GE

Grid Solutions

Multilin UR & UR$^{\text{Plus}}$

Proven, State-of-the-Art Protection & Control Systems

From the power plant to the power consumer, the Multilin™ UR & UR$^{\text{Plus}}$ family of advanced protection and control relays provides one integrated platform that delivers leading edge protection, control, monitoring & metering solutions for critical power system applications. Featuring proven protection algorithms, expandable I/O, integrated monitoring & high accuracy metering capabilities with the latest in communications technologies, the Multilin UR & UR$^{\text{Plus}}$ family of devices provides the situational awareness needed for a reliable, secure and efficient modern grid.

Key Benefits

- Modular construction: common hardware, reduced stock of pare parts, plug & play modules for maintenance cost savings and simplification (Multilin UR)
- Proven flexibility and customization capabilities make the Multilin UR/UR$^{\text{Plus}}$ devices suitable to retrofit almost any kind of legacy P&C scheme
- Large HMI and annunciator panels provide local monitoring & control capabilities, and backup the substation HMI
- Phase measurement Unit (synchrophasors) according to IEEE® C37.118 (2011) and IEC® 61850-90-5 directly streamed from your protective device
- Embedded IEEE 1588 Time Synchronization Protocol support eliminates dedicated IRIG-B wiring requirements for P&C devices (Multilin UR)
- Advanced IEC 61850 Ed. 1 and Ed. 2 certified implementation, complete settings via SCL files and comprehensive process bus support (IEC 61850-9-2LE or IEC 61869 or IEC 61850-9-2 Hardfiber) ensures interoperability, device managing optimization and reduced cost of ownership
- Routable GOOSE (R-GOOSE) enables customer to send GOOSE messages beyond the substation, which enables WAPC and more cost effective communication architectures for wide area applications
- Increased network availability via failover time reduced to zero through IEC® 62439-3 “PRP” support
- Supports IEEE C37.111-1999/2013, IEC 60255-24 Ed 2.0 COMTRADE standard

Applications

- Protection, control, monitoring and supervision of power assets across generation, transmission, distribution, substation and industrial systems
- Utility substation and industrial plant automation
- Digital fault recording and Sequence of Event (SOE) recording
- Predictive maintenance through data analysis and trending
- Synchrophasors based monitoring and control system with specialized PMU devices that support multiple feeders providing P&M class synchrophasors of voltage, current, and sequence components
- Complex protection & control and wide area monitoring solutions with complete diagnostic and automation capabilities (Multilin UR$^{\text{Plus}}$)

imagination at work

Protection and Control

- Fast, segregated line current differential & distance protection functionality in one device
- Phase distance (5 zones) with independent settings for compensation
- Single-pole tripping, breaker-and-a-half with independent current source support
- Comprehensive generator protection with 100% stator and field ground fault detection
- Protection and control functionality in one box, reducing the number of devices
- Integrated large, full color display, for real-time visualization and control of the protected bay

Advanced Communications

- 3 independent Ethernet ports for simultaneous & dedicated network connections with IEEE 1588 support
- IEC 61850-9-2LE/IEC 61869 networked or IEC61850-9-2 Hardfiber process bus support

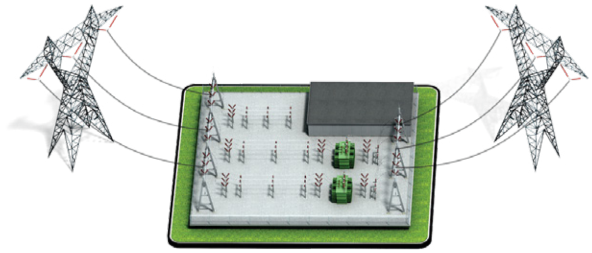
Cyber Security

- CyberSentry™ provides high-end cyber security aligned to industry standards and services (NERC® CIP, AAA, Radius, RBAC, Syslog)

Monitoring & Metering

- Advanced recording capabilities, configurable & extended waveform capture and data logger
- Fault locator fault reports & programmable
- Breaker condition monitoring including breaker arcing current (I2t), breaker re-strike and breaker flashover
- Metering: current, voltage, power factor, frequency, voltage & current harmonics, energy, demand, phasors, etc.

UR & UR^Plus Market Offerings



Generation

G60

Medium to Large Generators

The G60 provides comprehensive primary and backup protection for medium and large generators, including large steam and combustion turbines, combined-cycle generators and multi-circuit hydro units. The G60 includes advanced automation and communication capabilities, extensive I/O options, and powerful fault recording features that simplify postmortem analysis and minimize generator downtime.

G30

Combined Generator & Transformer Protection

The G30 is a flexible system that can be used on small and medium generators, generator and step-up transformer arrangements or backup protection of large generators. Similar to the G60, the G30 also offers comprehensive protection and monitoring elements.

Transmission & Distribution

D90^Plus

Sub-Cycle Distance Protection

The D90^Plus is ideally suited for application on transmission lines where fast fault detection and small breaker failure margin are required. The D90^Plus allows transmission limits to be maintained or even increased while respecting the transient stability limits of the power system.

D60

Fully Featured Distance Protection

The D60 is the ideal solution for providing reliable and secure primary and backup protection of transmission lines supporting: series compensation, teleprotection schemes, five mho or quad distance zones, single or three-pole tripping, breaker-and-half with independent current inputs, phasor measurement units (PMUs), and more.

D30

Backup Distance Protection

The D30 is the cost-effective choice for the primary protection of sub-transmission systems or backup protection of transmission systems. Using FlexLogic™ elements, basic pilot schemes can be programmed. The D30 has complementary protection, control, communication, monitoring and metering functions that meet the toughest requirements of the market.

L90

Complete Line Protection

The L90 is a fast and powerful high-end phase-segregated line current differential and complete distance protection system, suitable for MV cables, two or three terminal transmission lines having breaker-and-half and single or three-pole tripping schemes.

L60

Line Phase Comparison Protection

The L60 is an extremely fast line phase comparison system, suitable for two or three terminal transmission lines. This system is able to operate using power line carrier or fiber optic communications.

L30

Sub-Transmission Line Current Differential Protection

The L30 is a cost-effective phase-segregated line current differential system intended to provide primary protection for MV cables and two/three-terminal sub-transmission lines or backup protection to transmission lines.

B90

Low Impedance Busbar Protection

The B90 is an advanced low-impedance differential protection system that is intended to cover applications ranging from small to large substations, having either single or complex-split busbar schemes. It is able to support busbars with up to 24 breakers, and 4 single phase differential zones.

B30

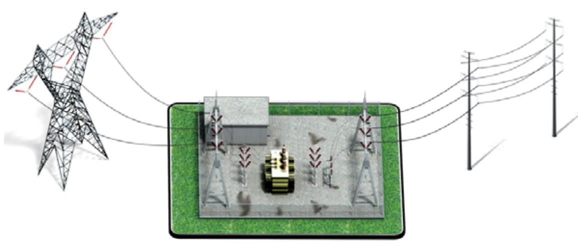
Low Impedance Busbar Protection

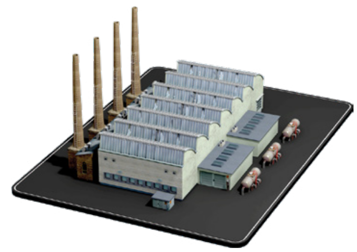
The B30 is a cost-effective, advanced protection system that fits busbars with up to 6 circuits and two protection zones. The B30 provides advanced elements like CT trouble, directional and CT saturation, breaker failure and voltage supervision that make the B30 an extremely fast and secure busbar protection system. B30 also fits conventional centralized or process bus based distributed bus bar protectionschemes.

B95^Plus

Distributed Busbar Protection System

The B95^Plus is GE's distributed busbar solution that can be applied to any kind of busbar configuration and uses standard IEC 61850 protocol to connect to the bay units. The B95^Plus delivers comprehensive and reliable protection for busbar applications with up to 24 feeders.





Transmission & Distribution (Continued)

F60

Feeder Protection with Hi-Z Fault Detection

The F60 provides comprehensive feeder protection, control, advanced communications, monitoring and metering in an integrated, economical, and compact package and more.

F35

Multiple Feeder Protection

The F35 is a cost-effective device for primary feeder protection. F35's modular design allows customers to protect groups of feeders as follows: independent current and voltage inputs, independent current and common voltage inputs or independent current inputs only.

C70

Capacitor Bank Protection

The C70 is an integrated protection, control, and monitoring device for shunt capacitor banks. The current and voltage-based protection functions are designed to provide sensitive protection for grounded, ungrounded single and parallel capacitor banks and banks with taps.

T60

Medium to Large Transformers

The T60 is a fully featured transformer protection system suitable for power transformers of any size that require current differential function. The T60 provides automatic or user-definable magnitude reference winding selection for CT ratio matching, and performs automatic phase shift compensation for all types of transformer winding connections.

T35

Basic Transformer Protection, Multiple CTs

The T35 is a basic transformer protection system capable of protecting combined main power transformers and up to five feeders downstream. The T35 provides automatic or user-definable magnitude reference winding selection for CT ratio matching, automatic phase shift compensation and allows users to enable removal of the zero-sequence current even for delta connected transformer windings.

C90Plus

Breaker Automation and Controller

The C90Plus is a powerful logic controller designed to be used in substation environments and for the unique automation requirements of industrial and utility power systems. The C90Plus provides unmatched logic processing ability combined with a powerful math engine with deterministic execution of logic equations regardless of the configuration of the number of lines of logic.

