OFF/ON/Alarm	Configurable
Detection Group	Configurable
Earth Detection	Configurable
Section ON/OFF	Configurable

flexVUE PANEL

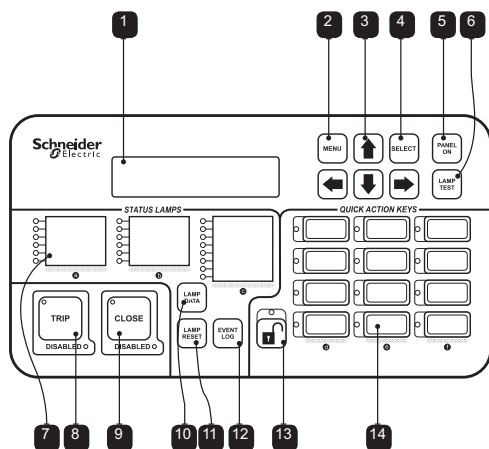


Figure 10. flexVUE O.I.

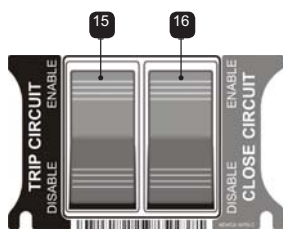


Figure 11. Trip/Close Enable Switches
Located below the O.I.

#	Item	Description
1	Display	Back-Lit LCD. 2 × 20 Character
2	MENU Key	When a computer is unavailable, pressing MENU allows the user to enter the configuration menu from where it is possible to navigate the LCD menu structure, select fields and edit settings. Navigating these pages is described separately.
3	Arrow/Navigation Keys	The ARROW buttons are used to browse between display groups, fields and change values.
4	SELECT Key	SELECT is used to select fields or values when changes are made.
5	PANEL ON Key	PANEL ON: turns the panel on or off. An optional door switch is available to turn the panel on when an operator opens the door and off when the door is closed. If the controller is fitted with this option the button can be used to turn the panel off/on while the door is open. Closing the door turns the panel off.
6	LAMP TEST Key	LAMP TEST: tests all lamps on the panel. The purpose is to alert the user of any lamps or colours that may not be working correctly. The test simultaneously cycles all lamps through Red, Orange and Green.
7	Indicator lamps	These lamps are used to provide instant indication of the controller and switchgear status. Depending on the configuration, the lamps can be RED, GREEN or ORANGE and ON, OFF or FLASHING. The multiple colours allow for grouping of similar functions e.g. red for protection, orange for voltage and green for system health. For example: ● LOCKOUT ● A - PHASE O/C ● B - PHASE O/C ● C - PHASE O/C ● GROUND FAULT ● SENSITIVE G/F ● A SOURCE LIVE ● B SOURCE LIVE ● C SOURCE LIVE ● MECH LOCK ● CONTROL OK ● AC POWER ● BATTERY PWR ● ALARM The configuration of the Status Lamps can be changed within WSOS Version 5.
8	TRIP Key	Trips the switchgear to Lockout and the green lamp located inside the button indicates the open state of the recloser.
9	CLOSE Key	Closes the switchgear and the red lamp located inside the button indicates the close state.
10	LAMP DATA Key	LAMP DATA is a future feature that will provide the operator with additional data specific to each status lamp. The feature is currently under development.
11	LAMP RESET Key	Resets the Status Lamps. Lamps requiring further attention from the operator remain lit. Note that some of the status lamps such as "controller power" and "terminal live" are continuously updated and therefore not affected by the reset command.
12	EVENT LOG Key	Displays the Switchgear and Controller Event Log on the LCD display. Older events can be viewed by pressing the UP arrow key.

13	Quick Action Key Unlock	To use the Quick Action Keys, an operator must first press the Unlock key. The lamp above the unlock key will remain lit while the quick action keys are active. To deactivate the quick action keys an operator can press the unlock key again. The lamp will turn off. Alternatively the Quick Action Keys will be deactivated automatically a short configurable delay after the last Quick Action Key was selected.
14	Quick Action Keys QAK	Quick Action Keys allow the user to activate/deactivate functions directly from the interface without having to use the menu. The status of the function is indicated by the lamp next to the button. The lamp can be configured to be red, green or orange in colour and flashing. Before using the Quick Action Keys it is necessary to unlock the keys using the unlock button described above. (Configuration) Pressing a Quick Action Key will apply that action without any further confirmation and the lamp next to the key will indicate the new status.
15	Enable/ Disable TRIP switch	Disables the Trip key. When the switch is in the Disable position the trip coil in the recloser is electrically disconnected from the control electronics. Thus the switch provides a physical isolation point for the control circuitry. The recloser cannot be opened, and an audible alarm in the panel will sound and the DISABLED lamp in the TRIP key will flash. The TRIP key operates normally when the switch is in the Enable position.
16	Enable/ Disable CLOSE switch	Disables the Close key. When the switch is in the Disable position the close coil in the recloser is electrically disconnected from the control electronics. Thus the switch provides a physical isolation point for the control circuitry. The recloser cannot be closed and an audible alarm in the panel will sound and the DISABLED lamp in the CLOSE key will flash. The CLOSE key operates normally when the switch is in the Enable position.

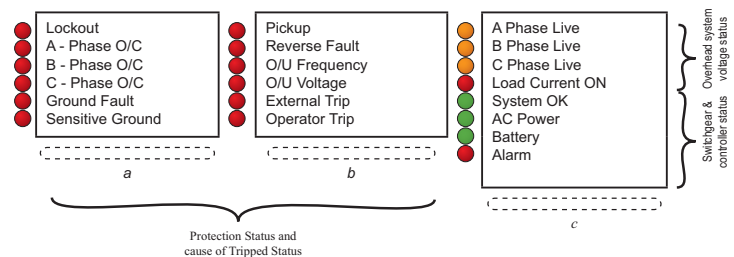
DEFAULT CONFIGURATION

The Status Lamps and the Quick Action Keys are programed in the factory to a default configuration. This can be changed to suit the needs of the user through Windows Switchgear Operating System (WSOS5).

Status Lamps

These lamps are used to indicate the controller and switchgear status. The default configuration is shown below. Each lamp indicates the state of the function described next to it. When a state is active, the lamp is lit.

For example, when the recloser is in Lockout the lamp next to "Lockout" will be on. Conversely if the lamp is off, the recloser is not in a lockout state.



It is possible that more than one lamp will be lit at a given time.



Example, when a recloser tripped to lockout due to an overcurrent fault on Phase A, both "Lockout" and "A-Phase O/C" lamps will be lit.

The table below describes the default function of each lamp.

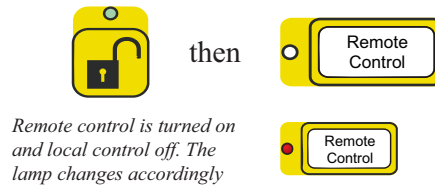
LED #	Colour	Description	Possible Causes
Column A			
A-1	Red	Lockout	Recloser has tripped to lockout due to a protection sequence or operator command. Automatic close operations are not possible and the operator has to close the recloser using the control panel or a remote command.
A-2	Red	A - Phase O/C	The most recent trip of the recloser was caused by an overcurrent event due to a fault on the relevant network phase/s.
A-3	Red	B - Phase O/C	
A-4	Red	C - Phase O/C	
A-5	Red	Ground Fault	A ground fault has caused the recloser to trip.
A-6	Red	Sensitive Ground	The recloser has tripped due to a sensitive ground fault event.
Column B			
B-1	Red	Pickup	One of the protection elements detected a value outside the preferred range for example when the phase current exceeds the trip setting value.
B-2	Red	Reverse Fault	Protection has operated in the reverse direction due to power flow from the load side to the source side of the recloser.
B-3	Red	O/U Frequency	An over or under frequency event has caused the recloser to trip.
B-4	Red	O/U Voltage	An over or under voltage event has caused the recloser to trip.
B-5	Red	External Trip	An external device has instructed the controller to trip the switchgear.
B-6	Red	Operator	A local or remote operator has tripped the recloser.
Column C			
C-1	Orange	A Phase Live	The source or load side bushing of the relevant phases are live.
C-2	Orange	B Phase Live	
C-3	Orange	C Phase Live	
C-4	Red	Load Current On	Red when a load current greater than 2A is flowing through the switchgear.
C-5	Green	System OK	The controller is functioning normally. Maintenance may be required when the lamp is flashing red. Consult the event log.
C-6	Green	AC Power	Flashing Red lamp when Auxiliary is off.
C-7	Green	Battery	Flashing Red lamp when Battery is off or test failed.
C-8	Red	Alarm	Flashing Red lamp when Trip or Close circuits are isolated, contact life is low or the switchgear is locked.

Quick Action Keys

The quick action keys allow the operator to select functions directly from the panel. Selecting a Quick Action will apply that action without any additional confirmation and the lamp next to the key will indicate when the action is active.

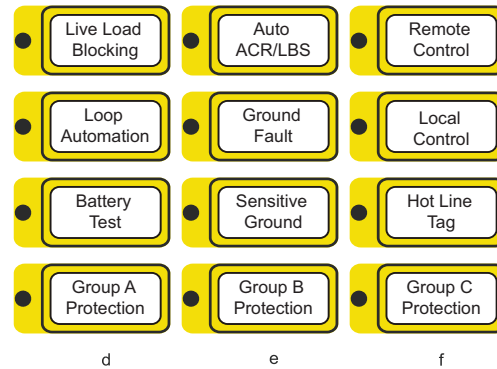
Before selecting a quick action the operator must first unlock the Quick Action Keys. This is done by pressing the “unlock” key.

Example, to activate supervisory control (Remote Control) an operator should press the following keys:



It is possible to press a sequence of Quick Action Keys while the unlock lamp is lit. The keys will be locked automatically after a short delay once the last key press or alternatively when the unlock key is pressed a second time.

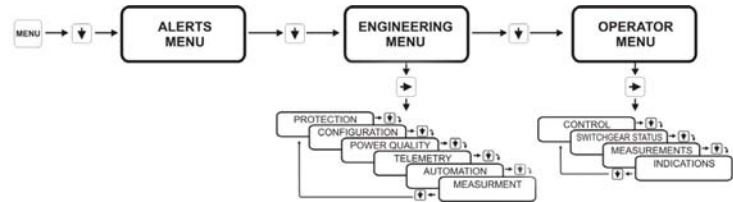
This controller is programmed with a default Quick Action Key (QAK) configuration that provides access to frequently used actions. The default configuration is shown on the following page.



QAK #	Colour	Description	Action
Column D			
D-1	Red	Live Load Blocking	The key toggles the Live Load Blocking feature ON/OFF. A red lamp indicator shows when the function is ON. More information on this function is available on " Live Load Blocking (page 9-12)"
D-2	Red	Loop Automation	Turns the Loop Automation feature ON/OFF
D-3	Red	Battery Test	This QAK performs a Battery Test and the result is displayed in the Event Log. The battery test function is described in detail on page " Battery Test Operation (page 18-1)"
D-4	Red	Group A Protection	Activates the settings configured in Protection Group A.
Column E			
E-1	Red	Auto ACR/LBS	The key toggles the Auto Reclose (for reclosers) or the Sectionalise Auto (for sectionalisers) feature ON/OFF. A red lamp indicator shows when Auto Reclose/Sectionalise is ON.
E-2	Red	Ground Fault	Turns (Ground) Fault protection ON/OFF.
E-3	Red	Sensitive Ground	Turns Sensitive Earth (Ground) Fault protection ON/OFF.
E-4	Red	Group B Protection	Activates protection settings configured in Protection Group B.
Column F			
F-1	Red	Remote Control	The key turns REMOTE control ON and LOCAL control OFF. A red lamp indicator shows when the controller is in Remote mode. Local/Remote Users are described on " Definition of Local or Remote User (page 8-1)"
F-2	Red	Local Control	The key turns LOCAL control ON and REMOTE control OFF. A red lamp indicator shows when the controller is in Local mode.
F-3	Red	Hot Line Tag	Hot Line Tag (Work Tag) is applied using this QAK. Work Tagging ensures that closing cannot take place and also activates the Work Tag protection settings. " Work Tag (page 8-4)"
F-4	Red	Group C Protection	Activates protection settings configured in Protection Group C.

DISPLAY GROUPS

The O.I. displays are organized into three logical groups. Within each group is a menu of pages and those pages have many various sub-menus. \



Navigating the Menu Structure

Refer to the diagram inside the controller door or to the Installation and Maintenance Manual for details of Navigation withing groups.

A detailed Menu Structure for the **flexVUE** O.I. can be found in "**Appendix Q flexVUE Menu Structure** (page Q-1)"

DISPLAY SCREEN LAYOUT

The display area consists of two lines, each twenty characters long. See Figure 12

The top line of the display is the page title. The top line of the display shows the current menu position and the second line shows the lists the options available one option at a time. An operator uses the UP and DOWN arrows to scroll through the list of options. The RIGHT arrow will progress to the next level of the option shown on the second line of the display. Use the LEFT arrow to go back one level.

When an operator is editing a setting, the top line of the display shows a few basic instructions and the bottom line shows the setting value.

PAGE TITLE
Options

Figure 12. flexVUE O.I. Display Screen



Please Note: Screen sizes between **flexVUE** and **setVUE** are not to scale in this manual.

The character size is approximately the same but the **flexVUE** is shown larger in this manual for readability.

↕EDIT, ←ESC, or SELECT
<<set ting to change>>

CHANGING SETTINGS

Three types of settings can be changed:

- Operator Settings
- Password protected settings
- Protection settings

Operator Settings

Find the display page containing the setting to be changed:

- 1: Press the **MENU** key to enter the Menu structure
- 2: Press the **↓** arrow, then the **→** arrow to enter the **Operator Menu**.
- 3: Use the **↑** / **↓** arrow keys to navigate to the setting to be changed.
- 4: Press the **SELECT** key
- 5: Use the **↑** / **↓** arrow keys to change the setting
- 6: Press the **SELECT** key to accept the change; or
- 6a: Press the **←** arrow to escape and leave the setting unchanged.

Alternatively, if a **QUICK ACTION KEY** operates the setting you wish to change:

- 1: Press the **QAK UNLOCK**
- 2: Press the required Quick Action Key within 10 seconds (Configurable)

Actions are executed without any confirmation via the arrow or select keys. The lamp indicates the new state.



The menu structure of the **flexVUE** is circular. When you navigate past the end of a menu group the ADVC Controller will *beep* and return you to the top of the menu list.

Similarly if you navigate up past the beginning the ADVC Controller it will *beep* and take you to the bottom of the menu list.



Password Protected Settings

Some settings are password protected. You will be prompted for a password before you can change the setting. To enter the password:

- 1: Press the  /  arrows until you find the required character for the password.
- 2: Press the  arrow key
- 3: Repeat steps 1 & 2 until the password is complete.
- 4: Press SELECT to enter the password

While the Operator Panel remains ON you will not be required to enter the password again.

The default factory password is **AAAA** but you can change it using Windows Switchgear Operator System (WSOS5) software. The factory password does not need to be remembered - the controller prompts you for it automatically.

ALERTS MENU

The flexVUE panel provides the user with a specific location to deal with alerts from the controller. The ALERTS menu is found as part of the MAIN MENU on the O.I.

You can view these Alerts in the same way you would view any other menu options

Alerts will be split into 2 categories, Critical and Normal.

Normal Alerts

All Normal alerts will go into the Alerts menu. The activation of a Normal Alert will cause the Title line of the current display to show:

xx Alerts Active

This will alternate with the current display title at a sufficient rate that the current display is easily readable so that panel usage and field editing can easily continue. xx is the number of Alerts that are present at the time.

The displayed number of Normal Alerts may change from one flash to the next if a new alert is added or an old one is removed.

The Title of the Alert Menu will contain the number of Alerts that are present. This will be shown as

ALERT MENU X/Y

where **X** is the alert currently displayed and **Y** is the total number of Alerts present.

A Normal Alert message will generally be longer than 20 characters and will automatically scroll to allow viewing of the complete message. If a Normal Alert is present a Beep will occur at a fixed time interval.

All buttons will function normally whilst a Normal Alert is present.

Critical Alerts:

A Critical Alert will completely subvert the operation of the LCD display regardless of what is being displayed. There will be no way to remove the Critical Alert from the display whilst it is active.

If a Critical Alert is present a Beep will occur at a fixed time interval.

All buttons with the exception of the navigation buttons (<-, >-, ^, v, Menu, Select, Lamp Data, Eventlog) will operate normally whilst a Critical Alert is present.

ACTIVATING Protection Settings

flexVUE Panel (cont)

When settings are changed in the Active protection group (via the **flexVUE** O.I.) those new settings will be saved but will not be put into service until they are made **ACTIVE**.

When changing Active Protection Group settings, once the first setting is changed the following screen will appear: (*scrolling*)

```
Settings Changed
SELECT to activate, ←↕→ cont change
```

This message will be displayed if:

- Settings are changed within the ACTIVE PROTECTION GROUP
- The current setting is the first one to be changed.
- Before changing this setting - all the current settings were ACTIVE in service

Once this message is displayed there are 3 options.

1: NO ACTION:

The new setting will automatically go in service if the operator ignores the above message, turns the operator interface off or the interface turns off automatically.

2: PRESS SELECT:

If the operator presses the **SELECT** key, the new setting is put in service. The operator can continue to browse the menu. With all the current settings in active service, if the operator makes another setting change the above message will be prompted when the first of the *new* settings is saved.

3: PRESS THE ARROWS:

This will allow the operator to browse settings and allow them to be changed.

Exiting the Protection Menu

The operator will not be prompted to **ACTIVATE** the settings again until they try to exit the **PROTECTION MENU**, when the following screen will appear:

```
Settings Changed
Activate? Y/N →
```

The operator has to press the **RIGHT ARROW** key. That will display the following:

```
↕EDIT, ←ESC or SELECT
ACTIVATE? Yes
```



```
↕EDIT, ←ESC or SELECT
ACTIVATE? No
```

When the operator scrolls to **YES** and presses **SELECT**, the settings are put in service. If the operator selects **NO** and presses the **SELECT** key, the following message is displayed: (*scrolling*)

```
←↕→ Continue
Settings activate on panel shutdown
```

Re-Entering the Protection Menu

If the operator exits the Protection Menu without activating the saved settings, when the Protection Menu is re-entered at a later point in time, providing the settings haven't been put into service by a panel shutdown, the process will run through the same activation sequence as shown in "**Exiting the Protection Menu** (page 6-13)".

7 Event Log

INTRODUCTION

The ADVC maintains a log of up to 30,000 events that reflect changes to the status of the switchgear, control electronics, and ADVC logic. The log also records setting changes.

The events can be seen via the Event Log O.I. display group. The event log display will update automatically with new events. The most recent event appears on the bottom line of the screen and older events are scrolled upwards. When the event log is full, newest events replace oldest events.

All events are date and time stamped to a 10ms resolution and displayed in the order that they occurred. The source of each event is also recorded.

It is possible to apply event category filters when viewing events.

WSOS5 software can also be used to read and display the event log. In addition to O.I.-like time stamp, source identification and filter category features, it also has text searches and go to a particular date/time. The event log can be saved as a text file or as a csv file. Refer to the WSOS5 help file for more information.

A complete list of events is given at “**Appendix N List of Events** (page N-1)”.

READING THE EVENT LOG

On the **setVUE** panel, the event log display group is one of the main display groups shown in “**Display Groups** (page 6-3)”.

On the **flexVUE** panel, the event log is found via an dedicated key on the O.I.

The Event Log is navigated slightly differently depending on which O.I. is installed. A navigation diagram for the **setVUE** O.I. is shown in **Figure 13.** (page 7-1) and for the **flexVUE** O.I. in **Figure 14.** (page 7-1).

The following table indicates the differences between setVUE and flexVUE event log navigation

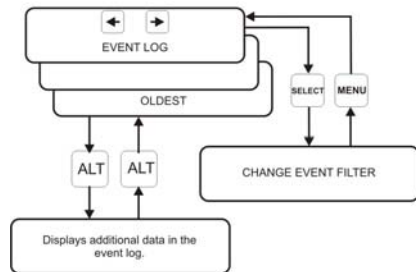


Figure 13. setVUE Navigation Diagram

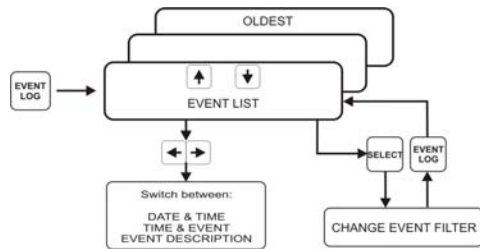


Figure 14. flexVUE Navigation Diagram

Description	setVUE	flexVUE
Number of Events shown on screen	4	2
Key to Scroll to OLDER events	←	↑
Key to Scroll to NEWER events	→	↓
Show the CHANGE EVENT FILTER screen	SELECT	SELECT
Return to EVENT LOG from FILTER screen	MENU	EVENT LOG
View additional information about event (if available)	ALT	EVENT LOG
Switch between DATE/TIME, TIME/EVENT & EVENT DESCRIPTION	-	← & →

TYPICAL EVENT LOG TRIP SEQUENCE DISPLAY

The following event log is an example of a phase trip sequence with two trips to lockout.

-----EVENTLOG -----E	Comment
08/06/05 09:27:52.64 Lockout	Lockout
08/06/05 09:27:52.63 C 305 Amp	C phase current at trip
08/06/05 09:27:52.63 B 302 Amp	B phase current at trip
08/06/05 09:27:52.63 A 303 Amp	A phase current at trip
08/06/05 09:27:52.36 Prot Trip 2	2nd trip after 17.26s
08/06/05 09:27:52.36 Phase Prot Trip	Phase element trip
08/06/05 09:27:52.36 Prot Group AActive	Protection group A
08/06/05 09:27:35.10 Pickup	Pickup again
08/06/05 09:27:33.70 Automatic Reclose	1st reclose
08/06/05 09:27:33.69 C 302 Amp	C phase current at trip
08/06/05 09:27:33.69 B 300 Amp	B phase current at trip
08/06/05 09:27:33.69 A 301 Amp	A phase current at trip
08/06/05 09:27:33.42 Prot Trip 1	1st trip after 17.27s
08/06/05 09:27:33.42 Phase Prot Trip	Phase element trip
08/06/05 09:27:33.42 Prot Group AActive	Protection group A
08/06/05 09:27:16.15 Pickup	Start of fault (pick up)

The following event log is an example of a sequence reset.

-----EVENT LOG -----E	Comment
09/01/05 10:39:22.50 Sequence Reset	Sequence reset after 10s
09/01/05 10:39:12.50 Automatic Reclose	1st reclose
09/01/05 10:39:12.49 C Max 301 Amp	C phase current at trip
09/01/05 10:39:12.49 B Max 302 Amp	B phase current at trip
09/01/05 10:39:12.49 A Max 300 Amp	A phase current at trip
09/01/05 10:39:12.22 Prot Trip 1	1st trip after 17.27s
09/01/05 10:39:12.22 Phase Prot Trip	Phase element trip
09/01/05 10:39:12.22 Prot Group AActive	Protection group A
09/01/05 10:38:54.95 Pickup	Start of fault (pick up)

Event Log (cont)



Please Note: Screen sizes between *flexVUE* and *setVUE* are not to scale in this manual.

The character size is approximately the same but the *flexVUE* is shown larger in this manual for readability.

Display of Events



The difference in the display on the *setVUE* and *flexVUE* are shown in the following example. Consider the following events, as shown on the *setVUE*:

```
09/01/05 10:39:12.49 B Max 302 Amp
09/01/05 10:39:12.49 C Max 301 Amp
09/01/05 10:39:12.50 Automatic Reclose
09/01/05 10:39:22.50 Sequence Reset
```



The *flexVUE*, by default, would display the bottom two lines (the most recent) first. See below:

```
10:39 Automatic Recl
10:39 Sequence Reset
```

From this screen, a complete TIME or EVENT DESCRIPTION is available by pressing the ◀ or ▶ keys respectively:

For the TIME press ◀:

```
09/01/05 10:39:12.50
09/01/05 10:39:22.50
```

For the EVENT DESCRIPTION press ▶:

```
Automatic Reclose
Sequence Reset
```

In this example, pressing the ↑ twice would scroll to the next two events.

```
10:39 B Max 302 Amp
10:39 C Max 301 Amp
```

Setting Change Events

A settings change can come from a variety of sources - WSOS5, Operator Interface, SCADA protocol, and IOEX. The controller includes in its log information regarding the source of each setting change.

If the **ALT** key (*setVUE*) or **EVENT LOG** key (*flexVUE*) is pressed whilst the event log is on the display then the date and time details are replaced with extra information that includes the setting source and, if applicable, the protection group, curve, and trip number. Pressing the **ALT** (*setVUE*) or **EVENT LOG** (*flexVUE*) key again will redisplay the date and time information.

The identification codes for sources are:

Identifier	Settings change source
WSOS	WSOS5 change
O.I.	Operator Interface change
PTCL	SCADA protocol change
IOEX	IOEX change

As it is possible for multiple WSOS5 applications to be simultaneously connected to the controller via Ethernet, a source identification of "WSOS" can be insufficient information. For WSOS5 over Ethernet connections the first four letters of the PC's login name are logged. The usage of "WSOS" is therefore restricted to serial port point to point communication links only.



For example, a **setVUE** event log display may look like this:

```
08/06/06 11:05:50.25 Very Inv IEC255  
08/06/06 11:07:15.66 Parity EVEN  
08/06/06 11:09:23.03 Work Tag Applied  
08/06/06 11:10:35.19 Load Supply ON
```

becomes:

```
WSOS Phase Trip 2 D Very Inv IEC255  
OCP RS232-B Parity EVEN  
PTCL Work Tag Applied  
Load Supply ON
```

when you press the **ALT** key.

In the above example it can be seen that:

- WSOS5 has been used to set a Very Inverse IEC255 curve for phase trip 2, group D
- the O.I. has been used to set the controller's RS-232 Port B communications parity to EVEN
- the work tag has been applied via a SCADA protocol communications link
- the controller has detected restoration of load supply. There is no setting change source.



The **flexVUE** screen might look like this:

```
11:05 Very Inv IEC255  
11:07 Parity EVEN
```

pressing **EVENT LOG** would change it to:

```
WSOS Phase Trip 2 D  
OCP RS232-B
```

Dual Events

Sometimes an event is reported as two related lines in the event log. The second event expands upon the reason for the first. Dual events can be recognized as they have the same time stamp.

For example:



```
08/06/06 16:35:40.22 Wrong Mode  
08/06/06 16:35:40.22 Operation Denied  
08/06/06 16:39:58.17 Quick Key 1 Changed  
08/06/06 16:39:58.17 Work Tag
```

In the above example it can be seen

- At 16:35:40.22 A close operation was denied because the switchgear was in the wrong mode (remote or local).
- At 16:39:58.17 Quick Key 1 was remapped to be Work Tag Applied/ OFF

Event Log (cont)

Event Filtering

As the controller can log a very large number of events it is possible to filter the events to show only those of interest. Up to six filter categories can be active at any one time. The filters are cumulative i.e. selecting two filters will mean only those events that fall into either category will be shown.

The controller supports the following filter categories.

Category	Description	Example Events
All	All events are shown.	
Protection (PRTN)	A general grouping of all protection related events.	Pick up, Prot Trip 1, Dead lockout, Single Shot, A Phase Lost, Earth Prot ON, NPS Available, Loop Auto ON
Controller (CTRL)	A general grouping of all controller hardware related events.	Battery Normal, Aux Supply Fail, SW Load Completed, Battery health test START, Load Profile, System Frequency 50Hz
Switchgear (SWGR)	All messages from Switchgear.	Switch Connected, Mechanical Fail, Cap Charge Fail, Trip Coil Isolated, SCEM type, Contact < 20%, DNP3 Trip Request, New SCEM data
Network (NWRK)	A general grouping of all electrical system events.	A1 Live, C2 Dead, Load Supply ON
Power Quality (PQ)	All quality of supply messages.	SOM Available, Source Out 00 m 59s, Harmonics ON V2a:THD 1.5%, Waveform captured
WSOS	All setting changes with source WSOS5 are shown.	
Panel (O.I.)	All setting changes with source O.I. are shown.	
Protocol (PTCL)	All setting changes and system status messages that are SCADA protocol related are shown.	DNP Address 5, DNP Unsol ON, PTCL SEF ON
IOEX	All setting changes and system status messages that are IOEX related are shown.	IOEX Input 1 ON, IOEX Output 2 OFF, IOEX Earth Prot ON
Settings	All setting changes with source WSOS, Panel, Protocol or IOEX are shown.	

An event may belong to two categories. For example, Switch connected can be seen in both switchgear and controller categories.

Active filters can be set via the Change Event Filter page, which you can access by pressing the **SELECT** key while the event log is displayed. After setting the filter, pressing the **MENU** key (**setVUE**) or **EVENT LOG** key (**flexVUE**) will return the display to the event log with filter active. Selecting a new filter may cause a momentary delay when returning to the event log.

The following display is an example of a possible event filter set up:

```
set  - - - - - CHANGE EVENT FILTER - - - - - E
      Protection      Switchgear
      - blank -      - blank -
      - blank -      - blank -
```

From the above example it can be seen that the event log is to display all events that are in the Protection or Switchgear categories.

The **flexVUE** shows these filters one filter at a time, using arrow keys to navigate.

```
flex CHANGE EVENT FILTER
      Protection
```


8 Work Tags and Controller Mode

An important feature of the ADVC is that it is always in one of two modes, either Local or Remote, and can have a Work Tag applied by Local or Remote operators.

The mode and the tag specify the circumstances under which the ACR can be closed to ensure operational safety.

DEFINITION OF LOCAL OR REMOTE USER

There are three kinds of **LOCAL** user:

- Operator Interface (O.I.).
- An IOEX card designated as "Local". This might apply, for example, to an IOEX card used in a substation to provide control from a remote panel inside a building.
- A PC running WSOS5 plugged into the computer port on the CAPE. See "**15 Windows Switchgear Operating System** (page 15-1)"

There are also three kinds of **REMOTE** user:

- An IOEX card designated as "Remote". This might apply, for example to an IOEX card used to interface to a SCADA system remote terminal unit. See "**17 Accessories** (page 17-1)"
- A SCADA control protocol. These are always designated as remote users. Full information is given in the relevant protocol manual.
- A PC running WSOS5 communicating via radios or modems connected to a telemetry port configured as a remote port.

Communication ports must be configured as local or remote on the O.I.. The Ethernet port may only be configured as remote.

Local, Remote, Hit and Run / Delayed Operation

The Local/Remote/Hit and Run selection is carried out on

 **SYSTEM STATUS – OPERATOR SETTINGS**

or

 Settings for Delayed operation on the **flexVUE** O.I. can only be changed within WSOS

There is a default quick key on the O.I. to make this fast and easy. Pressing the **LOCAL/REMOTE** quick key (**setVUE**) causes that data field within its menu screen to be displayed.

Pressing the same quick key again changes the mode. Press the **ENTER** key to activate the selected mode.

The default Quick Action Keys on the **flexVUE, REMOTE CONTROL & LOCAL CONTROL**, allow instant setting of the two available modes.

Depending on the mode set, closing and tagging can only be carried out by the designated local or remote users.

- Local/Remote/Hit and Run does not affect automatic reclosing.

Local Mode

In this mode only a local user can manually close the ACR. (The ACR can still close automatically with the auto-reclose function or during a protection sequence.)

This means a user can go to the ADVC Controller, set local control mode and know that remote closing is disabled.

Only a local operator can apply or remove the Work Tag when the ADVC is in Local Mode.



The Local/Remote mode can only be set from the Operator Interface.



Hit and Run is only available on the **setVUE** O.I..



The **flexVUE** panel uses Delayed Switching in place of Hit and Run

Remote Mode

In this mode only a remote user can manually close the ACR. (The ACR can still close automatically with the auto-reclose function or during a protection sequence.)

Only a remote operator can apply/remove the Work Tag when the controller is in Remote Mode.

If the local operator is denied a close operation or a Work Tag due to being in Remote Mode then the operator panel will flash the message

Not Allowed to Change to Local Control and/or remove Work Tag.

Hit and Run

The Hit and Run feature provides a delay between a local operator control TRIP or CLOSE request and when the ACR operates.

This feature is particularly useful in a Substation where occupational safety regulations may require personnel to vacate the area when the ACR operates.

There is no change to the local operator trip/close operation of the ACR when Hit and Run is turned OFF.

Hit and Run is made available via WSOS5 only. When Hit and Run is Available it is configured at:

SYSTEM STATUS – Hit and Run

The following tables show, for the Hit and Run screen, all fields, and the field description.

Hit and Run			S
Hit/Run Close OFF	P	Hit/Run Trip OFF	P
Hit/Run Close 120s		Hit/Run Trip 120s	

Table 1. Hit and Run all fields

Field	Description
Hit/Run Close OFF Hit/Run Close 10s	Hit and Run Close Time This field is used to delay a local operator panel close request. Range: OFF, 10 to 120 sec (increments of 5 secs). <i>Factory default is OFF</i>
Hit/Run Trip OFF Hit/Run Trip 10s	Hit and Run Trip Time This field is used to delay a local operator panel trip request. Range: OFF, 10 to 120 sec (increments of 5 secs). <i>Factory default is OFF</i>

Table 2. Hit and Run field descriptions

Once Hit and Run has been made available via WSOS5, it can then be configured either via WSOS5 or from the Hit and Run screen in the System Status menu. Finally, Hit and Run is turned ON via the LOCAL/ REMOTE field at:

SYSTEM STATUS– OPERATOR SETTINGS1: Hit and Run ON

When Hit and Run is turned ON the operator has a countdown period of 30 seconds to press either TRIP or CLOSE, otherwise the setting will revert to the setting prior to turning Hit and Run ON.

This will also occur when the Hit and Run request is aborted by using the SELECT key.

When Hit and Run is turned ON the following screen is displayed:

```

----- Hit and Run Countdown ----- S
Press TRIP or CLOSE within 30 sec
Press the SELECT key to abort
  
```

When the operator presses TRIP or CLOSE the following screen will be displayed and the countdown will begin:

----- Hit and Run Countdown ----- S
TRIP will occur in 120 sec
Press the SELECT key to abort

The panel will “beep” every two seconds when Hit and Run is on. The beeping will become more rapid during the final ten seconds to action.

An event will be recorded in the Event Log at the start of the Hit and Run period and the end of a Hit and Run countdown or timeout.



Delayed Trip/Close Operation

It is possible to set, *via WSOS only*, a separate delay for the trip and close buttons. This delay will be active for TRIP and/or CLOSE requests of an operator via the O.I.

This feature is particularly useful in a Substation where occupational safety regulations may require personnel to vacate the area when the ACR operates.

Protection, Detection and Automation features of the switchgear are not affected when Delayed Operation is available.

Delayed operation can be configured to trip or close the switchgear with a delay between 10 and 120 seconds for TRIP or CLOSE operations independently. Consult WSOS 5 Help Files on how to make Delayed Operation available on the *flexVUE* O.I..

Using Delayed Operation

When active, Delayed Operation is the *default action* for the TRIP and/or CLOSE buttons.

To trip/close the switchgear after a pre-set interval.

- Press the **TRIP** or **CLOSE** button.

The *flexVUE* screen will display the following message:

TRIP in 30 seconds
SELECT key aborts

or

CLOSE in 30 seconds
SELECT key aborts

The seconds will count down on the screen.

Cancelling a Delayed TRIP

To CANCEL the delayed operation, if you originally pressed **TRIP**:

- Press the **SELECT** button (or **CLOSE** button)

The following screen will display (along with a warning beep) when the operation is cancelled:

TRIP Aborted

Cancelling a Delayed CLOSE

To CANCEL the delayed operation, if you originally pressed **CLOSE**:

- Press the **SELECT** button (or **TRIP** button)

The following screen will display (along with a warning beep) when the operation is cancelled:

CLOSE Aborted



The default Delay time is 30 seconds.



The CAPE will beep will “beep” every two seconds when Hit and Run is on. The beeping will become more rapid during the final ten seconds to action.



If you wish to TRIP or CLOSE the switchgear immediately:

- Press the **TRIP** or **CLOSE** button a second time (before the counter reaches zero)



In the United States & other areas **WORK TAG** is sometimes referred to as **HOT LINE TAG**

Work Tag

Applying the Work Tag ensures that closing cannot take place at all, either by a local operator, a remote operator or automatically. Once applied, neither a local user, remote user or the Auto-Reclose function can close the recloser. Therefore, using Work Tag protects operators working on live lines.

Work Tag mode is activated when Work Tag is applied irrespective of Auto Reclose mode status, and is deactivated when the Work Tag is removed.

It is not possible for the operator to close the ACR whilst in Work Tag mode.

If the Work Tag is deactivated whilst Auto Reclose is ON then the Auto Reclose mode will be entered immediately.

If a trip occurs whilst the Work Tag is applied then an event is logged to identify the Work Tag mode.

Work Tags are applied and removed from:

set SYSTEM STATUS – SWITCHGEAR STATUS: Work Tag OFF

flex OPERATOR MENU – OPERATOR CONTROLS – Work Tag OFF

When applied the operator panel flashes the message:

set Warning – Work Tag Applied.

flex The **flexVUE** O.I. will display this message in the **ALERTS MENU**

Only a local user can apply/remove the tag when the controller is in Local Mode and only a remote user can apply/remove the tag when the controller is in Remote Mode. This means that a local user can remove the Work Tag applied by a remote user but they must first put the controller into Local Mode. If the local operator is denied a close operation due to the Work Tag being applied the operator panel will flash the message

set Not Allowed – Change to Local Control and/ or remove Work Tag.

flex This message is **not** shown in the **flexVUE**, an event Operation denied is logged.

Work Tag Mode Protection Settings

Work Tag protection settings are used to provide an appropriate protection curve when the Work Tag has been applied.

In both **setVUE** and **flexVUE** panels there are separate protection pages for Phase Work Tag Protection, Earth Work Tag Protection and NPS Work Tag Protection. Each page is similar to the normal protection trip pages.

set Example of **setVUE** Work Tag Protection Pages

```
---- NPS WORK TAG PROTECTION TRIP - A ---- P
Inv IEC255           Time Multiplier 100
No Instantaneous
Minimum 0.00s        Additional 0.00s
```

```
--- PHASE WORK TAG PROTECTION TRIP - A --- P
Inv IEC255           Time Multiplier 100
No Instantaneous
Minimum 0.00s        Additional 0.00s
```

```
-- EARTH WORK TAG PROTECTION TRIP - A --- P
Inv IEC255           Time Multiplier 100
No Instantaneous     SEF Definite 5.0s
Minimum 0.00s        Additional 0.00s
```

“**Appendix M Protection pages** (page **M-1**)” details all the fields for the Work Tag Phase, NPS and Earth protection settings.

flex **flexVUE** Work Tag Mode protection settings are available as part of the PROTECTION TRIP SETTINGS within the **flexVUE** menu. See “**Appendix Q flexVUE Menu Structure** (page **Q-1**)” for details.

9 Recloser Protection Features

INTRODUCTION

The ADVC Controller has the following protection elements which can be configured by the user to trip the circuit-breaker:

Any combination of these elements can be turned ON or OFF.

Protection Element
Phase Overcurrent (abbreviated OC in this manual)
Earth (Ground) Overcurrent (abbreviated EF in this manual)
Sensitive Earth (Sensitive Ground) Overcurrent (abbreviated SEF in this manual)
Negative Phase Sequence Overcurrent (abbreviated NPS in this manual)
Under Frequency (abbreviated UF in this manual)
Over Frequency (abbreviated OF in this manual)
Under Voltage (abbreviated UV in this manual)
Over Voltage (abbreviated OV in this manual)
Loss of Phase (abbreviated LOP in this manual)

In addition, the ADVC Controller supports Loop Automation.

The following protection features may change the way protection operates:

- Protection OFF
- Single Shot Mode
- Work Tag Mode
- Sequence Reset
- Sequence Control
- Live Load Blocking
- Dead Lockout
- High Current Lockout
- Inrush Restraint
- Cold Load Pickup
- Automatic Protection Group Selection
- Directional Blocking
- Directional Protection

In general, all protection elements operate simultaneously and independently of each other. There are a small number of interactions between protection elements which are described in later sections of this manual.

PROTECTION SETTINGS

The behaviour of the ACR during a fault depends on the Protection Settings. You can change protection settings using:

- **WSOS5 configuration software:**
WSOS5 can change any protection settings when connected locally or remotely.
- **Operator Interface (O.I.):**
A local operator can change any protection settings using the Operator Interface.
- **Telemetry Protocol:**
The telemetry protocol can not change protection settings, but can turn protection features on and off.

You can set up passwords to control who can change protection settings.

INVERSE TIME PROTECTION SETTINGS/SPECIFICATIONS

For more information on inverse time protection, please see “**OC Protection Element Time/Current Characteristics** (page 9-10)”.

Inverse Time Curves available	Ref. App. E, F, G.
Phase Setting Current Range	10 to 1260 Amp
Earth Setting Current Range	10 to 1260 Amp
Setting Current Resolution	1 Amp
Setting Current Accuracy ^a	5%
Maximum Current for which curve applies	12.5 kA
Maximum Setting Current Multiple for which curve applies	× 30
Time Multiplier	0.05 - 25.0
Time Multiplier Resolution	0.01
Maximum Time to Trip ^b	2 - 180 sec
Maximum Time to Trip Setting Resolution	0.1 sec
Minimum Time to Trip ^b	0 - 2 sec
Minimum Time to Trip Setting Resolution	0.01 sec
Additional Time to Trip ^c	0.0 - 30.0 sec
Additional Time to Trip Setting Resolution	0.01 sec
Phase Threshold Multiplier ^{b d}	1 - 10
Resolution of Multiplier Setting	0.1
Earth Threshold Multiplier ^{b d}	1 - 10
Reset Threshold Multiplier Range (Phase, Ground/Earth and NPS)	90% - 100% ^e 10% - 100% ^f
Resolution of Multiplier Setting	0.1
Timing Accuracy ^g	5%, ±20 ms
NPS Trip Current Setting Range	1 - 1260 Amp
NPS Trip Current Setting Resolution	1 Amp
NPS Trip Current Setting Accuracy	±10%
NPS Trips in sequence to Lockout	1 - 4

a. Current accuracy applies to protection relay function only and excludes accuracy of current transformers.

b. Applies to inverse time and instantaneous protection only.

c. Applies to inverse time protection only.

d. A trip is inhibited when the line current < “setting current” x threshold multiplier

e. Valid if Reset Curves is turned off.

f. Valid if Reset Curves is turned on.

g. Timing refers to time to initiate operation of circuit breaker (opening and closing times are in addition).

See “**Time Current Characteristic Modifiers** (page 9-11)”

DEFINITE TIME PROTECTION SETTINGS/SPECIFICATIONS

For more information on definite time protection, please see “**Definite Time (DT)** (page 9-10)”.

Available as an alternative to inverse time on phase, NPS and earth. Setting Current parameters are as for inverse time protection.

Definite Time range	0.05 - 100 sec
Definite Time resolution	0.01 sec
Timing Accuracy ^a	±50 ms

a. Timing refers to time to initiate operation of circuit breaker (opening and closing times are in addition).

See “**Time Current Characteristic Modifiers** (page 9-11)”

Recloser Protection Features (cont)

INSTANTANEOUS PROTECTION SETTINGS/SPECIFICATIONS

For more information on instantaneous protection, please see "*Instantaneous (INST)*" (page 9-10)".

Available as an additional element on inverse time or definite time protection or as an alternative without inverse time or definite time. Instantaneous protection can be applied to phase, NPS and earth protection.

Multiplier of Trip Current Setting (applies to both phase and earth)	1 - 30
Resolution of Multiplier Setting	0.1
Maximum Effective Setting	12.5 kA
Trip Current Setting Accuracy ^a	±10%
Transient Overreach for X/R < 10	<5%
Transient Overreach for X/R > 10	<10%

^a. Current accuracy applies to protection relay function only and excludes accuracy of current transformers.

SENSITIVE EARTH FAULT PROTECTION (SEF) SETTINGS/SPECIFICATIONS

For more information on sensitive earth fault protection, please see "Sensitive Earth Fault (SEF)" (page 9-11).

Available as an additional protection element. Operates as definite time. The number of SEF trips which can occur in a reclose sequence before lockout occurs is user set.

SEF Trip Current Setting Range	4 - 20 Amp ^a
SEF Trip Current Setting Resolution	1 A
SEF Trip Current Setting Accuracy ^b	±5%, ±0.5 A
SEF Operating Time	0.1 - 100 secs
SEF Operating Time Resolution	0.1 secs
SEF Operating Time Accuracy ^c	±50 ms
SEF Filter Attenuation at 150Hz	>28 dB
SEF Trips in sequence to lockout	1 - 4

^a. 1A SEF option available.

^b. Current accuracy applies to protection relay function only and excludes accuracy of current transformers

^c. Timing refers to time to initiate operation of circuit breaker (opening and closing times are in addition).

See "*Time Current Characteristic Modifiers*" (page 9-11)"

COLD LOAD PICKUP SETTINGS/SPECIFICATIONS

For more information on cold load pickup, please see "*Cold Load Pickup (CLP)*" (page 9-13)"

This is an additional protection feature, which operates with inverse time and instantaneous protection.

Cold Load Multiplier Range	1 - 5
Cold Load Multiplier Resolution	0.1
Cold Load Time Constant Range	1 - 480 mins
Cold Load Time Constant Resolution	1 min
Timing Accuracy	±1 min

INRUSH RESTRAINT SETTINGS/SPECIFICATIONS

For more information on inrush restraint, please see “**Inrush Restraint**” (page 9-50).

This is an additional protection feature, which operates with inverse time and instantaneous protection.

Inrush Restraint Multiplier Range	1 - 30
Inrush Restraint Multiplier Resolution	0.1
Inrush Restraint Time Range	0.05 - 30 sec
Inrush Restraint Time Resolution	0.01
Timing Accuracy	±20ms

LOSS OF PHASE PROTECTION SETTINGS/SPECIFICATIONS

For more information on loss of phase, please see “**Voltage Operated Protection Elements**” (page 9-32).

This is an additional protection feature, which operates independently of the protection elements.

Loss of Phase Threshold Voltage range	2 - 15 kV
Loss of Phase Threshold Voltage setting resolution	1V
Loss of Phase Threshold Voltage accuracy ^a	2.5%, ±25V
Loss of Phase Time range	0.1 - 100 sec
Loss of Phase Time resolution	0.1 sec
Loss of Phase Time accuracy	±50ms

^a. Includes accuracy of voltage transformers in circuit breaker.

UNDER AND OVER FREQUENCY PROTECTION SETTINGS/ SPECIFICATIONS

For more information on under and over frequency protection, please see “**Under and Over Frequency Protection Elements**” (page 9-33).

Frequency setting range ^a	45 - 65 Hz
Frequency setting resolution	0.1 Hz
Accuracy (for sinusoidal input)	± 0.05 Hz
Frequency Dead Band (hysteresis)	0.2 Hz
Number of under or over frequency cycles before tripping	2 - 1000
Frequency calculation	Once per cycle averaged over 2 cycles
Low Voltage Inhibit range	4 - 23 kV
Low Voltage Inhibit setting resolution	1V
Normal Frequency Close Time	1 - 1000 secs

^a. Under/Over tripping frequencies and normal frequencies are interlocked by software so that only viable settings are possible.

Recloser Protection Features (cont)

UNDER AND OVER VOLTAGE PROTECTION SETTINGS/ SPECIFICATIONS

For more information on under and over voltage protection, please see “**Under and Over Voltage Protection** (page 9-37)”.

This is an additional protection feature which is independent of all other protection features.

Voltage accuracy	2.5% $\pm$ 25 V
Dead Band (hysteresis)	2.0% of nominal system voltage
Voltage value updated	31.25 ms
Measured voltage evaluation	once/0.125 sec
Measured voltage averaged over	0.25 sec
Trip delay - time setting resolution	0.1 sec
Trip delay range	0.0 - 60.0 sec
Trip voltage setting resolution	1.0%
Nominal Phase to Earth Voltage	2.0 - 25.0 kV
Nominal Phase to Earth Voltage Resolution	1 V
Nominal voltage range	2.0 - 25.0 kV
Normal voltage close time	1 - 1000 sec
Sequence recovery time out	0 - 1000 sec
Excess Sequences	OFF, 1 - 20
Excessive sequence accumulation time	0 - 2880 Min
Under Voltage Pickup	0.5 - 0.93 pu ^a
Over Voltage Pickup	1.02 - 2.00 pu
Normal Voltage High	1.00 - 1.98 pu
Normal Voltage Low	0.52 - 1.00 pu
Under/Over Voltage Fault Reset Time	0 - 10 sec
Under/Over Voltage Fault Reset Time Resolution	10 ms
Under/Over Voltage Definite Time	10 ms - 100 sec
Under/Over Voltage Definite Time resolution	10 ms
Sag Pickup	0.5 - 0.98 pu
Swell Pickup	1.02 - 2.0 pu
Pickup/Normal Voltage Setting Resolution	0.01 pu
Sag/Swell Definite Time	10 ms - 100 sec
Sag/Swell Definite Time resolution	10 ms
Sag/Swell Reset Time	0 - 10 sec
Sag/Swell Reset Time Resolution	10 ms

a. per unit. Used for voltage description in relative terms based on a nominal system voltage.

LIVE LOAD BLOCKING SETTINGS/SPECIFICATIONS

For more information on live load blocking, please see “**Live Load Blocking** (page 9-12)”.

This is an additional protection feature, which operates independently of the protection elements.

Live Load Threshold Voltage	2 - 15kV
-----------------------------	----------

HIGH CURRENT LOCKOUT SETTINGS/SPECIFICATIONS

This is an additional protection feature, which operates in conjunction with the protection elements.

Maximum Effective Setting	12.5kA
Minimum Effective Setting	10 A
Current Setting Resolution	1 A
Accuracy	±15%

AUTOMATIC PROTECTION GROUP SELECTION SETTINGS/ SPECIFICATIONS

For more information on automatic protection group selection, please see “**Automatic Protection Group Selection** (page 9-16)”.

This is an additional protection feature.

Auto Change Time	10 - 180 sec
Auto Change Time Resolution	±1 sec

AUTO - RECLOSE SETTINGS/SPECIFICATIONS

For more information on auto-reclosing, please see “**Auto Reclosing** (page 9-45)”.

Trips in Sequence to Lockout	1 - 4
Reclose Time After First Trip in Sequence ^a	0.3 - 180 sec
Reclose Time After Second and Third Trips in Sequence	2 - 180 sec
Reclose Time, Timing Resolution	0.01 sec
Reclose Time, Timing Accuracy ^b	±0.01 sec
Single Shot Reset Time	0 - 180 sec
Single Shot Reset, Timing Resolution	1 sec
Single Shot Reset, Timing Accuracy	±1 sec
Sequence Reset Time	3 - 180 sec
Sequence Reset, Timing Resolution	1 sec
Sequence Reset, Timing Accuracy	±1 sec

a. The actual setting depends on the ACR. (e.g. N-Series is 0.5 sec)

b. Timing refers to time to initiate operation of circuit breaker (opening and closing times are in addition).
see “**Auto Reclosing** (page 9-45)”

Recloser Protection Features (cont)

DIRECTIONAL BLOCKING SETTINGS/SPECIFICATIONS

For more information on directional blocking, please see "*Directional Blocking* (page 9-27)".

System Phase/Earth Nominal Voltage for correct operation	2 - 25 kV
Phase Protection Blocking:	
Characteristic Angle setting range	±180 deg
Characteristic Angle setting resolution	1 deg
Characteristic Angle accuracy	±10 deg
Time to Determine fault direction	30 ms
Earth/SEF Protection Blocking:	
Characteristic Angle setting range	±180 deg
Characteristic Angle setting resolution	1 deg
Characteristic Angle accuracy from 2 – 5A earth current	±30 deg
Characteristic Angle accuracy from 5 – 20A earth current	±20 deg
Characteristic Angle accuracy above 20A earth current	±20 deg
Earth Protection Blocking Time to determine fault direction	30 ms
SEF Protection Blocking Time to determine fault direction	500 ms
Minimum Line/Earth Polarising Voltage for Phase Blocking to Operate	500 V
Minimum Residual Earth Polarising Voltage for Earth blocking to Operate	5 - 100%
Minimum Residual Earth Polarising Voltage for SEF blocking to Operate	5 - 100%
Residual Earth Voltage dynamic balance limit	20%
Residual Earth Voltage dynamic balance rate	0.6% per sec
Minimum SEF Definite time when Directional Blocking is ON	0.5 sec

DIRECTIONAL PROTECTION

System phase/earth nominal voltage for correct operation	2 - 25 kV
Minimum Line/Earth polarising voltage for phase directional protection to operate	500 V
Minimum residual earth polarising voltage for earth directional protection to operate	5 to 100%
Minimum residual earth polarising voltage for SEF directional protection to operate	5 to 100%
Minimum residual NPS polarising voltage for NPS directional protection to operate	0 - 2000 V
Phase characteristic angle	
Setting range	$\pm 180^\circ$
Setting resolution	1°
Accuracy	$\pm 10^\circ$
Time to determine fault direction	30 ms
Earth characteristic angle	
Setting range	$\pm 180^\circ$
Setting resolution	1°
Accuracy @ 2 to 5 A earth current	$\pm 30^\circ$
Accuracy @ 5 to 20 A earth current	$\pm 20^\circ$
Accuracy above 20 A earth current	$\pm 20^\circ$
Time to determine fault direction Earth protection	30 ms
Time to determine fault direction SEF protection	500 ms
NPS characteristic angle	
Setting range	$\pm 180^\circ$
Setting resolution	1°
Accuracy	$\pm 10^\circ$
Time to determine fault direction	30 ms
Control	
Phase Low V Action	Use Forward, Reverse, or Ignore
Earth Low Vzps Action	Use Forward, Reverse, or Ignore
SEF Low Vzps Action	Use Forward, Reverse, or Ignore
NPS Low Vnps Action	Use Forward, Reverse, or Ignore
High Vzps alarm timeout	1 - 180 s
Vzps balance	Enable/Disable

OTHER PROTECTION FEATURES SETTINGS/ SPECIFICATIONS

For more information on sequence control, please see "**Sequence Control** (page 9-45)".

Fault Reset Time ^a	0 - 10,000 ms
Fault Reset Time Accuracy	± 20 ms
Sequence Control	Available

^a. Applies to all protection elements.



Though 10 Protection groups are available, you may use fewer. The minimum number is 1, or 2 if directional protection is used.

PROTECTION GROUPS

There are up to 10 groups of protection settings (referred to as Protection Groups A, B, C, D, E, F, G, H, I and J). Each Protection Group can have different settings. You nominate which one of the 10 Protection Groups is active. The active Protection Group settings will be in operation during a fault.

If you have enabled Directional Overcurrent Protection then the number of available Protection Groups is reduced to 5 pairs because each Protection Group has two sets of settings - one set for forward faults and one set for reverse faults. In this case Groups A and B are the first Directional Group, Groups C and D are the second Directional Group etc.

PROTECTION OPERATION



This reset behaviour is identical to the reset behaviour of the Nu-Lec Pole Top Control Cubicle.

Overcurrent Protection Element Pickup and Reset

The ADVC protection logic starts operating when the measured currents exceed the trip current setting. This condition is called **Pickup**.

The protection element timing logic starts timing when the measured currents exceed the trip current setting multiplied by the phase threshold multiplier (or other multipliers active at the time). This condition is called **Timing**.

The protection element timing logic pauses when the current in a protection element is less than the Trip Current setting multiplied by the phase threshold multiplier (or other multipliers active at the time). This condition is called **Pause**.

The protection element timing logic resets when the primary current is less than 90% of the trip current setting for the fault reset time. This condition is called **Reset**.

The reset current is fixed at 90% of the Trip Current setting. The user specifies a Reset Time. The Reset Time can be set from 0 to 10,000 ms in 1 ms steps.

Figure 15. (page 9-9) illustrates the pickup, pause and reset characteristics for a Trip Current setting of 1000 A, a Reset Time of 100 ms, and a phase threshold multiplier of 1.0.

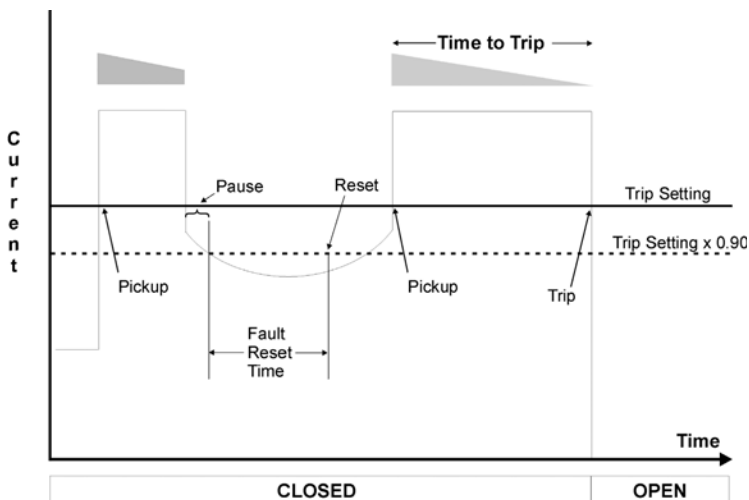


Figure 15. Pickup / Reset / Pickup example

Figure 16. (page 9-10) illustrates the pickup, pause and reset characteristics for a Trip Current setting of 1000 A, a Reset Time of 100 ms, and a phase threshold multiplier of 1.0

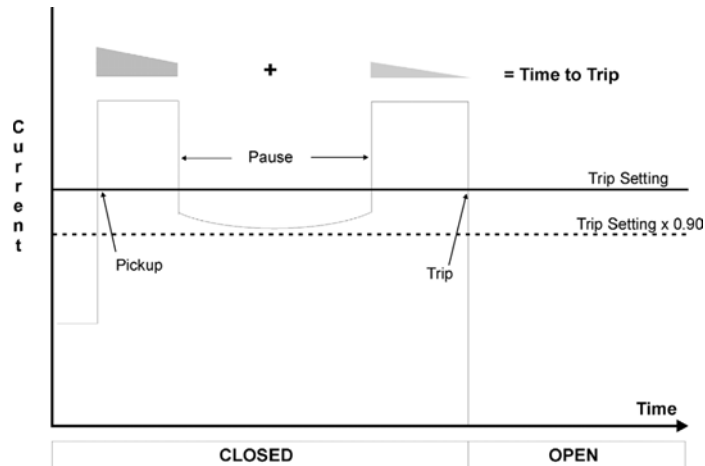


Figure 16. Pickup / Pause example

OC PROTECTION ELEMENT TIME/CURRENT CHARACTERISTICS

The following time/current characteristics are available for the overcurrent protection elements:

- Instantaneous (abbreviated in this manual as INST)
- Definite Time (abbreviated in this manual as DT)
- Inverse Current / Time (Inverse Definite Minimum Time, abbreviated in this manual as IDMT)

Instantaneous (INST)

The Instantaneous characteristic causes the protection element to operate instantaneously when the current is above the pickup setting. In practice, the protection algorithms take a certain minimum time to calculate the current, so the minimum operating time is greater than zero. Instantaneous characteristics can be modified by a minimum time setting where the trip needs to be delayed by a set time.

Definite Time (DT)

The Definite Time characteristic causes the protection element to operate at a fixed time after the element has picked up, regardless of the current magnitude. The current must be above the pickup setting throughout the Definite Time. Definite Time can be modified by an instantaneous setting only. The threshold current multipliers, and minimum, additional, and maximum times do not apply.

Inverse Current/Time (IDMT)

The Inverse Current Time characteristic causes the protection element to operate in a time inversely proportional to the magnitude of the current. There are many different inverse time characteristics. Some have been standardized by organisations such as IEC and IEEE. Refer to "**Appendix E IEC255 Inverse Time Protection Tables** (page E-1)" and "**Appendix F IEEE Inverse Time Protection Tables** (page F-1)"

There are also 42 curves available for coordinating with fuses etc. Refer to "**Appendix G Non-Standard Inverse Time Protection Curves** (page G-1)".

The basic characteristics of the Inverse Time curves can be modified by the use of time multipliers, instantaneous multipliers, additional times, minimum times and maximum times.

User Defined Curves

User defined curves are created using the User Defined Curve Editing tool which is part of WSOS5. The tool can be used to create curves with up to 60 time/current points. Five user defined curves may be written to each controller.

TIME CURRENT CHARACTERISTIC MODIFIERS

Time current characteristics can be modified by using the following modifiers:

- Minimum Time
- Maximum Time
- Additional Time
- Time Multiplier
- Threshold Multiplier
- Instantaneous Multiplier

MINIMUM TIME

This setting modifies the time current characteristic so that the operating time is not less than the Minimum Time regardless of the current magnitude. This can be used to provide grading between ACRs and fuses on the same feeder. See **Figure 17**. (page 9-11)

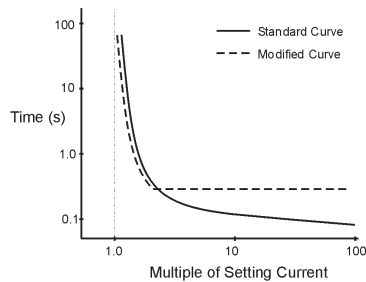


Figure 17. Minimum Time Curve Example

MAXIMUM TIME

This setting modifies the time current characteristic so that the operating time is not more than the Maximum Time regardless of the current magnitude. This is used to guarantee tripping when the current is only slightly above the pickup setting. See **Figure 18**. (page 9-11)

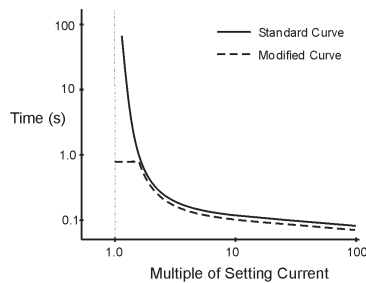


Figure 18. Maximum Time Curve Example

ADDITIONAL TIME

This setting modifies the time current characteristic so that the operating time is greater than the standard time specified by the time current characteristics by a fixed additional amount. This can be used to provide grading between multiple ACRs on the same feeder. See **Figure 19**. (page 9-11).

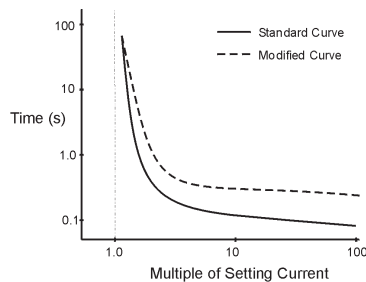


Figure 19. Additional Time Curve Example

TIME MULTIPLIER

This setting modifies the time current characteristic so that the operating time is a multiple of the standard time specified by the time current characteristics. This can be used to provide grading between multiple ACRs on the same feeder. See **Figure 20**. (page 9-11).

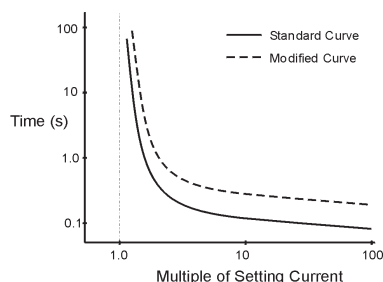


Figure 20. Time Multiplier Curve Example

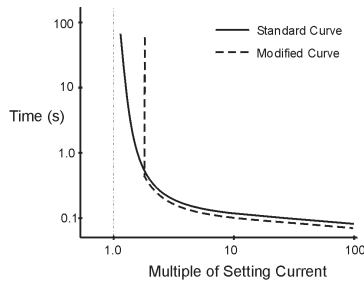


Figure 21. Threshold Multiplier Curve Example

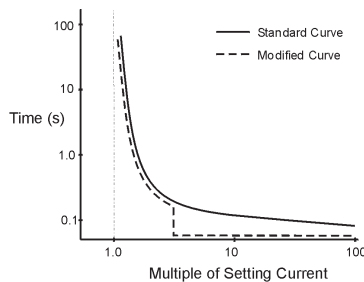


Figure 22. Instantaneous Multiplier Curve Example

THRESHOLD MULTIPLIER

This setting modifies the time current characteristic so that the protection will not operate unless the current exceeds the Pickup Setting X the Threshold Multiplier.

This can be used to provide grading between an ACR and an upstream or downstream protection device on the same feeder, when the other devices have a different time/ current characteristic. See **Figure 21.** (page 9-12)

INSTANTANEOUS MULTIPLIER

An Instantaneous Multiplier can be applied to an Inverse Time characteristic. This setting forces an instantaneous trip if the current exceeds the Pickup Setting X Instantaneous Multiplier. This can be used to provide faster tripping for high current faults. See **Figure 22.** (page 9-12)

SENSITIVE EARTH FAULT (SEF)

Sensitive Earth Fault (SEF) can be set up to be either available or not available and is a password protected feature located in:

set SYSTEM STATUS – OPTIONS 1: SEF Available

flex ENGINEER MENU – CONFIGURATION MENU –
FEATURE SELECTION – PROTECTION – SEF Available

This allows the engineer to ensure that SEF cannot be turned on at inappropriate locations.

If SEF is available then the operator can turn it on and off from:

set SYSTEM STATUS – OPERATOR SETTINGS 1

flex OPERATOR MENU – OPERATOR CONTROLS –E/F OFF, SEF OFF

without a password, by cycling between the following three settings:

- E/F OFF, SEF OFF - Earth Fault off and SEF off.
- E/F ON, SEF OFF - Earth Fault on and SEF off.
- E/F ON, SEF ON -Earth Fault on and SEF on.

E/F OFF will not be available if E/F OFF is set to Not Allowed. SEF operates as a definite time element. Therefore, the Threshold Current Multipliers, and Minimum, Additional, Maximum Times do not apply.

SEF will cause the ACR to trip when the earth current rises above the SEF trip current setting for longer than the SEF definite time setting. The SEF definite time setting can be set differently for each trip in a reclose sequence.

LIVE LOAD BLOCKING

When Live Load Block is selected, all close requests will be disregarded if any load side terminal is live.

Live Load Blocking is selected from:

set PROTECTION SETTING 3 (A..J): Live Load BlockOFF/ON

flex ENGINEER MENU – PROTECTION MENU – PROTECTION CONTROL

– Live Load Block OFF

Live Load Blocking uses the Live Terminal Threshold set on:

 SYSTEM STATUS – PHASE VOLTAGE and POWER FLOW:
LIVE if >2000

 ENGINEER MENU – CONFIGURATION MENU – SYSTEM SETTINGS
– NETWORK PARAMETERS – LIVE if > 2000V

Protection OFF

This setting turns off all the protection features and, therefore, the ACR will only trip or close as a result of manual operation. Protection OFF must be allowed at :

 OPTIONS PROTECTION 1

 ENGINEER MENU – CONFIGURATION MENU – FEATURE SELECTION
– PROTECTION – Prot OFF Allowed

before you can set Protection OFF at

 OPERATOR SETTINGS: Protection OFF

 OPERATOR MENU – OPERATOR CONTROLS
– Auto Reclose OFF/ON/Protection OFF

A Protection OFF event is generated and logged whenever protection is turned off.

When Protection is OFF:

- The ADVC still logs all pickups and maximum currents and sets the Pickup Flags¹.
- The ACR will not automatically trip on protection, and trip events are not logged.
- If a Loss of Phase (LOP) event occurs, the ACR will not trip but the LOP, A, B or C Pickup Flags are set.
- If an Under/Over Frequency condition is detected, the ACR will not trip but the Frequency Pickup Flag is set.
- If a NPS event occurs, the ACR will not trip but the Pickup Flag will register. Protection is normally turned ON by selecting either Auto Reclose ON or Auto Reclose OFF.

1.  The Protection OFF setting occupies the same field as Auto Reclose ON or Auto Reclose OFF. External Trips are not shown on the Pickup Flag display.

COLD LOAD PICKUP (CLP)

When a typical heterogeneous load has been without supply for a period of time (hours) it loses its diversity. After supply is restored the load is higher than before the loss of supply because all heater, refrigerator or air conditioner thermostats have turned on. The longer the time without supply the greater the loss of diversity, therefore the higher the load current after supply is restored. This increase in load current may cause overcurrent protection elements to operate.

The purpose of the Cold Load Pickup feature is to compensate for the loss of diversity automatically so the increased load will not cause overcurrent protection to operate. It works by measuring the time that supply is lost and then temporarily raising the Trip Current for a time according to the time supply was lost. The increase in Trip Current is determined by the Cold Load Multiplier which is set by the user.

The user specifies a multiplier and a time. The ADVC detects when load current is zero and starts a timer called the Operational Cold Load Time. Using this timer, an Operational Cold Load Multiplier is calculated using the following formula:

$$\text{Operational_Cold_Load_Mult}' = 1 + \left[\frac{\text{Operational_Cold_Load_Time}}{\text{User_Set_Cold_Load_Time}} \times (\text{User_Set_Cold_Load_Mult}' - 1) \right]$$

The Operational Cold Load Multiplier is used to modify the phase and earth Threshold Current Multipliers.

