

# Multilin 845

## Comprehensive Management for Power & Distribution Transformers

The Multilin™ 845 Transformer Protection System is a member of the Multilin 8 Series protective relay platform and has been designed for the protection, control and management of 2- and 3-winding power and distribution transformers in both utility and industrial applications.

The 845 provides advanced functionality delivering high-speed protection, customizable programmable logic, advanced transformer monitoring and diagnostics, and support for the latest communications protocols for easy integration into new or existing power systems.

The 845 delivers comprehensive transformer health monitoring, diagnostics, and reporting with integrated connectivity to single and multi-gas transformer DGA solutions such as, GE's Kelman Transformer Monitoring devices, delivering actionable analytics for asset optimization and life extension.

### Key Benefits

- Comprehensive transformer protection including fast operating differential protection, unique CT saturation and directional detection for enhanced security during through faults
- Advanced transformer monitoring & diagnostics and disturbance recording extending asset life
- Integrated protection & Dissolved Gas Analysis for continuous transformer monitoring, providing early warning of potential problems before they become critical transformer failures
- Integrated arc flash detection using light sensors supervised by over current to reduce incident energy and equipment damage
- Advanced cyber security tools such as AAA, Radius, RBAC, and Syslog enabling NERC® CIP requirements
- Draw-out design simplifies testing, commissioning and maintenance, thereby increasing process uptime
- Optional Wi-Fi connectivity minimizes system configuration and facilitates safe relay programming and diagnostic retrieval
- Patented environmental monitoring, providing visibility to changes in environmental conditions that can affect relay life

### Applications

- Primary protection and management of small, medium and larger power and distribution transformers, autotransformers and reactors
- Designed for Utility (Transmission & Distribution) or Industrial applications
- Integrated transformer protection, monitoring diagnostics and transformer health visualization



## Innovative Technology & Design

- Advanced transformer protection with unique Dissolved Gas Analysis integration
- Continuous monitoring and event driven analytics of both electrical and chemical characteristics
- Patented environmental monitoring
- Advanced, flexible and embedded communications: IEC® 61850 Ed2, IEC 62439/PRP, Modbus® RTU & TCP/IP, DNP3.0, IEC 60870-5-104, IEC 60870-5-103
- Single setup and configuration across the platform
- Field swappable power supply
- Enhanced relay draw-out construction
- Elimination of electrolytic capacitors

## Exceptional Quality & Reliability

- IPC A-610-E Class 3 manufacturing standards
- Highest reliability standards for electronics testing
- 100% Environmental Stress Screening and full functional testing
- Rated for IP54 (front) applications
- Standard Harsh Environment Conformal Coating

## Uncompromising Service & Support

- Covered under GE's 10 year warranty plan
- Designed, tested and assembled by GE

## Multilin 845 Overview

Transformers are an essential component in the transmission and distribution of power. Process & consumers depend on the performance and reliability of power and distribution transformers to ensure uninterrupted power supply.

Transformers are constantly under thermal & electrodynamic stress. The goal of the protective relay is to minimize the trip time in event of a fault within the transformer.

The 845 relay offers the ideal solution for protecting, monitoring and controlling transformers during disturbances or faults. With a fast protection pass, running every 1/8th of a cycle, the 845 relay provides fast operating current, voltage, power and frequency protection elements. Supporting the latest in industry standard communication protocols, including IEC 62439/PRP and IEC 61850 Ed2, the Multilin 845 relay easily integrates into new or existing networks.

The 845 provides highly configurable protection and control logic, allowing for simplified coordination with upstream and downstream disconnect devices. The 845 also offers enhanced features, such as diagnostics, preventative maintenance, condition and security options. Providing early detection and warning of potential problems before they become critical failures, the 845 enables a pro-active maintenance approach, mitigating the risks and costs associated with equipment failures or replacement.

## Protection & Control

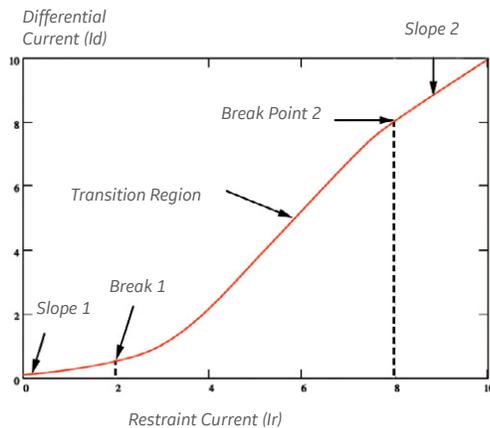
### Percent Differential Protection

The 845 provides enhanced security by including both restrained and unrestrained (instantaneous) differential protection. The percent differential element is based on a configurable dual-breakpoint/dual-slope differential restraint characteristic with inrush and overexcitation inhibits based on 2nd & 5th harmonics. The restraint current is calculated as a maximum of the internally compensated currents for better through-fault stability under CT saturation conditions.

The percent characteristic allows the element to account for both DC and AC saturation of the current transformers.

The “cubic spline” curve characteristics enables the relay to perform accurately for restraint current in range between the two slope breakpoints.

### Differential vs. Restraint Characteristic (Id vs. Ir)



The settings for the dual-slope, dual-breakpoint characteristic provides higher flexibility for shaping up the characteristic and achieving better sensitivity and security.

In addition, the 845 applies unique CT saturation and directional detection principles, offering robust security under through fault conditions.

