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INDUSTRIES

A SCHNEIDER ELECTRIC COMPANY

ELECTRICAL SWITCHGEAR ENGINEERS AND
AUTOMATION SPECIALISTS

U-Series solid dielectric automatic circuit recloser

The U-Series solid dielectric automatic circuit recloser (also known as a circuit breaker) represents Nu-Lec Industries' commitment to improved products and ongoing product development. It provides the features of a traditional recloser, plus the benefits of up to date design optimised for automation, remote control and monitoring, now or in the future.

The development of this product was driven by customer demand for improved return on capital investment in the distribution network. After carefully evaluating customers' needs, the U-Series ACR was developed to achieve optimum performance and reliability, making use of the very latest available technology in solid dielectrics, vacuum interruption and microelectronics. The result is a competitive world-class product of which we are justly proud.

In the past, distribution equipment such as reclosers have been purchased only to support load growth. Today your customers, electricity consumers, are demanding reduced outages and lower tariffs. We at Nu-Lec Industries are continually working to provide advanced equipment needed for tomorrow's competitive electricity distribution system.

By using this technologically advanced equipment, operating costs will be reduced, revenue will be increased through reduced outages and capital works can be deferred through better management of existing plant.

In addition to automatic circuit reclosers, the Nu-Lec Industries family of switchgear includes a range of remotely controlled and monitored pole mounted load break switches and sectionalisers as well as remote control and monitoring software. This product family is a complete solution for distribution system automation.

Reduced Purchase Cost

- The V23 FSK modem and Remote Terminal Unit (RTU) are included in the standard equipment. No additional RTU, modem, power supplies, batteries, wiring, connectors or enclosures are required.

Reduced Installation Costs

- Commissioning of the unit is simple. Configuration of the device is menu driven from the Operator Control Panel.
- Pole mounting brackets are provided in the standard package. Lightning arrester mounting is optional.

Reduced Operating Costs

- The integral protection relay provides fast isolation of faults, reducing damage.
- The recloser constantly monitors line current and voltage without the need for additional statistical measurement devices. This data can then be used for forward planning and optimisation of existing plant. This will reduce distribution system losses.
- Long lifetime, low maintenance equipment reduces lifetime cost. The solid dielectric construction ensures a long life, low maintenance product.

Improved Environmental Aspects

- Enclosing the vacuum interrupter in a solid epoxy bushing eliminates the need for oil or gas insulation.

DSA/SCADA Compatibility

When used with a compatible Distribution System Automation (DSA) or SCADA system, Nu-Lec Industries automatic circuit reclosers support remote control and monitoring to provide the following advantages:

- Information on recloser status and fault current values transmitted to system control allows fast location of the faulted line section, reducing the travelling time of line crews.
- This same information allows informed remote or automatic switching of lines, which reduces the area affected and quickly restores supply. Quality of supply is improved as a result.
- Reclosers can be configured and managed from system control, without technicians having to visit each individual recloser in the field to change configuration settings. This allows a reduction in staffing and improved system integrity.

Increased Revenue

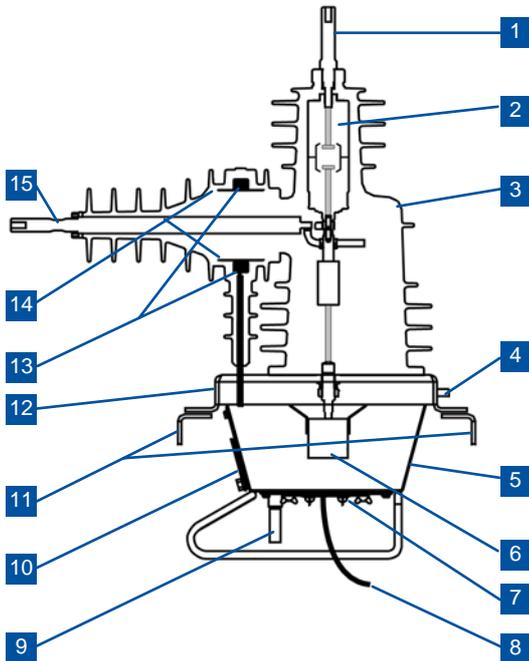
- Supply can be quickly restored to unaffected areas, resulting in less outage time and therefore increased revenue.

