GE

Grid Solutions

Multilin 469

Complete integrated protection and management of medium and large motors

The Multilin™ 469 Motor Protection System, a member of the SR family of relays, provides protection, control, simplified configuration and advanced communications in a cost effective industry leading draw-out construction. Designed for medium voltage motors, the 469 delivers advanced protection with customizable overload curves and single CT differential protection for added flexibility. The 469 also provides simplified configuration using the Motor Settings Auto-Configurator, providing a quick and easy set-up of motor parameters. Coupled with advanced protection and diagnostics, the 469 provides users the flexibility of multiple communication protocols allowing integration into new and existing control networks.

Key Benefits

- Comprehensive motor protection plus voltage dependant overload curves, torque metering and protection, broken rotor bar protection
- Most advanced thermal model - Including multiple RTD inputs for stator thermal protection
- Minimize replacement time - Draw-out construction
- Complete asset monitoring - Temperature, Analog I/O, full metering including demand & energy
- Improve uptime of auxiliary equipment - Through I/O monitoring
- Reduce troubleshooting time and maintenance costs - Event reports, waveform capture, data logger
- Built in simulation functions simplify testing and commissioning
- Cost Effective Access to information - Through standard RS232 & RS485 serial ports, and optional Ethernet and DeviceNet Ports
- Field upgradable firmware and settings
- Optional Conformal coating for exposure to chemically corrosive or humid environments

Applications

- Protection and Management of three phase medium and large horsepower motors and driven equipment, including high inertia, two speed and reduced-voltage start motors

Protection and Control

- Thermal model biased with RTD and negative sequence current feedback
- Start supervision and inhibit
- Mechanical jam
- Voltage compensated acceleration
- Undervoltage, overvoltage
- Underfrequency
- Stator differential protection
- Thermal overload
- Overtemperature protection
- Phase and ground overcurrent
- Current unbalance
- Power elements
- Torque protection
- Dual overload curves for 2 speed motors
- Reduced voltage starting control

Communications

- Multiple Ports - 10baseT Ethernet, RS485, RS232, RS422, DeviceNet
- Multiple Protocols - Modbus RTU, Modbus TCP/IP, DeviceNet

Monitoring & Metering

- A, V, W, var, VA, PF, Hz, Wh, varh, demand
- Torque, temperature (12 RTDs)
- Event recorder
- Oscillography & Data Logger (trending)
- Statistical information & learned motor data

EnerVista Software

- State of the art software for configuration and commissioning Multilin products
- Document and software archiving toolset to ensure reference material and device utilities are up-to-date
- EnerVista™ Integrator providing easy integration of data in the 469 into new or existing monitoring and control systems

Protection and Control

The 469 is a digital motor protection system designed to protect and manage medium and large motors and driven equipment. It contains a full range of selectively enabled, self contained protection and control elements as detailed in the Functional Block Diagram and Features table.

Motor Thermal Model

The primary protective function of the 469 is the thermal model with six key elements:

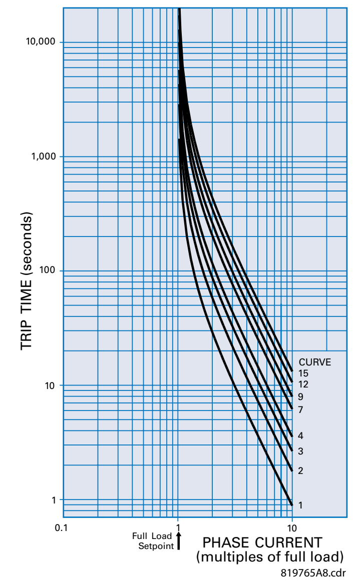
- Overload Curves
- Unbalance Biasing
- Hot/Cold Safe Stall Ratio
- Motor Cooling Time Constants
- Start Inhibit and Emergency Restart
- RTD Biasing

