**Guideform Specification**

**Compact Feeder Management Relays**

**Mechanical Specifications**

**Design**

* The device shall be presented in a 4U case height format (177mm), for ease of integration/standardization in standard protection racks and panels.
* The device shall be withdrawable type and housed in a case width 20TE or 30TE.
* The case width must be a multiple of 10TE (2 inches) to ensure easy engineering in 19 inch rack panels.

**Enclosure Protection**

The degree of protection offered shall be as per IEC 60529: 2002:

* IP 52 Protection (front panel) against dust and dripping water.
* IP 50 Protection for whole case against dust.
* IP 30 Protection for the sides of the case against dust.
* IP 10 Product safety protection for the rear due to live connections on the terminal block.
* The device shall be housed in a metallic case wrapper.
* The device case shall not include any ventilation louvres or other deliberate holes – it shall be an enclosed unit.

**General Input / Output Terminals**

All terminals shall be ring-lug screw type for security and robustness:

* The screw size shall be M4 to allow suitable torque tightness.
* Connection of up to two independent ring lugs per terminal shall be supported, to permit daisy-chaining of connections where required, without resorting to inserting two wires in a ferrule.

**Front Port Serial PC Interface**

A front panel communication port shall be provided for service access by relay technicians/engineers, communicating with the PC toolsuite software:

* The communication interface shall be USB.
* The maximum cable length supported up to the PC connection shall be 5m.

**Rear SCADA communication**

The rear communication port shall support the following:

* Modbus, IEC60870-5-103, DNP3, DNP3oE, IEC61850.
* One rear EIA (RS)485 port for SCADA communications.
* Capability for an optional additional rear RJ45 & F/O Ethernet port.
* Capability for an additional rear-panel EIA-485 port
* Windows®-based PC software for setting, event and disturbance record retrieval, metering, and control
* Relays with IEC61850 shall also support one of the serial protocols (Modbus, IEC60870-5-103, DNP3) in RS485 concurrently.

**Ratings**

**AC Measurement Range**

* The device shall be suitable for power systems operating at 50 and 60Hz.

The operating range for the network frequency shall be from 40 to 65Hz.

**Auxiliary Voltage (Vx)**

The device auxiliary power supply input shall accommodate all standard battery voltage ratings used by the utility, to minimize, or eliminate multiple ordering options and spares holdings. The nominal operating range should be 24-250 Vdc and 110-240 Vac with a tolerable ac ripple of up to 15% for a dc supply, as per IEC 60255-11: 2008.

**Digital (“Opto”) Inputs**

The relay shall have the option up to maximum 13 configurable opto inputs.

* The opto inputs shall be universal range, rated from 24V to 250Vdc nominal, with a withstand up to 300Vdc.
* The opto inputs shall have a software-selectable pick-up setting, without needing an ordering option nor any need to change jumpers.
* The pick-up setting shall be matched at approximately 80% of battery nominal, with reset hysteresis such that drop-off is at approximately 60% of battery nominal. Such operation shall ensure that spurious pickup is avoided for battery earth faults where half-voltage may be falsely experienced by capacitive coupling.
* Opto inputs shall be compliant to ESI 48-4 EB2, presenting a “high burden” to prevent spurious pickup for capacitive discharge, with intelligent switching to reduce the burden to a low quiescent value under genuine operated conditions.
* Opto inputs shall be immune to capacitor discharge and power frequency without the need for external suppression. External resistors shall not be permitted.

**Output Contacts**

The relay shall have the option up to maximum 12 configurable output contacts when Ethernet option is not chosen. The relay output contacts shall be electromechanical type.

**Standard Output Contacts**

The rating of the output contacts shall be as follows, in accordance with IEC 60255-1: 2009:

* Maximum continuous current shall be 10A, or 8A as measured by the harsher UL-compliant method.
* The short term make and carry rating shall be 30A for 3s, 250A for 30ms.
* The DC break capacity shall be 50W resistive or 62.5W inductive (L/R = 50ms)
* It shall be possible to configure a software latching (lockout) function for output contacts, whose status is memorized for reapplication after a power supply interruption

**Watchdog Contacts**

Watchdog contacts shall be provided, with relay healthy (normally open) and relay fail/de-energised (normally closed) connection outputs available. Any error detected by the device self-motoring shall cause an alarm to be raised, such that hardwiring of an alarm to adjacent devices is possible, if required. The contact ratings shall be:

* DC breaking capacity 30W resistive, 15W inductive (L/R = 40ms)

**LED Indicators**

The relay shall have the option up to maximum 11 freely-programmable LED indicators, in addition to fixed function LEDs for Alarm, Trip, Out of Service and Healthy indication.