Deferred Capital Works

- Remotely controlled and monitored reclosers give an improved knowledge of a system and enhance system control. Feeder and substation load can then be remotely managed and switched, providing cross re-inforcement of substations and improving utilisation of existing plant. Purchase of new plant can then most likely be deferred for a considerable period of time.

Recloser Overview and Operation

The U-Series automatic circuit recloser uses vacuum interrupters, contained in epoxy bushings, eliminating the need for insulants like oil and gas. The mechanism is enclosed in a 316 grade stainless steel tank with a stainless steel lid. The cyclo-aliphatic epoxy resin casting is bolted onto the lid.



Cross section of U-Series solid dielectric recloser

Legend

- | | |
|-------------------------|------------------------------------|
| 1. X-Side Terminal | 10. Pointer |
| 2. Vacuum Interrupter | 11. Lightning arrester brackets |
| 3. Epoxy bushing | 12. Stainless steel lid |
| 4. Earthing Point | 13. Current Transformer |
| 5. Stainless steel tank | 14. Capacitive Voltage Transformer |
| 6. Magnetic Actuator | 15. I-Side Terminal |
| 7. SCEM card | |
| 8. Control cable | |
| 9. Manual Trip Ring | |

Monitoring and control of the recloser is performed by the field proven Pole Top Control and Communications cubicle (PTCC), of which many thousand are in service worldwide. The PTCC houses the Operator Control Panel and microelectronics that provide the protection functions. It is normally located lower down the pole for ease of access and is connected to the circuit breaker by a detachable control cable. The circuit breaker and PTCC together form a remotely controlled and monitored automatic circuit recloser.

The recloser 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 PTCC. 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 PTCC for remote monitoring and display. The PTCC requires an auxiliary AC supply. A control cable connects the PTCC to the bottom of the circuit breaker through a covered plug/socket sealing arrangement on both the PTCC 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 Pole Top Control Cubicle (PTCC) interfaces to the recloser via the control cable and connects to the Switch Control Entry Module (SCEM) in the base of the tank. The SCEM uses EEPROM memory to store all relevant calibration data, ratings and number of operations conducted. The SCEM also provides the first stage of electrical isolation and shorting electronics to short the CTs and CVTs in the event the control cable is disconnected while current is flowing through the recloser.



U-Series solid dielectric casting

Communications Cubicle Overview

The advanced protection, data logging and communications abilities of the U-Series automatic circuit recloser are made possible by the technology housed in the control and communications cubicle. It has been designed especially for outdoor, pole mounted operation and is normally mounted low on the pole for ease of access by maintenance personnel.

The cubicle is insulated and designed to minimise any temperature rise resulting from solar heating. An internal equipment panel is used to mount all the equipment, including the batteries, storage capacitors, mains transformer, low voltage circuit breakers, Control And Protection Module (CAPM), Operator Control Panel and radio or modem. These components are carefully located so that the heat generating parts are at the top, while the battery is at the bottom to keep it cool. In this way battery life in excess of 5 years can be achieved.

All weather access is provided to the Operator Control Panel through a lockable door on the front of the control cubicle. Vents are screened against vermin entry and the door is sealed against the outer with a rubber extrusion. All electronic parts are well protected from entry of moisture and condensation ensuring a long lifetime.

Three models of control and communications cubicle are available, Tropical, Moderate and Temperate. The Tropical version is well ventilated and is suitable for climates where the ambient temperature can reach 50°C and only occasionally goes below 0°C, with a lower limit of -10°C.

The Moderate version has reduced ventilation and is used where temperatures rarely go above 40°C and occasionally go below -5°C, with a lower limit of -15°C.

The Temperate model has a heater installed, making it suitable for climates where the temperature rarely goes above 40°C but can fall as low as -30°C.