C60

Breaker Controller

The C60 is a substation hardened controller that provides a complete integrated package for the protection, control, and monitoring of circuit breakers, supporting dual-breaker busbar configurations, such as breaker-and-half or ring bus schemes.

C30

I/O Logic Controller

The C30 is designed to perform substation control logic that can also expand the I/O capability of protection devices and replace existing Sequence of Events (SOE) recorders.

Industrial & Network

M60

Motor Protection

The M60 offers comprehensive protection and control solutions for large-sized three-phase motors. The M60 provides superior protection, control, and diagnostics that includes thermal model with RTD and current unbalance biasing, stator differential, reverse and low forward power, external RRTD module, two-speed motors, reduced voltage starting, broken rotor bar detection, and more.

N60

Network Stability and Synchrophasor Measurement

The N60 is intended to be used on load shedding, remedial action, special protection and wide area monitoring and control schemes. Like no one device before, the N60 shares real-time operational data to remote N60s so the system can generate intelligent decisions to maintain power system operation.

Overview

The Universal Relay (UR) is a family of leading edge protection and control products built on a common modular platform. All UR products feature high-performance protection, expandable I/O options, integrated monitoring and metering, high-speed communications, and extensive programming and configuration capabilities. The UR forms the basis of simplified power management for the protection of critical assets, either as a stand-alone device or within an overall power automation system.

The UR is managed and programmed through EnerVista Launchpad. This powerful software package, which is included with each relay, not only allows the setpoints of the relay to be programmed, but also provides the capability to manage setpoint files, automatically access the latest versions of firmware/documentation and provide a window into the substation automation system.

The UR can be supplied in a variety of configurations and is available as a 19-inch rack horizontal mount unit or a reduced size (¾) vertical mount unit. The UR consists of the following modules: power supply, CPU, CT/VT input, digital input/output, transducer input/output, inter-relay communications, communication switch and IEC 61850 Process Bus. All hardware modules and software options can be specified at the time of ordering.

Protection and Control

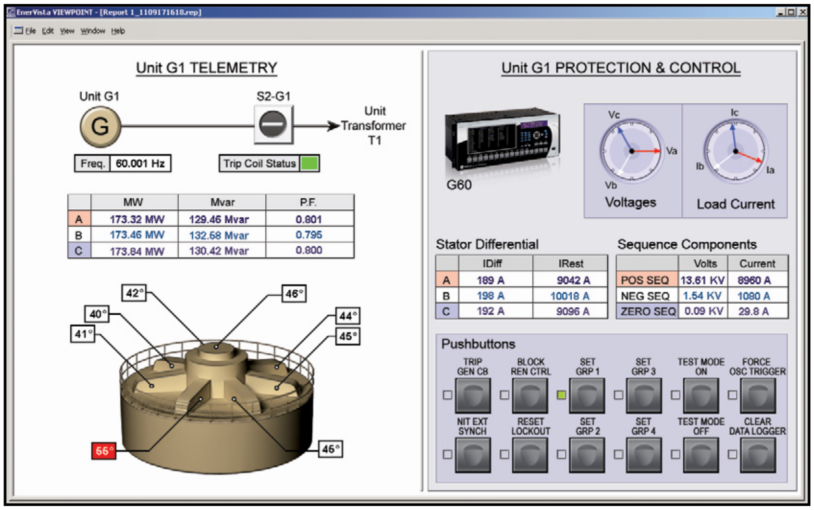
The UR incorporates the most complete and unique protection algorithms to provide unparalleled security and system uptime. The UR selector guide (in the following pages) lists all the protection elements found in each relay.

To support the protection and control functions of the UR, various types and forms of I/O are available (specific capabilities are model dependent). Supported I/Os include:

CTs and VTs

Up to 24 analog current transformer (CT) and voltage transformer (VT) signals can be configured to monitor AC power lines. Both 1 A and 5 A CTs are supported. Special function modules are available including: a CT module with sensitive ground input to provide ground fault protection on high-impedance grounded systems, and a high-impedance fault detection module that provides fast and reliable detection of faults caused by downed conductors.

UR - Protection, Metering, Monitoring and Control



The UR is the single point for protection, control, metering, and monitoring in one integrated device that can easily be connected directly into DCS or SCADA monitoring and control systems like Viewpoint Monitoring as shown.

Digital I/O

Up to 96 contact inputs (with utility voltage rating up to 250V), and up to 64 contact outputs, are available and can be used to monitor and control a wide range of auxiliary equipment found within a substation or other protection application. Types of digital I/O cards include trip-rated Form-A, Form-C, Fast Form-C, latching and Solid State Relay (SSR), with or without DC voltage, current monitoring and isolated inputs (with auto burnish feature). Mechanically latching outputs can be used to develop secure interlocking applications and replace mechanical switches and lockout relays. Form-A digital outputs have activation speeds of less than 4ms and both wet and dry contacts are supported.

Solid state output modules with high current breaking capability, fast tripping and reset time are ideal for direct tripping applications.

Transducer I/O

RTDs and DCmA cards are available to monitor system parameters, such as temperature, vibration, pressure, wind speed, and flow. Analog outputs can be used for hardwired connections from the controller to a SCADA system, to a programmable logic controller (PLC), or to other user interface devices (eg. panel display).

Advanced Automation

The UR incorporates advanced automation features including powerful FlexLogic programmable logic, communication, and SCADA capabilities that far surpass what is found in the average protection relay. Each UR can be seamlessly integrated with other UR relays for complete system protection and control.

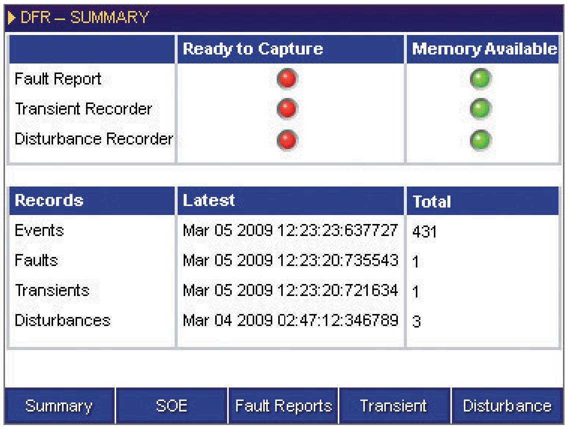
FlexLogic

FlexLogic is the powerful UR-platform programming logic engine that provides the ability to create customized protection and control schemes, minimizing the need and associated costs of, auxiliary components and wiring. With 1024 lines of FlexLogic, the UR can be programmed to provide the required tripping logic along with custom scheme logic for breaker control (including interlocking with external synchronizers), transfer tripping schemes for remote breakers and dynamic setting group changes.

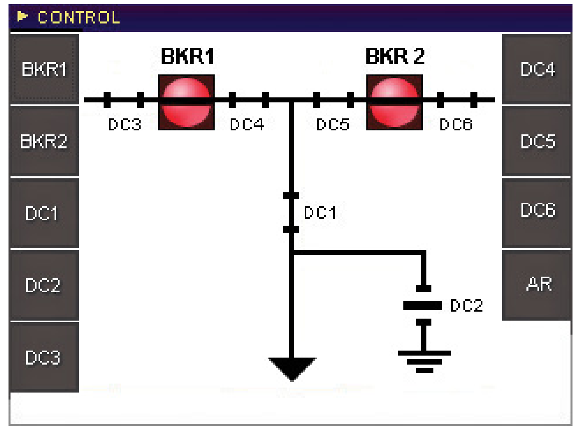
Scalable Hardware

The UR is available with a multitude of I/O configurations to suit the most demanding application needs. The expandable modular design allows for easy configuration and future upgrades.

- Multiple CT/VT configurations allow for the implementation of many different schemes, including concurrent split-phase and differential protection
- Flexible, modular high density I/O covering a broad range of input signals and tripping schemes with trip rated Form-A for high density outputs and Trip rated Form A, SSR, Form-C and mechanically latched relays for normal outputs
- Inter-relay communications module that enables the sharing of digital status and analog values between UR relays for control, fast tripping or teleprotection applications



Digital fault recorder summary with the latest information on the events, faults, transients and disturbances.



Control screen for the preconfigured bay with breaker & disconnect control in multiple pages using dedicated pushbuttons in the front panel.

- Types of digital outputs include trip-rated Form-A and SSR mechanically latching, and Form-C outputs
- Form-A and SSR outputs available with optional circuit continuity monitoring and current detection to verify continuity and health of the associated circuitry
- IEC 61850 Process Bus delivering advanced protection and control capabilities while providing significant savings on the total life cost of electrical substations
- RTDs and DCmA inputs are available to monitor equipment parameters such as temperature and pressure

Monitoring and Metering

The UR includes high accuracy metering and recording for all AC signals. Voltage, current, and power metering are built into the relay as a standard feature. Current and voltage parameters are available as total RMS magnitude, and as fundamental frequency magnitude and angle.