* It shall be possible to configure a software latching function for the LEDs, whose status is memorized for reapplication after a power supply interruption

**HMI Display**

* A textual LCD display screen shall be provided on the product, capable to display power system measurements, fault and event records, interrogate alarms, implement password access control, initiate commissioning test modes, monitor I/O status, alter protection settings, and change settings groups.
* The device menu shall incorporate dependency rules, such that menu cells which are rendered inapplicable as a result of a previous menu selection are removed/hidden.

**Functional Specifications**

**Protection and Control**

Feeder protection shall be provided by a numerical microprocessor-based relay equipped with the following protection, monitoring, control, automation, and reporting functions. The relay shall have the self-checking functions. Specific requirements are as follows:

• Minimum 3 stages of directional / non-directional, instantaneous / time delayed phase overcurrent (OcpPTOC/RDIR)

• Minimum 2 stages of directional / non-directional, instantaneous / time delayed earth overcurrent (EfdPTOC/EfmPTOC)

• Minimum 2 stages of Sensitive directional earth fault (SEF/I Cos I Sin) (SenEftPTOC)

• Wattmetric earthfault (SenEftPTOC)

• Neutral admittance protection

• Restricted earth fault (SenRefPDIF)

• Voltage controlled / restrained overcurrent

• Directional / non-directional negative sequence overcurrent (NgcPTOC)

• RMS thermal overload (single / dual time constant) (ThmPTTR)

• Phase and neutral undercurrent

• Minimum 3 stages of Undervoltage (VtpPhsPTUV)

• Minimum 3 stages of Overvoltage (VtpPhsPTOV)

• Minimum 3 stages Residual overvoltage (neutral displacement) (VtpResPTOV)

• Negative sequence overvoltage (NgvPTOV)

• 9 stage of underfrequency (PTUF)

• 9 stage of overfrequency (PTOF)

• 9 stage of rate of change of frequency protocol (PFRC)

• 9 stage of frequency supervised rate of change of frequency

• 9 stage of average rate of change of frequency

• 2 stage of rate of change of voltage protection

• Broken conductor (open jumper)

• Circuit-breaker failure (RBRF)

• Voltage transformer supervision (1, 2 & 3-phase fuse failure detection)

• Current transformer supervision

• 4 shot three-pole auto reclose (RREC) as option

• Check synchronizing (RSYN) as option

• 2nd harmonic blocking (2nd Harm Block)

• Phase segregated power

**Disturbance Recording**

The device shall include on-board disturbance recording, suitable to record a minimum of 8 fault clearance events

* The disturbance records shall have 9 analogue, 32 digital and 1 time channel.
* All channels and the trigger source shall be user configurable.
* The disturbance records time length shall be configurable from 0.5 s to 10.5 s.
* The disturbance records shall be able to be extracted from the relay via the remote communications and saved in the COMTRADE format.
* The resolution of the records shall be 24 samples per cycle or greater
* The record storage shall be maintained even after the device has been powered-down

**Event Recording**

The device shall include on-board event recording, suitable to record a minimum of 2048 time-tagged events:

* The time stamp resolution of the records shall be 1ms
* The record storage shall be maintained even after the device has been powered-down
* The menu and PC toolsuite shall provide shortcut access to at least the last 5 fault trip records

**Programmable Logic**

The device shall include a graphical programmable logic facility, to enable customizing of the device response to the utility’s exact requirements:

* Gate logic shall be provided including OR, AND and majority gate functions, with the ability to invert the inputs and outputs, and provide feedback paths in the logic. A minimum of 100 logic gates shall be available.
* Time delay functions shall be provided, including delay on pick-up (DPU), delay on drop-off (DDO), combined DPU/DDO, pulsed, and minimum dwell time functions. A minimum of 16 timers shall be provided (not counting the timer functions which are expected to be an inherent provision with each output contact and LED indicator function).
* The logic shall not take the form of logic equations, but must be formed with graphical drag and drop gates, with all logic processed concurrently. There shall be no need to observe sequential “rules” which constrain in what order gates are processed, and how they affect any declared result.
* The concurrent processing of the logic shall ensure that the full logic declares a stable result without any race effects due to calculation lag.
* The amount of logic programmed shall not in any way affect the deterministic behavior of the protection, control and communication functions in the relay. Whether the logic is sparsely used, or used up to its maximum capacity, this shall not change the operating time of those functions.
* Vice-versa, the programmable logic shall remain deterministic regardless of the extent of other device functions enabled.
* A license-free graphical PC tool shall be provided, to configure the programmable logic.