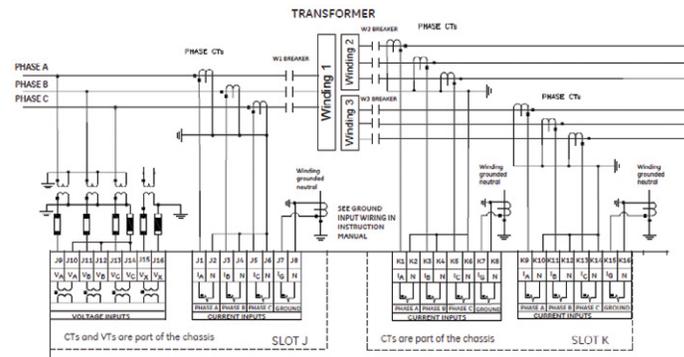
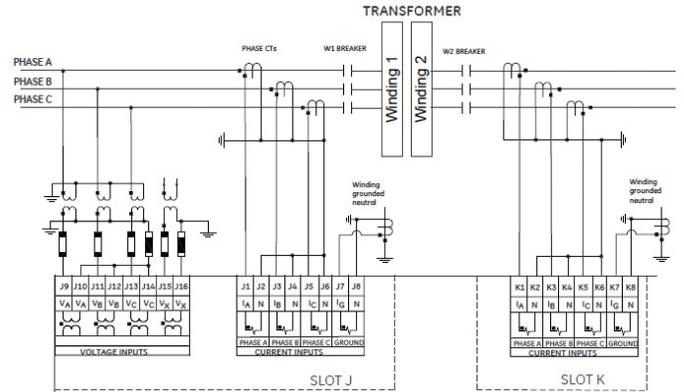
By accurately detecting tap position from the transformer LTC, the relay automatically performs magnitude compensation corresponding to the new voltage ratio and maintains no differential current.

### Harmonic Inrush /Overexcitation Inhibit

The 845 offers great performance in dealing with magnetizing current inrush during transformer energization, by providing four programmable restraint methods (Per Phase, Average, 2-out-of-3, 1-out-of-3), each of which can be enabled or disabled by the user.

An increase in transformer voltage or decrease in system frequency may result in overexcitation of the transformer. It is often desirable to prevent operation of the percent differential element in these cases therefore a fifth harmonic inhibit is integrated into the percent differential element to cater for overexcitation conditions resulting from an increased V/Hz ratio.

An independent fifth harmonic inhibit allows restraint for systems permitting intentional overexcitation (overfluxing) during energization.



### Unrestrained Differential

An unrestrained differential element current magnitude is provided for fast tripping on heavy internal faults to limit catastrophic damage to the transformer and minimize risks to the remainder of the power system.

**Restricted Ground Fault (RGF) /  
Restricted Earth Fault (REF) Protection**

Conventional overcurrent protection fails to provide adequate protection for star connected windings whose neutral is impedance earthed. Faults close to the neutral do not generate adequate fault current. RGF (also known as zero sequence differential) provides sensitive ground fault detection for low-magnitude fault currents.

**Overcurrent Elements**

The 845 can be used to provide backup protection for transformer and adjacent power system equipment. Instantaneous overcurrent (IOC) elements can be used for fast clearing of severe internal and external (through) faults. Up to six, time overcurrent protection (TOC) elements per winding allows coordination with the adjacent protection zones and acts as backup protection.

- IOC protection functions are provided for phase, neutral & ground currents
- TOC protection functions are provided for phase, neutral and ground currents. A variety of standard time curves including IEEE, IEC, GE IAC, I2t, definite time are provided
- FlexCurves to coordinate with adjacent protections (including fuses) as well as transformer damage curves and thermal/damage curves for downstream equipment

Directional protection functions are provided for phase, neutral and ground currents. The voltage memory function enables a more reliable relay operation, especially for faults close to the VTs.