Fault and Disturbance Recording

The advanced disturbance and event recording features within the UR can significantly reduce the time needed for postmortem analysis of power system events and the creation of regulatory reports. Recording functions include:

- Sequence of Event (SOE)
  - 1024 time stamped events (UR Relays)
  - 8192 time stamped events (URPlus)
- Oscillography
  - Supports IEEE C37.111-1999/2013, IEC 60255-24 Ed 2.0 COMTRADE standard
  - 64 digital & up to 40 analog channels
  - Events with up to 45s length
- Data Logger and Disturbance Recording
  - 16 channels up to 1 sample/cycle/channel
- Fault Reports
  - Powerful summary report of pre-fault and fault values

The very high sampling rate and large amounts of storage space available for data recording in the UR allows for the capture of complex events and can eliminate the need for installing costly stand-alone recording equipment.

Advanced Device Health Diagnostics

The UR performs comprehensive device health diagnostic tests at startup and continuously during run-time to test its own major functions and critical hardware. These diagnostic tests monitor for conditions that could impact security and availability of protection, and present device status via SCADA communications and front panel display. Providing continuous monitoring and early detection of possible issues help improve system uptime.

- Comprehensive device health diagnostic performed at startup
- Monitors the CT/VT input circuitry to validate the integrity of all signals
- Monitors internal DC voltage levels that allows for proactive maintenance and increased uptime

PMU - Synchrophasors

With the ability of having up to 6 PMU elements in one device, UR devices provide simultaneous data streams of up to four different clients.

UR devices exceed the IEEE C37.118 (2011) requirements for Total Vector Error (TVE) less than 1% over a range of 40Hz to 70Hz, and are able to measure and report synchrophasors over a frequency range from 30Hz to 90Hz with little effect on TVE.

A special feature of the synchrophasor implementation is the ability to apply magnitude and phase angle correction on a per-phase basis for known CT and PT magnitude and phase errors. Selected UR devices can apply a phase correction on each phase of up to ±5° in increments of 0.05°. They also provide the ability to adjust for delta-wye phase angle shifts or polarity reversal in the synchrophasor reporting of the voltage and current sequence components.

UR devices can stream PMU data through any of its three Ethernet ports using either IEEE C37.118 or IEC 61850-90-5 data formats. When streaming PMU data through a single port, a failover function can automatically switch the transmission over another Ethernet port.

Selected UR devices also support up to 16 user-definable command outputs via the command frame defined in the IEEE C37.118 standard.

PMU recording

UR devices include high accuracy metering and recording for all AC signals. Voltage, current, frequency, power and energy and demand metering are built into the relay as a standard feature. Current and voltage parameters are available as total RMS magnitude, and as fundamental frequency magnitude and angle. UR devices have 12MB of synchrophasor recording memory with multiple recording and triggering options. The PMU recorder can be triggered by an over/under frequency, over/under voltage, overcurrent, overpower, rate of change of frequency condition, or by a user-specified condition, freely configured through FlexLogic. The PMU status flag shows which of those functions triggered the PMU recorder.

UR Technical Specifications

PROTECTION

100% STATOR GROUND
Operating quantity: V_neutral_3rd/(V_neutral_3rd + V_zero_3rd)
Pickup level: 0.000 to 0.250 pu in steps of 0.001
Dropout level: 97 to 98% of pickup
Level accuracy: ±2% of reading from 1 to 120 V
Pickup delay: 0 to 600.00 s in steps of 0.01
3rd harmonic supervision level: 0.0010 to 0.1000 pu in steps of 0.0001
Time accuracy: ±3% or ±20 ms, whichever is greater
Operate time: < 30 ms at 1.10 × Pickup at 60 Hz

ACCELERATION TIME
Acceleration current: 1.00 to 10.00 × FLA in steps of 0.01
Acceleration time: 0.00 to 180.00 s in steps of 0.01
Operating mode: Definite Time, Adaptive

ACCIDENTAL ENERGIZATION
Operating condition: Overcurrent
Arming condition: Undervoltage and/or Machine Offline
Overcurrent:
Pickup level: 0.02 to 3.000 pu in steps of 0.001
Dropout level: 97 to 98% of pickup
Level accuracy: ±0.5% of reading from 0.1 to 2.0 × CT rating
Undervoltage:
Pickup level: 0.004 to 3.000 pu in steps of 0.001
Dropout level: 102 to 103% of pickup
Level accuracy: ±0.5% of reading 10 to 208 V
Operate Time: < 30 ms at 1.10 × Pickup at 60 Hz

AUTORECLOSURE C60/D60/L90/L60
Two breakers applications
Single- and three-pole tripping schemes
Up to 4 reclose attempts before lockout
Selectable reclosing mode and breaker sequence

AUTORECLOSURE F60/F35/D30
Single breaker applications, 3-pole tripping schemes
Up to 4 reclose attempts before lockout
Independent dead time setting before each shot
Possibility of changing protection settings after each shot with FlexLogic.

AMP UNBALANCE
Avg and Full Load amps: RMS
I_1 and 1_2 amps: Phasor
Pickup level: 0.0 to 100.0% in steps of 0.1
Dropout level: 97 to 98% of pickup
Level accuracy: ±0.1
Pickup delay: 0.00 to 600.00 s in steps of 0.01
Reset delay: 0.00 to 600.00 s in steps of 0.01
Operate time: < 20 ms at 1.10 × pickup at 60 Hz
Timing accuracy: ±3% or ±20 ms, whichever is greater

AUXILIARY OVERVOLTAGE
Pickup level: 0.004 to 3.000 pu in steps of 0.001
Dropout level: 97 to 98% of Pickup
Level accuracy: ±0.5% of reading from 10 to 208 V
Pickup delay: 0 to 600.00 s in steps of 0.01
Reset delay: 0 to 600.00 s in steps of 0.01
Timing accuracy: ±3% of operate time or ±4 ms (whichever is greater)
Operate time: < 30 ms at 1.10 × pickup at 60 Hz

AUXILIARY UNDERVOLTAGE
Pickup level: 0.004 to 3.000 pu in steps of 0.001
Dropout level: 102 to 103% of pickup
Level accuracy: ±0.5% of reading from 10 to 208 V
Curve shapes: GE IAV Inverse, Definite Time
Curve multiplier: Time Dial = 0 to 600.00 in steps of 0.01
Timing accuracy: ±3% of operate time or ±4 ms (whichever is greater)

BREAKER ARCING CURRENT
Principle: Accumulates breaker duty (I2t) and measures fault duration
Initiation: Programmable per phase from any FlexLogic operand
Compensation for auxiliary relays: 0 to 65.535 s in steps of 0.001
Alarm threshold: 0 to 50000 kA2-cycle in steps of 1
Fault duration accuracy: 0.25 of a power cycle
Availability: 1 per CT bank with a minimum of 2

PROTECTION

BREAKER FAILURE
Mode: 1-pole, 3-pole
Current supervision: phase, neutral current
Current supv. pickup: 0.02 to 30.000 pu in steps of 0.001
Current supv. dropout: 97 to 98% of pickup
Current supv. accuracy:
0.1 to 2.0 × CT rating: ±0.75% of reading or ±2% of rated (whichever is greater)
above 2 × CT rating: ±2.5% of reading

BREAKER FLASHOVER
Operating quantity: Phase current, voltage and voltage difference
Pickup level voltage: 0.02 to 1.500 pu in steps of 0.001
Dropout level voltage: 97 to 98% of pickup
Pickup level current: 0.004 to 1.500 pu in steps of 0.001
Dropout level current: 97 to 98% of pickup
Level accuracy: ±0.5% or ±0.1% of rated, whichever is greater
Pickup delay: 0 to 65.535 s in steps of 0.001
Time accuracy: ±3% or ±42 ms, whichever is greater
Operate time: <42 ms at 1.10 × pickup at 60 Hz

BUS DIFFERENTIAL (87B)
Pickup level: 0.050 to 6.000 pu in steps of 0.001
Low slope: 15 to 100% in steps of 1
High slope: 50 to 100% in steps of 1
Low breakpoint: 1.00 to 30.00 pu in steps of 0.01
High breakpoint: 1.00 to 30.00 pu in steps of 0.01
High set level: 0.10 to 99.99 pu in steps of 0.01
Dropout level: 97 to 98% of Pickup
Level accuracy:
0.1 to 2.0 × CT rating: ±0.5% of reading or ±1% of rated (whichever is greater)
>2.0 × CT rating ±1.5% of reading
Operating time: one power system cycle (typical)

CT TROUBLE
Responding to: Differential current
Pickup level: 0.020 to 2.000 pu in steps of 0.001
Pickup delay: 1.0 to 60.0 sec. in steps of 0.1
Time Accuracy: ±3% or ±40ms, whichever is greater
Availability: 1 per zone of protection (B90)

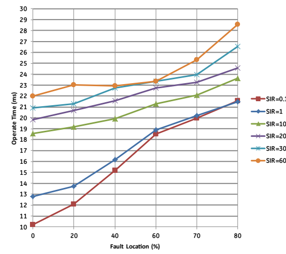
GENERATOR UNBALANCE
Gen. nominal current: 0.000 to 1.250 pu in steps of 0.001
Stages: 2 (I2t with linear reset and definite time)
Pickup level: 0.00 to 100.00% in steps of 0.01
Dropout level: 97 to 98% of pickup
Level accuracy:
0.1 to 2 × CT rating: ±0.5% of reading or 1% of rated (whichever is greater)
> 2.0 × CT rating: ±1.5% of reading
Time dial (K-value): 0.00 to 100.00 in steps of 0.01
Pickup delay: 0.0 to 1000.0 s in steps of 0.1
Reset delay: 0.0 to 1000.0 s in steps of 0.1
Time accuracy: ±3% or ±20 ms, whichever is greater
Operate time: < 50 ms at 60 Hz

