

ALP-4000 MULTI-FUNCTION PROTECTION RELAY



4000
SERIES

At the cutting edge of technology, the new ALP-4000 multi-function relay is a smart system that can be used to protect transformers and monitor critical system data. Algorithm performance paired with rugged design make this relay powerful, modern and flexible.

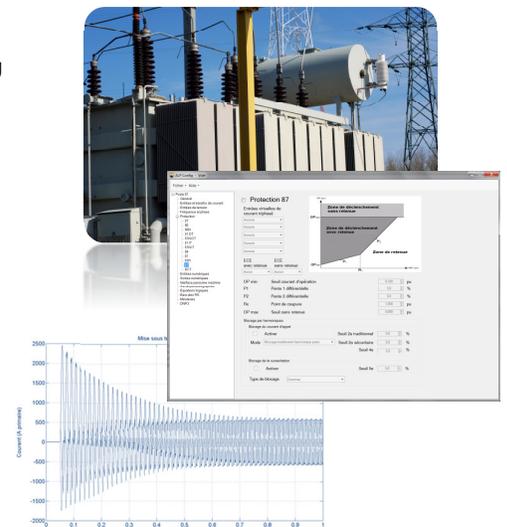


MAIN CHARACTERISTICS AND ADVANTAGES

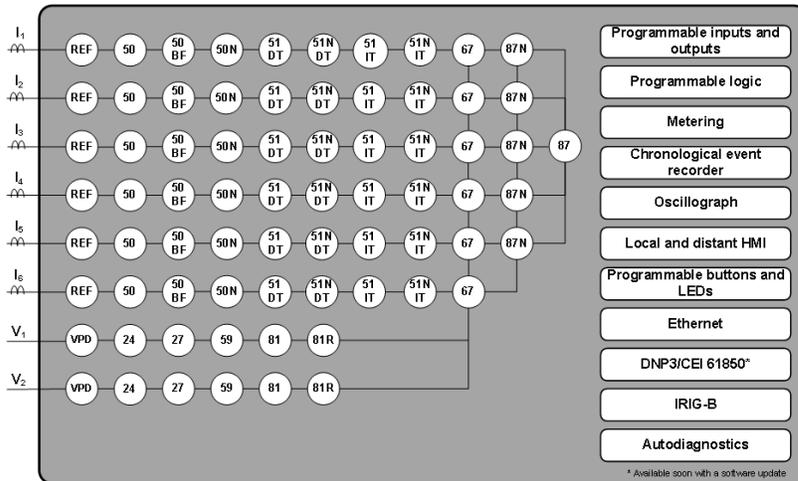
- Platform built with the most cutting-edge technologies, resulting in very high processing and storage capacity
- SECURE blocking adapted to ultrasaturation phenomenon of modern transformers
- Fast transformer differential restrained action as low as 1,4 cycle to keep your transformer safe and avoid false tripping under magnetization current
- Better precision of analog readings
- One of the highest sampling rate of the industry, enabling precise recording of fault and analysis
- Secure, rugged and reliable protection relay, in compliance with the latest utility standards
- Protection, automation, metering and monitoring functions built into a single product
- User-friendly interfaces and software, easing operation, configuration, start-up and engineering
- Scalable solution for the detection and treatment of non-conventional electrical phenomena
- Up to six three-phase current inputs and two three-phase voltage inputs

APPLICATION OF THE ALP-4000

- Used primarily for protection of transformer in transmission and generation stations
- Used to monitor current magnitude and angle, harmonics and symmetrical components through a secured web interface
- Used as a multi-function relay where logic and protection functions are necessary



ALP-4000 FUNCTION OVERVIEW



| Main Protection functions | |
|-----------------------------|------------------------------------|
| IEEE C37.2 Number | Description |
| 24 | Overfluxing |
| 27 | Undervoltage function |
| 50BF | Breaker failure |
| 50/50N | Instantaneous overcurrent function |
| 51/51N DT | Definite time overcurrent function |
| 51/51N IT | Inverse time overcurrent function |
| 59 | Overvoltage function |
| 67 | Directional overcurrent |
| 81R | Frequency Rate of change function |
| 81 | Frequency Under/Over function |
| 87R | Differential restrained function |
| 87U | Differential unrestrained function |
| *87N (REF) | Restricted earth fault |
| Voltage peak detector (DCT) | Peak voltage raw data function |

87- TRANSFORMER DIFFERENTIAL PROTECTION

The ALP-4000 provides the most commonly used transformer differential protection functions: percentage restrained differential protection (87R) and unrestrained differential protection (87U). Up to five three-phase current inputs can be used by these functions. Each input's magnitude and phase is independently compensated.