Overload Curves

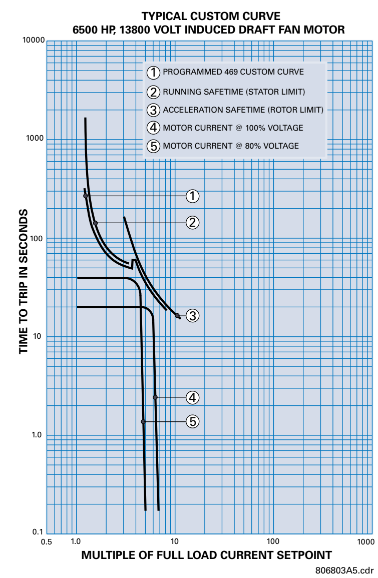
The curves can take one of three formats: standard, custom, or voltage dependent. For all curve styles, the 469 retains thermal memory in a thermal capacity used register which is updated every 0.1 second. The overload pickup determines where the running overload curve begins.

The 469 standard overload curves are of standard shape with a multiplier value of 1 to 15.

The voltage dependent overload curves are used in high inertia load applications, where motor acceleration time can actually exceed the safe stall time and motor thermal limits. During motor acceleration, the programmed thermal overload curve is dynamically adjusted with reference to the system voltage level. The selection of the overload curve type and the shape is based on motor thermal limit curves provided by motor vendor.

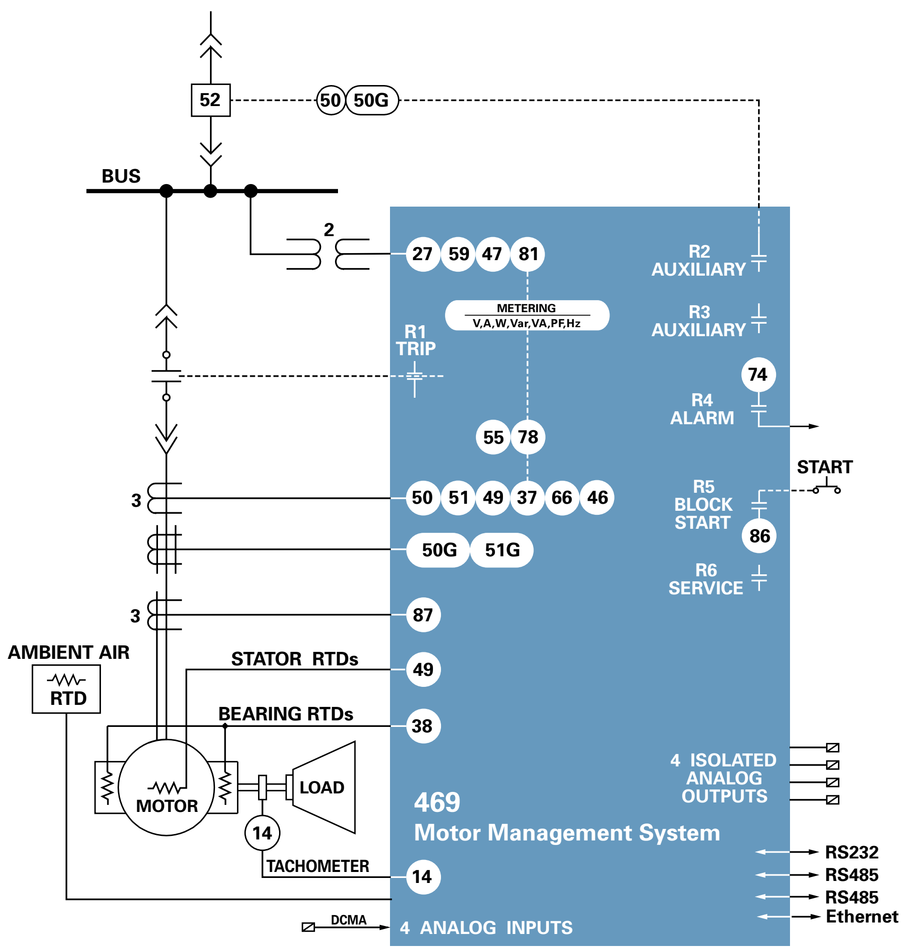


Fifteen standard overload curves.