All three cubicles are fitted with the same electronics and incorporate the functions of an overcurrent protection relay, a sensitive earth fault relay, a reclose relay, and a remote terminal unit. Additionally, the electronics measure line current, voltage, real and reactive power, fault currents, and stores these for transmission or off-line analysis.

A unique feature of the Nu-Lec Industries automatic circuit recloser is the built-in microprocessor controlled power supply. This provides uninterrupted operation of not only the circuit breaker and protection relay, but also the communications radio or modem. No other power supplies are required for connection into your SCADA or Distribution Automation System.

Due to careful design the efficiency of all parts is extremely high, allowing a battery hold up time of five days after auxiliary supply failure (from fully charged battery, excluding telemetry radio or modem usage). The architecture used has the advantage that the circuit breaker operation is independent of the high voltage supply, relying on a set of batteries charged by the auxiliary supply.

Due to sophisticated power supply management techniques, a circuit breaker operation is always guaranteed when attempted and alarms are raised over the telemetry when auxiliary power is lost.

A communications radio or special modem can be mounted within the control and communications cubicle. A V23 FSK modem is included as standard equipment.



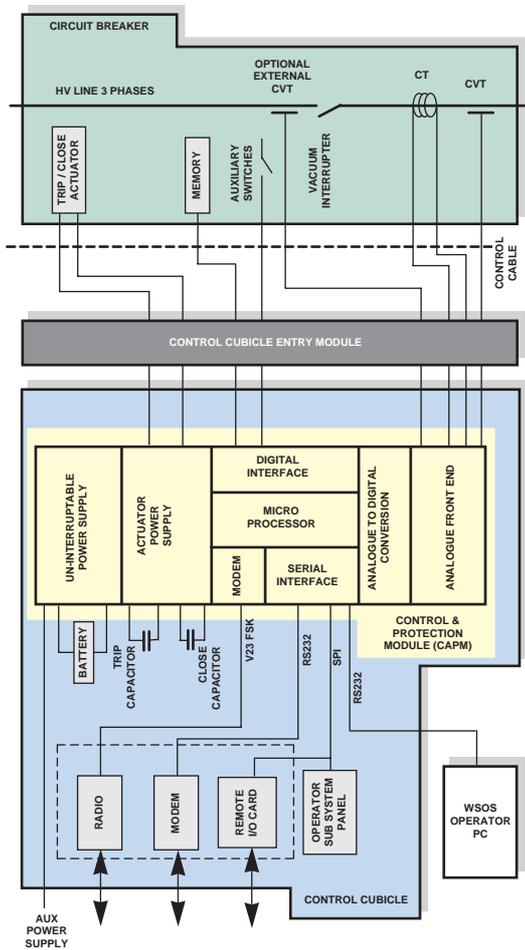
Pole Top Control & Communications Cubicle



Control and Protection Module (CAPM) Circuit Board

Block Diagram & Features

The Nu-Lec Industries automatic circuit reclosers provide many outstanding advantages to the user. New and innovative features have been made possible by the intimate way the pole mounted circuit breaker and communications cubicle work together. The block diagram below shows how the two items are interfaced. The heart of the unit is the Control and Protection Module (CAPM) and the intelligent Operator Control Panel.



Automatic circuit recloser block diagram

HV Line signals are connected into the electronics module by direct connection to the analogue front end. Special extended range current transformers provide a range from 1A to 12,500A for measurement and protection. Embedded voltage screens accurately image the primary voltage value and phase relationship, allowing measurement of voltage, current, power factor and frequency in the electronic module.

Each recloser is provided with an Operator Control Panel which has a four line liquid crystal display with back lighting for night operation. From here a user can access and program the many measurement and protection features available.

Three levels of user interface with the Operator Control Panel are provided as follows:

1. Operator Level

This allows basic operation like Trip, Close and display of settings, such as:

- Protection settings and fault history
- Line measurements and historical data
- Recloser functions such as:

Remote control	ON
Local control	ON
Sensitive Earth Fault	ON/OFF
Earth Fault	ON/OFF
Auto reclose mode	ON/OFF
Close/Trip	ISOLATE
- Alarms/Status such as:
 - Auxiliary supply fail
 - Battery supply fail
 - Lockout

2. Technician Level

This level is password protected at the user's discretion in the "Engineer Level" and allows the setting of all protection related parameters.