GROUND DISTANCE
Characteristic: Mho (memory polarized or offset) or Quad (memory polarized or non-directional), selectable individually per zone
Reactance polarization: negative-sequence or zero-sequence current
Non-homogeneity angle: -40 to 40° in steps of 1
Number of zones: 5
Directionality: Forward, Reverse, or Non-Directional per zone
Reach (secondary W): 0.02 to 250.00 in steps of 0.01
Reach accuracy: ±5% including the effect of CVT transients up to an SIR of 30
Distance characteristic angle: 30 to 90° in steps of 1
Distance comparator limit angle: 30 to 90° in steps of 1
Directional supervision
Characteristic angle: 30 to 90° in steps of 1
Limit angle: 30 to 90° in steps of 1
Zero-sequence compensation
Z0/Z1 magnitude: 0.00 to 10.00 in steps of 0.01
Z0/Z1 angle: -90 to 90° in steps of 1
Zero-sequence mutual compensation
Z0M/Z1 magnitude: 0.00 to 7.00 in steps of 0.01
Z0M/Z1 angle: -90 to 90° in steps of 1
Right blinder (Quad only):
Reach: 0.02 to 500 in steps of 0.01
Characteristic angle: 60 to 90° in steps of 1
Left blinder (Quad only):
Reach: 0.02 to 500 in steps of 0.01
Characteristic angle: 60 to 90° in steps of 1
Time delay: 0.000 to 65.535 s in steps of 0.001

PROTECTION

Timing accuracy: ±3% or 4 ms, whichever is greater
Current supervision:
Level: neutral current (3I_0)
Pickup: 0.050 to 30.000 pu in steps of 0.001
Dropout: 97 to 98%
Memory duration: 5 to 25 cycles in steps of 1
Voltage supervision pickup (series compensation applications): 0 to 5.000 pu in steps of 0.001
Operation time: 1 to 1.5 cycles (typical)
Reset time: 1 power cycle (typical)

GROUND DISTANCE OPERATING TIME CURVES
The operating times are response times of a microprocessor part of the relay. See output contacts specifications for estimation of the total response time for a particular application. The operating times are average times including variables such as fault inception angle or type of a voltage source (magnetic VTs and CVTs).



LINE CURRENT DIFFERENTIAL (87L)
Application: 2 or 3 terminal line, series compensated line, tapped line, with charging current compensation
Pickup current level: 0.20 to 4.00 pu in steps of 0.01
CT Tap (CT mismatch factor): 0.20 to 5.00 in steps of 0.01
Slope # 1: 1 to 50%
Slope # 2: 1 to 70%
Breakpoint between slopes: 0.0 to 20.0 pu in steps of 0.1
DTT: Direct Transfer Trip (1 and 3 pole) remote L90
Operating Time: 1.0 to 1.5 power cycles duration
Asymmetrical channel delay compensation using GPS: asymmetry up to 10ms

LINE CURRENT DIFFERENTIAL TRIP LOGIC
87L trip: Adds security for trip decision; creates 1 and 3 pole trip logic
DTT: Engaged Direct Transfer Trip (1 and 3 pole) from remote L90
DD: Sensitive Disturbance Detector to detect fault occurrence
Stub bus protection: Security for ring bus and 1½ breaker configurations
Open pole detector: Security for sequential and evolving faults

LINE PICKUP
Phase IOC: 0.02 to 30.000 pu
Undervoltage pickup: 0.004 to 3.000 pu
Overvoltage delay: 0.000 to 65.535 s

LOAD ENCROACHMENT
Responds to: Positive-sequence quantities
Minimum voltage: 0.004 to 3.000 pu in steps of 0.001
Reach (sec. W): 0.02 to 250.00 in steps of 0.01
Impedance accuracy: ±5%
Angle: 5 to 50° in steps of 1
Angle accuracy: ±2°
Pickup delay: 0 to 65.535 s in steps of 0.001
Reset delay: 0 to 65.535 s in steps of 0.001
Time accuracy: ±3% or ±4 ms, whichever is greater
Operate time: < 30 ms at 60 Hz

LOSS OF EXCITATION
Operating condition: Positive-sequence impedance
Characteristic: 2 independent offset mho circles
Center: 0.10 to 300.0 (sec.) in steps of 0.01
Radius: 0.10 to 300.0. (sec.) in steps of 0.01
Reach accuracy: ±3%
Undervoltage supervision
Level: 0.000 to 1.250 pu in steps of 0.001
Accuracy: ± 0.5% of reading from 10 to 208V
Pickup delay: 0 to 65.535 s in steps of 0.001
Timing accuracy: ±3% or ±20 ms, whichever is greater
Operate time: <50 ms

UR Technical Specifications

PROTECTION

MECHANICAL JAM

Operating condition: Phase overcurrent
Arming condition: Motor not starting
Pickup level: 1.00 to 10.00 × FLA in steps of 0.01
Dropout level: 97 to 98% of pickup
Level accuracy: at 0.1 to 2.0 × CT: ±0.5% of reading
at > 2.0 × CT rating: ±1.5% of reading
Pickup delay: 0.10 to 600.00 s in steps of 0.01
Reset delay: 0.00 to 600.00 s in steps of 0.01
Time accuracy: ±3% or ±20 ms, whichever is greater

MOTOR START SUPERVISION

Maximum no. of starts: 1 to 16 in steps of 1
Monitored time interval: 1 to 300 minutes in steps of 1
Time between starts: 0 to 300 minutes in steps of 1
Restart delay: 0 to 50000seconds in steps of 1

NEGATIVE SEQUENCE DIRECTIONAL OC

Directionality: Co-existing forward and reverse
Polarizing: Voltage
Polarizing voltage: V_2
Operating current: I_2 or I_0
Level sensing:
Zero-sequence: |I_0| - K × |I_1|
Negative-sequence: |I_2| - K × |I_1|
Restraint, K: 0.000 to 0.500 in steps of 0.001
Characteristic angle: 0 to 90° in steps of 1
Limit angle: 40 to 90° in steps of 1, independent for forward and reverse
Angle accuracy: ±2°
Offset impedance: 0.00 to 250.00W in steps of 0.01
Pickup level: 0.05 to 30.00 pu in steps of 0.01
Dropout level: 97 to 98%
Operation time: < 16 ms at 3 × Pickup at 60 Hz

NEGATIVE SEQUENCE IOC

Current: Phasor
Pickup level: 0.02 to 30.000 pu in steps of 0.001
Dropout level: 97 to 98% of Pickup
Level accuracy:
0.1 to 2.0 × CT rating: ±0.5% of reading or ±1% of rated (whichever is greater)> 2.0 × CT rating: ±1.5% of reading
Overreach: < 2%
Pickup delay: 0.00 to 600.00 s in steps of 0.01
Reset delay: 0.00 to 600.00 s in steps of 0.01
Operate time: < 20 ms at 3 × Pickup at 60 Hz
Timing accuracy: Operate at 1.5 × Pickup ±3% or ± 4 ms (whichever is greater)

NEGATIVE SEQUENCE OVERVOLTAGE

Pickup level: 0.004 to 1.250 pu in steps of 0.001
Dropout level: 97 to 98% of Pickup
Level accuracy: ±0.5% of reading from 10 to 208 V
Pickup delay: 0 to 600.00 s in steps of 0.01
Reset delay: 0 to 600.00 s in steps of 0.01
Time accuracy: ±3% or ±20 ms, whichever is greater
Operate time: < 30 ms at 1.10 × Pickup at 60 Hz

NEGATIVE SEQUENCE TOC

Current: Phasor
Pickup level: 0.02 to 30.000 pu in steps of 0.001
Dropout level: 97% to 98% of Pickup
Level accuracy: ±0.5% of reading or ±1% of rated (whichever is greater from 0.1 to 2.0 × CT rating ±1.5% of reading > 2.0 × CT rating
Curve shapes: IEEE Moderately/Very/Extremely Inverse; IEC (and BS) A/B/C and Short Inverse; GE IAC Inverse, Short/Very/ Extremely Inverse; I2t; FlexCurves. (programmable); Definite Time (0.01 s base curve)
Curve multiplier (Time dial): 0.00 to 600.00 in steps of 0.01
Reset type: Instantaneous/Timed (per IEEE) and L ear
Timing accuracy: Operate at > 1.03 × Actual Pickup ±3.5% of operate time or ±½ cycle (whichever is greater)

NEUTRAL DIRECTIONAL OVERCURRENT

Directionality: Co-existing forward and reverse
Polarizing: Voltage, Current, Dual, Dual-I, Dual-V
Polarizing voltage: V_0 or VX
Polarizing current: IG
Operating current: I_0
Level sensing: 3 × (|I_0| - K × |I_1|), IG
Restraint, K: 0.000 to 0.500 in steps of 0.001
Characteristic angle: -90 to 90° in steps of 1
Limit angle: 40 to 90° in steps of 1, independent for forward and reverse
Angle accuracy: ±2°
Offset impedance: 0.00 to 250.00W in steps of 0.01
Pickup level: 0.05 to 30.00 pu in steps of 0.01
Dropout level: 97 to 98%
Operation time: < 16 ms at 3 × Pickup at 60 Hz