Therefore the phase and earth protection thresholds will increase at a rate specified by the customer when the load is turned off – but only up to the User Set Cold Load



The rate of increase and decrease of threshold currents is the same.

Multiplier. The ADVC calculates the new thresholds every minute.

For example, if the User Set Cold Load Time is 2 hours, the User Set Cold Load Multiplier is x2 and the current has been off for 1 hour, then the Operational Cold Load Time is 1 hour. Consequently the phase and earth thresholds are increased to equal the Operational Cold Load Multiplier of 1.5.

Once load current is restored the Operational Cold Load Timer starts to count down. This means that the Operational Cold Load Multiplier returns to 1 in one hour and hence the phase and earth threshold currents also return to their normal values.

In this way, lost load diversity is automatically compensated for. It doesn't matter where the current was turned off (e.g. at the substation or at the recloser) the compensation will still work.

Some operational constraints are listed below:

- The User Set Cold Load Time and the User Set Cold Load Multiplier are set on:

 PROTECTION SETTINGS 5 (A...J)

 ENGINEER MENU – PROTECTION MENU – PROTECTION CONTROL
– COLD LOAD PICKUP

- The Operational Cold Load Multiplier will not go above the user set Cold Load Multiplier or below the user set thresholds on:

 PROTECTION SETTINGS 1 (A...J)

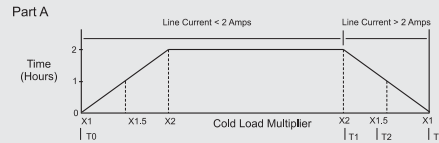
 OPERATOR MENU – OPERATOR CONTROLS – COLD LOAD

- On power up of the ADVC, the load is assumed to be diverse, i.e. the Operational Cold Load Time is zeroed and "Cold Load IDLE" will be displayed.
- Cold Load affects phase and earth protection thresholds including instantaneous but not SEF.
- High Current Lockout and Definite Time settings are not affected.
- Cold Load Pickup cannot be used if normal currents are expected to drop below 2.5A and should be turned off.

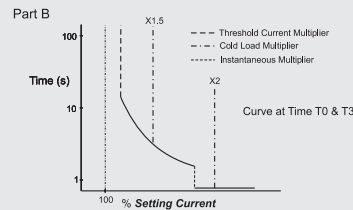
COLD LOAD PICKUP EXAMPLE

The figure below is an example of the Cold Load settings applied to an inverse curve. In this example, the Threshold Current Multiplier is set to $\times 1.1$, the Instantaneous Multiplier is set to $\times 1.75$, the Cold Load Multiplier is set to $\times 2$ and the Cold Load time is set to 2 hours.

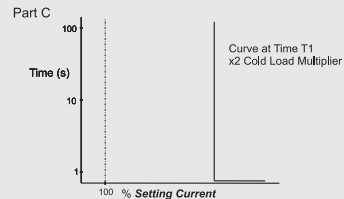
Part A indicates how the Current Multiplier will vary according to the length of time the line current is turned off and then restored.



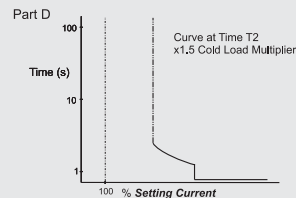
Part B indicates the original protection curve.



Part C indicates the protection curve that is constructed for use when the line current has been restored for 1 hour (T1 in Part A) and the Current Multiplier corresponds to 2 times the setting current. In this case an Instantaneous Trip will not occur until the line current exceeds 2 times the "setting current".



Part D indicates the protection curve that is constructed for use when the line current has been restored for 1 hour (T2 in Part A). This corresponds to a Current Multiplier of 1.5 times the setting current. Note that an Instantaneous Trip will now occur at the set value of 1.75 times the setting current. After the power has been restored for 1.8 hours the Cold Load Multiplier will revert to the original Threshold Multiplier settings and the protection curve will be as in Part B.



COLD LOAD PICKUP STATUS DISPLAY

The operational status of the cold load pickup is shown at:

set SYSTEM STATUS – OPERATORS SETTINGS 2: Cold Load
flex OPERATOR MENU – OPERATOR CONTROLS – COLD LOAD

This can show the following states:

- Cold Load OFF: Cold load pickup has been configured OFF in the currently active protection group, no operator control of Cold Load Pickup is possible.
- Cold Load IDLE: Cold Load Pickup is configured ON but Cold Load Pickup is not affecting the thresholds. This is probably because the load current is on and the Operational Cold Load Time is zero. This is the normal condition.
- CLP 60min $\times 1.5$ mult (for example). The display shows the current Operational Cold Load Time and Multiplier. This affects the protection thresholds. In this example the Operational Cold Load Time is 60mins and the Multiplier is 1.5.

OPERATOR CONTROL OF COLD LOAD PICKUP

When Cold Load Pickup is configured ON at the currently active protection group it can be further controlled (**set** on the **setVUE**) by using **SELECT**, and the **← →** keys.

These keys enable the following:

- Zero the Operational Cold Load Time. Note that if the load current is off the Operational Cold Load Time will start to increase.

- Set the Operational Cold Load Time and Multiplier to a desired value. Note that the Operational Cold Load Time will then increase or decrease depending on whether the load current is OFF or ON.

AUTOMATIC PROTECTION GROUP SELECTION

Sometimes a ACR is used at a location in a supply network where the power flow can be in either direction depending on the configuration of the rest of the network.

One example of this is a network tie point where the operator may have to select a different group of protection settings to compensate for a change in power flow when changing the network configuration. Emergency switching configurations may require more than one pair of Protection Groups.

ENABLING AUTOMATIC SELECTION

Automatic Protection Group Selection (APGS) allows the appropriate Protection Group to be selected automatically without the need for operator intervention. It works by automatically changing between Protection Groups depending on the direction of power flow.

- APGS is made available by setting:

 SYSTEM STATUS – OPTIONS 2: APGS Allowed

 ENGINEER MENU – CONFIGURATION MENU –FEATURE SELECTION
– PROTECTION – APGS Not Available

- Either the Primary or Alternate Group required is selected.

- APGS is then enabled by selecting:

 SYSTEM STATUS – OPERATOR SETTINGS 1:
Protection Auto

 OPERATOR MENU – OPERATOR CONTROLS – PROT 'x/y' ACTIVE

- The operator display will indicate the currently active set by displaying:

 SYSTEM STATUS – OPERATOR SETTINGS 1:
Auto "A" to "J" Active.

 OPERATOR MENU – OPERATOR CONTROLS – PROT 'x/y' ACTIVE

On power down, the ADVC saves the current status of Protection Auto and uses that status to determine the active Protection Group on power up.

DISABLING AUTOMATIC SELECTION

APGS is turned OFF (disabled) either by:

- A change of power flow configuration.
- Selecting a specific Protection Group other than APGS:
- Setting APGS Not Allowed

 SYSTEM STATUS – OPTIONS 2: APGS Not Allowed

 ENGINEER MENU – CONFIGURATION MENU –FEATURE SELECTION
– PROTECTION – APGS Not Available

SELECTION RULES

When the APGS feature is enabled, the active Protection Group is automatically selected in accordance with the following rules:

- There is a maximum of five pairs of APGS Protection Groups: A&B, C&D, E&F, G&H and I&J. Each pair comprises a Primary Protection Group and Alternate Protection Group respectively.
- The number of APGS pairs depends on how many protection sets are selected to be available. Where an odd number of Protection Groups have been selected the last group does not participate in APGS. Protection Auto can not be selected if this last group is active.
- When the power flow is in the positive direction (source to load) Primary

Protection Group A, C, E, G or I is used.

- When the power flow is in the negative direction (load to source) Alternate Protection Group B, D, F, H or J is used.
- For APGS to generate a change, from Primary to Alternate Protection Group, the power flow must be greater than 50kW in the negative direction (load to source), and for longer than the period set on

set SYSTEM STATUS – OPTIONS 2: APGS Change 60s

flex OPERATOR MENU – OPERATOR CONTROLS – APGS Change

- Similarly ; to revert to the Primary Protection Group the power flow must be greater than 50 kW in the positive direction (source to load) for the same amount of time as set above.

PROTECTION ELEMENTS

Protection elements use the fluctuation of voltages and currents in the ACR to drive protection logic which trips the ACR after a period of time determined by the specific protection settings used. The OC protection elements can be configured to be directional, that is they will only respond to fault current flowing in a particular direction.

The currents used for overcurrent protection are determined using analog and digital signal processing circuitry as shown in **Figure 23**. (page 9-17)

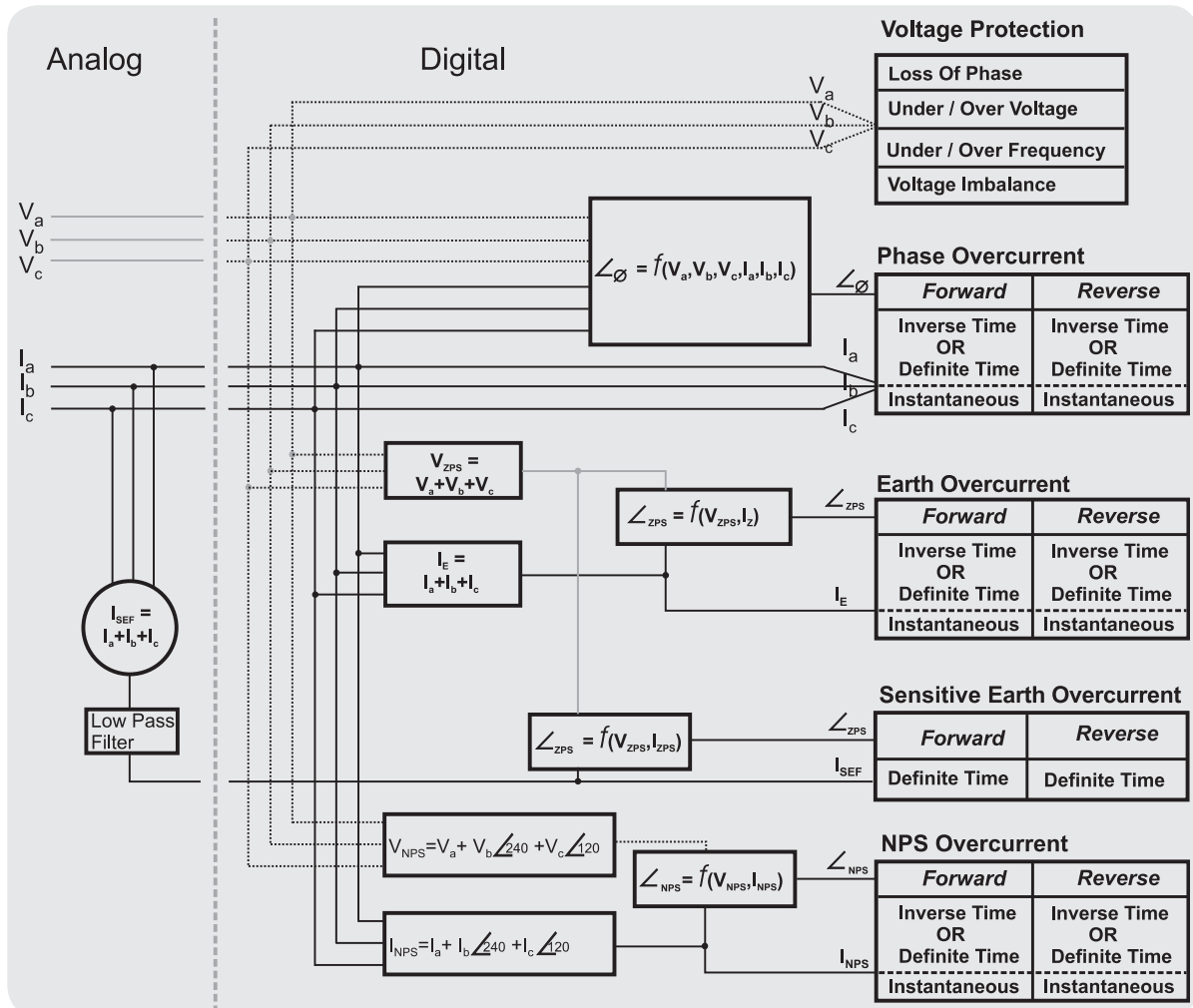


Figure 23. ADVC Protection Block Diagram

The circuitry works as follows:

- The current in the circuit is reduced by a factor of 2000 in the 2000:1 CTs built into the ACR.
- The CT secondary current is converted to a voltage by the three current sense resistors.
- A fourth current sense resistor in the CT common converts the residual current to a voltage for use in the SEF element.
- The voltages across the phase sense resistors are amplified in variable-gain amplifiers. These ensure high accuracy over a wide range of currents. The amplifier for the residual current sense voltage has a fixed gain because the SEF element operates over a small current range.
- The outputs of the amplifiers are connected to 16 bit Sigma Delta Analog to Digital Converters (ADC) with an effective sampling rate of 3200 samples per second. The output of the residual current sense resistor amplifier is passed through a low pass filter to reduce second and third harmonics.
- The output of the ADC is processed by the Digital Signal Processor (DSP) using various proprietary algorithms which measure the true RMS value of each current averaged over 1 cycle, updated at 2.5ms intervals. These true RMS values are used by the protection logic in the PowerPC microprocessor to determine if and when to trip the ACR.

Voltages used in the directional overcurrent protection elements are processed as follows:

- Phase-earth voltages on the bushing terminals are converted to a small current by the capacitive voltage sensors in the bushings. These currents are amplified and converted to voltages in the ADVC.
- The analog-digital conversion and digital processing of these voltages works in the same manner as for the currents.

CURRENT OPERATED PROTECTION ELEMENTS

The following are all current operated elements with their own separate trip current settings.

- Phase Overcurrent
- Earth
- Sensitive Earth
- Negative Phase Sequence

Each element is constantly monitoring the instantaneous level of phase, earth or NPS current as required.

Protection pickup will occur for each element when the trip current setting for that element multiplied by any threshold multipliers that are active, is exceeded.

The time delay between pickup and when a trip command is issued to the ACR depends on which protection trip is active at the time and the timing characteristic configured for that protection trip.

Up to twenty-four separate timing characteristics may need to be configured if 4 trips to lockout as well as Single Shot and Work Tag trips are being used, i.e. 4 protection elements X 6 protection trips).

At any given time, any one of six protection trips will be active: Trip 1, Trip 2, Trip 3, Trip 4, Single Shot, or Work Tag.

Providing the ACR is configured for 4 trips to lockout, see "**Lockout** (page 9-46)", trips 1 through 4 will occur in sequence when tripping is caused by a persistent fault and Auto Reclose is On. If the ACR is configured for 2 trips to lockout, trips 3 and 4 need not be configured for any of the protection elements.

The Single Shot trip, see "**Single Shot Tripping** (page 9-46)", is active when Auto Reclose is off but can also be active for a set time when the ACR is closed manually. Thus if the ACR is closed onto a fault it will trip according to the Single Shot settings.

The Work Tag trip is active whenever the Work Tag is applied. When the Work Tag is applied, protection trip timing will occur according to the Work Tag settings for the element that has picked up.

Phase Overcurrent (OC) Elements

The number of Phase OC elements varies depending on whether the overcurrent protection has been configured to be directional. If overcurrent protection is directional, then there are two independent OC elements per phase. If overcurrent protection is non-directional then there is one independent OC element per phase.

The OC elements in each phase are driven by the RMS current in the corresponding phase.

One of the OC elements responds to currents in the designated forward direction, the other OC element responds to currents in the designated reverse direction. Each OC element can be configured to have an Inverse Time characteristic, a Definite Time characteristic, or an Instantaneous characteristic.

Each phase in a direction share the same settings. So, for example, it is not possible to have different settings for A phase and B phase in the forward direction.

Detailed descriptions of the various time/current options are given later in this chapter.

The direction of current flow for the OC elements is determined by calculating the phase angle between the currents and voltages while the OC elements are picked up.

Earth Fault (EF) Elements

The number of EF elements varies depending on whether the overcurrent protection has been configured to be directional. If overcurrent protection is directional, then there are two independent EF elements. If overcurrent protection is non-directional then there is one independent EF element.

The EF elements are driven by the residual current, that is the real-time vector sum of the three phase currents. The residual current used for the EF elements is calculated in real time by digitally summing the phase currents, sample by sample:

$$\text{Residual current} = A \text{ phase current} + B \text{ phase current} + C \text{ phase current}$$

$$I_e = I_a + I_b + I_c$$

Note that the Zero Sequence Current (I_0) is defined as:

$$I_0 = (I_a + I_b + I_c) / 3$$

So, the zero sequence current is one third of the residual current. Similarly the residual voltage is given by:

$$V_e = V_a + V_b + V_c$$

One of the EF elements responds to current in the designated forward direction, the other responds to current in the designated reverse direction. Each EF element can be configured to have an Inverse Time characteristic, a Definite Time characteristic, or an Instantaneous characteristic.

Detailed descriptions of the various time/current options are given later in this chapter.

The direction of current flow for the EF elements is determined by the phase relationship between the zero sequence voltage and current while the EF elements are picked up.

Sensitive Earth Fault (SEF) Elements

The number of SEF elements varies depending on whether the overcurrent protection has been configured to be directional. If overcurrent protection is directional, then there are two independent SEF elements. If overcurrent protection is non-directional then there is one SEF element.

The SEF elements are driven by the measured residual current. The residual current used for the SEF elements is determined by measuring the current in the common connection between the three CTs in the ACR.

$$\text{Residual current} = A \text{ phase current} + B \text{ phase current} + C \text{ phase current}$$

$$I_e = I_a + I_b + I_c$$

Note that the Zero Sequence Current (I_0) is defined as:

$$I_0 = (I_a + I_b + I_c) / 3$$

So, the zero sequence current is one third of the residual current. Similarly the residual voltage is given by:

$$V_0 = V_a + V_b + V_c$$

One SEF element responds to current in the designated forward direction, the other SEF element responds to current in the designated reverse direction. The SEF elements have a Definite Time characteristic only.

The direction of current flow for the SEF element is determined by the phase relationship between the zero sequence voltage and current while the SEF element is picked up.

Negative Phase Sequence (NPS) Elements

The number of NPS elements varies depending on whether the overcurrent protection has been configured to be directional. If overcurrent protection is directional, then there are two independent NPS elements. If overcurrent protection is non-directional then there is one independent NPS element.

The NPS elements are driven by the Negative Phase Sequence current. The Negative Phase Sequence current used for the NPS elements is calculated in real time by digitally summing the phase currents, sample by sample:

$$I_2 = (I_a + (I_b \angle 240^\circ) + (I_c \angle 120^\circ)) / 3$$

Similarly Negative Phase Sequence Voltage is calculated in real time by digitally summing the phase voltages, sample by sample:

$$V_2 = V_a + (V_b \angle 240^\circ) + (V_c \angle 120^\circ)$$

One of the NPS elements responds to current in the designated forward direction, the other responds to current in the designated reverse direction. Each NPS element can be configured to have an Inverse Time characteristic, a Definite Time characteristic, or an Instantaneous characteristic.

The direction of current flow for the NPS elements is determined by the phase relationship between the NPS voltage and current while the NPS elements are picked up. Detailed descriptions of the various time/current options are described later in this chapter.

Reset Curves

Where an ACR is located downstream from an induction disc protection relay, the Reset Curves function allows you to coordinate the ACR with the upstream relay to ensure that, for a downstream fault, the ACR always trips before the relay.

When Reset Curves are enabled the reset timing after pickup will be according to one of the following:

- Definite Time. This is the default curve. A setting value of 50ms provides the same behaviour as provided with Reset Curves disabled. An instantaneous reset can be achieved by setting a definite time of 0ms.
- Inverse Time Curve. The curves provided are as per the following table:

IEEE Moderately Inverse	$T = \frac{4.85 * \text{Time_Multiplier}}{(M^2 - 1)}$
IEEE Very Inverse	$T = \frac{21.6 * \text{Time_Multiplier}}{(M^2 - 1)}$
IEEE Extremely Inverse	$T = \frac{29.1 * \text{Time_Multiplier}}{(M^2 - 1)}$
IEC255 Inverse	$T = \frac{13.5 * \text{Time_Multiplier}}{(M^2 - 1)}$
IEC255 Very Inverse	$T = \frac{47.3 * \text{Time_Multiplier}}{(M^2 - 1)}$



A Reset Threshold of 100% is recommended for close simulation of an Induction Disk Relay. This makes the formulae the same.



Tables of Reset Curves reset times are at “Appendix H Reset Curves Reset Times (page H-1)”

IEC255 Extremely Inverse

$$T = \frac{80 * \text{Time Multiplier}}{(M^2 - 1)}$$

No resetting occurs above the Reset Threshold level.

The Reset Curve starting point, which can be either “Reset Threshold” (default) or “Pickup”, determines the definition of M in the above formulae.

If the Reset Curve starting point is set to “Reset Threshold”,

$$M = (\text{Measured Current}) / (\text{Reset Threshold} \times \text{Pickup Current}).$$

If the Reset Curve starting point is set to “Pickup”,

$$M = (\text{Measured Current}) / (\text{Pickup Current}).$$

- User Defined Reset Curves. These are created, edited and downloaded via the WSOS5 curve editor. The maximum number of user defined reset curves which can be loaded in the ADVANCED at any time is 5. Each curve has 30 points.

There are no curve modifiers (i.e. maximum, minimum and additional time, instantaneous) provided.

The Reset Curves feature is enabled via the WSOS5 Feature Selection page or

set SYSTEM STATUS – DISPLAY GROUP PAGE: Options
Protection 1

flex ENGINEER MENU – CONFIGURATION MENU – FEATURE SELECTION
– PROTECTION – Reset Curves Available

If Reset Curves is not enabled, the behaviour will be as though a Definite Time curve had been selected.

Reset Current

As with the trip curve, a start value is required (i.e. a multiplier of 1). This is set as a percentage of the Pickup Current and has a default of 90% and a range of 10% to 100%. The default gives the same behaviour as for Reset Curves disabled when used with a Pickup Multiplier of 1.0.

Reset timing occurs when the current is below the Reset Current.

When Reset Curves is not enabled, the Reset Current will be adjustable in the range of 90% to 100% of the Pickup Current (not the Trip Curve Setting Current). A means is provided to adjust where the Reset Curve actually begins. By default, it starts at the Reset Current but can be adjusted to start at the Pickup Current at

set PROTECTION SETTING 4

flex ENGINEER MENU – PROTECTION MENU – PROTECTION GLOBAL
– FAULT RESET – Reset Curves Start At

DIRECTIONAL OVERCURRENT PROTECTION

All Overcurrent Protection elements can be configured to be directional, so that protection element operation depends on the direction of the fault current. This is useful when the network has multiple sources of supply, or is configured with closed rings instead of radial feeders.

Directionality is a global setting, i.e. it applies to all overcurrent elements in all Protection Groups. For example, it is not possible to have the OC element directional and the EF element non-directional.

There are three directional options:

Directional Setting	
Non-directional (the default setting)	The overcurrent elements operate regardless of the fault current direction
Directional Protection	Each overcurrent element has two groups of settings, one operates for faults in the forward direction and one operates for faults in the reverse direction

Directional Blocking	The overcurrent elements operate for faults in the user-selected direction (forward or reverse) but do not operate for faults in the other direction
----------------------	--

Directionality is enabled using the Feature Selection screen of WSOS5. See " (page 16-1)"

Directional Protection

When Directional Protection is enabled, each overcurrent element has two groups of settings, one operates for faults in the forward direction and one operates for faults in the reverse direction.

Determining Direction

The ADVC monitors the phase angle between voltage and current per phase in order to determine the direction of power flow through the recloser.

This means that when a fault is detected, the protection can determine on which side of the recloser the fault occurred.

Different protection settings can be applied to determine the pickup current and time to trip depending on which side of the recloser the fault has occurred.

Because the direction of a fault needs to be determined before the correct settings can be applied there is a minimum time that can be applied.

This time penalty is approximately 25ms for all elements (Phase, earth SEF and NPS) and will be present for all types of over current protection. This timing takes place concurrently with protection timing.

N-Series reclosers utilize the bushing designations U1,U2,V1,V2, W1 & W2. (The sides of the N-Series recloser are referred to as the "1" and "2" sides). U-Series reclosers utilize the bushing designations I,x,II,xx, III & xxx. (The sides of the U-Series recloser are referred to as the "I" and "x"-sides.)

Either side can be designated load or source at:



PHASE VOLTAGE and POWER FLOW: Source, Load



ENGINEER MENU – CONFIGURATION MENU – SYSTEM SETTINGS
– METERING PARAMETERS – Source 'x', Load 'y'

on the control panel or via the measurement page on WSOS5. Fault current flowing from source to load is considered a forward fault and fault current flowing from load to source as a reverse fault. It is essential to take account of the physical orientation of the breaker before determining configuration of source and load.

Protection Groups

When Directional Protection is ON, there are two protection groups active. A/B, C/D, E/F, G/H or I/J.

The first of these groups is known as the Forward protection group and the other is the Reverse protection group e.g. if C/D are active, C is Forward and D is Reverse.

The ADVC monitors the pickup settings for both protection groups. Initially, when a pickup is detected, the direction of the fault is not known and a delay of 25ms occurs before the fault direction is determined. However, the 25ms it takes to detect direction does not delay the time to trip which is counted from pickup. Once the direction of the fault is known, and the pickup is active for that direction, a pickup, either forward or reverse, is reported.

The pair of protection groups that become active when Directional Protection is turned on depends on which group was active at the time.

If Directional Protection is turned on when protection group A is active, then groups A and B become active.

The two active protection groups (Forward and Reverse) can be configured differently. This means that the pickup current and time to trip for a given fault can be different.

Also the ADVC can coordinate with different upstream devices depending on which direction the fault current is flowing.



In the case of a bolted earth fault on or close to the recloser terminals, the voltage to earth measured by the CVTs would be nearly zero. In this situation, the ADVC would not be able to determine the direction of power flow through the ACR.

Directional Protection Operation

When fault current is detected, the power flow direction is checked to determine if the fault has occurred on the Source or Load side of the recloser.

If the fault is discovered to be on the Load side and the forward protection group trip setting has been exceeded, a Pickup Fwd event is logged and the protection calculates the time to trip according to the forward protection group settings. If the active protection groups are A and B, then Group A is used.

If the fault is discovered to be on the Source side, a Pickup Rev event is logged and the protection calculates the time to trip according to the reverse protection group settings, in this case Group B.

When the currently picked up curve times out, a trip will occur.

Low V Configuration Settings

A trip cannot occur until the direction has been resolved. To resolve the direction of the fault current, Directional Protection utilises the new features of the ADVC's Digital Signal Processor (DSP) which directly calculates the fault angle.

To do this accurately, the DSP requires a minimum polarising voltage for each element. This minimum voltage may not be present during all fault conditions. Where insufficient voltage is present, protection will behave according to the Low V configuration settings.

Where the minimum voltage required to determine the direction of power flow through the ACR is not present, the ADVC has three options depending on the settings applied.

The options are:

- **Ignore Low V.** With this option, the voltage is ignored altogether and the power flow direction is not determined. Both active protection groups will react as though they would if they were the active group and directional protection was off.
- **Use the forward configuration settings for the protection.** With this option it is assumed that the power flow is in the forward direction. The time to trip is calculated according to the forward protection group settings.
- **Use the reverse configuration settings for the protection.** With this option, it is assumed that the power flow is in the reverse direction. The time to trip is calculated according to the reverse protection group settings.

Polarising Voltage

Each protection element has its own polarising voltage used to determine the direction of the fault current.

OC: Use Phase/Earth V 500+ V, this value is not configurable or dependent on the nominal system voltage.

Default: 500V

Range: 500V

EF: Use zero phase sequence voltage (VZPS) and compare to Nominal Phase/Earth Voltage

Default: 20% of Nominal Phase/Earth

Range: 5% - 100%

SEF: Use zero phase sequence voltage (Vzps) and compare to Nominal Phase/Earth Voltage

Default: 5% of Nominal Phase/Earth

Range: 5% - 100%

NPS: Use negative phase sequence voltage (VZPS)

Default: 0V

Range: 0 - 2000 VNPS

Characteristic Angle

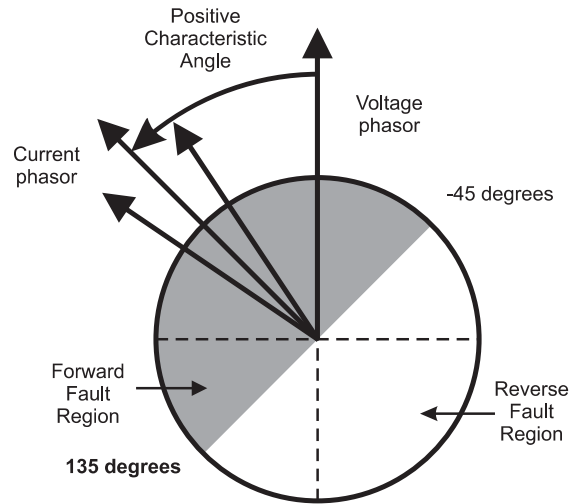


Figure 24. Characteristic Angle

In order to correctly resolve fault direction it is necessary for the network characteristic angles to be known. Angles must be set for:

- Phase
- Earth and SEF
- Negative Phase Sequence

Setting a positive phase characteristic angle of 45° means that it has been calculated using the network parameters that a phase fault will cause a fault current that leads the phase voltage by 45° .

During an actual fault, the angle of the fault current may vary from this calculated angle due to arc resistance or other external current paths.

Any fault current angle that falls within $\pm 90^\circ$ of the calculated value will be Any fault currents outside this range will be in the reverse fault region indicating a reverse fault.

Consider the phasor diagrams in **Figure 25**. (page 9-24) for an earthed neutral system with a single resistive phase to earth fault on the A-phase.

The voltage on the A-phase is reduced and the residual voltage phasor is as shown. The current in the A-phase is increased and the residual phasor (earth current) is as shown.

The characteristic angle of this hypothetical fault is 180° , that is the current is 180° out of phase with voltage. Therefore if this situation applied for single phase earthed faults in the network the earth characteristic angle would be set for -180° using:

set Directional Blocking 2:
Earth Characteristics Angle -180° deg

flex ENGINEER MENU – PROTECTION MENU – DIRECTIONAL ELEMENTS
– DIRECTIONAL BLOCKING – EARTH – Characteristic

The characteristic angle of the earth fault is determined by the network characteristics (line resistance and reactance, neutral earthing arrangement) and the fault characteristics (such as the nature of the short-circuit - solid or arcing, fault impedance and earth resistance).

The expected characteristic angle will be approximately:

- Minus 90° for systems with unearthed neutrals.

For typical solidly or impedance earthed medium voltage distribution networks the residual current lags the residual voltage by more than 180° . This is of course equivalent to leading the voltage by less than 180° .

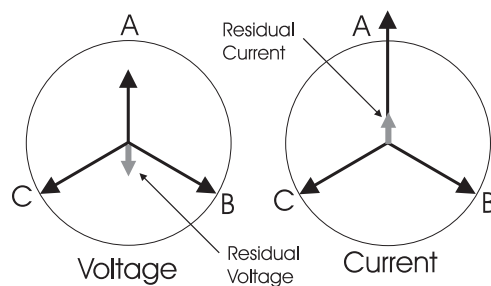


Figure 25. Earth / SEF directional protection

The expected characteristic Angle will be approximately:

- Plus 135 deg for systems with solidly or impedance earthed transformer neutrals.

Turning Directional Protection On/Off

Directional Protection can be turned On and Off via WSOS5 only.

When Directional Protection is turned On or Off a warning message will be displayed informing you of what protection groups will become active or inactive and giving you the option to continue or cancel the operation.

Directional Protection On/Off is selected on the WSOS5 Configuration -> Feature Selection page.

When directional protection is turned off, what was the forward protection group becomes active i.e. if groups E and F were active when directional protection was turned off, Group E will become active.

When turning Directional Protection ON two things should be considered:

- Firstly, Directional Protection and Directional Blocking are mutually exclusive. If Directional Blocking is On, it must be turned Off before Directional Protection can be turned On.
- Secondly, Directional Protection cannot be turned On if Automatic Protection Group Selection is Allowed. Directional Protection will be greyed out if APGS is Allowed.

The active protection groups will include the group that was previously active plus the other one in the same pair e.g. If A was active, then A and B become active; if D was active then C and D become active etc.

- When Directional Protection is on, the active protection group display on the interface screen changes to show both protection groups that are now active.

 -----Operator Settings 1-----S
LOCAL CONTROL ON EF ON SEF OFF
Auto Reclose ON NPS ON
Prot 2A/B0 Active

 Protection Group
A / B Active

- The protection menu screens include either FWD or REV in the title line of each screen for which there are separate settings for the forward and reverse directions respectively.

FWD or REV in the title line does not imply that the displayed protection group is active. All displayed protection groups will include either FWD or REV in their title line whenever Directional Protection is on.

e.g.  -----REV PROTECTION SETTING 1B-----S
Group B Displayed Copy OFF
Phase Trip 200 Amp Earth Trip 100 Amp
Phase Threshold 1.1 Earth Threshold 1.1

- Two protection groups are active and displayed in bold. In this example the active protection groups are A and B.

Most of the Directional Protection settings are on the Directional Protection page for the forward active protection group. The settings displayed for the reverse active protection group are a copy of the settings displayed for the forward group.

- A Forward or Reverse Auto Reclose setting appears on the Forward and/or Reverse Global Settings screens. If either Forward or Reverse Auto Reclose is selected OFF, Auto Restore ON/OFF becomes available for that group.

Trips To Lockout

The number of trips to lockout will never exceed 4.

There are separate sequence counters for the forward and reverse direction protection groups.

If a fault current causes a trip in the forward direction it will be fwd trip 1. If, after an auto reclose, another fault is detected in the reverse direction thus causing a reverse protection trip, it will be trip number 1 of the reverse protection sequence.

If this pattern repeats, the recloser will go to lockout on the 4th actual trip regardless of the direction of any particular trip.

Lockout occurs whenever the number of trips to lockout is reached or there is an operator-initiated trip. A lockout applies to both the forward and reverse directions. This means that it is not possible to have a lockout in one direction only.

Sequence Reset

There is a single Sequence Reset Timer setting for both the forward and reverse protection groups.

Whenever an automatic reclose occurs following a trip, the sequence reset timer will be started. When this timer expires, both forward and reverse sequence counters will be reset to trip 1.

If another trip occurs after an automatic reclose before the sequence reset timer expires, the timer will reset and start again when the next automatic reclose occurs.

The sequence reset timer is restarted whenever a curve is in pickup. The curve is considered to be in pickup until all curves have reset.

Auto Reclose

When Directional Protection is On, each protection group has its own Auto Reclose On/Off setting.

Automatic reclose will only occur following a protection trip if:

- Auto Reclose is On for the protection group that was active for that trip and:
- The global Auto Reclose setting was On prior to the trip.

For Auto Reclose to work with Directional Protection on, Auto Reclose must be selected ON on the Control page.

As well as this, Auto Reclose must be on for either the forward or reverse protection group for Auto Reclose to work for faults in the forward or reverse direction respectively.

With Directional Protection On, selecting Auto Reclose Off for any of the protection groups allows Auto Restore to be configured.

Auto Restore

Auto Restore is used to close a recloser with Directional Protection, after the fault that tripped the device has been cleared.

Auto Restore would normally be used where the reclose was part of a closed loop topology to restore the loop to the condition it was in prior to the fault.

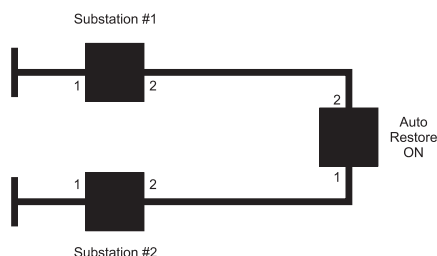
Auto Restore is configured by selecting the On setting and entering a value for the Auto Restore Time between 3 and 1800 seconds.

Live Load Blocking cannot be selected ON when Auto Restore is on as that would prevent Auto Restore from operating.

Auto Restore will close the recloser after it has done a Single Shot trip due to a fault and the voltage on both sides of the recloser has been restored to normal 'operating values for the Auto Restore time.

Auto Restore will only operate on a recloser that has voltage sensing on both sides of the recloser.

If Auto Restore is On, the recloser can't go to lockout as this would imply that there will not be any further automatic close attempts. Instead of Lockout, a End of Sequence event is logged.



The Auto Restore timer starts timing when the voltage on both sides is restored to normal.

When Auto Restore performs a close the recloser is in Single Shot mode and thus will go to Lockout if a trip occurs before the Single Shot timer expires.

Auto Restore and Auto Reclose are mutually exclusive.

The Auto Restore On/Off field and Auto Restore Time will be unavailable if the recloser does not have 6 CVTs.

When an End of Sequence event is logged, the following message is displayed:

ACR will close if Source and Load are restored

There is no retry counter.

This means that the Auto Reclose and then Auto Restore loop could continue forever. This would be unlikely, as the voltage would not be restored if there were a real fault that could not be cleared.

V_{ZPS} Balancing

The zero phase sequence voltage is measured from the instantaneous sum of all three phase voltages.

Even in unfaulted networks the ZPS voltage is not likely to be zero because the three phase voltages are not going to be perfectly balanced.

This could lead to problems in high impedance fault conditions because the ZPS voltage due to the earth fault might be dominated by the out-of-balance phase voltages which might lead to incorrect determination of direction.

Vzps balancing overcomes this by continually balancing the phase voltages under normal conditions.

When balancing is enabled, compensation for phase imbalances of up to 20% of the phase to earth voltage will be applied at a rate of 0.6% of phase/earth voltages per second. This allows correct determination of the direction of much lower level faults than would otherwise be possible.

Balancing is paused when any of the following conditions occur:

- A protection pickup occurs.
- The SCEM data is not valid.
- The ACR is open.
- Any of the bushings are dead.

When balancing is enabled the O.I. shows "Vzps Balancing" while the system is continually adjusting for balance, and "Vzps Balance Paused" when the balancing is suspended for one of the above reasons.

When balancing is disabled the O.I. shows 'Vzps Balance Disabled'.

DIRECTIONAL BLOCKING

Directional blocking is an optional protection feature that restricts tripping on faults to a designated side of the ACR. Only one time-current curve is used. At the time of the trip, the direction of the fault is tested and tripping or blocking occurs as per the operator setup. If this option is not available on your ADV C, contact your distributor.

Directional blocking has traditionally been used on simple interconnected primary network schemes as per **Figure 26**, (page 9-28) to secure supplies to important loads. In this simplistic case, ACRs L1 and L2 would be fitted with directional blocking protection facilities. Both would be set to trip for faults in the reverse direction with power flow from load to source but to block if the power flow is in the forward direction from source to load. A fault between S1 and L1 would mean that S1 would see fault current, S2 would see fault current L2 would see fault current from source to load and would block. L1 would also see fault current, flowing from load to source, due to the in feed from S2. L1 would be set to trip faster than S2. In this instance L1 and S1 would both trip to Isolate the fault. Supply would be maintained to the load.

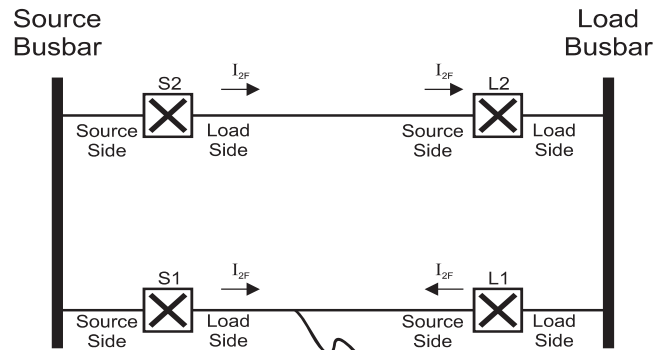


Figure 26. Sample Fault Situation

Radial systems use Directional Blocking to prevent nuisance tripping if particular network conditions are causing “false” earth faults. In this case directional blocking can prevent nuisance tripping by blocking faults in the source direction and only responding to faults in the load direction. This is particularly relevant on systems where the neutral is not earthed. In this instance the earth fault current, due to a line fault, is solely generated due to the line capacitance. There will also be an in-feed from adjacent circuits supplied from the same substation bus bar. The direction of current flow as seen by the ACRs connected to the bus bar will be different on the unfaulted circuits to the faulted circuit.

Characteristic Angle

Please refer to “**Characteristic Angle** (page 9-24)”

The user sets the characteristic angle to define the forward and reverse fault regions for the network and then determines in which region the protection is going to trip or block. The characteristic angle is set using:

set PROTECTION SETTINGS: Directional Blocking 1:
Phase Characteristic Angle 45 Deg

flex ENGINEER MENU – PROTECTION MENU – DIRECTIONAL ELEMENTS
– DIRECTIONAL BLOCKING – PHASE – Characteristic Angle

Tripping/Blocking directions are set separately for Phase, Earth and SEF Protection. See “**Parameters To Be Configured** (page 9-32)” for details of setting up directional blocking.

Phase Directional Blocking

When phase overcurrent protection picks up, the ADVC determines the phase relationship of the voltage and current phasors for the faulted phases taking account of the characteristic angle to determine the direction of the power flow.

If directional blocking is selected for the faulted direction, then the trip is blocked and no trip takes place. The device will pick up and the trip timer will be decremented for a fault in the blocked region however the trip will be inhibited.

The direction is selected on:

set PROTECTION SETTINGS: Directional Blocking 1:
Phase Characteristic Angle 45 Deg

flex ENGINEER MENU – PROTECTION MENU – DIRECTIONAL ELEMENTS
– DIRECTIONAL BLOCKING – PHASE – Characteristic Angle

This parameter can be set for forward tripping, reverse tripping or both forward and reverse tripping (i.e. non-directional).

The ADVC needs a polarising voltage to determine the direction of the fault. Please refer to “**Polarising Voltage** (page 9-23)” If there is a bolted phase fault on the terminals of the ACR there may not be sufficient voltage to determine direction. In this case whether the trip is blocked or armed is determined by

set PROTECTION SETTINGS: Directional Blocking 1:
Low V Block ON

flex ENGINEER MENU – PROTECTION MENU – DIRECTIONAL ELEMENTS
– DIRECTIONAL BLOCKING – PHASE – Low V Block

Setting Low V Block ON will block trips for low voltages. Setting Low V Block OFF will trip for faults in either direction irrespective of the direction if the voltage is low.

Earth/SEF Directional Blocking

Earth and SEF protection operate in a similar manner to phase directional protection, except that the fault direction is determined using earth current and the zero phase sequence voltage.

The Earth and SEF elements can be independently set to trip for faults in the forward or reverse direction or in both directions on:

set PROTECTION SETTINGS: Directional Blocking 1:

flex ENGINEER MENU – PROTECTION MENU – DIRECTIONAL ELEMENTS
– DIRECTIONAL BLOCKING

For SEF protection the fault is likely to be of a high impedance and the zero sequence voltage may be much lower, particularly in earthed neutral networks. The ADVC uses a polarising voltage to determine the direction of the fault. Please refer to “**Polarising Voltage** (page 9-23)”.

For both Earth and SEF protection, if the residual earth voltage is too low to determine fault direction then the trip is either blocked or armed depending on the corresponding setting of

set PROTECTION SETTINGS: Directional Blocking 1:
Low Vzps Block ON

flex ENGINEER MENU – PROTECTION MENU – DIRECTIONAL ELEMENTS
– DIRECTIONAL BLOCKING – EARTH or SEF – Low Vzps Block

Setting Low Vzps Block ON will block trips for low voltages. Setting Low Vzps Block OFF will trip for faults in either direction irrespective of the direction if the voltage is low. The residual voltage Vzps is not likely to be zero even in un-faulted networks. See “**SEF Zero Sequence Voltage Alarm** (page 9-29)”.



It is important to determine the actual earth fault characteristic angle for the network and set this parameter accordingly.

SEF Zero Sequence Voltage Alarm

The directional blocking facility includes detection of high zero sequence voltage (Vzps) above the

set PROTECTION SETTINGS: Directional Blocking 3:
Min SEF Vzps 5%

flex ENGINEER MENU – PROTECTION MENU – DIRECTIONAL ELEMENTS
– DIRECTIONAL BLOCKING – SEF – Minimum SEF Vzps

setting whether SEF protection has picked up or not. This is called the Zero Sequence Voltage alarm.

The alarm is set when Vzps is sustained above the Min SEF Vzps configurable threshold for longer than High Vzps configurable alarm time set at:

set PROTECTION SETTINGS: Directional Blocking 3:
High Vzps alarm 5 sec

flex ENGINEER MENU – PROTECTION MENU – DIRECTIONAL ELEMENTS
– DIRECTIONAL BLOCKING – HIGH Vzps – Alarm Timeout

and is cleared when Vzps falls below the threshold again.

The alarm status is displayed on the Operator Interface page:

set PROTECTION SETTINGS: Directional Blocking 3:
High Vzps Alarm ON/OFF

flex ENGINEER MENU – PROTECTION MENU – DIRECTIONAL ELEMENTS
– DIRECTIONAL BLOCKING – High Vzps – Alarm Status

and is available for transmission by telemetry protocols.

This indication can be useful in unearthed neutral networks for earth fault detection. The Zero Sequence Voltage Alarm is affected by the voltage balancing described in “**VZPS Balancing** (page 9-27)” and it is expected that Zero Sequence Voltage Balancing is disabled if the Zero Sequence Voltage Alarm is used.

Event Record

When the ADVC first resolves the fault direction an armed or blocked event is logged in the event record. The ADVC then continues to resolve the direction for the duration of the fault. Each time the direction changes another event is written. For all protection elements that pickup a separate event is written. The fault current maximum events are recorded in the normal way when the protection resets.

In the case of an earth or SEF pickup an event is logged to record the value of Vzps at the time of the maximum earth current.

The Directional Blocking events are listed in the table below. These events only occur when Directional Blocking is ON.

Event Text	Description
Earth Dir Arm	An earth protection pickup occurs and tripping is enabled in the faulted direction. The trip takes place as normal.
Earth Dir Block	An earth protection pickup occurs but tripping is blocked in the faulted direction. The recloser does not trip.
Earth Low Vzps Arm	An earth protection pickup occurs and tripping is enabled because the zero sequence voltage (Vzps) is less than the user-specified level and Low Vzps blocking is OFF. The trip takes place as normal.
Earth Low Vzps Block	An earth protection pickup occurs and tripping is blocked because the zero sequence voltage (Vzps) is less than the user-specified level and Low Vzps blocking is ON. The ACR does not trip.
Phase Dir Arm	A phase overcurrent pickup occurs and tripping is enabled in the faulted direction. The trip takes place as normal.
Phase Dir Block	A phase overcurrent pickup occurs but tripping is blocked in the faulted direction. The ACR does not trip.
Phase Low V Arm	A phase protection pickup occurs and tripping is enabled because the voltage on all three phases (V) is less than 500 V and Low V blocking is OFF. The trip takes place as normal.
Phase Low V Block	A phase protection pickup occurs and tripping is blocked because the voltage on all three phases (V) is less than 500 V and Low V blocking is ON. The ACR does not trip.
SEF Dir Arm	A SEF pickup occurs and tripping is enabled in the faulted direction. The trip takes place as normal.
SEF Dir Block	A SEF pickup occurs but tripping is blocked in the faulted direction. The ACR does not trip.
SEF Low Vzps Arm	A SEF protection pickup occurs and tripping is enabled because the zero sequence voltage (Vzps) is less than the user-specified level and Low Vzps blocking is OFF. The trip takes place as normal.
SEF Low Vzps Block	A SEF protection pickup occurs and tripping is blocked because the zero sequence voltage (Vzps) is less than the user-specified level and Low Vzps blocking is ON. The ACR does not trip.
Vzps 99999V	This event is generated to record the value of the zero sequence voltage Vzps) at the time of the maximum earth or SEF current.

Table 3. Fault Direction Event Record



Directional Blocking must be set to AVAILABLE through WSOS or the following pages will not be available.



Only displayed if Sequence Components are available.

Configuration Pages

This section shows Directional Blocking configuration pages on the O.I. These pages are in the Protection Settings Display Group at:

PROTECTION SETTINGS 5 (A...J)

These pages have the general format: (please refer to "**Appendix M Protection pages**" (page **M-1**)" for details).



```

----- DIRECTIONAL BLOCKING 1A ----- P
Phase      Trip Fwd/Rev Low V Block OFF
Earth      Trip Fwd/Rev Low V Block OFF
SEF        Trip Fwd/Rev Low V Block OFF
  
```

```

----- DIRECTIONAL BLOCKING 2A ----- P
NPS Trip Fwd & Rev  Low VNPS Block OFF
  
```

```

----- DIRECTIONAL BLOCKING 3A ----- P
Phase Characteristic Angle  -45 Deg
Earth Characteristic Angle   135 Deg
NPS Characteristic Angle     180 Deg
  
```

```

----- DIRECTIONAL BLOCKING 4A ----- P
Nom P E V 6.3kV      Min Earth VZPS 20%
                     Min SEF VZPS 5%
                     Min NPS VZPS 0V
  
```

```

----- DIRECTIONAL BLOCKING 5A ----- P
High VZPS DISABLED  VZPS Block DISABLED
HIGH VZPS Alarm OFF
  
```



The Directional Blocking settings for the **flexVUE** can be found in the menus under:

ENGINEER MENU – PROTECTION MENU – DIRECTIONAL ELEMENTS
– DIRECTIONAL BLOCKING

Parameters To Be Configured

Directional Blocking requires the following parameters to be set correctly:

- The Source/Load direction to be set at

 PHASE VOLTAGE and POWER FLOW: Source, Load

 ENGINEER MENU – CONFIGURATION MENU – SYSTEM SETTINGS
– METERING PARAMETERS – Source 'x', Load 'y'

- The System Voltage to be set at

 Directional Blocking: Nom P-E Volts 6.3kV

 ENGINEER MENU – PROTECTION MENU – DIRECTIONAL ELEMENTS
– DIRECTIONAL BLOCKING – SYSTEM VOLTAGE –
– Nominal Phase/Earth Voltage

This is the nominal phase/earth system voltage.

- Residual voltage balancing configured if required to improve SEF detection in earthed systems at

 Directional Blocking 3: Vzps Balance Disabled

 ENGINEER MENU – PROTECTION MENU – DIRECTIONAL ELEMENTS
– DIRECTION BLOCKING – Vzps BALANCE

- High Vzps alarm time, or disabled at

 Directional Blocking 3: High Vzps Alarm Disabled

 ENGINEER MENU – PROTECTION MENU – DIRECTIONAL ELEMENTS
– DIRECTION BLOCKING – High Vzps

- For Phase and Earth/SEF, the following parameters must be set at

 Directional Blocking 1,2 &3:

 ENGINEER MENU – PROTECTION MENU – DIRECTIONAL ELEMENTS
– DIRECTION BLOCKING – PHASE or EARTH or SEF

- The characteristic angle.
- The trip direction.
- The low voltage blocking to be turned on or off.
- The minimum Vzps for Earth and SEF protection (set independently).

In addition, the normal protection parameters must also be set.

Turning Directional Blocking ON/OFF

Directional blocking can only be turned on and off via WSOS5.

When directional blocking is turned on or off in the ADVC, a warning message will be displayed informing you that the current protection groups directional blocking settings will become active or inactive and giving you the option to continue or cancel the operation.

VOLTAGE OPERATED PROTECTION ELEMENTS

The following are all voltage operated elements:

- Under Frequency
- Over Frequency
- Under Voltage
- Over Voltage
- Loss of Phase

Under and Over Frequency protection can be configured separately and will cause the ACR to trip if the frequency of the voltage measured on the terminal bushings goes outside the limits set for a predetermined time.

An auto reclose cannot occur following either an under or over frequency trip, but the protection settings can be configured to automatically close the ACR when the frequency returns to normal.

Loss of Phase protection can be used to trip the ACR if the voltage on one or two phases drops below a predetermined value for a pre-set time. A loss of phase protection trip will always cause lockout. i.e. no automatic reclose can occur.

UNDER AND OVER FREQUENCY PROTECTION ELEMENTS

The ADVC can be configured to trip the ACR when the system frequency is above (Over Frequency) or below (Under Frequency) user-set frequencies for user-set times. The ADVC can also be configured to automatically close the ACR when the frequency has returned to user-set limits. To use Under/Over Frequency, it must be made available via

 **SYSTEM STATUS – OPTIONS:** U/O Freq Not Avail.

 **ENGINEER MENU – CONFIGURATION MENU – FEATURE SELECTION**
– PROTECTION – UOF Available/Not Available

Under Frequency Protection is commonly used to automatically shed load when generation capacity is not adequate to meet load requirements.

Over Frequency Protection is commonly used on systems with small generators operating.

Frequency Measurement

Frequency is measured on each available terminal. The frequency displayed and used for frequency protection is that of the first available terminal with voltage measurement, selected in the order:



■ for the N-Series: A1, B1, C1, A2, B2, C2

■ for the U-Series: AI, BI, CI, and if external Cts are fitted, then AX, BX, CX

 The measured frequency is displayed on the Measurement Pages.

A typical measurement display looks like this:

```
----- SYSTEM MEASUREMENTS ----- P
Current 100 A      Power P      1521 kW
Voltage 11036 Volt Power Q      -1146 kVAR
Freq 49.9 Hz      PF 0.81
```

The frequency value is updated every 0.5 seconds and averaged over 2.0 seconds. The displayed value is the measured frequency and is valid whenever the voltage on the selected terminal is above or equal to the Low Voltage Inhibit Threshold (LVIT).

When the voltage is below the LVIT on all available terminals the display will show Freq Unavailable.

UNDER/OVER FREQUENCY TRIPPING

When the measured frequency equals or exceeds the under or over frequency trip threshold an Under or Over Frequency Pickup event is generated and a Trip Delay Counter (TDC) is started.

The TDC is reset and an Under or Over Frequency Reset event is generated each time the measured frequency equals or goes below the threshold plus the dead band for any period of time. The Frequency dead band is used to prevent a frequency value that is fluctuating around the threshold from causing excessive pickup/reset events.

If the frequency remains equal to or greater than the Under or Over Frequency Threshold for the specified number of cycles, the TDC counts out and an Under or Over Frequency Trip event is generated and a Trip Request is issued.

Figure 27. (page 9-34) shows the method of Tripping and “Normal Frequency Closing” for Over Frequency. The same method applies to Under Frequency only mirrored about the Nominal Frequency Axis.

If the “Normal Frequency Close” function is switched OFF a “Lockout” event is generated after the trip and the Operator Settings Display shows a “Lockout” Status.

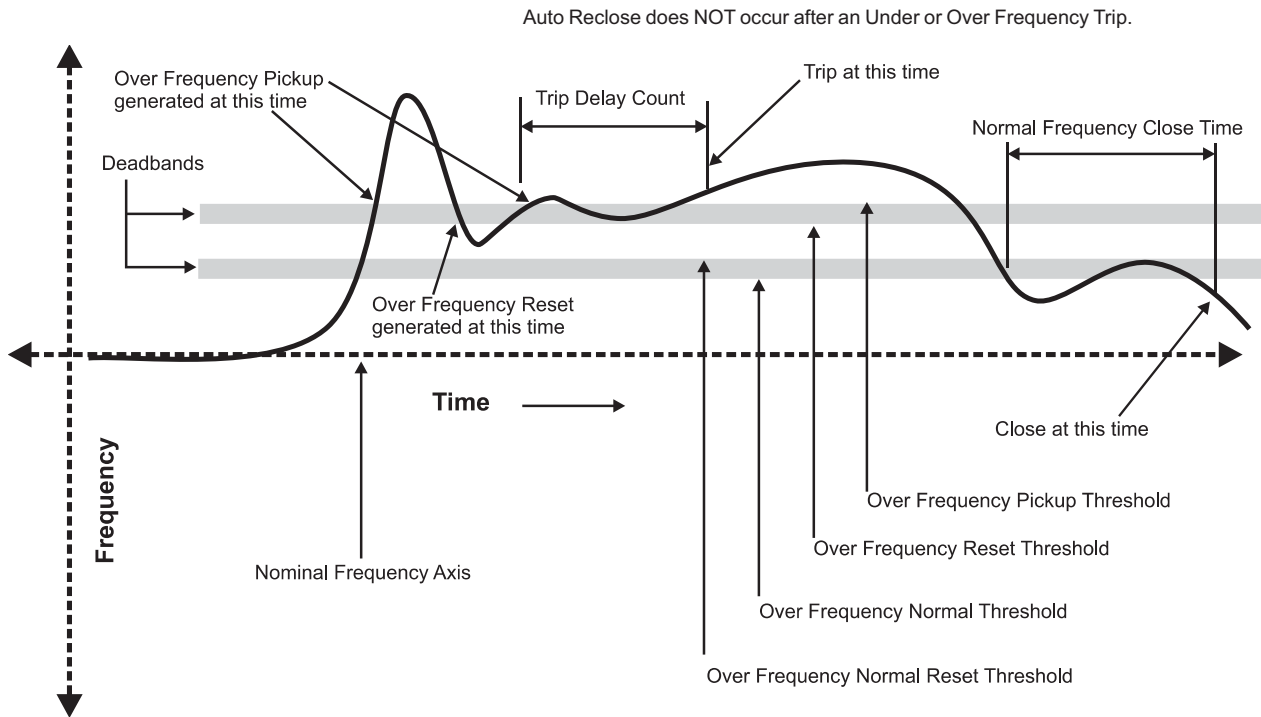


Figure 27. Over Frequency Detection

Normal Frequency Close

The "Normal Frequency Close" function closes the ACR automatically after an Under or Over Frequency trip when the frequency has returned to normal.

The automatic close occurs when:

- The ACR tripped due to Under or Over Frequency Protection.
- "Normal Frequency Close" was ON before the trip occurred and is still ON.
- The frequency has returned to be less than or equal to the Frequency Normal threshold and remained less than this threshold plus the dead band

AND

- the voltage on all three source side terminals has remained above the LVIT, for the "Normal Frequency Close Time".

The Normal Frequency Close Timing is aborted every time that the frequency exceeds the Normal Frequency threshold plus the dead band or the voltage on any of the three source side bushings has fallen equal to or below the LVIT.

A "Lockout" event is not generated when a Normal Frequency Close is ON and the ACR trips on Under or Over Frequency Protection. The Operator Settings display does not show "Lockout" and remains blank.

Whilst waiting for the frequency to return to normal, a special title will be flashing on the top line of the operator display:

ACR will auto-close when frequency normal

When the frequency returns to normal status the flashing title becomes:

Freq Normal – ACR will close in XXXX secs

The "XXXX" denotes the period of time remaining before closing occurs. In the final 10 seconds before actually closing the panel will "beep" to warn the operator.

The Normal Frequency Close ON/OFF setting may be controlled either via telemetry protocol or the configuration page.

A "Lockout" event will be generated if any of the following occur whilst the ADVG is waiting for the frequency to become normal:

- Normal Frequency Close is turned OFF.
- Under Frequency Normal setting is changed.
- Over Frequency Normal setting is changed.
- Normal Frequency Close setting is changed.
- LVIT setting is changed.

The Operator Settings page will display "Lockout" and the special titles will be removed if any of the above occur.



These elements have to be made available through either the O.I. or WSOS before they can be accessed on the O.I.

Configuration

Setting Frequency Protection Elements using the O.I.

This section details the Under/Over Frequency configuration pages displayed on the O.I.. Go to:

set PROTECTION – UNDER/OVER FREQUENCY PROTECTION

flex ENGINEER MENU – PROTECTION MENU – PROT TRIP SETTINGS
– UNDER OVER FREQUENCY

flex The following settings are available across three submenus - UNDER FREQUENCY, OVER FREQUENCY and NORMAL FREQ CLOSE

set Two configuration pages are available within the group.

Page One:

The default settings at this page are:

```
-- UNDER / OVER FREQUENCY PROTECTION 1 -- P
UF Trip OFF OF Trip OFF
UF Trip at 49.0 Hz after 4 UF cycles
OF Trip at 52.0 Hz after 50 OF cycles
```

The following table explains each of the above settings:

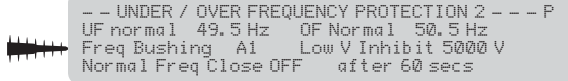
Field	Description
UF Trip ON/OFF	This field allows the Under Frequency protection to be enabled (ON) or disabled (OFF). Under Frequency tripping will not occur whilst set to OFF. Range: OFF - ON <i>Factory Default: OFF</i> Password: Yes
UF Trip at 49.0Hz	The frequency value at and below which an Under Frequency Pickup will occur. Range: 45.0 - U.F normal-deadband <i>Factory Default: 49.0Hz</i> Password: Yes
After 4 UF cycles	The number of continuous cycles at and below the Under Frequency Threshold required before an Under Frequency Trip will occur. Range: 2 - 1000 <i>Factory Default: 4</i> Password: Yes
OF Trip ON/OFF	This field allows the Over Frequency protection to be enabled (ON) or disabled (OFF). Over Frequency tripping will not occur whilst set to OFF. Range: OFF - ON <i>Factory Default: OFF</i> Password: Yes
OF Trip at 52.0Hz	The frequency value at and above which an Over Frequency Pickup will occur. Range: OF normal+deadband -65Hz <i>Factory Default: 52Hz</i> Password: Yes

Field	Description
After 50 OF cycles	The number of continuous cycles at and above the Over Frequency Threshold required before an Over Frequency Trip will occur. Range: 2 - 1000 <i>Factory Default: 50 cycles</i> Password: Yes

Table 4. Under/Over Frequency Protection 1 Fields

Page Two:

The default settings (for an N-Series ACR) at this page are:



```
-- UNDER / OVER FREQUENCY PROTECTION 2 --- P
UF normal 49.5 Hz OF Normal 50.5 Hz
Freq Bushing A1 Low V Inhibit 5000 V
Normal Freq Close OFF after 60 secs
```

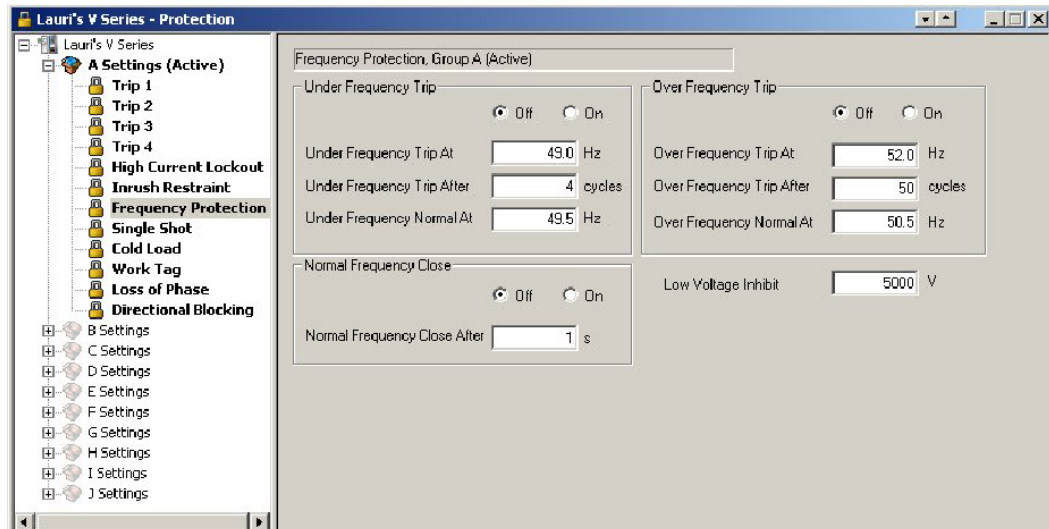
The following table explains each of the above settings:

Field	Description
UF Normal 49.5Hz	The frequency at or above which the Frequency is deemed to be Normal. Range: UF Trip+Deadband - OF Trip-Deadband <i>Factory Default: 49.5Hz</i> Password: Yes
OF Normal 50.5Hz	The frequency at or below which the Frequency is deemed to be Normal. Range: UF Trip+Deadband - OF Trip-Deadband <i>Factory Default: 50.5Hz</i> Password: Yes
Freq Bushing	Displays the terminals of the ACR being used for frequency measurement (Status - not a setting)
Low V Inhibit	The voltage at or below which the Under / Over Frequency protection will be disabled. Range: 2 - 15kV <i>Factory Default: 5kV</i> Password: Yes
Normal Freq Close ON/OFF	This field controls the use of the Normal Frequency Close feature. Range: OFF - ON <i>Factory Default: OFF</i> Password: Yes
After 60 secs	The time that the source voltage must have returned to normal before auto closing takes place. This field is only visible if Normal Frequency Close is ON. Range: 1 - 1000 <i>Factory Default: 60 sec</i> Password: Yes

Table 5. Under/Over Frequency Protection 2 Fields

Setting Frequency Protection Elements using WSOS5

The Frequency Protection page of WSOS5 has the same settings options as the Operator Interface.



Under and Over Voltage Protection

For the Under and Over Voltage protection feature to operate correctly you must specify a Nominal Phase to Earth System operating voltage. All deviations in voltage are referenced to this using pu¹.

Under/Over Voltage protection uses a form of voltage time curve to provide an envelope beyond which trips or alarms will occur. The curves available are:

- User defined custom curve.
- Definite time.

First configure or select a pair of voltage/time curves for under/over voltage tripping. The curves are configured using the curve editor in WSOS5 only. Refer to "**Curve Editor**" (page 9-40)" for details of this editor. The curve data is loaded into the ADVOC as required via WSOS5.

For Under/Over Voltage Protection to be used it must be made available first via the options page on the O.I. or the Feature Selection page in WSOS5. Under voltage and Over voltage protection can be ON or OFF independently. This is done from the O.I., WSOS5, or SCADA (via 331 points).

UOV Protection only operates on Source voltages. This requires that the user correctly set the Source/Load designation.

Phase Logic

Phase Logic controls the method by which measured voltages are evaluated against the UOV Threshold. The available options are as follows.

- **AND**
when ALL the measured phase voltages deviate beyond the 'Over Voltage Threshold' an 'Over Voltage Pickup' event is generated, and an 'Over Voltage Pickup' state persists; ditto for 'Under Voltage'.
- **OR**
If ANY measured phase voltage deviates beyond the 'Over Voltage Threshold' an 'Over Voltage Pickup' event is generated, and an 'Over Voltage Pickup' state persists; ditto for 'Under Voltage'.
- **AVERAGE**
If the numerical average of all three measured phase voltages deviates beyond the 'Over Voltage Threshold' an 'Over Voltage Pickup' event is generated and an 'Over Voltage Pickup' state persists; ditto for 'Under Voltage'.

¹

per unit. Used for voltage description in relative terms based on a nominal system voltage.

Pickup Threshold

The Pickup Thresholds are expressed as per unit values based on the nominal system voltage. The default values are 1.1pu (over voltage) and 0.9pu (under voltage). The UOV curves in use are normalised to these values. A pickup occurs when the measured voltage is;

- Under Voltage; Less than or equal to the Pickup Threshold
- Over Voltage; Greater than or equal to the Pickup Threshold

Pickup Reset

Pickup Reset occurs when the voltage has been in Pickup and then becomes;

- **Under Voltage;**
Greater than the Pickup Threshold plus the Deadband for the Fault Reset Time
OR less than the Live/Dead threshold
- **Over Voltage;**
Less than the Pickup Threshold minus the Deadband for the Fault Reset Time

Operation

When the voltage, as defined by the Phase Logic, goes outside the UOV pickup threshold a pickup is logged. The following event would be time-stamped into the event log:

UV Pickup

or

OV Pickup

If the voltage remains outside this voltage threshold for long enough to move outside the defined UOV curve, an UOV Trip Request is issued and a Trip event is logged as follows:

UV Trip

or

OV Trip

If the voltage falls below the voltage threshold minus the dead band before the UOV curve is exceeded a fault-reset timer is started. Expiration of the timer resets the pickup and generates an event, as in the following example, for each phase that was in fault and is now in pickup reset:

A Min XXX pu

or

A Max XXX pu

If the Phase Logic used is Average then only one event is generated

ABC Min XXX pu

or

ABC Max XXX pu

The Voltage Dead Band (hysteresis) is used to prevent a voltage value that is fluctuating around the threshold from causing excessive pickup/ reset events.

After the trip a "Lockout" event is generated and the Operator Settings Display shows a "Lockout" status provided that the "Normal Voltage Close" is OFF.

Normal Voltage

For the correct operation of UOV protection a Normal Voltage band must be defined. This gives the range within which the voltage is Normal. If the voltage moves outside this band then the voltage is Abnormal. This information is provided in the event log

as given in the following examples:

```
A Voltage Normal
B Voltage High
B Voltage Low
```

The High and Low thresholds are set above and below the Nominal voltage respectively. (See “**Settings** (page 9-41)”) The default range is 0.95pu to 1.05pu.