Typical custom overload curve.

Functional Block Diagram



Device Number	Function
14	Speed switch
19/48	Reduced voltage start and incomplete sequence
27/59	Undervoltage/Overvoltage
32	Reverse power
	Mechanical Jam
	Acceleration time
	Over Torque
37	Undercurrent/Underpower
38	Bearing RTD
46	Current Unbalance
47	Phase Reversal
49	Stator RTD
50	Short circuit backup
50G/51G	Ground overcurrent backup
51	Overload
55	Power factor
66	Starts/hour and time between starts
81	Frequency
86	Overload lockout
87	Differential

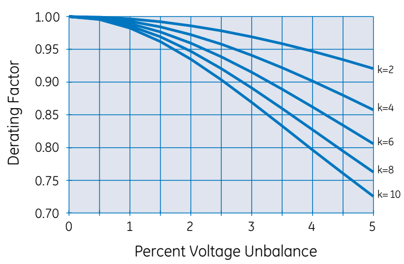
Unbalance (Negative Sequence Current) Biasing

Negative sequence current, which causes rotor heating, is not accounted for in the thermal limit curves supplied by the motor manufacturer. The 469 measures unbalance as the ratio of negative to positive sequence current. The thermal model is biased to reflect the additional heating. Motor derating due to current unbalance can be selected via the setpoint unbalance bias k factor. Unbalance voltage causes approximately 6 times higher level of current unbalance (1% of voltage unbalance equal to 6% of current unbalance). Note that the k=8 curve is almost identical to the NEMA derating curve.

Hot/Cold Safe Stall Ratio

The Hot/Cold Safe Stall time ratio defines the steady state level of thermal capacity used (TCU) by the motor. This level corresponds to normal operatingtemperature of the fully loaded motor and will be adjusted proportionally if motor load is lower then rated.

The Hot/Cold Safe Stall ratio is used by the relay to determine the lower limit of the running cool down curve, and also defines the thermal capacity level of the central point in RTD Biasing curve.



Motor derating factor due to unbalanced voltage

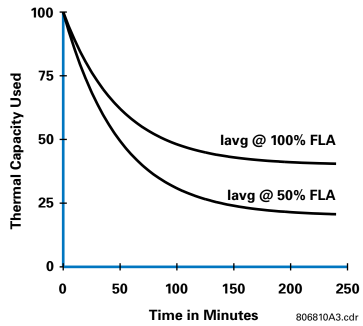
Motor Cooling Time Constants

When the 469 detects that the motor is running at a load lower then overload pickup setpoint, or the motor is stopped, it will start reducing the stored TCU value, simulating actual motor cool down process. TCU decays exponentially at a rate dictated by Cooling Time Constants setpoints. Normally the cooling down process of the stopped motor is much slower than that of a running motor, thus running and stopped cooling time constants setpoints are provided in the relay to reflect the difference.

The TCU lower limit of the running cool down curve is defined by Hot/Cold Safe Stall Ratio and level of the motor load. The TCU lower limit of the stopped cool down curve is 0% and corresponds to motor at ambient temperature.

Start Inhibit and Emergency Restart

The Start Inhibit function prevents starting of



Exponential cooldown (hot/cold curve ratio 60%

a motor when insufficient thermal capacity is available or motor start supervision function dictate the start inhibit. In case of emergency the thermal capacity used and motor start supervision timers can be reset to allow the hot motor starting.

RTD Biasing

The 469 thermal overload curves are based solely on measured current, assuming a normal 40°C ambient and normal motor cooling. The actual motor temperature will increase due to unusually high ambient temperature, or motor cooling blockage. Use the RTD bias feature to augment the thermal model calculation of Thermal Capacity Used, if the motor stator has embedded RTDs.