NEUTRAL OVERVOLTAGE

Pickup level: 0.004 to 3.000 pu in steps of 0.001
Polarizing: Voltage, Current, Dual, Dual-I, Dual-V
Level accuracy: ±0.5% of reading from 10 to 208 V
Pickup delay: 0.00 to 600.00 s in steps of 0.01
Reset delay: 0.00 to 600.00 s in steps of 0.01
Timing accuracy: ±3% or ±20 ms (whichever is greater)
Operate time: < 30 ms at 1.10 × Pickup at 60 Hz

PROTECTION

OPEN POLE DETECTOR

Detects an open pole condition, monitoring breaker auxiliary contacts, the current in each phase and optional voltages on the line
Current pickup level: 0.02 to 30.000 pu in steps of 0.001
Line capacitive reactances (XC1, XC0): 300.0 to 9999.9 sec. W in steps of 0.1
Remote current pickup level: 0.02 to 30.000 pu in steps of 0.001
Current dropout level: Pickup + 3%, not less than 0.05 pu

OVERFREQUENCY

Pickup level: 20.00 to 65.00 Hz in steps of 0.01
Dropout level: Pickup - 0.03 Hz
Level accuracy: ±0.01 Hz
Time delay: 0 to 65.535 s in steps of 0.001
Timer accuracy: ±3% or 4 ms, whichever is greater

PHASE COMPARISON PROTECTION (87PC)

Signal Selection: Mixed I_2 - K x I_1 (K=0.00 to 0.25 in steps of 0.01, or3I_0)
Angle Reference: 0 to 360° leading in steps of 1
Fault detector low:
Instantaneous Overcurrent: 0.02 to 15.00 pu in steps of 0.01
I_2 x Z - V_2: 0.005 to 15.00 pu in steps of 0.01
dI_2 / d_t: 0.01 to 5.00 pu in steps of 0.01
dI_1 / dt: 0.01 to 5.00 pu in steps of 0.01
Fault detector High:
Instantaneous Overcurrent: 0.10 to 15.00 pu in steps of 0.01
I_2 x Z - V_2: 0.005 to 15.00 pu in steps of 0.01
dI_2 / d_t: 0.01 to 5.00 pu in steps of 0.01
dI_1 / dt: 0.01 to 5.00 pu in steps of 0.01
Signal Symmetry Adjustment: -0.5 to 5.0 ms in steps of 0.1
Channel Delay Adjustment: 0.000 to 30.00 ms in steps of 0.001
Channel Adjustments: channel delay and signal symmetry compensation
Operate Time (Typical): 3/4 cycle for single phase comparison
Trip Security: First coincidence or enhanced
Second Coincidence Timer: 10 to 200 ms in steps of 1
Enhanced Stability Angle: 40 to 180° in steps of 1

PHASE DIRECTIONAL OVERCURRENT

Relay connection: 90° (quadrature)
Quadrature voltage:
ABC phase seq.: phase A (V_{BC}), phase B (V_{CA}), phase C (V_{AB})
ACB phase seq.: phase A (V_{CB}), phase B (V_{AC}), phase C (V_{BA})
Polarizing voltage threshold: 0.004 to 3.000 pu in steps of 0.001
Current sensitivity threshold: 0.05 pu
Characteristic angle: 0 to 359° in steps of 1
Angle accuracy: ±2°
Operation time: (FlexLogic elements):
Tripping (reverse load, forward fault): < 12 ms, typically
Blocking (forward load, reverse fault): < 8 ms, typically

PHASE DISTANCE

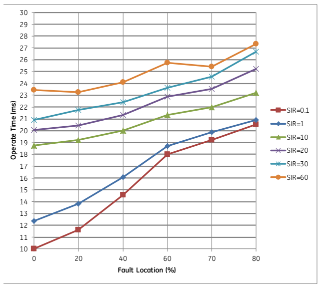
Characteristic: Mho (memory polarized or offset) or Quad (memory polarized or non-directional), selectable individually per zone
Number of zones: Up to 5
Directionality: Forward, Reverse, or Non-Directional per zone
Reach (secondary W): 0.02 to 250.00 in steps of 0.01
Reach accuracy: ±5% including the effect of CVT transients up to an SIR of 30
Distance:
Characteristic angle: 30 to 90° in steps of 1
Comparator limit angle: 30 to 90° in steps of 1
Directional supervision:
Characteristic angle: 30 to 90° in steps of 1
Limit angle: 30 to 90° in steps of 1
Right blinder (Quad only):
Reach: 0.02 to 500 in steps of 0.01
Characteristic angle: 60 to 90° in steps of 1
Left Blinder (Quad only):
Reach: 0.02 to 500 in steps of 0.01
Characteristic angle: 60 to 90° in steps of 1
Time delay: 0.000 to 65.535 s in steps of 0.001
Timing accuracy: ±3% or 4 ms, whichever is greater
Current supervision:
Level: line-to-line current
Pickup: 0.050 to 30.000 pu in steps of 0.001
Dropout: 97 to 98%

PROTECTION

Memory duration: 5 to 25 cycles in steps of 1
VT location: all delta-wye and wye-delta transformers
CT location: all delta-wye and wye-delta transformers
Voltage supervision pickup (series compensation applications): 0 to 5.000 pu in steps of 0.001

PHASE DISTANCE OPERATING TIME CURVES

The operating times are response times of a microprocessor part of the relay. See output contacts specifications for estimation of the total response time for a particular application. The operating times are average times including variables such as fault inception angle or type of a voltage source (magnetic VTs and CVTs).



PHASE/NEUTRAL/GROUND IOC

Pickup level: 0.02 to 30.000 pu in steps of 0.001
Dropout level: 97 to 98% of pickup
Level accuracy:
0.1 to 2.0 × CT rating: ±0.5% of reading or ±1% of rated (whichever is greater)
> 2.0 × CT rating: ±1.5% of reading
Overreach: <2%
Pickup delay: 0.00 to 600.00 s in steps of 0.01
Reset delay: 0.00 to 600.00 s in steps of 0.01
Operate time: <16ms at 3 × pickup at 60Hz (Phase/ Ground IOC) <20ms at 3 × pickup at 60Hz (Neutral IOC)
Timing accuracy: Operate at 1.5 × Pickup ±3% or ±4 ms (whichever is greater)

PHASE/NEUTRAL/GROUND TOC

Current: Phasor or RMS
Pickup level: 0.02 to 30.000 pu in steps of 0.001
Dropout level: 97% to 98% of Pickup
Level accuracy: for 0.1 to 2.0 × CT: ±0.5% of reading or ±1% of rated (whichever is greater) for > 2.0 × CT: ±1.5% of reading > 2.0 × CT rating
Curve shapes: IEEE Moderately/Very/Extremely Inverse; IEC (and BS) A/B/C and Short Inverse; GE IAC Inverse, Short/Very/ Extremely Inverse; I2t; FlexCurves. (programmable); Definite Time (0.01 s base curve)
Curve multiplier: Time Dial = 0.00 to 600.00 in steps of 0.01
Reset type: Instantaneous/Timed (per IEEE)
Timing accuracy: Operate at > 1.03 × actual Pickup ±3.5% of operate time or ±½ cycle (whichever is greater)

PHASE OVERVOLTAGE

Voltage: Phasor only
Pickup level: 0.004 to 3.000 pu in steps of 0.001
Dropout level: 97 to 98% of Pickup
Level accuracy: ±0.5% of reading from 10 to 208V
Pickup delay: 0.00 to 600.00 in steps of 0.01 s
Operate time: < 30 ms at 1.10 × Pickup at 60 Hz
Timing accuracy: ±3% or ±4 ms (whichever is greater)

PHASE UNDERVOLTAGE

Voltage: Phasor only
Pickup level: 0.004 to 3.000 pu in steps of 0.001
Dropout level: 102 to 103% of Pickup
Level accuracy: ±0.5% of reading from 10 to 208V
Curve shapes: GE IAV Inverse; Definite Time (0.1s base curve)
Curve multiplier: Time Dial = 0.00 to 600.00 in steps of 0.01
Timing accuracy: Operate at < 0.90 × Pickup ±3.5% of operate time or ±4 ms (whichever is greater)

PILOT-AIDED SCHEMES

Direct Underreaching Transfer Trip (DUTT)
Permissive Underreaching Transfer Trip (PUTT)
Permissive Overreaching Transfer Trip (POTT)
Hybrid POTT Scheme
Directional Comparison Blocking Scheme
Customizable version of the POTT and DCB schemes (POTT1 and DCB1)

UR Technical Specifications

PROTECTION

POWER SWING DETECT

Functions:	Power swing block, Out-of-step trip
Characteristic:	Mho or Quad
Measured impedance:	Positive-sequence
Blocking / tripping mozes:	2-step or 3-step
Tripping mode:	Early or Delayed
Current supervision:	
Pickup level:	0.050 to 30.000 pu in steps of 0.001
Dropout level:	97 to 98% of Pickup
Fwd / reverse reach (sec. W):	0.10 to 500.00W in steps of 0.01
Left and right blinders (sec. W):	0.10 to 500.00W in steps of 0.01
Impedance accuracy:	±5%
Fwd / reverse angle impedances:	40 to 90° in steps of 1
Angle accuracy:	±2°
Characteristic limit angles:	40 to 140° in steps of 1
Timers:	0.000 to 65.535 s in steps of 0.001
Timing accuracy:	±3% or 4 ms, whichever is greater