3. Engineer Level

This is accessible through a laptop or desktop computer only and allows advanced customisation of the operator panel, setting of passwords, and all the Operator and Technician Level functions.

Telemetry Interface

The Nu-Lec Industries automatic circuit recloser can be interfaced to your SCADA system either through its built-in V23 modem and a radio, or its RS232 port and a modem of your choice. A variable voltage uninterruptible power supply is included for the radio or modem, which can be mounted inside the communications cubicle. Almost all telemetry protocols can be supported. DNP3, IEC870, Conitel and Modbus are some of the available protocols.

Computer Interface

The Windows Switchgear Operating System (WSOS) is an advanced personal computer based software package to allow off-line and on-line programming, monitoring and control of a recloser via the RS232 port. This is available as an option to the basic Nu-Lec Industries recloser.

Remote Control

As an additional option, Nu-Lec Industries offers the WSOS multiple connect PC based software package to individually remote control and monitor a population of field mounted reclosers and/or load break switches. The system communicates with the control cubicle by either cable, fibre optic, telephone line or radio. WSOS provides additional features such as alarm and event handling, dial in and dial out facilities and report generation.



Operator control panel

Operating Sequence

Reclose times are individually selectable. The operating sequence is defined by:
O - 1st rt - CO - 2nd rt - CO - 3rd rt - CO where rt = reclose time.

Reclose Times

1st reclose time:	0.5 - 180 sec
2nd reclose time:	2.0 - 180 sec
3rd reclose time:	2.0 - 180 sec
Timing resolution:	0.1 sec

Fast Trip Input Module

This module is available as an accessory. It provides an optically isolated input to unconditionally trip the recloser within 60ms of activation (including debounce and breaker operating time). This module is purchased as an additional hardware item. For further details or application suitability, refer to Nu-Lec Industries.

Sequence Reset Time

Sequence reset time:	5 - 180 sec
Timing resolution:	1 sec

Trips to Lockout

Overcurrent and fault trips to lockout are selectable between 1 and 4. A separate setting is available for Sensitive Earth Fault (SEF).

Inverse Time Curves

The CAPM offers a total of 48 user selectable inverse time protection curves. These are:

Three IEC255 curves:	Standard Inverse, Very Inverse and Extremely Inverse.
Three IEEE C37.112 Inverse Time curves:	Moderately Inverse, Very Inverse and Extremely Inverse.
42 Non Standard Inverse Time Curves:	Refer to the Technical Manual for a full listing.

User Defined Curves

Up to five User Defined Curves (UDCs) may be selected at the control panel in the same manner as the above curves. The UDC module in WSOS is used to configure the UDCs.

Instantaneous Protection

Instantaneous Protection works by tripping the recloser if the line current exceeds the Instantaneous Multiplier x Setting Current.

Multiplier Range:	1 - 30
Resolution of setting:	0.1
Max effective setting:	12.5kA

Definite Time Protection

Definite Time is available on phase and earth protection as an alternative to Inverse Time protection. It works by tripping the recloser at a fixed time after pickup.

Setting current range:	10 - 1260A
Definite time resolution:	0.1 sec
Definite time range:	0.5 - 100 sec
Setting current resolution:	1A

Sensitive Earth Fault (SEF)

SEF causes the recloser to trip when the earth current rises above a set level for longer than the set time.

SEF trip current range:	4 - 20A
SEF operating time:	0.1 - 100 sec
SEF trip current setting resolution:	1 A
SEF operating time resolution:	0.1 sec

Sequence Coordination

Sequence Coordination allows a recloser to keep its trip sequence in step with another recloser downstream.

Directional Blocking

Directional blocking is an additional protection feature that restricts tripping on faults to a designated side of the recloser. It prevents nuisance tripping if particular network conditions are causing “false” earth faults. In radial systems Directional Blocking prevents nuisance tripping by blocking faults in the source direction and only responding to faults in the load direction.

Live Load Blocking

Live Load Blocking prevents a recloser from closing if any of the load side terminals are live.