The RTD bias feature is feedback of measured stator temperature. This feedback acts to correct the assumed thermal model. Since RTDs have a relatively slow response, RTD biasing is useful for slow motor heating. Other portions of the thermal model are required during starting and heavy overload conditions when motor heating is relatively fast.

For RTD temperatures below the RTD BIAS MINIMUM setting, no biasing occurs. For maximum stator RTD temperatures above the RTD BIAS MAXIMUM setting, the thermal memory is fully biased and forced to 100%. At values in between, if the RTD bias thermal capacity used is higher compared to the thermal capacity used created by other features of the thermal model, then this value is used from that point onward.

Motor Start Supervision

Motor Start Supervision consists of the following features: Time-Between-Starts, Start-per-Hour, Restart Time.

These elements are intended to guard the motor against excessive starting duty, which is normally defined by the motor manufacturer in addition to the thermal damage curves.

Mechanical Jam and Acceleration Time

These two elements are used to prevent motor damage during abnormal operational conditions such as excessively long acceleration times or stalled rotor.

Phase Differential Protection

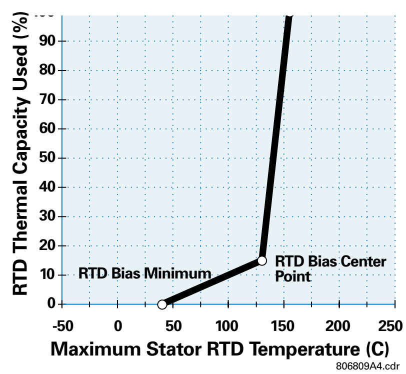
This function is intended to protect the stator windings and supply power cables of large motors. Two types of current transformers connections are supported:

- 6 CT's externally connected in the summing configuration.
- 3 Flux Balancing CT's.

Separate trip pickup levels and time delays are provided for motor starting and running conditions.

Short Circuit Trip

This function is intended to protect the stator windings of the motors against phase-to-phase faults.



RTD Bias curve.

Equipped with an overreach filter, the 469 removes the DC component from the asymmetrical current present at the moment a fault occurs or motor starts.

A trip backup feature is also available as part of this function, used to issue a second trip if the fault is not cleared within a given time delay.

The backup feature can also be assigned to an auxiliary contact for annunciation or remote tripping of upstream protection devices

Ground Fault

This function is designed to protect motors against phase to ground faults.

There are two dedicated ground current inputs in the relay, which support the following types of ground current detection.

- Core balance (Zero sequence) current transformer.
- Core balance (Zero sequence) 50:0.025 A (sensitive) current transformer.
- Residual connection of phase current transformers.

The function is equipped with an overreach filter, which removes the DC component from the asymmetrical current present at the moment a fault occurs, or a motor starts. Two pickup levels (trip and alarm) with individual time delays are available for ground fault detection.

A trip Backup feature is also available as part of this function. The operational principal of Ground Fault Trip Backup is the same as of Short Circuit Trip Backup.

Voltage and Frequency Protection

Use the voltage and frequency protection functions to detect abnormal system voltage and frequency conditions, potentially hazardous to the motor.

The following voltage elements are available:

- Over and Undervoltage
- Over and Underfrequency
- Phase Reversal

To avoid nuisance trips, the 469 can be set to block the undervoltage element when the bus that supplies power to the motor is de-energized, or under VT fuse failure conditions.

Power Elements

The following power elements are available in 469 relay. The first four elements have blocking provision during motor starting.

Power Factor

This element is used in synchronous motors applications to detect out-of-synchronism conditions.

Reactive Power

This element is used in applications where the reactive power limit is specified.

Underpower

Used to detect loss of load.

Reverse Active Power

Useful to detect conditions where the motor can become a generator.

Overtorque

This element is used to protect the driven load from mechanical breakage.