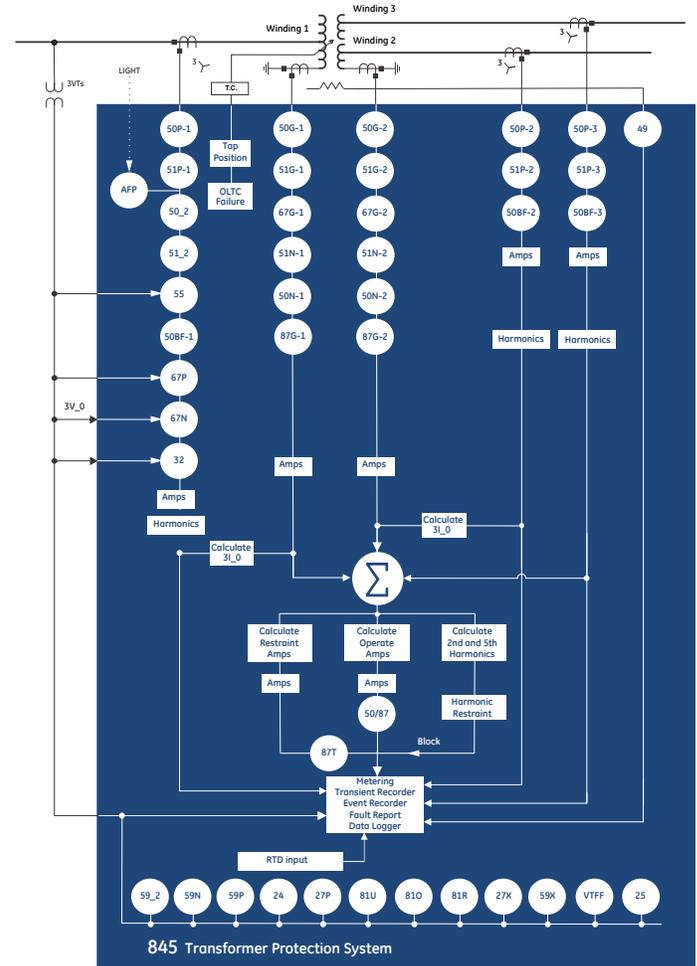
**User-Definable Protection Functions**

Eight user-definable protection functions (FlexElements) can be programmed to respond to quantities measured or computed by the relay (phase, ground and sequence current and voltage power, frequency, etc.) These elements respond to variations in its input signal. Applications could include: overvoltage, overpower, low power factor, temperature differential, and more.

**Auto CT Configuration**

All CTs are connected in a wye configuration for simplicity. All phase and magnitude corrections as well as zero-sequence current compensation are performed automatically based on a choice of over 100 transformer types.

**Functional Block Diagram**



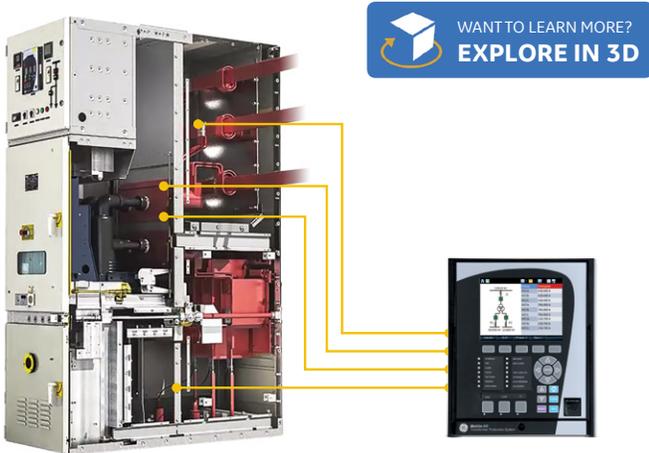
ANSI DEVICE	DESCRIPTION
24	Volts per Hertz
25	Synchrocheck
27P	Phase Undervoltage
27X	Auxiliary Undervoltage
32	Directional Power
49	Hottest Spot Temperature
	Aging Factor
	Loss of Life
50/87	Instantaneous Differential Overcurrent
50BF	Breaker Failure
50G	Ground Instantaneous Overcurrent
50N	Neutral Instantaneous Overcurrent
50P	Phase Instantaneous Overcurrent
50_2	Negative Sequence Instantaneous Overcurrent
51G	Ground Time Overcurrent
51N	Neutral Time Overcurrent
51P	Phase Time Overcurrent

ANSI DEVICE	DESCRIPTION
51_2	Negative Sequence Time Overcurrent
55	Power Factor
59N	Neutral Overvoltage
59P	Phase Overvoltage
59X	Auxiliary Overvoltage
59_2	Negative Sequence Overvoltage
67G	Ground Directional Element
67N	Neutral Directional Element
67P	Phase Directional Element
81O	Overfrequency
81U	Underfrequency
81R	Frequency Rate of Change
87G	Restricted Ground Fault (RGF)
87T	Transformer Differential
AFP	Arc Flash Protection
VTFF	Voltage Transformer Fuse Failure

## Integrated Arc Flash Protection

The Multilin 8 Series supports an integrated arc flash module providing constant monitoring of an arc flash condition within the switchgear, motor control centers, or panelboards. With a 2ms protection pass, the 8 Series is able to detect light and overcurrent using 4 arc sensors connected to the 8 Series relay. In situations where an arc flash/fault does occur, the relay is able to quickly identify the fault and issue a trip command to the associated breaker thereby reducing the total incident energy and minimizing resulting equipment damage.

Self-monitoring and diagnostics of the sensors ensures the health of the sensors as well as the full length fiber cables. LEDs on the front panel display of the 845 can be configured to indicate the health of the sensors and its connections to the relay.



MV Switchgear or Motor Control Center      Multilin 8 Series

*Fast, reliable arc flash protection with light-based arc flash sensors integrated within the Multilin 8 Series of protection & control devices. With arc flash detection in as fast as 2msec, the costs associated with equipment damage and unplanned downtime is significantly reduced.*

## Switchgear Control and Configurable SLD

The Multilin 845 provides a configurable, dynamic Single Line Display (SLD), up to six (6) pages for comprehensive switchgear control. Up to 15 digital and metering status elements can be configured per SLD page. These pages can be configured to show breakers, switches, metering, and status elements or measurements. Individual SLD pages can be selected as the default home screen pages. Automatic cycling through these pages can also be achieved through default screen settings.

The provision of such powerful control and display capability within the relay (“One Box” concept) eliminates the need for external controls, switches and annunciation on the panel reducing equipment and engineering cost.

## Annunciator panel and virtual PBs

The Multilin 845 offers a configurable annunciator panel that can be constructed to show up to 36 alarms in either self-reset mode or latched mode per ISA 18.1 standard similar to a physical annunciator panel - eliminating the need for physical one. The alarms can be displayed on the front panel in a configurable grid layout of 2x2 or 3x3.