RATE OF CHANGE OF FREQUENCY

df/dt trend:	increasing, decreasing, bi-directional
df/dt pickup level:	0.10 to 15.00 Hz/s in steps of 0.01
df/dt dropout level:	96% of pickup
df/dt level accuracy:	80 mHz/s or 3.5%, whichever is greater
Overvoltage supv.:	0.02 to 3.000 pu in steps of 0.001
Overcurrent supv.:	0.000 to 30.000 pu in steps of 0.001
Pickup delay:	0 to 65.535 s in steps of 0.001
Reset delay:	0 to 65.535 s in steps of 0.001
Time accuracy:	±3% or ±4 ms, whichever is greater
95% settling time for df/dt:	< 24 cycles
Operate time:	
at 2 × pickup:	12 cycles
at 3 × pickup:	8 cycles
at 5 × pickup:	6 cycles

RESTRICTED GROUND FAULT

Pickup:	0.000 to 30.000 pu in steps of 0.001
Dropout:	97 to 98% of Pickup
Slope:	0 to 100% in steps of 1%
Pickup delay:	0 to 600.00 s in steps of 0.01
Dropout delay:	0 to 600.00 s in steps of 0.01
Operate time:	< 1power system cycle

SENSITIVE DIRECTIONAL POWER

Measured power:	3-phase, true RMS
Number of stages:	2
Characteristic angle:	0 to 359° in steps of 1
Calibration angle:	0.00 to 0.95° in steps of 0.05
Minimum power:	-1.200 to 1.200 pu in steps of 0.001
Pickup level accuracy:	±1% or ±0.001 pu, whichever is greater
Hysteresis:	2% or 0.001 pu, whichever is greater
Pickup delay:	0 to 600.00 s in steps of 0.01
Time accuracy:	±3% or ±4 ms, whichever is greater
Operate time:	50 ms

SPLIT PHASE PROTECTION

Operating quantity:	split phast CT current biased by generator load current
Pickup level:	0.000 to 1.500 pu in steps of 0.001
Dropout level:	97 to 98% of Pickup
Level accuracy:	±0.5% of reading or ±1% of rated
Pickup delay:	0.000 to 65.535 s in steps of 0.001
Time accuracy:	±3% of ± cycles, whichever is greater
Operate time:	< 5 cycles at 1.10 × pickup at 60Hz

STATOR DIFFERENTIAL

Pickup:	0.050 to 1.00 pu in steps of 0.01
Slope 1/2:	1 to 100% in steps of 1
Break 1:	1.00 to 1.50 pu in steps of 0.01
Break 2:	1.50 to 30.00 pu in steps of 0.01
Level accuracy:	±2%

SYNCHROCHECK

Max voltage difference:	0 to 400000 V in steps of 1
Max angle difference:	0 to 100° in steps of 1
Max freq. difference:	0.00 to 2.00 Hz in steps of 0.01
Hysteresis for max. freq. diff.:	0.00 to 0.10 Hz in steps of 0.01
Dead source function:	None, LV1 & DV2, DV1 & LV2, DV1 or DV2, DV1 xor DV2, DV1 & DV2 (L = Live, D = Dead)
Freq. Slip Maximun dF:	0.10 to 2.00 in steps of 0.01 Hz
Freq. Slip Minimun dF:	0.01 to 1.00 in steps of 0.01 Hz
Freq. Slip Close Breaker Time:	0.010 to 0.500 in steps of 0.001 s

PROTECTION

THERMAL MODEL

Thermal overload curves:	Standard curve, FlexCurve, voltage dependent curve
Standard Curve Time Multiplier:	0.00 to 600.00 in steps of 0.01
Thermal Overload Pickup:	pu = overload factor × FLA
Overload (OF):	1.00 to 1.50 in steps of 0.001
Standard Overload Curve:	

trip time =

$$\frac{TD \times 2.2116623}{0.02530337 \times \left(\frac{I_{motor}}{OF \times FLA}\right)^2 + 0.05054758 \times \frac{I_{motor}}{OF \times FLA}}$$

Motor Rated Voltage:	1 to 50000 V in steps of 1
Thermal Motor Biasing:	Current unbalance, RTDs
Thermal Model Update Rate:	1 power cycle
Stopped/Running Time Cool Constants:	1 to 65000 min. in steps of 1
Stopped/Running Time Cool Constants Decay:	Exponential
Hot/Cold Safe Stall Ratio:	0.01 to 1.00 in steps of 0.01
Current Accuracy:	Per phase current inputs
Current Source:	True RMS
Timing Accuracy	± 100 ms or ± 2% whichever is greater
Timing Accuracy for Voltage Dependent Overload:	± 100 ms or ± 4%, whichever is greater

THIRD HARMONIC NEUTRAL UNDERVOLTAGE

Operating quantity:	3rd harmonic of auxiliary undervoltage
Undervoltage:	
Pickup level:	0.001 to 3.000 pu in steps of 0.001
Dropout level:	102 to 103% of pickup
Accuracy:	±2% of reading from 1 to 120V
Power:	
Pickup level:	0.000 to 1.200 pu in steps of 0.001
Dropout level:	97 to 98% of pickup
Accuracy:	±5% or ±0.01 pu, whichever is greater
Undervoltage Inhibit Level:	0.000 to 3.000 pu in steps of 0.001 pu
Accuracy:	±0.5% of reading from 10 to 208V
Pickup delay:	0 to 600.00 s in steps of 0.01
Time accuracy:	±3% or ±20 ms, whichever is greater
Operate time:	< 30 ms at 1.10 × pickup at 60 Hz

TRANSFORMER AGING FACTOR

Operating quantity:	computed aging accelaration factor (pu)
Pickup level:	1 to 10 pu in steps of 0.1
Pickup delay:	0 to 30000 min. in steps of 1

TRANSFORMER INSTANTANEOUS DIFFERENTIAL

Pickup level:	2.00 to 30.00 pu in steps of 0.01
Dropout level:	97 to 98% of pickup
Level accuracy:	±0.5% of reading or ±1% of rated (whichever is greater)
Operate time:	< 20 ms at 3 × pickup at 60 Hz

TRANSFORMER HOTTEST-SPOT TEMPERATURE

Operating quantity:	computed temperature in °C
Pickup level:	50 to 300°C in steps of 1
Dropout level:	1°C below pickup
Pickup delay:	0 to 30000 min. in steps of 1

TRANSFORMER LOSS OF LIFE

Operating quantity:	computed accumulated transformer loss of life, in hours
Pickup level:	0 to 500000 hours in steps of 1

TRANSFORMER PERCENT DIFFERENTIAL

Characteristic:	Differential Restraint pre-set
Number of zones:	2
Minimum pickup:	0.05 to 1.00 pu in steps of 0.001
Slope 1 range:	15 to 100% in steps of 1%
Slope 2 range:	50 to 100% in steps of 1%
Kneepoint 1:	1.0 to 2.0 pu in steps of 0.0001
Kneepoint 2:	2.0 to 30.0 pu in steps of 0.0001
2nd harmonic inhibit level:	1.0 to 40.0% in steps of 0.1
2nd harmonic inhibit function:	Adaptive, Traditional, Disabled
2nd harmonic inhibit mode:	Per-phase, 2-out-of-3, Average
5th harmonic inhibit range:	1.0 to 40.0% in steps of 0.1
Operate times:	
Harmonic inhibits selected:	20 to 30 ms
No harmonic inhibits selected:	5 to 20 ms
Dropout level:	97 to 98% of pickup
Level accuracy:	±0.5% of reading or ±1% of rated (whichever is greater)

PROTECTION

TRIP OUTPUT

Collects trip and reclose input requests and issues outputs to control tripping and reclosing.

Communications timer delay:	0 to 65535 s in steps of 0.001
Evolving fault timer:	0.000 to 65.535 s in steps of 0.001
Timing accuracy:	±3% or 4 ms, whichever is greater

UNDERFREQUENCY

Minimum signal:	0.10 to 1.25 pu in steps of 0.01
Pickup level:	20.00 to 65.00 Hz in steps of 0.01
Dropout level:	Pickup + 0.03 Hz
Level accuracy:	±0.01 Hz
Time delay:	0 to 65.535 s in steps of 0.001
Timer accuracy:	±3% or 4 ms, whichever is greater

VOLTS PER HERTZ

Voltage:	Phasor only
Pickup level:	0.80 to 4.00 in steps of 0.01 pu V/Hz
Dropout level:	97 to 98% of Pickup
Level accuracy:	±0.02 pu
Timing curves:	Definite Time; Inverse A, B, and C, FlexCurves. A, B, C, and D
TD Multiplier:	0.05 to 600.00 s in steps of 0.01
Reset delay:	0.0 to 1000.0 s in steps of 0.1
Timing accuracy:	±3% or ± 4 ms (whichever is greater)

VT FUSE FAIL

Monitored parameters:	V_2, V_1, I_1

WATTMETRIC ZERO-SEQUENCE DIRECTIONAL

Measured Power	Zero-Sequence
Number of Elements:	2
Characteristic Angle:	0 to 360° in steps of 1
Minimum Power:	0.001 to 1.20pu in steps of 0.001
Pickup Level Accuracy:	±1% or ± 0.0025 pu, whichever is greater
Pickup Delay:	Definite time (0 to 600.00 s in steps of 0.01), inverse time, or FlexCurve
Inverse Time Multiplier:	0.01 to 2.00 s in steps of 0.01
Time Accuracy:	±3% or ±8 ms, whichever is greater
Operate Time:	<30 ms at 60 Hz