Current Unbalance

In addition to thermal model biasing current unbalance is available in the 469 relay as an independent element with 2 pickup levels and a built-in single phasing detection algorithm.

RTD Protection

The 469 has 12 programmable RTD inputs supporting 4 different types of RTD sensors. RTD inputs are normally used for monitoring stator, bearings, ambient temperature as well as other parts of the motor assembly that can be exposed to overheating. Each RTD input has 3 operational levels: alarm, high alarm and trip. The 469 also supports RTD trip voting and provides open/short RTD failure alarms.

Additional and Special Features

- Two speed motor protection.
- Load averaging filter for cyclic load applications
- Reduced voltage starting supervision.
- Variable frequency filter allowing accurate sensing and calculation of the analog values in VFD applications.
- Analog input differential calculation for dual drives applications.
- Speed counter trip and alarm.
- Universal digital counter trip and alarm.
- Pulsing KWh and Kvarh output.
- Trip coil supervision.
- Drawout indicator, Setpoints Access and Test permit inputs.
- Undervoltage Autorestart (Optional)
- Broken rotor bar detection system (Optional)
- VT Fuse Failure

Inputs and Outputs

Current and Voltage Inputs

The 469 has two sets of three phase CT inputs, one for phase current, and one dedicated for differential protection.

The ratings of the phase current inputs (1A and 5A) must be specified when ordering the relay, while the ratings for differential inputs are field programmable, supporting both 1A and 5A secondary currents.

There are also 2 single-phase ground CT inputs: A standard input with settable secondary rating; 5A or 1A, and a high sensitivity ground current detection input for high resistance grounded systems.

Three phase VT inputs support delta and wye configuration and provide voltage signals for all voltage, frequency and power based protection elements and metering.

Digital Inputs

The 469 has 5 predefined inputs:

- Starter Status
- Emergency Restart
- Remote Reset
- Setpoint Access
- Test Switch

The 469 also has four assignable digital inputs, which can be configured as the following functions:

- Remote Trip and Alarm
- Speed Switch Trip and Tachometer
- Vibration Switch Trip and Alarm
- Pressure Switch Trip and Alarm
- Load Shed Trip
- Universal Digital Counter
- External oscillography trigger and External Relay Fault Simulation initiation
- General Switch with programmable functions and outputs

Analog Inputs and Outputs

Use the four configurable analog inputs available in the 469 to measure motor operation related quantities fed to the relay from standard transducers. Each input can be individually set to measure 4-20 mA, 0-20 mA or 0-1 mA transducer signals. The 469 can also be set to issue trip or alarm commands based on signal thresholds.

Use the four configurable analog outputs available in the 469 to provide standard transducer signals to local monitoring equipment. The desired output signal must be specified when the relay is ordered, either 4-20 mA, or 0-1 mA. The analog outputs can be configured to provide outputs based on any measured analog value, or any calculated quantity.

Output Relays

There are six Form-C output relays available in the 469. Four relays are always non-failsafe and can be selectively assigned to perform trip, or alarm functions. A non-failsafe block start relay is also provided, controlled by protection functions requiring blocking functionality. Loss of control power or 469 internal failures are indicated via the failsafe service relay. The trip and alarm relays can also be configured with latching functionality.

Monitoring and Metering

The 469 includes high accuracy metering and recording for all AC signals. Voltage, current, RTD and power metering are built into the relay as a standard feature.