Live Load Threshold Voltage Range: 2 - 15kV

Loss of Phase

Loss of Phase Protection trips the recloser if phase-ground voltage on one or two phases falls below a set voltage threshold for a set length of time.

Threshold voltage range: 2 - 15kV
Voltage resolution: 1V
Time range: 0.1 - 100 sec
Time resolution: 0.1 sec

Negative Phase Sequence

Negative Phase Sequence (NPS) current protection enables detection of low level phase-to-phase faults in the presence of high level three phase loads. Inverse Time, Definite Time and Instantaneous operation are available.

Setting current range: 10 - 1260 A

Inrush Restraint

Inrush Restraint raises the phase and earth threshold currents for a short period of time to allow for short duration inrush currents when closing onto a load.

Multiplier Range: 1 - 30
Multiplier Resolution: 0.1
Time Range: 0.05 - 30 sec
Time resolution: 0.05 sec

Cold Load Pickup

Cold Load Pickup allows for a loss of diversity when a load has been without supply for a period of time.

Multiplier Range: 1 - 5
Multiplier Resolution: 0.1
Time Constant Range: 1 - 480 min
Time constant resolution: 1 min

Under / Over Frequency Protection

This is an additional protection feature.

Frequency tripping range: 45 - 65 Hz
Frequency calculation: Once per cycle over a two cycle period
Number of under/over frequency cycles before tripping: 2 - 1000
Accuracy: $\pm 0.05\text{Hz}$

Multiple Protection Groups

The CAPM supports up to 10 Protection Groups, each of which can be configured with completely separate protection characteristics with different inverse time curves and setting currents. The number of protection groups available to the operator can be configured using the Windows Switchgear Operating System thereby restricting or enabling access to protection settings as required.

Range of protection groups: A - J

Automatic Protection Group Selection

Automatic Protection Group Selection is used to change the protection characteristics depending on the direction of power flow. This allows the recloser to be correctly graded with devices downstream regardless of the power flow direction.

Range of protection group pairs: A&B, C&D, E&F, G&H, I&J

Automation Software

Optional software for Loop Automation and Auto-Changeover can be purchased at time of order or for field upgrade.

Voltage

True RMS voltage is measured on all three phases on the default source side (I-Side). A user configured threshold indicates live terminal (accuracy $\pm 2.5\%$). Load side voltage measurement is available if the optional external CVTs are installed.

Current

RMS current is measured on three phases (accuracy $\pm 2.5\%$, reading 2 - 800A), Earth and Negative Phase Sequence.

Real Power (signed or unsigned)

Determined by multiplying V x I in real time and averaging over several cycles (accuracy $\pm 5\%$ of reading, within limits of V and I above).

Power Factor

Determined from line voltage and line current phase relationship and the previously calculated real power (accuracy $\pm 5\%$ of reading, within limits of V and I above).

Default Historical Measurements

Power flow is integrated over 5, 15, 30, or 60 minute intervals (kWH) and recorded for 2 months at the default setting. This can be viewed on the Operator Control Panel, computer, or compatible SCADA system. Additionally, data can be uploaded into a portable computer or a compatible SCADA system.