MONITORING

DATA LOGGER

Number of channels:	1 to 16
Parameters:	Any available analog actual value
Sampling rate:	15 to 3600000 ms in steps of 1
Trigger:	Any FlexLogic operand
Mode:	Continuous or Triggered
Storage capacity:	(NN is dependent on memory)
1-second rate:	01 channel for NN days 16 channels for NN days
60-minute rate:	01 channel for NN days 16 channels for NN days

EVENT RECORDER

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

FAULT LOCATOR

Method:	Single-ended
Maximum accuracy if:	Fault resistance is zero or fault currents from all line terminals are in phase
Relay accuracy:	±1.5% (V > 10 V, I > 0.1 pu)
Worst-case accuracy:	VT%error + (user data) CT%error + (user data) ZLine%error + (user data) METHOD%error + (Chapter 6) RELAY ACCURACY%error + (1.5%)

HIGH-IMPEDANCE FAULT DETECTION (HIZ)

Detections:	Arc Suspected, Arc Detected, Downed Conductor, Phase Identification

OSCILLOGRAPHY

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

USER-PROGRAMMABLE FAULT REPORT

Number of elements:	2
Pre-fault trigger:	any FlexLogic. operand
Fault trigger:	any FlexLogic. operand
Recorder quantities:	32 (any FlexAnalog value)

UR Technical Specifications

MONITORING

PHASOR MEASUREMENT UNIT

Output format:	per IEEE C37.118 standard
Number of channels:	14 synchrophasors, 16 analogs, 16 digitals
TVE (total vector error):	<1%
Triggering:	frequency, voltage, current, power, rate of change of frequency, user-defined
Reporting rate:	1, 2, 5, 10, 12, 15, 20, 25, 30, 50, 60 or 120 times per second
Number of clients:	One over TCP/IP port, two over UDP/IP ports
TAC ranges:	As indicated in appropriate specifications sections
Network reporting format:	16-bit integer or 32-bit IEEE floating point numbers
Network reporting style:	Rectangular (real and imaginary) or polar (magnitude and angle) coordinates
Filtering:	P and M class
Calibration:	Angle ±5°, magnitude +/-5% per phase
Compensation:	-180 to 180° in steps of 30° (current and voltage components)
Mode of operation:	Normal and test
PMU Recording:	46 configurable channels (14 syncrophasor, 16 digital, 16 analogs)

METERING

RMS CURRENT: PHASE, NEUTRAL, AND GROUND

Accuracy at:	
0.1 to 2.0 × CT rating:	±0.25% of reading or ±0.1% of rated (whichever is greater)
> 2.0 × CT rating:	±1.0% of reading

RMS VOLTAGE

Accuracy:	±0.5% of reading from 10 to 208 V

REAL POWER (WATTS)

Accuracy:	±1.0% of reading at -0.8 < PF < -1.0 and 0.8 < PF < 1.0

REACTIVE POWER (VARS)

Accuracy:	±1.0% of reading at -0.2 < PF < 0.2

APPARENT POWER (VA)

Accuracy:	±1.0% of reading

WATT-HOURS (POSITIVE AND NEGATIVE)

Accuracy:	±2.0% of reading
Range:	±0 to 2 × 109 MWh
Parameters:	3-phase only
Update rate:	50 ms

VAR-HOURS (POSITIVE AND NEGATIVE)

Accuracy:	±2.0% of reading
Range:	±0 to 2 × 109 Mvarh
Parameters:	3-phase only
Update rate:	50 ms

CURRENT HARMONICS

Harmonics:	2nd to 25th harmonic: per phase, displayed as a % of f1 (fundamental frequency phasor) THD: per phase, displayed as a % of f1
Accuracy:	
Harmonics:	1. f1 > 0.4pu: (0.20% + 0.035% / harmonic) of reading or 0.15% of 100%, whichever is greater 2. f1 < 0.4pu: as above plus %error of f1
THD:	1. f1 > 0.4pu: (0.25% + 0.035% / harmonic) of reading or 0.20% of 100%, whichever is greater 2. f1 < 0.4pu: as above plus %error of f1

DEMAND

Measurements:	Phases A, B, and C present and maximum measured currents 3-Phase Power (P, Q, and S) present and maximum measured currents
Accuracy:	±2.0%

FREQUENCY

Accuracy at	
V = 0.8 to 1.2 pu:	±0.01 Hz (when voltage signal is used for frequency measurement)
I = 0.1 to 0.25 pu:	±0.05 Hz
I > 0.25 pu:	±0.02 Hz (when current signal is used for frequency measurement)

VOLTAGE HARMONICS

Harmonics:	2nd to 25th harmonic: per phase, displayed as a % of f1 (fundamental frequency phasor) THD: per phase, displayed as a % of f1
Accuracy:	
Harmonics:	1. f1 > 0.4pu: (0.20% + 0.035% / harmonic) of reading or 0.15% of 100%, whichever is greater 2. f1 < 0.4pu: as above plus %error of f1
THD:	1. f1 > 0.4pu: (0.25% + 0.035% / harmonic) of reading or 0.20% of 100%, whichever is greater 2. f1 < 0.4pu: as above plus %error of f1

USER-PROGRAMMABLE ELEMENTS

CONTROL PUSHBUTTONS

Number of pushbuttons:	3 (standard), 16 (UR Enhanced HMI) or 8 plus 10 soft pushbuttons (UR color HMI)
Operation:	drive FlexLogic. operands

FLEXCURVES

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

FLEXLOGIC

Programming language:	Reverse Polish Notation with graphical visualization (keypad programmable)
Lines of code:	1024
Internal variables:	64
Supported operations:	NOT, XOR, OR (2 to 16 inputs), AND (2 to 16 inputs), NOR (2 to 16 inputs), NAND (2 to 16 inputs), Latch (Reset Dominant), Edge Detectors, Timers
Inputs:	any logical variable, contact, or virtual input
Number of timers:	32
Pickup delay:	0 to 60000 (ms, sec., min.) in steps of 1
Dropout delay:	0 to 60000 (ms, sec., min.) in steps of 1

FLEXELEMENTS

Number of elements:	8 or 16
Operating signal:	any analog actual value, or two values in Differential mode
Operating signal mode:	Signed or Absolute Value
Operating mode:	Level, Delta
Comparator direction:	Over, Under
Pickup Level:	-30.000 to 30.000 pu in steps of 0.001
Hysteresis:	0.1 to 50.0% in steps of 0.1
Delta dt:	20 ms to 60 days
Pickup & dropout delay:	0.000 to 65.535 s in steps of 0.001

FLEXSTATES

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

LED TEST

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

NON-VOLATILE LATCHES

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

SELECTOR SWITCH

Number of elements:	2
Upper position limit:	1 to 7 in steps of 1
Selecting mode:	Time-out or Acknowledge
Time-out timer:	3.0 to 60.0 s in steps of 0.1
Control inputs:	step-up and 3-bit
Power-up mode:	restore from non-volatile memory or synchronize to a 3-bit control input

USER-DEFINABLE DISPLAYS

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

USER-PROGRAMMABLE LEDS

Number:	48 plus Trip and Alarm (UR Enhanced HMI), 8 plus Trip and Alarm (UR Color HMI)
Programmability:	from any logical variable, contact, or virtual input
Reset mode:	Self-reset or Latched

USER-PROGRAMMABLE PUSHBUTTONS (OPTIONAL)

Number of pushbuttons:	13 (standard), 16 (UR Enhanced HMI) or 8 plus 10 soft pushbuttons (UR color HMI)
Mode:	Self-Reset, Latched
Display message:	2 lines of 20 characters each

8-BIT SWITCH

Number of elements:	6
Input signals:	two 8-bit integers via FlexLogic operands
Control:	any FlexLogic operand
Response time:	< 8 ms at 60 Hz, < 10 ms at 50 Hz

INPUTS

AC CURRENT

CT rated primary:	1 to 50000 A
CT rated secondary:	1 A or 5 A by connection
Nominal frequency:	20 to 65 Hz
Relay burden:	< 0.2 VA at rated secondary
Conversion range:	
Standard CT:	0.02 to 46 × CT rating RMS symmetrical
Sensitive Ground/HI-Z CT module:	0.002 to 4.6 × CT rating RMS symmetrical
Current withstand:	20 ms at 250 times rated 1 sec. at 100 times rated continuous at 3 times rated continuous 4xInom; URs equipped with 24 CT inputs have a maximum operating temp. of 50°C

AC VOLTAGE

VT rated secondary:	50.0 to 240.0 V
VT ratio:	1.00 to 24000.00
Nominal frequency:	20 to 65 Hz For the L90, the nominal system frequency should be chosen as 50 Hz or 60 Hz only.
Relay burden:	< 0.25 VA at 120 V
Conversion range:	1 to 275 V
Voltage withstand:	continuous at 260 V to neutral 1 min./hr at 420 V to neutral

CONTACT INPUTS

Dry contacts:	1000 Ω maximum
Wet contacts:	300 V DC maximum
Selectable thresholds:	17 V, 33 V, 84 V, 166 V
Tolerance:	±10%
Contacts Per Common Return:	4
Recognition time:	< 1 ms
Debounce timer:	0.0 to 16.0 ms in steps of 0.5
Continuous Current Draw:	3mA (when energized)