Metering

The following system values are accurately metered and displayed:

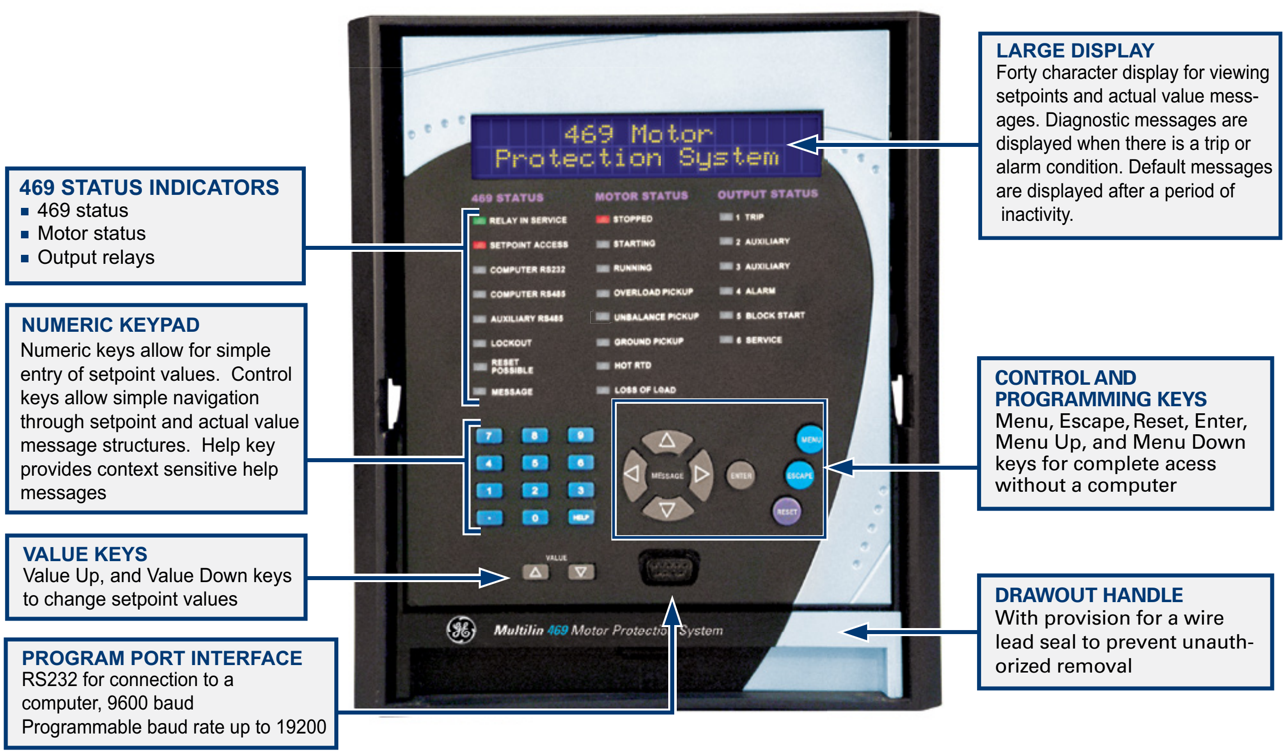
- Phase, differential and ground currents, average current, motor load, current unbalance.
- Phase-to-ground and Phase-to-phase voltages, average phase voltage, system frequency.
- Real, reactive, apparent power, power factor, watthours, varhours, torque
- Current and power demand.
- Analog inputs and RTD temperatures.
- Thermal capacity used, lockout times, motor speed

Monitoring

The 469 is equipped with monitoring tools to capture data. The following information is presented in a suitable format.

- Status of inputs, outputs and alarms
- Last trip data
- Motor learned parameters: last and maximum acceleration times, starting currents and starting TCU, average currents, RTD maximums, analog inputs maximums and minimums.
- Trip and general counters, motor running hours and start timers.
- Event recorder
- Oscillography

User Interface



Technical Specifications (continued)