The Multilin 845 extends local control functionality with 20 virtual pushbuttons that can be assigned for various functions. Each programmable pushbutton has its own programmable LED which can be used to acknowledge the action taken by the tab pushbutton.

## Tap Position, Ambient Temperature, Analog Inputs, Analog Outputs

The 845 monitors and displays tap position and ambient temperature. The 845 supports Tap position based on BCD, mA or resistance input. The 845 provides for 7 Analog Outputs (dc mA), 4 Analog Inputs (dc mA), 1 RTD input & resistance input for the tap changer.

The configurable analog inputs can be used to measure transformer 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 845 can also be set to issue trip or alarm commands based on signal thresholds.

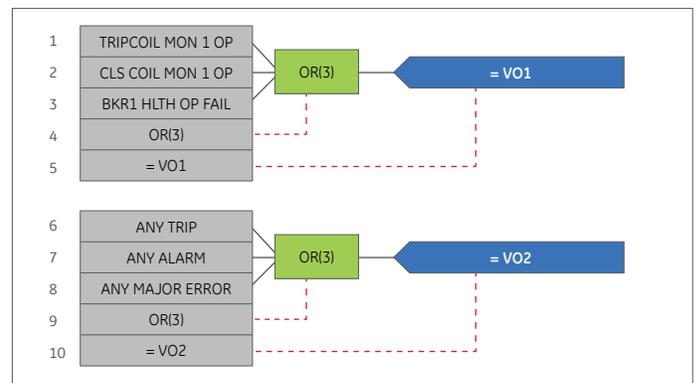
The configurable analog outputs can be used to provide standard transducer signals to local monitoring equipment. The analog outputs can be configured to provide outputs based on any measured analog value, or any calculated quantity. An optional general purpose transducer input allows a user-defined quantity to be monitored and used as part of the protection as defined by FlexLogic™.

## Advanced Automation

The Multilin 845 incorporates advanced automation capabilities that exceeds what is found in most transformer protection relays. This reduces the need for additional programmable controllers or discrete control relays including programmable logic, communication, and SCADA devices. Advanced automation also enables seamless integration of the 845 into other protection or process systems (SCADA or DCS).

### FlexLogic™

FlexLogic is the powerful 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. Using FlexLogic, the 845 can be programmed to provide the required tripping logic along with custom scheme logic for transformer breaker control (including external inputs for interlocking), interlocking schemes with adjacent protections and dynamic setting group changes.



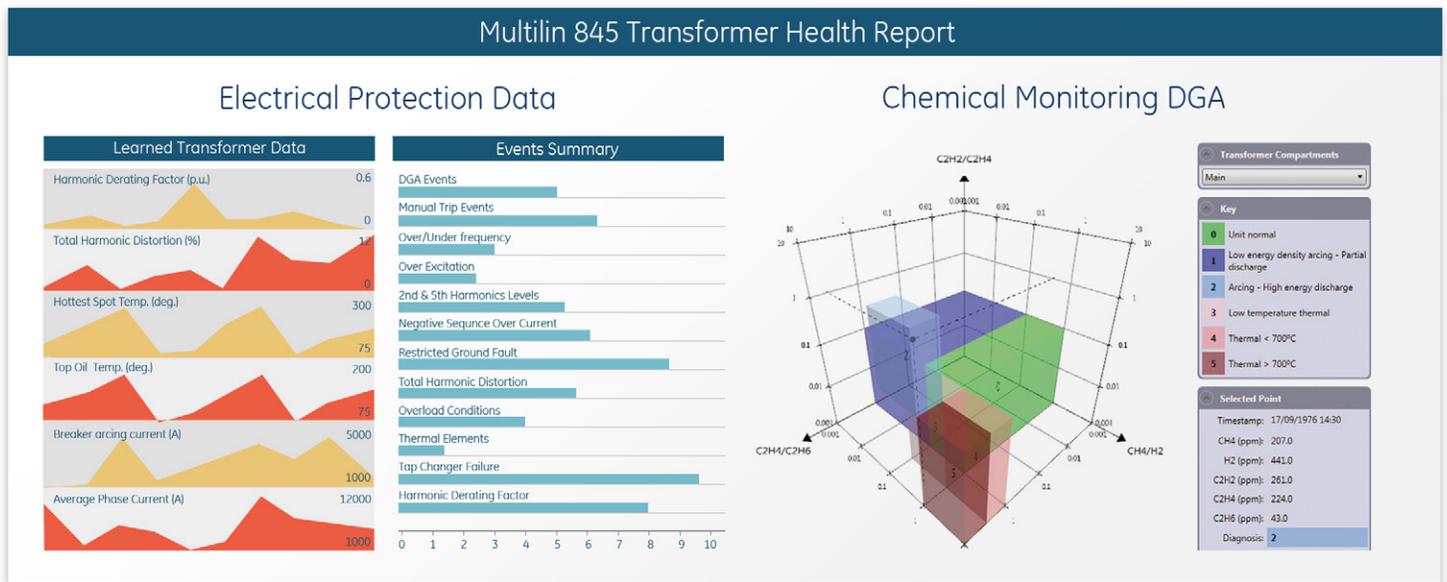
*FlexLogic provides operation and control flexibility to meet the needs and complex protection schemes and applications.*

## Monitoring & Diagnostics

The Multilin 845 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.