24-OVERFLUXING PROTECTION

V/Hz surveillance is done using predefined or user defined curves. The overfluxing of generator transformer can be dangerous while causing winding overheating and powerful magnetotritractive forces.

27/59- UNDERVOLTAGE/OVERVOLTAGE PROTECTION

The ALP-4000 also monitors voltage levels via undervoltage (27) and overvoltage functions (59).

50/51- OVERCURRENT PROTECTION

The ALP-4000 also provides overcurrent protection for the transformer either via instantaneous trip (50/50N), definite time (51 DT/51N DT) and/or inverse time functions (51 IT/51N IT). These functions work simultaneously.

81- FREQUENCY PROTECTION

Under/over-frequency (81) and rate-of-change-of-frequency functions (81R) are available to protect the transformer during network frequency deviations.

67- DIRECTIONAL OVERCURRENT

Directional overcurrent allows the isolation of faulted zone depending on the flow and magnitude of the current.

*87N (REF)- RESTRICTED EARTH FAULT

Increased sensibility of earth fault detection inside the protection zone is possible by using the restricted earth fault function.

*50BF- BREAKER FAILURE

Provides additional protection in case of a breaker failure to isolate the fault. Building the breaker failure is simple using logic equations and overcurrent elements.

VOLTAGE PEAK DETECTOR (DCT)

The ALP-4000 includes a voltage peak detection function which analyzes sampled raw values before filtering. This function identifies non-conventional electrical phenomena which are undetected by traditional protection functions.

PROGRAMMABLE INPUTS/OUTPUTS

Outputs of the ALP-4000 can be configured individually to operate from the value of any of the relay's binary points (e.g. output of a function, timer, flip-flop or latch, logic equation etc.). Similarly, digital inputs of the relay can be used in any element using a binary point as an input (e.g. a logic equation).

HIGH-SPEED & HIGH POWER OUTPUTS

The ALP-4000 features 8 high-speed and high power outputs based on a parallel combination of optocoupled transistors and mechanical relays.

METERING AND MONITORING

Real-time measurements are taken from raw voltages and currents with a sampling rate of 7,680 Hz. The relay can be configured to track the frequency of the network and to adjust its sampling rate to 128 samples per network cycle.

PROGRAMMABLE LOGIC CONTROLLERS AND EQUATIONS

Up to 50 logic equations can be configured. Flip-flops or latches, timers and logic functions are available to build complex equations.

RUNTIME SANITY CHECK

Runtime sanity check continuously verifies system integrity in order to effectively detect any hardware malfunction in the device.

EXPANDABILITY

With its flexible and modular architecture, the ALP-4000 is the perfect solution for detecting and treating non-conventional electrical phenomena.

OSCILLOGRAPHIC RECORDER

The ALP-4000 can support the configuration of 10 oscillographic recorders. Oscillographic files including a maximum duration of 5 seconds of data are stored using IEEE C37.111 format, either in version 1999 or 2013 according to the user's preferences. The increased storage of the ALP enables the user to store raw data at one of the highest sampling rate of the industry (128 samples/cycle), enabling better analysis of the faulted equipment.

SECURE ACCESS

Three user levels are available to secure access to the relay interfaces.

SEQUENCE OF EVENTS RECORDER

Up to 1,000 different kinds of events (Protection, Security, Configuration and Maintenance) can be recorded in the ALP-4000. Each event may provide details of the system status at the time of the event.