When the voltage is in the Normal range the thresholds are:

- **High**
Voltage is greater than the High threshold setting + the Deadband.
- **Low**
Voltage is less than the Low threshold setting - the Deadband.

When the voltage is outside the Normal range the thresholds are:

- **Normal**
Voltage is less than or equal to the High threshold setting AND Voltage is greater than or equal to the Low threshold setting.

Normal Voltage Close

A “Normal Voltage Close” closes the ACR automatically after an UOV trip when the following are ALL true:

- The trip was attributed to UOV Protection,
- “Normal Voltage Close” was ON before the UOV trip and is still ON,
- The voltage on ALL Source phases have returned to and stayed Normal for the duration of the Normal Voltage Close Time plus the fault reset time. This means that the fault must reset before Normal Voltage Close timing starts.
- The Normal Voltage Close Timing is aborted every time the measured voltage is not Normal.

When Normal Voltage Close is ON and the ACR trips on UOV Protection, no lockout event is generated and the Operator Settings Display does not show Lockout, it shows “blank”.

While waiting for the voltage to return to normal a special ‘Alert’ title will be flashed on the top line of the operator display:

```
ACR will auto-close when Voltage Normal
```

When the Voltage returns to normal the ‘Alert’ title becomes.

```
Volt Normal – ACR will close in xxxx secs
```

The ‘xxxx’ is the time remaining before closing. In the last 10 seconds before the close the O.I. will beep as a warning to the operator.

The Normal Voltage Close setting can be controlled by a SCADA protocol, O.I. configuration page, or WSOS5. If Normal Voltage Close is turned off while the ADVC is waiting for the voltage to become normal then a “Lockout” event will be generated, the Operator Settings page will display “Lockout” and any special ‘Alert’ title lines will be removed.

Voltage Protection Recovery Timeout

Should the ACR NOT close subsequent to a Voltage Protection trip within the operator designated time period then the ACR will go to ‘Lockout’, an event will be logged, and a SCADA alarm point will be set

e.g:

```
UOV Recover Timeout
```

It should be noted that the minimum value for this time period is the Normal Voltage Close time. Any time less than this would cause a timeout before a close was to be attempted. This feature can be turned OFF if required.

If the UOV Recovery Timeout feature is used, a Normal Voltage Close does not remain pending forever. A Lockout is performed when a UOV Recovery Timeout occurs. The maximum value of the Normal Voltage Close time is the UOV Recovery Timeout (when it is ON).

If the voltage on all source side bushings drops below the Live/Dead threshold the Normal Voltage Close will be aborted and the switch will go to Lockout.

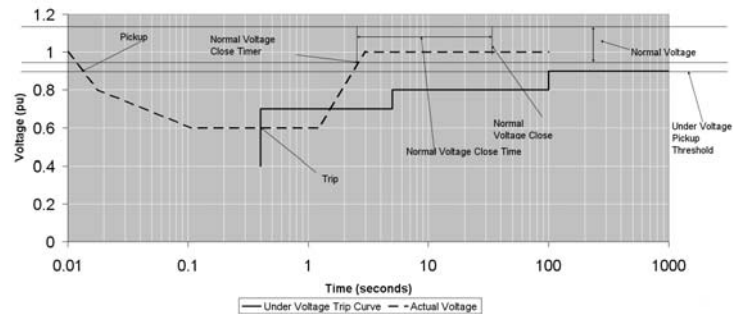


Figure 28. Over Frequency Detection

Changing Settings

If any protection settings, or settings from the following list, change during an UOV protection sequence the sequence will be aborted. If the ACR was tripped due to UOV Protection then the ACR will go to 'Lockout'.

- Load/Source Designation
- Protection On/Off
- UOV Protection Available

Excess Voltage Protection Sequences

An UV (or OV) Sequence is an UV (or OV) Trip followed by a Normal Voltage Close.

If the number of UV (or OV) sequences equals an operator designated threshold within an operator designated time period, then UV (or OV) Protection will be turned OFF by forcing 'UV Trip' (or 'OV Trip') to OFF. An event will be logged and a SCADA alarm point will be set at the time of the last Close e.g:

UV Excess Seq
OV Excess Seq

The time period is a rolling window that is updated every minute. At the update time the oldest minutes count of trips is removed from the total trips and the count for the present minute is added.

Single Sided CVT ACR

If UOV Protection is enabled on the ADVC, and the attached ACR is only fitted with CVTs to one 'side', and if the ADVC Source/Load designation is set such that the 'Load' designated side has the CVTs fitted, then UOV Protection Normal Close will be forced to OFF. If the ACR is in a UOV Protection tripped 'state', then the ACR will go to 'Lockout'.

Curve Editor

This is a graphical tool embedded in WSOS that allows alteration of the selected curves by dragging points or altering values in a data table. Additional curves may be produced as required by the user.

UOV Protection Configuration

The default settings are:

Settings	Default Value
UOV Protection	Not Available
UV Protection	OFF
UV Pickup threshold	0.9pu
UV Normal threshold	0.95pu
UV Definite Time	1.00s

UV Excess Sequences	OFF
UV Phase Logic	AND
OV Protection	OFF
OV Pickup threshold	1.1pu
OV Normal threshold	1.05pu
OV Definite Time	1.00s
OV Excess Sequences	OFF
OV Phase Logic	AND
Normal Voltage Close	OFF
UOV Recovery Time	OFF
UOV Curve	Definite Time
UOV Fault Reset Time	50ms

Making UOV Protection Available

set The Options pages provide the means to make the UOV feature available for use. The **OPTIONS – PROTECTION 2** page is assigned for Protection features availability. This page will look like the following with the default settings:

```

----- OPTIONS – PROTECTION 2 ----- S
Automation OFF      UOF Not Available
AGPS Not Available  UOV Not Available

```

flex For the **flexVUE** panel, these settings can be found under:

ENGINEERING – Configuration – Feature Selection
– Protection

Field	Description
UOV	This field allows UOV protection feature to be enabled (Available) or disabled (Not Avail). When this is set to Not Avail no UOV Pickup or Tripping will occur and all the settings for it will be removed from user access. Range: Not Avail/Available Factory Default: Not Avail Password: Yes

Settings

set The first display page of the UOV protection settings looks like this with the default settings:

```

----- UNDER VOLTAGE PROTECTION ----- S
UV Protection OFF    Phase Logic OR
Pickup Volt 0.90 pu  Fault Reset 50 ms
ExSeq OFF in 0 min   Definite 1.00 s

```

```

----- OVER VOLTAGE PROTECTION ----- S
OV Protection OFF    Phase Logic OR
Pickup Volt 1.10 pu  Fault Reset 50 ms
ExSeq OFF in 0 min   Definite 1.00 s

```

```

--- UNDER/OVER VOLTAGE PROTECTION 3 --- P
Nom P-E V 6.300 kV   Definite Time
NV Low 0.95puNV      Close OFF
NV High 1.05pu       Recovery Tout 60 s

```

flex For the **flexVUE** panel, these settings can be found under:

ENGINEERING – Protection – Protection Trip
Settings – Under/Over Voltage

Field	Description
UV Protection	This field allows Under Voltage protection trips to be enabled (ON) or disabled (OFF). When this is set to OFF no Under Voltage Tripping will occur. Range: ON/OFF <i>Factory Default: OFF</i> Password: Yes
OV Protection	This field allows Over Voltage protection trips to be enabled (ON) or disabled (OFF). When this is set to OFF no Over Voltage Tripping will occur. Range: ON/OFF <i>Factory Default: OFF</i> Password: Yes
Phase Logic	This field allows Phase Logic (see " Phase Logic " (page 9-37)) used for Under Voltage protection trips to set. Range: OR / AND / AVG(average) <i>Factory Default: AND</i> Password: Yes
Pickup Volt	Designates the voltage level at which an UV or OV Pickup is considered to have occurred. UVOV UV Range UV: 0.5pu to the lower of 0.99pu - Deadband and NV Low - Deadband OV Range OV: The higher of 1.01pu + Deadband and NV High + Deadband to 2.0pu <i>Factory Default</i> UV: 0.9pu OV: 1.1pu Password Yes
Fault Reset	This field allows the value of the Fault Reset Time to be set. This time is the wait after a voltage excursion has fallen below the pickup threshold minus the dead band before the fault is reset. Range: 0-10sec <i>Factory Default: 50ms</i> Password: Yes
Definite x.xxs	This field allows the value of the Definite Time to be set. This time is only used and visible if the Curve selected is Definite Time. This is the time that a fault must be present before the trip will occur. Range: 0-100sec <i>Factory Default: 1.00 sec</i> Password: Yes
ExSeq OFF ExSeq 1 in 10min	The number of Sequences after which UOV Protection is turned off. The sequence count and setting is specific to either UV or OV protection. Changing this field will reset any in progress accumulation. Number of Sequences: Range: OFF, 1 to 20 <i>Factory Default: OFF</i> Sequence Time Allowed (This field is only displayed if the "Excess Seq" is set to ON): Range: 1 to 2880 min <i>Factory Default: 0 min</i> Password: Yes
Nom P-E V	This field sets the voltage that is the typical system value. This is used to derive the pu values by comparing the actual measured voltage with this value. Note that this is exactly the same value used by Sag/Swell Monitoring, Directional Blocking and Directional Protection. Range: 2.0 to 25.0kV <i>Factory Default: 6.3kV</i> Password: Yes

Field	Description
Curve	This field allows the Voltage - Time curve to be selected. Range: Definite Time, User curve 1 to 5 <i>Factory Default: Definite Time</i> Password: Yes
NV Low NV High	Designates the range within which the voltage is considered to be Normal. Range NV Low: The higher of 0.5pu+ Deadband and UV Pickup + Deadband to 0.99pu NV High: 1.01pu to the lower of 2.0pu - Deadband and OV Pickup - Deadband <i>Factory Default</i> <i>NV Low: 0.95pu</i> <i>NV High: 1.05pu</i> Password Yes
Close OFF Close XXs	This field controls the use of the Normal Voltage Close feature. Either OFF or the time that the source voltage must have returned to and stayed within the UO Voltage Normal thresholds (plus dead-bands) before an automatic 'Normal Voltage' close takes place. Range: OFF, 1 to (Lower of 1000 sec Or Recovery Tout (if ON) - 1 sec) <i>Factory Default: OFF</i> Password: Yes
Recovery Tout	The time period allocated for the recovery of the voltage to within the 'Normal System Voltage' range after an Under or Over Voltage trip. This field is only visible if Normal Voltage Closing is ON. Range: OFF, ((“Normal Voltage Close time”/60) + 1) to 1440 min. <i>Factory Default: OFF</i> Password: Yes

Voltage Imbalance Monitoring

Voltage Imbalance is usually defined as the ratio between Negative Phase Sequence Voltage and Positive Phase Sequence Voltage (IEEE Std 1159-1995 3.1.69 and IEEE Std 1100-1992). A typical requirement (e.g. IEC / EN 50160) for Medium Voltage networks is a maximum ratio of 2%.

Positive and Negative Phase Sequence Voltage monitoring is available through WSOS5 Configurable History. Voltage imbalance can easily be calculated from the historical data as required.

Voltage imbalance does not cause a trip or alarm.

Fail to Operate Under Protection

If the ACR fails to trip under protection, a 'mechanism fail' will be logged in the event record and no further trip attempts will occur until all the protection elements have reset. When the next pickup/protection trip sequence occurs the ACR will then attempt another trip.

If the ACR fails to auto reclose then it goes to lockout.

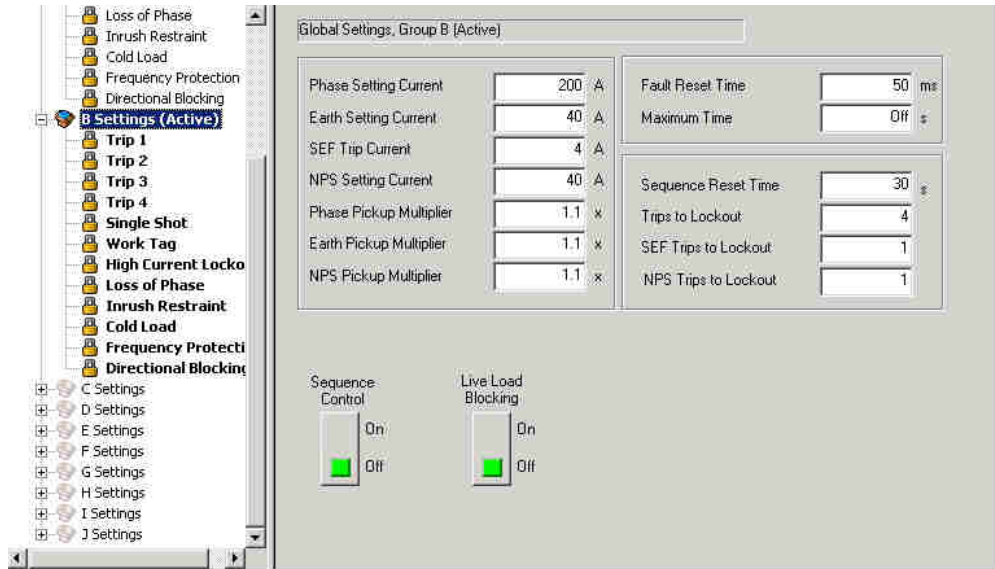
Setting Overcurrent Protection Elements

Overcurrent Protection Elements can be set using the Operator Interface (O.I.) but a more typical method would be via WSOS5.

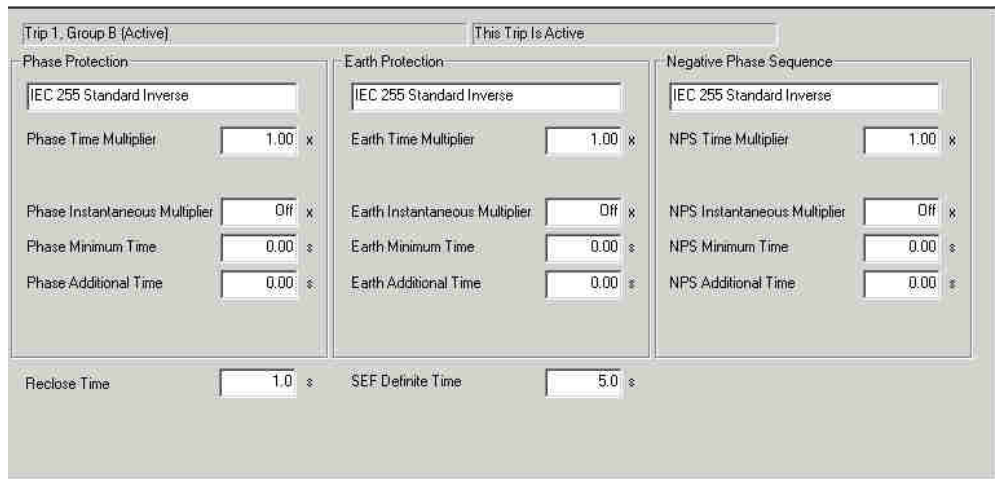
Setting Overcurrent Protection Elements using WSOS5

The WSOS5 Protection Settings screens are shown below.

This screen has common settings for all overcurrent trips in a reclose sequence, including the number of trips before lockout.



Each trip in a reclose sequence has a screen for setting the reclose time, time current curve characteristics, including the curve modifiers, and the instantaneous multipliers.



AUTO RECLOSING

A recloser (ACR) is a circuit-breaker with an electronic controller (ADVC) providing measurement, communication, protection and auto reclosing capabilities. Auto reclosing is the ability to automatically reclose the ACR after a protection trip.

Auto reclosing is very useful on overhead networks where most faults are caused by transient events (such as lightning, insulator flashover, conductor clashing, birds and animals causing faults). When such a fault occurs the electronic controller trips the circuit-breaker then automatically recloses it after a time delay. Auto reclosing is not usually appropriate for underground networks where faults are more likely to be of a non-transient nature.

The number of recloses and the time delay between tripping and reclosing are user configurable. Typically, you will configure up to three recloses (up to four protection trips).

A series of protection trips followed by automatic recloses is called a Reclose Sequence.

If the ACR has automatically reclosed the configured number of times, but the fault is still present (such as a line down on the ground), the ADVC will stop reclosing and the circuit-breaker will remain open. This is called Lockout.

You can set different protection settings for each trip in a reclose sequence. Typically the first trip may be very fast, followed by a rapid reclose. Subsequently, the tripping and reclose times may be longer. The final trip to lockout is typically fast.

Sequence Control

Sequence control causes the ACR to step to the next count in the reclose sequence on reset of all protection elements whether or not the ACR tripped. The sequence will only advance if Auto Reclose is on and the Single Shot Timer has timed out.

Consider a situation where there are two ACRs in a feeder. Both are programmed for fast tripping on the first trip and slow tripping on the second trip in order to co-ordinate with fuses on the spur lines. Suppose there is a fault downstream of the second ACR which is big enough to be picked up by the first ACR as well. The ACR closest to the fault trips, steps onto the second set of protection settings which is a slow trip and then recloses. If the fault has not been cleared the ACR nearest to the substation is still on its fast trip settings and will now trip. This situation would result in unnecessary loss of supply to the load connected to the first recloser.

This problem is overcome by setting Sequence control on in the ACR nearest to the primary substation. When Sequence control is on, the ACR steps onto the next stage in the protection trip sequence after it has seen a fault **whether that fault cleared without tripping**. In this way an upstream ACR will keep its sequence coordinated with a downstream ACR. If the fault is cleared i.e. Sequence Reset, the trip count will reset to zero after the sequence reset time in the normal way.

The SEF and NPS counters are also coordinated with the downstream ACR and will increment if that element has picked up.

Sequence Reset

After a protection trip, the ACR is in a Reclose Sequence. If a successful reclose occurs and the fault has cleared, the ACR will, after a period of time, abort the reclose sequence. This is called a Sequence Reset. The time after a successful reclose before Sequence Reset is called the Sequence Reset Time, and is user configurable.

Lockout

Lockout is a state in which the ACR will not automatically reclose. The ACR can be in the Lockout state for various reasons:

- A complete Auto Reclose Sequence has occurred
- The ACR has tripped in Single Shot mode (see below)
- The ACR has tripped in Work Tag mode (see below)
- Dead Lockout is ON, the ACR has tripped, and no voltage bushings are live
- Live Load Blocking has prevented an auto reclose
- Manual Trip.

Dead Lockout

Dead Lockout prevents the ACR from reclosing after a protection trip if all the source and load side terminals are dead. Dead Lockout is OFF by default and is turned on using:

 OPERATOR SETTINGS 2: Dead Lockout OFF
 ENGINEER MENU – PROTECTION MENU – PROTECTION CONTROL
– Dead Lockout ON/OFF

Live Load Blocking

Live Load Blocking prevents the ACR from closing or reclosing after a protection trip if any of the load terminals are live. Live Load Blocking is OFF by default.

Single Shot Tripping

Under some circumstances you may want to prevent the ACR from auto reclosing after a protection trip. For example, if a fault is detected as soon as the ACR is closed it is unlikely to be of a transient nature. It may be because safety earths have been accidentally left connected after maintenance of the system. In this circumstance auto reclosing is not appropriate, so the circuit-breaker will trip and lock out even though Auto Reclose is on. This is called Single Shot Mode.

Single Shot Mode has its own protection settings and these can be used to provide an appropriate protection curve when non-reclosing operation is required, for example, when manually closing onto a fault.

You can configure Single Shot settings for OC, EF, SEF and NPS protection in the same manner as for Trips 1, 2, 3 and 4. The EF, NPS and OC Single Shot Protection trip settings can be selected individually via separate protection pages. Each page is similar to the normal protection trip page.

In Single Shot Mode the ADVC goes directly to lockout after one trip and will not auto reclose.

Single Shot Mode is activated when:

- Auto Reclose is turned off, and Work Tag is not applied.
- For a set duration (Single Shot Reset Time) after the ACR is closed by an operator command irrespective of the state of Auto Reclose. The Single Shot reset time is set at

 OPERATOR SETTINGS 2 (A...J)
 ENGINEER MENU – PROTECTION MENU – PROT TRIP SETTINGS
– SINGLE SHOT – RESET

Single Shot Mode is de-activated when:

- Auto Reclose is turned back on,
- Work Tag is not active, and the Single Shot Timer expires without a protection pickup occurring (see below).

When Single Shot Mode is active, it is displayed at:

 SYSTEM STATUS – OPERATOR SETTINGS 1

ENGINEER MENU – PROTECTION MENU – PROT TRIP SETTINGS – SINGLE SHOT

When Single Shot Mode is active the values set on the relevant EF/OC/ NPS protection page are used.

When Single Shot Mode de-activates, protection reverts to the fully programmed sequence.²

A trip in Single Shot Mode generates a 'single shot' event, preceded by the Active Protection Group and the type of Protection trip.

Single Shot Reset Timer

This timer starts when the ACR is closed manually and runs for the preset number of seconds, see :

 OPERATOR SETTINGS 2 (A..J): SS Reset Time 1s

ENGINEER MENU – PROTECTION MENU – PROT TRIP SETTINGS – SINGLE SHOT– RESET – SS Reset Time 1s

Single Shot Tripping remains active while the timer is counting. If a protection pickup occurs whilst timing, the timer is reset to zero and held there while pickup is active. A protection pickup reset will restart the timer. A protection trip will result in a lockout without reclosing. The "time to trip setting" may be longer than the Single Shot Reset Time.

Single Shot Tripping may be disabled by setting the Single Shot Reset Time to zero. When set to zero, auto reclosing will always be enabled while the operator command

 SYSTEM STATUS – OPERATOR SETTINGS 1: Auto Reclose ON

 OPERATOR MENU – OPERATOR CONTROLS – Auto Reclose ON

is set. This means that Single Shot Mode does not activate after an operator or automation close command.

Work Tag Tripping

When work is being done on a network you may apply a Work Tag to the ACR. In some countries Work Tag is called Hot Line Tag. When Work Tag is applied special Work Tag protection settings are active and the ACR is in Single Shot Mode. Typically Work Tag protection settings will cause a fast trip with no auto reclosing if a fault is detected while the work tag is applied.

Work Tag Mode has its own protection settings. The user can configure Work Tag settings for OC, EF, SEF and NPS protection in the same manner as for Trips 1, 2, 3 and 4.

Trip Flags

Trip Flag Display Page

This is the first System Status page (default) to appear when the O.I. is turned on.

The display identifies each protection element that may cause a trip and next to it a ☐ box.

If that particular element caused the most recent protection trip then the box will be filled i.e. ☒.

The following display is a typical example of this page which indicates that the most recent trip was caused by an Instantaneous Overcurrent (OC) fault between phases A and B. There has been a total of three overcurrent events.

```
----- TRIP FLAGS ----- S
O/C ☒ 03 AB I      LOP ☐ 00      EXT ☐ 00
E/F ☐ 01      UOV ☐ 00      FRQ ☐ 00
SEF ☐ 00      NPS ☐ 00      OPS 1234
```

The counter beside the Earth Fault (EF) element shows that at some time previously there has been a single occurrence of an EF trip. In this case any instantaneous indication for EF would have reset when the ACR tripped on O/C protection.

² The ACR can be closed or Auto Reclose can be turned on/off by a number of sources (from the Control Panel, by a telemetry command, by WSOS5 command or by IOEX command). Single Shot is activated/de-activated irrespective of the source of the control.

The counter next to the status indicator shows the number of times each protection element has caused a trip. Each counter has a range of 01 to 99 (cannot count past 99).

- Some elements display the letters A, B, C to identify the phase.
- Some elements also display the letter "I" to identify instantaneous trips.

The Trip Flags page field descriptions are shown below:

Field	Description	
O/C	Phase Overcurrent	The phase or phases faulted are identified by letter: A, B, C. The letter I indicates instantaneous trip.
E/F	Earth Fault	As for O/C
SEF	Sensitive Earth Fault	This field is not displayed when SEF is unavailable.
LOP	Loss of Phase	The phase or phases lost are identified by letter: A, B, C.
UOV	Under/Over Voltage	Indicates either under or over voltage trip.
NPS	Negative Phase Sequence Overcurrent	The letter I indicates instantaneous trip.
EXT	External Trip	External trip sources. A trip caused by the activation of an FTIM or an IOEX protection trip input.
FRQ	Frequency Fault	Indicates both under and over frequency conditions.
OPS	Operations Counter	The OPS field indicates the total number of trip/ close operations performed by the ACR.

Table 6. Trip Flags - field descriptions

Turning Protection OFF with the setting of:

 OPERATOR SETTINGS: Protection OFF

 OPERATOR MENU – OPERATOR CONTROLS – Auto Reclose OFF/ ON/Protection OFF

displays Pickup Flags instead of Trip Flags and more than one element may be set at a time.

Resetting The Trip Flags

The Trip Flags will be reset by:

- Any operator close, including remote control commands.
- Start of a new sequence.

The Trip Flags and counters will be reset by:

- Pressing a Quick Key configured as "Reset Flags" twice within a ten second period.
- Turning Protection OFF, however the flags and counters will not appear until Protection is turned ON.
- Pressing the **SELECT** key twice within a ten second period whilst the Trip Flags screen is displayed.

On the first press of the **SELECT** key the following display advises the operator what to do next

```

----- RESET TRIP FLAGS ----- S
Press the key again to reset the flags
Press the menu key to cancel.

```

Pickup Flags

The Pickup Flags page is displayed in place of the Trip Flags page in the System Status display group when Protection is OFF:

```

----- TRIP FLAGS ----- S
O/C ■ 00      LOP □ 00      EXT □ 00
E/F □ 00      UOV □ 00      FRQ □ 00
SEF □ 00      NPS □ 00      OPS 1234

```

The Pickup Flags and counters will be reset by:

- Pressing a Quick Key configured as "Reset Flags" twice within a ten second period.
- Pressing the **SELECT** key twice within a ten second period whilst the Pickup screen is displayed.

The following display is an example of the Pickup Flag screen indicating an Under Frequency condition with "**Protection OFF**".

```

----- PICKUP FLAGS ----- S
O/C □ 03      LOP □ 00      EXT □ 00
E/F □ 01      UOV □ 00      FRQ ■ 00
SEF □ 00      NPS □ 00      OPS 0001

```

On the first press of the SELECT key the following page is displayed:

```

----- RESET TRIP FLAGS ----- S
Press the key again to reset the flags
Press the menu key to cancel.

```

Protection Off

This command turns all the Protection Features OFF and the ACR will only trip or close in response to a manual operation.³

Protection OFF must be Allowed at

 OPTIONS PROTECTION 1

 ENGINEER MENU – CONFIGURATION MENU – FEATURE SELECTION
– PROTECTION – Prot OFF Allowed

before Protection can be turned OFF.

A 'Protection OFF' event is generated and logged whenever Protection is turned off.

When configured as:

 OPERATOR SETTINGS: Protection OFF

 OPERATOR MENU – OPERATOR CONTROLS
– Auto Reclose OFF/ON/Protection OFF

the controller still logs all pickups and maximum currents and sets the Pickup Flags.

- The circuit breaker will not automatically trip on protection and trip events are not logged.
- If a Loss of Phase (LOP) event occurs, the circuit breaker will not trip but the LOP, A, B or C Pickup Flags are set.
- If either an Under or Over Frequency condition is detected, the ACR will not trip but the Frequency Pickup Flag is set.
- If either an Under or Over Voltage condition is detected, the ACR will not trip but the Voltage Pickup Flag is set.
- If a NPS event occurs, the circuit breaker will not trip but the Pickup Flag will register.

It is possible to configure the controller so the "Protection Off" state cannot be reached. This is set using:

 OPTIONS PROTECTION 1

³ The Protection OFF command resides in the same field as the Auto Reclose ON or Auto Reclose OFF.

 ENGINEER MENU – CONFIGURATION MENU – FEATURE SELECTION
– PROTECTION – Prot OFF Not Allowed

In this case you cannot select the “Protection OFF” state, only the active protection groups. Selecting the above navigation reference also has the effect of turning the protection ON if it is not already ON. Protection is normally switched from OFF to ON by selecting either Auto Reclose ON or Auto Reclose OFF.



The ADVC protection firmware filters out harmonics so that the overcurrent protection elements only respond to the fundamental frequency. This is different to the operation of the older Pole Top Control Cubicle (PTCC).

Therefore optimum Inrush Restraint settings for the ADVC may be different to those for the PTCC because transformer magnetizing current harmonics will not affect ADVC protection elements.

Inrush Restraint

When closing onto a typical load there is a transient increase in current caused by such loads as:

- magnetizing current in transformers
- starting current of motors
- startup current of incandescent and arc lights

This transient current is called Inrush Current, and may cause overcurrent protection to operate.

The purpose of Inrush Restraint is to prevent the ACR from tripping when inrush current occurs. Inrush Restraint works by raising the Pickup Currents for phase, NPS and Earth overcurrent protection for a short period of time while the inrush current is flowing. The user sets the Inrush Current Multiplier and the Inrush Time. Inrush time can be specified in 10 millisecond increments.

Inrush Restraint is activated whenever the current through the ACR goes to zero. This will happen if the ACR opens, or if an upstream or downstream device opens.

Typical Inrush Restraint settings are:

Inrush Current Multiplier: 4

Inrush Time: 200 ms

10 Sectionaliser Fault Detection



The RL Series is a dedicated sectionaliser (LBS), while all other Series (N/U), need to be morphed from a recloser (ACR), to an LBS. See “Morphing (page 10-1)”

OVERVIEW

The controller has many different detection features, described in this section. In summary it operates as follows:

- The fault Detection Elements are Phase, Earth, and Sensitive Earth Fault (SEF). Each individual element can be programmed to log a fault detection depending on the relevant setting.
- The controller stores up to ten groups of Detection Settings that can be selected by the operator, these are Detection Groups A to J.
- In addition to the Detection Settings there are Operator Settings. This group of settings is independent of the Detection Settings and changes the main functionality of the Load Break Switch.

ROLE OF THE SECTIONALISER

The Load Break Switch (LBS) is equipped with automatic sectionalising logic. The sectionalising logic opens the LBS during the dead time of an upstream recloser after it has tripped and closed a number of times as configured by the user.

The sectionaliser feature can be enabled or disabled by an operator from the Operator Interface. When a downstream fault is detected, the sectionaliser uses the Supply Interruption Counter to “count” the trips of an upstream recloser during a reclose sequence. When the counter reaches the user configured value the LBS is automatically tripped. The downstream fault is isolated from the network and the upstream recloser restores supply to feeders upstream of the LBS.

The following figure of a simple network shows the relative positioning of the LBS downstream of a recloser.

From this figure it can be seen how a fault condition downstream of the LBS can be isolated and supply restored by the recloser to feeders upstream of it.

The fault condition must be rectified before the LBS is manually closed to restore downstream supply.

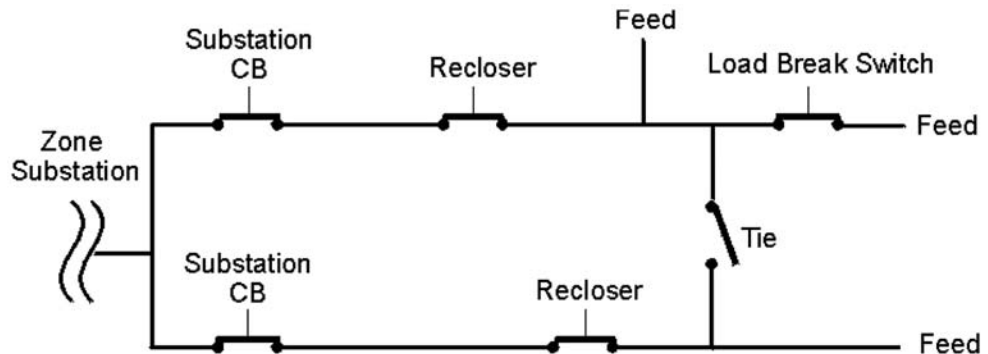


Figure 29. Positioning of the Load Break Switch

MORPHING

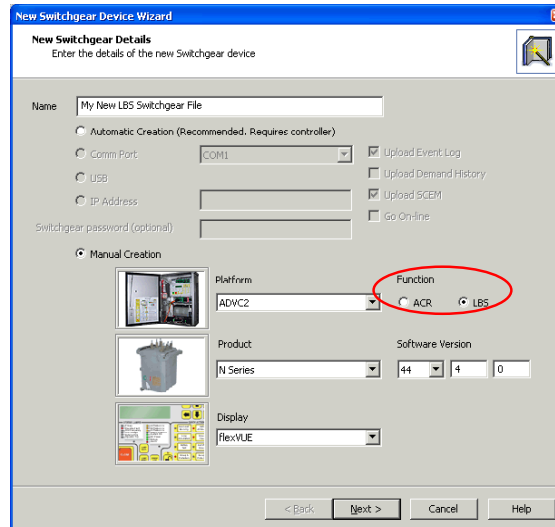
Morphing is the process that can be done to change an ADVC controller’s function from an ACR to a LBS and visa versa. This process is only available from WSOS5, and is done when configuring the unit.

N-Series and U-Series controllers by default are configured as ACR devices, which run protection code. A N-Series or U-Series switch can also be changed to operate as a LBS device even though it has reclosing capability. Note by doing so the “recloser” will lose its reclosing functionality and behave with LBS functionality.



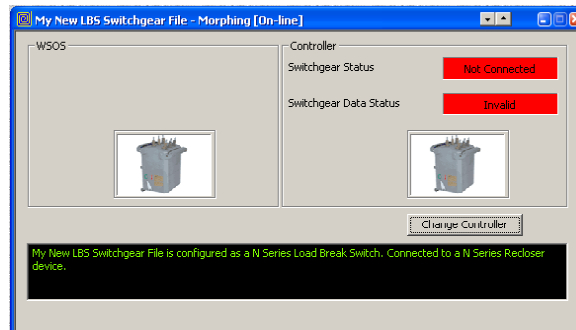
Morphing is only supported in A43-00.00+, and in WSOS5.X.Y+

To change a controller from an ACR to a LBS, first use WSOS5 and manually create a new file, and select **LBS** as the **FUNCTION**:



Once the file has been created, setup the Communications as required (select "WSOS Communications" from the "Customise" Menu). Then go online to the controller.

Once online, WSOS will ask if you would like to morph the controller to a LBS, as shown below:



Once morphed the controller will no longer have any protection functionality running, and will not trip on fault current even if the recloser is capable of doing so.

Clicking **CHANGE CONTROLLER** will change the function of the switchgear from an ACR to an LBS device, which is password protected. Morphing back to an ACR can be done by the same process where an ACR file is created (or already in existence), and connected to online. This will Morph back the controller to an ACR device.

After morphing all the detection settings will be able to be setup as explained previously in this chapter. All the settings should be revisited even if similar settings were configured when the device was configured as a ACR. Also when morphing back from an LBS to an ACR the protection settings will all need to be reviewed.



If an N-Series or U-Series is connected to a configured LBS controller (may of been previously connected to a RL), the N-Series or U-Series will work as a LBS using the current detection settings with no issues.

However if a RL-Series is connected to a configured ACR controller, then an critical alert will be displayed on the panel and the controller will become unusable until WSOS5 has morphed the controller into a LBS device (or a reclosing device is reconnected).

Sectionaliser Fault Detection (cont)

BASIC FAULT DETECTION

The phase, earth and SEF fault detection elements are monitored with independent definite time and fault current settings.

A pickup event is generated for each element if the current exceeds the fault current setting for that element.

A pickup normally initiates a timer which runs for the definite time setting for that element. When this timer expires a fault is said to have occurred and is reported in the Event Log.

The current level at which the definite time timer starts can be modified by a multiplier in the case of Inrush Restraint or Cold Load Pickup.

When all pickups have reset, a peak current event is generated for each element that have picked up. A peak current event is a record of the maximum current measured between fault pickup and fault reset.

The Phase, Earth and SEF fault detection thresholds and definite times are found on:

 DETECTION SETTINGS – 2

 ENGINEER MENU – DETECTION MENU – DETECTION GLOBAL
– FAULT DETECTION – PHASE or EARTH or SEF

See “**Appendix L Fault Detection pages** (page **L-1**)”

UPSTREAM RECLOSER OPERATION

The LBS can be configured to automatically trip in order to isolate a downstream fault. This action is referred to as sectionalising and is explained more fully in - “**Role of the Sectionaliser** (page **10-1**)”. To enable this feature, Sectionaliser Auto must be selected at

 SYSTEM STATUS – OPERATOR SETTINGS

 OPERATOR MENU – OPERATORS CONTROLS – Sectionaliser ON/OFF

Sectionalising depends on the ability of the LBS to detect fault current flowing through it and to count the operations (trips) of an upstream recloser.

An upstream trip at the recloser is detected by a fault followed by no current and no voltage. This condition is called a Supply Interruption.

A supply interrupt detect occurs when the current drops from above the fault threshold to zero within one second and the other phases also reduce to zero current¹.

Interruption of supply is confirmed by ensuring that the source and load side voltages fall below the “Live If” threshold. This causes the Supply Interrupt Count to increment.

The supply interrupt count is displayed at:

 SYSTEMS STATUS – OPERATORS

 OPERATOR MENU – OPERATOR CONTROLS – Interruption Count

A Sequence Reset Timer is used which is triggered each time the supply interrupt counter increments. When the timer expires, the supply interrupt count is cleared.

1

Zero current is defined as all three phase currents less than 2.5 Amp.

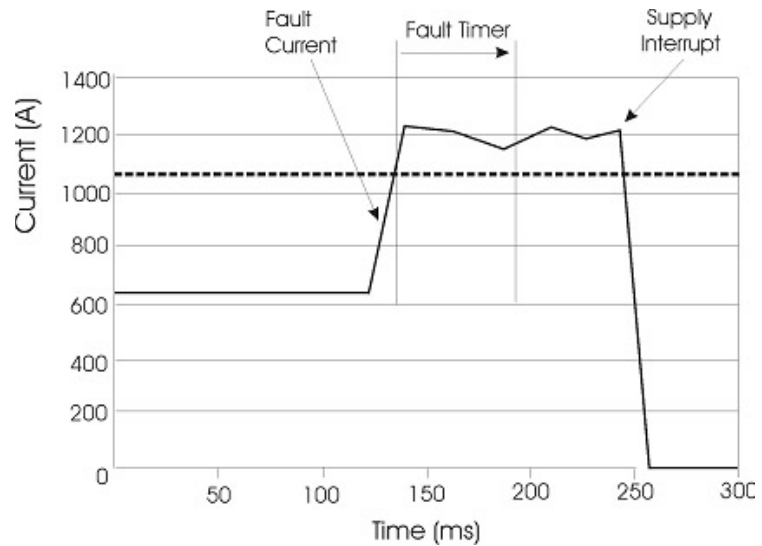


Figure 30. Supply Interruption Detection



FAULT FLAGS operate the same way as **TRIP FLAGS** when the switchgear is set as a Recloser.

However, when the switchgear is defined as a Sectionalizer, a number of Fault Flags will not be available. These Include:

- Loss of Phase
- Under/ Over Voltage
- Frequency Fault
- External Trip

FAULT FLAGS

Fault Flag Display Page

This is the default first page in the System Status menu to appear when the panel is turned on. The display identifies each detection element that could detect a fault and information on the fault history of that element.

Each element has an associated fault flag, , and a counter. If the fault flag is set thus, , it indicates that the element detected a fault during the most recent fault sequence. If the overcurrent flag is set it will also display the phases between which the fault occurred. The counter indicates the number of faults that element has detected since the counter was last reset.

```

----- FAULT FLAGS ----- S
O/C  --- 00
E/F  --- 00
SEF  --- 00      NPS  00      OPS 0000
    
```

Figure 31. Fault Flags Screen

Field		Description
O/C	Phase Overcurrent	The letters to the right of the O/C field identifies the phase or phases faulted.
E/F	Earth Fault	
NPS	Negative Phase Sequence Overcurrent	The letter  indicates instantaneous trip.
SEF	Sensitive Earth Fault	This field is not displayed when SEF is unavailable.
OPS	Operations Counter	The "OPS" field indicates the total number of operations performed by the LBS.

Table 7. Fault Flags - field description

Below is a typical example of this page.

```

----- FAULT FLAGS ----- S
O/C  --- 03 AB
E/F  --- 01
SEF  --- 00      NPS  00      OPS 1234
    
```

The page as shown indicates:

- The Overcurrent element was the only one to detect a fault during the last fault sequence. There have been three overcurrent fault detections since this counter

Sectionalizer Fault Detection (cont)

was last reset. They may not have all occurred during the last sequence. The last overcurrent fault detected involved A and B phases.

- The Earth Fault element has detected one fault since the last time its counter was reset. This fault did not occur during the most recent fault sequence and therefore was most likely a phase to phase fault.
- There have not been any SEF and NPS faults detected since the counters were last reset.

Each counter has a range of 00 to 99. Faults in excess of 99 will not be recorded until the counters have been reset.

Only the overcurrent element displays the letters A, B, C to identify the phase.

Resetting The Fault Flags

The Fault Flags will be reset by:

- Any operator close, including remote control commands.
- Start of a new sequence.

The Fault Flags and counters will be reset by:

Pressing a Quick Key configured as "Reset Flags" twice within a ten second period.

Turning Protection OFF, however the flags and counters will not appear until Protection is turned ON.

Pressing the **SELECT** key twice within a ten second period whilst the Fault Flags screen is displayed.

On the first press of the **SELECT** key the following display advises the operator what to do next

```
----- RESET TRIP FLAGS ----- S
Press the key again to reset the flags
Press the menu key to cancel.
```

Higher Level Settings

The LBS can be configured as a sectionalizer that trips during the dead time of an upstream recloser after a configurable number of supply interrupts.

Sectionalizing occurs when Sectionalizer Auto is selected at:

 OPTIONS DETECTION : Sectionalizer Auto

 OPERATOR MENU - OPERATORS CONTROLS - Sectionalizer ON/OFF
and the number of supply interrupts counted exceeds the "Trip After" setting at:

 DETECTION SETTING-1: Trip on Count

 ENGINEER MENU - DETECTION MENU - DETECTION GLOBAL
- Trip after 'x' Supply Interrupts

The supply interrupt count is displayed on:

 OPERATOR SETTINGS: Supply Interrupt

 OPERATOR MENU - OPERATOR CONTROLS - Interruption Count

When sectionalizing is enabled, the upstream recloser reclose time must exceed 1.2 seconds to allow for the opening time of the LBS.

OPERATOR SETTINGS

Operator Settings are different from Detection Settings.

They are used by an operator, on an everyday basis, to set the controller into the required mode. For example an operator may want to disable Sectionalising and Sensitive Earth Fault prior to commencing live line work.

The Operator Settings are all found at:

 SYSTEM STATUS – OPERATOR SETTINGS

 OPERATOR MENU – OPERATOR CONTROLS

These are:

- Local/Remote Control selection.
- Sectionaliser ON/OFF.
- Operational Cold Load Time and Multiplier.
- Selection of the Active Detection Group or
- Detection OFF

These operator settings are not affected by changing the Active Detection Group.

For example; if Sectionaliser ON is in force before the Active Group is changed from A to B then Sectionaliser ON will also be in force after the change.

FAULT RESET TIME

The fault reset time setting determines the amount of time taken for a pickup to reset after the over-current that caused the pickup has gone.

The fault reset time timer starts running after a pickup when the current falls to 90% of the fault current setting. If the current is still below 90% of the fault current setting when this timer expires, the fault is reset. If the current returns to above the 90% level before the fault reset timer expires, the definite time timer continues uninterrupted.

If the current drops below the fault current setting after a pickup but remains above the 90% level, the definite time timer that started at pickup will continue to run. However even if this timer expires, a fault will not be detected unless the current rises back above the fault current setting.

This setting is found on:

 DETECTION SETTING – 3: Flt Reset Time 30s

 ENGINEER MENU – DETECTION MENU – DETECTION GLOBAL
– FAULT RESET – Fault Reset Time

SEQUENCE RESET

In the event of a temporary fault, a sequence reset timer is used to reset the supply interrupt counters to zero. This ensures the supply interrupt count starts at one when the next fault occurs.

It starts timing when the Supply Interrupt count is incremented. However, if the fault returns the detection will pick-up again and hold the sequence reset timer at zero. The sequence reset timer “expires” when it reaches the user set sequence reset time at which a “Sequence Reset” event is then logged.

The Sequence Reset Time is set on:

 FAULT DETECTS: Seq Reset Time 30s

 ENGINEER MENU – DETECTION MENU – DETECTION GLOBAL
– SECTIONALISE – Sequence Reset Time

Sectionaliser Fault Detection (cont)

DETECTION SETTINGS AND DETECTION GROUPS

Detection settings are normally applied when a LBS is first put into service and don't need to be changed unless significant changes to network conditions occur.

A detection group is a group of settings which determines when a pickup or fault is detected for each of the detection elements.

The controller supports up to ten completely independent detection groups referred to as detection groups A to J.

At the Operator Interface, the operator selects either Group A, B, C, ... or J to be Active on:

 SYSTEM STATUS – OPERATOR SETTINGS: Det 'A'...'J' Active
 OPERATOR MENU – OPERATOR CONTROLS – Detection Group
Active

The number of detection sets (A-J) available to the operator may also be configured using the Windows Switchgear Operating System (WSOS) program.

Whenever a new Detection Group is activated or a fault detection occurs, an event is written to the Event Log indicating which Detection Group is now in operation. The following are examples of logged events:

Det Group A Active

Det Group B Active

All timers associated with the new setting are reset.

All the detection parameters are programmed and stored independently for each of the groups. For example, if the Sequence Reset Time is required to be 20 seconds in both A and B groups, then it must be explicitly set to 20 seconds in both groups of detection settings.

CHANGING DETECTION SETTINGS

All detection parameters and operator settings are held in non-volatile memory in the CAPE. This ensures they are retained through power interruptions. However, if a different CAPE is installed in a control cubicle, or if the control cubicle is replaced, then the detection parameters need to be re-programmed. This is carried out either through the operator panel or through Windows Switchgear Operator System (WSOS).

The ten groups of detection settings are programmed on the detection pages and passwords are required to make changes. Detection Groups should not be changed whilst a detection sequence is in progress.

When programming detection settings the technician first selects which detection group of parameters to display on:

 DETECTION SETTING 1 (A...J): Group A-J Displayed
 ENGINEER MENU – DETECTION MENU – DETECTION GLOBAL
– GROUP CONTROL – Group 'x' Displayed

This group can then be changed. Selecting a detection group to be displayed does not make it active, that is done by the operator in:

 OPERATOR SETTINGS: Det 'A'...'J' Active
 OPERATOR MENU – OPERATOR CONTROLS – Detection Group
Active

Because one detection group can be active and another detection group can be displayed (in the detection pages), care must be taken or confusion will result. However, the title line of the display always shows which detection group is currently being displayed by showing an "A", "B" to "J" suffix, such as:

e.g.  ----- DETECTION SETTINGS 3 E ----- S

The operator can change either the active group or the inactive group.

When changes are made to the active group they do not go into service immediately. Instead the changes are saved into the internal database in the controller and go into service when:

- The operator moves off the fault detection group of pages.
- The operator turns off the control panel.
- The control panel turns itself off after the timeout period.
- The controller is powered off and on again.

This allows the operator to edit the active group and then put the new settings into service as a whole. The operator is informed when the changes are going into service.

Whilst the active group is being edited, the page title flashes to indicate the settings being worked on are different to the ones in service.

Changes can also be made by remote operators using WSOS. If a WSOS operator changes settings, the local operator will see the page title flash to indicate changes are pending. When any user puts their changes into service, all pending changes (including those made by other users) go into service.

Group Copy

Group Copy is available to facilitate the setting of several detection groups which all have the same or similar settings.

It is possible to copy from the displayed detection group to any of the groups available on the ADVC including the active group².

This feature is accessed through the detection group at:

```
set DETECTION SETTING 3 (A-J) Copy OFF
flex ENGINEER MENU - DETECTION MENU - DETECTION GLOBAL
    - GLOBAL CONTROL - Copy 'x-y'
```

Selecting the field allows the operator to scroll through the available copy options, shown in "**Appendix L Fault Detection pages** (page L-1)"

Changes to detection groups are put into service as for any other changes to the active detection group.

LIVE LOAD BLOCKING

When Live Load Block is selected, all close requests will be disregarded if any load side terminal is live.

Live Load Blocking is selected from

```
set PROTECTION SETTING 3 (A...J): Live Load Block OFF/
    ON
flex ENGINEER MENU - DETECTION MENU - DETECTION GLOBAL
    - LIVE LOAD BLOCKING - Live Load Blocking ON/OFF

set SYSTEM STATUS - PHASE VOLTAGE and POWER: "Live" if
    >2000
flex ENGINEER MENU - DETECTION MENU - DETECTION GLOBAL
    - FAULT DETECTION - Phase Setting Current
```

² It is not possible to replicate an existing group to itself i.e.; Detection Group "B" cannot be copied and saved as Detection Group "B".

INRUSH AND UPSTREAM RECLOSER OPERATION

Purpose of Inrush Restraint

When closing onto a typical load there is always a short lived inrush current caused by, for example, transformer magnetisation currents, low resistance lamp filaments and motors starting. Inrush Restraint inhibits fault detection when inrush current occurs.

Inrush restraint³ works by raising the phase and earth Threshold Currents for a short period of time to allow the inrush to flow. The inrush time and multiplier settings are specified on:

set DETECTION SETTINGS 4 (A...J)

flex ENGINEER MENU- DETECTION MENU – DETECTION GLOBAL
– INRUSH RESTRAINT

Typical values would be 200ms with a multiplier of five.

Inrush Restraint is armed for operation whenever the load current goes to zero (zero current is defined as all three phase currents less than 2.5 Amp). For example, when the load is disconnected either by the LBS itself, or by an upstream or downstream LBS.

When the measured current at a later time becomes non-zero (either through the LBS or an upstream device being closed), inrush restraint is activated for the duration of the inrush restraint time setting. During this time, the phase, earth and SEF elements will still pickup at their respective fault current settings, but the level required for phase and earth fault detection is raised to a new threshold by the inrush restraint multiplier setting.

Operation of Inrush

Whenever the current goes from zero to non zero, the inrush restraint timer is started. While this timer is running the current threshold that must be exceeded in order to start the phase or earth definite time timers becomes the fault current setting for those elements multiplied by the inrush restraint multiplier setting. The inrush restraint time and multiplier settings should be selected in order to mask the inrush current as shown in **Figure 32.** (page 10-9)

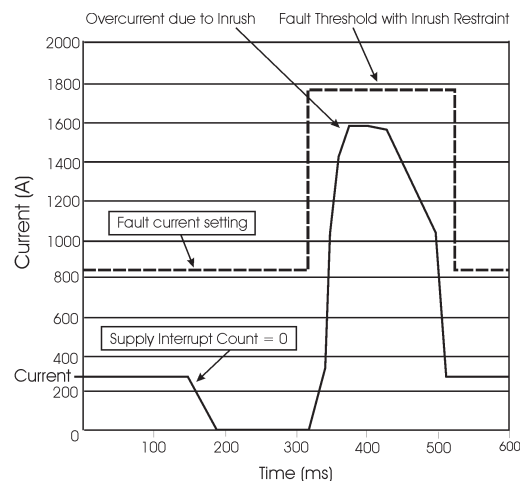


Figure 32. Fault Detection and Inrush

In **Figure 32.** (page 10-9), the inrush current has subsided and normal load current is present when the inrush restraint timer expires. Consequently no fault has been detected. However because the measured current exceeded the fault current setting, a pickup and max current events will be logged.

If the measured current had been still higher than the fault current setting when the inrush restraint timer expired, the definite time timer for that element would have started. If the current remained above the fault current setting for the definite time setting, a fault for that element would be detected.

Inrush restraint is disabled if the supply interrupt count is greater than zero.

In other words, if the current is zero due to the protection trip of an upstream recloser, the LBS should have also seen the fault and its supply interrupt count will be at least one. In this case as shown in **Figure 33**, (page 10-10), the inrush restraint will be disabled and the multiplier will not apply if the current goes to non-zero when the upstream recloser closes.

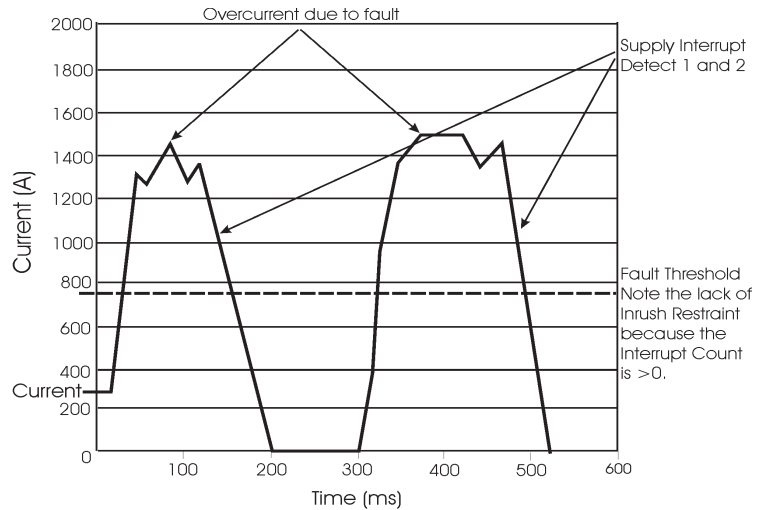


Figure 33. Downstream fault detection

Inrush will not work with load currents of less than 2.5 amps.

COLD LOAD PICKUP

Whether you are using switchgear as an automatic circuit recloser or as a Load break switch, cold load pickup functions in the same way.

For more information on Cold Load Pickup please see "**Cold Load Pickup (CLP)** (page 9-13)"

AUTOMATIC DETECTION GROUP SELECTION

Sometimes a Load Break Switch is used at a location within a supply network where the power flow may be in either direction depending on the configuration of the rest of the network.

One example of this is at a network tie point.

In this situation the operator may have to select a different group of detection settings to compensate for a change in power flow when changing the network configuration. In other situations, emergency switching configurations may require more than one pair of Detection Groups.

Enabling Automatic Selection

The Automatic Detection Group Selection (ADGS) function allows the appropriate Detection Group to be selected automatically without the need for operator intervention. It works by automatically changing between Detection Groups depending on the direction of power flow.

- ADGS is made available by setting:

set SYSTEM STATUS – OPTIONS 1: ADGS Allowor (A...J)

flex ENGINEER MENU–CONFIGURATION MENU– FEATURE SELECTION
– Automatic Detection Group Selection

Either the Primary or Alternate Group is selected.

- ADGS is then enabled by selecting:

set SYSTEM STATUS – OPERATOR SETTINGS: Detection Auto

Sectionalizer Fault Detection (cont)

 OPERATOR MENU – OPERATOR CONTROLS – ADGS Auto

- The display will show the currently active detection group set by displaying:

 SYSTEM STATUS – OPERATOR SETTINGS: Auto
'A'to'J' Active

 OPERATOR MENU – OPERATOR CONTROLS – Detection Group
Active

- On power-down the controller saves the current status of Detection Auto and uses that to determine the active Detection Group on power-up.

Disabling Automatic Selection

ADGS is turned OFF (disabled) either by:

- An operator change in power flow direction on the following page
(e.g. changing from Source I and Load X to Source X and Load I).

 SYSTEM STATUS – PHASE VOLTAGE and POWER FLOW

 ENGINEER MENU – CONFIGURATION MENU – SYSTEM SETTINGS
– METERING PARAMETERS – Source/Load Direction

- Selecting a Detection Group other than

 SYSTEM STATUS – OPERATOR SETTINGS: Detection Auto

 OPERATOR MENU – OPERATOR CONTROLS – ADGS Auto

- Setting

 SYSTEM STATUS – OPTIONS 1: ADGS Not Allowed

 ENGINEER MENU – CONFIGURATION MENU – FEATURE SELECTION
– Automatic Detection Group Selection Not Allowed

Selection Rules

Once the ADGS function is enabled the active Detection Group is automatically selected according to the following rules:

- There are a maximum of five pairs of ADGS Detection Groups: A & B, C & D, E & F, G & H and I & J. Each pair consists of a primary Detection Group and Alternate Detection Group respectively.
- The number of ADGS pairs depends on how many detection sets are selected to be available. Where an odd number of Detection Groups have been selected, the last group does not participate in ADGS. Detection Auto cannot be selected with this last group active.
- Primary Detection Group A, C, E, G or I is used when the power flow is in the positive direction (source to load).
- Alternate Detection Group B, D, F, H or J is used when the power flow is in the negative direction (load to source).
- For APGS to generate a change, from Primary to Alternate Detection Group, the power flow must be greater than 50kW in the negative direction (load to source), and for for longer than the period set on

 SYSTEM STATUS – OPTIONS 1: Auto Change Time 60 sec

 OPERATOR MENU – OPERATOR CONTROLS – ADGS Change

- Similarly ; to revert to the Primary Detection Group the power flow must be greater than 50 kW in the positive direction (source to load) for the same amount of time as set above.

11 Power Systems Measurement

INTRODUCTION

The ADVC measures up to 10 power system components:

- A, B, and C phase currents, and CT spill (earth/ground) current,
- phase to earth/ground voltage on all six terminals.

For more information about how to view the above measurements from the O.I., see **"6 Operator Interfaces (page 6-1)"**.

The ADVC uses the above measurements to derive many system measurements including:

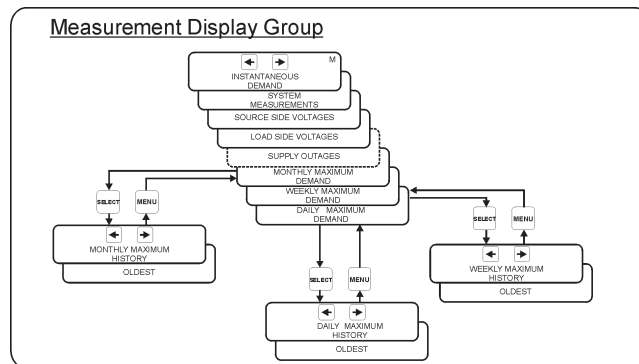
- frequency,
- phase to phase voltages,
- total and per phase power (kW, kVA, kVAR),
- total and per phase power factor,
- harmonic, voltages and currents
- earth current, and
- sequence components.

In addition the ADVC also measures several internal values such as:

- CAPE temperature,
- switchgear temperature¹ (N-Series, U-Series ACRs only)
- auxiliary voltage,
- gas pressure (N-Series ACR and RL-Series LBS only),
- battery voltage.

NAVIGATION

 All system measurement pages are contained within the Measurement display group.



DAILY, WEEKLY, MONTHLY DEMAND

The ADVC maintains a log of three sets of demand records that show total power (kWh) for the previous day, week and month. In addition it also logs the interval and value of the peak real power and power factor for the demand period.

The ADVC maintains approximately six years of daily, weekly and monthly data.

When the log is full, the oldest record is deleted as the newest is added.

The sample period of the three demand logs is configurable to be 5, 15, 30 and 60 minutes. All values are averaged over this period. The sample period can be set at

 **SYSTEM STATUS – OPERATOR SETTINGS 2**

 **OPERATOR MENU – OPERATOR CONTROL – Demand Period**

¹ The ADVC measures the temperature of the SCEM in the ACR and from that, calculates the switchgear temperature.

Logging begins on the hour, or on intervals past the hour. For example, if 15 minute sample period is selected at 12 minutes past the hour then averaging begins at 15 minutes past the hour and data is stored at 30 minutes past the hour.

If the sample period is changed then the new sample period data will be added to any existing data for that demand period. When the demand record is stored it will consequently look at all data for that period irrespective of sample period.

The ADVC can be set to have power as a signed or unsigned quantity at

set SYSTEM STATUS – PHASE VOLTAGE and POWER FLOW

flex ENGINEER MENU – CONFIGURATION MENU – SYSTEM SETTINGS
– METERING PARAMETERS – Power Signed/Unsigned

Total power flow (kWh) logged during the demand period will show either the net energy flow (i.e. zero if equal energy had flowed both ways) or total power flow irrespective of the direction depending on the signed/unsigned power setting.

Below is an example of the **setVUE** daily maximum demand screen:

```

----- DAILY MAXIMUM DEMAND ----- S
Day ending 1/04/2008 Total 26565kWh
Peak period 1/04/2008 17:14:59
Peak demand 1235kW 0.97PF
  
```

In the above example, assume the sample period has been set to 15 minutes. It can therefore be seen that the total power flow for the day ending midnight 1 April 2004 was 28565 kWh. The peak 15 minute average consumption was 1235kW with power factor 0.97. The peak occurred during the period 17:00:00 to 17:14:59 inclusive.

The weekly and monthly demand screens follow the same format as the daily demand shown above.

To view other demand records press the SELECT key and then either the left or right arrow keys until desired record is seen. To return to the most recent record press the MENU key. \

CONFIGURABLE HISTORY

The ADVC maintains a history log of user selectable data.

The number of data types collected and the log sample period can be selected via the WSOS5 History - Configurable History window seen at left. The history log cannot be viewed or configured via the panel.

The log sample period can be set to 1, 5, 10, 15, 30, 60, 120, 360, 480, 720 or 1440 minutes.

Logging begins at the real time multiple of the sample period selected. For example, if 15 minutes sample period is selected at 12 minutes past the hour then averaging starts at 15 minutes past the hour and the first data stored is at 30 minutes past the hour.

The following formula shows the estimated time before oldest data is overwritten by newest data:

$$\text{Estimated time} = \frac{\text{log period} \times 360448}{(9 + \text{number of data selections})}$$

The historical data can be saved to a text file or to a csv file using WSOS5. Refer to the WSOS5 help file for more information.

12 Power Quality Measurement

POWER QUALITY TOOL KIT

Utilities are coming under increasing pressure from both customers and regulatory bodies alike to review the quality of power they are providing. This requires monitoring of their networks for various indices such as number of and duration of outages, sag/surge voltages and system harmonics.

The ADVC takes advantage of its ACR's built in current and voltage sensors to provide power-monitoring abilities to meet the benchmark needs without the need for highly priced specialised monitoring instruments that require expensive additional current and voltage transformers.

Together, these ADVC abilities comprise the Power Quality Tool Kit.

The power quality tool kit consists of three components:

- Supply Outage Measurement
- Harmonic Analysis
- Disturbance Waveform Capture
- Sag and Swell Monitoring

SUPPLY OUTAGE MONITORING

Introduction

Many utilities analyse their network outages to measure the supply reliability to their customers. The average duration and frequency of outages are key indicators in this process and they are commonly defined as:

System Average Interruption Duration Index (SAIDI). This is equal to the average minutes lost per customer per year. Each utility has its own definition of lost customer minutes. For example, it may not include outages of one minute or less or outages resulting from transmission grid failure or major storms.

System Average Interruption Frequency Index (SAIFI). This is equal to the average number of outages per customer per year. Each utility may define an outage in a different way.

The Supply Outage Measurement feature utilises built in recloser features to record the number and duration of outages. These statistics are recorded in the ADVC and are available to the utility to help calculate SAIDI and SAIFI. The ADVC records the:

- Cumulative total number of outages,
- Cumulative total outage duration, and
- The time and duration of each outage event in the Event log

Determination of Supply Outage

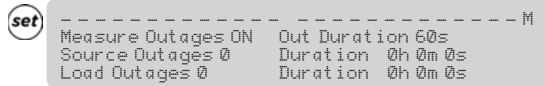
The ADVC monitors the ACR terminal voltages to determine when there is an outage. A loss of supply voltage on one or more phases for a user-set time is defined as the start of the outage and when voltage is restored to all three phases for the same user-set time, the end of the outage has been reached. The reported outage duration is the actual time without voltage. The ADVC logs:

- the number of,
- the total duration of, and
- the start and finish times,

of each outage on the network segment on either side of the ACR. When an outage is detected on one side it is timed and the data is recorded.

If the ACR is disconnected from the ADVC or the ADVC is powered down during an outage then it cannot determine the outage duration. In such cases the outage duration data for that specific outage is discarded. The outage counter is maintained.

Configuration



The outage counter data can be reset by pressing the **SELECT** key until the desired field starts flashing, press either the left or right arrow key, and then press **ENTER**.

To access Power Quality options on the **flexVUE** panel, first you have to allow them at the following menu location:

ENGINEER MENU – CONFIGURATION MENU –
FEATURE SELECTION – POWER QUALITY

: then the values can be found at:

ENGINEER MENU – POWER QUALITY

Setting	Description
Measure Outages OFF/ ON	Measure Outages This setting indicates whether measure outages has been enabled or disabled. Password protected setting. Range: OFF, ON <i>Factory default is OFF</i>
Outage Duration	Outage Duration Minimum time for terminals to be without voltage to be counted as supply outage. Also used as the minimum time for restored voltage before an outage is considered finished. Range: 1 to 3600 seconds <i>Factory default is 60 seconds</i>
Source Outages	Source Outages Number of supply outages on the source terminals. <i>(Display only setting)</i>
Load Outages	Load Outages Number of supply outages on the load terminals. <i>(Display only setting)</i>
Duration	Duration Total duration of supply outages in hours, minutes, and seconds for both source and load side terminals. Range: 0 h 0 m 0 s to 9999 h 99 m 99 s. <i>(Display only setting)</i>

HARMONIC ANALYSIS

Many utilities are finding that the nature of their electricity network load is changing as an increasing number of distorting devices are attached to it. Typical sources of waveform distortion include variable speed drives, personal computer power supplies, uninterruptible power supplies, fluorescent lamp ballasts, and transformer excitation currents.

Simultaneously with the increased level of waveform distorting sources there is also an increasing quantity of advanced electronic equipment that is sensitive to waveform purity of the power it receives. Examples of such equipment include personal computers; modern home electronic equipment such as televisions, audio and visual entertainment devices, dishwashers, washing machines, microwaves, etc.; and sensitive industrial control and instrumentation equipment.

To complicate things further, high levels of distortion can also lead to increased line losses and transmission equipment burn out which means increased utility equipment costs.

Utilities are therefore finding it necessary to analyse their network currents and voltages to detect the level of waveform distortion. The index for distortion most commonly used is harmonics. In addition to monitoring the harmonics themselves a Total Harmonic Distortion (THD) value can be calculated. THD is a relative value of

Power Quality Measurement (cont)

all harmonics with respect to the fundamental that is expressed as a percentage.

The advanced controller calculates harmonics 2 to 16 and THD over a 80ms period for 4 currents (3 x phase + earth/ground), 6 phase - phase voltages and 6 phase-earth/ground voltages. Each harmonic and the THD is averaged for a moving 2 second window, updated every 500ms.

Determination of Harmonics Alarms

The ADVC harmonics and THD values can be viewed in graphical form in WSOS5 as shown in **Figure 34.** (page 12-3).

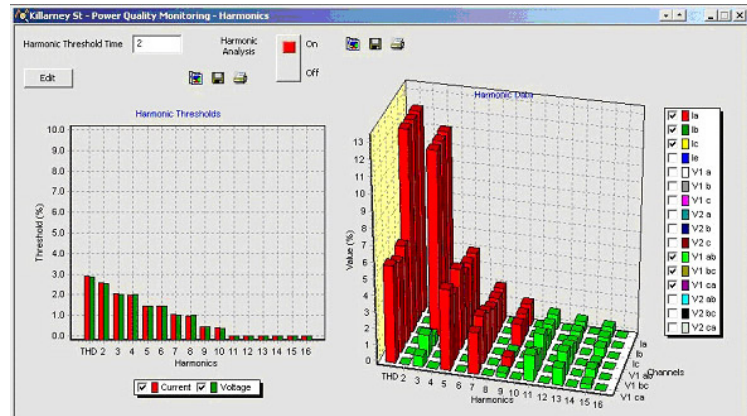


Figure 34. WSOS 5 Harmonics Screen

Logging of Harmonics Alarms

In addition to calculating and displaying the harmonics, the ADVC also reports by exception in its event log when any individual harmonic exceeds a user-set threshold for a user-set time. The event records the harmonic, the peak% value and a time stamp. To indicate the duration of the harmonic, another event is logged when the harmonic drops below the threshold for two seconds. A threshold setting of zero disables recording for that harmonic. Both the user-set, threshold value and user-set time can be set only via WSOS5. Refer to the WSOS5 help file for more information.

An example harmonic event logging is shown below

----- EVENT LOG ----- E	Comment
01/03/05 15: 22: 24. 27 Vxca: THD 10. 0%	At 3:22:24.27pm on 1st March 2005 the X side Vca total harmonic distortion reached 10%.
07/03/05 5: 22: 26. 36 Ia5H 13. 2%	At 5:22:26.36am on 7th March 2005 the A phase current 5th total harmonic distortion reached 13.2%.
01/04/05 12: 24: 28. 63 Vxca: THD OFF	At 12:24:28.63pm on 1st April 2005 the X side Vca total harmonic distortion dropped below its threshold for 2 seconds.
05/05/05 17: 34: 12. 66 Viab: 16H OFF	At 5:34:12.66pm on 5th May 2005 the I side Vab 16th harmonic dropped below its threshold for 2 seconds.