**Integrated Electrical and DGA for Comprehensive Transformer Monitoring & Diagnostics**

The Multilin 845 offers advanced transformer health monitoring and diagnostics through advanced notification of potential issues before they become critical. The Multilin 845 features detailed learned data, summarized pre/post-fault records, and integration with GE's DGA devices to collect, trend, and analyze a transformer's fault gasses. This enables operators to minimize costly unplanned outages and equipment failures.

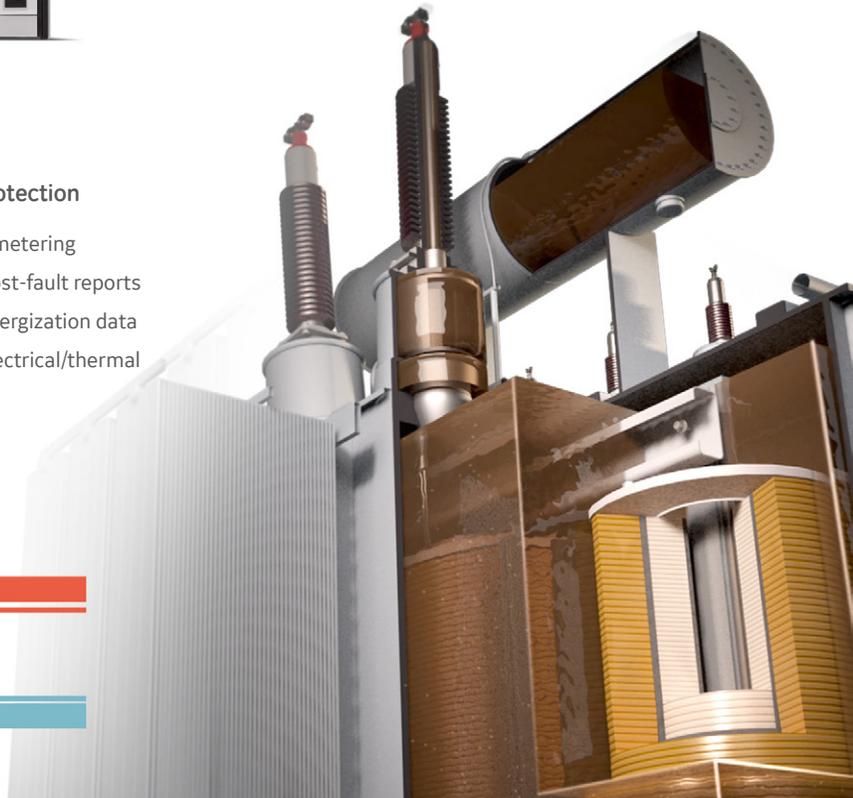
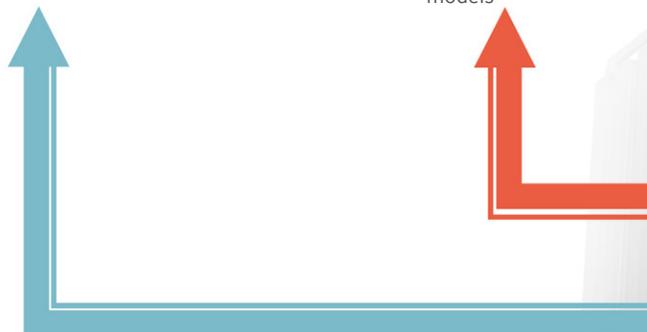


**Kelman TRANSFIX Monitoring & Diagnostics**

- Hourly sampling of key fault gasses
- Photo Acoustic Technology for DGA
- Up to 9 fault gasses and oxygen
- Measured oil moisture data (ppm)

**Multilin 845 Transformer Protection**

- High accuracy metering
- Detailed pre/post-fault reports
- Transformer energization data
- Transformer electrical/thermal models



**Integrated DGA Operation**

In addition to monitoring a transformer’s electrical characteristics such as voltage, current, power, load, and demand through metering data, oscillography, thermal elements, and harmonics, the 845 also provides integrated Dissolved Gas Analysis (DGA) with the ability to collect, trend, and analyze a transformer’s fault gasses. With integrated connectivity to GE’s Kelman composite and multi-gas DGA devices, the 845 is able to detect and alert operators to electrical or chemical conditions (i.e.: incipient and/or insulation degradation) that could result in a fault or asset failure.

GE’s transformer M&D devices offer single and multi-gas (DGA) measurements in oil filled transformers for detecting insulation degradation, incipient faults and monitoring various mechanical characteristics. Integrated operation of a transformer protection relay with M&D DGA device(s) helps in creating an advanced technology platform for transformer monitoring with data & information correlation between protection and DGA data. This integrated platform captures multi-fold data from both the relay and M&D device, summarizes and analyzes the data, then presents it as useful information in the form of operational records, reports and visualization screens which can be viewed and used by both electrical and maintenance engineers.

**GE M&D devices supported for integrated operation** - The 845 supports a wide range of both composite gas and multi-gas DGA devices, including the Hydran M2 single composite gas DGA device, Minitrans 3-gas plus moisture DGA device, DGA 500 5-gas plus moisture DGA device and the Transfix 9-gas plus moisture DGA device.