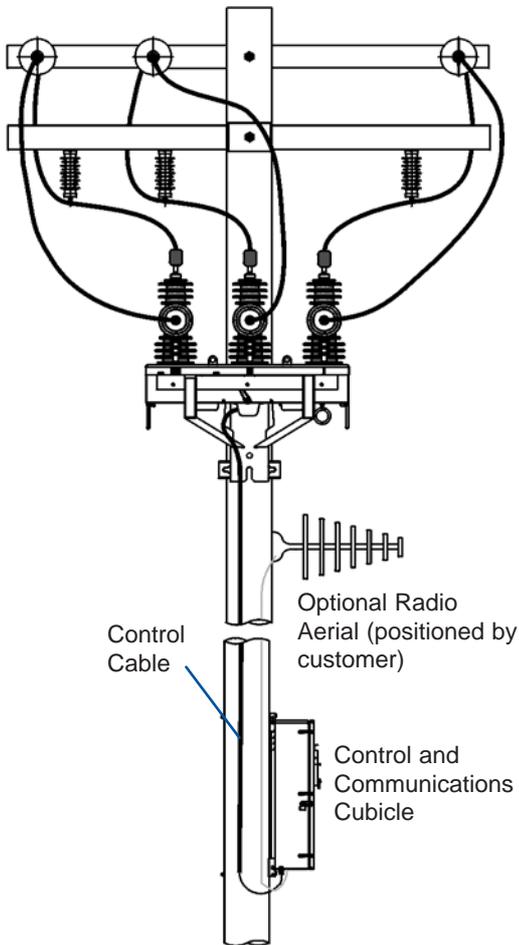
Configurable Historical Measurements

Average Demand Profiles may be configured using WSOS. Customised configuration enables the user to specify only the parameters that are required negating unnecessary information capture.

Event History

Minimum number of typical events stored in the event history:	3,000 events
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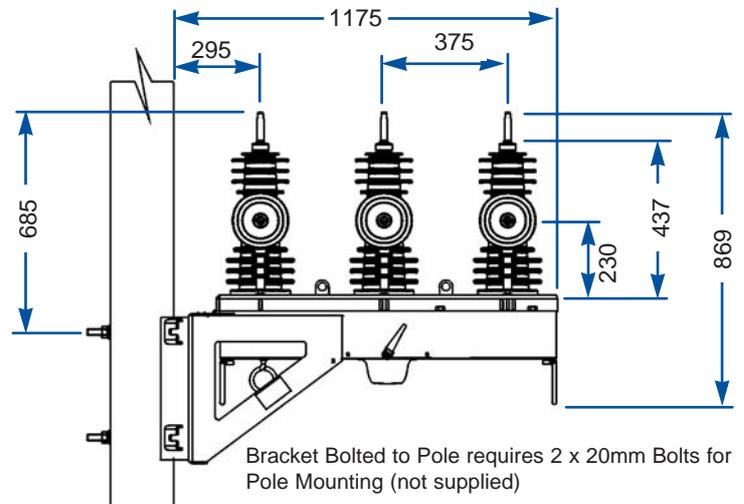
End and Mid-point mounting arrangements



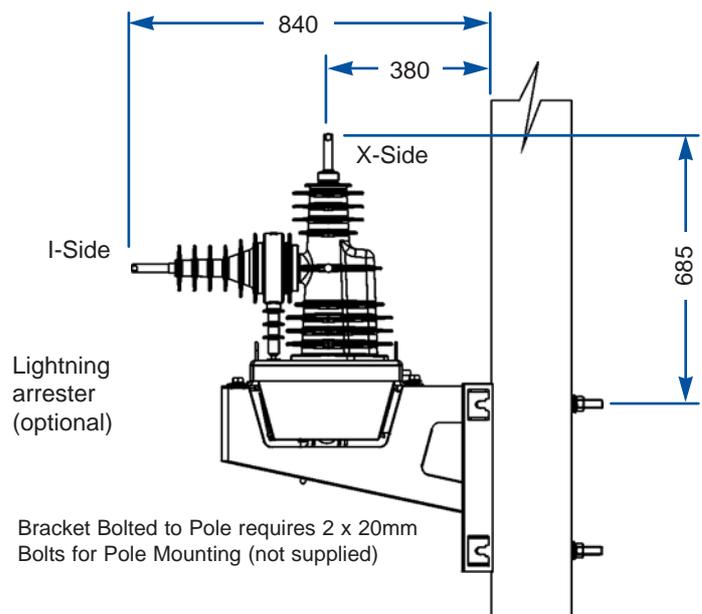
U-Series solid dielectric automatic circuit recloser and Control Cubicle

Note:

1. Details given in the illustrations on this page are subject to change without notice. For full details see the separate Technical Manual.
2. Earthing connections are not shown and are to be in accordance with the Technical Manual.
3. Optional substation mounting frame available on request.