Historical Data Logging of Harmonics

If long term monitoring of harmonic values is required then the harmonic averages data type can be selected for logging along with the log sample period, using the ADVC configurable history feature. Refer to "**Configurable History** (page 11-2)".

Waveform Capture

The ability to capture and view system current and voltage waveform data of an electrical network system in oscilloscope format is an integral part of any power quality analysis. The power quality tool kit has a feature that enables capture of the raw input data (3200 samples per second) as presented to the electronics by the A/D converters. The scaled raw data includes the three phase currents, earth current, six phase-earth/ground voltages and six phase-phase voltages.

The total recording time, the proportioning of the total recording to pre-trigger or post-trigger recording and the events that trigger the recording are user configurable from both the O.I. and WSOS5.

The captured data can be retrieved later in COMTRADE (IEEE Std C37.111-1999) format using WSOS5. WSOS5 has the ability to display the data in waveform and vector formats.

 The data captured is raw A/D data and hence shows noise, as seen by the electronics, prior to software filtering. This noise is often be seen in captured data especially on inputs that do not have anything connected and/or have poor earthing.

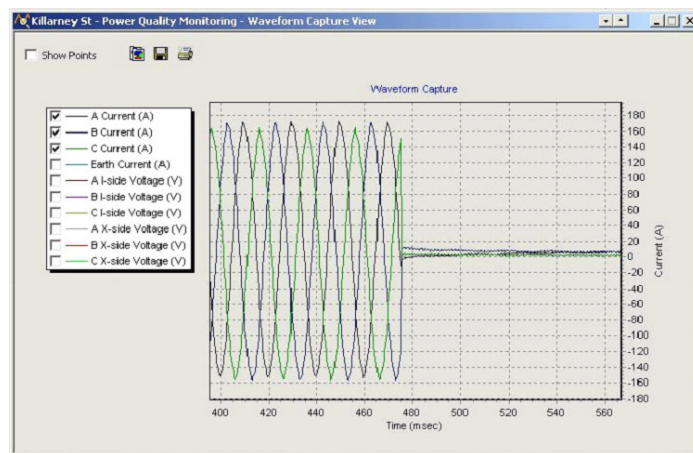


Figure 35. WSOS5 Currents Waveform Capture Display - Manual Trip

For more information about the WSOS5 waveform data retrieval and viewing capabilities refer to the WSOS5 help file.

Configuration

```
----- Waveform Capture ----- M
Wave Capture  ON   W/C Window is
W/C Ration    50/50  Capture Now OFF
```

ENGINEER MENU – POWER QUALITY – WAVE CAPTURE MENU

Setting	Description
Wave Capture	Waveform Capture ON/OFF Control Enables or disables waveform capture triggering. Range: OFF, ON <i>Factory default is OFF</i>
W/C Window	Waveform Capture Recording Window The total time window during which data is recorded per waveform capture. The number of capture events that the controller can capture is directly related to the size of the capture window: - 0.5 seconds allows 32 capture events - 1.0 seconds allows 16 capture events - 2.0 seconds allows 8 capture events When the capture event buffer is full, a new capture event overwrites the oldest capture event. Range: 0.5s, 1.0s, 2.0s <i>Factory Default is 1.0 seconds</i>

Power Quality Measurement (cont)

Setting	Description
W/C Ratio	Pre and Post Trigger Ratio The portion of the waveform capture prior to and post a trigger event. Range:10/90, 20/80, 30/70, 40/60, 50/50, 60/40, 70/30, 80/20, 90/10 <i>Factory Default is 50/50</i>
Capture Now	Capture Now ON/OFF Manual trigger to triggering a waveform capture. When put to Capture Now ON the controller performs a waveform capture and sets the setting to Waveform Captured. Range: ON/OFF <i>Factory default is OFF</i>
Waveform Captured	

----- Waveform Capture ----- M
 Prot Trip blank
 blank blank
 blank blank

flex ENGINEER MENU – POWER QUALITY – WAVE CAPTURE MENU
 – WAVEFORM TRIGGER – Trigger 1-6

Setting	Description
	Waveform Capture Trigger Automatic triggers for waveform capture:
Prot Trip	Protection Trip
Manual Close	Manual Close (includes IOEX close and protocol close)
Manual Trip	Manual Trip
Auto Close	Auto Close (includes auto-reclose, loop automation close, and generator control close)
Harmonics	Harmonics outside their alarm limit <i>Factory default is blank.</i>

The timing of the trigger is from the internal controller request signal

e.g. O.I.M Trip Request seen in Event Log. The accuracy of the pre and post trigger ratio is therefore subject to minor software variances plus the operating time of the switchgear.

If a second trigger becomes active while a waveform capture is in progress, it will be ignored.

Waveform Replay

Once a waveform has been captured and the data processed by the ADV C, it can be read by WSOS5 and stored on the PC as a COMTRADE file.

All captured waveform data that is read and stored by WSOS5 can be replayed through the ADV C in order to emulate the network conditions. This enables analysis of ADV C behaviour for certain conditions.

For more information about the WSOS5 waveform replay capabilities refer the WSOS5 help file.

SAG AND SWELL MONITORING

This feature enables sags and swells in the voltage of any of the available bushings to be recorded in the event log, and in historical data for later examination. To use this feature, first make it available via the the O.I. or the Feature Selection page in WSOS5. Sag monitoring and Swell monitoring can be switched ON or OFF independently via the O.I., WSOS5, or SCADA.

Monitoring occurs regardless of whether the ACR is closed or tripped.

For the Sag/Swell Monitoring feature to operate correctly you must specify a Nominal Phase to Earth System operating voltage. All deviations in voltage are referenced to this using pu¹.

Sag/Swell Monitoring uses a form of voltage time curve to provide an envelope beyond which alarms occur. The curves available are:

- User defined custom curve.
- Definite time.

You configure or select a pair of voltage/time curves for Sag/Swell monitoring. The curves are configured using the curve editor in WSOS5 only. Refer to "**Curve Editor**" (page 9-40) for details of this editor. The curve data is loaded into the ADVC as required via WSOS5.

Every excursion of the voltage of any phase below the Sag curve or above the Swell curve causes a Sag/Swell event to be logged at the conclusion of the excursion.

Excursion Conclusion and Event Duration

The conclusion of the excursion is defined as the voltage returned to Normal for the Fault Reset Time. The Fault Reset Time is user configurable. If the voltage is picked up again before the reset time expires the timer is reset.

The duration of a Sag/Swell event is defined as the time from the instant that the voltage goes outside any point on the curve in use (i.e. the pickup threshold) until the voltage returns to Normal for that type of excursion.

Pickup Threshold

The Pickup Thresholds are expressed as per unit values based on the nominal system voltage. The default values are 1.1pu (Swell) and 0.9pu (Sag). The curves in use are normalised to these values. A voltage is in Pickup if:

- Sag; Less than or equal to the Pickup Threshold
- Swell; Greater than or equal to the Pickup Threshold

Pickup Reset

Pickup Reset occurs when the voltage has been in Pickup and then becomes;

- Sag; > Pickup Threshold plus the Deadband for the Fault Reset Time
- Swell; < Pickup Threshold minus the Deadband for the Fault Reset Time.

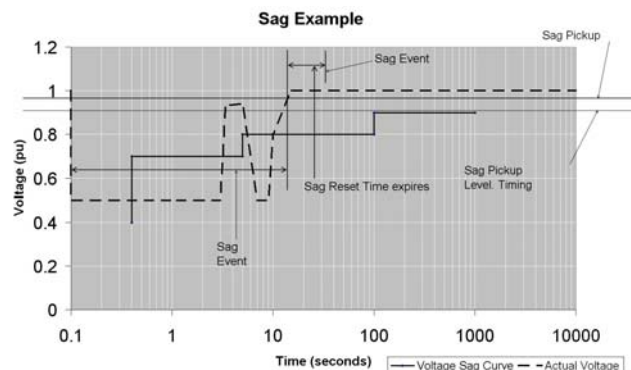


Figure 36. Sag Example

¹ per unit. Used for voltage description in relative terms based on a nominal system voltage.

Power Quality Measurement (cont)

Events

Sag/Swell events take the following form where the initial text is a qualifier and thus only visible when the  **ALT** button or  **EVENT LOG** button on the Operator Interface is pressed or via WSOS event history display. The side of the ACR that experiences the Sag/Swell is identified as part of the event. There is one event per phase that experiences the Sag/Swell. If the ACR is Closed then only the source side phases are monitored.

----- EVENT LOG ----- E	after pressing  ALT or  EVENT LOG
17/01/05 12: 23: 34. 45 Sag to 0.82pu	A Phase LOAD Sag to 0.82pu
17/01/05 12: 23: 34. 45 Sag for 0.043s	A Phase LOAD Sag for 0.043s
17/01/05 12: 23: 34. 45 Swell to 1.10pu	C Phase SRC Swell to 1.10pu
17/01/05 12: 23: 34. 45 Swell for 0.123s	C Phase SRC Swell for 0.123s

Historical Data

To enable the use of the data gathered, it can be exported from WSOS5 in the normal manner for event logs. Sag/Swell events are in the category of Power Quality. A filter on Power Quality events provides just those events of interest that can then be saved as text or CSV files.

Additionally a record is added to the demand logs which includes:

- Sag or Swell
- Faulted Phase
- Faulted Side
- Excursion value (in pu)
- Excursion length (in ms)

This information is available from WSOS5 via the history page only, on the tab labelled Sag/Swell History. Parameters for Sag/Swell Monitoring are configured and displayed on the "SAG/SWELL MONITORING" pages of the Menu

Sag/Swell Configuration

The default settings are:

Settings	Default Value
Sag/Swell Monitoring	Not Available
Sag Monitoring	OFF
Sag Pickup threshold	0.9pu
Sag Normal threshold	0.99pu
Sag Definite Time	1.00s
Swell Monitoring	OFF
Swell Pickup threshold	1.1pu
Swell Normal threshold	1.01pu
Swell Definite Time	1.00s
Curve	Definite Time
Fault Reset Time	50ms

Making Sag/Swell Available

set Make the Sag/Swell feature available on the Power Quality options page:

```
----- OPTIONS - POWER QUALITY ----- M
SOM Not Avail    Wave Capt Not Avail
Harmonics Not Avail Sag/Swell Not Avail
```

flex ENGINEER MENU - CONFIGURATION MENU - FEATURE SELECTION
- POWER QUALITY - SAG/SWELL Available/Not Available

Setting	Description
Sag/Swell	This field allows the Sag/Swell Monitoring feature to be enabled (Available) or disabled (Not Avail). When set to Not Avail, no Sag/Swell Monitoring occurs and all relevant settings are removed from user access. Range: Not Avail/Available <i>Factory Default: Not Avail</i> Password: Yes

Settings

set The Sag/Swell Monitoring settings pages are only available if Sag/Swell Monitoring is set as Available. These pages are part of the Measurement display group and appear after the Supply Outage Measurement page.

```
----- SAG/SWELL MONITORING ----- M
Nom P-E V 6.300kV
Fault Reset 50ms
Definite Time
```

```
----- SAG MONITORING ----- M
Sag Monitor OFF    Definite 1.00s
Pickup Volt 0.90pu
```

```
----- SWELL MONITORING ----- M
Swell Monitor OFF    Definite 1.00s
Pickup Volt 1.10pu
```

flex ENGINEER MENU - POWER QUALITY - SAG SWELL MENU
- Sag/Swell Monitoring or Sag Monitoring or Swell Monitoring

Setting	Description
Sag Monitor	This field turns Sag monitoring On or OFF. Range: ON/OFF <i>Factory Default: OFF</i> Password: Yes
Swell Monitor	This field turns Swell monitoring On or OFF. Range: ON/OFF <i>Factory Default: OFF</i> Password: Yes
Definite Time	This field allows the Voltage - Time curve to be selected. Range: Definite Time, User curve 1 to 5 <i>Factory Default: Definite Time</i> Password: Yes
Nom P-E V	This field sets the voltage that is the typical system value. This is used to derive the pu values by comparing the actual measured voltage with this value. Note that this is exactly the same value used by UV Protection, Directional Blocking and Directional Protection. Range: 2.0 to 25.0kV <i>Factory Default: 6.3kV</i> Password: Yes

Power Quality Measurement (cont)

Setting	Description
Sag Pickup	Designates the voltage level at or below which a Sag Pickup is considered to have occurred. Voltages going below this level start the Sag event timing. Range: 0.5pu to 0.98pu ^a <i>Factory Default: 0.9pu</i> Password: Yes
Swell Pickup	Designates the voltage level at or below which a Sag Pickup is considered to have occurred. Voltages going below this level start the Sag event timing. Range: 1.02pu to 2.0pu <i>Factory Default: 1.1pu</i> Password: Yes
Fault Reset 50ms	This field sets the time delay for a Sag/Swell event reset after the voltage returns to normal. Range: 0 to 10sec <i>Factory Default: 50ms</i> Password: Yes

a. per unit. Used for voltage description in relative terms based on a nominal system voltage.

13 Communications

COMMUNICATION INTERFACE

Introduction

The controller has eight communications ports, for which you can configure:

- the selection of active communication ports,
- the set up of each port,
- the communication protocol that uses each port, and
- the settings for the protocol itself.

For information about port pin outs, refer to the installation and maintenance manual.

Enabling/Disabling Communication Ports

The eight communication ports are:

Port Label	Port Type	Configuration Status	Comment
Port A	RS-232	Selectable	Default for WSOS5 (57.6kBaud, 8 bit, no parity, 1 start/stop bit) No hardware handshake lines.
Port B	RS-232	Selectable	No hardware handshake lines.
Port C	RS-232	Selectable	RTS CTS DTR CD
Port D	RS-232	Permanent	RTS CTS DTR CD
Port E	USB	Permanent	Local PC Connection Currently not supported.
RS-485	RS-485	Selectable	
V23	FSK	Selectable	Supports BUSY and PTT handshaking
10BASE-T	Ethernet	Permanent	

Table 8. Communication Ports

Enabling and disabling of ports can only be performed using WSOS5 using the Switchgear Communications dialogue.

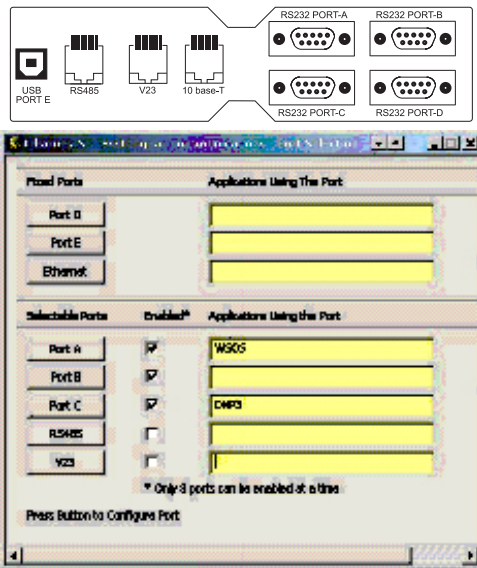
For more information, refer to the WSOS5 help file.

PORT DETAILS RS232

Four RS232 ports (A to D) are provided to connect to conventional modems that provide the correct signalling for the communications network used, e.g. optical fibre modem, or telephone dial up modem, or RS232 radio modem. Each port has a factory assigned default baud rate. Please refer to “**RS232 Communication Port Settings** (page I-1)” to see the default Baud settings. All four ports have standard 9 pin D male connectors and have the following pin connections:

RS232 Pin No	Direction	Use	Port A	Port B	Port C	Port D
1	To ADVC	Data Carrier Detect (DCD)	-	-	Yes	Yes
2	To ADVC	Rx Data (RxD)	Yes	Yes	Yes	Yes
3	From ADVC	Tx Data (TxD)	Yes	Yes	Yes	Yes
4	From ADVC	Data Terminal ready (DTR)	-	-	Yes	Yes
5		0V (ground/earth)	Yes	Yes	Yes	Yes
6		Not connected	-	-	-	-
7	From ADVC	Request to Send (RTS)	-	-	Yes	Yes
8	To ADVC	Clear to Send (CTS)	-	-	Yes	Yes
9		Reserved	-	Yes	-	-

Table 9. RS232 Pin Connections



 Due to hardware restrictions not all selectable ports can be active. At any one time, you may configure as ENABLED up to a maximum of three of the ports identified as selectable in the above table.



Use of serial ports to connect directly to other devices outside the controller can cause damage and void warranty. If connections to other devices are required then isolation interfaces *MUST* be used.

All RS-232 ports are not isolated from one another or from the controller electronics. They therefore can only be connected to devices inside the controller that are powered by the controller radio supply, including modems, optical isolators, and radios.

Only Ports C and D can be connected to a Hayes compatible modem.

USB PORT E

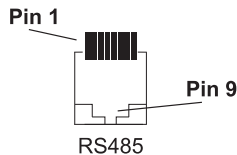
Port E is the dedicated port for USB communications to a PC. The USB port is currently not supported.



USB
PORT E

Pin	Name	Description
1	VCC	+5 VDC
2	D-	Data -
3	D+	Data +
4	GND	Ground

Table 10. Port E Pin Connections



RS485

RS485

The RS485 port must be enabled via WSOS before it can be used in any network configuration. If RS485 is used in conjunction with WSOS, it should be configured on WSOS5 using SOS MultiDrop (not Direct connection). An ADVC switchgear can not be created under WSOS with RS485, instead you must create the switchgear by setting up serial or TCP/IP communications and then configuring RS485 with SOS Multidrop under WSOS5 and on the ADVC.

An RS485 port has been provided to enable higher speed (115kbits per second) multi-drop connections that often occur within substations. The RS-485 port is a female RJ45 connector.

Pin	Use	Pin	Use
1	Not connected	6	Transmit (+)
2	Receive (+)	7	Not connected
3	Not connected	8	Transmit (-)
4	Receive (-)	9	Shield
5	Not connected		

Table 11. RS485 Pin Connections

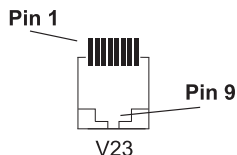


Levels in excess of $\pm 13V$ should not be applied. The FET is rated for a maximum of +32V and negative voltages are not permitted. Transmit and receive are unbalanced signals relative to 0 volts and are not isolated. If a DC level is imposed by the radio on the transmit line then this should be less than 2.5 VDC.

V23 FSK

An in-built FSK modem provides half duplex V23 signalling at 1200 bits per second. This interface is primarily designed for use with voice frequency radio systems and provides additional signals for this purpose.

The V23 connector is RJ45.:



V23

Pin	Direction	Use
1	To ADVC	Receive, 10 kOhm impedance. Sensitivity 0.1 – 2V pk-pk
2		0 Volts (ground/earth)
3		Not connected
4	To ADVC	CD, 5 kOhm impedance
5	Not connected	
6	From ADVC	Transmit, 600 Ohm impedance. Level 2.5V pk-pk
7		Not connected
8	From CAPM	Press to talk (PTT)
9		Shield

Table 12. V23 Pin Connections

The Press to Talk (PTT) signal is used to key up a radio transmitter. PTT is implemented using a Field Effect Transistor (FET) with an on resistance of 3.3 ohm. When PTT is asserted the transistor is turned on and connects the PTT signal to 0V.

A busy signal can be provided by the radio to indicate receive channel busy. High

Communications (cont)



If the controller is connected to a LAN or WAN then it is strongly recommended that:

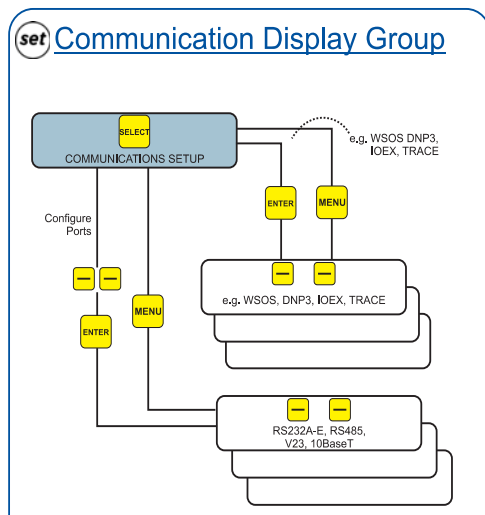
1. Firewalls be used to limit user access to the controller
2. Ethernet switches be used to limit the volume of Ethernet data reaching the controller's 10Base-T port. (Use of Ethernet hubs is not recommended.)

level is +3.5 to +5V, low level 0V to +0.5V. The busy signal should be driven by an open collector output or current limited to 10 mA.

If multiple ACRs are in use in a substation application they can be connected to a single radio using the 600ohm line isolator accessory available from the manufacturer.

ETHERNET

The controller has a 10 base T Ethernet port with a baud rate of 10Mbits per second. The port is a RJ45 female connector.



Communication Display Group Navigation

The communication display group is one of the main display groups. See your ACR Installation and Maintenance Guide for an explanation of display groups.

Navigation within the communication menu is shown at left

This is an example of a typical Communications group main page:

```
----- COMMUNICATIONS SETUP ----- C
Configure Ports      WSOS Port RS232-A
DNP3 Port RS232-C    Trace Port NONE
IOEX Port NONE
```

See “**Appendix M Protection pages** (page **M-1**)” for details of all Communications Group pages.

It can be seen in the above example that:

- WSOS5 communications can be performed via RS232 Port A,
- SCADA protocol DNP3 has been made available and is communicating via port C,
- the communication trace feature has been made available and is currently inactive, and
- IOEX support has been made available and is currently not configured to communicate via any port.

Navigating to a Port Setup Page

Whilst on the main COMMUNICATIONS SETUP screen, press the **SELECT** key once, press the left or right arrow keys until the desired port is displayed then press the **ENTER** key to display the port's settings. Subsequent left & right arrow key presses display more settings pages and pressing the **MENU** key at any time returns to the main communications set up screen.

ENGINEER MENU – TELEMETRY MENU – CONFIG PORTS MENU

Then scroll using the **UP** and **DOWN** arrow keys until you have found the port you wish to configure.

A typical RS232 communication port set up screen is shown below:

```
----- RS232-PORT-A1 ----- C
ENABLED      Baud 57600
Driver None   Parity None
Mode LOCAL    Stop Bits 1
```

- it has been ENABLED to transmit/receive messages,
- it has no port driver support,
- it is operating at 57600 baud, 8 bit, no parity, 1 stop bit,
- it is a LOCAL mode port.

Scrolling through the **RS232-PORT-A** to menu option to see these settings would show the following text :

```
☐ ENABLED
☐ Baud 5760
☐ Driver NONE
☐ Parity NONE
☐ Mode LOCAL
☐ Stop bits 1
```

Navigating to a Communication Protocol

Whilst on the main COMMUNICATIONS SETUP screen, press the **SELECT** key until the desired protocol begins flashing and then press the **ENTER** key to display the protocol's settings. Subsequent left or right arrow key presses display more settings, and pressing the **MENU** key at any time returns to the main communication set up screen.

ENGINEER MENU – TELEMETRY MENU – CONFIGURE COMMS

Then scroll using the **UP** and **DOWN** arrow keys until you have found the protocol submenu you wish to configure.

A typical protocol application first screen can be seen in the example below:

```
----- WSOS COMMUNICATIONS ----- C
Port RS232-A  RUNNING
Change-of-State OFF
```

It can be seen in the above example that:

- the WSOS5 protocol used to communicate with WSOS5 has been configured to communicate using Port A,
- the application is running i.e. no other application has excluded it from controlling the port,
- the WSOS5 change of state feature is currently OFF.

flex Each Port has its settings on individual pages. The layout out of the RS-232 configuration menus is as shown below:

CONFIG PORTS MENU

```

↳ RS-232-PORT-A/B/C/D
  ↳ IN USE/ENABLED/DISABLED
  ↳ Baud 800 - 57600
  ↳ Driver NONE
  ↳ Parity ODD/EVEN/NONE
  ↳ Mode LOCAL/Remote
  ↳ Stop bits 1/2
  ↳ *RTS DISABLED/ENABLED
  ↳ *Pre-Tx 0 - 3000ms
  ↳ *CTS Ignore/Don't Ignore
  ↳ *Post-Tx 0 - 3000ms
  ↳ *DTR DISABLED/ENABLED
  ↳ *DCD Ignore/Don't Ignore
  ↳ *CA Delay 0 - 180000ms
  ↳ Preamble DISABLED/Enabled
  ↳ First Char 0x55 (default)
  ↳ Repeat First 0 - 20
  ↳ Last Char 0xFF (default)
  ↳ **RS232-PORT-CorD Hayes 1
  
```

* These settings are only available on RS-232-Ports C and D.

** Only available on Ports C & D when made available.

Configuring RS-232 Port Settings

The controller has four user configurable RS232 Ports - A, B, C and D. Details for these are given below.

set RS-232 Configuration Settings

A number of settings can be configured for each RS232 port. The settings are located across four pages which are numbered 1 through 4. An example of each page is shown below.

flex ENGINEER MENU – TELEMETRY MENU – CONFIG PORTS MENU

Complete details of these settings are given at “**RS232 Communication Port Settings** (page I-1)”

```

----- RS232-PORT-C1 ----- C
ENABLED          Baud 57600
Driver None      Parity None
Mode LOCAL       Stop Bits 1
  
```

```

----- RS232-PORT-C2 ----- C
RTS DISABLED     Pre-Tx 250ms
CTS Ignore       Post-Tx 35ms
DTR DISABLED
  
```

```

----- RS232-PORT-C3 ----- C
DCD Ignore       CA Delay 1000ms
  
```

```

----- RS232-PORT-C4 ----- C
Preamble DISABLED Last Char 0x55
Repeat First 3     Last Char 0xFF
  
```

RS232 Transmission of a data packet

The following is a typical RS232 communications behaviour for communication with a radio modem. Requires RTS ENABLED and CTS Don't Ignore settings.

1. RTS line is asserted
2. Controller waits until the pre-transmission (Pre-Tx) delay expires and checks that CTS has been asserted.

The preamble is transmitted (optional).

3. Checks CTS is still asserted.
4. The packet is transmitted
5. Waits until the post-transmission (Post-Tx) delay expires.
6. RTS is negated

COMMUNICATIONS PROTOCOLS

The following communications protocols are supported:

- DNP3 - See ADC01-DOC-146
- MITS - See ADC01-DOC-210
- IEC 60870-101 - See ADC01-DOC-246
- IEC 60870-104 - See ADC01-DOC-246
- SOS Multidrop (Nulec 2)

RDI MODEM SUPPORT

The controller can support connection to a device that uses the RDI protocol. The RDI driver is used to interface to the EDACS radio system used in some parts of USA.

RDI is both a physical and a logical flow control protocol and is proprietary to M/A-COM Private Radio Systems. For the physical interface it requires RX TX, RTS, GND, and may optionally use CTS.

The operation is such that a packet of data generated by a protocol (e.g. DNP3) is wrapped in RDI control data and transmitted out of the physical port. The RDI device to which the controller is connected must acknowledge each transmitted packet. An optional additional acknowledgement (ACK2) may be used to verify end-to-end data transfer (i.e. from EDACS radio to EDACS radio). The CTS signal is used along with the ACK2 to indicate the success or failure of the data transmission.

Any protocol using the RDI protocol must allow sufficient time between retries to allow the RDI protocol to exhaust all transmission attempts. The Resend Wait setting allows configuration of a delay before any communication is attempted and after any successful transmission or any failed retry sequence only. The purpose is to avoid continual failures due to timing synchronization problems between the Master and Slave units.

Data received by the controller from the RDI device is acknowledged if it is valid, stripped of the RDI data, and passed on to the protocol that is attached to the port.

Complete details of the settings shown in the following Communications Display Group screens are given at "**RDI Modem Support Settings** (page I-4)".



Depending on the implementation of RDI, a prefix to the data messages may be required. The Prefix Data setting allows the prefix to be enabled or disabled. The prefix used is 0x14.



```
----- RDI Communications ----- C
MSG Attempts 4      Resend Wait 50
ACK2 ON
Prefix Data OFF
```

```
----- RDI Communications ----- C
ACK0 Err Cnt 0
ACK1 Err Cnt 0
ACK2 Err Cnt 0
```



When made available, the RDI driver configuration menu opens in the RS232-PORT-C or D menu. The structure of this menu is shown below:

RS-232-PORT-C/D

```
├─ RDI SETTINGS
│  ├─ MSG Attempts
│  ├─ Resend Wait
│  ├─ ACK2 ON
│  └─ Prefix Data OFF
└─ RDI STATS
   ├─ ACK0 Err Cnt
   ├─ ACK1 Err Cnt
   └─ ACK2 Err Cnt
```



Settings for RDI can be found in the **flexVUE** at the following location:

```
ENGINEER MENU – TELEMETRY MENU – CONFIG PORTS MENU
– RS232-PORT-C/D – RDI Settings
```

All of the above counters are zeroed when:

- the controller is reset;
- the RDI driver is selected/deselected;
- an RDI configuration parameter is changed; or
- the Reset All button is selected in WSOS5 RDI dialog.

All communication statistic parameters are not password protected.

HAYES COMPATIBLE MODEM SUPPORT

To allow the ADVC to initiate a call to a remote device, if, for example, there are change-of-state events to be reported to the master the Hayes driver needs to be set up.

The ADVC uses a list of up to 10 phone numbers. If it fails to establish communication via one number, it then tries the next number on its list. The list is configured via WSOS only.

The Hayes compatible modem, which has dialling / auto answer capability, must be connected to port C or D.

The driver uses the state of the DCD input from the modem to determine the modem's status. If DCD is asserted then the modem is online. If DCD is negated the modem is considered offline.

Communications (cont)

If the driver is active then the communication port DCD Ignore field is set to DCD Don't Ignore, and this field becomes display only. Changes from WSOS5 are also ignored.

The modem must be set up to:

- auto answer any call,
- not return results codes,
- not echo commands.

It will also help if the modem resets when it receives an ON-to-OFF change of the DTR. Need DTR enabled to use this feature. The controller must also have DTR enabled to utilise this functionality.

To establish a remote connection the driver issues an "ATD", "ATDT", or "ATDP" Hayes command followed by the currently active phone number. The driver will then wait up to 90 seconds (configurable) for the modem to assert the DCD line. If the modem fails to assert the DCD line within 90 seconds then the dial out attempt is aborted, the next configured phone number is selected and another attempt to dialout is made.

If the DCD line is asserted, or all numbers in the phone list have been dialled, then this is counted as a dial out attempt. However if the data is not sent, then the next dial out attempt will begin after "Attempt Delay" seconds. This will happen no more than "Max Attempts" times.

After successful communications (i.e. a phone line has been established) the driver will hang up the modem after a delay of 30 seconds (configurable) if no data has been received or transmitted.

The active phone number is reset to the head of the list.

To hang up the modem the driver will:

1. Send "+++"
2. Wait 1.2 second
3. And then send "ATH"
4. Wait 5 second
5. Toggle the DTR line if enabled.

The driver will then check to ensure the modem has negated the DCD line. If the DCD is still asserted and radio power supply cycle is ON, the driver will turn the radio power supply (AUX+) off for 1 minute to disconnect power from the modem and reset it.

If, after the radio power reset, the dial out sequence initialisation conditions are still met then a new sequence is initiated.

 The Hayes driver is made available on:

```
----- OPTIONS COMMUNICATIONS 2 ----- C
Trace Available      DNP3 Available
RDI Not Available    Hayes Available
```

 Settings for Hayes Driver can be made available on the **flexVUE** at the following location:

```
ENGINEER MENU - CONFIGURATION MENU - FEATURE
SELECTION - COMMUNICATIONS - Hayes Avail/Not Avail
```

The Hayes driver is selected from the port configuration screen

 Example below is for Port C, but the same screens are available for Port D.

```
----- RS232-PORT-C 1 ----- C
IN USE      Baud 9600
Driver Hayes Parity None
Mode REMOTE Stop Bits 1
```

 Selecting the Hayes Driver can be done within Port C or D settings which can be found in the **flexVUE** at the following location:

```
ENGINEER MENU - TELEMETRY MENU - CONFIG PORTS MENU
- RS232-PORT-C or D - Driver Hayes
```



The driver does not consider all devices using the radio power supply. They will be disrupted even if in operation.

 When made available, the Hayes driver configuration menu opens in the RS232-PORT-C or D menu. The structure of this menu is shown below:

RS-232-PORT-C/D

```
└─ RS-232-PORT-C/D HAYES 1
   ├── Dial Command ATDT
   ├── No Data Timeout 0 - 86400s
   ├── Max Attempts 1 - 255
   ├── Attempt Count
   └── Modem Pwr Cyc OFF/1 - 48hr
```

 The Hayes driver configuration screen is accessed via the port configuration screen once selected.

```
----- RS232-PORT-C HAYES 1 ----- C
Dial Command ATST      No Data Timeout 30s
Dial Timeout 90        Attempt Delay 30s
Max Attempts 3         Attempt Count 0
```

```
----- RS232-PORT-C Hayes 2 ----- C
Radio Pwr Cyc OFF
```

 Hayes Driver configuration can be done within Port C or D settings which can be found in the **flexVUE** at the following location:

```
ENGINEER MENU - TELEMETRY MENU - CONFIG PORTS MENU
- RS232-PORT-CoD - RS232-PORT-CoD Hayes 1
```

Complete details of the settings shown in the above Communications Display Group screens are given at “**RDI Modem Support Settings** (page I-4)”

SOS MULTIDROP

The ADVC supports WSOS communications using the SOS Multidrop driver.

Overview

Normal WSOS communications, being point to point, does not require device addressing.

Where WSOS communications is not point to point, device addressing is required, and is achieved via the SOS Multidrop driver. Examples of shared communication media are RS485 and Radio.

RS232 Ports A and B do not have RS232 handshaking lines, so are not supported by the SOS Multidrop driver.

RS232 RADIO

An RS232 radio can be connected to port C or D. The driver uses the state of the DCD input from the radio to determine the radio's status. If DCD is asserted then the radio is online. If DCD is negated the radio is considered offline.

If the driver is active then the communication port's DCD Ignore field is set to DCD Don't Ignore and this field becomes display only. Changes from WSOS5 are ignored in this case

SOS Multidrop Driver Settings

 The SOS Multidrop driver is made available on:

```
----- OPTIONS COMMUNICATIONS 2 ----- C
Trace Available      DNP3 Available
RDI Not Available    Hayes Available
SOS Multi Available
```

 SOS Multidrop Driver can be made available in the **flexVUE** at the following location:

```
ENGINEER MENU - CONFIGURATION MENU - FEATURE SELECTION
- COMMUNICATIONS - SOS Multi Available/Not Available
```

The SOS Multidrop driver is selected from the port configuration screen.

 Example given is for Port C, but the same screens are available for Port D.

```
----- RS232-PORT-C 1 ----- C
IN USE      Baud 9600
Driver SOS Multi  Parity None
Mode REMOTE  Stop Bits 1
```

 Selecting the SOS Multidrop Driver can be done within Port C or D settings which can be found in the **flexVUE** at the following location:

```
ENGINEER MENU - TELEMETRY MENU - CONFIG PORTS MENU
- RS232-PORT-CoD - Driver SOS Multi
```

Communications (cont)

 When made available, the SOS Multidrop driver configuration menu opens in the RS232-PORT-C or D menu. The structure of this menu is shown below:

RS-232-PORT-C/D

- SOS MULTI SETTINGS
 - Char Timeout 20 - 999ms
 - Address 1 - 2⁸¹
 - Max Frag Size 10 - 1982
 - Frag Retry Time 1 - 999s
 - Frag Retries 1 - 100
- SOS MULTI STATS
 - Tx Count
 - Rx Count
 - Rx CRC Err
 - Rx Length Err



"Carrier Detect" and "Busy" work in an either/or relationship with respect to collision avoidance i.e. if Busy Don't Ignore and CD ENABLED then either a BUSY state or CARRIER DETECTED blocks V23 transmissions and the CA Delay mechanism is invoked.

 The SOS Multidrop driver configuration screen is accessed via the port configuration screen once selected.

```
----- RS232-PORT-C SOS Multi 1 ----- C
Char Timeout 20ms      Address 1
Max Frag Size 1982     Frag Retry Time 10s
Frag Retries 10
```

```
----- RS232-PORT-C SOS Multi 2 ----- C
Tx Count 0             Rx Count 0
Rx CRC Err 0           Rx Length Err 0
```

Complete setting details are given in "**Appendix I Communication Settings** (page I-1)"

CONFIGURING RS-485 PORT SETTINGS

Complete details of the RS-485 configuration settings are given at "**RS485 Communication Port Settings**. (page I-7)"



```
----- RS 485-1 ----- C
ENABLED                Baud 57600
Mode LOCAL              Parity
```

 Configuring the RS-485 on the **flexVUE** can be done at the following location:

ENGINEER MENU – TELEMETRY – CONFIG PORTS MENU – Port RS485

CONFIGURING V23 FSK PORT SETTINGS

Signal frequencies conform to V23 standard.

The controller only supports half duplex (i.e. receive and transmit can not occur at the same time) when using the V23 port.

V23 CONFIGURATION SETTINGS

 Complete details of the V23 FSK configuration settings are given at "**V23 FSK Port Settings** (page I-7)"

```
----- V23 FSK 1 ----- C
ENABLED                Baud 1200
Mode REMOTE             Parity NONE
```

```
----- V23 FSK 2 ----- C
CD DISABLED            Pre-Tx 250ms
CD if input low        Post-TX 35ms
Busy Don't Ignore      CA Delay 1000ms
```

```
----- V23 FSK 3 ----- C
Preamble DISABLED      First Char 0x55
CD if input low        Last Char 0x55
```

 Configuring the RS-485 on the **flexVUE** can be done at the following location:

ENGINEER MENU – TELEMETRY MENU – CONFIG PORTS MENU – Port RS485

CONFIGURING 10BASE-T PORT

Complete details of the 10Base-T configuration settings are given at “**10Base-T Port Settings** (page I-9)”



```
----- 10 Base-T 1 ----- C
ENABLED                IP 10.178.28.101
Mode REMOTE            Subnet 255.255.0.0
DHCP OFF
```



Configuring 10 Base-T on the **flexVUE** can be done at the following location:
ENGINEER MENU – TELEMETRY MENU – CONFIG PORTS MENU – 10BASE-T

COMMUNICATIONS DIAGNOSTIC FEATURE

When commissioning or troubleshooting a SCADA communication links it is often necessary to capture and /or monitor communication channels to aid in problem resolution and to confirm correct operation.

When combined with an external capture facility, the controller has a useful feature that allows viewing and/or capturing of SCADA communications.

The communications diagnostic feature has three major modes of operation:

- Communications Trace Mode.
- Communications Loop-Back Mode.
- Communications Capture Mode.



The “Trace” and “Loop-back” modes are accessed and controlled via the Operator Interface page

COMMUNICATIONS TRACE 1



Configuring Trace on the **flexVUE** can be done at the following location:

ENGINEER MENU – TELEMETRY – CONFIGURE COMMS – Trace Menu

The Communications “Capture” mode and “traced” message stream is controlled and captured by WSOS5.

Communication Trace

Typical operator configuration for communications “Trace”:



```
----- Communications Trace ----- C
Output RS232-A          RUNNING
Target RS485            Timeout 15 Min
Fmt ASCII-HEX           End of Line CR/LF
```

All data bytes received and transmitted on the target port are copied and then transmitted through the output port. The output port data can be viewed and/or captured using a PC running third party software such as Hyper-terminal.

Traced messages can optionally have a date, time, port, driver, application, Tx/Rx indicator and data length, and header prefixed when the Fmt field is set to ASCII-HEX or HEADER BINARY.

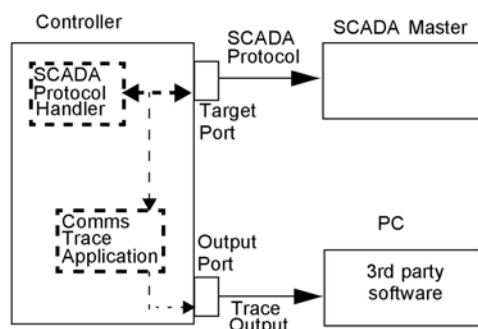
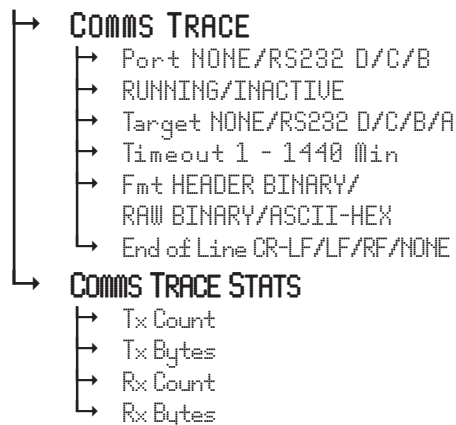
With Fmt set to ASCII-HEX, the End of Line field setting controls the character(s) that are placed at either end of the prefixed header which is enclosed in the < > character pair. The body of the traced message is transformed into ASCII two character per byte human readable format.

For example:

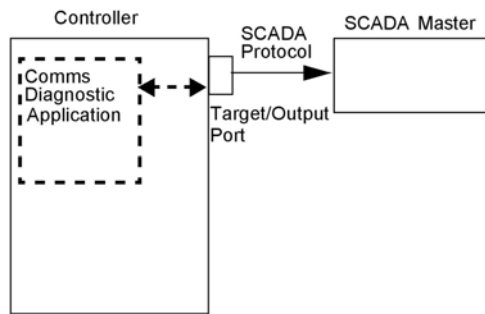
```
<End of Line0 character (s)>
<10/03/04 16: 03: 21. 537, RS485, NONE, DNP3, Tx, 10> <End of Line0
character (s)>
05 64 05 40 03 00 05 00 C8 CD <End of Line character (s)>
<10/03/04 16: 03: 21. 929, RS485, NONE, Rx, 10> <End of Line0 character (s)>
05 64 05 80 05 00 03 00 AB A4
```

When made available, the Trace configuration menu opens in the CONFIGURE COMMS menu. The structure of this menu is shown below:

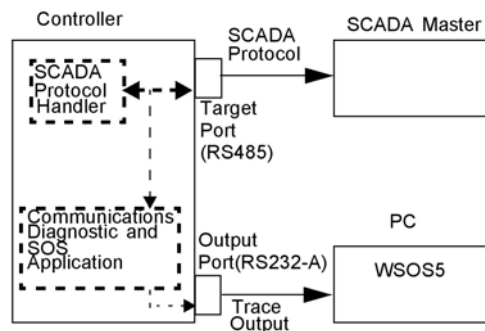
TRACE MENU



Communications (cont)



Only ports that are available and in an **ENABLED** state (" **RS-232 Configuration Settings** (page 13-5)") are shown in the **Output** field, i.e. other 'protocols/applications that are active and have the desired Output port selected need to be turned OFF or select another port to make the desired output port available for the communications diagnostic.



Communication Loop-Back

Typical operator configuration for communications "Loop-back":

```
----- Communications Trace ----- C
Output RS232-C      RUNNING
Target RS232-C      Timeout 15 Min
Fmt RAW LOOPBACK    End of Line CR/LF
```

The Output and Target fields are set to the same port, which creates a software loop back within the controller. Any SCADA messages received on the Target/Output port are reflected as a transmitted message.

The Fmt field will display 'RAW LOOPBACK' which is the only format supported within 'Loop-back' mode.

The End of Line field setting has no effect.

Communications Capture

Typical operator configuration for communications "Capture":

```
----- Communications Trace ----- C
Output WSOS5        RUNNING
Target RS485         Timeout 15 Min
Fmt HEADER BINARY    End of Line CR/LF
```

Communications Capture mode is controlled entirely via WSOS5.

All data bytes received and transmitted on the Target port is captured by the WSOS5 communication capture tool.

In this mode, WSOS5 overrides the following settings:

- Output port setting is overridden to be WSOS5
- Target port is selected via WSOS5.
- Format (Fmt) setting is overridden to be HEADER BINARY (reverts to previous setting at end of WSOS5 capture session).

The COMMUNICATION TRACE 1 panel page fields become status display only and the Timeout and End of Line fields have no effect.

Communications Trace Settings

See " (page 1-9)" for details of these settings.

```
----- Communications Trace ----- C
Output NONE          INACTIVE
Target NONE          Timeout 15 Min
Fmt HEADER BINARY    End of Line CR/LF
```

```
----- Communications Trace ----- C
Tx Count 0           Rx Count 0
Tx Bytes 0           Rx Bytes 0
```

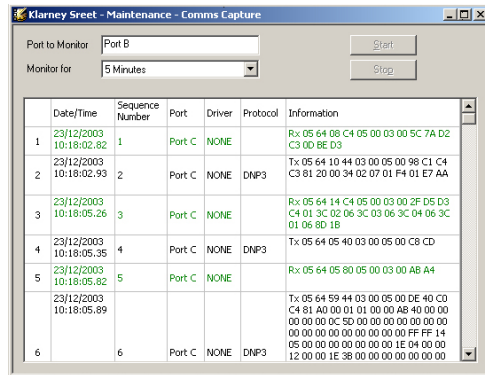


Figure 37. WSOS5 Communications Capture Display

Example Communications Capture

Figure 37. (page 13-12) shows a typical WSOS5 communications capture display.

WSOS5 Controlled Mode Operation

In order for WSOS5 to successfully capture the controller's SCADA protocol messages, the following rules must be applied:

- WSOS5 cannot capture communications on the controller's port upon which it is communicating.
- WSOS5 must be connected to the controller via "Direct", "Modem" or "IP".
- The WSOS5 connection speed must be greater than the SCADA protocol speed. The table below gives examples of valid connection methods.

WSOS5 connection	SCADA protocol to monitor	Valid
Direct 57600	Direct 9600	Yes
Direct 57600	Direct 19200	Yes
Direct 57600	Direct 57600	Yes
Direct 57600	Modem 1200 baud	Yes
Direct 57600	Modem 9600 baud	Yes
Direct 57600	Modem 19200 baud	Yes
Direct 57600	V23 (1200 baud)	Yes
Modem 9600	Direct 9600	Yes
Modem 19200	Direct 19200	Yes
Modem 57600	Direct 57600	No

- When off-line, the "Start" and "Stop" buttons are disabled. When on-line the "Start" and "Stop" buttons are enabled/disabled depending on the operating mode. A valid port to monitor must be selected before pressing the start button. After the start button is pressed, the screen can be closed and the capturing will continue for the time period selected. Other screens can be displayed and values changed etc. The stop button, when enabled, can be pressed to stop the capturing. The communications capture file can be included as part of the export file.

Clicking the right mouse button on the grid displays a menu of options.

14 Automation

The Loop Automation option is available under licence from your distributor.

INTRODUCTION

Loop Automation is a Distribution System Automation (DSA) scheme that will automatically reconfigure a network to restore supply to fault free sections that have been disconnected due to a fault in another part of the network. Loop Automation can also re-install the normal network configuration automatically when the faulted section has been repaired and re-energised.

Loop Automation becomes available and adds additional display pages to the Automation display group when the setting

 **SYSTEM STATUS - OPTIONS 2 - Loop Auto Available**

 **ENGINEERING - Configuration - Feature Selection - Automation**

is selected.

A Loop Automation scheme consists of a number of automatic circuit reclosers that have been programmed to react to a loss of supply and/ or change of power flow. The way each recloser reacts to changing network conditions is determined by its type designation. There can be three types of recloser in a Loop Automation scheme and the type assigned to each recloser is determined by its location in the network.

The types of recloser are:

- Feeder Recloser - this recloser is positioned close to the sub-station and is normally closed.
- Tie Recloser - positioned close to or at the end of two feeders which can be connected and is normally open.
- Mid-Point Recloser - can be positioned anywhere along a feeder between a Feeder and Tie recloser.

Each of the recloser types operates independently according to its own set of rules. A Loop Automation scheme does not require communications between reclosers, therefore no additional equipment is needed. Loop Automation is a software feature.

EXAMPLE L.A. SCHEME

Fault Isolation and Network Re-Configuration

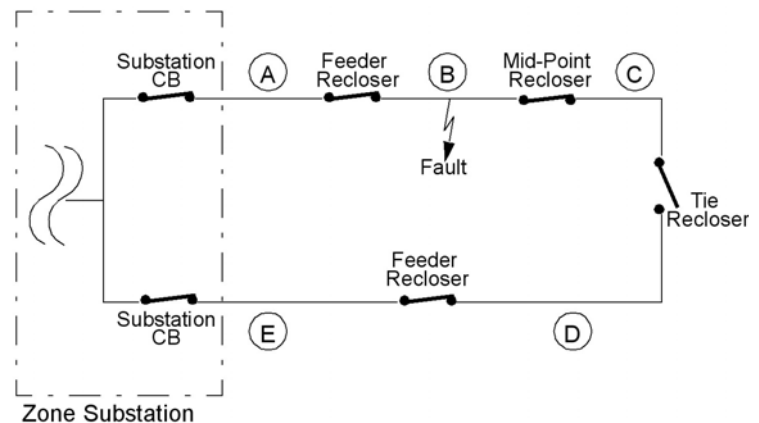


Figure 38. Example of a Loop Automation Scheme

The example in the above figure shows a Loop Automation scheme consisting of two feeder reclosers, one midpoint and one tie. A fault in section B will cause the protection for the upstream feeder recloser to trip that recloser and de-energise the faulted section B as well as the fault-free section C.

The feeder recloser may trip and auto-reclose a number of times in an attempt to clear the fault. This is the normal protection operation which will happen regardless of whether or not Loop Automation is enabled.

If Loop Automation is enabled it will initiate the following sequence of events after the auto-reclose sequence has finished and the feeder recloser has gone to lockout:

1. The MP ACR changes protection group in anticipation of power flow change.
2. The tie recloser will detect loss of volts on one side and close.
3. The midpoint recloser is tripped by its protection due to the fault on section B and goes directly to lockout without an auto-reclose.

The network has now been configured with the faulted section B isolated at both ends and the unfaulted section C energised via the closed tie recloser.

Auto-Restoration Option

Loop Automation can auto-restore the original network configuration when the fault on section B is removed.

Auto-restoration is initiated when the fault on section B is removed and either the feeder or midpoint recloser is closed. This will initiate the following sequence:

- The remaining open point (either the midpoint or feeder recloser) will automatically close.
- The tie recloser will open to restore the normal configuration.

To access the auto-restore option go to

 Automation – Loop Automation Configuration 1
– AutoRestore OFF

 ENGINEERING – Automation – Loop Automation
– LA ON/OFF

Loop Automation is documented in its own Technical Manual (Part Number ADC01-DOC-223)

Contact the manufacturer or your distributor for more information.



The auto-restore capability is an option - if the network cannot be run as a closed loop then auto-restore cannot be used and must be turned off.

15 Windows Switchgear Operating System

(WSOS5)

Basic configuration of the ADVC can be performed by either the O.I. or WSOS5. Some advanced features can only be configured via WSOS5.

INTRODUCTION

Windows Switchgear Operating System (WSOS5) is an alternative ADVC interface. It is a software package, based on Microsoft Windows®¹, for a Personal Computer (PC) that allows management, control and monitoring of a population of ACRs. WSOS5 is purchased as an additional item.

WSOS5 provides easy access to all switchgear functions from opening/ closing, through configuring protection and communication parameters to accessing measurement and analytical data. By using a desktop or portable PC engineers can manage a large number of reclosers either remotely via a communications link or locally via a serial port or Ethernet connection.

WSOS5 includes:

- Local language support
- Advanced Controller support
- SCADA communications capture tool
- Controller firmware loading
- Switchgear explorer
- Launch pad
- Switchgear status
- Event log and filtering
- Feature selection page
- Setting page

WSOS5 provides facilities for:

- On-line and off-line management of all protection settings.
- Tripping and Closing of the ACR and other operator control functions.
- Up-loading of historical data (e.g. event record or demand measurements) into the computer, which can be taken away and processed elsewhere.

Embedded in the ADVC is server software for the WSOS5 package. The server provides two interfaces for connection to WSOS5:

- Local connection through an RS232 port. (Default Port A)
- Via the Ethernet port.

¹ Windows is a registered trademark of Microsoft Corporation in the United States of America, and other countries.

O.I. vs WSOS5

Most ADVC settings and/or features are available via both the O.I. and WSOS5, however:

- some are available on the Operator Interface only
- some via WSOS5 only.

Other features are specific to WSOS5. The following sections give details.

O.I. and not WSOS5

- Switchgear local/remote mode
- Maximum Demand Indication reset

WSOS5 and not O.I.

- SCEM data read/writing and viewing
- Event log history find by text and date
- Event log history include & exclude text filter
- Configurable history configuration and viewing and graphing
- Harmonic history configuration and viewing
- Waveform capture data retrieval, storage and viewing
- Waveform generation
- Configuration of IOEX2 maps
- Configuration of DNP3 maps
- Configuration of *flexVUE* O.I. mapping
- Communication port selection
- Communications capture
- Per phase power monitoring
- Feature selection Available/Not Available for
 - ☐ Low Gas Interlock,
 - ☐ Hit and Run,
 - ☐ Directional Blocking, and
 - ☐ Directional Protection
- VT Configurator
- Custom Menu configuration
- Standard Menu first screen configuration
- ADVC Password configuration

WSOS5 features that are not controller features

- Launch pad
- Switchgear explorer
- Switchgear navigator
- Switchgear status
- Automatic data retrieval (ADR)
- Operator Log
- Communications Output Log
- Display and printing of settings
- ADVC code loader
- Communication statistics
- Settings retrieval and storage
- Settings export/import
- 4 user levels - operation, telecontrol, protection and system

INTRODUCTION

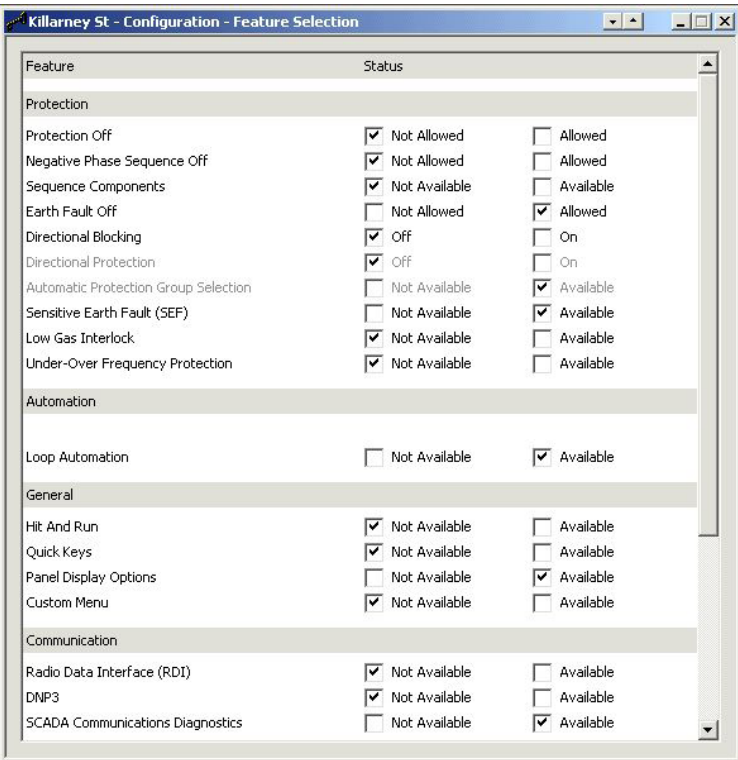
The ADVC can be set up to operate in a manner of a user's or utility's preference via several customisation options:

- Feature selection - the ability to enable or disable a controller feature. This includes enabling/disabling not only the feature's logic but also all references to the feature's settings in WSOS5 and O.I.. This constrains both user interfaces to only the desired features.
-  Standard **setVUE** menu:
 -  Custom **setVUE** menus - a user defined collection of ADVC standard displays duplicated in a separate menu to enable ease of use. Also included is the ability to make the ADVC rotate the displays at a predetermined rate to show the ADVC settings and states without the need to touch a key on the panel.
 -  First screen selection - if using standard menus, the first display seen by an operator on power up is selectable from any page in the system.
 -  Configurable Quick Keys - the function of the quick keys can be changed to suit individual needs. (Custom "stick-on" labels provided)
-  **flexVUE** customisation:
 -  20 configurable status lamps
 -  12 configurable quick action keys
 -  Customise labels of status lamps and quick action keys
 -  Configurable delay of operator trip and close commands via the operator interface
- Language support - the panel can display its information in multiple languages e.g. English international, English USA, Spanish and Portuguese.
- Display Settings Units - the ADVC Controller can be set up to display either Imperial or Metric units.
- Plant name - a 30 character message can be added to the initial power up screen for equipment identification purposes.

FEATURE SELECTION

The ADVC has a feature enable/disable capability that allows it to be customised to include or remove much of its functionality. Features that are not required can be disabled or enabled via WSOS5 or the O.I. on the ADVC. When a feature is disabled all logic associated with that feature is turned off, and any references to the feature are removed from the O.I.. This simplifies ADVC operation as well as O.I. usage.

Enabling or disabling of ADVC features can be performed either via the panel “Options” pages or WSOS5 “Feature Selection” page:



A typical **setVUE** options page can be seen in the example below:

```
----- OPTIONS 1 ----- C
Prot OFF Not Allow    SEF Available
E/F OFF Allowed      Seq Comp Available
NPS OFF Allowed
```

Many of these Protection features can be found in the **flexVUE** at the following location:

ENGINEERING - Configuration - Feature Selection - Protection

The displaying of Options pages of the O.I. is also configurable. Enabling/disabling the options pages can be done via

SYSTEM STATUS - SYSTEM SETTINGS 2.

ADVC Customisation (cont)

Protection

Some settings can only be selected if certain other settings are appropriate. Selecting some settings can cause other settings to change. Such effects and dependencies are listed below:

User Selection	Prerequisite	Setting(s) Changed
Protection OFF <i>Allowed to Not Allowed</i>	None	Protection ON Protection OFF Not Allowed
Negative Phase Sequence OFF <i>Allowed to Not Allowed</i>	Seq Comp Available	Negative Phase Sequence ON Negative Phase Sequence OFF Not Allowed
Sequence Components <i>Available to Not Available</i>	None	Negative Phase Sequence OFF Allowed Negative Phase Sequence OFF Sequence Components Not Available
Earth Fault OFF <i>Allowed to Not Allowed</i>	None	Earth Fault ON Earth Fault OFF Not Allowed
Sensitive Earth Fault <i>Available to Not Available</i>	None	Sensitive Earth Fault OFF Sensitive Earth Fault Not Available
Directional Blocking <i>OFF to ON</i>	Directional Protection is OFF	If the active protection group is B, D, F, H, or J then the active settings group is set to one less eg if group B is active then group A becomes active Directional Blocking ON
Directional Protection <i>OFF to ON</i>	Directional Blocking is OFF Automatic Protection Group Selection is Not Available	Directional Protection ON
Directional Protection <i>ON to OFF</i>	None	Directional Protection OFF If Loop Automation is ON then Automatic Protection Group Selection is set to Available
Automatic Protection Group Selection <i>Available to Not Available</i>	Loop Automation is Not Available	Automatic Protection Group Selection OFF Automatic Protection Group Selection Not Available
Automatic Protection Group Selection <i>Not Available to Available</i>	Number of protection groups is greater than 1	Automatic Protection Group Selection OFF Automatic Protection Group Selection Available
 Low Gas Interlock , for N-Series only . <i>Available to Not Available</i>	None	Low Gas Interlock Not Available
Under-Over Frequency Protection <i>Available to Not Available</i>	None	Prot Groups A through J points: - - Under Frequency Trip - Over Frequency Trip - Normal Frequency Close Active Protection Group Change is enabled Under-Over Under-Over Frequency Protection Not Available

Automation

Automation features are greyed out if not licensed.

User Selection	Prerequisite	Setting(s) Changed
Loop Automation <i>Not Available to Available</i>	None	If Directional Protection is OFF then : Automatic Protection Group Selection is set to Available Loop Automation Available

General

The following general feature selections have no operational dependencies and as such operate entirely independently of any other ADVC feature.

-  Hit And Run - Not Available/Available
-  Configurable Quick Keys - Not Available/Available
-  Custom Menu - Not Available/Available
- IOEX - Not Available/Available
- Panel Display Options - Not Available/Available
- Battery Health Test - Not Available/Available

Communications

The following communication feature selections have no operational dependencies and as such operate entirely independently of any other ADVC feature.

- Radio Data Interface - Not Available/Available
- DNP3 - Not Available/Available
- SCADA Communications Diagnostics - Not Available/Available

Power Quality

Power Quality features are greyed out if not licensed.

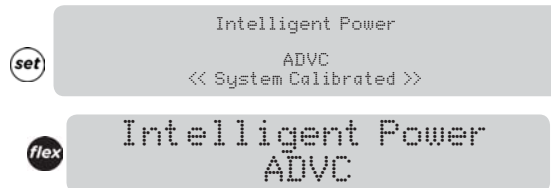
The following power quality feature selections have no operational dependencies and as such operate entirely independently of any other ADVC feature.

- Supply Outages - Not Available/Available
- Waveform Capture - Not Available/Available
- Harmonic Analysis - Not Available/Available

O.I. DISPLAY

Plant Name

When the O.I. is activated the following power up screen is seen momentarily. The text "Intelligent Power" can be replaced by a user defined 30 character message. This is useful for displaying the DAFT's tag name or plant name to an operator.

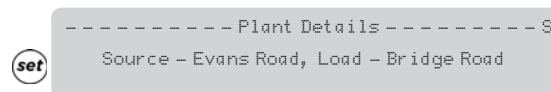


To change the default text: "Intelligent Power", use WSOS5. From the WSOS5 Display menu choose Status. In the Status window, Controller Status section, there is a field called Plant Name in which you type the plant name and/or details in order to enable you to identify or provide information about the ACR or ADVC. The field can accept 90 characters but only the first 30 are shown on the O.I..

Each time the content of the Plant Name field is changed and a new string downloaded to the controller an event log entry is recorded.

Plant Details

The Plant Details system status page is set up and enabled in WSOS5. From the WSOS5 Display menu choose Status. In the Status window, Controller Status section, there is a field called Plant Details in which you enter the plant details in order to enable you to provide information about the ACR or ADVC e.g. information to help identify which is Source and which is Load side of the ACR. The field can accept 90 characters but only the first 30 (set), (20 for flex) are shown on the O.I..





MENU TYPES

The following section relates to the **setVUE** Operator Interface. For more detailed information on the flexVUE *“flexVUE Configuration tool”* (page 16-10).

The **setVUE** supports two types of menu configuration:

- Standard Menu
- Custom Menu

Advanced Controller Default Display Group Navigation

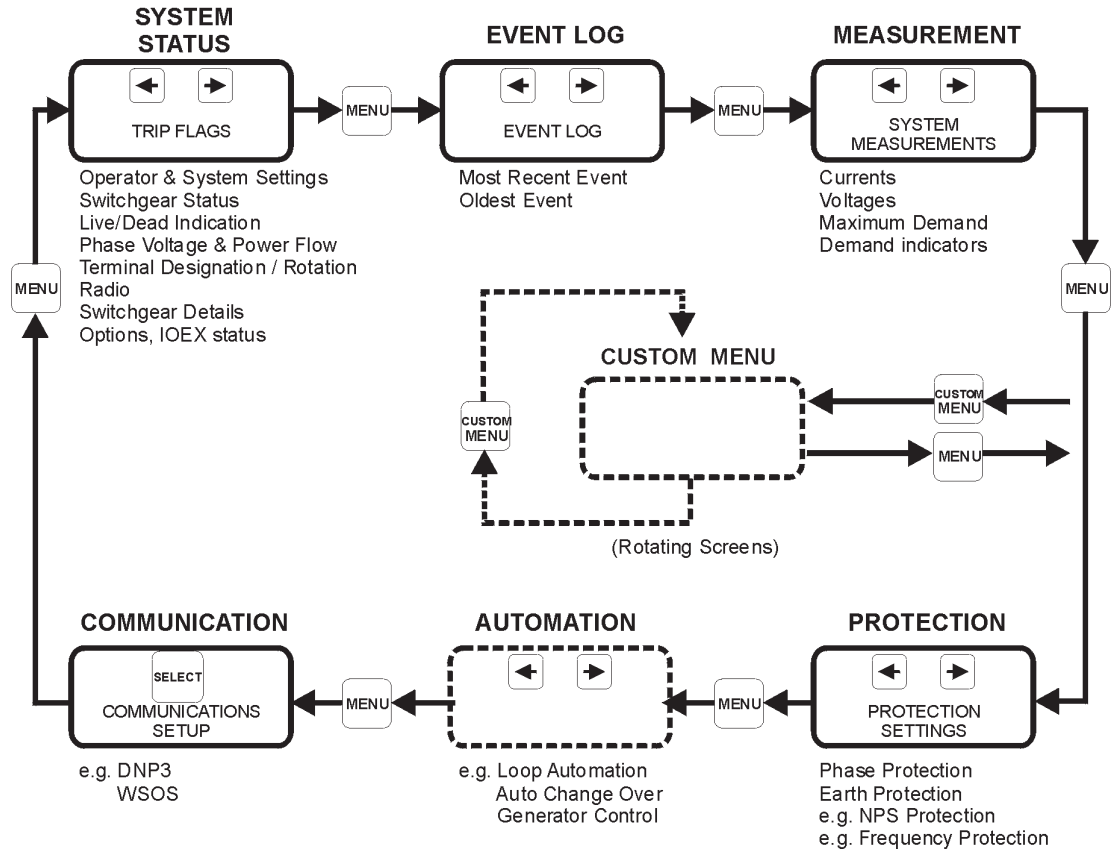


Figure 39. setVUE Display Group Navigation

STANDARD MENU

The controller's standard menu has a six display group navigation structure. Navigation within the standard menu is described in the product's Installation and Maintenance manual. Diagrams of menu navigation are also available under the controller hatch and inside the controller door.

System Status Display Group

Contains all status information about the recloser and controller eg battery low, operations count, SEF enabled/disabled.

Information on this display group is given in **“Appendix J System Status pages”** (page J-1). All system status displays are identified by the symbol “S” in the top right hand corner of display.



Event Log Display Group

Shows the event record for the controller. More information is given in the chapter “7 **Event Log** (page 7-1)” and see the list of events in “**Appendix N List of Events** (page N-1)”

Measurement Display Group

Contains all information about the controller's current, voltage, frequency and power measurements. All measurement displays are identified by the symbol “M” in the top right hand corner of display.

Information on this display group is given in “**Appendix K Measurement pages** (page K-1)”

Protection Display Group

Contains all the protection settings currently in use eg Trip current settings, curves, reclose times. All protection displays are identified by the symbol “P” in the top right hand corner of display.

Information on this display group is given in “**Appendix M Protection pages** (page M-1)”

Detection Display Group *(replacing Protection Display Group)*

When the controller is configured as a Secionaliser, the Protection display group is replaced with the Detection display group. Contains all the detection settings currently in use eg Overcurrent fault detection settings, definite times. All detection display pages are identified by the symbol “D” in the top right hand corner of display.

Information on this display group is given in “**Appendix L Fault Detection pages** (page L-1)”.

Automation Display Group

Contains all the information for controller automation schemes such as Loop automation, auto changeover and generator control. All automation displays are identified by the symbol “A” in the top right hand corner of display.

This group is only displayed when one or more automation features are available.

Information on this display group is given in “**Appendix O Automation Pages** (page O-1)”.

Communication Display Group

Contains all the information for configuring communication ports as well as communication protocols. All communication displays are identified by the symbol “C” in the top right hand corner of display.

Information on this display group is given in “**Appendix I Communication Settings** (page I-1)”

First Screen Selection

The page displayed when the panel is first activated is user selectable in

WSOS5 – Display – Configuration – Menu Configuration.

It can be any page in the standard menu. The system default is the Trip Flags screen.

If Custom Menu is used and rotating screens mode is active then the first screen feature is overridden.

If the first screen selected is unavailable in the controller then the controller will default to the trip flags screen.

Selection of first screen can only be done via the WSOS5 Configuration

- Menu Configuration window. Refer to the WSOS5 help file for more information.



CUSTOM MENU

The ADVC can be configured such that the user is shown a custom menu containing only those pages from the standard menu that are of interest. Up to 12 pages can be mapped to the custom menu.

Selection of custom menu screens can only be done via the WSOS5 Configuration - Menu Configuration window. Refer to the WSOS5 help file for more information.

Menu screens for features that are unavailable can be selected for the custom menu. If the feature is unavailable then the screen is skipped by the custom menu.