**Measurements**

* The device shall include capabilities for real-time AC measurements, derived power and energy quantities, and demand values.

**Setting Groups**

The device shall offer four programmable setting groups.

**PC Toolsuite**

The device shall be supported by a license-free Windows®-based toolsuite, with support for operating systems up to Windows 7. The toolsuite shall support:

* Creation of offline protection settings, downloading and uploading to the device
* Standard application template creation for protection settings, such that the utility can standardize on a number of global templates, where only local (feeder-specific) thresholds change at each site.
* Settings file export and import in Excel format
* Graphical creation and editing of programmable logic
* Comparison of setting and programmable logic files to identify any differences between versions
* Creation of IEC 61850 configuration and reports
* Retrieval of fault, event and disturbance records, and cybersecurity logs
* Display of extracted records, including disturbance record waveform graphics
* Changing of settings groups, control and resetting commands
* Polling of measurement values
* Export of settings files in .xrio format, for compatibility with protection testing equipment.

**Communications**

**Station Bus – IEC 61850-8-1**

* The relay shall support up to 16 concurrent IEC61850 client connections.
* Simple Network Management Protocol (SNMP) shall be provided to manage the device in an IP network.

**Time synchronization**

* The device shall support up to two time synchronization sources such as IRIG-B and SNTP with the ability to dynamically switch based on the availability of each of the two chosen sources.

**Environmental Conditions**

The following norms and standards compliance shall be demonstrated. All shall be carried out at an ILAC accredited laboratory:

**Ambient Temperature Range**

As per IEC 60255-27: 2005

* Operating temperature range: -25°C to +55°C (or -13°F to +131°F).
* Storage and transit: -25°C to +70°C (or -13°F to +158°F)

Tested as per IEC 60068-2-1: 2007:

* -40°C storage (96 hours), -40°C operation (96 hours)

IEC 60068-2-2: 2007: +85°C storage (96 hours), +70°C operation (96 hours)

**Ambient Humidity Range**

* As per IEC 60068-2-78: 2001: 56 days at 93% relative humidity and +40°C
* As per IEC 60068-2-30: 2005: Damp heat cyclic, six (12 + 12) hour cycles, 93% RH, +25 to +55°C

**Corrosive Environments**

The device shall provide harsh environmental coating of printed circuit boards as standard. The coating shall be applied after printed circuit boards have been subjected to a cleaning and drying process.

The environmental claims achieved shall be:

* As per IEC 60068-2-52 Salt mist (7 days)
* As per IEC 60068-2-43 for H2S (21 days), 10 ppm
As per IEC 60068-2-42 for SO2 (21 days), 25 ppm

**Type Tests**

The following norms and standards compliance shall be demonstrated:

**Insulation**

As per IEC 60255-27: 2005

* Insulation resistance > 100MΩ at 500Vdc (using only electronic/brushless insulation tester).

**Creepage Distances and Clearances**

As per IEC 60255-27: 2005

* Pollution degree 3,
* Overvoltage category III,
* Impulse test voltage (not RJ45) 5 kV.
* Impulse test voltage (RJ45) 1 kV.

**High Voltage (Dielectric) Withstand**

* IEC Compliance IEC 60255-27: 2005
* Between independent opto-inputs or Vx and other circuits 2.82kV dc for 1 minute
* Between all other independent circuits 2 kV ac rms for 1 minute
* Between Vx or opto-inputs, and protective earth terminal 2.82kV dc for 1 minute
* Between all other independent circuits and protective earth terminal 2 kV ac rms for 1 minute
* Across open watchdog contacts 1 kV ac rms for 1 minute
* Across open contacts of changeover output relays 1 kV ac rms for 1 minute
* Between all RJ45 contacts and protective earth terminal 1 kV ac rms for 1 minute
* Between all screw-type EIA(RS)485 contacts and protective earth terminal 1 kV ac rms for 1 minute
* ANSI/IEEE Compliance ANSI/IEEE C37.90-2005
* Across open contacts of normally open output relays 1.5 kV ac rms for 1 minute
* Across open contacts of normally open changeover output relays 1 kV ac rms for 1 minute
* Across open watchdog contacts 1 kV ac rms for 1 minute

