***Guide form Specifications***

**GE Multilin 845 Transformer Protection Relay**

Protection, monitoring and metering shall be supplied in one integrated digital relay package for application to power transformers suitable for incorporation into an integrated station control system.

The Digital Relay shall have a common Hardware & Firmware platform that shall support Feeder, Motor, Transformer & Generator applications. The relay shall be equipped with separate processors for protection and for communication related functions. The relay shall be equipped with the following protection monitoring, control, automation, and reporting functions. If supporting functions are not available within the relay suitable external devices shall be provided to meet the specification requirements.

## Protection and Control

* The protection relay shall be capable of providing protection for 2 or 3 winding transformers.
* The protection relay shall be capable of accepting a minimum of 3 phase voltage.
* The protection relay shall be capable of accepting an additional Aux VT input.
* The protection relay shall provide analog input systems that can reproduce up to 46 times CT rating RMS symmetrical.
* The relay shall execute protection related main algorithms at 8 times per power system cycle.
* The relay shall provide the following current based protection functions
	+ Dual slope, dual breakpoint Transformer differential protection (87T) with:
		- Inrush inhibit options : 2nd harmonic ”Per Phase”, ”Average”, “2-out-of-3”, “1-out-of-3”
		- Over-excitation Inhibit: 5th harmonic
	+ Instantaneous Phase Differential
	+ Transformer Overload
	+ Phase/Neutral/Ground instantaneous overcurrent (50P/N/G)
	+ Phase/Neutral/Ground time overcurrent (51P/N/G) Negative sequence instantaneous overcurrent (50\_2)
	+ Negative sequence time overcurrent (51\_2)
	+ Phase/Neutral/Ground directional overcurrent (67P/N/G)
	+ Restricted Ground Fault (87REF)
	+ Breaker Failure (50BF)
	+ Over current function shall support flex curves A, B, C, D, I2t, I4t
* The relay shall support Volts/Hertz (V/Hz) with voltage mode options
	+ Phase-Ground
	+ Phase-Phase
* The V/Hz shall support Definite Time, Inverse A, Inverse B, Inverse C, Flex Curve A, Flex Curve B, Flex Curve C, Flex Curve D
* The phase time over current can be selected to operate either on RMS or Fundamental value.
* The relay shall provide the following voltage based function
	+ Phase Over and Under Voltage (59P, 27P)
	+ Auxiliary Over Under Voltage (59x, 27x)
	+ Neutral Over Voltage (59N)
	+ Negative Sequence Over Voltage (59\_2)
	+ Directional Power (32)
	+ Over/Under Frequency (81O/81U)
	+ Synchrocheck (25)
	+ VT Fuse failure
* The relay shall provide support for up to 13 RTD inputs for temperature based protection with an ability to detect open and shorted RTDs and a configurable voting using 2 or 3 RTDs. Relay shall support 100 Ohm Nickel, 120 Ohm Nickel, 100 Ohm Platinum or 10 Ohm Copper RTD’s.
* The relay shall be capable of being configured for a Breaker controlled scheme.
* The relay shall have an ability to build trip and alarm matrices and directly assign corresponding output relay without using programmable logic or without using dedicated Trip bus function
* The relay shall have configurable option to select any protection elements to be used as a trip, alarm or latched alarm function without using programmable logic
* The relay shall have 6 switchable setting groups for dynamic reconfiguration of the protection elements due to changed conditions.
* The relay should have frequency tracking function.
* The maximum magnitude compensation factor should be at least 20
* The relay shall support On Load Tap changer status input based on Ohms, mA or BCD inputs
* The relay shall have the option to support tap changer on either side of winding
* The relay shall have the ability to compensate phase angles & zero sequence
* The relay shall have the option for harmonic derating
* The relay shall be able to detect the status of the protected transformer based on
	+ Breaker Status
	+ Voltage
	+ Current supervision
* Relay shall support 8 Flex elements that can use any available/calculated analog parameters within the relay (e.g. comparator, inverter, over/under, etc)
* The relay shall support up to 16 Digital Counters
* It should be possible to test the Binary Inputs, Outputs and protection functions without the need for an external test kit
* Relay shall provide temperature or other parameter monitoring (using dcmA Analog Input)

## Programmable Logic

* Relays shall support 1024 lines of user defined logic to build control schemes supporting logic gates, timers, nonvolatile latches.
* The programmable logic in the relay shall be executed at 8 times per power system cycle
* The relay configuration tool shall have embedded graphical user interface to build programmable logic.
* The relay shall provide up to 32 Virtual Inputs and Outputs.
* Mention Logic designer and Logic Monitor – i.e. graphical logic editing tool and online monitoring of logic states in graphical way.