*DNP3 SECURE AUTHENTICATION

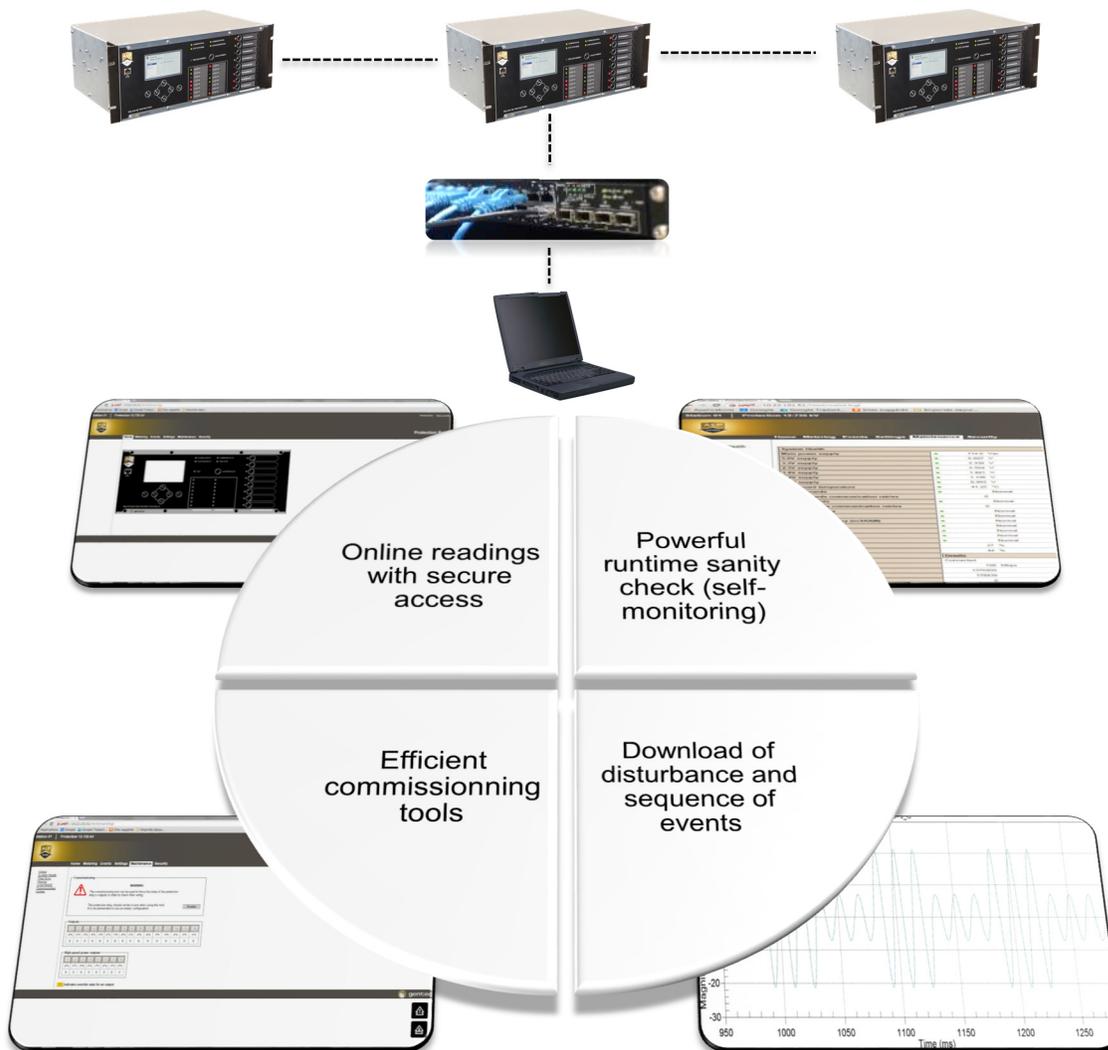
DNP3 protocol is now available with "DNP3 Secure Authentication" ensuring the relay communicates with an authenticated user before giving access to critical functions. This feature helps meet substation cybersecurity requirements.

*61850 GOOSE MESSAGES

Transmit and receive GOOSE (Generic Object Oriented Substation Events) messages over the substation Ethernet LANs. GOOSE messaging will reduce the amount of hard wiring between devices in the substation while allowing low-latency, real-time transmission of events.

*Soon available upon firmware update

SECURED WEB INTERFACE

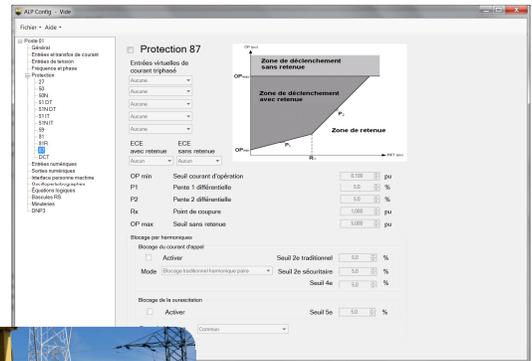


APPLICATION EXAMPLE OF ALP4000

TRANSFORMER DIFFERENTIAL PROTECTION

Transformers are a crucial piece of equipment in an electrical network. They suffer electrically and mechanically from stresses generated by many types of events such as external short circuits, internal faults, grid perturbations and thermal stresses. As current flow through a transformer, the differential between currents at the input and output gives indication that the unit must be quickly removed from the grid. Meanwhile, returning a transformer back on the grid requires analysis of the current harmonic content to avoid false tripping under inrush conditions resulting in a differential current greater than the protection settings.