**Impulse Voltage Withstand Test**

* Compliance IEC 60255-27: 2005
* Between all independent circuits Front time: 1.2 μs, Time to half-value: 50 μs, Peak value: 5 kV, 0.5 J
* Between terminals of all independent circuits Front time: 1.2 μs, Time to half-value: 50 μs, Peak value: 5 kV, 0.5 J
* Between all independent circuits and protective
* earth conductor terminal Front time: 1.2 μs, Time to half-value: 50 μs, Peak value: 5 kV, 0.5 J

**Electromagnetic Compatibility (EMC)**

The following norms and standards compliance shall be demonstrated. All shall be carried out at an ILAC accredited laboratory:

**1 MHz Burst High Frequency Disturbance Test**

* Compliance IEC 60255-22-1: 2008, Class III, IEC 60255-26:2013
* Common-mode test voltage (level 3) 2.5 kV
* Differential test voltage (level 3) 1.0 kV

**Damped Oscillatory Test**

* Compliance EN61000-4-18: 2011: Level 3, 100 kHz and 1 MHz. Level 4: 3 MHz,
* 10 MHz and 30 MHz, IEC 60255-26:2013
* Common-mode test voltage (level 3) 2.5 kV
* Common-mode test voltage (level 4) 4.0 kV
* Differential mode test voltage 1.0 kV

**Immunity to Electrostatic Discharge**

* Compliance IEC 60255-22-2: 2009 Class 3 and Class 4, IEC 60255-26:2013
* Class 4 Condition 15 kV discharge in air to user interface, display, and exposed metalwork
* Class 3 Condition 8 kV discharge in air to all communication ports

**Electrical Fast Transient or Burst Requirements**

* Compliance IEC 60255-22-4: 2008 and EN61000-4-4:2004. Test severity level lll and lV,
* IEC 60255-26:2013
* Applied to communication inputs Amplitude: 2 kV, burst frequency 5 kHz and 100 KHz (level 4)
* Applied to power supply and all other
* inputs except for communication inputs Amplitude: 4 kV, burst frequency 5 kHz and 100 KHz (level 4)

**Surge Withstand Capability**

* Compliance IEEE/ANSI C37.90.1: 2002
* Condition 1 4 kV fast transient and 2.5 kV oscillatory applied common mode and differential
* mode to opto inputs, output relays, CTs, VTs, power supply
* Condition 2 4 kV fast transient and 2.5 kV oscillatory applied common mode to
* communications, IRIG-B

**Surge Immunity Test**

* Compliance IEC 61000-4-5: 2005 Level 4, IEC 60255-26:2013
* Pulse duration Time to half-value: 1.2/50 μs
* Between all groups and protective earth conductor terminal Amplitude 4 kV
* Between terminals of each group (excluding communications
* ports, where applicable) Amplitude 2 kV

**Immunity to Radiated Electromagnetic Energy**

* Compliance IEC 60255-22-3: 2007, Class III, IEC 60255-26:2013
* Frequency band 80 MHz to 3.0 GHz
* Spot tests at 80, 160, 380, 450, 900, 1850, 2150 MHz
* Test field strength 10 V/m
* Test using AM 1 kHz @ 80%
* Compliance IEEE/ANSI C37.90.2: 2004
* Frequency band 80 MHz to 1 GHz
* Spot tests at 80, 160, 380, 450 MHz
* Waveform 1 kHz @ 80% am and pulse modulated
* Field strength 35 V/m

**Radiated Immunity from Digital Communications**

* Compliance IEC 61000-4-3: 2006, Level 4, IEC 60255-26:2013
* Frequency bands 800 to 960 MHz, 1.4 to 2.0 GHz
* Test field strength 30 V/m
* Test using AM 1 kHz / 80%

**Radiated Immunity from Digital Radio Telephones**

* Compliance IEC 61000-4-3: 2006, IEC 60255-26:2013
* Frequency bands 900 MHz and 1.89 GHz
* Test field strength 10 V/m

**Immunity to Conducted Disturbances Induced by Radio Frequency Fields**

* Compliance IEC 61000-4-6: 2008, Level 3, IEC 60255-26:2013
* Frequency bands 150 kHz to 80 MHz
* Test disturbance voltage 10 V rms
* Test using AM 1 kHz @ 80%
* Spot tests 27 MHz and 68 MHz