CONTACT INPUTS WITH AUTO-BURNISHING

Dry contacts:	1000 Ω maximum
Wet contacts:	300 V DC maximum
Selectable thresholds:	17 V, 33 V, 84 V, 166 V
Tolerance:	±10%
Contacts Per Common Return:	2
Recognition time:	< 1 ms
Debounce timer:	0.0 to 16.0 ms in steps of 0.5
Continuous Current Draw:	3mA (when energized)
Auto-Burnish Impulse Current:	50 to 70 mA
Duration of Auto-Burnish Impulse:	25 to 50 ms

DCMA INPUTS

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

DIRECT INPUTS

Number of input points:	32
No. of remote devices:	16
Default states on loss of comms.:	On, Off, Latest/Off, Latest/On
Ring configuration:	Yes, No
Data rate:	64 or 128 kbps
CRC:	32-bit
CRC alarm:	
Responding to:	Rate of messages failing the CRC
Monitoring message count:	10 to 10000 in steps of 1
Alarm threshold:	1 to 1000 in steps of 1
Unreturned message alarm:	
Responding to:	Rate of unreturned messages in the ring configuration
Monitoring message count:	10 to 10000 in steps of 1
Alarm threshold:	1 to 1000 in steps of 1

IRIG-B INPUT

Amplitude modulation:	1 to 10 V pk-pk
DC shift:	TTL
Input impedance:	22 kW
Isolation:	2 kV

REMOTE INPUTS (IEC 61850 GSSE)

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

RTD INPUTS

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

UR Technical Specifications

OUTPUTS

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

DCMA OUTPUTS
Range: -1 to 1 mA, 0 to 1 mA, 4 to 20 mA
Max. load resistance: 12 k for -1 to 1 mA range
12 k for 0 to 1 mA range
600 for 4 to 20 mA range
Accuracy: ±0.75% of full-scale for 0 to 1 mA range
±0.5% of full-scale for -1 to 1 mA range
±0.75% of full-scale for 0 to 20 mA range
99% Settling time to a step change: 100 ms
Isolation: 1.5 kV
Driving signal: any FlexAnalog quantity
Upper & lower limit for the driving signal: -90 to 90 pu in steps of 0.001

DIRECT OUTPUTS
Output points: 32

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

FORM-A RELAY
Make & carry for 0.2s: 30 A as per ANSI C37.90
Carry continuous: 6 A
Break at L/R of 40 ms: 1 A DC max. at 24 V
0.5 A DC max. at 48 V
0.3 A DC max. at 125 V
0.2 A DC max. at 250 V
Operate time: < 4 ms
Contact material: Silver alloy

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

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

FORM-C AND CRITICAL FAILURE RELAY
Make & carry for 0.2 s: 30 A
Carry continuous: 8 A
Break at L/R of 40 ms: 0.25 A DC max. at 48 V
0.10 A DC max. at 125 V
Operate time: < 8 ms
Contact material: Silver alloy

FAST FORM-C RELAY
Make & carry: 0.1 A max. (resistive load)
Minimum load impedance:
Operate time: < 0.6 ms
Internal Limiting Resistor: 100, 2

IRIG-B OUTPUT
Amplitude: 10 V peak-peak RS485 level
Maximum load: 100 ohms
Time delay: 1 ms for AM input
40 µs for DC-shift input
Isolation: 2 kV

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

REMOTE OUTPUTS (IEC 61850 GSSE)
Standard output points: 32
User output points: 32

SOLID-STATE OUTPUT RELAY
Operate & release time: <100 µs
Maximum voltage: 265 V DC
Maximum continuous current: 5 A at 45°C; 4 A at 65°C
Make & carry for 0.2 s: as per ANSI C37.90
For 0.3s: 300 A
Breaking capacity:

	IEC 647-5/UL508	UTILITY APPLICATION (AUTORECLOSE SCHEME)	INDUSTRIAL APPLICATION
Operations/ interval	5000 ops 1 s-On, 9 s-Off	5 ops/ .2 s-On, 0.2 s-Off within 1 minute	10000 ops/ 0.2 s-On, 30 s-Off
	1000 ops 0.5 s-On, 0.5 s-Of		
Break capability (0 to 250 VDC)	3.2 A L/R = 10 ms	10 A L/R = 40 ms	10 A L/R = 40 ms
	1.6 A L/R = 20 ms		
	0.8 A L/R = 40 ms		

COMMUNICATIONS

RS232
Front port: 19.2 kbps, Modbus® RTU, DNP 3.0

RS485
1 or 2 rear ports: Up to 115 kbps, Modbus® RTU, DNP 3.0 isolated together at 36 Vpk
Typical distance: 1200 m
Isolation: 2 kV

ETHERNET PORT
10Base-F: 820 nm, multi-mode, supports half-duplex/full-duplex fiber optic with ST connector
Redundant 10Base-F: 820 nm, multi-mode, half-duplex/ full-duplex fiber optic with ST connector
10Base-T: RJ45 connector
Power budget: 10 dB
Max optical input power: -7.6 dBm
Max optical output power: -20 dBm
Receiver sensitivity: -30 dBm
Typical distance: 1.65 km
SNTP Clock (redundant) synchronization error: <10 ms (typical)

PROTOCOLS

	RS232	RS485	10BaseF	10BaseT	100BaseT
IEC 61850			•	•	•
DNP 3.0	•	•	•	•	•
Modbus	•	•	•	•	•
IEC104			•	•	•
EGD			•	•	•

INTER-RELAY COMMUNICATIONS

SHIELDED TWISTED-PAIR INTERFACE OPTIONS

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

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

LINK POWER BUDGET

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

* NOTE: These power budgets are calculated from the manufacturers' worst-case transmitter power and worst-case receiver sensitivity.

MAXIMUM OPTICAL INPUT POWER

EMITTED, FIBER TYPE	MAX. OPTICAL INPUT POWER
820 nm LED, Multimode	-7.6 dBm
1300 nm LED, Multimode	-11 dBm
1300 nm ELED, Singlemode	-14 dBm
1300 nm Laser, Singlemode	-14 dBm
1500 nm Laser, Singlemode	-14 dBm

TYPICAL LINK DISTANCE

EMITTED TYPE	FIBER TYPE	CONNECTOR TYPE	TYPICAL DISTANCE
820 nm LED	Multimode	-7.6 dBm	1.65 km
1300 nm LED	Multimode	-11 dBm	3.8 km
1300 nm ELED	Singlemode	-14 dBm	11.4 km
1300 nm Laser	Singlemode	-14 dBm	64 km
1500 nm Laser	Singlemode	-14 dBm	105 km

INTER-RELAY COMMUNICATIONS

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

CONNECTOR LOSSES (TOTAL OF BOTH ENDS)
ST connector: 2dB

FIBER LOSSES
820 nm multimode: 3 dB/km
1300 nm mulimode: 1 dB/km
1300 nm singlemode: 0.35 dB/km
1550 nm singlemode: 0.25 dB/km
Splice losses: One splice every 2 km, at 0.05 dB loss per splice

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

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

POWER SUPPLY

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

HIGH RANGE
Nominal DC voltage: 125 to 250 V at 0.7 A
Min/max DC voltage: 88 / 300 V
Nominal AC voltage: 100 to 240 V at 50/60 Hz, 0.7 A
Min/max AC voltage: 88 / 265 V at 25 to 100 Hz

ALL RANGES
Volt withstand: 2 × Highest Nominal Voltage for 10 ms
Voltage loss hold-up: 50 ms duration at nominal
Power consumption: Typical = 15 VA; Max. = 30 VA

INTERNAL FUSE
RATINGS
Low range power supply: 8 A / 250 V
High range power supply: 4 A / 250 V
INTERRUPTING CAPACITY
AC: 100 000 A RMS symmetrical
DC: 10 000 A
Hold up time: 200 ms

TYPE TESTS
Electrical fast transient: ANSI/IEEE C37.90.1
IEC 61000-4-4
IEC 60255-22-4
Oscillatory transient: ANSI/IEEE C37.90.1
IEC 61000-4-12
Insulation resistance: IEC 60255-5
Dielectric strength: IEC 60255-6
ANSI/IEEE C37.90
Electrostatic discharge: EN 61000-4-2
Surge immunity: EN 61000-4-5
RFI susceptibility: ANSI/IEEE C37.90.2
IEC 61000-4-3
IEC 60255-22-3
Ontario Hydro C-5047-77
Conducted RFI: IEC 61000-4-6
Voltage dips/interruptions/variations:
IEC 61000-4-11
IEC 60255-11
Power frequency magnetic field immunity:
IEC 61000-4-8
Vibration test (sinusoidal): IEC 60255-21-1
Shock and bump: IEC 60255-21-2
*** NOTE:** Type test report available upon request.

PRODUCTION TESTS

THERMAL
Products go through an environmental test based upon an accepted quality level (AQL) sampling process

ENVIRONMENTAL

OPERATING TEMPERATURES
Cold: IEC 60028-2-1, 16 h at -40°C
Dry Heat: IEC 60028-2-2, 16 h at +85°C

OTHER
Humidity(noncondensing): IEC 60068-2-30, 95%, Variant 1,6days.
Altitude: Up to 2000 m
Installation Category: II

APPROVALS
UL Listed for the USA and Canada
Manufactured under an ISO9000 registered system.

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

imagination at work

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English
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