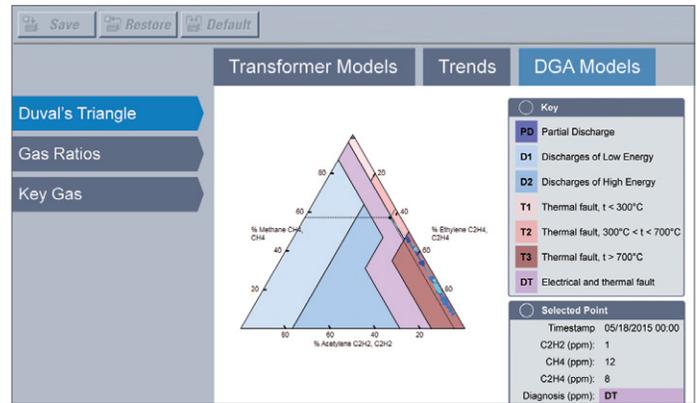
**DGA data and history** - With samples taken at regular intervals, operators are able to view individual gas and moisture levels to understand both historical and current gas ppm values, alarms associated with gas ppm values and short term history trend of 50-100 latest values.

**DGA models** - Industry standard DGA models such as Duval, Key Gas, and Gas Ratios are utilized by the 845 to provide analysis of the measured gas data. Presented graphically, the 845 converts static data to actionable information providing operators with a clear view of changes to the chemical characteristics and composition within the transformer.

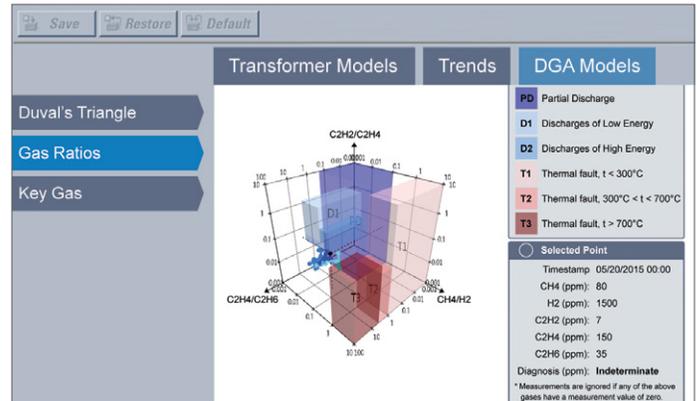
**Learned Data Record** - The 845 captures key electrical and DGA data values during transformer energization and continuous operation to trend and analyze transformer performance. Data is summarized and presented to operators through a pre-formatted Learned data report to clear indication of changes to measured parameters. Up to 365 latest records are supported in the 845 relay. This data is cumulatively visualized through the transformer model screens, enabling operators to identify trends and the correlation of key electrical and DGA parameters.



Transformer Learned Data Record Visualization



Duval Triangle DGA model



Gas Ratios DGA model

**Historical maximum record** - Historical maximum data record updates new maximum values of key electrical and DGA parameters along with the time stamp, over the operating life time of transformer indicating peak stress experienced by transformer at any instant of time over its operating life.

**Transformer integrated digital fault record** - Integrated transformer digital fault record captures data required to analyze the stress created by an internal or through fault occurrence on the transformer and identify any possible failure modes in order to take the necessary preventive & maintenance actions. It also enables operators to analyze and identify the risk of failure in further operation of the transformer. Protection & DGA related data is triggered, stored and displayed within GE’s EnerVista 8 Series Setup Software as an integrated transformer fault record. up to 5 latest records are available for display simplifying post-fault analysis.

**Transformer health report** - Provides a pre-formatted, easy to read, Health Report, in PDF format, which captures key operational data of the transformer combining both electrical and DGA characteristics. Health reports provide clear indication of transformer condition at any instant of time and helps utilities in analyzing risk associated with transformer and condition based maintenance planning.

**Transformer energization record** - Energization record captures the transient record (oscillography) for initial 10 cycles and computes various electrical data representing stress experienced by transformer during the energization event. Energization record will be computed specific to select or configured winding source in general setup by user and up to 6 latest records will be available for display.

## Advanced Asset Monitoring

The 845 has advanced functions that raise an alarm or trip the scheme when an internal condition in the power transformer or breaker could lead to a fault. These functions are conditions of:

**Hottest-spot temperature:** element provides a mechanism for detecting abnormal winding hottest-spot temperatures inside the transformer.

**Aging factor:** the aging factor element detects transformer aging in per-unit normal insulation aging

**Loss of Life:** This feature provides an estimate of how much of the transformer's total insulation life has elapsed.

**Harmonic Derating:** This derating factor is used to evaluate the load capability of the installed transformer under the non-sinusoidal load currents.

**Tap Changer Failure:** This element picks up when the actual tap changer position exceeds the maximum number of taps or the actual tap changer position lowers below the minimum number of taps. The 845 supports three ways of connecting a tap changer input - BCD, dcmA or Potentiometer

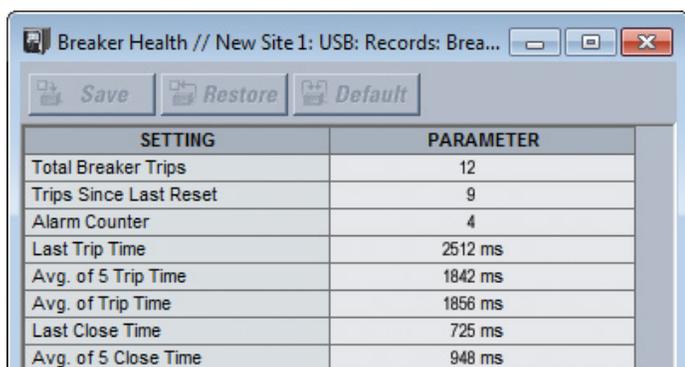
**Breaker arcing current:** This element calculates an estimate of the per-phase deterioration on the breaker contacts by measuring and integrating the current (squared) passing through the breaker contacts as an arc.