**Power Frequency Magnetic Field Immunity**

* Compliance IEC 61000-4-8: 2009 Level 5
* IEC 61000-4-9/10: 2001 Level 5
* IEC 61000-4-8 test 100 A/m applied continuously, 1000 A/m applied for 3 s
* IEC 61000-4-9 test 1000 A/m applied in all planes
* IEC 61000-4-10 test 100 A/m applied in all planes at 100 kHz/1 MHz with a burst duration of 2 Seconds

**Conducted Emissions**

* Compliance EN 55022: 2010, IEC 60255-26:2013
* Power supply test 1 0.15 - 0.5 MHz, 79 dBμV (quasi peak) 66 dBμV (average)
* Power supply test 2 0.5 – 30 MHz, 73 dBμV (quasi peak) 60 dBμV (average)
* RJ45 test 1 (where applicable) 0.15 - 0.5 MHz, 97 dBμV (quasi peak) 84 dBμV (average)
* RJ45 test 2 (where applicable) 0.5 – 30 MHz, 87 dBμV (quasi peak) 74 dBμV (average)

**Radiated Emissions**

* Compliance EN 55022: 2010, IEC 60255-26:2013
* Test 1 30 – 230 MHz, 40 dBμV/m at 10 m measurement distance
* Test 2 230 – 1 GHz, 47 dBμV/m at 10 m measurement distance
* Test 3 1 – 2 GHz, 76 dBμV/m at 10 m measurement distance

**Power Frequency**

* Compliance IEC 60255-22-7:2003, IEC 60255-26:2013
* Opto-inputs (Compliance is achieved using the optoinput
* filter)
* 300 V common-mode (Class A)
* 150 V differential mode (Class A)

**EU Directives**

* Compliance with the European Commission Directive on EMC and LVD is demonstrated by self certificationagainst international standards.
* 

**EMC Compliance**

* Compliance with EN60255-26:2009 was used to establish conformity.

**Product Safety**

* As per 2006/95/EC: Compliance with EN60255-27:2005 was used to establish conformity.

Protective Class

* IEC 60255-27: 2005 Class 1 (unless otherwise specified in equipment documentation). This equipment requires a protective conductor (earth) to ensure user safety.

Installation category

* IEC 60255-27: 2005 Overvoltage Category 3. Equipment in this category is qualification tested at 5kV peak, 1.2/50 mS, 500 Ohms, 0.5 J, between all supply circuits and earth and also between independent circuits.

Environment

* IEC 60255-27: 2005, IEC 60255-26:2009. The equipment is intended for indoor use only. If it is required for use in an outdoor environment, it must be mounted in a cabinet with the appropriate degree of ingress protection.

**R&TTE Compliance**

Radio and Telecommunications Terminal Equipment (R&TTE) directive 99/5/EC.

* Compliance demonstrated by compliance to both the EMC directive and the Low voltage directive, down to zero volts. Applicable to rear communications ports.

**Mechanical Robustness**

The following norms and standards compliance shall be demonstrated:

**Vibration Test**

As per IEC 60255-21-1: 1996

* Response Class 2
* Endurance Class 2

**Shock and Bump**

As per IEC 60255-21-2: 1995

* Shock response Class 2
* Shock withstand Class 1
* Bump Class 1

**Seismic Test**

As per IEC 60255-21-3: 1995

* Class 2

**Transit Packaging Performance**

The primary packaging carton shall comply with the international freight standard ISTA 1C specification, to minimize the risk of damage in transit:

* Vibration tests in 3 orientations, vibratory movement 7 Hz, amplitude 5.3 mm, acceleration 1.05g
* Drop tests - 10 drops from 61 cm height on multiple carton faces, edges and corners

**Quality**

* The company’s quality management system shall be accredited and independently audited to ISO 9001: 2008
* The company’s environmental management system shall be accredited and independently audited to ISO 14001: 2004
* The company’s occupational health and safety management system shall be accredited and independently audited to OHSAS 18001: 2007
* Each device shall be subjected to a 24 hour heat-soak during the manufacturing process, in order to minimize the risk of early-life failures.
* The vendor shall supply the actual measured Mean-Time Between Failures (MTBF) for the device upon request.
* The device shall include a ten-year warranty for material and workmanship defects.
* The vendor shall offer a nominal 5 day turn-around for warranty repairs
* The relay shall be made from lead free components and manufactured in a lead free process.