## Communications/Integration

* The relay shall support the following communication protocols; Modbus RTU, Modbus TCP/IP, IEC 61850 GOOSE, IEC 61850 Ed 2, DNP 3.0, IEC 60870-5-104, IEC 60870-5-103, OPC-UA
* The relay shall have the ability to configure both protection and IEC61850 related settings directly from a single setting (IEC 61850-6 based XML format) file. There shall be direct uploading of single IEC 61850-6 based XML file into the relay. There shall be no further proprietary file format conversion required. All setting managements through a single IEC 61850-6 based file shall be supported. The relay shall support up to four IEC61850 concurrent client connections.
* The relay shall support file transfer protocol TFTP and file transfer through 61850.
* The relay shall support multiple time synchronization sources such as IRIG-B, IEEE 1588 and SNTP with the ability to configure priority for the time sources Relays shall provide two fiber optic Ethernet ports with two modes of operation – fail over mode or independent mode.
* Relays shall support networks for IEC62439/PRP (Parallel Redundancy Protocol)
* Relay shall have an option for Wi-Fi (IEEE 802.11 b/g/n) connectivity to configure settings and retrieve operational records.
* A front panel USB port that shall provide connectivity to configure settings and retrieve operational records.
* The relay shall provide a User Definable Memory Map.

## Relay Configuration/Setting File Management

* Entire relay setting from only single setting file shall be supported
* Entire relay settings (not only communication related but also protection & control functional settings) shall be part of the same single setting file.
* The relay shall be configured through IEC 61850-6 standard based Configured IED Description (CID in XML) format file only.
* There shall be only single relay setting (i.e. CID based XML format) file which can be directly uploaded into the device. No intermediate conversion of any proprietary setting file formats which requires managing multiple settings files for just one relay.
* Relay shall be able to receive this single configuration/setting files from any third party tool (not only vendor specific proprietary relay configuration tool).

## Front-Panel Visualization

* User interface shall provide a large color LCD front panel display, and navigation keys
* Front panel color LCD to display Single Line Diagram (SLD) of the generator with online metering & status information
* The front panel shall be capable of displaying measured values, calculated values, I/O status, device status, target messages, events, and configured relay settings
* The front panel shall have user-programmable LEDs and pushbuttons.
* The front panel shall have SLD with provision to control up to 3 devices
* Monitoring, Metering & Digital Fault Recording The relay shall provide the following functions for transformer monitoring
	+ Winding Hot spot
	+ Aging acceleration factor
	+ Transformer loss of life
	+ Harmonic derating
* The relay shall provide breaker information by monitoring and analyzing the operation count, arcing energy of breaking current, arcing time, tripping time, closing time and spring charging time.
* Relay shall record its exposure to temperature, humidity and surge and a report shall be retrievable via the communication ports on the min, max average of those recorded values
* The relay shall provide up to 32 digital channels and up to 16 analog channels of oscillography at a sampling rate of 128 samples per cycle.
* The relay shall provide a fault report with option for fault locator.
* The relay shall provide Event Records - with a record of the last 1024 events, time tagged with a resolution of 1ms.
* The relay shall store all its recorded data in nonvolatile memory.
* The relay shall provide a separate data logger function which shall record a maximum of 16 Analog channels with a settable sampling rate of 1 cycle, 1 second, 30 seconds, 1 minute, 15 minutes, 30 minutes or 1 hour.
* The current metering accuracy shall be at +/- 0.25% of the reading for up to 2 time’s rated secondary current and +/- 1% for above them.
* The voltage metering accuracy shall be at +/- 0.5% of the reading from 15 to 208V.
* The power metering accuracy shall be at +/- 1% of the reading.
* The frequency metering accuracy shall be typically at 1 mill Hertz accuracy level.

## Hardware

* The relay shall have conformal coated electronic board assemblies for harsh environment deployment.
* Microprocessor based protective relays shall employ IPC (Institute for Interconnecting and Packaging Electronic Circuits) Class 3 printed circuit boards (PCB). Specifically, IPC Class 610-3
* The relay shall have a draw-out construction to facilitate testing, maintenance and interchange flexibility
* The relay shall provide field swappable power supply module.
* The relay shall have a scan rate of 128 samples per power system cycle for digital inputs and provide less than 1 msec time stamp resolution for state changes.
* The relay shall provide an Operating temperature range of –40° to + 60°C and tested to per IEC60068 for 16-hour operation between -40 and +85°C.
* The relay shall provide an optional sensitive ground input
* The relay shall support at a minimum 10 Digital Outputs & 14 Digital Inputs.
* The relay shall provide inbuilt Trip Coil & Close coil supervision.
* The Digital Inputs should be capable of accepting wet or dry input signals. In case external wetting voltage is used, the Voltage Threshold shall be software selectable for 24V, 48V, 125V & 250V DC sources.
* The relay contacts should be rated for a minimum of 10A continuous
* The relay shall support 7 dcmA output + 4 dcmA input + 1 RTD
* The relay shall support a total of 13 RTDs
* The relay shall support 4 integrated Arc flash sensors

## Security

* The relay shall provide an option for RBAC (Role based access control) with three roles such as Observer for accessing operational data, Operator for executing control commands and Administrator for configuring the relay.
* The relay shall provide option for password complexity
* The relay shall provide option for local device level authentication and for remote server authentication using RADIUS.
* The relay shall provide optional support for SYSLOG to publish security related events
* The relay shall support secure file transfer protocol SFTP
* Security Setting Reports must include the following events with time stamp:
	+ Failed Authentication
	+ User lock out
	+ Setting changes
	+ Login
	+ Logout
	+ RADIUS server unreachable
	+ Clear Event/Transient/Fault records

## Service And Support

* Warranty: The relay shall include a ten-year warranty for all material and workmanship defects.