The ALP-4000 uses a dual slope percent differential function to protect the transformer. Inrush conditions are detected using either one of two mechanisms. First is a standard algorithm monitoring the second and fourth harmonics. Second is a SECURE mode using a decision tree and lowering the second harmonic threshold for proper transformer inrush protection of newest transformers encountering ultrasaturation of the core. The relay also provides restraint in overexcitation conditions by monitoring the fifth harmonic. The friendly user interface makes the implementation of the protection settings very easy.



Simple and efficient configuration of differential protection including SECURE blocking for safe and reliable protection of newest transformers

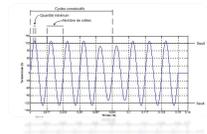
VOLTAGE PEAK DETECTOR (DCT)

In some particular electrical network configurations, various event may create surge and overvoltage condition. Users of these electrical grids can monitor these overvoltage conditions to isolate series compensation lines, to trigger specific regulating devices and to manage islanding conditions more efficiently.

Typically, voltage readings in a protective relay is averaged and conditioned into RMS values before performing protection functions. Faster response to non-conventional electric phenomena is achieved by a Voltage Peak Detector algorithm that uses each raw sample of data as input.



7680Hz



The Voltage Peak Detector function is easily enabled in the configurator by setting a peak voltage threshold, a minimum number of samples per peak and a count of peaks per cycle. The function can trip whether a consecutive number of cycles are found to be active, or if some cycles are found active in a sliding window. The friendly user interface gives access to 6 instances of the Voltage Peak Detector function.

| TRANSFORMER DIFFERENTIAL (87U / R) | |
|---|---------------------------------------|
| Current inputs | 2 to 6 inputs |
| Tap range: | 0.7 – 174, 0.1 steps |
| RESTRAINED (87 R) | |
| Pickup range | 0.1 – 1 p.u., 0.001 p.u. steps |
| Slopes 1 and 2 range : | 5 – 100%, 0.1% steps |
| Accuracy : | ±5%, ±0.03 p.u. minimum |
| 2^e 4^e 5^e harmonic pickup range: | 5 – 100%, 0.1% steps |
| Accuracy : | ±5%, ±0.03 p.u. minimum |
| Minimum pickup time : | 1.4 cycles |
| Maximum pickup time : | 1.75 cycles |
| Average pickup time : | 1.5 cycles |
| UNRESTRAINED (87 U) | |
| Pickup range | 5 – 20 p.u., 0.001 p.u. range |
| Accuracy : | ±5%, min de ±0.03 p.u. |
| Minimum pickup time : | 0.6 cycle |
| Maximum pickup time : | 1.6 cycles |
| Average pickup time : | 1.1 cycles |

| VOLTAGE (27 / 59) | |
|-------------------------------|---|
| Pickup | 1 – 300 V, 0.001 V steps |
| Accuracy (steady state) : | ±3%, ±2.1 V minimum |
| Pickup time (0.1 x pickup) | Total RMS < 1.9 cycles Fundamental RMS : < 1 cycle |
| Pickup time (0.8 x pickup) | Total RMS < 2.5 cycles Fundamental RMS : < 1.75 cycles |
| Operate time | 0 – 100 s, 1 ms steps |
| Accuracy : | ±0.1%, ±0.125 cycle minimum |
| Hold time | 0 – 100 s, 1 ms steps |
| Accuracy : | ±0.1%, ±0.125 cycle minimum |

| FREQUENCY (81/ 81R) | |
|---------------------------------------|--|
| UNDERFREQUENCY AND OVERFREQUENCY (81) | |
| Pickup | 40 – 75 Hz, 0.001 Hz steps |
| Accuracy (steady state) : | ±0.04%, ±25 mHz minimum |
| Maximum pickup time | 6 cycles average, 12 cycles max |
| Operate time | 0 – 900 s, 1 ms steps |
| Accuracy : | ±0.1%, ±0.125 cycle minimum |
| FREQUENCY RATE-OF-CHANGE (81R) | |
| Pickup | ±0.1 – ± 10 Hz/s, 0.01 Hz steps |
| Accuracy (steady state) : | ±3%, ±5 mHz/s minimum |