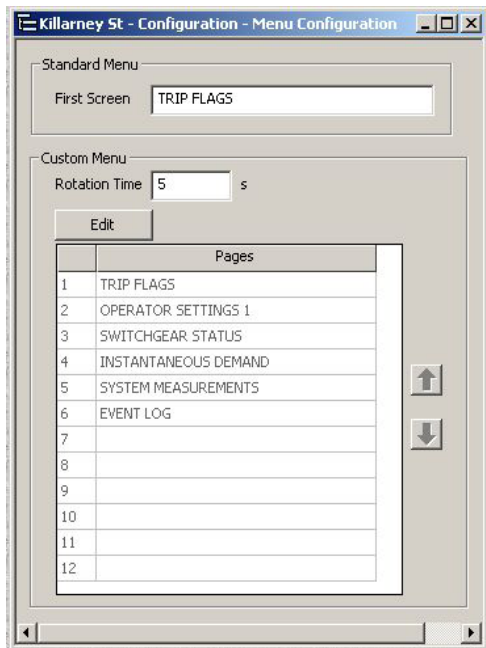


Figure 40. setVUE Menu Configuration Window (WSOS)

Rotating Custom Menu

The custom menu can be placed in rotation mode. When in rotation mode the panel will continuously cycle through the custom menu screens. The period of the cycle is user configurable. This allows users to view all relevant settings or find a particular page without pressing a key on the panel.

Enabling/disabling the rotating screen feature as well as setting the rotation delay period can only be done via the WSOS5 Configuration - Menu Configuration window shown above. Refer to the WSOS5 help file for more information.

Custom/Standard Menu Navigation

The custom and standard menus are designed to co-exist on the ADVC. If a custom menu has been configured it, rather than the standard menu, is shown by default. Switching between the custom and standard menus is achieved by pressing the **CUSTOM MENU** key.

The standard menu display is always available. In all circumstances movement around the standard menu is as described in the product's Installation and Maintenance manual.

If the Custom Menu feature is enabled and rotation mode is disabled:

- Pressing the **MENU** key at any time will move the user to the next standard menu display group.
- Pressing the **CUSTOM MENU** key will move the user to the next page in the custom display group.
- When displaying the custom display menu, operation of the quick keys, the **ALT** key, the **SELECT** key and the arrow keys are as per standard display group behaviour e.g. the **SELECT** key highlights a setting and the arrow keys move to the previous or next screen. However, if the Custom Menu feature is enabled and rotation mode is enabled then:
 - ☐ Pressing the **ALT** key, **MENU** key, **SELECT** key or either arrow key will halt rotation and the currently visible page will remain displayed. For the currently visible page, pressing **ALT**, **SELECT** or either arrow key are as per standard menu group behaviour.
 - ☐ Pressing the **MENU** key will move the display to the next standard menu display group.
 - ☐ Pressing the **CUSTOM MENU** key will restart rotation.
 - ☐ If rotation is halted when a quick key operation is completed, rotation will remain halted.
 - ☐ If rotation is active when a quick key operation is completed, rotation will continue.

The **TRIP** and **CLOSE** keys are always active and are independent of standard or custom menu behaviour.

LOCALE RELATED SYSTEM SETTINGS

The ADVC has a number of global settings that enable you to customise its behaviour. These settings are mainly locale related and include engineering units used, date/time format, system frequency, and language display.

```

----- System Settings 1 ----- C
Lang English (Intl)   Display Metric
System Freq 50Hz     Date/Time 1/04/2005
07:42:43
  
```

 These settings can be found in the following locations:

ENGINEER MENU - CONFIGURATION MENU - SYSTEM SETTINGS
- DISPLAY and NETWORK PARAMETERS - System Freq

Setting	Description
Lang	Language Selection If English (Intl) selected then - All references to ground become earth - All references to Hot Line Tag become Work Tag If English (USA) selected then - All references to earth become ground - All references to Work Tag become Hot Line Tag Range: English (Intl), English (USA) <i>Factory default is English (Intl)</i>
Display	Display Engineering Units If Metric is selected, gas pressure ^a is displayed in kPa. If Imperial is selected, gas pressure is displayed in PSI. This is a system-wide change that affects panel and WSOS5 displayed values, as well as configurable history data. Range: Metric, Imperial <i>Factory default is Metric.</i>
System Freq	System Frequency The frequency of the network to which the ACR is connected. It is vital that this setting is set up correctly in order for the ACR to measure current accurately. Range: 50, 60 Hz <i>Factory default is 50 Hz.</i>
Date/Time	System Date/Time System time and date/time format. Range: DD/MM/YYYY, MM/DD/YYYY <i>Factory default is DD/MM/YYYY.</i>



a. Only applicable to the N-Series ACR.

CONFIGURABLE QUICK KEYS

The controller has four keys that can be configured by the user for a specific purpose to enable ease of use. The Default quick keys are shown below:

```

----- Quick Key Selection ----- C
LOCAL/Remote   Enter   Earth Prot
Auto ON/OFF    Prot Group
  
```

Any of the these keys (except the **ENTER** key) can be mapped to one of the settings listed below:

- LOCAL/Remote/Hit and Run
- Loop Auto ON/OFF
- Prot Group

- Reset Flags
- Work Tag ON/OFF
- Auto Reclose ON/OFF
- Protection ON/OFF
- Cold Load ON/OFF
- Earth Protection ON/OFF
- Live Block
- Negative Phase Sequence Protection OFF/ON/Alarm

Sectionaliser Specific Quick Keys

- Sectionalise ON/OFF
- Detection Group
- Earth Detection ON/OFF

A quick key can also be set to Blank if it is not required.

Quick Key Configuration

This option is only available for the **setVUE** O.I.
The ability to re-configure the Quick Keys must be made available from:

SYSTEM STATUS – OPTIONS 3

```

----- OPTIONS 3 ----- S
Config QK Available      APGS Not Allowed
                        APGS Change 60s
    
```

If Config QK is Available, make changes on:

SYSTEM STATUS – QUICK KEY SELECTION

```

-----CHANGE QUICK KEY SELECTION----- S
LOCAL/Remote            Enter  Earth Prot
Auto ON/OFF              Prot Group
    
```

To configure a Quick Key, press **SELECT**. The following screen is displayed with the first setting selected (blinking)

```

----- Quick Key Selection ----- S
LOCAL/Remote            Enter  Earth Prot
Auto ON/OFF              Prot Group
    
```

Press  or  to scroll through the list of settings that can be linked to Quick Keys.

Press **MENU** or **ENTER** when the required setting is displayed.

To configure another Quick Key, press **SELECT** and repeat the above procedure.

- Each setting can only be assigned to one Quick Key.
- It is not possible to select the same function on more than one Quick Key.
- When a Quick Key is changed an event is generated in the Event Log.

Using a Quick Key

1. Press a Quick Key at any time to display the relevant page, with the linked setting selected:
2. Press the same Quick Key again to display the next setting option for that setting. Repeat until you have displayed the setting you require.
3. Press the **ENTER** key to activate the displayed setting AND, after a short delay, to return to the page that was displayed when you first pressed the Quick Key.¹

¹ A particular option may not be available to the operator if it has been disabled on the "SYSTEM STATUS-OPTIONS" page



Changing the quick keys configuration requires updating of the panel quick keys using stickers provided with controller. Failure to match software and panel may cause incorrect operation of controller.



Whenever a Quick Key is in use the   and **SELECT** keys are disabled.



flexVUE CONFIGURATION TOOL

The **flexVUE** O.I. has 20 Status lamps, 12 Quick Action Keys and 12 LED's embedded within the Quick Action Keys, all of which are configurable/customisable using the OCP Configuration Tool through WSOS5.

Using the Configuration Tool it is possible to configure/customize the following:

1: Function of Status Lamps and Quick Action key Lamps

The function of Status lamps and Quick Action Keys can be customised to indicate various switchgear/controller status and fault types by mapping them to one or more N00-331 digital status points using Boolean operators

2: Description of Status Lamps and Quick Action keys

The description of Status lamps and Quick Action keys. The tool will also allow the printing of labels with these descriptions which will be later cut to size and inserted into the respective pockets within the **flexVUE** O.I.

3: Lamp Colour for TRUE/FALSE state

Status Lamp Colour can be configured to different colours (Red, Green, Orange in addition to Off) to indicate the TRUE/FALSE state of the Status Lamps, Quick Action keys lamps, TRIP button lamp, TRIP Disabled lamp, CLOSE button lamp and CLOSE Disabled lamp.

4: Flashing of Lamps

Status lamps, Quick Action Key lamps, TRIP button lamp, CLOSE button lamp, TRIP Disabled lamp and CLOSE Disabled lamp from every colour (Red, Green and Orange) can be configured to indicate their TRUE/FALSE state. They can also specify the flash ON time and period.

5: Function of Quick Action keys

The functionality of Quick Action keys can be configured as required. The Quick Action keys can be mapped to a single N00-331 digital status point which will be set to TRUE/FALSE when the key is pressed. These keys can be configured totally independently of the QAK Lamp if required.

6: Locking of Quick Action keys

Each Quick Action Key can be individually configured to prevent its accidental use if required.

To unlock, users will have to push the Unlock key in the OCP which will unlock all keys that are locked for a pre-defined time that can be set by the user to make them functional. The keys will be locked again once the unlock time expires. Users will need to press the Unlock key a second time to make them active again. The Unlock key will not be applicable to the Quick Action keys which are not locked.

7: Set Quick Action keys Active when panel is OFF

Quick Action keys to be configured to be active even when the panel is OFF so that they can perform their assigned function without having to turn the panel ON.

8: Display status of Status Lamps and Quick Action key lamps when panel is OFF

Status lamps and Quick Action key lamps can be configured to display their TRUE/FALSE state when panel is OFF.

9: Set TRIP and CLOSE buttons Active when panel is OFF

TRIP and CLOSE buttons can be configured to be active when the panel is OFF so that they can TRIP/CLOSE the switchgear without having to turn the panel ON.

10: Delay operation of TRIP and CLOSE buttons.

A delayed TRIP/CLOSE operation can be configured for a pre-defined time This feature will replace the Hit and Run functionality of the setVUE O.I.



11: Error Indication for Quick Action key Output

An audible beep or error message displayed on the LCD can be configured when a Quick Action key encounters an error condition (e.g. When the user presses the Work tag ON Quick Action key when Work tag has already been set to ON).

12: Beep Acknowledgement on button/key press

Buttons/keys can be configured to emit beeps when they are pressed.

USING THE CONFIGURATION TOOL

The **flexVUE** Configuration Tool (*OCP Configuration*) is available through WSOS5.

A comprehensive online help is available for detailed instructions on how to use the configuration tool. Some screen shots are shown below:

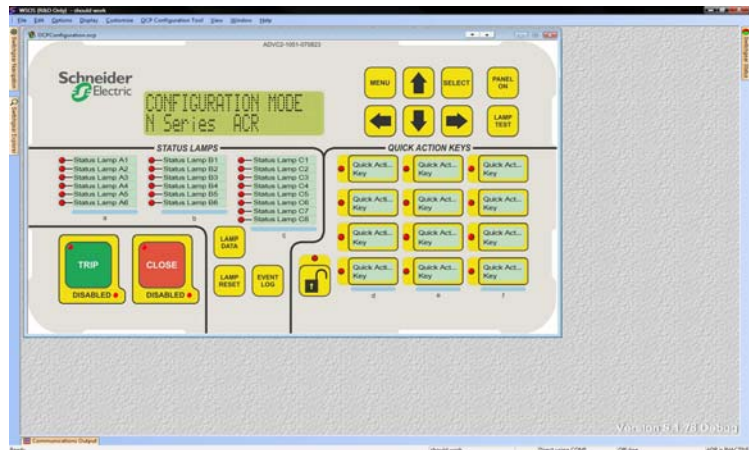


Figure 41. OCP Configuration Tool in WSOS5

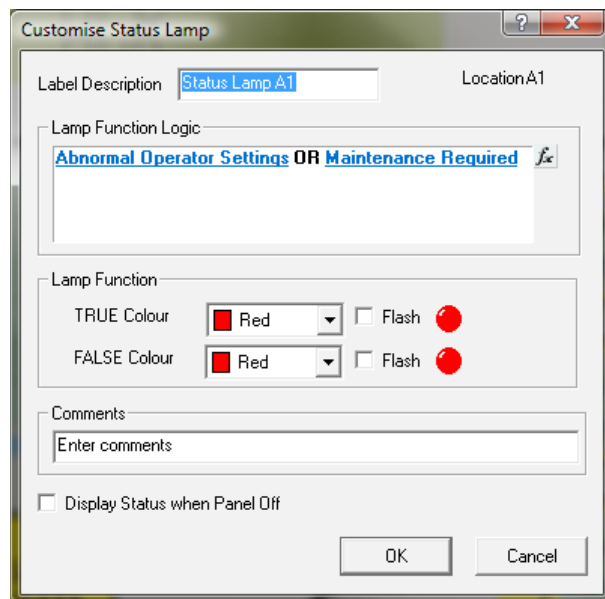


Figure 42. Customising a Status Lamp Function

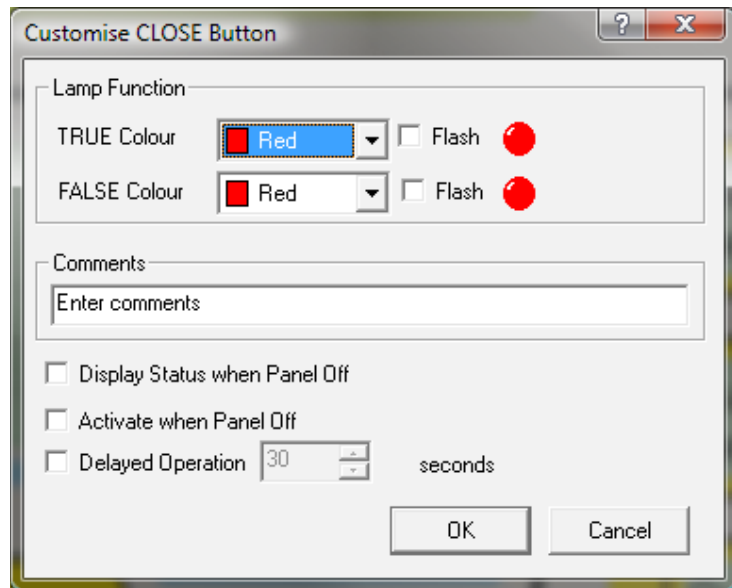


Figure 43. Customising the CLOSE button functionality

17 Accessories

The following accessories are available for the ADVC:

- IOEX;
- TTS.

Additional accessories are under development.



INPUT OUTPUT EXPANDER CARD (IOEX)

The Input Output Expander (IOEX) card provides optically isolated input contacts and voltage free output contacts to allow connection of an external Remote Terminal Unit (RTU). It is installed in a die cast, sealed enclosure which is mounted on, and earthed via, a DIN rail in the customer compartment.

A "mapping" held in the ADVC database controls the function of the IOEX. It specifies what database information is "mapped" into the IOEX outputs and which controls are "mapped" into the IOEX inputs.

The bottom line of the IOEX Status display page identifies the mapping loaded:

- The standard mapping for inputs and outputs are shown in "**Inputs - Standard Mapping** (page 17-4)" and "**Outputs - Standard Mapping** (page 17-4)".
- Some equipment may be supplied with alternative mappings.

Item	Description
Switchgear	Any
Controller	ADVC only
Communications interface	RS232 to the CAPE, baud rate 19,200, no parity, 1 stop bit.
Inputs	8
Input Specification	12V – 150V AC or DC - must be sourced externally to the ADVC.
Outputs	8
Max Output Specification	150VDC at 1A or 150VAC RMS at 2A Non-inductive - must be sourced externally to the ADVC.
Impulse Performance	Immune to reset and can withstand a 900A impulse current applied to any input or output pin without failure.
Required Power Supply	18-40 VDC
RS232 Pinouts	Pin 2 - Transmit Pin 3 - Receive Pin 5 - Ground

I/O Field Excitation

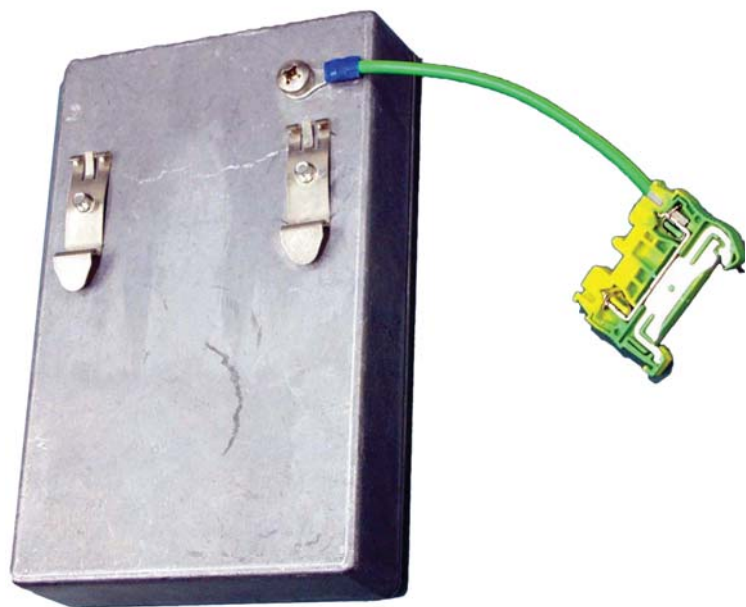
The field excitation for IOEX inputs/outputs MUST NOT be provided from the control cubicle battery nor the radio power supply. Doing so will breach the isolation barriers and introduce serious risk of damage or interference to the control electronics.

IOEX INSTALLATION

The IOEX is mounted on the DIN rail in the Customer enclosure at the top of the ADVC as shown in the following picture:



The IOEX is suspended from the DIN rail by way of two fittings on its rear surface:



Accessories (cont)



Ensure that the ADVC is switched off before proceeding with the installation of the IOEX2.

To fit the IOEX:

1. Holding the IOEX perpendicular, place the upper hooks of the hanging fittings over the top edge of the DIN rail.
2. Push the IOEX firmly against the back surface of the Customer compartment until the lower end of the hanging fittings engage with the bottom edge of the DIN rail.
3. Push the green/yellow earth terminal firmly on to the DIN rail until it is engaged at both the top and bottom.
4. Connect the IOEX supply (18-40 VDC) and the RS 232 plug from the controller.

IOEX Status Page

The **SYSTEM STATUS – IOEX STATUS** page displays the status of the IOEX inputs and outputs to assist debugging during installation and maintenance.

The top line of the display is the page title and the letter “S” to the right indicates that this page is located in the System Status Display Group. The next three lines are the data on display.

The fields are described as follows:

Field	Description
Inputs 1---*----8	This indicates the current state of the inputs. A dash – represents the OFF state and an asterisk * the ON state.
Outputs 1-*-----8	This indicates the current state of the outputs. A dash – represents the OFF state and an asterisk * the ON state.
IOEX OK	Shows the status of the IOEX: “IOEX OK” means that the mapping is valid and in service.
Invalid Map	“Invalid Map” means there is a problem with the IOEX mapping in the database. Contact the manufacturer.
Unplugged	“Unplugged” is displayed if the ADVC is not receiving data from the IOEX, check the cabling.
Wrong Type	“Wrong Type” is displayed if the IOEX hardware is detected as being different to the mapping, contact the manufacturer.
Initialising	“Initialising” is displayed while the IOEX is being initialised.

When the IOEX configuration is invalid or has some other problems such as wrong hardware type, the O.I. flashes the message “IOEX Configuration Corrupt or Invalid” at the top of the screen.

The displayed data looks like this:

```

----- IOEX STATUS ----- S
Inputs 1-----8           Local
Outputs 1*--*-----8       Unplugged
Standard IOEX Mapping
  
```

Inputs - Standard Mapping

The IOEX has 8 independent, optically isolated inputs, each with Metal Oxide Varistor (MOV) protection. DC in either polarity or AC input signals are accepted. Input Voltage range is 12V – 150V AC or DC.

Input Number	Terminal Number	Inputs ON
1	1-2	Trip the switchgear, set lockout and inhibit all close operations
2	3-4	Close the ACR
3	5-6	SEF protection ON
4	7-8	SEF protection OFF
5	9-10	Auto Reclose ON
6	11-12	Auto Reclose OFF
7	13-14	Protection Set A Selected
8	15-16	Protection Set B Selected

- The recloser “close” input will only function when the Work Tag is off.
- Tripping and controlling all other settings is independent of the Work Tag status.
- If the IOEX Trip input is held on while either the IOEX close or manual close input is activated, the recloser will not close. This is indicated in the event log by a ‘Close Blocking ON’ and ‘Close Blocking OFF’ event whenever the IOEX Trip input changes state.
- The SEF protection ON functionality operates as discussed in “**9 Recloser Protection Features** (page 9-1)”. If the earth fault protection or the SEF availability for the active protection group are turned off then the SEF protection will NOT turn on.
- If both SEF protection ON and OFF inputs are on, the default is SEF protection ON.
- If both Auto Reclose ON and OFF inputs are on, the default is Auto Reclose ON.

All the above inputs are edge-triggered, so the effect will not take place if the blocking condition is removed.

Outputs - Standard Mapping

The IOEX has 8 independent voltage free relay contact outputs, each with MOV protection. The contacts are rated for 150VDC at 1A or 150VAC RMS at 2A non-inductive.

Output Number ^a	Terminal Number	Output On (relay closed)	Output Off (relay open)
1	17-18	Tripped	Closed
2	19-20	Closed	Tripped
3	21-22	Flag A, Overcurrent Protection Trip indication.	
4	23-24	Lockout	Not in lockout
5	25-26	SEF protection ON	SEF protection OFF
6	27-28	Auto Reclose ON	Auto Reclose OFF
7	29-30	Flag B, Overcurrent Protection Trip indication.	
8	31-32	System Healthy See “ System Healthy Indicator (page 17-5)”	Other conditions

a. The IOEX contacts are not guaranteed to change during fast Auto Reclose sequences but will indicate the final steady state condition within 150ms.

Accessories (cont)

Trip Source ^a	Flag A, Trip indication	Flag B, Trip indication
Reset, Set to this state on Recloser Close.	Off	Off
Phase Trip	On	On
Earth Trip	Off	On
SEF Trip	On	Off

a. The trip Source outputs do not indicate other causes of a trip such as Loss of Phase.

System Healthy Indicator

The IOEX system healthy indicator is present when all of the following are true:

- Aux Supply OK.
- Battery Supply OK.
- SCEM Data Valid.
- ADVC Electronics OK.
- Gas pressure normal.
- Contact Life greater than 20% on all phases.
- IOEX to ADVC communications OK.
- Mechanism OK

Failure of any of these will cause the system healthy flag to be extinguished.

Power Consumption

If an IOEX is fitted to the control cubicle, the battery hold-up time may be affected.

This is due to the current drawn by the IOEX. The manufacturer's battery hold-up time rating is based on a recloser installation without the IOEX fitted.

Configuring the IOEX

WSOS5 Version 5.1 or higher incorporates the Configurable IOEX Tool which allows you to generate custom I/O mappings for an IOEX.

Logic can be applied to each point with up to five sets of logic or "actions" for each input and one trigger action for each output.

The tool can be used to read mappings from previous versions of software but can only create files for use with the specified software versions.

Custom maps can be created for an IOEX and loaded into the ADVC directly from WSOS5. The types of actions that can be mapped to each input or output is dependent on the software version loaded into the ADVC.

When the tool is started you are asked to input the software version number. This is then used to retrieve a valid set of points to use when constructing logic within the tool.

The mappings and I/O logic are created using the tool and saved to an IOEX mapping file in WSOS5. Once a valid file has been created it is linked to the switchgear device configuration in WSOS5 and written to the ADVC.

The IOEX Configuration tool is intended to be used Off-Line only. Mappings are created, saved and linked to a WSOS5 switchgear device configuration while disconnected from the switchgear. Once these tasks have been completed you connect to the device and write the new mapping into the ADVC along with the switchgear device configuration.

Refer to the WSOS5 Help file for more information.

TEST AND TRAINING SET

For simplified testing in the field or in the workshop a purpose built test set called a Test and Training Set (TTS) is available.

The TTS is a briefcase sized test set which connects to the ADVC and allows a standard secondary injection test set to be connected to inject currents into the ADVC. The TTS will also simulate the ACR and allow comprehensive testing of the control electronics. The TTS is highly suited to train staff in maintenance and operations.

The test and training set is purchased as a separate item. For further information refer to your distributor.

18 Battery Testing

INTRODUCTION

The Battery Testing feature allows you to check the condition of the battery to determine the extent of battery deterioration.

Battery testing can be activated automatically according to a preconfigured schedule which you set up using WSOS5, or manually when required. A manual battery test can be requested from WSOS5 or from the O.I..

CONFIGURING FOR BATTERY TEST

In WSOS5, from the Display menu, select Configuration, and then Feature Selection. In General features, make the Battery Health Test available by selecting the Available check box. Then again from the Display menu, select Maintenance, and then Battery Health Test. The following screen will be displayed:

Use this dialog to specify the battery test frequency you require, or to request a battery test at any time.

The operator may make the battery test available or not available at:

SYSTEM STATUS – OPTIONS 3 ???
 ENGINEER MENU – CONFIGURATION MENU – FEATURE SELECTION – GENERAL – Batt Test Available

BATTERY TEST OPERATION

ADVC batteries have a capacity of either 7.2 Ah (the default) or 12 Ah if required. For the battery test to be effective, the correct battery capacity must be configured. (The battery capacity will be correctly set at the factory.)

The auxiliary supply is removed from the batteries and the voltage measured. This is the Start Voltage. A load is then placed across the batteries for 10 seconds and the voltage measured again. This is the Mid Voltage. The load is removed and after 10 seconds the voltage is measured again. This is the End Voltage. The difference between the Mid and End voltages is determined, and temperature compensated, and if the difference is less than 1.8 volts the batteries are considered to be good. At the end of the test the Auxiliary supply is reinstated.

The battery test will be performed if:

- the scheduled time for a battery test has been reached, or
- a battery test is manually requested.

The battery test will not begin:

- if there is no battery present,
- during a protection sequence,
- if there is a protection pickup,
- within 15 minutes of another battery test,
- if there is no auxiliary supply.

The battery test will be stopped if:

- a pickup is detected,
- a trip or close is requested,
- the operator requests it to stop.



Battery charging will be OFF during a test. The battery status, and voltage will not be updated during a battery test.



If an automated test is scheduled to begin within 15 minutes of a manual test ending, it will not begin at the scheduled time. Instead, it will begin 15 minutes after the conclusion of the manual test.

Normal operation of the CAPE is suspended for the twenty second duration of the battery test unless the battery test has been stopped. If the battery test is stopped, the CAPE reverts to its pre-battery test state.

The result of the battery test will be Capacity NOT OK if the voltage drops by more than 4V between the Start and End Voltages, or if the Final Voltage differs from the initial voltage by more than 1V.

Settings

The battery test configuration settings are at:

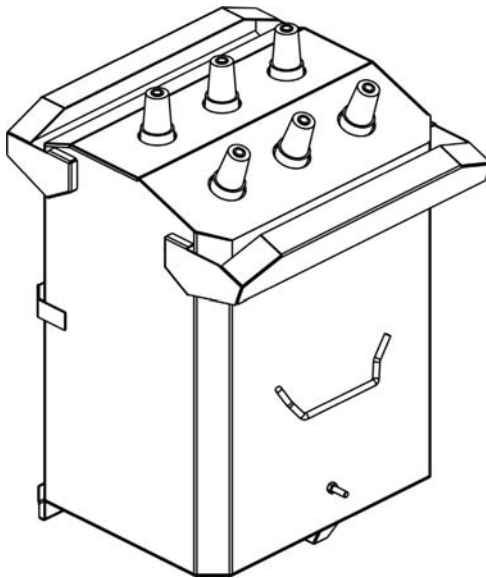
```

----- BATTERY TEST ----- S
Test Status OFF      Test OFF, Ready
Auto Test 9 days     Test Time 1
Capacity OK          7.2 Ah battery
  
```

Setting	Description
Test Status	This setting controls the pre-configured, automatic battery testing. When set to OFF, the scheduled battery test will not run. When set to AUTO, the battery test is waiting until the next scheduled time. Range: OFF, AUTO Factory default is AUTO
Test	This is the battery test control setting. OFF is the setting displayed when the setting is not in use. Select START to request a battery test. Select ABORT to stop a manual battery test (requested or in progress). Range: OFF, START, ABORT Factory default is OFF
Auto Test	This setting will be either DISABLED or the configured automatic battery test frequency which is one or more days in the range 1 -31. Range: DISABLED, 24 - 744 hours in multiples of 24 hours Factory default is 168 hours (displayed as 7 days).
Test Time	This is the desired automatic battery test start time, expressed in multiples of 30 minutes. The test may hold off until conditions are suited to running the test e.g. Not in pickup, Auxiliary supply on. Range: 00.00 - 23.30 Factory default is 12.00
Capacity	This setting reports on the battery capacity as determined by the result of the last battery test. The capacity is set to UNKNOWN until the first battery test. Range: UNKNOWN, OK, NOT OK Factory default is UNKNOWN
Battery	This setting displays the specified battery capacity i.e. the rated total capacity of the batteries. Range: 7.2Ah battery, 12Ah battery Factory default is set to correspond to the battery installed at the factory.

Appendix A - Switchgear Models

N-SERIES RECLOSER



The N-Series ACR utilises vacuum interrupters contained in a fully welded and sealed 316 marine grade stainless steel enclosure. The enclosure is filled with sulphur hexafluoride (SF_6) gas as an insulator.

The ACR is operated by sending a controlled pulse of current from storage capacitor in the ADVC through a solenoid. This attracts the mechanism plate which, in turn closes the contacts in the vacuum interrupter. The contacts are held in the closed position by latch tongues resting on the trip bar.

Opening of the contacts is achieved by releasing a controlled pulse of current from a capacitor through the trip coil. This attracts the trip bar armature, turning the trip bar and releasing the latch. The opening spring and the contact pressure springs accelerate the contacts open. A flexible connection is provided to allow movement of the contacts to occur.

Epoxy bushings insulate the main circuit conductors from the tank and provide a double "O" ring seal. They also provide the necessary insulation and support for the embedded capacitive voltage transformers (CVT) and for the current transformers (CT). The bushings are DIN 47 636 (threaded option) and allow the connection of alternative cable connection elbows if desired. Lightning arrester mounting is provided for installation convenience.

A standard kit for field fitting is supplied with the ACR. It contains Silicone bushing boots and 3 metre lengths (other lengths are available) of 185 mm² aluminium insulated water tight cable tails rated at one of: 250A, 340A, 400A, 630A (all aluminium water-blocked) or 800A (copper not water-blocked). This arrangement results in a recloser suitable for connection into an insulated conductor system, or a bare conductor system, as appropriate. The fully insulated system provides freedom from faults caused by birds and other wildlife.

An auxiliary voltage supply in one of three configurations: 240V, 110V, or 28V (28V connected to the SCEM, 240V and 110V connected into the PSU) is required to power the unit. Where this is inconvenient, a voltage transformer can be provided as a purchase option. The ADVC is connected by a control cable to the bottom of the ACR through a rubber covered plug/socket arrangement.

A clearly visible external pointer shows the contact position. The recloser can be tripped from the ground by a hookstick. It can then be locked out by opening the isolating switches located on the Operator Interface. These switches are physically connected in series with both the Trip and Close solenoids.

The ADVC interfaces to the recloser via the control cable and connects to the Switch Cable Entry Module (SCEM) in the base of the tank. The SCEM uses non-volatile memory to store all relevant calibration data, ratings and number of operations. The SCEM also provides shorting electronics to short the CTs and CVTs in the event the control cable is disconnected while current is flowing through the recloser.

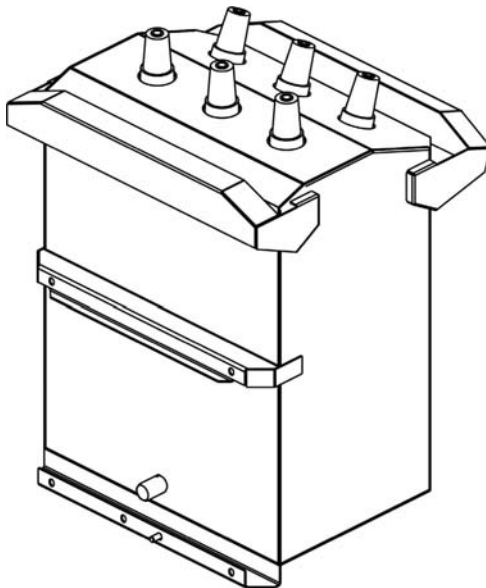


Figure 44. N-Series Switchgear

U-SERIES RECLOSER

The U-Series ACR is operated by a magnetic actuator which produces a positive opening and closing action. Switching occurs when a controlled pulse is sent through the open/close actuator from a storage capacitor in the ADVC. When closed, the switch is latched magnetically. Spring loaded pushrods provide contact loading on the interrupters.

A Current Transformer (CT) and a Capacitive Voltage Transformer (CVT) are moulded in the CT-housing. These are monitored by the ADVC for protection, remote monitoring and display.

An auxiliary voltage supply in one of three configurations: 240V, 110V, or 28V (28V connected to the SCEM, 240V and 110V connected into the PSU) is required to power the unit. Where this is inconvenient, a voltage transformer can be provided as a purchase option. A control cable connects the ADVC to the bottom of the ACR through a covered plug/socket sealing arrangement on both the ADVC and the tank.

The recloser is supplied with copper stems or optional cable clamp connectors. Mounting brackets for lightning arresters are optionally available.

The recloser contact position is shown by a large, clearly visible external pointer.

A hookstick can be used to engage the manual trip ring to trip and lockout the recloser from the ground. The mechanical trip ring has two positions. In the "up" position normal operation takes place. In the "down" position the recloser is tripped and both mechanically and electronically locked open.

The ADVC interfaces to the recloser via the control cable and connects to the Switch Cable Entry Module (SCEM) in the base of the tank. The SCEM uses non-volatile memory to store all relevant calibration data, ratings and number of operations. The SCEM also provides shorting electronics to short the CTs and CVTs in the event the control cable is disconnected while current is flowing through the recloser.

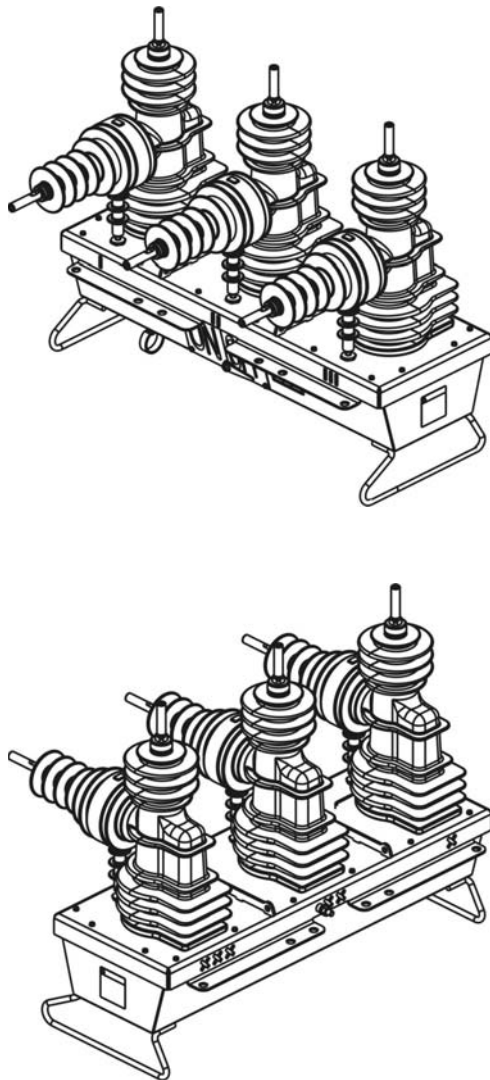


Figure 45. U-Series Switchgear

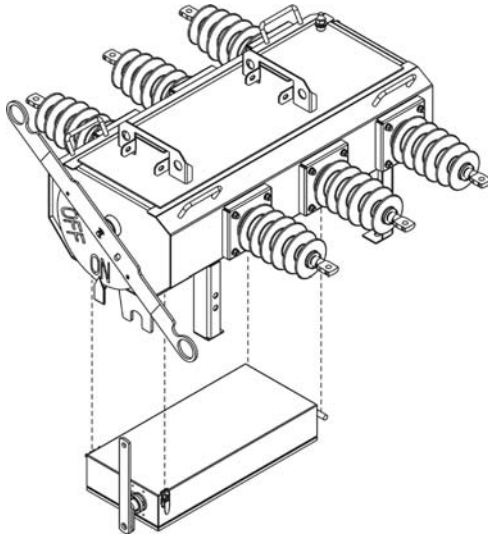


Figure 46. RL-Series Switchgear with optional Motor Pack

RL-SERIES RECLOSER

The RL-Series Load Break Switch is a pole or pylon mounted, gas insulated, three phase Load Break Switch (LBS)/ Sectionalizer optimised for remote control and automation schemes.

Using a puffer interruption system insulated by SF6 gas and enclosed in a sealed-for-life 316 Marine Grade stainless steel tank ensures a long, low-maintenance service life. A fully insulated cabling system and a simple pole hanging arrangement all contribute to quick, low cost installation.

The actuation of the LBS can be achieved in two ways:

- Manually: by use of a hookstick to pull on an external operating lever
- Electronically: With the addition of a motor pack mounted on the switch and operated via the controller.

The interrupters are ganged together and driven by an over-centring spring mechanism which is "operator independent" so that it does not matter how fast or slow the arm is moved by the operator.

Current transformers and voltage screens embedded in the bushings. These send signals to the control electronics to monitor line current, earth current and phase to earth voltages. Combined with the additional Motor Pack the RL-Series switchgear can integrate easily into a SCADA system.

Available in 15, 27 & 38kV variations, the RL-Series also has the option of attaching surge arrestors and capabilities for monitoring internal SF6 gas pressure through sensors and highly visible low pressure external indicator. There is also a high pressure release to avoid explosions or detachment from the RL-Series mountings.

The switchgear position is shown by a large, clearly visible indicator, which is attached to the external operating level.

The ADVC interfaces to the recloser via the control cable and connects to the Switch Cable Entry Module (SCEM) in the base of the tank. The SCEM uses non-volatile memory to store all relevant calibration data, ratings and number of operations. The SCEM also provides shunting electronics to short the CTs and CVTs in the event the control cable is disconnected while current is flowing through the recloser.

Appendix B - Dimensions

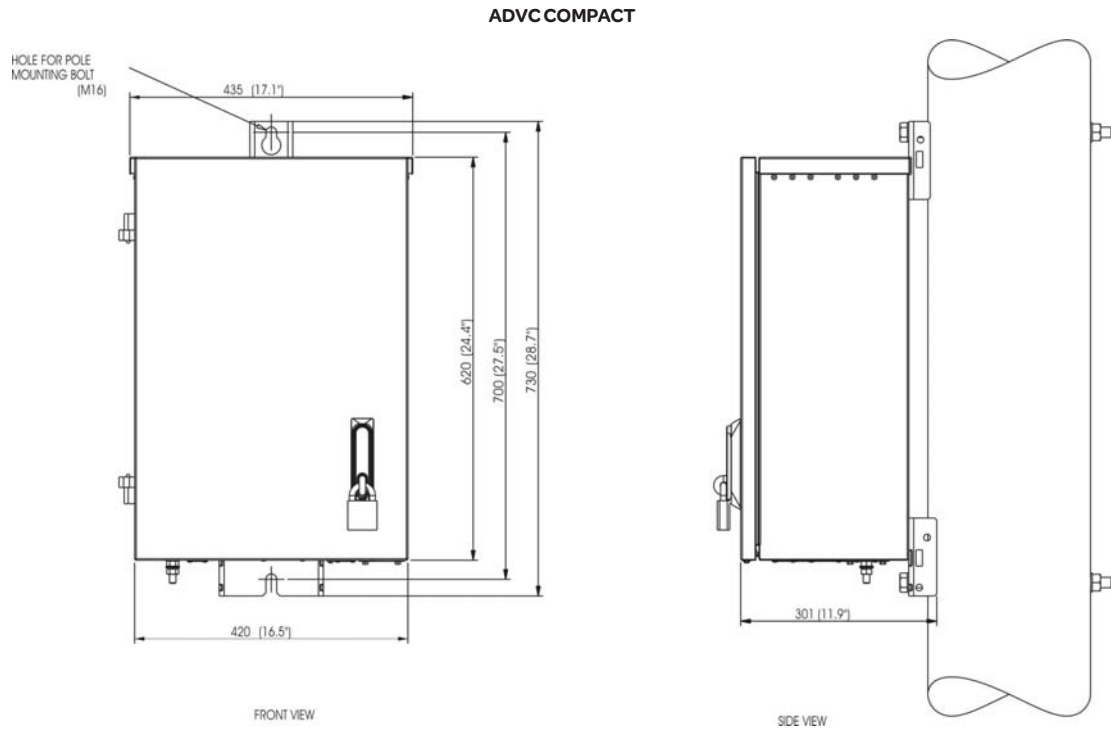


Figure 47. Front & Side View of ADVC **COMPACT** Cubicle

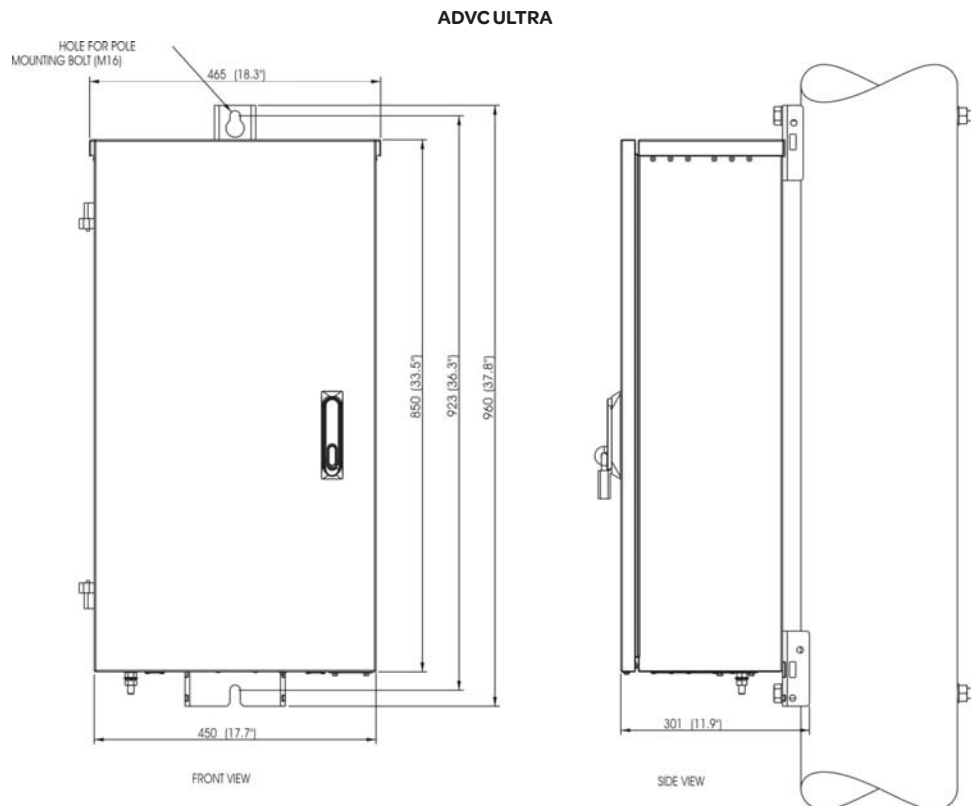


Figure 48. Front & Side View of ADVC **ULTRA** Cubicle

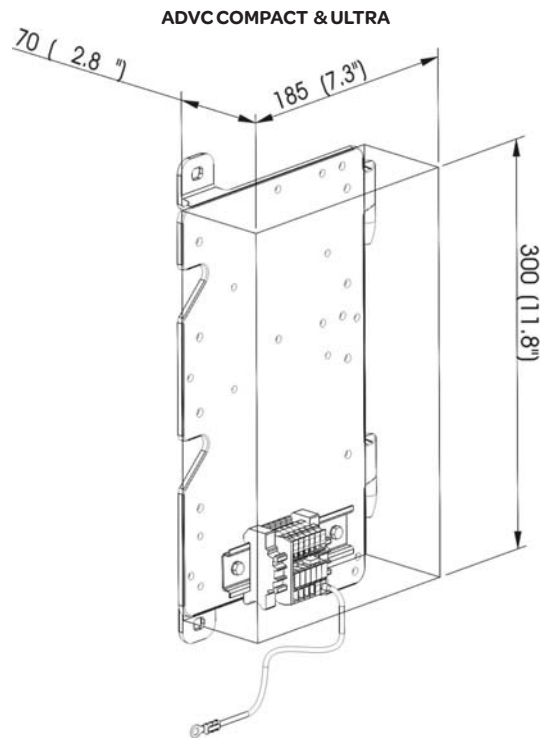


Figure 49. Side Customer Tray in ADVC **COMPACT & ULTRA** Cubicle

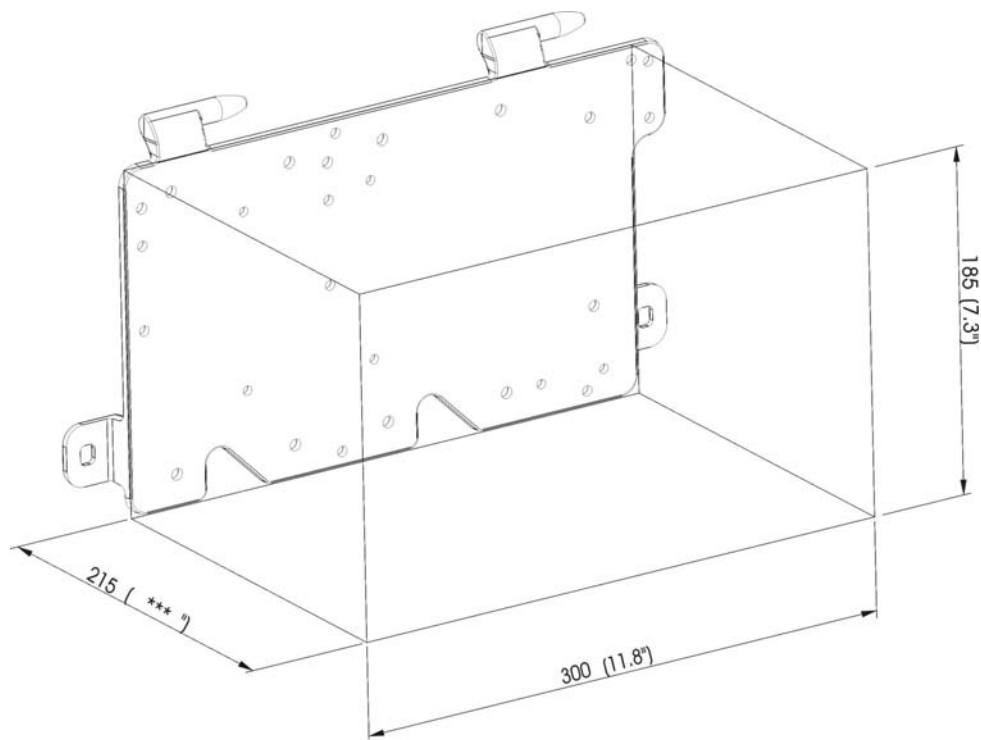


Figure 50. Top Customer Tray in ADVC **ULTRA** Cubicle

Dimensions (cont)

ADVC COMPACT

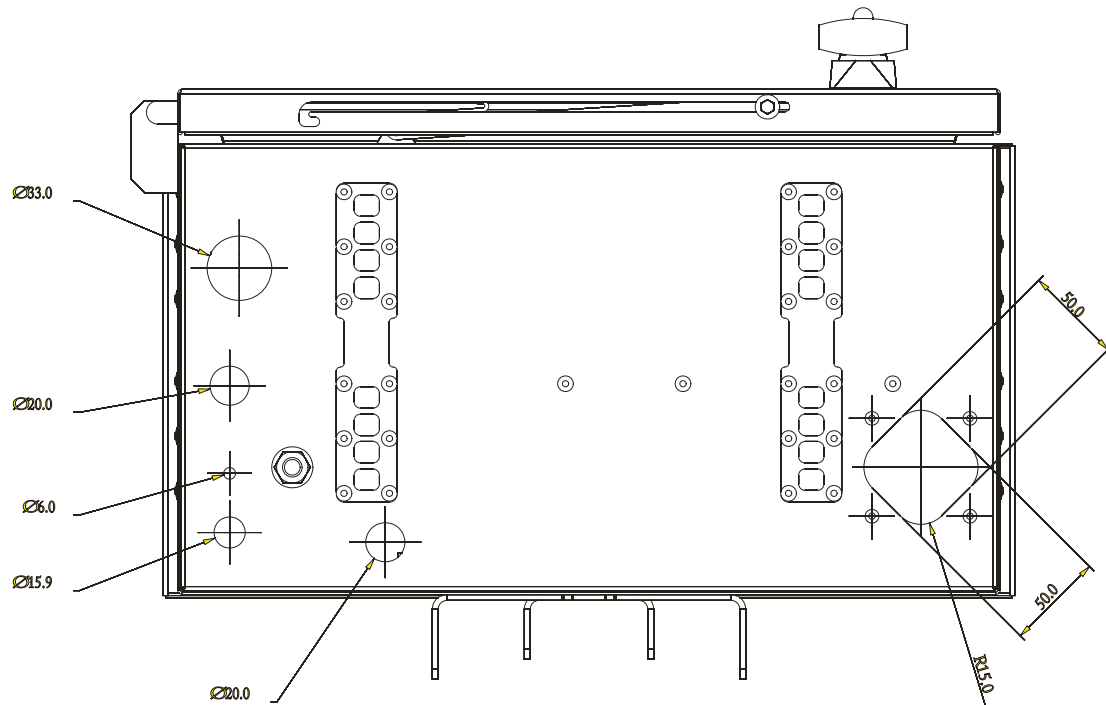


Figure 51. Base View of ADVC **COMPACT** Cubicle

ADVANCED ULTRA

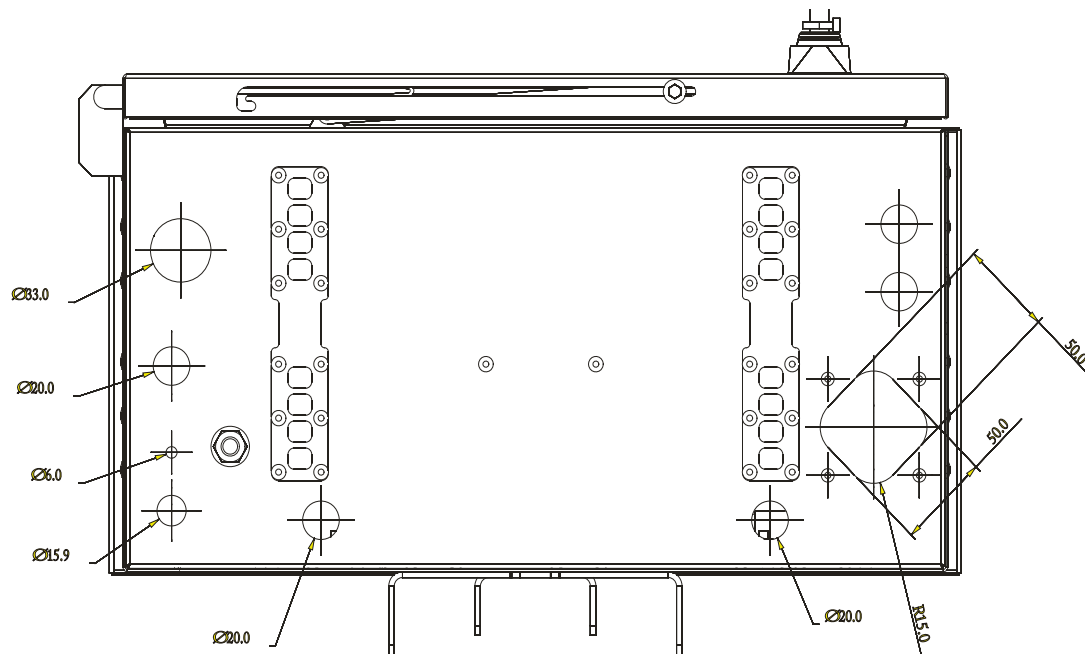


Figure 52. Base View of ADVC **ULTRA** Cubicle

Appendix C

Replaceable Parts and Tools

All replacement parts listed in the following table are available from the manufacturer, special purpose tools are also listed.

ADVC Part	Stock or Part Number
Antenna Surge Arrester	ELCMIS0211
Basic Display Unit (BDU1 - Nu-Lec English)	998000025
Basic Display Unit (BDU1 - Merlin Gerin English)	998000026
Basic Display Unit (BDU1 - Nu-Lec USA)	998000028
Battery 12 V 7.2 Ah Sealed Lead Acid, set of 2	997000000
Battery 12 V 12 Ah Sealed Lead Acid, set of 2	998000055
Battery Heater	998000040
CAPE Housing Main Gasket	ADC-101
Control and Protection Enclosure (CAPE1 - for manufacturer's switch)	998000015
Control Cubicle Body	998000045
Control Cubicle Door	998000050
Control Cubicle Door Seal (24 mm x 6 mm, Black)	NEO091008
Customer Tray 1	998000030
Customer Tray Terminal Block	998000035
Fiber optic modem	998000090
IOEX2 kit	998000080
Pole mount adapter for PTCC retrofit	998000125
Power Supply Unit (PSU1 - English international)	998000020
Power Supply Unit (PSU1 - English USA)	998000020
PSU Main gasket	ADC-110
Tait radio accessory kit	998000085
Test and Training Set (TTS)	TTS1-02
WSOS5 cable	998000095

Appendix D

ADVC Schematics

ADVC Controller

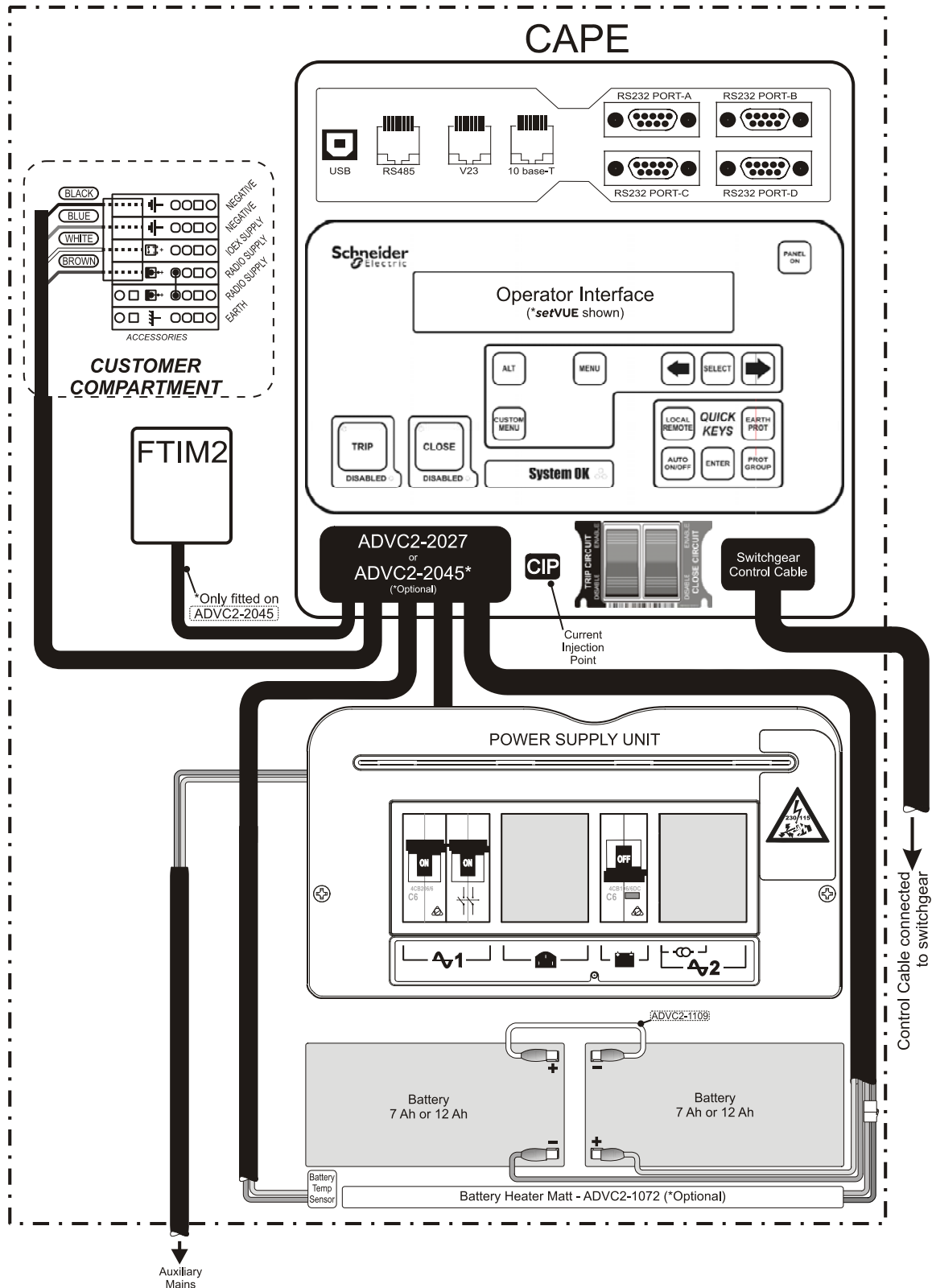


Figure 53. ADVC Controller General Arrangement

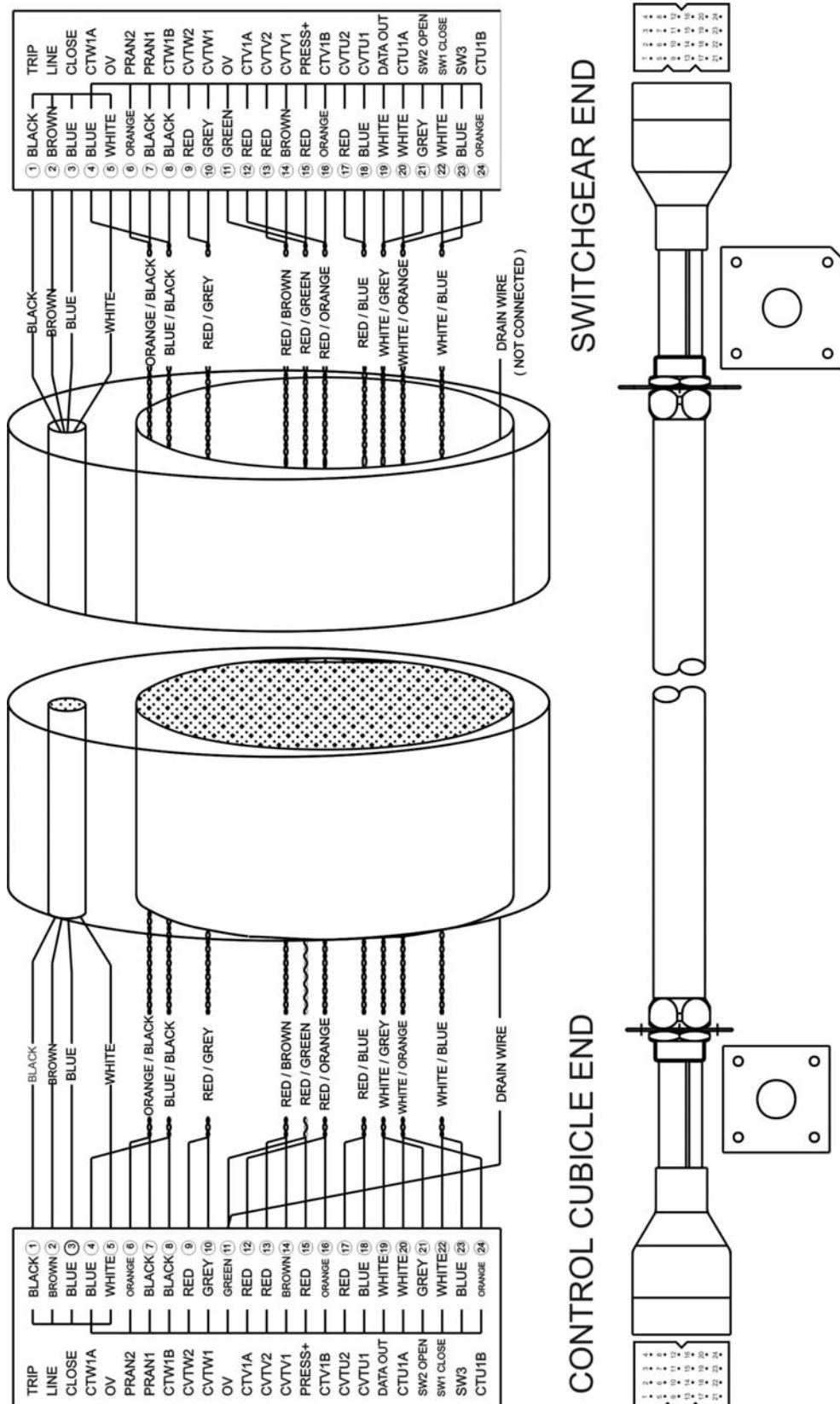


Figure 54. Control cable service drawing

Appendix E

IEC255 Inverse Time Protection Tables

The Inverse time protection curves in this appendix are as defined by IEC255 standard where "I" is the actual current expressed as a multiple of the trip current set by the user:

- Type A - Inverse, for which the equation is:
Time to Trip = $0.14 / (I^{0.02} - 1)$
- Type B - Very Inverse, for which the equation is:
Time to Trip = $13.5 / (I - 1)$
- Type C - Extremely Inverse, for which the equation is:
Time to Trip = $80 / (I^2 - 1)$.

They are defined in terms of a formula such as:

$$\text{Time} = T / (IN - Q) + B$$

Where

T = time parameter specific to characteristic
I = ratio of current to pickup setting
N = parameter specific to characteristic
Q = parameter specific to characteristic
B = parameter specific to characteristic

Tables for the times to trip for each of these curves are given below.

Setting Current Multiple	Inverse Time (secs)	Very Inverse Time (secs)	Extremely Inverse Time (secs)
1.10	73.37	135.00	380.95
1.50	17.19	27.00	64.00
2.00	10.03	13.50	26.67
2.50	7.57	9.00	15.24
3.00	6.30	6.75	10.00
3.50	5.52	5.40	7.11
4.00	4.98	4.50	5.33
4.50	4.58	3.86	4.16
5.00	4.28	3.38	3.33
5.50	4.04	3.00	2.74
6.00	3.84	2.70	2.29
6.50	3.67	2.45	1.94
7.00	3.53	2.25	1.67
7.50	3.40	2.08	1.45
8.00	3.30	1.93	1.27
8.50	3.20	1.80	1.12
9.00	3.12	1.69	1.00
9.50	3.04	1.59	0.90
10.00	2.97	1.50	0.81
10.50	2.91	1.42	0.73
11.00	2.85	1.35	0.67
11.50	2.80	1.29	0.61
12.00	2.75	1.23	0.56
12.50	2.70	1.17	0.52
13.00	2.66	1.13	0.48
13.50	2.62	1.08	0.44
14.00	2.58	1.04	0.41
14.50	2.55	1.00	0.38
15.00	2.52	0.96	0.36
15.50	2.48	0.93	0.33
16.00	2.46	0.90	0.31

Setting Current Multiple	Inverse Time (secs)	Very Inverse Time (secs)	Extremely Inverse Time (secs)
16.50	2.43	0.87	0.29
17.00	2.40	0.84	0.28
17.50	2.38	0.82	0.26
18.00	2.35	0.79	0.25
18.50	2.33	0.77	0.23
19.00	2.31	0.75	0.22
19.50	2.29	0.73	0.21
20.00	2.27	0.71	0.20
20.50	2.24	0.69	0.19
21.00	2.23	0.68	0.18
21.50	2.21	0.66	0.17
22.00	2.20	0.64	0.17
22.50	2.18	0.63	0.16
23.00	2.16	0.61	0.15
23.50	2.15	0.60	0.15
24.00	2.13	0.59	0.14
24.50	2.12	0.57	0.13
25.00	2.11	0.56	0.13
25.50	2.09	0.55	0.12
26.00	2.08	0.54	0.12
26.50	2.07	0.53	0.11
27.00	2.05	0.52	0.11
27.50	2.04	0.51	0.11
28.00	2.03	0.50	0.10
28.50	2.02	0.49	0.10
29.00	2.01	0.48	0.10
29.50	2.00	0.47	0.09
30.00	1.99	0.47	0.09

Table 13. IEC255 Inverse Time Protection table

Appendix F

IEEE Inverse Time Protection Tables

The Inverse time protection curves in this appendices are as defined by IEEE Std C37.112-1996 standard where "I" is the actual current expressed as a multiple of the trip current set by the user:

- Std Moderately inverse, for which the equation is:
Time to Trip = $(0.0515 / (I^{0.02} - 1)) + 0.114$
- Std Very inverse, for which the equation is:
Time to Trip = $(19.61 / (I^2 - 1)) + 0.491$
- Std Extremely Inverse, for which the equation is:
Time to Trip = $(28.2 / (I^2 - 1)) + 0.1217$
- These are defined in terms of a formula such as:

$$Time = T / (IN - Q) + B$$

Where

T = time parameter specific to characteristic
I = ratio of current to pickup setting
N = parameter specific to characteristic
Q = parameter specific to characteristic
B = parameter specific to characteristic

Tables for the times to trip for each of these curves are given below.

Setting Current Multiple	Std Moderately Inverse Time (secs)	Std Very Inverse Time (secs)	Std Extremely Inverse Time (secs)
1.10	27.11	93.87	134.41
1.50	6.44	16.18	22.68
2.00	3.80	7.03	9.52
2.50	2.90	4.23	5.49
3.00	2.43	2.94	3.65
3.50	2.14	2.23	2.63
4.00	1.95	1.80	2.00
4.50	1.80	1.51	1.59
5.00	1.69	1.31	1.30
5.50	1.60	1.16	1.09
6.00	1.53	1.05	0.93
6.50	1.46	0.97	0.81
7.00	1.41	0.90	0.71
7.50	1.37	0.85	0.63
8.00	1.33	0.80	0.57
8.50	1.29	0.77	0.52
9.00	1.26	0.74	0.47
9.50	1.23	0.71	0.44
10.00	1.21	0.69	0.41
10.50	1.18	0.67	0.38
11.00	1.16	0.65	0.36
11.50	1.14	0.64	0.34
12.00	1.12	0.63	0.32
12.50	1.11	0.62	0.30
13.00	1.09	0.61	0.29
13.50	1.08	0.60	0.28
14.00	1.06	0.59	0.27
14.50	1.05	0.58	0.26
15.00	1.04	0.58	0.25
15.50	1.03	0.57	0.24
16.00	1.02	0.57	0.23

Setting Current Multiple	Std Moderately Inverse Time (secs)	Std Very Inverse Time (secs)	Std Extremely Inverse Time (secs)
16.50	1.01	0.56	0.23
17.00	1.00	0.56	0.22
17.50	0.99	0.56	0.21
18.00	0.98	0.55	0.21
18.50	0.97	0.55	0.20
19.00	0.96	0.55	0.20
19.50	0.96	0.54	0.20
20.00	0.95	0.54	0.19
20.50	0.94	0.54	0.19
21.00	0.93	0.54	0.19
21.50	0.93	0.53	0.18
22.00	0.92	0.53	0.18
22.50	0.92	0.53	0.18
23.00	0.91	0.53	0.18
23.50	0.90	0.53	0.17
24.00	0.90	0.53	0.17
24.50	0.89	0.52	0.17
25.00	0.89	0.52	0.17
25.50	0.88	0.52	0.17
26.00	0.88	0.52	0.16
26.50	0.87	0.52	0.16
27.00	0.87	0.52	0.16
27.50	0.87	0.52	0.16
28.00	0.86	0.52	0.16
28.50	0.86	0.52	0.16
29.00	0.85	0.51	0.16
29.50	0.85	0.51	0.15
30.00	0.85	0.51	0.15

Table 14. IEEE Inverse Time Protection table

Appendix G

Non-Standard Inverse Time Protection Curves

The 42 Inverse time protection curves in this appendix are non-standard inverse curves.

Tables for the times to trip for each of these curves are given below.