OUTPUTS

ANALOG OUTPUTS

Type: Active
Range: 4 to 20 mA, 0 to 1 mA (must be specified with order)
Accuracy: ±1% of full scale
Maximum Load: 4 to 20 mA input: 1200 Ω, 0 to 1 mA input: 10 kΩ
Isolation: 36 Vpk (Isolation with RTDs and Analog Inputs)
4 Assignable Outputs: phase A current, phase B current, phase C current, 3 phase average current, ground current, phase AN (AB) voltage, phase BN (BC) voltage, phase CN (CA) voltage, 3 phase average voltage, hottest stator RTD, hottest bearing RTD,hottest other RTD, RTD # 1 to 12, Power factor, 3-phase Real power (kW), 3-phase Apparent power (kVA, 3-phase Reactive power (kvar), Thermal Capacity Used, Relay Lockout Time, Current Demand, kvar Demand, kW Demand, kVA Demand, Motor Load, Torque Motor Load, Torque

OUTPUT RELAYS

Configuration: 6 Electromechanical Form C
Contact Material: silver alloy
Operate Time: 10 ms
Max ratings for 100000 operations

VOLTAGE		M/C CONT.	M/C 0.2 SEC.	BREAK	MAX LOAD
DC Resistive	30 VDC	10 A	30A	10 A	300 W
	125 VDC	10 A	30A	0.5 A	62.5 W
	250 VDC	10 A	30A	0.3 A	75 W
DC Inductive L/R = 40 ms	30 VDC	10 A	30A	5 A	150 W
	125 VDC	10 A	30A	0.25 A	31.3 W
	250 VDC	10 A	30A	0.15 A	37.5 W
AC Resistive	120 VAC	10 A	30A	10 A	2770 VA
	250 VAC	10 A	30A	10 A	2770 VA
AC Inductive P.F. = 0.4	120 VAC	10 A	30A	4 A	480 VA
	250 VAC	10 A	30A	3 A	750 VA

POWER SUPPLY

CONTROL POWER

Options: LO / HI (must be specified with order)
LO Range: DC: 20 to 60 V DC AC: 20 to 48 V AC at 48 to 62 Hz
Hi Range: DC: 90 to 300 V DC AC: 70 to 265 V AC at 48 to 62 Hz
Power: 45 VA (max), 25 VA typical
Proper operation time without supply voltage: 30 ms

COMMUNICATIONS

RS232 Port: 1, Front Panel, non-isolated
RS485 Ports: 2, Isolated together at 36 Vpk
Baud Rates: RS485: 300 - 19,200 Baud programmable parity RS232: 9600
Parity: None, Odd, Even
Protocol: Modbus® RTU / half duplex
Ethernet Port: 10BaseT, RJ45 Connector, ModBus® RTU over TCP/IP

MONITORING

POWER FACTOR

Range: 0.01 lead or lag to 1.00
Pickup Level: 0.99 to 0.05 in steps of 0.01, Lead & Lag
Time Delay: 0.2 to 30.0 s in steps of 0.1
Block From Start: 0 to 5000 s in steps of 1
Pickup Accuracy: ±0.02
Timing Accuracy: ±100 ms or ±0.5% of total time
Elements: Trip and Alarm

3-PHASE REAL POWER

Range: 0 to ±99999 kW
Underpower Pkp: 1 to 25000 kW in steps of 1
Time Delay: 1 to 30 s in steps of 1
Block From Start: 0 to 15000 s in steps of 1
Pickup Accuracy: at Iavg < 2 × CT: ±1% of √3 × 2 × CT × VT × VT full scale at Iavg > 2 × CT±1.5% of 3 × 20 × CT × VT × VT full scale
Timing Accuracy: ±0.5 s or ±0.5% of total time
Elements: Trip and Alarm

3-PHASE APPARENT POWER

Range: 0 to 65535 kVA at Iavg < 2 × CT: ±1% of √3 × 2 × CT × VT × VT full scale at Iavg > 2 × CT±1.5% of √ 3 × 20 × CT × VT × VT full scale CT × VT × VTfull scale