| VOLTAGE PEAK DETECTOR | |
|-----------------------|-------------------------------------|
| Pickup | 0.250 – 425 V, 0.001 V steps |
| Accuracy : | ±0.1%, ± 10 mV minimum |
| Hold time | 0 à 100 s Per step of 1 ms |
| Accuracy : | ±0.1%, ±0,125 cycle minimum |

| OVERCURRENT (50 / 50N/ 51 DT / 51N DT/ 51 IT / 51N IT) | | |
|---|---|---------------------|
| Pickup | 1 A Nominal | 5 A Nominal |
| | 0.05 – 20 A | 0.25 – 100 A |
| Range : | 0.1 – 100 A secondary, 0.001 A steps | |
| Hysteresis : | 98% of pickup | |
| Accuracy (steady state) : | ±3%, ±30 mA minimum | |
| Transient overreach : | < 2%, up to X/R = 240 | |
| Pickup time (10 x pickup) | Total RMS : < 1.75 cycles Fundamental RMS : < 1 cycle | |
| Pickup time (1.2 x pickup) | Total RMS : < 2.5 cycles Fundamental RMS : < 2 cycles | |
| Hold time | 0 – 100 s, 1 ms steps | |
| Accuracy : | ±0.1%, ±0.125 cycle minimum | |
| Definite time (51 DT / 51N DT) | | |
| Operate time | 0 – 100 s, 1 ms steps | |
| Accuracy : | ±0.1%, ±0.125 cycle minimum | |
| Reset time | 0 – 100 s, 1 ms steps | |
| Accuracy : | ±0.1%, ±0.125 cycle minimum | |
| Inverse time (51 IT / 51N IT) | | |
| Curve shapes | IEC Inverse IEC Very inverse IEC Extremely inverse IEC Long-Time Inverse IEEE Moderately inverse IEEE Very inverse IEEE Extremely inverse | |
| Curve multipliers | IEC : 0.05 – 1.1, 0.001 steps IEEE : 0.1 – 3.0, 0.001 steps | |
| Accuracy (operate) | ±1%, ±1.5 cycles minimum | |
| Accuracy (reset) | ±1%, ±1.5 cycles minimum | |
| Overshoot time | < 1 cycle | |
| Response to time varying value of measured current | ±3%, ±4.5 cycles minimum | |

| MAIN SPECIFICATIONS | |
|--|--|
| AC current inputs | 6 three-phase groups |
| AC voltage inputs | 2 three-phase groups |
| DC digital inputs | 16 |
| Digital outputs | 16 |
| High-speed, high-power digital outputs | 8 |
| Assignable buttons | 8 |
| Programmable LED | 16 |
| Synchronization | IRIG-B modulated / unmodulated |
| Interface | Secure web / Graphical LCD display |
| Communications | HTTPS, DNP3 (with Secure Authentication) |
| Power supply | 105 Vdc – 140 Vdc 85 Vac – 265 Vac @ 60Hz |
| Typical power consumption | 23 W (dc) / 38 W (ac) |
| Maximum power consumption | 30 W (dc) / 50 W (ac) |
| Independent inputs/outputs | Dielectric strength between channels 2800 Vdc (1 min) |
| Sampling | 128 samples / cycle |

| METERING | |
|------------------------------|----------------------|
| Current | |
| RMS Value : | 0,5-100A :0.2%±10mA |
| Phasor magnitude : | 0,5-100A :0.2%±10mA |
| Phasor angle : | 0,5-100A : ±1° |
| Symetrical comp. magnitude : | 0,5-100A :0.2%±10mA |
| Symetrical comp. angle : | 0,5-100A : ±1° |
| Voltage | |
| RMS Value : | 5-300V :0.1%±12mV |
| Phasor magnitude : | 5-300V :0.1%±12mV |
| Phasor angle : | 5-300V : ±1° |
| Symetrical comp. magnitude : | 5-300V :0.1%±12mV |
| Symetrical comp. angle : | 0,1-100A : ±1° |
| Frequency | 60 Hz nominal |
| Accuracy : | ±0,001 Hz (at 60 Hz) |
| Measuring range : | 30 to 90 Hz |
| Tracking range: | 40 to 75 Hz |

Note : Unless otherwise specified, metering was done at 25 °C.