## Breaker Health Monitoring

The breaker is monitored by the relay not only for detection of breaker failure, but also for the overall "breaker health" which includes:

- Breaker close and breaker open times
- Trip circuit monitoring
- Spring charging time
- Per-phase arcing current
- Trip counters

All algorithms provide the user with the flexibility to set up initial breaker trip counter conditions and define the criteria for breaker wear throughout a number of setpoints.

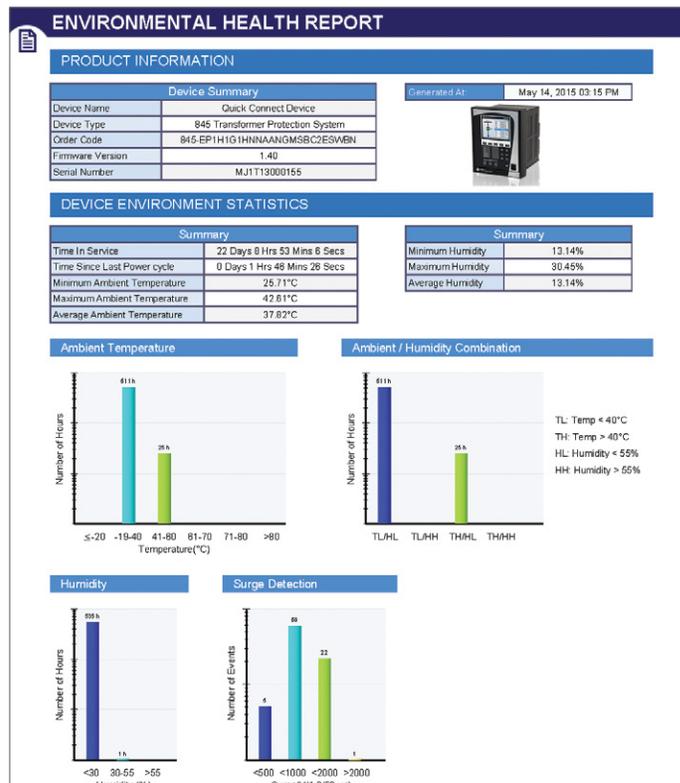


SETTING	PARAMETER
Total Breaker Trips	12
Trips Since Last Reset	9
Alarm Counter	4
Last Trip Time	2512 ms
Avg. of 5 Trip Time	1842 ms
Avg. of Trip Time	1856 ms
Last Close Time	725 ms
Avg. of 5 Close Time	948 ms

Multilin 8 Series Breaker Health Report available on the display or via the setup software

## Environmental Monitoring

The Multilin 8 Series includes an environmental monitoring system that measures and provides operating condition information for the relay.



Environmental health report is available via Multilin PC Software

## Metering

The Multilin 845 offers high accuracy power quality monitoring for fault and system disturbance analysis. The Multilin 8 Series delivers unmatched power system analytics through the following advanced features and monitoring and recording tools:

- Up to 9-gases ( $H_2$ ,  $CO_2$ ,  $CO$ ,  $C_2H_4$ ,  $C_2H_6$ ,  $CH_4$ ,  $C_2H_2$ ,  $H_2O$ ,  $O_2$ , and  $N_2$ ), TDCG and moisture are supported for integrated operation of 845 relay with Transfix M&D device.
- Up to 5-gases ( $H_2$ ,  $CO$ ,  $C_2H_2$ ,  $C_2H_4$ , and  $CH_4$ ) and moisture are supported for integrated operation of 845 relay with DGA500 M&D device.
- Up to 3-gases ( $H_2$ ,  $CO$ ,  $C_2H_2$ ) and moisture are supported for integrated operation of 845 relay with Minitrans M&D device.
- Hydran  $H_2$  ppm, Hydran  $H_2$  ppm daily & hourly trend and moisture are supported for integrated operation of 845 relay with Hydran M2 device.
- Harmonics measurement up to 25th harmonic for both currents and voltages including THD.
- The length of the transient recorder record ranges from 31 cycles to 1549 cycles.
- 32 digital points and 16 analog values.
- Comprehensive data logger provides the recording of 16 analog values.
- Detailed Fault Report.
- 1024 Event Recorder.

## Communications

The Multilin 8 Series provides advanced communications technologies for remote data and engineering access, making it easy and flexible to use and integrate into new and existing infrastructures. Direct support for fiber optic Ethernet provides high-bandwidth communications, allowing for low-latency controls and high-speed file transfers of relay fault and event record information. The 845 also supports two independent IP addresses, providing high flexibility for the most challenging of communication networks.

Two independent network ports enables the 8 Series to connect with the primary protection network and the secondary monitoring network to deliver integrated asset monitoring and diagnostics by combining protection and DGA data.