3-PHASE REACTIVE POWER

Range: 0 to ±99999 kW
Pickup Level: ±1 to 25000 kW in steps of 1
Time Delay: 0.2 to 30.0 s in steps of 1
Block From Start: 0 to 5000 s in steps of 1
Pickup Accuracy: at Iavg < 2 × CT: ±1% of ?3 × 2 × CT × VT × VTfull scale at Iavg > 2 × CT: ±1.5% of √3 × 20 × CT × VT × VT full scale
Timing Accuracy: ±100 ms or ±0.5% of total time
Elements: Trip and Alarm

OVERTORQUE

Pickup Level: 1.0 to 999999.9 Nm/ft·lb in steps of 0.1; torque unit is selectable under torque setup
Time Delay: 0.2 to 30.0 s in steps of 0.1
Pickup Accuracy: ±2.0%
Time Accuracy: ±100 ms or 0.5% of total time
Elements: Alarm (INDUCTION MOTORS ONLY)

METERED REAL ENERGY CONSUMPTION

Description: Continuous total real power consumption
Range: 0 to 999999.999 MW·hours.
Timing Accuracy: ±0.5%
Update Rate: 5 seconds

METERED REACTIVE ENERGY CONSUMPTION

Description: Continuous total reactive power consumption
Range: 0 to 999999.999 Mvar·hours
Timing Accuracy: ±0.5%
Update Rate: 5 seconds

METERED REACTIVE POWER GENERATION

Description: Continuous total reactive power generation
Range: 0 to 2000000.000 Mvar·hours
Timing Accuracy: ±0.5%
Update Rate: 5 seconds

PRODUCT TESTS

Thermal Cycling: Operational test at ambient, reducing to –40°C and then increasing to 60°C
Dielectric Strength: 2.0 kV for 1 minute from relays, CTs, VTs, power supply to Safety Ground

TYPE TESTS

Dielectric voltage withstand: EN60255-5
Impulse voltage withstand: EN60255-5
Damped Oscillatory: IEC 61000-4-18 / IEC 60255-22-1
Electrostatic Discharge: EN61000-4-2 / IEC 60255-22-2
RF immunity: EN61000-4-3 / IEC 60255-22-3
Fast Transient Disturbance: EN61000-4-4 / IEC 60255-22-4
Surge Immunity: EN61000-4-5 / IEC 60255-22-5
Conducted RF Immunity: EN61000-4-6 / IEC 60255-22-6
Radiated & Conducted Emissions: CISPR11 / CISPR22 / IEC 60255-25
Sinusoidal Vibration: IEC 60255-21-1
Voltage Dip & interruption: IEC 61000-4-11
Ingress Protection: IEC 60529
Environmental (Cold): IEC 60068-2-1
Environmental (Dry heat): IEC 60068-2-2
ESD: IEEE / ANSIC37.90.3
Safety: UL508 / UL C22.2-14 / UL1053

CERTIFICATION

ISO: Manufactured under an ISO9001 registered system.
CE: EN60255-5 / EN60255-27 / EN61010-1 / EN50263
cULus: UL508 / UL1053 / C22.2.No 14

ENVIRONMENTAL

Temperature Range:
Operating: -40 °C to +60 °C
Ambient Storage: -40 °C to +80 °C
Ambient Shipping: -40 °C to +80 °C
Humidity: Operating up to 95% (non condensing) @ 55C
Pollution degree: 2
IP Rating: IP40 (front), IP20 (back)

DeviceNet CONFORMANCE TESTED™

Ordering

469	*	*	*	*	*	
469						Basic Unit
	P1					1 A phase CT secondaries
	P5					5 A phase CT secondaries
		LO				DC: 24 - 60 V; AC: 20 - 48 V @ 48 -62 Hz control power
		HI				DC: 90 - 300 V; AC: 70 - 265 V @ 48 -62 Hz control power
			A1			0 - 1 mA analog outputs
			A20			4 - 20 mA analog outputs
				D		DeviceNet
				E		Enhanced front panel
				T		Enhanced front panel with Ethernet 10BaseT option
					H	Harsh (Chemical) Environment Conformal Coating

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imagination at work

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