Setting Multiple Current	TCC 010	TCC 101	TCC 102	TCC 103	TCC 104	TCC 105	TCC 106	TCC 107	TCC 111
1.10	0.136	0.100	0.214	0.301	0.445	0.604	1.019	1.217	2.220
1.50	0.100	0.036	0.065	0.128	0.251	0.351	0.396	0.597	1.121
2.00	0.080	0.022	0.028	0.075	0.155	0.233	0.204	0.291	0.651
2.50	0.069	0.019	0.022	0.052	0.108	0.171	0.118	0.159	0.443
3.00	0.060	0.017	0.019	0.040	0.068	0.137	0.074	0.095	0.324
3.50	0.056	0.016	0.017	0.033	0.040	0.113	0.047	0.055	0.250
4.00	0.053	0.016	0.016	0.029	0.028	0.097	0.030	0.034	0.200
4.50	0.050	0.015	0.016	0.024	0.022	0.085	0.021	0.023	0.169
5.00	0.048	0.015	0.016	0.023	0.020	0.076	0.019	0.020	0.146
5.50	0.046	0.015	0.016	0.020	0.017	0.068	0.016	0.017	0.127
6.00	0.045	0.015	0.016	0.019	0.016	0.059	0.015	0.016	0.113
6.50	0.044	0.015	0.016	0.018	0.015	0.052	0.014	0.015	0.101
7.00	0.043	0.015	0.016	0.017	0.014	0.048	0.013	0.014	0.091
7.50	0.042	0.015	0.016	0.016	0.013	0.043	0.012	0.013	0.083
8.00	0.041	0.015	0.016	0.016	0.012	0.038	0.012	0.013	0.076
8.50	0.041	0.015	0.016	0.015	0.012	0.033	0.011	0.013	0.069
9.00	0.040	0.015	0.016	0.015	0.011	0.030	0.011	0.012	0.063
9.50	0.040	0.015	0.016	0.015	0.011	0.027	0.011	0.012	0.057
10.00	0.039	0.015	0.016	0.015	0.011	0.025	0.011	0.012	0.053
10.50	0.039	0.015	0.016	0.015	0.011	0.024	0.011	0.012	0.048
11.00	0.039	0.015	0.016	0.014	0.011	0.022	0.011	0.012	0.045
11.50	0.038	0.015	0.016	0.014	0.011	0.020	0.011	0.011	0.042
12.00	0.038	0.015	0.016	0.014	0.011	0.020	0.011	0.011	0.038
12.50	0.038	0.015	0.016	0.014	0.011	0.018	0.011	0.011	0.036
13.00	0.038	0.015	0.016	0.014	0.011	0.018	0.011	0.011	0.034
13.50	0.037	0.015	0.016	0.014	0.011	0.017	0.011	0.011	0.031
14.00	0.037	0.015	0.016	0.014	0.011	0.016	0.011	0.011	0.030
14.50	0.037	0.015	0.016	0.014	0.011	0.016	0.011	0.011	0.029
15.00	0.037	0.015	0.016	0.014	0.011	0.015	0.011	0.011	0.027
15.50	0.037	0.015	0.016	0.014	0.011	0.015	0.011	0.011	0.026
16.00	0.036	0.015	0.016	0.014	0.011	0.014	0.011	0.011	0.026
16.50	0.036	0.015	0.016	0.014	0.011	0.014	0.011	0.011	0.025
17.00	0.036	0.015	0.016	0.014	0.011	0.014	0.011	0.011	0.024
17.50	0.036	0.015	0.016	0.014	0.011	0.014	0.011	0.011	0.023
18.00	0.036	0.015	0.016	0.014	0.011	0.013	0.011	0.011	0.022
18.50	0.035	0.015	0.016	0.014	0.011	0.013	0.011	0.011	0.021
19.00	0.035	0.015	0.016	0.014	0.011	0.013	0.011	0.011	0.021
19.50	0.035	0.015	0.016	0.014	0.011	0.013	0.011	0.011	0.020
20.00	0.035	0.015	0.016	0.014	0.011	0.013	0.011	0.011	0.020
20.50	0.035	0.015	0.016	0.014	0.011	0.012	0.011	0.011	0.020
21.00	0.035	0.015	0.016	0.014	0.011	0.012	0.011	0.011	0.019
21.50	0.035	0.015	0.016	0.014	0.011	0.012	0.011	0.011	0.019
22.00	0.035	0.015	0.016	0.014	0.011	0.012	0.011	0.011	0.019
22.50	0.035	0.015	0.016	0.014	0.011	0.012	0.011	0.011	0.018
23.00	0.035	0.015	0.016	0.014	0.011	0.012	0.011	0.011	0.018
23.50	0.035	0.015	0.016	0.014	0.011	0.012	0.011	0.011	0.017
24.00	0.035	0.015	0.016	0.014	0.011	0.012	0.011	0.011	0.017
24.50	0.035	0.015	0.016	0.014	0.011	0.012	0.011	0.011	0.017

Setting Multiple Current	TCC 010	TCC 101	TCC 102	TCC 103	TCC 104	TCC 105	TCC 106	TCC 107	TCC 111
25.00	0.035	0.015	0.016	0.014	0.011	0.012	0.011	0.011	0.017
25.50	0.035	0.015	0.016	0.014	0.011	0.012	0.011	0.011	0.017
26.00	0.035	0.015	0.016	0.014	0.011	0.012	0.011	0.011	0.017
26.50	0.035	0.015	0.016	0.014	0.011	0.011	0.011	0.011	0.017
27.00	0.035	0.015	0.016	0.014	0.011	0.011	0.011	0.011	0.016
27.50	0.035	0.015	0.016	0.014	0.011	0.011	0.011	0.011	0.016
28.00	0.035	0.015	0.016	0.014	0.011	0.011	0.011	0.011	0.016
28.50	0.035	0.015	0.016	0.014	0.011	0.011	0.011	0.011	0.016
29.00	0.035	0.015	0.016	0.014	0.011	0.011	0.011	0.011	0.016
29.50	0.035	0.015	0.016	0.014	0.011	0.011	0.011	0.011	0.016
30.00	0.035	0.015	0.016	0.014	0.011	0.011	0.011	0.011	0.016

Table 15. Non-standard Inverse Time Protection table, TCC 010-111

Setting Multiple Current	TCC 112	TCC 113	TCC 114	TCC 115	TCC 116	TCC 117	TCC 118	TCC 119	TCC 120
1.10	2.069	2.605	5.372	4.689	4.920	4.626	5.957	5.881	7.886
1.50	1.021	1.266	2.351	1.794	2.303	2.290	2.517	2.506	3.759
2.00	0.563	0.704	1.396	0.727	1.216	1.397	1.248	1.516	2.013
2.50	0.356	0.463	0.951	0.375	0.748	0.920	0.754	1.143	1.302
3.00	0.256	0.358	0.699	0.219	0.499	0.648	0.522	0.938	0.923
3.50	0.197	0.291	0.532	0.141	0.351	0.488	0.384	0.807	0.695
4.00	0.158	0.259	0.420	0.096	0.259	0.391	0.295	0.713	0.547
4.50	0.131	0.233	0.335	0.067	0.200	0.321	0.234	0.652	0.462
5.00	0.113	0.212	0.262	0.050	0.159	0.270	0.193	0.602	0.397
5.50	0.099	0.203	0.207	0.038	0.129	0.231	0.162	0.570	0.347
6.00	0.087	0.195	0.164	0.030	0.107	0.200	0.138	0.548	0.310
6.50	0.079	0.189	0.129	0.025	0.090	0.176	0.121	0.529	0.281
7.00	0.073	0.183	0.099	0.021	0.078	0.156	0.108	0.512	0.256
7.50	0.068	0.181	0.076	0.018	0.068	0.140	0.096	0.499	0.235
8.00	0.063	0.180	0.056	0.017	0.060	0.126	0.087	0.487	0.219
8.50	0.059	0.179	0.038	0.017	0.053	0.115	0.078	0.476	0.206
9.00	0.055	0.177	0.031	0.016	0.048	0.105	0.071	0.467	0.195
9.50	0.052	0.176	0.027	0.015	0.043	0.097	0.065	0.459	0.184
10.00	0.051	0.175	0.026	0.014	0.039	0.090	0.060	0.455	0.176
10.50	0.048	0.174	0.024	0.014	0.036	0.083	0.055	0.451	0.167
11.00	0.046	0.174	0.022	0.014	0.034	0.078	0.051	0.448	0.161
11.50	0.044	0.173	0.021	0.014	0.031	0.073	0.048	0.445	0.155
12.00	0.043	0.173	0.020	0.014	0.029	0.069	0.045	0.441	0.150
12.50	0.041	0.172	0.019	0.014	0.027	0.064	0.042	0.438	0.145
13.00	0.040	0.172	0.019	0.014	0.026	0.059	0.040	0.436	0.141
13.50	0.039	0.172	0.018	0.014	0.024	0.056	0.037	0.433	0.137
14.00	0.038	0.171	0.017	0.014	0.023	0.052	0.036	0.431	0.133
14.50	0.037	0.171	0.017	0.014	0.022	0.049	0.034	0.430	0.130
15.00	0.036	0.171	0.016	0.014	0.020	0.045	0.032	0.429	0.128
15.50	0.035	0.170	0.016	0.014	0.019	0.041	0.031	0.429	0.126
16.00	0.034	0.170	0.016	0.014	0.019	0.039	0.030	0.428	0.124
16.50	0.034	0.170	0.016	0.014	0.018	0.036	0.029	0.428	0.122
17.00	0.033	0.169	0.015	0.014	0.017	0.035	0.028	0.427	0.121
17.50	0.032	0.169	0.015	0.014	0.016	0.033	0.026	0.427	0.119
18.00	0.031	0.169	0.015	0.014	0.016	0.031	0.025	0.426	0.117
18.50	0.030	0.169	0.014	0.014	0.015	0.030	0.024	0.425	0.115

Non-Standard Inverse Time Protection Curves (cont)

Setting Multiple Current	TCC 112	TCC 113	TCC 114	TCC 115	TCC 116	TCC 117	TCC 118	TCC 119	TCC 120
19.00	0.030	0.168	0.014	0.014	0.015	0.029	0.023	0.425	0.114
19.50	0.029	0.168	0.014	0.014	0.014	0.028	0.023	0.424	0.112
20.00	0.029	0.168	0.014	0.014	0.014	0.027	0.022	0.424	0.111
20.50	0.029	0.168	0.014	0.014	0.014	0.027	0.022	0.424	0.110
21.00	0.028	0.168	0.014	0.014	0.013	0.026	0.021	0.423	0.109
21.50	0.028	0.168	0.013	0.014	0.013	0.025	0.021	0.423	0.108
22.00	0.028	0.167	0.013	0.014	0.013	0.025	0.020	0.422	0.107
22.50	0.027	0.167	0.013	0.014	0.013	0.024	0.019	0.422	0.105
23.00	0.027	0.167	0.013	0.014	0.012	0.024	0.019	0.421	0.104
23.50	0.027	0.167	0.013	0.014	0.012	0.023	0.018	0.421	0.103
24.00	0.027	0.167	0.013	0.014	0.012	0.023	0.018	0.421	0.103
24.50	0.026	0.166	0.013	0.014	0.012	0.023	0.018	0.421	0.102
25.00	0.026	0.166	0.013	0.014	0.012	0.022	0.018	0.421	0.101
25.50	0.026	0.166	0.013	0.014	0.012	0.022	0.017	0.421	0.100
26.00	0.026	0.166	0.013	0.014	0.012	0.021	0.017	0.421	0.099
26.50	0.026	0.166	0.012	0.014	0.011	0.021	0.017	0.421	0.098
27.00	0.025	0.166	0.012	0.014	0.011	0.021	0.017	0.421	0.097
27.50	0.025	0.166	0.012	0.014	0.011	0.021	0.017	0.421	0.097
28.00	0.025	0.166	0.012	0.014	0.011	0.020	0.016	0.421	0.096
28.50	0.025	0.166	0.012	0.014	0.011	0.020	0.016	0.421	0.096
29.00	0.025	0.166	0.012	0.014	0.011	0.020	0.016	0.421	0.096
29.50	0.025	0.166	0.012	0.014	0.011	0.020	0.016	0.421	0.095
30.00	0.025	0.166	0.012	0.014	0.011	0.020	0.016	0.421	0.095

Table 16. Non-standard Inverse Time Protection table, TCC 112-120

Setting Multiple Current	TCC 121	TCC 122	TCC 131	TCC 132	TCC 133	TCC 134	TCC 135	TCC 136	TCC 137
1.10	8.877	8.215	10.608	12.547	11.533	11.373	12.003	15.121	17.469
1.50	1.241	4.424	8.297	4.459	5.607	4.790	6.370	4.652	10.158
2.00	0.019	2.615	7.100	2.597	3.020	2.387	3.674	2.780	6.486
2.50	0.015	1.689	6.423	1.571	1.921	1.507	2.564	1.884	4.751
3.00	0.012	1.104	6.100	0.993	1.329	1.075	1.968	1.338	3.661
3.50	0.011	0.656	5.898	0.722	0.973	0.846	1.614	1.023	2.932
4.00	0.011	0.373	5.729	0.552	0.753	0.698	1.361	0.833	2.419
4.50	0.011	0.124	5.623	0.438	0.613	0.617	1.196	0.689	2.004
5.00	0.011	0.034	5.536	0.353	0.511	0.552	1.070	0.550	1.688
5.50	0.011	0.022	5.458	0.287	0.432	0.508	0.968	0.448	1.463
6.00	0.011	0.019	5.390	0.237	0.371	0.484	0.900	0.368	1.287
6.50	0.011	0.017	5.358	0.199	0.322	0.463	0.849	0.304	1.145
7.00	0.011	0.016	5.334	0.169	0.283	0.444	0.805	0.255	1.060
7.50	0.011	0.015	5.311	0.147	0.252	0.436	0.765	0.210	0.989
8.00	0.011	0.014	5.289	0.126	0.227	0.432	0.734	0.173	0.926
8.50	0.011	0.013	5.269	0.110	0.205	0.427	0.710	0.143	0.872
9.00	0.011	0.013	5.250	0.096	0.186	0.423	0.689	0.117	0.823
9.50	0.011	0.012	5.232	0.085	0.170	0.419	0.669	0.093	0.780
10.00	0.011	0.012	5.216	0.077	0.157	0.416	0.651	0.067	0.747
10.50	0.011	0.012	5.208	0.070	0.145	0.415	0.634	0.046	0.730
11.00	0.011	0.011	5.208	0.064	0.137	0.415	0.618	0.038	0.713
11.50	0.011	0.011	5.208	0.058	0.128	0.415	0.606	0.033	0.698
12.00	0.011	0.011	5.208	0.053	0.121	0.415	0.598	0.029	0.684
12.50	0.011	0.011	5.208	0.049	0.115	0.415	0.591	0.026	0.671

Setting Multiple Current	TCC 121	TCC 122	TCC 131	TCC 132	TCC 133	TCC 134	TCC 135	TCC 136	TCC 137
13.00	0.011	0.011	5.208	0.046	0.109	0.415	0.584	0.024	0.658
13.50	0.011	0.011	5.208	0.043	0.103	0.415	0.577	0.022	0.659
14.00	0.011	0.011	5.208	0.040	0.098	0.415	0.571	0.021	0.645
14.50	0.011	0.011	5.208	0.038	0.093	0.415	0.565	0.020	0.639
15.00	0.011	0.011	5.207	0.036	0.089	0.415	0.569	0.018	0.634
15.50	0.011	0.011	5.207	0.033	0.085	0.415	0.555	0.018	0.629
16.00	0.011	0.011	5.207	0.032	0.082	0.415	0.553	0.017	0.625
16.50	0.011	0.011	5.207	0.030	0.078	0.415	0.551	0.017	0.621
17.00	0.011	0.011	5.207	0.029	0.076	0.415	0.549	0.017	0.618
17.50	0.011	0.011	5.207	0.027	0.074	0.415	0.548	0.016	0.616
18.00	0.011	0.011	5.207	0.026	0.072	0.415	0.546	0.016	0.614
18.50	0.011	0.011	5.207	0.025	0.070	0.415	0.544	0.015	0.612
19.00	0.011	0.011	5.207	0.024	0.068	0.415	0.542	0.015	0.610
19.50	0.011	0.011	5.207	0.022	0.066	0.415	0.541	0.015	0.608
20.00	0.011	0.011	5.207	0.022	0.064	0.415	0.539	0.015	0.606
20.50	0.011	0.011	5.207	0.022	0.063	0.415	0.538	0.015	0.604
21.00	0.011	0.011	5.207	0.021	0.061	0.415	0.536	0.015	0.603
21.50	0.011	0.011	5.207	0.021	0.060	0.415	0.535	0.015	0.602
22.00	0.011	0.011	5.207	0.020	0.058	0.415	0.534	0.015	0.602
22.50	0.011	0.011	5.207	0.020	0.057	0.415	0.532	0.015	0.602
23.00	0.011	0.011	5.207	0.019	0.055	0.415	0.531	0.015	0.602
23.50	0.011	0.011	5.207	0.019	0.054	0.415	0.530	0.015	0.602
24.00	0.011	0.011	5.207	0.019	0.054	0.415	0.529	0.015	0.602
24.50	0.011	0.011	5.207	0.018	0.053	0.415	0.528	0.015	0.602
25.00	0.011	0.011	5.207	0.018	0.052	0.415	0.528	0.015	0.602
25.50	0.011	0.011	5.207	0.018	0.051	0.415	0.528	0.015	0.602
26.00	0.011	0.011	5.207	0.018	0.051	0.415	0.528	0.015	0.602
26.50	0.011	0.011	5.207	0.018	0.050	0.415	0.528	0.015	0.602
27.00	0.011	0.011	5.207	0.017	0.049	0.415	0.528	0.015	0.602
27.50	0.011	0.011	5.207	0.017	0.049	0.415	0.528	0.015	0.602
28.00	0.011	0.011	5.207	0.017	0.048	0.415	0.528	0.015	0.602
28.50	0.011	0.011	5.207	0.017	0.047	0.415	0.528	0.015	0.602
29.00	0.011	0.011	5.207	0.017	0.047	0.415	0.528	0.015	0.602
29.50	0.011	0.011	5.207	0.017	0.046	0.415	0.528	0.015	0.602
30.00	0.011	0.011	5.207	0.017	0.046	0.415	0.528	0.015	0.602

Table 17. Non-standard Inverse Time Protection table, TCC 121-137

Setting Multiple Current	TCC 138	TCC 139	TCC 140	TCC 141	TCC 142	TCC 151	TCC 152	TCC 161	TCC 162
1.10	17.173	13.641	21.472	19.752	30.174	34.255	60.062	19.922	24.199
1.50	9.719	5.053	10.149	15.224	16.548	11.574	45.011	3.695	8.088
2.00	5.899	2.888	5.800	13.151	9.181	5.848	39.219	1.688	3.793
2.50	4.113	1.943	4.121	12.154	5.893	3.687	36.391	1.001	2.331
3.00	3.112	1.444	3.233	11.508	3.703	2.537	35.012	0.687	1.573
3.50	2.495	1.138	2.707	11.093	2.418	1.888	33.888	0.494	1.117
4.00	1.943	0.929	2.319	10.857	1.502	1.488	32.975	0.371	0.819
4.50	1.582	0.775	2.056	10.653	1.100	1.242	32.228	0.299	0.615
5.00	1.299	0.661	1.857	10.475	0.845	1.067	31.575	0.248	0.486
5.50	1.082	0.563	1.694	10.418	0.701	0.972	30.995	0.208	0.394
6.00	0.925	0.485	1.586	10.383	0.595	0.892	30.546	0.180	0.325
6.50	0.802	0.423	1.505	10.351	0.511	0.826	30.232	0.158	0.273

Non-Standard Inverse Time Protection Curves (cont)

Setting Multiple Current	TCC 138	TCC 139	TCC 140	TCC 141	TCC 142	TCC 151	TCC 152	TCC 161	TCC 162
7.00	0.703	0.373	1.434	10.320	0.444	0.772	29.944	0.140	0.234
7.50	0.625	0.331	1.371	10.293	0.390	0.726	29.679	0.126	0.205
8.00	0.561	0.297	1.314	10.267	0.345	0.686	29.434	0.114	0.182
8.50	0.508	0.267	1.263	10.243	0.309	0.651	29.205	0.105	0.163
9.00	0.461	0.242	1.225	10.220	0.279	0.619	29.001	0.097	0.145
9.50	0.422	0.220	1.195	10.198	0.253	0.595	28.874	0.091	0.130
10.00	0.388	0.202	1.168	10.179	0.231	0.579	28.763	0.085	0.117
10.50	0.358	0.185	1.143	10.175	0.211	0.564	28.657	0.079	0.106
11.00	0.335	0.171	1.118	10.175	0.193	0.551	28.558	0.075	0.097
11.50	0.315	0.158	1.096	10.175	0.179	0.538	28.462	0.071	0.088
12.00	0.296	0.147	1.076	10.175	0.166	0.526	28.371	0.067	0.081
12.50	0.279	0.136	1.060	10.175	0.155	0.518	28.284	0.064	0.075
13.00	0.265	0.126	1.052	10.175	0.144	0.513	28.200	0.061	0.071
13.50	0.251	0.117	1.045	10.175	0.133	0.508	28.121	0.059	0.067
14.00	0.241	0.110	1.038	10.175	0.122	0.504	28.043	0.057	0.064
14.50	0.232	0.103	1.032	10.175	0.112	0.499	27.987	0.055	0.060
15.00	0.224	0.097	1.025	10.175	0.104	0.495	27.969	0.053	0.057
15.50	0.216	0.091	1.019	10.175	0.095	0.490	27.954	0.051	0.053
16.00	0.208	0.084	1.013	10.175	0.088	0.487	27.938	0.049	0.051
16.50	0.202	0.079	1.008	10.175	0.081	0.484	27.923	0.048	0.047
17.00	0.195	0.074	1.002	10.175	0.075	0.481	27.909	0.046	0.045
17.50	0.189	0.070	0.998	10.175	0.069	0.479	27.896	0.044	0.043
18.00	0.184	0.066	0.995	10.175	0.065	0.477	27.882	0.043	0.040
18.50	0.179	0.062	0.994	10.175	0.062	0.474	27.868	0.043	0.038
19.00	0.175	0.058	0.993	10.175	0.058	0.472	27.856	0.042	0.036
19.50	0.171	0.055	0.992	10.175	0.055	0.470	27.844	0.041	0.034
20.00	0.167	0.051	0.992	10.175	0.052	0.468	27.831	0.040	0.032
20.50	0.164	0.049	0.992	10.175	0.050	0.468	27.820	0.040	0.032
21.00	0.161	0.046	0.991	10.175	0.048	0.468	27.809	0.039	0.030
21.50	0.157	0.043	0.990	10.175	0.046	0.467	27.797	0.038	0.029
22.00	0.155	0.041	0.989	10.175	0.044	0.467	27.786	0.038	0.028
22.50	0.151	0.038	0.988	10.175	0.043	0.467	27.775	0.037	0.027
23.00	0.149	0.036	0.987	10.175	0.041	0.466	27.765	0.036	0.026
23.50	0.146	0.035	0.987	10.175	0.040	0.466	27.755	0.035	0.025
24.00	0.144	0.033	0.987	10.175	0.039	0.466	27.745	0.035	0.025
24.50	0.141	0.032	0.986	10.175	0.038	0.466	27.737	0.035	0.024
25.00	0.138	0.030	0.985	10.175	0.037	0.466	27.733	0.034	0.024
25.50	0.136	0.029	0.985	10.175	0.036	0.465	27.731	0.033	0.023
26.00	0.135	0.027	0.985	10.175	0.036	0.465	27.728	0.033	0.023
26.50	0.134	0.026	0.985	10.175	0.035	0.465	27.725	0.033	0.022
27.00	0.132	0.025	0.985	10.175	0.034	0.465	27.722	0.032	0.022
27.50	0.132	0.024	0.985	10.175	0.034	0.465	27.719	0.032	0.022
28.00	0.131	0.023	0.984	10.175	0.033	0.464	27.716	0.032	0.021
28.50	0.130	0.022	0.984	10.175	0.033	0.464	27.714	0.031	0.020
29.00	0.130	0.022	0.984	10.175	0.033	0.464	27.711	0.031	0.020
29.50	0.129	0.021	0.984	10.175	0.032	0.464	27.709	0.031	0.020
30.00	0.129	0.021	0.984	10.175	0.032	0.464	27.709	0.031	0.020

Table 18. Non-standard Inverse Time Protection table, TCC 138-162

Setting Multiple Current	TCC 163	TCC 164	TCC 165	TCC 200	TCC 201	TCC 202
1.10	31.586	45.197	71.194	73.067	99.961	100.000
1.50	3.679	18.608	31.740	17.200	27.007	64.006
2.00	1.357	7.911	12.946	10.027	13.494	26.652
2.50	0.720	4.333	6.016	7.572	9.003	15.240
3.00	0.482	2.598	3.204	6.302	6.749	9.996
3.50	0.355	1.732	2.054	5.518	5.400	7.110
4.00	0.276	1.166	1.461	4.980	4.501	5.335
4.50	0.222	0.788	1.102	4.584	3.856	4.153
5.00	0.187	0.558	0.862	4.280	3.375	3.333
5.50	0.161	0.419	0.714	4.036	3.000	2.735
6.00	0.140	0.331	0.602	3.838	2.700	2.285
6.50	0.123	0.272	0.515	3.670	2.454	1.939
7.00	0.110	0.228	0.449	3.528	2.250	1.667
7.50	0.097	0.196	0.396	3.405	2.077	1.448
8.00	0.087	0.174	0.352	3.297	1.929	1.270
8.50	0.077	0.155	0.317	3.202	1.800	1.123
9.00	0.070	0.140	0.287	3.116	1.687	1.000
9.50	0.064	0.127	0.262	3.040	1.588	0.896
10.00	0.059	0.116	0.240	2.971	1.500	0.808
10.50	0.053	0.106	0.221	2.918	1.421	0.732
11.00	0.049	0.098	0.204	2.850	1.350	0.667
11.50	0.046	0.090	0.190	2.797	1.286	0.610
12.00	0.042	0.085	0.177	2.748	1.227	0.559
12.50	0.039	0.079	0.166	2.702	1.174	0.516
13.00	0.037	0.075	0.156	2.660	1.125	0.476
13.50	0.035	0.071	0.146	2.620	1.080	0.442
14.00	0.033	0.068	0.135	2.583	1.038	0.410
14.50	0.031	0.065	0.126	2.549	1.000	0.382
15.00	0.029	0.062	0.118	2.515	0.964	0.357
15.50	0.028	0.059	0.110	2.484	0.931	0.334
16.00	0.027	0.057	0.103	2.456	0.900	0.314
16.50	0.026	0.055	0.096	2.428	0.871	0.295
17.00	0.025	0.053	0.091	2.402	0.844	0.278
17.50	0.023	0.051	0.085	2.376	0.818	0.262
18.00	0.022	0.049	0.081	2.353	0.794	0.248
18.50	0.021	0.048	0.077	2.330	0.772	0.234
19.00	0.021	0.046	0.073	2.308	0.750	0.222
19.50	0.020	0.045	0.069	2.287	0.730	0.211
20.00	0.019	0.044	0.065	2.267	0.711	0.200
20.50	0.019	0.043	0.062	2.248	0.692	0.190
21.00	0.019	0.042	0.059	2.230	0.675	0.182
21.50	0.018	0.041	0.057	2.212	0.659	0.174
22.00	0.018	0.039	0.055	2.195	0.643	0.165
22.50	0.017	0.038	0.052	2.179	0.628	0.158
23.00	0.017	0.037	0.050	2.163	0.614	0.152
23.50	0.017	0.036	0.049	2.148	0.600	0.145
24.00	0.017	0.036	0.047	2.133	0.587	0.139
24.50	0.016	0.035	0.046	2.119	0.575	0.133
25.00	0.016	0.034	0.044	2.106	0.563	0.129
25.50	0.016	0.033	0.043	2.092	0.551	0.123
26.00	0.016	0.033	0.042	2.079	0.540	0.119

Non-Standard Inverse Time Protection Curves (cont)

Setting Multiple Current	TCC 163	TCC 164	TCC 165	TCC 200	TCC 201	TCC 202
26.50	0.015	0.032	0.041	2.067	0.530	0.114
27.00	0.015	0.031	0.041	2.055	0.519	0.110
27.50	0.015	0.031	0.041	2.043	0.509	0.106
28.00	0.015	0.030	0.040	2.031	0.500	0.102
28.50	0.014	0.030	0.039	2.020	0.490	0.099
29.00	0.014	0.030	0.039	2.009	0.482	0.096
29.50	0.014	0.029	0.038	2.001	0.475	0.093
30.00	0.014	0.029	0.038	2.001	0.475	0.093

Table 19. Non-standard Inverse Time Protection table, TCC 163-202

Appendix H

Reset Curves Reset Times

Tables listing the reset times for the available Reset Curves are given below:

% of Setting Current	IEEE Inverse	IEEE Very Inverse	IEEE Extremely Inverse
0%	4.85	21.60	29.10
1%	4.85	21.60	29.10
2%	4.85	21.61	29.11
3%	4.85	21.62	29.13
4%	4.86	21.63	29.15
5%	4.86	21.65	29.17
6%	4.87	21.68	29.21
7%	4.87	21.71	29.24
8%	4.88	21.74	29.29
9%	4.89	21.78	29.34
10%	4.90	21.82	29.39
11%	4.91	21.86	29.46
12%	4.92	21.92	29.53
13%	4.93	21.97	29.60
14%	4.95	22.03	29.68
15%	4.96	22.10	29.77
16%	4.98	22.17	29.86
17%	4.99	22.24	29.97
18%	5.01	22.32	30.07
19%	5.03	22.41	30.19
20%	5.05	22.50	30.31
21%	5.07	22.60	30.44
22%	5.10	22.70	30.58
23%	5.12	22.81	30.73
24%	5.15	22.92	30.88
25%	5.17	23.04	31.04
26%	5.20	23.17	31.21
27%	5.23	23.30	31.39
28%	5.26	23.44	31.58
29%	5.30	23.58	31.77
30%	5.33	23.74	31.98
31%	5.37	23.90	32.19
32%	5.40	24.06	32.42
33%	5.44	24.24	32.66
34%	5.48	24.42	32.90
35%	5.53	24.62	33.16
36%	5.57	24.82	33.43
37%	5.62	25.03	33.72
38%	5.67	25.25	34.01
39%	5.72	25.47	34.32
40%	5.77	25.71	34.64
41%	5.83	25.96	34.98
42%	5.89	26.23	35.33
43%	5.95	26.50	35.70
44%	6.01	26.79	36.09
45%	6.08	27.08	36.49
46%	6.15	27.40	36.91
47%	6.23	27.72	37.35
48%	6.30	28.07	37.81
49%	6.38	28.42	38.29

% of Setting Current	IEEE Inverse	IEEE Very Inverse	IEEE Extremely Inverse
50%	6.47	28.80	38.80
51%	6.55	29.19	39.33
52%	6.65	29.61	39.88
53%	6.74	30.04	40.47
54%	6.85	30.49	41.08
55%	6.95	30.97	41.72
56%	7.07	31.47	42.40
57%	7.18	32.00	43.10
58%	7.31	32.55	43.85
59%	7.44	33.13	44.64
60%	7.58	33.75	45.47
61%	7.72	34.40	46.34
62%	7.88	35.09	47.27
63%	8.04	35.81	48.25
64%	8.21	36.59	49.29
65%	8.40	37.40	50.39
66%	8.59	38.27	51.56
67%	8.80	39.19	52.80
68%	9.02	40.18	54.13
69%	9.26	41.23	55.54
70%	9.51	42.35	57.06
71%	9.78	43.56	58.68
72%	10.07	44.85	60.42
73%	10.38	46.24	62.30
74%	10.72	47.75	64.32
75%	11.09	49.37	66.51
76%	11.48	51.14	68.89
77%	11.91	53.06	71.48
78%	12.39	55.16	74.31
79%	12.90	57.46	77.41
80%	13.47	60.00	80.83
81%	14.10	62.81	84.62
82%	14.80	65.93	88.83
83%	15.59	69.43	93.54
84%	16.47	73.37	98.85
85%	17.48	77.84	104.86
86%	18.63	82.95	111.75
87%	19.95	88.85	119.70
88%	21.50	95.74	128.99
89%	23.33	103.90	139.97
90%	25.53	113.68	153.16
91%	28.21	125.65	169.28
92%	31.58	140.63	189.45
93%	35.90	159.88	215.40
94%	41.67	185.57	250.00
95%	49.74	221.54	298.46
96%	61.86	275.51	371.17
97%	82.06	365.48	492.39
98%	122.47	545.45	734.85
99%	243.72	1085.43	1462.31

Table 20. IEEE Reset Curves

Reset Curves Reset Times (cont)

% of Setting Current	IEC255 Inverse	IEC255 Very Inverse	IEC255 Extremely Inverse
0%	13.50	47.30	80.00
1%	13.50	47.30	80.01
2%	13.51	47.32	80.03
3%	13.51	47.34	80.07
4%	13.52	47.38	80.13
5%	13.53	47.42	80.20
6%	13.55	47.47	80.29
7%	13.57	47.53	80.39
8%	13.59	47.60	80.52
9%	13.61	47.69	80.65
10%	13.64	47.78	80.81
11%	13.67	47.88	80.98
12%	13.70	47.99	81.17
13%	13.73	48.11	81.38
14%	13.77	48.25	81.60
15%	13.81	48.39	81.84
16%	13.85	48.54	82.10
17%	13.90	48.71	82.38
18%	13.95	48.88	82.68
19%	14.01	49.07	83.00
20%	14.06	49.27	83.33
21%	14.12	49.48	83.69
22%	14.19	49.71	84.07
23%	14.25	49.94	84.47
24%	14.33	50.19	84.89
25%	14.40	50.45	85.33
26%	14.48	50.73	85.80
27%	14.56	51.02	86.29
28%	14.65	51.32	86.81
29%	14.74	51.64	87.35
30%	14.84	51.98	87.91
31%	14.94	52.33	88.51
32%	15.04	52.70	89.13
33%	15.15	53.08	89.78
34%	15.26	53.48	90.46
35%	15.38	53.90	91.17
36%	15.51	54.34	91.91
37%	15.64	54.80	92.69
38%	15.78	55.28	93.50
39%	15.92	55.78	94.35
40%	16.07	56.31	95.24
41%	16.23	56.86	96.17
42%	16.39	57.43	97.13
43%	16.56	58.03	98.15
44%	16.74	58.66	99.21
45%	16.93	59.31	100.31
46%	17.12	59.99	101.47
47%	17.33	60.71	102.68
48%	17.54	61.46	103.95
49%	17.77	62.25	105.28
50%	18.00	63.07	106.67
51%	18.25	63.93	108.12

% of Setting Current	IEC255 Inverse	IEC255 Very Inverse	IEC255 Extremely Inverse
52%	18.50	64.83	109.65
53%	18.77	65.78	111.25
54%	19.06	66.77	112.93
55%	19.35	67.81	114.70
56%	19.67	68.91	116.55
57%	20.00	70.06	118.50
58%	20.34	71.28	120.55
59%	20.71	72.56	122.72
60%	21.09	73.91	125.00
61%	21.50	75.33	127.41
62%	21.93	76.84	129.95
63%	22.38	78.43	132.65
64%	22.87	80.12	135.50
65%	23.38	81.90	138.53
66%	23.92	83.81	141.74
67%	24.50	85.83	145.16
68%	25.11	87.98	148.81
69%	25.77	90.28	152.70
70%	26.47	92.75	156.86
71%	27.22	95.38	161.32
72%	28.03	98.21	166.11
73%	28.90	101.26	171.27
74%	29.84	104.55	176.83
75%	30.86	108.11	182.86
76%	31.96	111.98	189.39
77%	33.16	116.19	196.51
78%	34.47	120.79	204.29
79%	35.91	125.83	212.82
80%	37.50	131.39	222.22
81%	39.26	137.54	232.63
82%	41.21	144.38	244.20
83%	43.39	152.04	257.15
84%	45.86	160.67	271.74
85%	48.65	170.45	288.29
86%	51.84	181.64	307.22
87%	55.53	194.57	329.08
88%	59.84	209.66	354.61
89%	64.94	227.51	384.80
90%	71.05	248.95	421.05
91%	78.53	275.16	465.39
92%	87.89	307.94	520.83
93%	99.93	350.11	592.15
94%	115.98	406.36	687.29
95%	138.46	485.13	820.51
96%	172.19	603.32	1020.41
97%	228.43	800.34	1353.64
98%	340.91	1194.44	2020.20
99%	678.39	2376.88	4020.10

Table 21. IEC255 Reset Curves

Appendix I

Communication Settings

This appendix contains a table of setting for each of the communications port types.

RS232 COMMUNICATION PORT SETTINGS

Setting	Description
DISABLED ENABLED IN USE	Port Operation This setting indicates whether the port is DISABLED or ENABLED or ENABLED and IN USE by an application within the ADVC. Range: DISABLED, ENABLED, IN USE <i>(Display only setting)</i>
Driver	Communication Driver Communication driver attached to port e.g. modem driver This setting is only applicable for ports C and D. R Range: Hayes, RDI, SOS Multi, NONE <i>Factory default is NONE</i>
Mode	Mode State LOCAL/Remote mode of communication assigned to this port. Range: LOCAL, Remote A port used by SCADA protocols should use Remote, WSOS5 or IOEX should be set to LOCAL or Remote depending upon requirements. Refer to “ Local, Remote, Hit and Run / Delayed Operation (page 8-1)” for more information about Remote/LOCAL modes. <i>Factory default is Port A LOCAL, Port B-D REMOTE</i>
Baud	Communications Baud Rate Range: 300, 600, 1200, 2400, 4800, 9600, 19200, 38400, or 57600 baud. <i>Factory default is Port A 57600 Baud, Port B 19200 Baud, Port C 9600 Baud, Port D 57600 Baud</i>
Parity	Parity Parity of the communications port Range: NONE, EVEN, ODD <i>Factory default is NONE</i>
Stop bits	Number of Stop Bits Number of stop bits appended to transmitted byte Range: 1, 2 <i>Factory default is 1</i>
RTS	RTS Support When ENABLED, RTS is asserted for Pre-Tx period of time prior to transmission of data as well as Post-Tx period of time after transmission. Pre and post transmission RTS is required on most radio modems. This setting is only applicable for ports C and D. Range: DISABLED, ENABLED <i>Factory default is ENABLED</i>
CTS	CTS Support If the modem does not support a Clear To Send (CTS) signal and/or the cabling has no CTS wiring, this setting should be set to CTS Ignore. When set to CTS Ignore, the protocol asserts RTS as normal but does not check for a returned CTS input signal. If the modem supports a Clear To Send (CTS) signal, setting CTS Don't Ignore, allows data to be transmitted only when CTS is asserted. This setting is only applicable for ports C and D. Range: Ignore, Don't Ignore <i>Factory default is Ignore</i>

Setting	Description
DTR	DTR Support When set to ENABLED, DTR is asserted whenever the port is in use. This setting is only applicable for ports C and D. Range: DISABLED, ENABLED <i>Factory default is ENABLED</i>
Pre-Tx	Pre-Transmission Period If RTS support is ENABLED, Pre-Tx is the time delay between asserting RTS and when the message starts. This setting is only applicable for ports C and D. Range: 0 to 3000 ms. <i>Factory default is 250 ms</i>
Post-Tx	Post-Transmission Period If RTS support is ENABLED, Post-Tx is the time after the last character is sent before RTS is negated. This setting is only applicable for ports C and D. Range: 0 to 3000 ms. <i>Factory default is 35 ms</i>
DCD	DCD Usage If the modem does not support a Data Carrier Detect (DCD) signal this setting should be set to DCD Ignore. Even if the modem does support a DCD signal this setting is usually set to DCD Ignore. This is because most point-point systems using conventional modems run as full duplex so that the DCD is always asserted during normal operation. When set to DCD Ignore, the protocol uses any received data to build an incoming packet irrespective of DCD input signal. Also the protocol will transmit irrespective of the DCD input signal. If the modem supports a Data Carrier Detect (DCD) signal this setting can be set to DCD Don't Ignore. When set to this mode, the protocol will only read data and build an incoming protocol packet when DCD is asserted. In addition, the protocol will not transmit when DCD is asserted. This is necessary for multi-dropped systems or ones shared with voice users or some radio-modems. This setting is only applicable for ports C and D. Range: DCD Ignore, DCD Don't Ignore <i>Factory default is DCD Ignore</i>
CA Delay	Collision Avoidance Delay On a multidrop communications link this setting can be used to provide priority access. If the controller prepares to transmit and finds the link busy (DCD asserted), it waits until it is no longer busy, then waits a back off time as follows: Back off time = CA Delay + (random delay with range 0.0 to CA Delay) After the back off time the device tries again. If still unsuccessful then the controller will continue in an indefinite loop until successful. If the DCD usage is configured to DCD Ignore, the CA Delay time is disabled. This setting is only applicable for ports C and D. Range: 0 to 180000 milliseconds <i>Factory default is 1000 ms</i>
Preamble	Preamble Usage Determines whether the port transmits some preamble characters prior to transmitting a message. The message itself is not otherwise modified. Some modems require these characters to assist with message reception and synchronisation at the master station. Start of frame filtering at the master station ensures identification of the transmitted message. ENABLED means that the preamble characters are transmitted prior to a message transmission. DISABLED means that the message is transmitted without any preamble characters. Range: ENABLED, DISABLED <i>Factory default is DISABLED</i>

Communication Settings (cont)

Setting	Description
First Char	Preamble First Character This is the first character to be transmitted as a preamble. The character is specified by entering its ASCII code in hexadecimal format. Range: is 0 to FF hexadecimal. <i>Factory default is 0x55</i>
Repeat First	Number of Preamble First Characters This is the number of times the first character will be repeated as part of the preamble. For example, if all preamble settings are at default values then the preamble sent is 0x55, 0x55, 0x55, 0xFF Range: 0 to 20. <i>Factory default is 3</i>
Last Char	Last Preamble Character This is the last char that will be sent as part of the preamble. The character is specified by entering its ASCII code in hexadecimal format. Range: is 0 to FF hexadecimal. <i>Factory default is 0xFF</i>

Table 22. RS232 Communication Port Settings

RDI MODEM SUPPORT SETTINGS

Setting	Description
Msg Attempts	Message Retry Attempts This is the number of complete attempts made to transfer a protocol packet to the radio system. Failure at any stage in the transfer process will cause another attempt. Once the number of attempts is exhausted the protocol packet is discarded by RDI. It is then up to the protocol to handle the failure as it would normally if RDI was not in use. Factory default is 4
Resend Wait	This setting allows configuration of a delay before any communications is attempted after any successful transmission or any failed retry sequence only. The purpose is to avoid continual failures due to timing synchronisation problems between the Master and Slave units. Range 10 - 5000ms Factory default is 50ms
Prefix Data	Depending on the implementation of RDI a prefix to the data messages may be required. This setting allows the prefix to be enabled or disabled. The prefix used is 0x14. Range: OFF, ON Factory default is OFF
ACK2 ON/OFF	ACK2 Support An ACK2 is an acknowledgement that confirms that the protocol packet has been accepted by the receiving EDACS radio. This type of acknowledgement is optional and can be turned On or Off via this setting. If it ON then CTS is also used. Factory default is ON
ACK0 Err Cnt	ACK0 Error Count Counts the number of times that 'ACK0' is not received within 500msec of data transfer request message being sent. Range: 0 to 2147483648
ACK1 Err Cnt	ACK1 Error Count Counts the number of times that 'ACK1' is not received within 1 second of DATA message being sent. Range: 0 to 2147483648
ACK2 Err Cnt	ACK2 Error Count Counts the number of times that 'ACK2' is not received from the receiving EDACS radio within 45 seconds of DATA message being transmitted. Range: 0 to 2147483648

Table 23. RDI Modem Support Settings

HAYES COMPATIBLE MODEM SUPPORT

Setting	Description
Hayes Available	Hayes Modem Driver Availability This enables the use of the Hayes modem driver.  Making Hayes Available enables the radio power cycle feature whether or not Ports C or D are using the Hayes driver. Factory default is 'Not Available'.
Dial Command ATD/ ATDT/ ATDP	Dial Command The dial command preceding the dial out phone number. Factory default is ATDT.
No Data Timeout	No Data Timeout The driver will disconnect the modem if it has not received or transmitted any data for this time. Range: 10 to 999sec. Factory default is 30sec.

Communication Settings (cont)

Setting	Description
Dial Timeout	Dial Timeout The next phone number dialled if the DCD has not been asserted within this time. Range: 20 to 999sec. <i>Factory default is 90sec.</i>
■ Attempt Delay	■ Attempt Delay ■ Delay before next connection attempt. An attempt ends after either the DCD line is asserted, or all numbers in the phone list have been dialled. There are additional delays to the "Dial Timeout": ■ Disconnect delay for each phone number (6.2sec), ■ 60sec power down delay if the end of the phone list is reached. ■  If two modems are using the Hayes driver, then the 60sec delay may be longer since the power down will not begin until both drivers are ready to power down. This attempt delay is in addition to the above times. ■ ■ Range: 0 to 86400 sec. ■ <i>Factory default is 30 sec.</i>
Max Attempts	Maximum Attempts The maximum number of connection attempts. There will be no more connection attempts from the ADVc once this limit is reached. The dial out capability is re-enabled when valid messages are received while the DCD line is asserted. Characters received without DCD are assumed to be noise. If the attempts are set to 255 then the attempts will be unlimited. Range: 1 to 255 <i>Factory default is 3.</i>
Radio Pwr Cycle OFF	Radio Power Cycle This determines the minimum frequency of power cycling the radio power supply. It is possible to power the modems via the radio power supply. For some modems, this is the only way of resetting them. This setting affects both modems if they are using the radio power supply.  Unless this is ON, cycling of the radio power supply will not be possible.  If two modems are using the Hayes driver, then the power down will not begin until both drivers are ready to power down.  Caution: The driver does not consider all devices using the radio power supply. They will be disrupted even if in operation. Range: OFF, 1 to 48 hours. <i>Factory default is OFF.</i>
Attempt Count	Attempt Count The number of attempts to connect to the master station. An attempt will call each of the PSTN numbers in the list until a connection is established. An attempt ends after either the DCD line is asserted, or all numbers in the phone list have been dialled.  This does not indicate the number of phone calls made. (Display Only)

Table 24. Hayes Compatible Modem Support Settings

SOS MULTIDROP SUPPORT SETTINGS

Setting	Description
SOS Multi Available	SOS Multidrop Driver Availability This enables the use of the SOS Multidrop driver. <i>Factory default is 'Not Available'.</i>
Address	ADVC Controller Address Address of the ADVC. This is used by every driver instance. Range: 1 to 2147483647 <i>Factory default is 1.</i>
Max Frag Size	Maximum Data Fragment Size Maximum data fragment size not including any header, address, or CRC bytes. This is useful when very long messages are unlikely to succeed e.g. V23, Radio. It makes the driver fragment the long message to increase the chance of successful transmission. Range: 10 to 1982 bytes. <i>Factory default is 30sec.</i>
Dial Timeout	Dial Timeout The next phone number dialled if the DCD has not been asserted within this time. Range: 20 to 999sec. <i>Factory default is 500 for V23, and 1982 for other ports.</i>
Frag Retry Time	Fragment Retry Timeout Maximum time to wait for a confirm message from WSOS5.  Do not set lower than the worst-case delay for transmission and reply time. Range: 1 to 999 sec. <i>Factory default is 10 sec.</i>
Frag Retries	Maximum Fragment Retry Count Maximum count for fragment retries per message to WSOS5. Range: 1 to 100 <i>Factory default is 10.</i>
Char Timeout	Inter character Timeout Delay If no character is received within this time, an attempt is made to decode the packet. Range: 20 to 999 ms. <i>Factory default is 20 ms.</i>
Tx Count	Transmission Count The total number of packets transmitted by the ADVC, including retries of unacknowledged packets. <i>Display only.</i>
Rx Count	Receive Count The total number of packets transmitted by the ADVC, including retries of unacknowledged packets. <i>Display only.</i>
Rx CRC Err	Receive CRC Error The number of packets received by the ADVC that fail the CRC test. Display only.
Rx Length Err	Receive Length Error The number of packets received by the ADVC that do not have the required amount of characters. Usually the result of an inter character timeout. <i>Display only.</i>

Table 25. SOS Multidrop Driver Support Settings

Communication Settings (cont)

RS485 COMMUNICATION PORT SETTINGS.

Setting	Description
ENABLED DISABLED	Port Operation This setting indicates whether the port is DISABLED or ENABLED or ENABLED and IN USE by an application with in the controller. Range: DISABLED, ENABLED, IN USE <i>(Display only setting)</i>
Baud	Communications Baud Rate Range: 300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, or 115200 baud. <i>Factory default is 57600 Baud</i>
Parity	Communication Parity Determines the parity of the communication port. Range: NONE, EVEN, ODD <i>Factory default is NONE</i>
Mode	Mode State LOCAL/Remote mode of communication assigned to this port. Range: LOCAL/Remote A port used by SCADA protocols should use 'Remote'. WSOS5 & IOEX should be set to LOCAL or 'Remote' depending upon requirements. Refer to " Local, Remote, Hit and Run / Delayed Operation (page 8-1)" for more information about LOCAL/Remote modes. <i>Factory default is Remote</i>

Table 26. RS485 Communication Port Settings

V23 FSK PORT SETTINGS

Setting	Description
ENABLED DISABLED	Port Operation This setting indicates whether the port is DISABLED or ENABLED or ENABLED and IN USE by an application with in the controller. Range: DISABLED, ENABLED, IN USE (<i>Display only setting)</i>
Baud	Communications Baud Rate Not configurable for V23 FSK. Factory default is 1200 Baud <i>(Display only setting)</i>
Mode	Mode State LOCAL/Remote mode of communication assigned to this port. Range: LOCAL/Remote A port used by SCADA protocols should use 'Remote'. WSOS5 & IOEX should be set to LOCAL or 'Remote' depending upon requirements. Refer to " Local, Remote, Hit and Run / Delayed Operation (page 8-1)" for more information about LOCAL/Remote modes. <i>Factory default is Remote</i>
Parity	Communication parity Determines the parity of the communication port. Range: NONE, EVEN, ODD <i>Factory default is NONE</i>

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Setting	Description
CD (Carrier Detect)	CD Usage CD ENABLED If set to this mode, the handler will utilise the V23 ports Carrier Detect input as set in "CD if input HIGH/ LOW" below, else if CD DISABLED the handler will ignore the Carrier Detect V23 port input. Range: CD Disabled, CD Invalid <i>Factory default is CD DISABLED</i>
CD if input LOW CD if input HIGH	Polarity of CD Signal This setting determines the sense of an asserted CD input signal from a device connected to the V23 port. "CD when input LOW" means that a low input signal will assert Carrier Detect. "CD when input HIGH" means that a high input signal will assert Carrier Detect. When CD is in the asserted state and CD ENABLED the handler will not transmit, instead it will use the use the Collision Avoidance mechanism as described in CA Delay. Range: CD when input low, CD when input high. <i>Factory default is CD when input LOW</i>
Busy Ignore Busy Don't Ignore	Busy Status Usage "Busy Ignore" - When set to this mode, the handler uses any received data to build a packet and the handler is able to transmit at any time. "Busy Don't Ignore" - When set to this mode, the handler will only read data and build packets when the V23 modem detects busy. In addition, the handler will not transmit when the V23 modem in the busy state, instead it will use the use the Collision Avoidance mechanism as described in CA Delay. This reduces clashes with voice users. Range: Busy Ignore, Busy Don't Ignore <i>Factory default is Busy Ignore</i>
CA Delay	Collision Avoidance Delay On a multidrop communications link this setting can be used to provide a collision avoidance 'back-off' mechanism. If the controller prepares to transmit and finds the link busy (DCD asserted), it waits until it is no longer busy, then waits a back off time as follows: Back off time = CA Delay + (random delay with range 0.0 to CA Delay) After the back off time the device tries again. If still unsuccessful then the controller will continue in an indefinite loop until successful. If the CD usage is configured to CD Disabled then the CA Delay time is disabled. Range: 0 to 180000 milliseconds <i>Factory default is 1000 ms</i>
Pre-TX	Pre-Transmission Period Pre-Tx is the time delay between asserting PTT to when the message starts. Range: 0 to 3000 ms. <i>Factory default is 250 ms</i>
Post-TX	Post-Transmission Period Post-Tx is the time after the last character is sent before PTT is negated. Range: 0 to 3000 ms. <i>Factory default is 35 ms</i>
Pre-amble	Preamble Usage Determines whether the port transmits some preamble characters prior to transmitting a message. The message itself is not otherwise modified. Some modems require these characters to assist with message reception and synchronisation at the master station. Start of frame filtering at the master station ensures identification of the transmitted message. ENABLED means that the preamble characters are transmitted prior to a message transmission. DISABLED means that the message is transmitted without any preamble characters. Range: ENABLED, DISABLED <i>Factory default is DISABLED</i>

Communication Settings (cont)

Setting	Description
First Char	Preamble First Character This is the first character to be transmitted as a preamble. The character is specified by entering its ASCII code in hexadecimal format. Range: is 0 to FF hexadecimal. <i>Factory default is 0x55</i>
Repeat First	Number of Preamble First Characters This is the number of times the first character will be repeated as part of the preamble. Eg if all preamble settings are at default values then the preamble sent is 0x55, 0x55, 0x55, 0xFF Range: 0 to 20. <i>Factory default is 3</i>
Last Char	Last Preamble Character This is the last char that will be sent as part of the preamble. The character is specified by entering its ASCII code in hexadecimal format. Range: is 0 to FF hexadecimal. <i>Factory default is 0xFF</i>

Table 27. V23 FSK Port Settings

10BASE-T PORT SETTINGS

Setting ^a	Description
ENABLED	Port Operation Not configurable for 10Base-T. Range: ENABLED, IN USE
Remote	LOCAL/Remote Status Not configurable for 10Base-T. <i>Factory default is Remote</i>
IP ^b	Internet Protocol Address IP address of controller. Range: 0.0.0.0 to 255.255.255.255 <i>Factory default is 10.176.x.y where x is 20 + (controller serial number ÷ 256) and y is controller serial number modulo 256</i>
Sub ^b	Subnet mask Subnet mask is used when controller is not in DHCP mode. Range: 0.0.0.0 to 255.255.255.255 <i>Factory default is 255.255.0.0</i>
DHCP ^{b, c}	DHCP Support If ENABLED then IP address of controller is automatically determined from an DHCP server. If DISABLED then IP address is determined via configuration of IP and Subnet mask settings. Range: ENABLED, DISABLED <i>Factory default is DISABLED</i>

Table 28. 10Base-T Port Settings

a. All of these settings are read only.

b. If the IP address and Subnet mask settings are blank then the controller has failed to establish a connection with the DHCP server and therefore has no IP address nor subnet mask. The test for DHCP server is only done on power up. To retry the communication, check the 10base-T connection and cycle the power to the controller.

c. WSOS5 is required for configuration of 10Base-T settings. If DHCP mode is changed then WSOS5 prompts the operator that a controller reset is required.

COMMUNICATIONS TRACE SETTINGS

Setting	Description
Output	Output Port The port out of which data captured from the <i>Target</i> port is transmitted, except when the Trace application is being used by WSOS5 to capture communication data. If <i>Trace</i> port and <i>Target</i> port are the same, a software loopback is created. If in WSOS5 Controlled mode, the <i>Trace</i> port indicates WSOS5. Range: NONE, RS232-A, RS232-B, RS232-C, RS232-D, WSOS <i>Factory default is NONE</i>
INACTIVE/ RUNNING	Trace Application Status Indicates the current state of the trace application. To trigger a trace, select RUNNING. To halt a trace, select INACTIVE Status will automatically be set to INACTIVE after maximum trace time, Timeout. Range: RUNNING, INACTIVE <i>Factory default is INACTIVE</i>
Target	Target Port The port that the Trace application will trace/loop back to when Trace is 'RUNNING' Range: NONE, RS232-A, RS232-B, RS232-C, RS232-D, V23 FSK, RS485 <i>Factory default is NONE</i>
Timeout	Maximum Trace Time If the trace is not being controlled by WSOS5, <i>Timeout</i> is the maximum time the trace will run during any one trace session. <i>Timeout</i> is ignored if the Trace port is controlled by WSOS5. Range: 1 to 1440 Minutes <i>Factory default is 15 Minutes</i>
Fmt	Format The format applied to the traced data stream sent to the output port or to WSOS5 when WSOS5 Communications Capture is Active. RAW LOOPBACK Indicates Target port is "Looped Back", data is unformatted. N.B. Fmt reverts to its previous setting after a Trace 'loop back' session. RAW BINARY Trace output is unformatted. HEADER BINARY An informational header containing: timestamp, traced port name, Tx/Rx indicator, byte count and transmitting application is pre-pended to each discrete transmit/receive "byte group" transported through the Target port. (HEADER BINARY is the only format supported by WSOS5 Communications Capture. Fmt will revert to its previous setting after a WSOS5 Comms Capture session. HEADER ASCII As for HEADER BINARY but the header and data is translated to a space delimited ASCII/HEX character stream. <i>Factory default is HEADER BINARY</i>
End of Line	End of Line Character Character(s) used for end of line HEADER ASCII trace output. Range: CR/LF- Carriage Return / Line Feed (0x0D 0x0A) CR - Carriage Return (0x0D) LF - Line Feed (0x0A) NONE - No "end of line" termination character <i>Factory default is CR/LF</i>

Setting	Description
Tx Count ^a See Note Below	Transmission Message Count Count of transmissions by the traced port. Range: 0 to 2147483648 messages
Rx Count ^a See Note Below	Receive Message Count Count of messages received by the traced port. Range: 0 to 2147483648 messages
Tx Bytes ^a See Note Below	Transmission Byte Count Count of bytes transmitted by the traced port. Range: 0 to 2147483648 bytes
Rx Bytes ^a See Note Below	Receive Byte Count Count of bytes received by the traced port. Range: 0 to 2147483648 bytes

a. The transmission and receive counters:

- continue between trace sessions on the same target port but are reset to zero upon selection of a different target port.
- can be individually cleared by an operator at any time. To clear a counter press the **SELECT** key until the desired counter starts flashing, press either the left or the right arrow key, and then press the **Enter** key.
- will roll over to zero when the maximum count is reached.

Appendix J

System Status pages

This appendix shows all the System Status group pages. The top line of each page is the page title. To the right of the title is a letter which indicates the display group to which the page belongs. For the System Status group the letter is "S". The next three lines are the data on display. Most displays have six data fields. These lines are shown in the following tables.

Typical or default values are shown in the tables. For example, Reclose Time 0.5 sec, is shown for the reclose time setting. When you view the actual display it would show the actual setting, e.g Reclose Time 3.0 sec¹.

Where field text differs to indicate different settings e.g. SEF Protection ON or SEF Protection OFF, all the possible texts are shown, one below the other. For example, in the table overleaf for the page

```
----- OPERATOR SETTINGS 1 ----- S
LOCAL CONTROL ON      E/F OFF,      SEF OFF
Auto Reclose ON       NPS OFF
                       Prot 'B' Active
```

the first data field can be either:

- LOCAL CONTROL ON, or
- Remote Control ON

Where field text differs according to whether the chosen display language is international or US English, the international English will be given first, followed by the US English in brackets e.g. SEF (SGF) Protection ON. For example, in the table overleaf for the page

the second data field is:

- E/F (G/F) ON, or E/F (G/F) OFF

and the third data field is:

- SEF (SGF) ON, or SEF (SGF) OFF

For explanatory purposes only within this publication, the letters in the small column to the right of each display text column indicate the type of data displayed. These have significance as follows:

- O** Operator Controlled
- D** Display Only (i.e. cannot be changed)
- P** Password Protected (i.e. can only be changed if the password is known)
- R** Operator Controlled Reset (i.e. resets a field or group of fields)

Trip Flags

TRIP FLAGS					S
O/C ☐ 00-99ABC	R	LOP ☐ 00-99ABC ^a	R	Ext ☐ 00-99	R
E/F (G/F) ☐ 00-99I	R	FRQ ☐ 00-99 ^{ab}	R		R
SEF (SGF) ☐ 00-99	R	NPS ☐ 00-99I	R	OPS0000-9999	R

a. Not Available when configured as a sectionaliser

b. This is a feature only.

PICKUP FLAGS

PICKUP FLAGS					S
O/C ☐ 00-99ABC	R	LOP ☐ 00-99ABC ^a	R		
E/F (G/F) ☐ 00-99I	R	FRQ ☐ 00-99 ^{ab}	R		
SEF (SGF) ☐ 00-99	R	NPS ☐ 00-99I	R	OPS0000-9999	R

a. Not Available when configured as a sectionaliser

b. This is a feature only.

OPERATOR SETTINGS 1

OPERATOR SETTINGS 1			S
LOCAL CONTROL ON Remote Control On Hit and Run ON Hit and Run OFF	O	E/F (G/F) OFF, SEF (SGF) OFF E/F (G/F) ON, SEF (SGF) OFF E/F (G/F) ON, SEF (SGF) ON E/F (G/F) ON E/F (G/F) OFF The options appearing in this field are dependent on the SEF (SGF) and E/F (G/F) Control settings.	O
Auto Reclose OFF Auto Reclose ON Protection OFF ^a <i>When Configured as Sectionaliser:</i> Sectionaliser OFF Sectionaliser Auto Detection OFF	O	NPS OFF NPS ON NPS Prot Alarm	O
Lockout Single Shot Active (blank in normal operation) Reclose 1, 2 & 3 <i>When configured as Sectionaliser</i> <blank in normal operation> Supply Interrupt 1 Supply Interrupt 2 etc. Supply Interrupt 4 Sectionaliser Trip	D	Protection Auto ^{b,c} Prot 'A', 'B', ... , 'J' Active ^d Auto 'A' Active ^c Auto 'B' Active ^c <i>When Configured as Sectionaliser</i> Det Auto Auto 'A' Active Auto 'B' Active etc. Auto 'J' Active Det 'A', 'B', ..., 'J' Active	O O D D

a. If (SYSTEM STATUS-OPTIONS 1:Prot OFF Not Allowed) is configured then this option is not shown.

b. Navigation of this field starts with "Protection Auto" (when configured) to minimise key presses.

c. If (SYSTEM STATUS-OPTIONS 1:APGS Not Allowed) is configured then this option is not shown.

d. One of ten different Protection Groups (A-J) can be active. For example, if Protection Group D is active the display will read {Prot 'D' Active}.

System Status Pages (cont)

OPERATOR SETTINGS 2

OPERATOR SETTINGS 2		S	
Cold Load OFF	O	Demand Period 15 min	
Cold Load IDLE			
Cold Load NO CHANGE			
Cold Load MAX			
CLP120min x 2.3 mult ^a			
		Dead Lockout OFF	
		Dead Lockout ON	
APGS Change 60s (Range 10s -180s)			

a. This field is "display only" when configured as Cold Load OFF.

SYSTEM SETTINGS 1

SYSTEM SETTINGS 1		S	
Lang English (Intl)	O	Display Metric	O
Lang English (USA)		Display Imperial	
Lang English (USA2)			
System Freq 50 Hz	P		
System Freq 60 Hz			
GMT Offset +0.0 hr	O	DD/MM/YYYY (MM/DD/YYYY) HH:MM:SS	O

SYSTEM SETTINGS 2

SYSTEM SETTINGS 2		S	
Options Available	P		
Options Not Avail			

SWITCHGEAR STATUS

SWITCHGEAR STATUS		S	
Hot Line (Work Tag) OFF	O	SF6 Normal 5.3 psig	D
Hot Line (Work Tag) Applied			
Aux Supply Normal	D	Bty Normal X.XV	D
Aux Supply Fail		Bty Off X.XV	
		Bty Low Volts X.XV	
		Bty Overvolt X.XV	
Switch Connected	D	Switch Data Valid	D
Switch Unplugged		Switch Data Invalid	

BUSHING LIVE/DEAD INDICATION

BUSHING LIVE/DEAD INDICATION				S
A1 Live or Ai Live	D	A2 Live or Ax Live		D
A1 Dead or Ai Dead		A2 Dead or Ax Dead		
B1 Live or Bi Live	D	B2 Live or Bx Live		D
B1 Dead or Bi Dead		B2 Dead or Bx Dead		
C1 Live or Ci Live	D	C2 Live or Cx Live		D
C1 Dead or Ci Dead		C2 Dead or Cx Dead		

PHASE VOLTAGE AND POWER FLOW

PHASE VOLTAGE and POWER FLOW				S
LIVE if > 2000V	P	Supply Timeout 4.0s		P
Power Signed	P	Source 1, Load 2 or Source i, Load x		P
Power Unsigned		Source 2, Load 1 Source x, Load i		
Display Ph/Ph Volt	P			
Display Ph/Earth (Gnd) Volt				

TERMINAL DESIGNATION/ROTATION

TERMINAL DESIGNATION				S
A Phase = Bushings U1 & U2		Phasing ABC		P
or		Phasing ACB		
		Phasing BAC		
		Phasing BCA		
A Phase = Bushings i & x		Phasing CAB		
		Phasing CBA		
B Phase = Bushings V1 & V2 or ii & xx				
C Phase = Bushings W1 & W2 or iii & xxx				

RADIO

RADIO				S
Radio Supply OFF	O	Radio Supply 12V		P
Radio Supply ON				
Radio Hold 60 min	P			

SWITCHGEAR TYPE AND RATINGS

SWITCHGEAR TYPE and RATINGS				S
	D	S/N 123456		D
12500A Interruption	D	Rated 27000 Volts		D
630A Continuous	D	Ops 0081		D

SWITCHGEAR WEAR/GENERAL DETAILS

SWITCHGEAR WEAR/GENERAL DETAILS				S
U Contact 75.6%	D	Cubicle S/N 1234		D
V Contact 75.6%	D	App. Ver A42-00.00		D
W Contact 74.5%	D			

System Status Pages (cont)

PLANT DETAILS

PLANT DETAILS			S
This field will contain the plant details text which was entered in the Plant Details field of the Controller Status page in WSOS5.			D

OPTIONS PROTECTION 1

Options - Protection 1				S
Prot OFF Allowed	P	SEF (SGF) Available		
Prot OFF Not Allowed		SEF (SGF) Not Avail		
E/F OFF Allowed	P	Seq Comp Available		
E/F OFF Not Allowed		Seq Comp Not Avail		
NPS OFF Allowed	P	Rst Curves Available		
NPS OFF Not Allowed		Rst Curves Not Avail		

OPTIONS PROTECTION 2

OPTIONS - PROTECTION 2				S
Automation OFF	P	UOF Available		P
Loop Auto Available		UOF Not Avail		
APGS Available	P	UOV Available		P
APGS Not Avail		UOV Not Avail		
	P			

OPTIONS CONTROLLER 1

OPTIONS - CONTROLLER 1				S
Batt Test Available	P	Config QK Available		P
Batt Test Not Avail		Config QK Not Avail		
IOEX Available	P	Gas Interlock ON		P
IOEX Not Avail		Gas Interlock OFF		
Aux Panel Available	P	Details Available		P
Aux Panel Not Avail		Details Not Avail		

OPTIONS CONTROLLER 2

OPTIONS - CONTROLLER 2				S
Aux Evts ON	P			
Aux Evts OFF				
	P			
	P			

OPTIONS COMMUNICATIONS 1

OPTIONS - COMMUNICATIONS 1				S
SOS Available	P	DNP3 Available		P
SOS Not Available		DNP3 Not Available		
MITS Available	P			P
MITS Not Available				

OPTIONS COMMUNICATIONS 2

OPTIONS - COMMUNICATIONS 2				S
Trace Available	P	RDI Not Available		P
Trace Not Available		RDI Available		
Hayes Available	P	IP Not Avail		P
Hayes Not Avail		IP Available		
SOS Multi Available	P			
SOS Multi Not Avail				

OPTIONS POWER QUALITY

OPTIONS -POWER QUALITY				S
SOM Available	P	Wave Capt Available		P
SOM Not Available		Wave Capt Not Avail		
Harmonics Available	P	Sag/Swell Available		P
Harmonics Not Avail		Sag/Swell Not Avail		

QUICK KEY SELECTION

QUICK KEY SELECTION				S
Text Description of QK1	P	Text Description of QK3		P
Text Description of QK2	P	Text Description of QK4		P

IOEX STATUS

IOEX STATUS				S
Inputs 1-----8	D			
Outputs 1-----8	D	IOEX OK		D
		Invalid Map		
		Initialising		
		Unplugged		
		Wrong Type		
ADVC Standard ACR IOEX Map				D

HIT AND RUN

HIT AND RUN				S
Hit/Run Close OFF	P	Hit/Run Trip OFF		P
Hit/Run Close 10s.....120s		Hit/Run Trip 10s.....120s		

WAVEFORM CAPTURE

WAVEFORM CAPTURE				S
Wave Capture OFF	P	Wcap Window 0.5s		P
Wave Capture ON		Wcap Window1s		
		Wcap Window2s		

System Status Pages (cont)

WAVEFORM CAPTURE			S
Wcap Ratio 0/100	P	Capture Now ON	D
Wcap Ratio 10/90		Capture Now OFF	
Wcap Ratio 20/80			
Wcap Ratio 30/70			
Wcap Ratio 40/60			
Wcap Ratio 50/50			
Wcap Ratio 60/40			
Wcap Ratio 70/30			
Wcap Ratio 80/20 Wcap Ratio 90/10			

WAVEFORM TRIGGER

WAVEFORM TRIGGER			S
Prot Trip	O	Prot Trip	O
Manual Trip		Manual Trip	
Manual Close		Manual Close	
Auto Close		Auto Close	
Harmonics		Harmonics	
- blank -		- blank -	
Prot Trip	O	Prot Trip	O
Manual Trip		Manual Trip	
Manual Close		Manual Close	
Auto Close		Auto Close	
Harmonics		Harmonics	
- blank -		- blank -	
Prot Trip	O	Prot Trip	)
Manual Trip		Manual Trip	
Manual Close		Manual Close	
Auto Close		Auto Close	
Harmonics		Harmonics	
- blank -		- blank -	

BATTERY TEST

BATTERY TEST			S
Test Status OFF	P	Test OFF, Ready	P
Test Status AUTO		Test START	
		Test ABORT	
Auto Test DISABLED	P	Test Time 00.00	P
Auto Test 24 hr			
Capacity UNKNOWN	D	7.2Ah Battery	P
Capacity OK		12Ah Battery	
Capacity NOT OK			

Appendix K

Measurement pages

This appendix shows the Measurement Group of pages on the Operator Interface display. "Appendix J System Status pages (page J-1)" explains the format of this appendix.