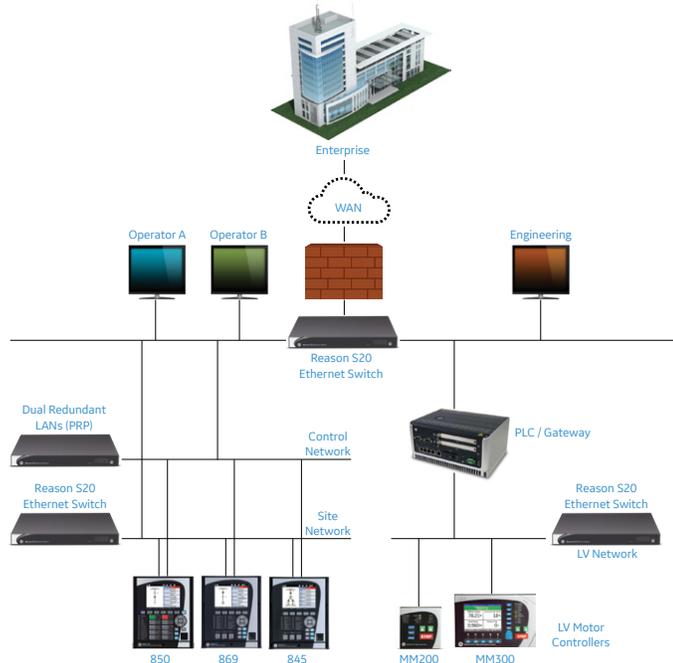
Providing several Ethernet and serial port options and supporting a wide range of industry standard protocols, the 8 Series enables easy, direct integration into DCS and SCADA systems. The 8 Series supports the following protocols:

- IEC 61850 Ed2, IEC 62439 / PRP
- DNP 3.0 serial, DNP 3.0 TCP/IP, IEC 60870-5-103, IEC 60870-5-104
- Modbus RTU, Modbus TCP/IP

The 845 has USB front port and Wi-Fi interfaces for ease of access to the relay.

Wi-Fi Connectivity:

- Simplify set-up and configuration
- Simplify diagnostic retrieval
- Eliminate personnel in front of switchgear
- WPA-2 security



## Cyber Security

The 845 cyber security enables the device to deliver full cyber security features that help operators to comply with NERC CIP guidelines and regulations.

- AAA Server Support (Radius/LDAP)
- Role Based Access Control (RBAC)
- Event Recorder (Syslog for SEM)

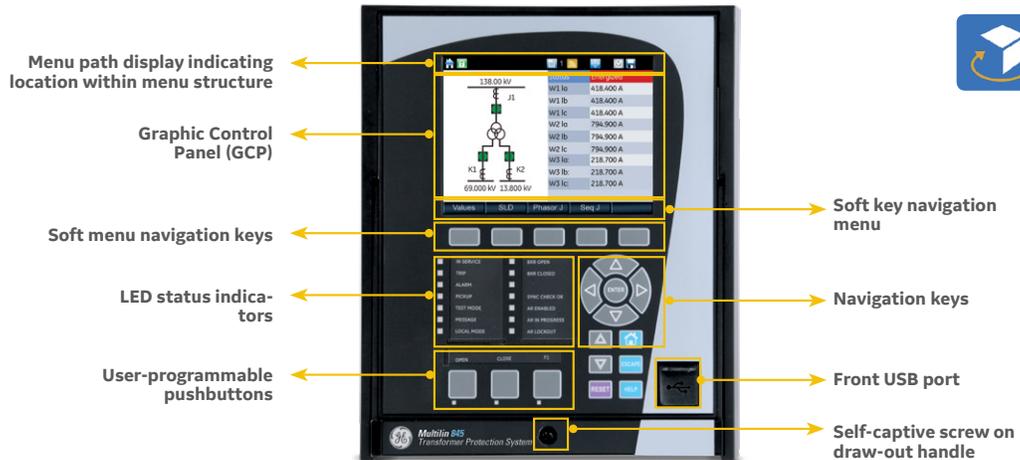


Cyber Security with Radius Authentication

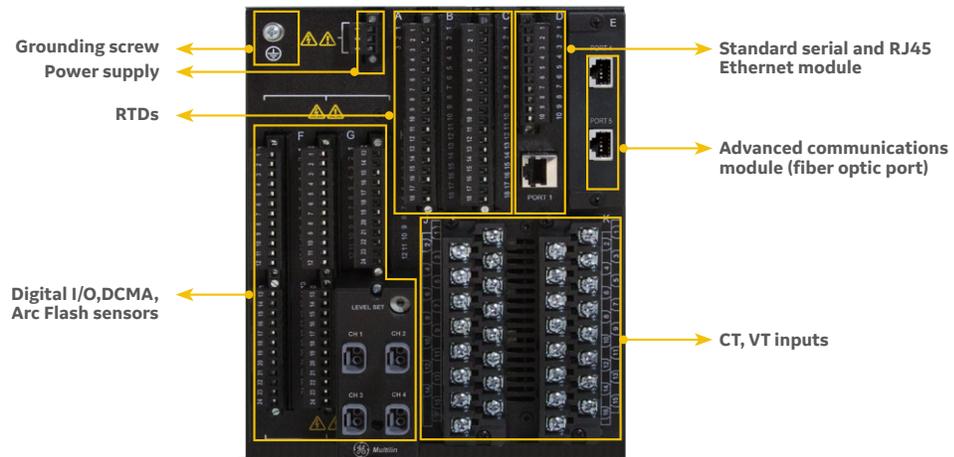
## Dimensions & Mounting



## Front View



## Rear View



Optional IP20 cover available



imagination at work

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