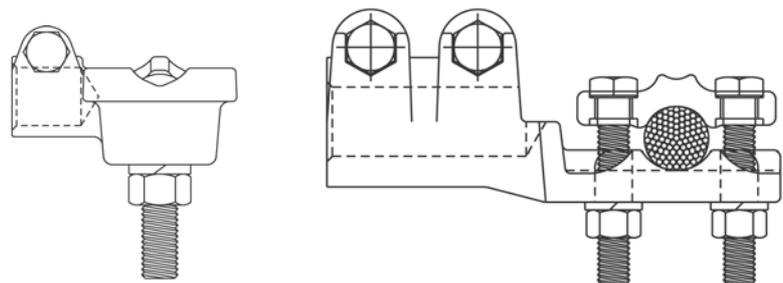
Side View of End Mounting



Side View of Mid-Point Mounting

Cable connection options

Connections are made to the bare recloser terminals using crimp lugs, parallel groove clamps or stud connectors. This arrangement is suitable for connection into an insulated or bare conductor system, as appropriate.



400-15TP stud connector

630-30TP stud connector

Ratings	15.5 kV	27 kV
Rated Maximum Voltage	15.5kV	27kV
Rated Continuous Current	630A	630A
Fault Make Capacity (RMS)	12.5kA	12.5kA
Fault Make Capacity (Peak)	32.5kA	32.5kA
Fault Break Capacity	12.5 kA	12.5 kA
Power Operating Time (Close/Open)	0.1 / 0.05s	0.1 / 0.05s
Mechanical Operations	10000	10000
Rated Full Load Operations	10000	10000
Short Time Current (3 seconds)	12.5kA	12.5kA

Breaking Capacity	15.5 kV	27 kV
Mainly Active (0.7pf)	630A	630A
Cable Charging	25A	25A
Line Charging	5A	5A
Transformer Magnetizing Current	22A	22A

Lightning Impulse Withstand Voltage	15.5 kV	27 kV
Phase to Earth	110kV	125kV
Across Interrupter	110kV	125kV

One Minute Power Frequency Withstand Voltage	15.5 kV	27 kV
Phase to Earth	50kV	60kV
Across Interrupter	50kV	60kV

Environmental	15.5 kV	27 kV
Ambient Temperature ⁽¹⁾	-30 to 50°C	-30 to 50°C
Radiation (Max)	1.1kW/m ²	1.1kW/m ²
Humidity	0 to 100%	0 to 100%
Altitude (Max) ⁽²⁾	3000m	3000m

Net Weight	15.5 kV	27 kV
Recloser tank	118kg	118kg
Control Cubicle and Sundry items	145kg	145kg

Crate Dimensions	15.5 kV	27 kV
Standard	W=1160mm	D=960mm H=1020mm

- 1 Temperature rating dependent on control cubicle model purchased with equipment.
- 2 For altitudes above 1000m derate in accordance with ANSI C37.60.

Ordering Information

The U-Series ACR ordering information comprises two part numbers. The circuit breaker part number includes a Model Identifier and fields describing the Insulation Type, System Voltage, Interrupt Capacity, Insulation Level, Terminal Rating and Mounting Bracket. The Pole Top Control Cubicle (PTCC) comprises temperature range, cable length and auxiliary supply and radio cable. The part numbers do not include measurement units and is constructed using only one option per field in the selection chart below. A part number example is shown below:

Nu-Lec-U27-ACR-Solid-27-12-110-630-BT-M and **Nu-Lec-PTCC-Moderate-240-7**

Nu-Lec - - ACR-Solid - - - - - and
 Nu-Lec-PTCC - - -

Field descriptions

1. Model:
U27 is the current model

2. Insulation medium:
Solid dielectric automatic circuit recloser

3. System Voltage:
15 = 15.5kV
27 = 27kV

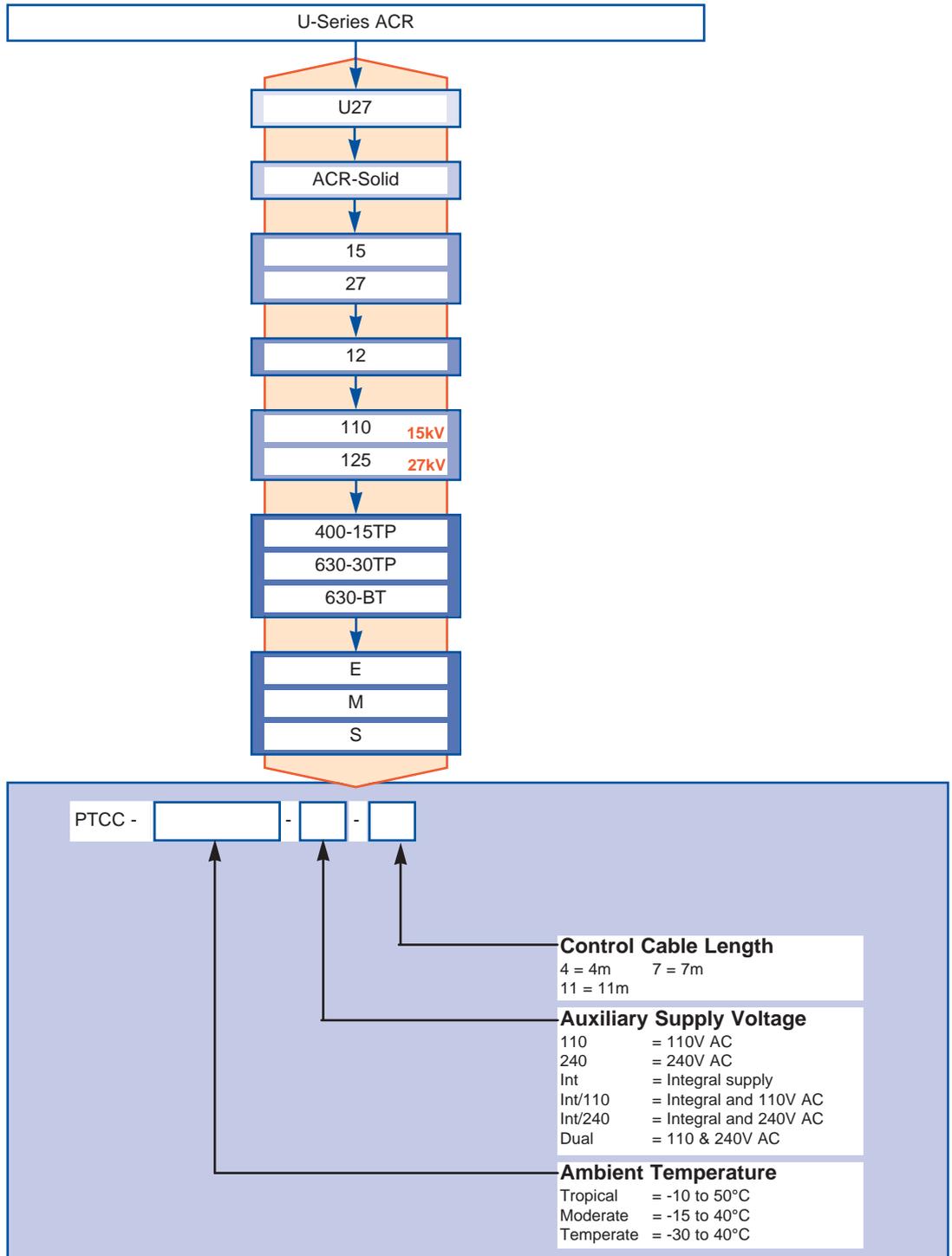
4. Interrupt Capacity:
12 = 12.5kA

5. Insulation Level:
110 = 110kV (15kV U27)
125 = 125kV (27kV U27)

6. Terminal Rating:
400-15TP = 400A stud connector
630-30TP = 630A stud connector
630-BT = 630A Bare Terminal (BT)

7. Mounting Bracket:
E = End mounting bracket
M = Mid mounting bracket
S = Substation mounting frame

Common control cubicle:
Specify the temperature range, auxiliary supply voltage and control cable length for the Pole Top Control Cubicle (PTCC). Communication Protocol and radio/modem cable type must be separately specified at time of order.





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