See "11 Power Systems Measurement (page 11-1)" for more information on measurement functionality.

SYSTEM MEASUREMENTS

SYSTEM MEASUREMENTS				M
Current	D	Power P	2479 kW	D
Voltage		Power Q	200 kVAR	D
Frequency 50.0 Hz		P F	0.93	D

CURRENT

CURRENT						M
A Phase	0A	0°	Gnd	0A	0°	D
B Phase	0A	0°	lpps	0A	0°	D
C Phase	0A	0°	Inps	0A	0°	D

VOLTAGE

SOURCE	VOLTAGE	LOAD	M
< 2000 Volt	A-G	< 2000 Volt	D
< 2000 Volt	B-G	< 2000 Volt	D
< 2000 Volt	C-G	< 2000 Volt	D

SEQUENCE VOLTAGE

SEQUENCE VOLTAGE		M
Vzps xxxxx Volt		D
Vpps xxxxx Volt		D
Vnps xxxxx Volt		D

POWER

SOURCE	VOLTAGE		LOAD	M
A P	0 kW	Q	0 kVARPF 0.00	D
B P	0 kW	Q	0 kVARPF 0.00	D
C P	0 kW	Q	0 kVARPF 0.00	D

SUPPLY OUTAGES

SUPPLY OUTAGES				M
Measure Outages OFF	P	Outage Duration 60 s		P
Measure Outages ON				
Source outages	2	R	Duration Unavailable 4h14m56s	R
Load outages	3	R	Duration Unavailable 6h23m24s	R

DAILY MAXIMUM DEMAND

DAILY MAXIMUM DEMAND			M
day name	Total	7565 kWh	D
dd/mm/yyyy	max at		D
	of		D

WEEKLY MAXIMUM DEMAND

WEEKLY MAXIMUM DEMAND				M
Week ending	10 / 01 / 2001	total	7565 kWh	D
Peak period	07 / 01 / 2001	17:15:00		D
Peak demand	31141 kW	0.93 PF		D

MONTHLY MAXIMUM DEMAND

MONTHLY MAXIMUM DEMAND				M
Jan/2001		total	28865 kWh	D
Peak period	07 / 01 / 2001	17:15:00		D
Peak demand	31141 kW	0.93 PF		D

MAXIMUM DEMAND INDICATOR

MAXIMUM DEMAND INDICATOR				M
A	0A Max 0A	01/01 00:00:00:00		R
B	0A Max 0A	01/01 00:00:00:00		R
C	0A Max 0A	01/01 00:00:00:00		R

RESET MAXIMUM DEMAND INDICATOR

RESET MAXIMUM DEMAND INDICATOR M				M
Press the key again to reset the flags. Press the Menu key to cancel.				

SOURCE SIDE VOLTAGES *When Source side is X and Load side is I.*

SOURCE SIDE VOLTAGES ^a				M
Ax – Bx phase to phase Unavailable ^a				D
Bx – Cx phase to phase Unavailable ^a				D
Cx – Ax phase to phase Unavailable ^a				D

a. Standard U-Series without external CVTs.

LOAD SIDE VOLTAGES *When Source side is X and Load side is I.*

LOAD SIDE VOLTAGES				M
Ai – Bi phase to phase 22000 Volt				D
Bi – Ci phase to phase 22000 Volt				D
Ci – Ai phase to phase 22000 Volt				D

SAG/SWELL MONITORING

SAG/SWELL MONITORING				M
Nom P-E V 6.300kV				P
Range: 2.0 to 25.0kV				
Factory Default: 6.3kV				
Fault Reset 50ms				P
Range: 0 to 10sec				
Factory Default: 50ms				
Definite Time				P
Range: Definite Time, ITIC, User curve 1 to 5				
Factory Default: Definite Time				

Measurement Pages (cont)

SAG MONITORING		M
Sag Monitor OFF		P
Sag Monitor ON		
Pickup Volt		P
Range: 0.5pu to 0.99pu ^a		
Factory Default: 0.9pu		

a. per unit. Used for voltage description in relative terms based on a nominal system voltage.

SWELL MONITORING		M
Swell Monitor OFF		P
Swell Monitor ON		
Pickup Volt		P
Range: 1.01pu to 2.0pu		
Factory Default: 1.1pu		

Appendix L

Fault Detection pages

This appendix shows all the Detection Group of pages on the Operator Interface display.

DETECTION SETTINGS .

DETECTION SETTINGS 1 (A – J)			D
Group A – J Displayed	P	Copy OFF Copy from # to A Copy from # to B Copy from # to C Copy from # to D Copy from # to E Copy from # to F Copy from # to G Copy from # to H Copy from # to I Copy from # to J Copy from # to ALL (except #) ^a Copy # Incomplete ^b Copy ALL Incomplete	P
Seq Reset Time 30 s	P	Trip on count 1 Trip on count 2 Trip on count 3 Trip on count 4	P

a. Use the select key to scroll through these options. When either the ENTER or MENU key is pressed, the copy is performed and the field defaults to the "Copy OFF" display

b. Advises failure of the copy feature.

DETECTION SETTINGS 2 (A – J)			D
Phase Fault 200 Amp	P	Definite Time 0.05 s	P
Phase Fault OFF			
Earth Fault Earth 40 Amp	P	Definite Time 0.05 s	P
Fault OFF			
SEF Fault 4 Amp	P	Definite Time 5.00 s	P
SEF Fault OFF			

DETECTION SETTINGS 3 (A – J)			D
Flt Reset Time 50ms	P	Live Load Block OFF Live Load Block ON	P

DETECTION SETTINGS 4 (A – J)			D
Inrush OFF	P	Cold Load OFF	P
Inrush ON		Cold Load ON	
Inrush Time 0.10s	P	Cold Load Time 120m	P
Inrush Mult x 4.0	P	Cold Load Mult x 2.0	P

Appendix M

Protection pages

This appendix shows all the Protection Group pages on the Operator Interface display. "**Appendix J System Status pages** (page **J-1**)" explains the format of this appendix. See "**9 Recloser Protection Features** (page **9-1**)" for more information on protection operation.

PROTECTION SETTING 1 (A-J)

PROTECTION SETTING 1 (A – J)			P
Group A – J Displayed	P	Copy OFF ^a Copy from # to A Copy from # to B Copy from # to C Copy from # to D Copy from # to E Copy from # to F Copy from # to G Copy from # to H Copy from # to I Copy from # to J Copy from # to ALL (except #) Copy # Incomplete ^b Copy ALL Incomplete	P
Phase Set 200 Amp	P	Earth Set 10 Amp	P
Phase Pickup 1.0x	P	Earth Pickup 1.0x	P

a. Use SELECT key to scroll through the options. When either the MENU or ENTER key is pressed, the copy is performed and the field defaults to the "Copy OFF" display.

b. Advises failure of the copy system.

PROTECTION SETTING 2 (A-J)

PROTECTION SETTING 2 (A – J)			P
NPS Set 40 Amp	P	Seq Reset Time 30s	P
NPS Pickup 1.0x	P	Flt Reset Time 50ms	P
NPS Trips Lockout 1	P	SS Reset Time 1s	P

PROTECTION SETTING 3 (A-J)

PROTECTION SETTING 3 (A – J)			P
SEF Trip 4 Amp	P	Live Load Block OFF ^a Live Load Block ON	P
SEF Trips to Lockout 1	P	Maximum Time OFF Maximum Time 2.0s	P
Trips to Lockout 4	P	Sequence Control OFF Sequence Control ON	P

a. In order for this function to work correctly, the unit must be programmed with the correct Power Flow direction

PROTECTION SETTING 4 (A-J)

PROTECTION SETTING 4 (A – J)			P
Phase Reset 90% ^a	P	Start at Rst Thresh ^b Start at Pickup	P
Ground/Earth Reset 90% ^a	P		
NPS Reset 90% ^a	P		

a. If Reset Curves is enabled the range will be 10 -100. If Reset Curves is not enabled, the range will be 90 - 100.

b. This setting will only become available/visible if Reset Curves is enabled.

PROTECTION SETTING 5 (A-J)

PROTECTION SETTING 5 (A – J)			P
High Lockout OFF	P	Loss Phase Prot OFF	P
High Lockout ON		Loss Phase Prot ON	
		Loss Phase Prot Alm	
High Lockout 5000A	P	Phase Lost @ 10000V	P
Activation Trip 1	P	Phase Lost 10.0s	P
Activation Trip 2			
Activation Trip 3 A			
Activation Trip 4			

PROTECTION SETTING 6 (A-J)

PROTECTION SETTING 6 (A – J)			P
Inrush OFF	P	Cold Load OFF	P
Inrush ON		Cold Load ON	
Inrush Time 0.10s	P	Cold Load Time 120m	P
Inrush Mult x 4.0	P	Cold Load Mult x 2.0	P

DIRECTIONAL BLOCKING 1

DIRECTIONAL BLOCKING 1 ^a			P
Phase: Trip Fwd&Rev	P	Low V Block OFF	P
Phase: Trip Rev		Low V Block ON	
Phase: Trip Fwd			
Earth: Trip Fwd&Rev	P	Low Vo Block OFF	P
Earth: Trip Rev		Low Vo Block ON	
Earth: Trip Fwd			
SEF: Trip Fwd&Rev	P	Low Vo Block OFF	P
SEF: Trip Rev		Low Vo Block ON	
SEF: Trip Fwd			

a. The Directional Blocking pages are not displayed if {SYSTEM STATUS – OPTIONS 2: DIRB Not Available} IS SET.

Protection Pages (cont)

DIRECTIONAL BLOCKING 2

The description of the fields shown in the display page 2A are shown below. Both fields are Password Protected.

Field	Description
Phase Characteristic Angle 45 Deg	Sets the characteristic angle for phase trip blocking. <i>Default is 45 deg</i>
Earth Characteristic Angle -180 Deg	Sets the characteristic angle for earth trip blocking. <i>Default is -180 deg</i>
Phase: Trip Fwd Phase: Trip Rev Phase: Trip Fwd&Rev	Controls the tripping direction for Phase protection. <i>Default is Phase: Trip Fwd&Rev</i>
Earth: Trip Fwd Earth: Trip Rev Earth: Trip Fwd&Rev	Controls the tripping direction for Earth protection. <i>Default is Earth: Trip Fwd&Rev</i>
SEF: Trip Fwd SEF: Trip Rev S EF: Trip Fwd&Rev	Controls the tripping direction for SEF protection. <i>Default is SEF: Trip Fwd&Rev</i>
Phase: Low V Block OFF Phase: Low V Block ON	This field determines the action that will occur when the polarising phase/earth voltage is below 500V. When set to Low V Block ON all phase overcurrent trips will be blocked if the line-earth voltage is below 500 V on all three phases. If Low V Block OFF is set then the phase overcurrent faults will trip irrespective of direction if the line-earth voltage on all three phases is below 500 V. <i>Default is Phase: Low V Block OFF</i>
Earth: Low Vo Block OFF Earth: Low Vo Block ON	This field determines the action that will occur when the polarising residual voltage Vo voltage is less than the user-set minimum Vo. When set to Low Vo Block ON all Earth overcurrent trips will be blocked if the residual voltage is less than the user-set minimum Vo. If Low Vo Block OFF is set then the Earth overcurrent faults will trip irrespective of direction if the residual voltage is less than the user-set minimum. <i>Default is Earth: Low Vo Block OFF</i>
SEF: Low Vo Block OFF SEF: Low Vo Block ON	This field determines the action that will occur when the polarising residual voltage Vo voltage is less than the user-set minimum Vo. When set to Low Vo Block ON all SEF overcurrent trips will be blocked if the residual voltage is less than the user-set minimum Vo. If Low Vo Block OFF is set then the SEF overcurrent faults will trip irrespective of direction if the residual voltage is less than the user-set minimum. <i>Default is SEF: Low Vo Block OFF</i>

DIRECTIONAL BLOCKING 2 ^a	P
Phase Characteristic Angle 45 Deg	P
Earth Characteristic Angle -180 Deg	P

a. The Directional Blocking pages are not displayed if {SYSTEM STATUS – OPTIONS 2: DIRB Not Available} IS SET.

DIRECTIONAL BLOCKING 3

Field	Description ^a
Nom P-E Volts 6.3kV	Sets the nominal system phase to earth voltage. This is used to calculate the Vo% thresholds. <i>Default is 6.3kV</i>
VZPS Balance ENABLED VZPS Balance DISABLED VZPS Balance Paused VZPS Balancing	Shows the status of the residual voltage dynamic balancing process, and allows the operator to enable or disable residual voltage balancing. "VZPS Balance Disabled" means that balancing is OFF. "VZPS Balance Paused" means no balancing is taking place. "VZPS Balancing" means that phase balancing is taking place (up to 20% of Nom P-E Volts). <i>Default is disabled</i>
Min Earth Vo	This field allows the user to set the Low Vo level. This level is specified as a percentage of the nominal system phase to Earth voltage. <i>Default and minimum value is 5%</i>
Min SEF Vo	This field allows the user to set the Low Vo level. This level is specified as a percentage of the nominal system phase to Earth voltage. <i>Default and minimum value is 5%</i>
High Vo Alarm DISABLED High Vo Alarm 5s	Controls the High Vo alarm. Setting a time enables the alarm. Setting disable, disables the alarm. <i>Default is DISABLED</i>
High Vo Alarm OFF High Vo Alarm ON	This is display indication of the High Vo alarm status

^a. Different default values may be factory loaded.

DIRECTIONAL BLOCKING 3 ^a			P
Nom P-E Volts 6.3kV	P	Vo Balance DISABLED	P
		Vo Balance ENABLED	P
		Vo Balance Paused	D
		Vo Balancing	D
Min Earth Vo 20%	P	Min SEF Vo 5%	P
High Vo DISABLED	P	High Vo Alarm OFF	D
High Vo 5s		High Vo Alarm ON	

^a. The Directional Blocking pages are not displayed if {SYSTEM STATUS – OPTIONS 2: DIRB Not Available} IS SET.

UNDER/OVER FREQUENCY PROTECTION 1

UNDER / OVER FREQUENCY PROTECTION 1 (A - J)				P
UF Trip OFF	P	OF Trip	OFF	P
UF Trip ON		OF Trip	ON	
UF Trip at 49.0Hz	P	After	4 cycles	P
OF Trip at 52.0Hz	P	After	50 cycles	P

Protection Pages (cont)

UNDER/OVER FREQUENCY PROTECTION 2

UNDER / OVER FREQUENCY PROTECTION 2 (A - J)					P
UF Normal	49.5Hz	P	OF Normal	50.5Hz	P
Low V Inhibit	5000V	P			
Normal Freq Close OFF			After 60 secs		P
Normal Freq Close ON			This display only appears if the Normal Frequency Close is ON.		

PHASE PROTECTION TRIP

PHASE PROTECTION TRIP NUMBER 1, 2, 3, 4 (A – J)				P
IEC255 Curves (1, 2 or 3)	P	Time Multiplier 1.00		P
Definite Time		1.00s		
Instantaneous Only				
IEEE Curves (1, 2 or 3)		Time Multiplier 1.00		
User Defined Curve (1, 2, 3, 4 or 5)		Time Multiplier 1.00		
User Defined Curves Not Set				
Additional Curve Selection ^a				
No Instantaneous	P	Reclose Time 1.0s		P
Instant Mult x 1.0		Reclose time not available on trip 4		
Minimum 0.00s	P	Additional 0.00s		P

a. See Appendices for the available curves.

PHASE RESET TRIP NUMBER 1, 2, 3, 4 (A – J)				P
Instantaneous,	P	0.05s Definite		P
Definite Time,		(Range 0ms - 999sec)		
Mod Inv IEEE,				
Very Inv IEEE,				
Ext Inv IEEE.				

PHASE SINGLE SHOT PROTECTION TRIP

PHASE SINGLE SHOT PROTECTION TRIP (A – J)				P
IEC255 Curves (1, 2 or 3)	P	Time Multiplier 1.00		P
Definite Time		1.00s		
Instantaneous Only				
IEEE Curves (1, 2 or 3)		Time Multiplier 1.00		
User Defined Curve (1, 2, 3, 4 or 5)		Time Multiplier 1.00		
User Defined Curves Not Set				
Additional Curve Selection ^a				
No Instantaneous Instant Mult x 1.0	P			
Minimum 0.00s	P	Additional 0.00s		P

a. See Appendices for the available curves.

PHASE WORK TAG PROTECTION TRIP

PHASE WORK TAG PROTECTION TRIP (A – J)			P
IEC255 Curves (1, 2 or 3)	P	Time Multiplier 1.00	P
Definite Time		1.00s	
Instantaneous Only			
IEEE Curves (1, 2 or 3)		Time Multiplier 1.00	
User Defined Curve (1, 2, 3, 4 or 5)		Time Multiplier 1.00	
User Defined Curves Not Set			
Additional Curve Selection ^a			
No Instantaneous	P		
Instant Mult x 1.0			
Minimum 0.00s	P	Additional 0.00s	P

a. See Appendices for the available curves.

EARTH PROTECTION TRIP

EARTH PROTECTION TRIP NUMBER 1, 2, 3, 4 (A – J)			P
IEC255 Curves (1, 2 or 3)	P	Time Multiplier 1.00	P
Definite Time		1.00s	
Instantaneous Only			
IEEE Curves (1, 2 or 3)		Time Multiplier 1.00	
User Defined Curve (1, 2, 3, 4 or 5)		Time Multiplier 1.00	
User Defined Curves Not Set			
Additional Curve Selection ^a			
No Instantaneous	P	SEF Definite 5.0s	P
Instant Mult x 1.0			
Minimum 0.00s	P	Additional 0.00s	P

a. See Appendices A, B and C, for the available curves.

EARTH RESET TRIP NUMBER 1, 2, 3, 4 (A – J)			P
Instantaneous, Definite Time, Mod Inv IEEE, Very Inv IEEE, Ext Inv IEEE.	P	0.05s Definite (Range 0ms - 999sec)	P
	P	SEF 0.05s Definite (Range 0ms - 999sec)	

Protection Pages (cont)

EARTH SINGLE SHOT PROTECTION TRIP

EARTH SINGLE SHOT PROTECTION TRIP (A – J)			P
IEC255 Curves (1, 2 or 3)	P	Time Multiplier 1.00	P
Definite Time		1.00s	
Instantaneous Only			
IEEE Curves (1, 2 or 3)		Time Multiplier 1.00	
User Defined Curve (1, 2, 3, 4 or 5)		Time Multiplier 1.00	
User Defined Curves Not Set			
Additional Curve Selection ^a			
No Instantaneous	P	SEF Definite 5.0s	P
Instant Mult x 1.0			
Minimum 0.00s	P	Additional 0.00s	P

a. See Appendices for the available curves.

EARTH WORK TAG PROTECTION TRIP

EARTH WORK TAG PROTECTION TRIP (A – J)			P
IEC255 Curves (1, 2 or 3)	P	Time Multiplier 1.00	P
Definite Time		1.00s	
Instantaneous Only			
IEEE Curves (1, 2 or 3)		Time Multiplier 1.00	
User Defined Curve (1, 2, 3, 4 or 5)		Time Multiplier 1.00	
User Defined Curves Not Set			
Additional Curve Selection ^a			
No Instantaneous Instant Mult x 1.0	P	SEF Definite 5.0s	P
Minimum 0.00s	P	Additional 0.00s	P

a. See Appendices for the available curves.

NPS PROTECTION TRIP

NPS PROTECTION TRIP NUMBER 1, 2, 3, 4 (A – J)			P
IEC255 Curves (1, 2 or 3)	P	Time Multiplier 1.00	P
Definite Time		1.00s	
Instantaneous Only			
IEEE Curves (1, 2 or 3)		Time Multiplier 1.00	
User Defined Curve (1, 2, 3, 4 or 5)		Time Multiplier 1.00	
User Defined Curves Not Set			
Additional Curve Selection ^a			
No Instantaneous	P	Reclose Time 0.00s	
Instant Mult x 1.0			
Minimum 0.00s	P	Additional 0.00s	P

a. See Appendices A, B and C, for the available curves.

NPS RESET TRIP NUMBER 1, 2, 3, 4 (A – J)			P
Instantaneous,	P	0.05s Definite	P
Definite Time,		(Range 0ms - 999sec)	
Mod Inv IEEE,			
Very Inv IEEE,			
Ext Inv IEEE.			

NPS SINGLE SHOT PROTECTION TRIP

NPS SINGLE SHOT PROTECTION TRIP (A-J)			P
IEC255 Curves (1, 2 or 3)	P	Time Multiplier 1.00	P
Definite Time		1.00s	
Instantaneous Only			
IEEE Curves (1, 2 or 3)		Time Multiplier 1.00	
User Defined Curve (1, 2, 3, 4 or 5)		Time Multiplier 1.00	
User Defined Curves Not Set			
Additional Curve Selection ^a			
No Instantaneous	P		
Instant Mult x 1.0			
Minimum 0.00s	P	Additional 0.00s	P

a. See Appendices A, B and C, for the available curves.

NPS WORK TAG PROTECTION TRIP

NPS WORK TAG PROTECTION TRIP (A-J)			P
IEC255 Curves (1, 2 or 3)	P	Time Multiplier 1.00	P
Definite Time		1.00s	
Instantaneous Only			
IEEE Curves (1, 2 or 3)		Time Multiplier 1.00	
User Defined Curve (1, 2, 3, 4 or 5)		Time Multiplier 1.00	
User Defined Curves Not Set			
Additional Curve Selection ^a			
No Instantaneous	P		
Instant Mult x 1.0			
Minimum 0.00s	P	Additional 0.00s	P

a. See Appendices D, E and F, for the available curves.

Appendix N List of Events

Each event falls into one or more categories as shown in the Category column of the main table below. The categories are described as follows:

Category	Abbreviation	Description
Protection	PRTN	A general grouping of all protection related events.
Controller	CTRL	A general grouping of all controller hardware related events.
Switchgear	SWGR	All messages from Switchgear.
Network	NWRK	A general grouping of all electrical system events.
Power Quality	PQ	All quality of supply messages.
Windows Switchgear Operating System 5	WSOS	All setting changes with source WSOS5 are shown.
Operator Interface	O.I.	All setting changes with source O.I. are shown.
Protocol	PTCL	All setting changes and system status messages that are SCADA protocol related are shown.
Input/Output Expander 2	IOEX	All setting changes and system status messages that are IOEX2 related are shown.
Settings		All setting changes with source WSOS, Panel, Protocol or IOEX are shown.

Event Text	Description	Switchgear	Category
- blank -	Quick Key function or Waveform Capture Trigger Setting. See “ Waveform Capture ” (page 12-4).	C N R L U V	CTRL PQ
## Contact < 20%	Amount of Contact Life remaining is low. Less than 20%.	N R L M 2 U	SWGR
## Dead	A terminal changed from live to dead.	C N R L U V	NWRK
## Live	A terminal changed from dead to live.	C N R L U V	NWRK
### Voltage High	The Voltage on this phase has exceeded the Normal Voltage High threshold.	N U R L V C	PRTN
### Voltage Low	The Voltage on this phase has gone below the Normal Voltage Low threshold.	N U R L V C	PRTN
### Voltage Normal	The Voltage on this phase has returned to the normal range.	N U R L V C	PRTN
101/4 Available/Not Available	IEC 60870-5-101/4 protocol available/not available. Please refer to manufacturers technical manual for ADV C. Part No. ADV C01-DOC-246	N U R L V C	PTCL
12Ah Battery	Battery capacity was configured as 12 AmpHour.	N U R L V C	CTRL
12V Rail Failure	12V supply rail failed.	C N R L U V	CTRL SWGR
A Max #####pu	Phase A Maximum Voltage NNpu	N U R L V C	PRTN
A Min #####pu	Phase A Minimum Voltage NNpu	N U R L V C	PRTN
A/B/C ### Amp	The phase and current of the maximum demand. See “ Daily, Weekly, Monthly Demand ” (page 11-1).	N U R L V C	PRTN
A/B/C dd/mm/yy hh:mm:ss	The time and phase of the maximum demand. See “ Daily, Weekly, Monthly Demand ” (page 11-1).	N U R L V C	PRTN
A/B/C Max NN Amp	Following pickup of the overcurrent protection element on A, B or C phase, the maximum fault current recorded was NN Amps. This event was logged only after the current fell back below the phase setting current. See “ Protection Elements ” (page 9-17).	N U R L V C	PRTN
A/B/C Phase LOST	Loss of supply occurred on this phase.	N U V C	PRTN
A/B/C/E/NPS ## Amp	Current measured at time of trip. See “ Current Operated Protection Elements ” (page 9-18).	N U R L V C	PRTN
ABC Max #####pu	Average Phase ABC Maximum Voltage NNpu	N U R L V C	PRTN
ABC Min #####pu	Average Phase ABC Minimum Voltage NNpu	N U R L V C	PRTN
ACK2 ON/OFF	On/Off for Radio Data Interface (RDI) acknowledgement at remote radio.	N U R L V C	PTCL
ACR Function	Switchgear is setup to function as an ACR	N U R L V C	CTRL

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Event Text	Description	Switchgear	Category
Additional #####s	Additional time to trip in seconds. Added to the associated protection curve.	N U R L V C	PRTN
Addr Mode Extended	MITS protocol addressing mode is extended. Valid address range is 1 to 32767.	N U R L V C	PTCL
Addr Mode Normal	MITS protocol addressing mode is normal. Valid address range is 1 to 126.	N U R L V C	PTCL
Address #####	SOS Multidrop address of the ADVC was set. Valid range 1 to 2147483647.	N U R L V C	PTCL
Advload Reset	WSOS5's ADVC Loader reset the controller. See " 15 Windows Switchgear Operating System (page 15-1)".	N U R L V C	CTRL
After ## sequences	Excess Voltage Trip/Close sequences will occur after this number of sequences.	N U V C	PRTN
After ##### O/F cyc	An over frequency protection trip would occur after this number of frequency cycles. See " Under and Over Frequency Protection Elements (page 9-33)".	N U R L V C	PRTN
After ##### U/F cyc	An under frequency protection trip would occur after this number of frequency cycles. See " Under and Over Frequency Protection Elements (page 9-33)".	N U R L V C	PRTN
All Paused	All picked up protection elements were paused. See " Protection Operation (page 9-9)".	N U R L V C	PRTN
All Paused Fwd/Rev	All picked up protection elements in this direction had paused. See " Directional Protection (page 9-22)".	N U R L V C	PRTN
All Resetting	All picked up protection elements were resetting. See " Protection Operation (page 9-9)".	N U R L V C	PRTN
All Resetting Fwd/Rev	All picked up protection elements in this direction were resetting. See " Directional Protection (page 9-22)".	N U R L V C	PRTN
Analog Flag ON/OFF	For DNP3, determines whether or not a byte containing the status of the analog was included with the reported value. See " 13 Communications (page 13-1)".	N U R L V C	PTCL
Analog Size 16/32 bit	For DNP3, determines the size of the default analog objects. See " 13 Communications (page 13-1)".	N U R L V C	PTCL
Analog Time ON/OFF	For DNP3, determines whether or not a time tag was included with analog change of state events. See " 13 Communications (page 13-1)".	N U R L V C	PTCL
APGS Change ###s	Automatic protection group selection change time. See " Protection Operation (page 9-9)".	N U R L V C	PRTN
APGS Not/Available	Automatic protection group selection feature not available or available. See " Protection Operation (page 9-9)".	N U R L V C	PRTN
APGS ON/OFF	Automatic protection group selection ON or OFF. See " Protection Operation (page 9-9)".	N U R L V C	PRTN
Apl Cf TO #####ms	For DNP3, determines the application confirm timeout. See " 13 Communications (page 13-1)".	N U R L V C	PTCL
Apl Frag Size ####	For DNP3, determines the maximum size of the application layer fragment that can be sent at any one time. See " 13 Communications (page 13-1)".	N U R L V C	PTCL
App. Ver #####	Controller software version number. See " Software Identification System (page 2-1)".	N U R L V C	CTRL
Attempt Delay #####s	RS232 port's Hayes modem driver delay before next connection attempt. See " Hayes compatible modem support (page 13-6)".	N U R L V C	PTCL
Auto Close	Waveform Capture Trigger On Auto Close. See " Waveform Capture (page 12-4)".	N U R L V C	PQ
Auto Close OFF	Waveform Capture Trigger On Auto Close turned off. See " Waveform Capture (page 12-4)".	N U R L V C	PQ
Auto ON/OFF	Automatic Reclose ON/OFF selected for a Quick Key. See " Quick Key Configuration (page 16-9)".	N U R L V C	CTRL
Auto Reclose OFF	Auto Reclose was turned OFF by a local or remote operator. See " Auto - Reclose Settings/Specifications (page 9-6)".	N U R L V C	PRTN
Auto Reclose ON	Auto Reclose was turned ON by a local or remote operator. See " Auto - Reclose Settings/Specifications (page 9-6)".	N U R L V C	PRTN

List of Events (cont)

Event Text	Description	Switchgear	Category
Auto Restore #####s	Directional protection automatic restore time. See “ Directional Protection (page 9-22)”	N U R L V C	PRTN
Auto Test ##	Automatic battery test frequency. See “ 18 Battery Testing (page 18-1)”	N U R L V C	CTRL
Automatic Reclose	The circuit breaker was automatically re-closed following a protection trip. See “ Auto - Reclose Settings/Specifications (page 9-6)”.	N U R L V C	PRTN
AutoRes. Not Avail	For loop automation, automatic restore feature not made an available option. See “ 14 Automation (page 14-1)”.	N U R L V C	PRTN
AutoRestore Avail	For loop automation, automatic restore feature made an available option. See “ 14 Automation (page 14-1)”	N U R L V C	PRTN
AutoRestore ON/OFF	For loop automation or directional protection, automatic restoration of supply was ON or OFF. See “ Directional Protection (page 9-22)”	N U R L V C	PRTN
Aux Fail	Batt Test Aborted because of Aux Fail	N U R L V C	CTRL
Aux Supply Fail	The auxiliary power supply failed. See “ Auxiliary Power Source (page 5-1)”	N U R L V C	CTRL
Aux Supply Normal	The auxiliary power supply became normal. See “ Auxiliary Power Source (page 5-1)”	N U R L V C	CTRL
Aux Supply Overvolt	The auxiliary power supply exceeded its threshold voltage. See “ Auxiliary Power Source (page 5-1)”	N U R L V C	CTRL
B Max #####pu	Phase B Maximum Voltage NNpu	N U R L V C	PRTN
B Min #####pu	Phase B Minimum Voltage NNpu	N U R L V C	PRTN
Batt Test Not/Avail	Battery test feature not available or available. See “ 18 Battery Testing (page 18-1)”	N U R L V C	CTRL
Battery High	The battery voltage was too high. This could only occur if there was a battery charger hardware failure. If this event occurs the equipment may require maintenance. Contact the Manufacturer or Distributor for advice. See “ 18 Battery Testing (page 18-1)”.	N U R L V C	CTRL
Battery Low	The battery voltage was below the low battery voltage setting. This can also be a reason for an operation denied. See “ 18 Battery Testing (page 18-1)”	C N R L U V	CTRL SWGR
Battery NA	Batt Test Aborted because of Batt N/A	N U R L V C	CTRL
Battery Normal	The battery was in the normal range. See “ 18 Battery Testing (page 18-1)”.	N U R L V C	CTRL
Battery OFF	The battery was not connected. See “ 18 Battery Testing (page 18-1)”.	C N R L U V	CTRL
Battery Unavailable	Ignore. Invalid state.	C N R L U V	CTRL SWGR
Baud #####	Port baud rate changed. See “ Port Details RS232 (page 13-1)”.	N U R L V C	PTCL
Beg #####V	Battery test has not yet been performed so battery capacity is unknown.	N U R L V C	CTRL SYS
Binary Output ON/OFF	For DNP3, determines whether binary outputs are included in an integrity poll. See “ 13 Communications (page 13-1)”.	N U R L V C	PTCL
Binary Time ON/OFF	For DNP3, determines whether or not a time tag was included for change of state events. See “ 13 Communications (page 13-1)”.	N U R L V C	PTCL
Busy (Don't) Ignore	Whether to use the V23 Busy signal for Tx/Rx messages. See “ Configuring V23 FSK Port Settings (page 13-9)”.	N U R L V C	PTCL
C Max #####pu	Phase C Maximum Voltage NNpu	N U R L V C	PRTN
C Min #####pu	Phase C Minimum Voltage NNpu	N U R L V C	PRTN
C# Delay #####s	For DNP3, maximum class notification delay in seconds an event was held before an unsolicited response was triggered. See “ 13 Communications (page 13-1)”.	N U R L V C	PTCL
C# Max Count #	For DNP3, unsolicited response class notification maximum count that must have occurred before an unsolicited response message was triggered. See “ 13 Communications (page 13-1)”.	N U R L V C	PTCL
CA Delay #####ms	Port transmit collision avoidance delay. See “ 13 Communications (page 13-1)”.	N U R L V C	PTCL

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Event Text	Description	Switchgear	Category
Cap Charge status	Logged if a trip/close request was denied due to a capacitor inverter problem. Where status was the current status of the inverter, for example "Cap Charge Resting". Refer to the "Maintenance" chapter of the manufacturer's ACR Installation and Maintenance Guide, supplied with the equipment.	N U	CTRL SWGR
Cap Charging	Warning that the capacitor was charging. Unable to be used in an operation. Refer to the "Maintenance" chapter of the manufacturer's ACR Installation and Maintenance Guide, supplied with the equipment.	N U	CTRL SWGR
Cap failure mode	Trip and/or close capacitors did not charge correctly. Where failure mode, was the cause of the failure. For example, "CAP Excess Closes". Refer to the "Maintenance" chapter of the manufacturer's ACR Installation and Maintenance Guide, supplied with the equipment.	N U	CTRL SWGR
Cap Resting	Warning that inverter was resting from capacitor charging. This can occur after an excessive number of operations. Refer to the "Maintenance" chapter of the manufacturer's ACR Installation and Maintenance Guide, supplied with the equipment.	N U	CTRL
Capacity NOT/OK	The result of the battery test, whether or not the inferred capacity was satisfactory.	N U R L V C	CTRL
Capacity Unknown	Battery test has not yet been performed so battery capacity is unknown.	N U R L V C	CTRL
Capture Now ON/OFF	Waveform capture was set ON or OFF. See " Waveform Capture (page 12-4)".	N U R L V C	PQ
CD DISABLED	Transmission on V23 not blocked when carrier was detected. See " 13 Communications (page 13-1)".	N U R L V C	PTCL
CD ENABLED	Transmission on V23 blocked when carrier was detected. See " 13 Communications (page 13-1)".	N U R L V C	PTCL
CD if input HIGH	When CD input was HIGH then the V23 carrier detect was asserted. See " 13 Communications (page 13-1)".	N U R L V C	PTCL
CD if input LOW	When CD input was LOW then the V23 carrier detect was asserted. See " 13 Communications (page 13-1)".	N U R L V C	PTCL
CFG Hist Time ##	Configurable history sample time.	N U R L V C	CTRL
Char Angle ##### Deg	Characteristic angle in degrees between voltage and current. See " Directional Protection (page 9-22)".	N U R L V C	PRTN
Char Timeout ###ms	SOS Multidrop inter character timeout in milliseconds.	N U R L V C	PTCL
Close Block	Reason for a close operation being denied.	N U R L V C	SWGR CTRL
Close Blocking OFF	Close blocking was disabled. The circuit breaker would now close when requested. See " 5 Control Electronics Operation (page 5-1)".	N U R L V C	CTRL
Close Blocking ON	The circuit breaker was prevented from closing. See " 5 Control Electronics Operation (page 5-1)".	C N R L U V	CTRL
Close Coil Connect	The close solenoid isolate switch on the Operator Interface was changed to Enable position. See " 5 Control Electronics Operation (page 5-1)".	N U R L V C	SWGR
Close Coil Disconn	The Close solenoid isolate switch on the Operator Interface was changed to Isolate position. See " 5 Control Electronics Operation (page 5-1)".	C N R L U V	CTRL SWGR
Close Coil Failed		N U R L V C	SWGR
CLP Time ###min	User change to operational cold load time in minutes. See " Cold Load Pickup (CLP) (page 9-13)".	N U R L V C	PRTN
Cold Load	Quick Key configured for Cold Load option.	N U R L V C	CTRL
Cold Load Mult x###	User cold load multiplier value. See " Cold Load Pickup (CLP) (page 9-13)".	N U R L V C	PRTN
Cold Load ON/OFF	Cold load pickup was enabled or disabled. See " Cold Load Pickup (CLP) (page 9-13)".	N U R L V C	PRTN
Cold Load Time ###m	User set cold load time in minutes. See " Cold Load Pickup (CLP) (page 9-13)".	N U R L V C	PRTN
Common Addr ###		N U R L V C	PTCL
Common Addr Size ##		N U R L V C	PTCL
Config QK Not/Avail	Configurable quick key maps are available or not available.	N U R L V C	CTRL

List of Events (cont)

Event Text	Description	Switchgear	Category
COS Retries ###	MITs Protocol change of state(COS) retry setting. The maximum number of times a COS message will be tried.	N U R L V C	PTCL
COS Scan On/Off	MITs protocol change of state (COS) reporting was turned on or off. See “ 13 Communications (page 13-1)”.	N U R L V C	PTCL
COT Size #	IEC101 Cause Of Transmission field size in octets.	N U R L V C	PTCL
CTS Don't/Ignore	For a port with handshaking lines, whether to ignore or use the clear to send signal. See “ 13 Communications (page 13-1)”.	N U R L V C	PTCL
Cubicle S/N #####	Cubicle serial number.	N U R L V C	CTRL
Custom Menu Not/Avail	Expand Custom Menu avail See “ Custom Menu (page 16-7)”.	N U R L V C	CTRL
Cyclic Dly ###s		N U R L V C	PTCL
Data Type NORMAL		N U R L V C	PTCL
Data Type SCALED		N U R L V C	PTCL
Daylight Save #####hr	Amount of daylight saving to add or remove in hours.	N U R L V C	PTCL
DCB OPEN/CLOSED	Dummy circuit break open or closed. Used for SCADA testing. See “ 13 Communications (page 13-1)”.	N U R L V C	PTCL
DCD Don't/Ignore	Whether to ignore or use Data Carrier Detect signal. See “ 13 Communications (page 13-1)”.	N U R L V C	PTCL
DD/MM	Display format of Day/Month. See “ Operator Settings (page 6-4)”.	N U R L V C	CTRL
Dead Lockout	Switchgear would not reclose unless one or more terminals were live. See “ Lockout (page 9-46)”.	N U R L V C	PRTN
Dead Lockout ON/OFF	Dead Lockout feature was enabled or disabled. Prevent reclose unless one or more terminals are live. See “ Lockout (page 9-46)”.	N U R L V C	PRTN
Definite #####s	Definite time in seconds. See “ Definite Time Protection Settings/ Specifications (page 9-2)”.	C N R L U V	PQ PRTN
Delay Time ###s	Loop Automation action delay after supply ON-to-OFF in seconds. See “ 14 Automation (page 14-1)”.	N U R L V C	PRTN
Demand Period ##min	Demand logging sample period value in minutes. See “ 11 Power Systems Measurement (page 11-1)”.	N U R L V C	CTRL
Details Not/Avail	Plant details available or not available. See “ Operator Settings (page 6-4)”.	N U R L V C	CTRL
Detect Group		RL	CTRL
Dial Command ATD/T/P	Expand dial command	N U R L V C	PTCL
Dial Timeout ###s	RS232 port's Hayes modem driver timeout without DCD being asserted for phone number dialled. See “ RS-232 Configuration Settings (page 13-5)”.	N U R L V C	PTCL
Dir Blocking ON/OFF	Directional blocking feature enabled or disabled. See “ Directional Blocking (page 9-27)”.	N U R L V C	PRTN
Dir Protection ON/OFF	Directional protection feature enabled or disabled. See “ Directional Protection (page 9-22)”.	N U R L V C	PRTN
DirP Auto Restore	Directional protection automatic restoration of supply. See “ Directional Protection (page 9-22)”.	N U R L V C	PRTN
DISABLED/ENABLED	Port was enabled or disabled.	N U R L V C	PTCL
Display Imperial	Display configured for imperial measurements (e.g. psi). See “ System settings 1 (page J-3)”.	N U R L V C	CTRL
Display Metric	Display configured for metric measurements (e.g. kPa). See “ System settings 1 (page J-3)”.	N U R L V C	CTRL
Display Ph/Earth V	The voltage measurement page was set to display phase to earth voltages.	N U R L V C	CTRL
Display Ph/Ph Volt	The voltage measurement page was set to display phase to phase voltages.	N U R L V C	CTRL
DL Cf Rqd ###	For DNP3, whether datalink confirm was required never, sometimes or always. Please refer to the manufacturer's DNP3 Protocol Technical Manual for Advanced Controller, Part No: ADC01-DOC-146.	N U R L V C	PTCL

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Event Text	Description	Switchgear	Category
DL Cf TO #####ms	For DNP3, datalink confirm timeout period. Please refer to the manufacturer's DNP3 Protocol Technical Manual for Advanced Controller, Part No: ADC01-DOC-146.	N U R L V C	PTCL
DL Max Retries ####	For DNP3, datalink maximum retry count. Please refer to the manufacturer's DNP3 Protocol Technical Manual for Advanced Controller, Part No: ADC01-DOC-146.	N U R L V C	PTCL
DNP Address #####	DNP3 Protocol Station Address. Please refer to the manufacturer's DNP3 Protocol Technical Manual for Advanced Controller, Part No: ADC01-DOC-146.	N U R L V C	PTCL
DNP3 Not/Avail	DNP3 protocol available or not available. Please refer to the manufacturer's DNP3 Protocol Technical Manual for Advanced Controller, Part No: ADC01-DOC-146.	N U R L V C	PTCL
DNP3 Trip/Close Req	DNP3 protocol trip/close request. Please refer to the manufacturer's DNP3 Protocol Technical Manual for Advanced Controller, Part No: ADC01-DOC-146.	N U R L V C	SWGR
Double Cmd ###		N U R L V C	PTCL
Double Pts ###		N U R L V C	PTCL
Driver #####	Driver selected for a port. This refers to another communications layer outside the protocol. See " 13 Communications (page 13-1)".	N U R L V C	PTCL
DTR ENABLED/DISABLED	RS232 port Data Terminal Ready signal disabled/enabled. See " RS-232 Configuration Settings (page 13-5)".	N U R L V C	PTCL
E Max NN Amp	Following pickup of the overcurrent protection element on earth or SEF, the maximum fault current recorded was NN Amps. This event was logged only after the current fell back below the earth setting current. See " 9 Recloser Protection Features (page 9-1)".	N U R L V C	PRTN
E/F OFF Not/Allowed	Whether earth fault protection was allowed to be turned OFF. See " 9 Recloser Protection Features (page 9-1)".	N U R L V C	PRTN
Earth Dir Arm	An earth protection pickup occurred and tripping was enabled in the faulted direction. The trip could take place as normal. This event can only occur with Directional Blocking ON. See " Directional Blocking (page 9-27)".	N U R L V C	PRTN
Earth Dir Block	An earth protection pickup occurred but tripping was blocked in the faulted direction. The circuit breaker would not trip. This event can only occur with Directional Blocking ON. See " Directional Blocking (page 9-27)".	N U R L V C	PRTN
Earth Low Vzps	An Earth overcurrent trip occurred with a low Vzps condition present. See " 9 Recloser Protection Features (page 9-1)".	N U R L V C	PRTN
Earth Low Vzps Arm	An earth protection pickup occurred and tripping was enabled because the residual voltage (Vzps) was less than the user-specified level and Low Vzps blocking was OFF. The trip could take place as normal. This event can only occur with Directional Blocking ON. See " 9 Recloser Protection Features (page 9-1)".	N U R L V C	PRTN
Earth Low Vzps Blk	An earth protection pickup occurred but tripping was blocked because the residual voltage (Vzps) was less than the user-specified level and Low Vzps blocking was ON. The circuit breaker would not trip. This event can only occur with Directional Blocking ON. See " Directional Blocking (page 9-27)".	N U R L V C	PRTN
Earth Low Vzps Fwd/Rev/Ignore	Set the fault direction for an earth protection pickup or ignore. See " 9 Recloser Protection Features (page 9-1)".	N U R L V C	PRTN
Earth Pickup ###x	Protection earth setting current multiplier to give the pickup level. See " 9 Recloser Protection Features (page 9-1)".	N U R L V C	PRTN
Earth Prot	Quick Key configured for Earth Protection.	N U R L V C	CTRL
Earth Prot OFF	Earth fault protection was turned OFF by a local or remote operator. See " 9 Recloser Protection Features (page 9-1)".	N U R L V C	PRTN
Earth Prot ON	Earth fault Protection was turned ON by a local or remote operator. See " 9 Recloser Protection Features (page 9-1)".	N U R L V C	PRTN
Earth Prot Trip	A protection trip was generated by the Earth overcurrent protection element. See " 9 Recloser Protection Features (page 9-1)".	N U R L V C	PRTN
Earth Reset ###%	Protection earth current multiplier to give the reset level. See " 9 Recloser Protection Features (page 9-1)".	N U R L V C	PRTN

List of Events (cont)

Event Text	Description	Switchgear	Category
Earth Set ##### Amp	Protection earth setting current level. See "9 Recloser Protection Features" (page 9-1).	N U R L V C	PRTN
End #####V	Battery test has not yet been performed so battery capacity is unknown.	N U R L V C	CTRL SYS
End Day ##	Daylight saving's end day of the end month.	N U R L V C	PTCL
End Month ##	Daylight saving's end month.	N U R L V C	PTCL
End of Line CR	For a communications trace, an end of line was a carriage return character. See "13 Communications" (page 13-1).	N U R L V C	PTCL
End of Line CR/LF	For a communications trace, an end of line was a carriage return followed by a linefeed character. See "13 Communications" (page 13-1).	N U R L V C	PTCL
End of Line LF	For a communications trace, an end of line was a linefeed character. See "13 Communications" (page 13-1).	N U R L V C	PTCL
End of Line NONE	For a communications trace, there was no end of line. See "13 Communications" (page 13-1).	N U R L V C	PTCL
End of Sequence	The end of the protection sequence was reached. See "9 Recloser Protection Features" (page 9-1).	N U R L V C	PRTN
Excess Motor Ops		RL	SWGR CTRL
Excess Pickups Trip	Trip due excessive number of pickups. See "9 Recloser Protection Features" (page 9-1).	N U R L V C	PRTN
ExSeq ##	Excess Voltage Trip/Close sequences will occur after this number of sequences.	N U R L V C	PRTN
ExSeq OFF	Monitoring of excess Voltage Trip/Close sequences is Disabled. See "9 Recloser Protection Features" (page 9-1).	N U R L V C	PRTN
Extern Req	Batt Test Aborted because of an external Request (one of the protocols)	N U R L V C	CTRL
External Prot Trip	External protection trip.	N U R L V C	PRTN
Fault Reset #####ms	Protection element fault reset time. See "9 Recloser Protection Features" (page 9-1).	C N R L U V	PQ PRTN
Feeder ACR	Feeder ACR type defined for loop automation. See "14 Automation" (page 14-1).	N U R L V C	PRTN
First Char ##	Preamble first character on this communications port. See "13 Communications" (page 13-1).	N U R L V C	PTCL
Fmt ASCII-HEX	Communications trace format was ASCII of Hexadecimal. See "13 Communications" (page 13-1).	N U V C	PTCL
Fmt ASCII-HEX VT100	Communications trace format was ASCII of Hexadecimal with VT100 terminal display controls. See "13 Communications" (page 13-1).	N U V C	PTCL
Fmt HEADER BINARY	Communications trace format configured to a header and binary data. See "13 Communications" (page 13-1).	N U V C	PTCL
Fmt RAW BINARY	Communications trace format was unchanged. See "13 Communications" (page 13-1).	N U V C	PTCL
Fmt RAW LOOPBACK	Communications trace format was replying with the characters received. See "13 Communications" (page 13-1).	N U V C	PTCL
Frag Retries ###	SOS Multidrop maximum amount of fragment retries See "13 Communications" (page 13-1).	N U R L V C	PTCL
Frag Retry Time ####s	SOS Multidrop fragment retry time in seconds. The delay between retries. See "13 Communications" (page 13-1).	N U R L V C	PTCL
Frame TO ####ms	MITS protocol frame timeout in milliseconds. See "13 Communications" (page 13-1).	N U R L V C	PTCL
Fwd AutoReclose ON/OFF	Forward directional protection automatic reclose enabled or disabled. See "Auto Reclosing" (page 9-45).	N U R L V C	PRTN
Fwd AutoRestore OFF	Auto Restore was turned OFF for the forward protection group by a local or remote operator. See "Auto Restore" (page 9-26).	N U R L V C	PRTN
Fwd AutoRestore ON	Auto Restore was turned ON for the forward protection group by a local or remote operator. See "Auto Restore" (page 9-26).	N U R L V C	PRTN
Fwd Earth Blocked	Directional protection blocked on forward earth current. See "Directional Protection" (page 9-22).	N U R L V C	PRTN

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Event Text	Description	Switchgear	Category
Fwd Earth Prot Trip	Protection trip on forward flowing earth current.	N U R L V C	PRTN
Fwd NPS Blocked	Directional protection blocked on forward negative phase sequence current. See " Directional Protection (page 9-22)".	N U R L V C	PRTN
Fwd NPS Prot Trip	Protection trip on forward flowing negative phase sequence current. See " Directional Protection (page 9-22)".	N U R L V C	PRTN
Fwd Phase Blocked	Directional protection blocked on forward phase current. See " Directional Protection (page 9-22)".	N U R L V C	PRTN
Fwd Phase Prot Trip	Protection trip on forward flowing phase current. See " Directional Protection (page 9-22)".	N U R L V C	PRTN
Fwd SEF Blocked	Directional protection blocked on forward sensitive earth fault current. See " Directional Protection (page 9-22)".	N U R L V C	PRTN
Fwd SEF Prot Trip	Protection trip on forward flowing sensitive earth fault current. See " Directional Protection (page 9-22)".	N U R L V C	PRTN
Fwd Sequence Adv	Directional protection sequence advance in the forward direction. See " Directional Protection (page 9-22)".	N U R L V C	PRTN
Gas Inhibit Not/Avail	Expand gas inhibit not avail	N R L	CTRL
Gas Inhibit Not/Avail	Low gas inhibit available or not available.	N R L	CTRL
Gas Inhibit ON/OFF	Gas low inhibit was set ON or OFF.	N R L	CTRL
Gas Override OFF		N U R L V C	CTRL
Gas Override ON		N U R L V C	CTRL
Gas Press Invalid	An operation was attempted with an invalid gas pressure.	N R L	SWGR CTRL
Gas Press Low	This event was recorded after an operation was attempted with sulphur hexafluoride (SF6) gas pressure low and Gas Low Lockout ON.	N R L	SWGR CTRL
Group # Displayed	Panel protection group displayed. See " Protection Groups (page 9-9)".	N U R L V C	CTRL
GW ###	Default Gateway IP address	N U R L V C	CTRL
H/AAlm ON Time ##s	Harmonic analysis time to alarm ON. See " Harmonic Analysis (page 12-2)".	N U R L V C	PQ
H/A Logging ## mins	Harmonic analysis logging period. See " Harmonic Analysis (page 12-2)".	N U R L V C	PQ
Hardware Failure	Problem with controller hardware.	N U R L V C	CTRL
Harmonics	Waveform capture to trigger on harmonics. See " Waveform Capture (page 12-4)".	N U R L V C	PQ
Harmonics Not/Avail	Harmonic analysis available or not available. See " Harmonic Analysis (page 12-2)".	N U R L V C	PQ
Harmonics OFF	Waveform capture to trigger on harmonics turned off.	N U R L V C	PQ
Harmonics ON/OFF	Harmonic analysis ON or OFF. See " Harmonic Analysis (page 12-2)".	N U R L V C	PQ
Hayes Not/Available	Hayes available. See " Hayes compatible modem support (page 13-6)".	N U R L V C	PTCL
HCL Active Trip ###	High current lockout active after this trip. See " High Current Lockout Settings/Specifications (page 9-6)".	N U R L V C	PRTN
Heater Connected	Heater power supply is connected.	N U R L V C	CTRL
Heater Disconnected	Heater power supply is disconnected.	N U R L V C	CTRL
Heater Shorted	Heater power supply is shorted.	N U R L V C	CTRL
High Current	Operation denied because of High Current.	N U R L V C	SWGR CTRL
High Lockout #####A	The circuit breaker tripped with a current above the High Current Lockout setting whilst the High Current Lockout was effective, the event shows the value of setting at the time the event occurred. See " High Current Lockout Settings/Specifications (page 9-6)".	N U R L V C	PRTN
High Lockout ON/OFF	High current lockout ON/OFF. See " High Current Lockout Settings/Specifications (page 9-6)".	N U R L V C	PRTN
High Vzps ###s	Directional Blocking High Vzps alarm time in seconds. See " Directional Blocking (page 9-27)".	N U R L V C	PRTN

List of Events (cont)

Event Text	Description	Switchgear	Category
High Vzps Alarm ON/OFF	Directional blocking high Vzps alarm ON/OFF. See “ Directional Blocking (page 9-27)”.	N U R L V C	PRTN
High Vzps DISABLED	Directional blocking high Vzps was disabled. See “ Directional Blocking (page 9-27)”.	N U R L V C	PRTN
Hit and Run OFF	End of Hit and Run request countdown, or timeout. See “ Hit and Run (page 8-2)”.	N U R L V C	CTRL
Hit and Run ON	Start of Hit and Run period, or reason for an operation denial. See “ Hit and Run (page 8-2)”.	C N R L U V	CTRL SWGR
Hit&Run Close ###s	Hit and Run close time in seconds. See “ Hit and Run (page 8-2)”.	N U R L V C	CTRL
Hit&Run Close OFF	Hit and Run close is OFF. See “ Hit and Run (page 8-2)”.	N U R L V C	CTRL
Hit&Run Not/Avail	Hit and Run feature available or not available. See “ Hit and Run (page 8-2)”.	N U R L V C	CTRL
Hit&Run Trip ###s	Hit and Run trip time in seconds. See “ Hit and Run (page 8-2)”.	N U R L V C	CTRL
Hit&Run Trip OFF	Hit and Run trip is OFF. See “ Hit and Run (page 8-2)”.	N U R L V C	CTRL
Idioma Espanol		N U R L V C	CTRL
IEC870 Close Req		N U R L V C	SWGR
IEC870 Trip Req		N U R L V C	SWGR
in ####min	Excess Voltage Trip/Close sequences will occur in this time.	N U R L V C	PRTN
Inrush Mult x #####	Inrush current restraint multiplier. See “ Inrush Restraint Settings/Specifications (page 9-4)”.	N U R L V C	PRTN
Inrush ON/OFF	Inrush current restraint enabled or disabled. See “ Inrush Restraint Settings/Specifications (page 9-4)”.	N U R L V C	PRTN
Inrush Ready	The Inrush current timer has been reset ready for an inrush current. See “ Inrush Restraint Settings/Specifications (page 9-4)”.	N U R L V C	PRTN
Inrush Time #####s	Inrush current restraint time in seconds. See “ Inrush Restraint Settings/Specifications (page 9-4)”.	N U R L V C	PRTN
Inrush Timed Out	The Inrush current timer has been expired. See “ Inrush Restraint Settings/Specifications (page 9-4)”.	N U R L V C	PRTN
Inrush Timing	Inrush current has been detected and the Inrush timer has started. See “ Inrush Restraint Settings/Specifications (page 9-4)”.	N U R L V C	PRTN
Instant Mult x ####	Instantaneous Multiplier Value. See “ INSTANTANEOUS MULTIPLIER (page 9-12)”.	N U R L V C	PRTN
Integ Total ###		N U R L V C	PTCL
Integ Total Rep OFF		N U R L V C	PTCL
Integ Total Rep ON		N U R L V C	PTCL
Invalid Mapping	Invalid protocol mapping. See “ 13 Communications (page 13-1)”.	N U R L V C	PTCL
Invalid Profile	Database profile was invalid.	N U R L V C	CTRL
Invalid Switch ###	Invalid switch number detected.	N U R L V C	SWGR
IOEX Close Req	Input/Output Expander operation close request.	N U R L V C	SWGR
IOEX Input## OFF	IOEX Input XX changed from the ON state to the OFF state (where XX is from 01 to 08).	N U R L V C	IOEX
IOEX Input## ON	IOEX Input XX changed from the OFF state to the ON state (where XX is from 01 to 08).	N U R L V C	IOEX
IOEX Not/Available	IOEX feature was made available or not available.	N U R L V C	IOEX
IOEX Oper Trip Req	Input/Output Expander operation trip request	N U R L V C	SWGR
IOEX Output## OFF	IOEX Output XX changed from the ON state to the OFF state (where XX is from 01 to 08).	N U R L V C	IOEX
IOEX Output## ON	IOEX Output XX changed from the OFF state to the ON state (where XX is from 01 to 08).	N U R L V C	IOEX
IOEX Prot Trip Req	Input/Output Expander protection trip request.	N U R L V C	SWGR
IP ###	Internet protocol address.	N U R L V C	CTRL
Iso. fail, blocking		N U R L V C	SWGR
k:Max Uncnfm ###	Maximum number of unconfirmed I-Format APDU transmitted.	N U R L V C	PTCL

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Event Text	Description	Switchgear	Category
Keep-alive #ms	DNP3 TCP/IP Keep-alive Timeout Period.	N U R L V C	PTCL
Lang English (Intl)	Language English (International) was selected for the display.	N U R L V C	CTRL
Lang English (USA)	Language English (USA) was selected for the display.	N U R L V C	CTRL
Last Char ##	Last preamble character for this communications port. See “ 13 Communications (page 13-1)”.	N U R L V C	PTCL
LBS Function	Switchgear is setup to function as an LBS	N U R L V C	CTRL
Link Addr ###		N U R L V C	PTCL
Link Addr Size ##		N U R L V C	PTCL
Link BALANCED		N U R L V C	PTCL
Link Reset EO.I. OFF		N U R L V C	PTCL
Link Reset EO.I. ON		N U R L V C	PTCL
Link UNBALANCED		N U R L V C	PTCL
Live Block	Quick key configured to control live load blocking.	N U R L V C	CTRL
LIVE if > ####V	Voltage configured to live if greater than #### volts.	N U R L V C	CTRL PRTN
Live Load Block ON/OFF	Live load blocking enabled or disabled. See “ Live Load Blocking Settings/Specifications (page 9-5)”.	N U R L V C	PRTN
Live Load Blocking	A close request was disregarded due to a load side terminal being alive. See “ Live Load Blocking Settings/Specifications (page 9-5)”.	C N R L U V	CTRL SWGR
Load Out...	The accumulated time the load side terminals have experienced an outage.	N U R L V C	PQ
Load Profile	Saved database profile was loaded into current database.	N U R L V C	CTRL
Load Supply ON/OFF	All configured load side voltages are ON or OFF.	N U R L V C	NWRK PRTN
LOCAL CONTROL ON	A local operator put the controller in LOCAL mode. See “ Definition of Local or Remote User (page 8-1)”.	N U R L V C	CTRL
LOCAL/Remote	Quick key configured to change LOCAL/Remote mode.	N U R L V C	CTRL
Lockout	The protection went to lockout and would not perform any more automatic recloses. See “ Trips To Lockout (page 9-26)”.	N U R L V C	SWGR PRTN
Loop Auto	Quick key configured to control loop automation ON/OFF.	N U R L V C	CTRL
Loop Auto Close Req	Close request from loop automation. See “ 14 Automation (page 14-1)”.	N U R L V C	SWGR
Loop Auto Not/Avail	Loop automation option was made available or not available. See “ 14 Automation (page 14-1)”.	N U R L V C	PRTN
Loop Auto ON/OFF	Loop automation was set ON or OFF. See “ 14 Automation (page 14-1)”.	N U R L V C	PRTN
Loop Auto Trip Req	Trip request from loop automation. See “ 14 Automation (page 14-1)”.	N U R L V C	SWGR
LOP Prot Trip	A protection trip was generated by Loss Of Phase protection. See “ Loss of Phase Protection Settings/Specifications (page 9-4)”.	N U R L V C	PRTN
LOP/Loop Linked	Loss Of Phase and Loop Automation features are linked.	N U R L V C	PRTN
LOP/Loop Unlinked	Loss Of Phase and Loop Automation features are not linked.	N U R L V C	PRTN
Loss Phase Prot Alm	Loss of phase protection was set to alarm. See “ Loss of Phase Protection Settings/Specifications (page 9-4)”.	N U R L V C	PRTN
Loss Phase Prot ON/OFF	Loss of phase protection was set ON or OFF. See “ Loss of Phase Protection Settings/Specifications (page 9-4)”.	N U R L V C	PRTN
Low Batt	Batt Test Aborted because of low batt	N U R L V C	CTRL
Low Power Mode	If the power supply voltage drops below the threshold for a certain time then the radio supply is turned off. The switchgear would operate but would go to lockout if the capacitors cannot be charged quickly enough.	N U R L V C	CTRL
Low V Block OFF	For Low Phase to earth voltage, directional blocking OFF. See “ Directional Blocking (page 9-27)”.	N U R L V C	PRTN
Low V Block ON	For Low Phase to earth voltage, directional blocking ON. See “ Directional Blocking (page 9-27)”.	N U R L V C	PRTN
Low V Inhibit ####V	The voltage below which the Under/Over frequency protection was disabled.	N U R L V C	PRTN

List of Events (cont)

Event Text	Description	Switchgear	Category
Low Vnps Block ON/OFF	For Low negative phase sequence voltage, directional blocking was set ON or OFF. See " Directional Blocking (page 9-27)".	N U R L V C	PRTN
Low Vzps Block ON/OFF	For Low residual voltages, directional blocking was set ON or OFF. See " Directional Blocking (page 9-27)".	N U R L V C	PRTN
Maint. Req.		N U R L V C	CTRL
Manual Close	Waveform capture trigger on manual close. See " Waveform Capture (page 12-4)".	N U R L V C	PQ
Manual Close OFF	Waveform capture trigger on manual close turned off. See " Waveform Capture (page 12-4)".	N U R L V C	PQ
Manual Trip	Waveform capture trigger on manual trip. See " Waveform Capture (page 12-4)".	N U R L V C	PQ
Manual Trip OFF	Waveform capture trigger on manual trip turned off. See " Waveform Capture (page 12-4)".	N U R L V C	PQ
Map Already Used	Operation denied. Another protocol was already using this map. See " 13 Communications (page 13-1)".	N U R L V C	SWGR CTRL
Master Addr #####	DNP3 protocol master address. See " 13 Communications (page 13-1)".	N U R L V C	PTCL
Master Port #	DNP3 TCP/IP Master port number.	N U R L V C	PTCL
Max ASDU Size ###	IEC maximum size of ASDU (frame) in octets.	N U R L V C	PTCL
Max Attempts ###	RS232 port's Hayes modem driver maximum connection attempts. See " 9 Recloser Protection Features (page 9-1)".	N U R L V C	PTCL
Max Current >=... Amps	High current lockout measurement. See " High Current Lockout Settings/Specifications (page 9-6)".	N U R L V C	PRTN
Max Frag Size ####	SOS Multidrop maximum fragment size. No SOS Multidrop message will exceed this size.	N U R L V C	PTCL
Maximum Time #####s	Maximum time to trip in seconds. See " 9 Recloser Protection Features (page 9-1)".	N U R L V C	PRTN
MDI Reset	A reset was done on the Maximum Demand Indicator Meter Values.	N U R L V C	PRTN
Meas Vals ###		N U R L V C	PTCL
Measured Time OFF		N U R L V C	PTCL
Measured Time ON		N U R L V C	PTCL
Mech Interlocked	Switchgear was mechanically interlocked.	U V C	SWGR CTRL
Mech Locked	Switchgear was mechanically locked.	U V C	SWGR
Mech UnLocked	Switchgear was mechanically unlocked.	U V C	SWGR
Mechanical Close	A mechanical close occurred.	N U R L V C	SWGR
Mechanical Trip	A mechanical trip occurred.	N U R L V C	SWGR
Mechanism Fail	Switchgear mechanism failed to operate after being requested by the controller.	N U R L V C	SWGR
Mid #####V	Battery test has not yet been performed so battery capacity is unknown.	N U R L V C	CTRL SYS
MidPoint ACR	Loop automation switchgear device type was set to be a midpoint recloser.	N U R L V C	PRTN
Min Earth Vzps ####	Minimum earth residual voltage as a percentage of phase to earth voltage. See " 9 Recloser Protection Features (page 9-1)".	N U R L V C	PRTN
Min NPS Vnps #####V	Minimum NPS residual voltage. c	N U R L V C	PRTN
Min SEF Vzps ####	Minimum Sensitive Earth Fault Vo. See " 9 Recloser Protection Features (page 9-1)".	N U R L V C	PRTN
Minimum #####s	Minimum Time to Trip (in seconds). See " 9 Recloser Protection Features (page 9-1)".	N U R L V C	PRTN
MITS Close Req	MITS protocol close request. See " 9 Recloser Protection Features (page 9-1)".	N U R L V C	SWGR
MITS Not/Available	MITS protocol was made available or not available. See " 9 Recloser Protection Features (page 9-1)".	N U R L V C	PTCL
MITS Trip Req	MITS protocol trip request. See " 9 Recloser Protection Features (page 9-1)".	N U R L V C	SWGR

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Event Text	Description	Switchgear	Category
MM/DD	Display format of Month/Day.	N U R L V C	CTRL
Mode LOCAL/Remote	Port mode was made LOCAL or Remote. See " Local Mode (page 8-1)".	N U R L V C	PTCL
Modem Pwr Cyc ## hr	Time in hours to automatically cycle power of the radio power supply. It is a way of resetting problem modems. See " 13 Communications (page 13-1)".	N U R L V C	PTCL
Modem Pwr Cyc OFF	Automatic power cycle of radio power supply is OFF. It is a way of resetting problem modems. See " 13 Communications (page 13-1)".	N U R L V C	PTCL
Msg Attempts ##	RDI Number of attempts to transmit. See " 13 Communications (page 13-1)".	N U R L V C	PTCL
N Series Switch	N Series Switch	N	CTRL
N/F CIs after #####s	Frequency protection close time after normal frequency reached. See " Under and Over Frequency Protection Elements (page 9-33)".	N U R L V C	PRTN
Network End Point DATAGRAM	For DNP3, UDP End Point.	N U R L V C	PTCL
Network End Point DUAL	For DNP3, Dual Point.	N U R L V C	PTCL
Network End Point LISTENING	For DNP3, TCP Listening End Point.	N U R L V C	PTCL
New IOEX Mapping	New IOEX Mapping loaded. See " Input Output Expander Card (IOEX) (page 17-1)".	N U R L V C	IOEX
New SCEM Data	New SCEM data was written to the SCEM.	N U R L V C	SWGR
No Data Timeout ####s	RS232 port's Hayes modem driver disconnect timeout without any data transmitted, or received. See " 13 Communications (page 13-1)".	N U R L V C	PTCL
No PSU Detected	No power supply unit was detected.	N U R L V C	CTRL
No SWGM Detected	No switchgear module detected.	N U R L V C	CTRL
Nom P-E V #####kV	Nominal phase-earth voltage. See " 9 Recloser Protection Features (page 9-1)".	N U R L V C	PRTN
Normal Freq Close	Under/Over frequency protection, the source frequency returned to normal and a close request was issued. See " Under and Over Frequency Protection Elements (page 9-33)".	N U R L V C	PRTN
Normal Freq Close ON/OFF	Under/Over frequency protection close was enabled or disabled. See " Under and Over Frequency Protection Elements (page 9-33)".	N U R L V C	PRTN
Normal Power Mode	If the power supply voltage returns to normal then the power mode would return to normal after 15min.	N U R L V C	CTRL
NPS Alarm Mode ON	Negative phase sequence protection set to alarm. See " Negative Phase Sequence (NPS) Elements (page 9-20)".	N U R L V C	PRTN
NPS Dir Arm	Directional blocking NPS fault armed. See " Negative Phase Sequence (NPS) Elements (page 9-20)".	N U R L V C	PRTN
NPS Dir Block	Directional blocking NPS fault blocking. See " Negative Phase Sequence (NPS) Elements (page 9-20)".	N U R L V C	PRTN
NPS Low Vnps	An NPS overcurrent trip occurred with a low Vnps condition present. See " Negative Phase Sequence (NPS) Elements (page 9-20)".	N U R L V C	PRTN
NPS Low Vnps Arm	Directional blocking low Vnps fault armed. See " Directional Protection (page 9-22)".	N U R L V C	PRTN
NPS Low Vnps Block	Directional blocking low Vnps fault blocking. See " Directional Protection (page 9-22)".	N U R L V C	PRTN
NPS Low Vnps Fwd	Directional protection low Vnps was in forward fault region. See " Directional Protection (page 9-22)".	N U R L V C	PRTN
NPS Low Vnps Ignore	Directional protection low Vnps was disabled. See " Directional Protection (page 9-22)".	N U R L V C	PRTN
NPS Low Vnps Rev	Directional protection low Vnps was in reverse fault region.	N U R L V C	PRTN
NPS Max ##### Amp	Following pickup of the NPS overcurrent protection, the maximum fault current recorded was ## Amps. This event was logged only after the current fell back below the NPS setting current. See " Negative Phase Sequence (NPS) Elements (page 9-20)".	N U R L V C	PRTN
NPS OFF Not/Allowed	NPS protection OFF allowed or not allowed. See " Negative Phase Sequence (NPS) Elements (page 9-20)".	N U R L V C	PRTN

List of Events (cont)

Event Text	Description	Switchgear	Category
NPS ON/OFF	Negative phase sequence protection was set ON or OFF. See " Negative Phase Sequence (NPS) Elements (page 9-20)".	N U R L V C	PRTN
NPS Pickup ###x	Protection negative phase sequence setting current multiplier to give the pickup level. See " Negative Phase Sequence (NPS) Elements (page 9-20)".	N U R L V C	PRTN
NPS Prot	Quick key configured to control negative phase sequence protection ON and OFF. See " Negative Phase Sequence (NPS) Elements (page 9-20)".	N U R L V C	CTRL
NPS Prot Alarm	Negative phase sequence current exceeded the pickup setting for the user-specified time. See " Negative Phase Sequence (NPS) Elements (page 9-20)".	N U R L V C	PRTN
NPS Prot Trip	Negative phase sequence protection trip. See " Negative Phase Sequence (NPS) Elements (page 9-20)".	N U R L V C	PRTN
NPS Reset ###%	Protection negative phase sequence current multiplier to give the reset level. See " Negative Phase Sequence (NPS) Elements (page 9-20)".	N U R L V C	PRTN
NPS Set ##### Amp	Negative phase sequence setting current level. See " Negative Phase Sequence (NPS) Elements (page 9-20)".	N U R L V C	PRTN
NPS Trips Lockout #	Negative phase sequence trips to lockout. See " Negative Phase Sequence (NPS) Elements (page 9-20)".	N U R L V C	PRTN
Null Resp Port #	DNP3 UDP Null response port number.	N U R L V C	PTCL
NV Close	Under/Over voltage protection, the source voltage returned to normal and a close request was issued.	N U R L V C	PRTN
NV Close #####s	Closing due to Normal Voltage will occur after the Voltage is Normal for this time.	N U R L V C	PRTN
NV Close OFF	Closing due to Normal Voltage after an Under/Over Voltage Trip is NOT enabled.	N U R L V C	PRTN
NV High #####pu	The High Voltage threshold for Voltage Normal.	C N R L U V	PQ PRTN
NV Low #####pu	The Low Voltage threshold for Voltage Normal.	C N R L U V	PQ PRTN
O/F Normal #####Hz	Over frequency protection's normal frequency in Hertz. See " Under and Over Frequency Protection Elements (page 9-33)".	N U R L V C	PRTN
O/F Trip at ###Hz	Over frequency protection trip this frequency in Hertz. See " Under and Over Frequency Protection Elements (page 9-33)".	N U R L V C	PRTN
O/F Trip ON/OFF	Over frequency protection trip was enabled or disabled. See " Under and Over Frequency Protection Elements (page 9-33)".	N U R L V C	PRTN
Object Addr Size ##		N U R L V C	PTCL
O.I. Door Closed	Operator Interface door closed. See " Operator Interface/ Door Assembly (page 5-2)".	N U R L V C	CTRL
O.I. Door Opened	Operator Interface door opened. See " Operator Interface/ Door Assembly (page 5-2)".	N U R L V C	CTRL
One Octet Ack OFF		N U R L V C	PTCL
One Octet Ack ON		N U R L V C	PTCL
One Octet Resp OFF		N U R L V C	PTCL
One Octet Resp ON		N U R L V C	PTCL
Operation Denied	Attempt to perform a change was denied. See " Operator Settings (page 6-4)".	C N R L U V	SWGR CTRL
OPS #####	Number of switchgear close operations.	N U R L V C	SWGR
Options Available	The panel pages displaying configurable options are accessible. See " Display Groups (page 6-3)".	N U R L V C	CTRL
Options Not Avail	The panel pages displaying configurable options are not accessible. See " Display Groups (page 6-3)".	N U R L V C	CTRL
Out. Duration #####s	Time in seconds, for terminals without voltage to be counted as a supply outage.	N U R L V C	PQ
Outages ON/OFF	The supply outage measurement feature was enabled or disabled.	N U R L V C	PQ
Outages Reset	All supply outage measurement counters have been reset to zero.	N U R L V C	PQ
OV Excess Seq	Over Voltage Protection excess sequences.	N U R L V C	PRTN

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Event Text	Description	Switchgear	Category
OV Pickup	The measured voltage was equal to or above the over voltage threshold.	N U R L V C	PRTN
OV Protection OFF	Over Voltage protection is turned off. See “ Under and Over Voltage Protection (page 9-37)”.	N U R L V C	PRTN
OV Protection ON	Over Voltage protection is turned on. See “ Under and Over Voltage Protection (page 9-37)”.	N U R L V C	PRTN
OV Reset	The measured voltage dropped to equal or below the Over voltage trip threshold minus the dead band. See “ Under and Over Voltage Protection (page 9-37)”.	N U R L V C	PRTN
OV Trip	The source voltage was equal to or above the Over Voltage threshold for the Trip Delay count and a trip request was issued. See “ Under and Over Voltage Protection (page 9-37)”.	N U R L V C	PRTN
Over Freq Pickup	The measured frequency was equal to or above the Over Frequency trip threshold.	N U R L V C	PRTN
Over Freq Reset	The measured frequency fell to equal or above the Over Frequency trip threshold plus the dead band.	N U R L V C	PRTN
Over Freq Trip	The source frequency was equal to or above the Over Frequency threshold for the Trip Delay count and a trip request was issued.	N U R L V C	PRTN
Panel Close Req	Request to close made from the panel.	N U R L V C	SWGR
Panel Trip Req	Request to trip made from the panel.	N U R L V C	SWGR
Panel Trip Req	Request to trip made from the panel.	N U R L V C	SWGR
Param Cmd ###		N U R L V C	PTCL
Parity EVEN	Communications port parity bit was even. See “ 13 Communications (page 13-1)”.	N U R L V C	PTCL
Parity NONE	Communications port parity bit was none. See “ 13 Communications (page 13-1)”.	N U R L V C	PTCL
Parity ODD	Communications port parity bit was set to odd. See “ 13 Communications (page 13-1)”.	N U R L V C	PTCL
Password Changed	Either the panel password or the write access password was changed.	N U R L V C	CTRL
PCOM S/N #####	PCOM Serial Number.	N U R L V C	CTRL
Performing Test...	Battery test in progress.	N U R L V C	CTRL
Phase A/B/C LOST	Loss of supply occurred on this phase. See ~~~.	N U R L V C	PRTN
Phase Dir Arm	Phase overcurrent pickup and trip enabled in faulted direction. The trip can take place as normal. This can only occur with Directional Blocking ON. See “ Directional Blocking (page 9-27)”.	N U R L V C	PRTN
Phase Dir Block	Phase overcurrent pickup and trip blocked in faulted direction. The trip can not take place. This can only occur with Directional Blocking ON. See “ Directional Blocking (page 9-27)”.	N U R L V C	PRTN
Phase Logic AND	The logic used to combine the phase voltages for Voltage Protection is set to AND.	N U R L V C	PRTN
Phase Logic AVG	The logic used to combine the phase voltages for Voltage Protection is set to AVERAGE.	N U R L V C	PRTN
Phase Logic OR	The logic used to combine the phase voltages for Under or Over Voltage Protection is set to OR.	N U R L V C	PRTN
Phase Lost #####s	Phase considered lost if below a voltage for this time.	N U R L V C	PRTN
Phase Lost @ ####V	Phase considered lost below this voltage for a set time.	N U R L V C	PRTN
Phase Low V	A phase overcurrent trip occurred with a low V condition present.	N U R L V C	PRTN
Phase Low V Arm	A phase protection pickup occurred and tripping was enabled because the voltage on all three phases (V) was less than 500V and Low V blocking was OFF. The trip takes place as normal. This event can only occur with Directional Blocking ON. See “ Directional Blocking ” on page 9-26.	N U R L V C	PRTN
Phase Low V Block	A phase protection pickup occurred and tripping was blocked because the voltage on all three phases (V) was less than 500 V and Low V blocking was ON. The circuit breaker does not trip. This event can only occur with Directional Blocking ON. See “ Directional Blocking (page 9-27)”.	N U R L V C	PRTN
Phase Low V Fwd	Directional protection overcurrent pickup allowed if low voltage and power flowing in the forward direction. See “ Directional Blocking (page 9-27)”.	N U R L V C	PRTN

List of Events (cont)

Event Text	Description	Switchgear	Category
Phase Low V Ignore	Directional protection overcurrent pickup allowed if low voltage. See “ Directional Blocking (page 9-27)”.	N U R L V C	PRTN
Phase Low V Rev	Directional protection overcurrent pickup allowed if low voltage and power flowing in the reverse direction. See “ Directional Blocking (page 9-27)”.	N U R L V C	PRTN
Phase Pickup ###x	Protection phase setting current multiplier to give the pickup level.	N U R L V C	PRTN
Phase Prot Trip	A protection trip was generated by the Phase overcurrent protection element. See “ Phase Overcurrent (OC) Elements (page 9-19)”.	N U R L V C	PRTN
Phase Reset ##%%	Protection phase current multiplier to give the reset level. See “ Phase Overcurrent (OC) Elements (page 9-19)”.	N U R L V C	PRTN
Phase Set #### Amp	Protection phase setting current level.	N U R L V C	PRTN
Phase Set OFF	Protection phase setting current OFF.	N U R L V C	PRTN
Phase Set ON	Protection phase setting current ON.	N U R L V C	PRTN
Phasing ABC	Phase Rotation was made A,B,C.	N U R L V C	CTRL
Phasing ACB	Phase Rotation was made A,C,B.	N U R L V C	CTRL
Pickup	One of the protection elements picked up (phase, earth, SEF or NPS). This event was generated by the first element to pick up, if more elements pick up subsequently then no more pickup events are generated until all the elements have reset. See “ Pickup Threshold (page 9-38)”.	N U R L V C	PRTN
Pickup Fwd	Protection overcurrent pickup in the forward direction.	N U R L V C	PRTN
Pickup Rev	Protection overcurrent pickup in the reverse direction.	N U R L V C	PRTN
Pickup Volt ####pu	Voltage at which an Voltage pickup occurs.	C N R L U V	PQ PRTN
Plant Detail:	Plant Detail.	N U R L V C	CTRL
Plant Name:	Plant Name.	N U R L V C	CTRL
Port #####	A protocol was configured to use this RS232 port. See “ RS-232 Configuration Settings (page 13-5)”.	N U R L V C	PTCL
Port in REQ ON	Port number in request is ON.	N U R L V C	PTCL
Port in REQ OFF	Protection phase setting current OFF.	N U R L V C	PTCL
Post-Tx #####ms	Post-Transmission time in milliseconds.	N U R L V C	PTCL
Power Down	Power supply to CAPE was removed.	N U R L V C	CTRL
Power Signed	Power measurement displayed in a signed format.	N U R L V C	CTRL
Power Unsigned	Power measurement displayed in an unsigned format.	N U R L V C	CTRL
Power Up	Power supply to CAPE was restored.	N U R L V C	CTRL
Pre-Tx #####ms	Pre-Transmission time in milliseconds.	N U R L V C	PTCL
Preamble DISABLED	Sending of preamble characters out of this communications port was disabled.	N U R L V C	PTCL
Preamble ENABLED	Sending of preamble characters out of this communications port was enabled.	N U R L V C	PTCL
Prefix Data OFF	All RDI Data messages are as per the RDI specification.	N U R L V C	PTCL
Prefix Data ON	All RDI Data messages are as per the RDI specification.	N U R L V C	PTCL
Pressure Invalid	Sulphur hexafluoride (SF6) gas pressure invalid.	N R L	SWGR
Program Fault	A program fault was detected. Contact the Manufacturer or Distributor for advice.	N U R L V C	CTRL
Prot Group	Quick Key to change the protection group.	N U R L V C	CTRL
Prot Group # Req	Change to active protection group requested. See “ Protection Groups (page 9-9)”.	N U R L V C	PRTN
Prot Grp # Active	The protection group that was then active. See “ Protection Groups (page 9-9)”.	N U R L V C	PRTN
Prot OFF Allowed	Protection can be turned OFF.	N U R L V C	PRTN
Prot OFF Not Allow	Protection can not be turned OFF.	N U R L V C	PRTN
Prot Req	Batt Test Aborted because of Protection Request	N U R L V C	CTRL

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Event Text	Description	Switchgear	Category
Prot Reset Fwd/Rev	All of the protection elements picked up (phase, earth, SEF or NPS) have reset. This is analogous to the induction disk returned to the stop position, but it also occurs for fault reset, definite time, and instantaneous. See " Protection Groups (page 9-9)".	N U R L V C	PRTN
Prot Trip	Waveform capture trigger on protection trip. See " Waveform Capture (page 12-4)".	N U R L V C	PQ
Prot Trip 1/2/3/4	Protection trip sequence number.	N U R L V C	PRTN
Prot Trip OFF	Waveform capture trigger on protection trip turned off. See " Waveform Capture (page 12-4)".	N U R L V C	PQ
Prot Trip Req	Protection trip request.	N U R L V C	SWGR
Protection ON/OFF	All the Protection features are ON or OFF.	N U R L V C	PRTN
Protocol Reset		N U R L V C	CTRL
PSU Unprogrammed	Power supply unit was unprogrammed.	N U R L V C	CTRL
Ptcl Map Updated	Protocol map was updated.	N U R L V C	PTCL
Quick Key # Changed	Quick Key changed.	N U R L V C	CTRL
Radio Batt Charger	Radio Supply voltage reached the minimum voltage.	N U R L V C	CTRL
Radio Hold ##### min	Amount of time radio power supply was set to hold up after the loss of auxiliary power.	N U R L V C	CTRL
Radio OFF Requested	Request to remove the power supply from the radio was made.	N U R L V C	CTRL
Radio ON Requested	Request to restore the power supply to the radio was made.	N U R L V C	CTRL
Radio Shutdown	The radio power supply was shutdown.	N U R L V C	CTRL
Radio Supply ##V	The voltage to supply to the radio.	N U R L V C	CTRL
Radio Supply FAILED	The radio power supply failed.	N U R L V C	CTRL
Radio Supply OFF	The radio power supply was turned OFF.	N U R L V C	CTRL
Radio Supply ON	The radio power supply was turned ON.	N U R L V C	CTRL
RDI Not/Available	RS232 RDI interface driver was made available or not available.	N U R L V C	PTCL
Reclose Time #####s	Time delay in seconds after a trip before reclosing.	N U R L V C	PRTN
Recovery Tout #####s	The time period allocated for the recovery of the voltage to Normal after an Under/Over voltage trip.	N U R L V C	PRTN
Recovery Tout OFF	Monitoring of the time for the recovery of the voltage to Normal after an Under/Over voltage trip is OFF.	N U R L V C	PRTN
Remote Control ON	A local operator put the controller in REMOTE mode. See " Local, Remote, Hit and Run / Delayed Operation (page 8-1)".	N U R L V C	CTRL
Repeat First #####	Number of preamble first characters to repeat on this communications port.	N U R L V C	PTCL
Resend Wait #####ms	All RDI Data messages are as per the RDI specification.	N U R L V C	PTCL
Reset Database	Indicates that the databases have been reset and a default database used.	N U R L V C	CTRL
Reset Flags	The quick key was configured to reset the trip/protection flags.	N U R L V C	CTRL
Retry Delay ###s	MITS Protocol retry delay between change of state (COS) attempts.	N U R L V C	PTCL
Rev AutoReclose OFF	Reverse directional protection automatic reclose OFF. See " Directional Protection (page 9-22)".	N U R L V C	PRTN
Rev AutoReclose ON	Reverse directional protection automatic reclose ON. See " Directional Protection (page 9-22)".	N U R L V C	PRTN
Rev AutoRestore OFF	Auto Restore was turned OFF for the reverse protection group by a local or remote operator. See " Auto Restore (page 9-26)".	N U R L V C	PRTN
Rev AutoRestore ON	Auto Restore was turned ON for the reverse protection group by a local or remote operator. See " Auto Restore (page 9-26)".	N U R L V C	PRTN
Rev Cold Load	Quick key configured to operate the reverse direction cold load.	N U R L V C	CTRL
Rev Earth Blocked	Directional protection blocked on reverse earth current. See " Directional Protection (page 9-22)".	N U R L V C	PRTN
Rev Earth Prot Trip	Protection trip on reverse flowing earth current.	N U R L V C	PRTN

List of Events (cont)

Event Text	Description	Switchgear	Category
Rev NPS Blocked	Directional protection blocked on reverse negative phase sequence current. See “ Directional Protection (page 9-22)”.	N U R L V C	PRTN
Rev NPS Prot Trip	Protection trip on reverse flowing negative phase sequence current.	N U R L V C	PRTN
Rev Phase Blocked	Directional protection blocked on reverse phase current. See “ Directional Protection (page 9-22)”.	N U R L V C	PRTN
Rev Phase Prot Trip	Protection trip on reverse flowing phase current.	N U R L V C	PRTN
Rev SEF Blocked	Directional protection blocked on reverse sensitive earth fault current. See “ Directional Protection (page 9-22)”.	N U R L V C	PRTN
Rev SEF Prot Trip	Protection trip on reverse flowing sensitive earth fault current. See “ Directional Protection (page 9-22)”.	N U R L V C	PRTN
Rev Sequence Adv	Directional protection sequence advance in the reverse direction. See “ Directional Protection (page 9-22)”.	N U R L V C	PRTN
RL2 Series Switch	RL Series Switch	RLM2	CTRL
Rst Curve Available	The Reset Curves Feature is Available for use.	N U R L V C	CTRL
Rst Curve Not Avail	The Reset Curves Feature is NOT Available for use.	N U R L V C	CTRL
RTS ENABLED/DISABLED	RS232 port Request to Send signal disabled/enabled.	N U R L V C	PTCL
Rx Bytes #####	Number of bytes received by trace utility.	N U R L V C	PTCL
Rx Count #####	For the communications trace utility, the number of byte groups received. Note this does not necessarily relate to packets.	N U R L V C	PTCL
Rx Sync Err ####		N U R L V C	PTCL
Rx TO Err #####		N U R L V C	PTCL
Sag for #####s	A Sag event of this duration occurred. See “ Sag and Swell Monitoring (page 12-6)”.	N U R L V C	PQ
Sag Monitor OFF	Sag Monitoring is turned OFF. See “ Sag and Swell Monitoring (page 12-6)”.	N U R L V C	PQ
Sag Monitor ON	Sag Monitoring is turned ON. See “ Sag and Swell Monitoring (page 12-6)”.	N U R L V C	PQ
Sag to #####pu	A Sag event to this pu level occurred. See “ Sag and Swell Monitoring (page 12-6)”.	N U R L V C	PQ
Sag/Swell Available	Sag/Swell Monitoring was made available. See “ Sag and Swell Monitoring (page 12-6)”.	N U R L V C	PQ
Sag/Swell Not Avail	Sag/Swell Monitoring was made Not available. See “ Sag and Swell Monitoring (page 12-6)”.	N U R L V C	PQ
Sag/Swell Reset	All Sag and Swell measurement counters have been reset to zero. See “ Sag and Swell Monitoring (page 12-6)”.	N U R L V C	PQ
Save Profile	The settings of the database are being saved as a profile.	N U R L V C	CTRL
SCEM Corrupted	Data in the SCEM (switch cable entry module) was corrupted.	N U R L V C	SWGR
SCEM Memory Fail	SCEM (switch cable entry module) memory failure.	N U R L V C	SWGR
SCEM Type 93C46	SCEM (switch cable entry module) was type 93C46.	N U	SWGR
SCEM Type SCEM11	SCEM (switch cable entry module) was type 11.	U	SWGR
SCEM Type SCEM11P	SCEM (switch cable entry module) was type 11P.	N, RL	SWGR
SCEM Type SCEM9	SCEM (switch cable entry module) was type 9.	U	SWGR
SCEM Type Unknown	SCEM (switch cable entry module) type was unknown.	N U R L V C	SWGR
SCEM Write Fail	Controller was unable to write switchgear data to the SCEM (switch cable entry module).	N U R L V C	SWGR
Section ON/OFF		RL	CTRL
SEF Available	Sensitive earth fault protection was made available. See “ Sensitive Earth Fault Protection (SEF) Settings/ Specifications (page 9-3)”.	N U R L V C	PRTN
SEF Definite #####s	Sensitive earth fault protection after a definite time after pickup. Also applicable to work tag and single shot protection. See “ Sensitive Earth Fault Protection (SEF) Settings/ Specifications (page 9-3)”.	N U R L V C	PRTN

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Event Text	Description	Switchgear	Category
SEF Dir Arm	A SEF pickup occurred and tripping was enabled in the faulted direction. The trip could take place as normal. This event can only occur with Directional Blocking ON. See “ Sensitive Earth Fault Protection (SEF) Settings/ Specifications (page 9-3)”.	N U R L V C	PRTN
SEF Dir Block	A SEF pickup occurred but tripping was blocked in the faulted direction. The circuit breaker would not trip. This event can only occur with Directional Blocking ON. See “ Sensitive Earth Fault Protection (SEF) Settings/ Specifications (page 9-3)”.	N U R L V C	PRTN
SEF Fault ##### Amp		RL	PRTN
SEF Low Vzps	An SEF overcurrent trip occurred with a low Vzps condition present. See “ Sensitive Earth Fault Protection (SEF) Settings/ Specifications (page 9-3)”.	N U R L V C	PRTN
SEF Low Vzps Arm	A SEF protection pickup occurred and tripping was enabled because the residual voltage (Vo) was less than the user-specified level and Low Vo blocking was OFF. The trip could take place as normal. This event can only occur with Directional Blocking ON. See “ Sensitive Earth Fault Protection (SEF) Settings/ Specifications (page 9-3)”.	N U R L V C	PRTN
SEF Low Vzps Block	A SEF protection pickup occurred and tripping was blocked because the residual voltage (Vo) was less than the user-specified level and Low Vo blocking was ON. The circuit breaker would not trip. This event can only occur with Directional Blocking ON. See “ Sensitive Earth Fault Protection (SEF) Settings/ Specifications (page 9-3)”.	N U R L V C	PRTN
SEF Low Vzps Fwd	A SEF pickup would occur in the forward direction if there was a low Vzps. See “ Sensitive Earth Fault Protection (SEF) Settings/ Specifications (page 9-3)”.	N U R L V C	PRTN
SEF Low Vzps Rev	A SEF pickup would occur in the reverse direction if there was a low Vzps. See “ Sensitive Earth Fault Protection (SEF) Settings/ Specifications (page 9-3)”.	N U R L V C	PRTN
SEF Not Available	Sensitive earth fault protection was made not available. See “ Sensitive Earth Fault Protection (SEF) Settings/ Specifications (page 9-3)”.	N U R L V C	PRTN
SEF Prot OFF	Sensitive earth fault protection was set OFF. See “ Sensitive Earth Fault Protection (SEF) Settings/ Specifications (page 9-3)”.	N U R L V C	PRTN
SEF Prot ON	Sensitive earth fault protection was set ON. See “ Sensitive Earth Fault Protection (SEF) Settings/ Specifications (page 9-3)”.	N U R L V C	PRTN
SEF Prot Trip	A protection trip was generated by the SEF overcurrent protection element. See “ Sensitive Earth Fault Protection (SEF) Settings/ Specifications (page 9-3)”.	N U R L V C	PRTN
SEF Trip ##### Amp	Sensitive earth fault trip current in Amperes. See “ Sensitive Earth Fault Protection (SEF) Settings/ Specifications (page 9-3)”.	N U V C	PRTN
SEF Trips Lockout #	The number of sensitive earth fault trips to lockout. See “ Sensitive Earth Fault Protection (SEF) Settings/ Specifications (page 9-3)”.	N U R L V C	PRTN
SEF Vzps Ignore	Sensitive earth fault protection ignored if Vzps was too low. See “ Sensitive Earth Fault Protection (SEF) Settings/ Specifications (page 9-3)”.	N U R L V C	PRTN
Select/Exec TO ####s		N U R L V C	PTCL
Select/Op #####ms	For DNP3, maximum time permitted in milliseconds, between receiving a select command message and an operate command message from the master station for the control action to be deemed valid.	N U R L V C	PTCL
Send Class ALL	For DNP3, unsolicited response class reporting. All available events, irrespective of class, would be included in the unsolicited message.	N U R L V C	PTCL
Send Class PRIORITY	For DNP3, unsolicited response class reporting. Any events available of equal or higher priority are sent.	N U R L V C	PTCL
Send Class READY	For DNP3, unsolicited response class reporting. Only the events of that class are reported.	N U R L V C	PTCL
Seq Comp Available	Sequence components measurements are available.	N U R L V C	CTRL
Seq Comp Not Avail	Sequence components measurements are not available.	N U R L V C	CTRL
Seq Reset Time ####s	Auto reclose sequence reset time in seconds.	N U R L V C	PRTN
Seq:Reset Flags OFF		N U R L V C	CTRL

List of Events (cont)

Event Text	Description	Switchgear	Category
Seq:Reset Flags ON		N U R L V C	CTRL
Sequence Advance	With sequence control ON, this event was generated when the sequence counter advanced due to a downstream fault which did not cause a protection trip. See " Sequence Control (page 9-45)".	N U R L V C	PRTN
Sequence OFF	Automatic reclose sequence control was disabled. See " Sequence Control (page 9-45)".	N U R L V C	PRTN
Sequence ON	Automatic reclose sequence control was enabled. See " Sequence Control (page 9-45)".	N U R L V C	PRTN
Sequence Reset	The sequence reset timer expired. This causes the protection relay to reset to the start of the circuit breaker sequence for the next fault. See " Sequence Control (page 9-45)".	N U R L V C	PRTN
Set PT Cmd ###		N U R L V C	PTCL
SF6 Pressure High	Sulphur hexafluoride (SF6) gas pressure was high.	N R L	SWGR
SF6 Pressure Low	Sulphur hexafluoride (SF6) gas pressure low.	N R L	SWGR
SF6 Pressure Normal	Sulphur hexafluoride (SF6) gas pressure was normal.	N R L	SWGR
Sim Sawtooth Wave	Simulated data was set to a sawtooth wave.	N U R L V C	CTRL
Sim Sine Wave ON	Simulated data was set to a sine wave.	N U R L V C	CTRL
Sim Square Wave ON	Simulated data was set to a square wave.	N U R L V C	CTRL
Sim Triangle Wave	Simulated data was set to a triangle wave.	N U R L V C	CTRL
Simulation OFF	Waveform simulation was set OFF. See " Waveform Capture (page 12-4)".	N U R L V C	CTRL
Single Cmd ###		N U R L V C	PTCL
Single Pts ###		N U R L V C	PTCL
Single Shot	A trip occurred whilst in Single Shot Mode. See " Auto Restore (page 9-26)".	N U R L V C	PRTN
Single Shot Trip ##	Single shot active trip number.	N U R L V C	PRTN
Slave Port #	DNP3 TCP/IP Slave port number.	N U R L V C	PTCL
SOM Not/Available	Supply outage monitoring feature was made available or not available.	N U R L V C	PQ
SOS Multi Not/Avail	SOS Multidrop feature not available or available.	N U R L V C	PTCL
Source... Load...	The operator (local or remote) changed the power flow direction. See " Directional Protection (page 9-22)".	C N R L U V	CTRL
Source Out...	The accumulated time the source side terminals have experienced an outage.	N U R L V C	PQ
Source Supply ON/OFF	All configured source side voltages are ON or OFF. See " Directional Protection (page 9-22)".	N U R L V C	NWRK PRTN
SS Reset Time #####s	Single shot protection reset time in seconds.	N U R L V C	PRTN
Start at Pickup		N U R L V C	PRTN
Start at Rst Thresh		N U R L V C	PRTN
Start Day ##	Daylight saving's start day of the start month.	N U R L V C	PTCL
Start Month ##	Daylight saving's start month.	N U R L V C	PTCL
Station Addr ###	MITS Protocol station address number.	N U R L V C	PTCL
Stop bits #	The number of RS232 stop bits for a communications port.	N U R L V C	PTCL
Sub ###		N U R L V C	CTRL
Supply Timeout #####s	Time in seconds the lines must be live/dead before changing live/dead state.	N U R L V C	CTRL PRTN
SW Inconsistent	Software installed in the CAPE and the PSU are inconsistent. New code should be installed via WSOS5's ADV C Loader.	N U R L V C	CTRL
SW Load Aborted	Software load was aborted.	N U R L V C	CTRL
SW Load Completed	Software load was completed.	N U R L V C	CTRL
SW Load Flash Write	Software load flash write in progress.	N U R L V C	CTRL
SW Load Starting	Software load process was started.	N U R L V C	CTRL

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Event Text	Description	Switchgear	Category
Swell for #####s	A Swell event of this duration occurred. See “ Sag and Swell Monitoring (page 12-6)”.	N U R L V C	PQ
Swell Monitor OFF	Swell Monitoring is turned OFF. See “ Sag and Swell Monitoring (page 12-6)”.	N U R L V C	PQ
Swell Monitor ON	Swell Monitoring is turned ON. See “ Sag and Swell Monitoring (page 12-6)”.	N U R L V C	PQ
Swell to #####pu	A Swell event to this pu level occurred. See “ Sag and Swell Monitoring (page 12-6)”.	N U R L V C	PQ
SWGM Unprogrammed	SWGM was unprogrammed.	N U R L V C	CTRL
Switch Closed	On power up and switch re-connection the circuit breaker was measured as closed.	N U R L V C	SWGR
Switch Connected	Switchgear was connected to the controller.	N U R L V C	SWGR
Switch Disconnected	Switchgear was disconnected from the controller.	C N R L U V	CTRL SWGR
Switch Open	On power up and switch re-connection the circuit breaker was measured as open.	N U R L V C	SWGR
Switch S/N #####	Switchgear with serial number ##### was connected.	N U R L V C	SWGR
Switch Unsupported	Switchgear connected was unsupported.	C N R L U V	CTRL SWGR
System Freq 50Hz	Nominal system frequency was 50Hz.	N U R L V C	CTRL
System Freq 60Hz	Nominal system frequency was 60Hz.	N U R L V C	CTRL
t0:Connect TO ####s	Seconds to try an 'Active Open' before starting another Active Open	N U R L V C	PTCL
t1:Confirm TO ####s	Seconds the controller will wait for an outstanding confirmation.	N U R L V C	PTCL
t2:Ack TO ####s	time the receiving station will hold-off sending an acknowledgement.	N U R L V C	PTCL
t3:Idle TO #####s	Seconds before a test message is transmitted - zero means NO message	N U R L V C	PTCL
Target #####	Communication trace target port. See “ 13 Communications (page 13-1)”.	N U R L V C	PTCL
TCP/IP Port #####	The TCP/IP port number defined for IEC104 on this controller	N U R L V C	PTCL
TCP/IP Un/Available	TCP/IP communications available or not available. See “ 13 Communications (page 13-1)”.	N U R L V C	PTCL
Terminals A/B/C	Terminal to phase designation.	N U R L V C	CTRL
Terminals A/C/B	Terminal to phase designation.	N U R L V C	CTRL
Terminals B/A/C	Terminal to phase designation.	N U R L V C	CTRL
Terminals B/C/A	Terminal to phase designation.	N U R L V C	CTRL
Terminals C/A/B	Terminal to phase designation.	N U R L V C	CTRL
Terminals C/B/A	Terminal to phase designation.	N U R L V C	CTRL
Test ABORT	Battery test aborted. See “ 18 Battery Testing (page 18-1)”.	N U R L V C	CTRL
Test Batt	Quick key configured to access the battery test.	N U R L V C	CTRL
Test OFF	The battery test was turned OFF. See “ 18 Battery Testing (page 18-1)”.	N U R L V C	CTRL
Test START	The battery test started. See “ 18 Battery Testing (page 18-1)”.	N U R L V C	CTRL
Test Status AUTO	The battery test was set to operate automatically. See “ 18 Battery Testing (page 18-1)”.	N U R L V C	CTRL
Test Status OFF	The battery test was turned OFF. See “ 18 Battery Testing (page 18-1)”.	N U R L V C	CTRL
Test Time #####	The time of day to operate the automatic battery test. See “ 18 Battery Testing (page 18-1)”.	N U R L V C	CTRL
Tie ACR	Tie ACR type defined for loop automation.	N U R L V C	PRTN
TieRestore Both ways	Loop automation Tie restore supply for loss of load or source supply. See “ 14 Automation (page 14-1)”.	N U R L V C	PRTN
TieRestore One way	Loop automation Tie restore supply for loss of load supply. See “ 14 Automation (page 14-1)”.	N U R L V C	PRTN

List of Events (cont)

Event Text	Description	Switchgear	Category
Time Dly Rq #####min	The amount of time, in minutes, after the last master station time synchronisation message that the controller was set to wait before setting the 'Time Synchronisation Required' internal indication bit (IIN1-4). This bit is sent to the master station in every controller DNP3 message.	N U R L V C	PTCL
Time Mult #####	Protection curve time multiplier. Multiplies the time to trip.	N U R L V C	PRTN
Time size 24		N U R L V C	PTCL
Time size 56		N U R L V C	PTCL
Timeout ##### Min	Communications trace timeout in minutes. This was the maximum duration of the trace.	N U R L V C	PTCL
Timing	One or more protection elements were timing.	N U R L V C	PRTN
Timing Fwd/Rev	One or more protection elements in this direction were timing.	N U R L V C	PRTN
Trace Available	Communications trace was made available.	N U R L V C	PTCL
Trace Not Available	Communications trace was not made available.	N U R L V C	PTCL
Trip after # faults		RL	PRTN
Trip Angle ##### Deg	Directional protection trip angle (in degrees) between the voltage and current.	N U R L V C	PRTN
Trip Blocking OFF	Trip blocking was disabled. The circuit breaker would now trip when requested. See ~~~.	N U R L V C	CTRL
Trip Blocking ON	The circuit breaker was prevented from tripping. See ~~~.	C N R L U V	CTRL SWGR
Trip Coil Connected	The Trip solenoid isolate switch on the Operator Interface was changed to the Enable position. See "6 Operator Interfaces (page 6-1)" .	N U R L V C	SWGR
Trip Coil Disconn	The Trip solenoid isolate switch on the Operator Interface was changed to the Isolate position. See "6 Operator Interfaces (page 6-1)" .	C N R L U V	CTRL SWGR
Trip Coil Failed		N U R L V C	SWGR
Trip Fwd	Directional blocking would allow tripping in the forward direction. This could be applied to phase, earth, SEF, and NPS protection. See "Directional Blocking (page 9-27)" .	N U R L V C	PRTN
Trip Fwd & Rev	Directional blocking would allow tripping in the either direction. This could be applied to phase, earth, SEF, and NPS protection. See "Directional Blocking (page 9-27)" .	N U R L V C	PRTN
Trip Rev	Directional blocking would allow tripping in the reverse direction. This could be applied to phase, earth, SEF, and NPS protection. See "Directional Blocking (page 9-27)" .	N U R L V C	PRTN
Trips to Lockout ##	Number of protection trips to lockout.	N U V C	PRTN
Tx Bytes #####	Communications trace count of transmitted bytes.	N U R L V C	PTCL
Tx Count #####	For the communications trace utility, the number of byte groups transmitted. Note this does not necessarily relate to packets.	N U R L V C	PTCL
Tx Delay #####ms	For DNP3, additional time in milliseconds, between receiving a request and sending a response.	N U R L V C	PTCL
U Series Switch	U Series Switch	U	CTRL
U/F Normal ###Hz	Under frequency protection's normal frequency in Hertz. See "Under and Over Frequency Protection Elements (page 9-33)" .	N U R L V C	PRTN
U/F Trip at ###Hz	Under frequency protection trip this frequency in Hertz. See "Under and Over Frequency Protection Elements (page 9-33)" .	N U R L V C	PRTN
U/F Trip ON/OFF	Under frequency protection trip was enabled or disabled. See "Under and Over Frequency Protection Elements (page 9-33)" .	N U R L V C	PRTN
U/O Freq Available	Under/Over frequency protection was made available. See "Under and Over Frequency Protection Elements (page 9-33)" .	N U R L V C	PRTN
U/O Freq Not Avail	Under/Over frequency protection was not made available. See "Under and Over Frequency Protection Elements (page 9-33)" .	N U R L V C	PRTN
Under Freq Pickup	Measured frequency was equal to or below the under frequency threshold. See "Under and Over Frequency Protection Elements (page 9-33)" .	N U R L V C	PRTN

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Event Text	Description	Switchgear	Category
Under Freq Reset	The measured frequency rose to equal or above the Under Frequency trip threshold plus the dead band. See " Under and Over Frequency Protection Elements (page 9-33)".	N U R L V C	PRTN
Under Freq Trip	The measured frequency was equal to or below the Under Frequency threshold for the Trip Delay count and a trip request was issued. See " Under and Over Frequency Protection Elements (page 9-33)".	N U R L V C	PRTN
Unknown	Batt Test Aborted because of an unknown reason	N U R L V C	CTRL
Unsol Delay #####s	For DNP3, unsolicited response retry delay in seconds.	N U R L V C	PTCL
Unsol Retries ###	For DNP3, maximum number of attempts to re-transmit an unsolicited response without getting a confirmation from the master.	N U R L V C	PTCL
Unsolicited FORCED	For DNP3, the controller would transmit unsolicited response change of state events immediately without waiting for the 'Enable Unsolicited Messages' command from the master station.	N U R L V C	PTCL
Unsolicited OFF	For DNP3, unsolicited messages from the controller are disabled.	N U R L V C	PTCL
Unsolicited ON	For DNP3, unsolicited messages from the controller are enabled.	N U R L V C	PTCL
UOV Available	Under/Over Voltage protection was made available. See " Under and Over Voltage Protection (page 9-37)".	N U R L V C	PRTN
UOV Not Avail	Under/Over Voltage protection was made unavailable. See " Under and Over Frequency Protection Elements (page 9-33)".	N U R L V C	PRTN
UV Excess Seq	Under Voltage Protection excess sequences.	N U R L V C	PRTN
UV Pickup	The measured voltage was equal to or below the under voltage threshold.	N U R L V C	PRTN
UV Protection OFF	Under Voltage protection is turned off. See " Under and Over Frequency Protection Elements (page 9-33)".	N U R L V C	PRTN
UV Protection ON	Under Voltage protection is turned on. See " Under and Over Frequency Protection Elements (page 9-33)".	N U R L V C	PRTN
UV Reset	The measured voltage rose to equal or above the Under voltage trip threshold plus the dead band.	N U R L V C	PRTN
UV Trip	The measured voltage was equal to or below the Under Voltage threshold for the Trip Delay count and a trip request was issued.	N U R L V C	PRTN
V Series Switch	V Series switchgear connected.	V C	CTRL
V/I a/b/c/e: THD #.##%	Harmonic analysis alarm ON. Total harmonic distortion of #.##%. See " Harmonic Analysis (page 12-2)".	N U R L V C	PQ
V/I a/b/c: THD OFF	Harmonic analysis alarm OFF. Below total harmonic distortion level. See " Harmonic Analysis (page 12-2)".	N U R L V C	PQ
"Very/Ext Inv IEC255, Definite Time, Instantaneous Only, Mod/Very/Ext Inv IEEE, TCC###"	Different curve selected for Earth, NPS, Phase, Work Tag or Single Shot Protection.	C N R L U V	PQ PRTN
Vnps ##### Volt	Directional blocking measure of negative phase sequence volts. See " Directional Blocking (page 9-27)".	N U R L V C	PRTN
VWE/VWVE Emulator	SCEM type was VWE/VWVE Emulator.	V C	SWGR
Vzps ##### Volt	Directional blocking measure of zero phase sequence voltage at the time of maximum earth or SEF current. This event can only occur with Directional Blocking ON. See " Directional Blocking (page 9-27)".	N U R L V C	PRTN
Vzps Bal DISABLED	Directional blocking zero phase sequence voltage balancing disabled. See " Directional Blocking (page 9-27)".	N U R L V C	PRTN
Vzps Bal ENABLED	Directional blocking zero phase sequence voltage balancing enabled. See " Directional Blocking (page 9-27)".	N U R L V C	PRTN
w:Max Unack ###	Maximum number of unacknowledged I-Format APDU received.	N U R L V C	PTCL
Wave Capt Avail	Waveform capture was made available. See " Waveform Capture (page 12-4)".	N U R L V C	PQ
Wave Capt Not Avail	Waveform capture was not made available. See " Waveform Capture (page 12-4)".	N U R L V C	PQ
Wave Capture OFF	Waveform capture was set OFF. See " Waveform Capture (page 12-4)".	N U R L V C	PQ
Wave Capture ON	Waveform capture was set ON. See " Waveform Capture (page 12-4)".	N U R L V C	PQ

List of Events (cont)

Event Text	Description	Switchgear	Category
Waveform Captured	Waveform data was captured. See " Waveform Capture (page 12-4)".	N U R L V C	PQ
Waveform Playback	The simulation feature was playing back the captured waveform. See " Waveform Capture (page 12-4)".	N U R L V C	CTRL
WCap Ratio #####	Waveform capture ratio indicates the percentage prior to the trigger then the percentage after the trigger. See " Waveform Capture (page 12-4)".	N U R L V C	PQ
WCap Window 0.5s	Waveform capture window was set to 0.5 seconds long. See " Waveform Capture (page 12-4)".	N U R L V C	PQ
WCap Window 1s	Waveform capture window was set to 1 second long. See " Waveform Capture (page 12-4)".	N U R L V C	PQ
WCap Window 2s	Waveform capture window was set to 2 second long. See " Waveform Capture (page 12-4)".	N U R L V C	PQ
Work Tag	A work tag protection trip, or the quick key now controls the work tag. See " Work Tag Mode Protection Settings (page 8-4)".	C N R L U V	CTRL PRTN
Work Tag Applied	The Work Tag was applied. See " Work Tag (page 8-4)".	C N R L U V	CTRL PRTN SWGR
Work Tag OFF	The Work Tag was turned OFF. See " Work Tag (page 8-4)".	N U R L V C	PRTN CTRL
Wrong Mode	When the switch was in a different mode (LOCAL, Remote or Work Tag Applied) to the device which attempted the close. See " Local, Remote, Hit and Run / Delayed Operation (page 8-1)".	N U R L V C	SWGR CTRL
WSOS Close Req	WSOS initiated the close request.	N U R L V C	SWGR
WSOS Trip Req	WSOS initiated the trip request.	N U R L V C	SWGR
WSOS Un/Available	WSOS communications available or not available.	N U R L V C	PTCL

Appendix O Automation Pages

This appendix shows the Automation Group of pages on the Operator Interface (O.I.). Appendix J (page 1) explains the format of this appendix.

See “Automation” on page 14-1. for more information on automation functionality.

LOOP AUTOMATION STATUS

LOOP AUTOMATION STATUS				A
Loop Auto OFF	P	Tie ACR		P
Loop Auto ON	P			
LOOP AUTO TURNED OFF BY OPERATOR ACTION MUST BE ON FOR AUTOMATIC OPERATION				D

LOOP AUTOMATION CONFIGURATION

LOOP AUTOMATION CONFIGURATION 1				A
Tie ACR	P	AutoRestore OFF		P
	P	TieRestore one way		
	P	Delay Time 30s		

LOOP AUTOMATION CONFIGURATION 2				A
AutoRes Avail	P			
AutoRes Not Avail				
LOP/Loop Unlinked	P			

Appendix P

ANSI Device Numbers ANSI

DEVICE NUMBERS

ANSI Device #	ADVC Protection Element	ANSI Device Description
12	Overspeed Relay	
14	Underspeed Relay	
21	Distance Relay	
24	OVEREXCITATION RELAY	Functions with time delay (inverse, step or definite time) for overexcitation conditions as evidenced by Volts/Hertz.
25	SYNC-CHECK RELAY	Functions when two AC circuits are within desired limits of frequency, phase angle and voltage to permit the paralleling of these two circuits.
25A	AUTOMATIC SYNCHRONIZING RELAY	Acts to bring two AC circuits within desired limits of frequency, phase angle and voltage, then initiates the paralleling of these two circuits.
26	OVER TEMPERATURE RELAY	
27	UNDERVOLTAGE RELAY	Functions on a given value of undervoltage.
27N	GROUND FAULT UNDERVOLTAGE RELAY	Functions on a given value of third harmonic undervoltage.
32	POWER RELAY	Functions on a desired value of power flow in a given direction.
37	UNDERCURRENT RELAY	Functions on a given value of undercurrent.
40	LOSS OF FIELD RELAY	Functions on a given value of dc field current.
46	PHASE BALANCE CURRENT RELAY	Functions on a given degree of imbalance between the polyphase currents.
46N	NEGATIVE SEQUENCE OVERCURRENT	Functions when the polyphase currents contain negative sequence components above a given value.
47	PHASE SEQUENCE VOLTAGE RELAY	Functions on a given value of polyphase voltage in the desired phase sequence.
47N	NEGATIVE SEQUENCE VOLTAGE RELAY	Functions on a given value of the negative sequence component of the polyphase voltage.
49	THERMAL RELAY	Functions when the temperature of a machine, transformer or other load-carrying winding exceeds a given value.
50	INSTANTANEOUS OVERCURRENT RELAY	Functions without intentional time delay when the current exceeds a given value.
50BF	BREAKER FAILURE RELAY	Functions when current continues to flow after the monitored breaker should have interrupted a fault.
51	TIME OVERCURRENT RELAY	Functions with a definite or inverse time characteristic when the current exceeds a given value.
51/27C	VOLTAGE CONTROLLED TIME OVERCURRENT RELAY	A time overcurrent relay whose pickup is adjusted by an undervoltage function.
51/27R	VOLTAGE RESTRAINED TIME OVERCURRENT RELAY	A time overcurrent relay whose pickup is adjusted by an undervoltage function.
59	OVERVOLTAGE RELAY	Functions as a given value of overvoltage.
59N	GROUND FAULT OVERVOLTAGE RELAY	Functions on a given value of Overvoltage at the fundamental frequency.
60	VOLTAGE BALANCE RELAY	Functions on a quantitative voltage difference between two circuits.
67	AC DIRECTIONAL OVERCURRENT RELAY	Functions on a desired value of AC overcurrent flowing in a predetermined direction.
78	PHASE ANGE RELAY	
79	AC RECLOSING RELAY	Controls the automatic reclosing and locking out of an ac circuit interrupter.
81	FREQUENCY RELAY	Functions on a predetermined value of frequency (either under or over or on normal system frequency) or rate of change of frequency.
87	DIFFERENTIAL PROTECTIVE RELAY	Functions on a percentage or phase angle or other quantitative difference of two currents or of some other electrical quantities.

Appendix Q

flexVUE Menu Structure

Operator Menu (cont)

MENU

- ↳ OPERATOR MENU
- ↳ ENGINEER MENU
- ↳ ALERTS MENU

The submenus for these options are shown below. (Alerts menu is not detailed)

- Fields with **ACR** indicate availability only when the switchgear is operating as an *AUTOMATIC CIRCUIT RECLOSER*
- Fields with **LBS** indicate availability only when the switchgear is operating as a *LOAD BREAK SWITCH*
- If the field has no indicator it applies to *BOTH* ACR and LBS
- The curly bracket indicates that the options replace each other depending on operation as ACR or LBS.

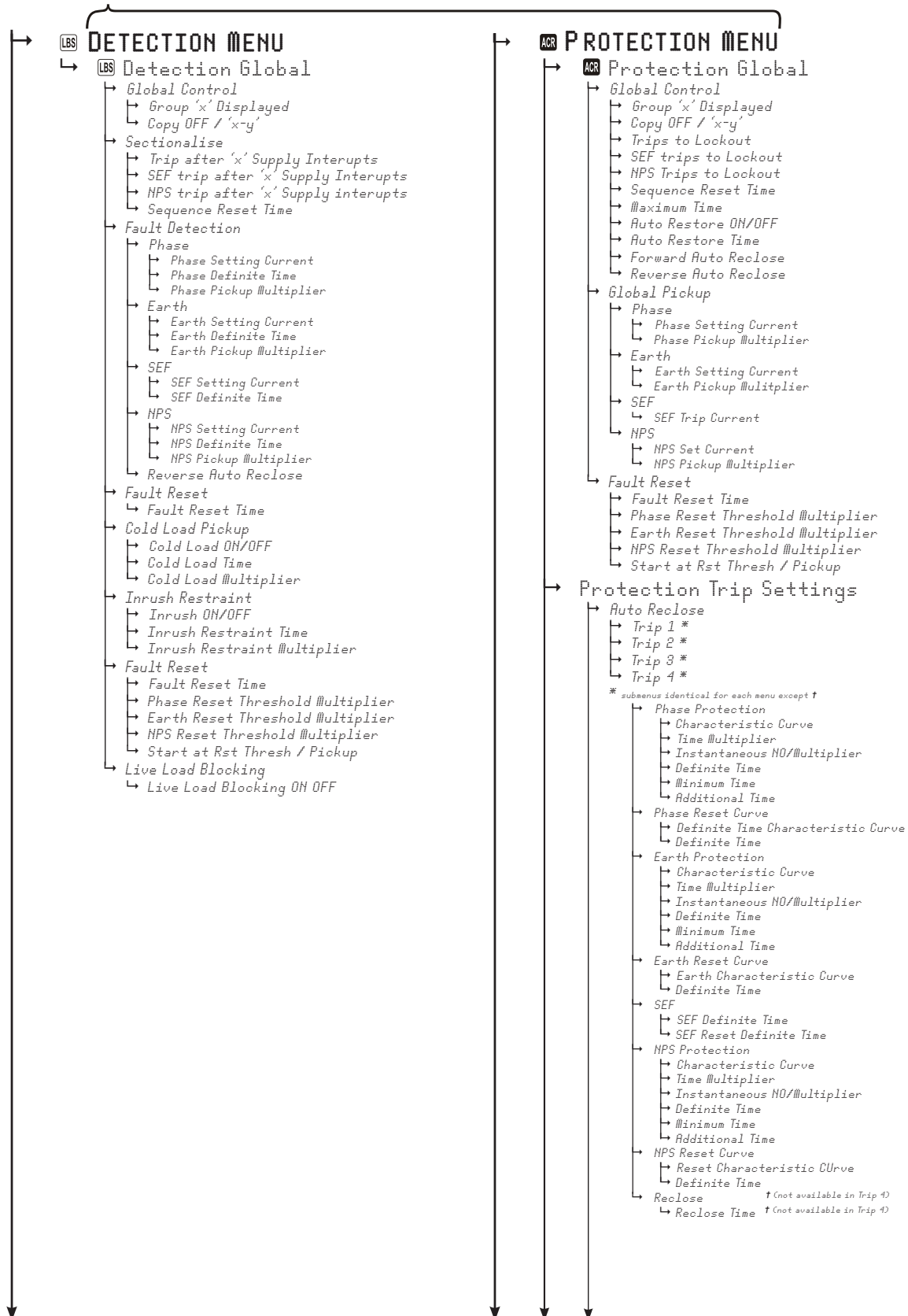
OPERATOR MENU

- ↳ OPERATOR CONTROLS
 - ↳ Local/Remote/Hot&Run
 - ↳ { **LBS** Sectionalizer AUTO/OFF
 - ↳ { **ACR** Autoreclose ON/OFF/Protection OFF
 - ↳ Earth-SEF ON/OFF
 - ↳ NPS Alarm/Trip/OFF
 - ↳ { **LBS** Detection Group Active
 - ↳ { **ACR** Protection Group Active
 - ↳ { **LBS** ADGS Off/Auto
 - ↳ { **ACR** APGS Off/Auto
 - ↳ Work Tag ON/OFF
 - ↳ Cold Load
 - ↳ { **ACR** Forward CLP xx###INxxX
 - ↳ { **ACR** Reverse CLP xx###INxxX
 - ↳ Battery Health Test Manual Start
 - ↳ Radio Supply ON/OFF
 - ↳ Low Gas Inhibit ON/OFF
 - ↳ Demand Period
 - ↳ { **LBS** Interruption Counter
 - ↳ { **ACR** Sequence
- ↳ SWITCHGEAR STATUS
 - ↳ Switchgear Info
 - ↳ Function - ACR/LBS
 - ↳ Switch Type (eg N,U,III,RL)
 - ↳ Switch Serial #
 - ↳ Interruption kA
 - ↳ Voltage Rating
 - ↳ Current Rating
 - ↳ Cubicle S/N (set by commissioning tech)
 - ↳ App. Ver A44.. - Code Version
 - ↳ Switchgear Data
 - ↳ SF6 Pressure
 - ↳ Auxiliary Supply Status
 - ↳ Battery Status
 - ↳ Switch Status [Connected]
 - ↳ Switch Data [Valid]
 - ↳ Switch Operations
 - ↳ Contact Wear
 - ↳ U Contact %
 - ↳ U Contact %
 - ↳ III Contact %

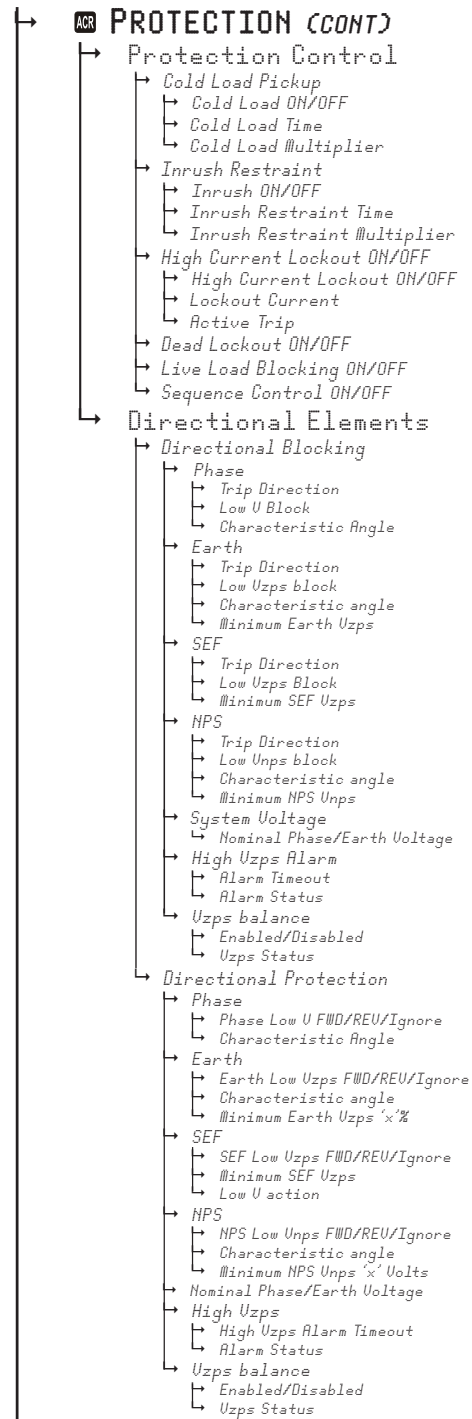
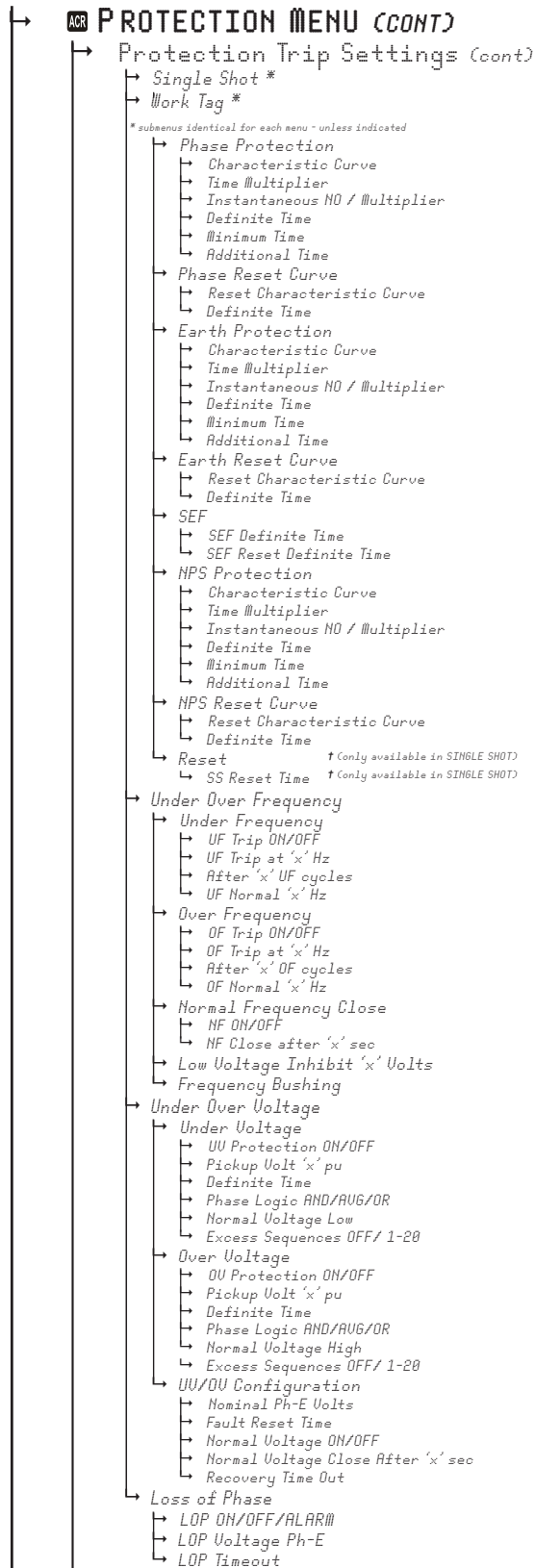
OPERATOR MENU (CONT)

- ↳ MEASUREMENTS
 - ↳ System Measurements
 - ↳ AVG Current
 - ↳ AVG Voltage
 - ↳ Frequency
 - ↳ Power Factor
 - ↳ 3PH Power P [Kw]
 - ↳ 3PH Power Q [kVAr]
 - ↳ Current
 - ↳ A Phase Magnitude & Angle
 - ↳ B Phase Magnitude & Angle
 - ↳ C Phase Magnitude & Angle
 - ↳ Earth Magnitude & Angle
 - ↳ Bushing Indication
 - ↳ A1 Live/Dead
 - ↳ A2 Live/Dead
 - ↳ B1 Live/Dead
 - ↳ B2 Live/Dead
 - ↳ C1 Live/Dead
 - ↳ C2 Live/Dead
 - ↳ Maximum Demand Indicator
 - ↳ A Phase Max & Time (scroll)
 - ↳ B Phase Max & Time (scroll)
 - ↳ C Phase Max & Time (scroll)
 - ↳ Reset MDI
- ↳ INDICATIONS
 - ↳ Flags
 - ↳ O/C
 - ↳ E/F
 - ↳ SEF
 - ↳ { **ACR** LOP
 - ↳ { **ACR** UOV
 - ↳ NPS
 - ↳ { **ACR** EXT
 - ↳ { **ACR** FRQ
 - ↳ Operations Count

ENGINEER MENU

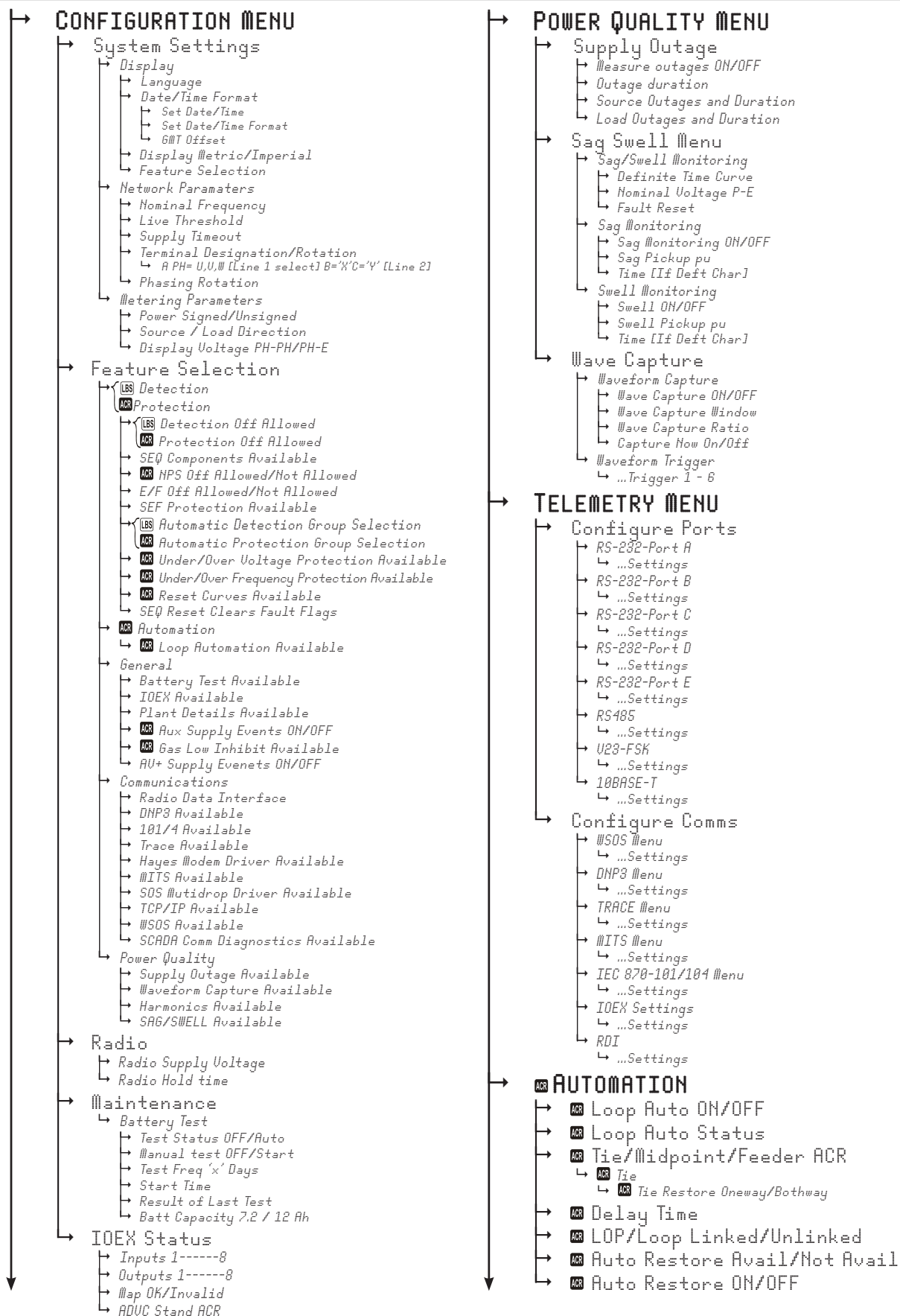


Engineer Menu (cont)

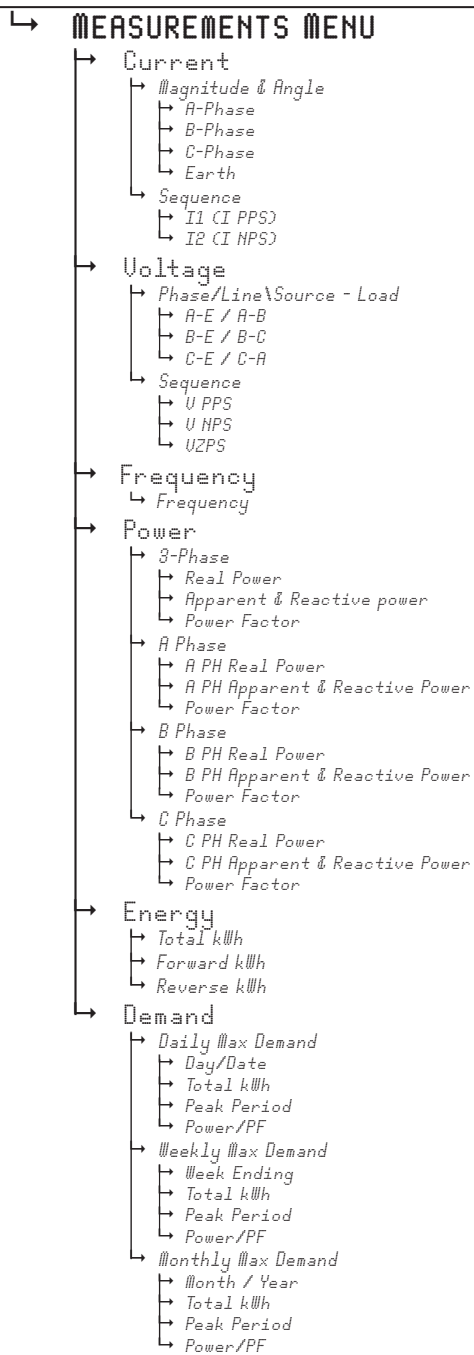


ADVC Controller Operations Manual

Engineer Menu (cont)



Engineer Menu (cont)



Appendix R

setVUE Menu Structure

The **setVUE** menu system allows for up to six fields on the LCD. And many categories have multiple pages for each setting category.

This page provides a guide as to the **setVUE** menu structure.

SYSTEM STATUS

- TRIP FLAGS
- OPERATOR SETTINGS
- SYSTEM SETTINGS
- SWITCHGEAR STATUS
- LIVE/DEAD INDICATION
- PHASE VOLTAGE AND POWER FLOW
- TERMINAL DESIGNATION/ROTATION
- RADIO
- SWITCHGEAR TYPE AND RATINGS
- SWITCHGEAR WEAR/GENERAL DETAILS
- OPTIONS
 - Optional Pages
 - Quick Key Selection
 - IOEX Status
 - Hit and Run
 - Waveform Capture
 - Waveform Trigger
 - etc

EVENT LOG

- << EVENT TEXT >>
 - ↳ Event Filters

MEASUREMENTS

- SYSTEM MEASUREMENTS
- CURRENT
- VOLTAGES
- POWER
- DAILY MAXIMUM DEMAND
 - ↳ Daily Maximum Demand History
- WEEKLY MAXIMUM DEMAND
 - ↳ Weekly Maximum Demand History
- MONTHLY MAXIMUM DEMAND
 - ↳ Monthly Maximum Demand History
- MAXIMUM DEMAND INDICATOR
 - ↳ Reset Maximum Demand Indicator
- Optional Pages
 - Sequence Voltage
 - Supply Outages
 - etc

PROTECTION

- PROTECTION SETTINGS
- PHASE PROTECTION TRIP NUMBER
- PHASE SINGLE SHOT PROTECTION TRIP
- PHASE WORK TAG PROTECTION TRIP
- EARTH PROTECTION TRIP NUMBER
- EARTH SINGLE SHOT PROTECTION TRIP
- EARTH WORK TAG PROTECTION TRIP
- Optional Pages
 - NPS Protection Trip Number
 - NPS Single Shot Protection Trip
 - NPS Work Tag Protection Trip
 - Under/Over Frequency Protection
 - etc

AUTOMATION

- E.G. LOOP AUTOMATION

COMMUNICATION

- COMMUNICATIONS SETUP
- CONFIGURE PORTS
 - ↳ RS-232-A/B/C/D
 - ↳ RS485
 - ↳ V23
 - ↳ 10BASE-T
 - ↳ etc
- CONFIGURE COMMS
 - ↳ WSOS
 - ↳ DNP3
 - ↳ IOEX
 - ↳ TRACE
 - ↳ etc