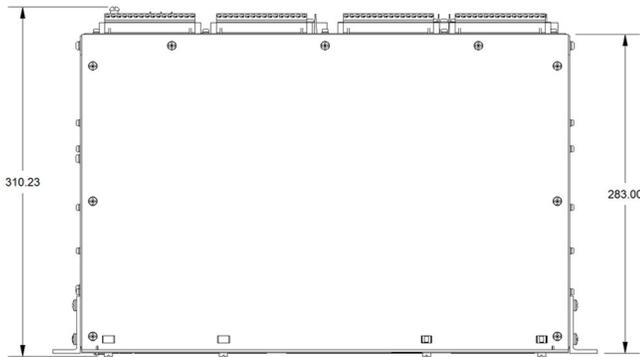
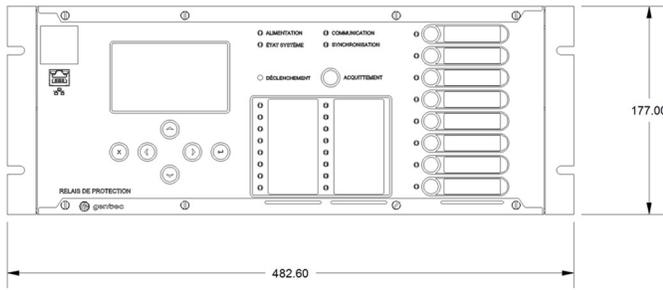
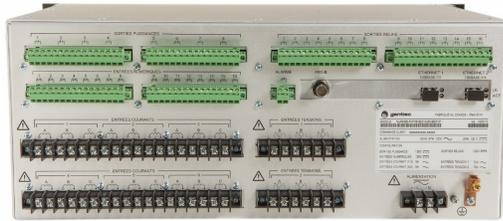
| ENVIRONMENTAL CONDITIONS | | |
|---|------------------------------------|---|
| Dry heat – Functional and storage | CEI 60068-2-2 :2007 Bd and Rb | +85°C 16 hours |
| Cold – Functional and storage | CEI 60068-2-1 :1990 – Ab and Ab | -40°C 16 hours |
| Cyclic temperatures | CEI 60068-2-14 :2009 Nb | -40°C to 85°C 5 cycles |
| Damp heat, continuous | CEI 60068-2-78 :2012 Cab | +40°C, 240 hours 93% relative humidity |
| Damp heat, cyclic | CEI 60068-2-30 :2005 Dd | 25°C to 55°C 8 cycles 95% relative humidity |
| Behavior under vibrations and endurance (sinusoidal) | 60255-21-1 :1998 | Class 1 |
| Response to shocks, resistance to shocks and vibrations | 60255-21-2 :1998 | Class 1 |
| Seismic tests | 60255-21-3 :1993 | Class 2 |
| Enclosure protection | IP3X | |
| Surge category | II | |
| Pollution degree | 2 | |
| Equipment class | 1 | |
| Maximum elevation | < 2000 m | |
| Maximum relative humidity | 95% non-condensing | |
| Operating temperature | -40°C to 70°C | |

| SECURITY | | |
|-------------------------------|----------------|--|
| Impulse voltage | 60255-27 :2013 | 5 kV, 0.5J |
| Dielectric voltage | 60255-27 :2013 | 2800 Vdc Copper ethernet port 2250Vdc |
| Insulation resistance | 60255-27 :2013 | > 100 MΩ after damp heat test (CEI 60068-2-78) |
| Protective bonding resistance | 60255-27 :2013 | < 0,03 Ω |
| Thermal short time | 60255-27 :2013 | 4*In (20 A) continuous 100*In (500A) for 1 s 1250Ac for 1 cycle |

| ELECTROMAGNETIC COMPATIBILITY | | |
|--|---|--|
| Radiated emission | CISPR 11/CISPR 22 | Classe A |
| Conducted emission | CISPR 22 : 2008 | Classe A |
| Electrostatic discharge immunity | CEI 6100-4-2 :2008 Niveau 4 | ±15 kV dans air ±8 kV au contact |
| Radiated electromagnetic field immunity | CEI 61000-4-3 :2006 A1 :2008 A2 :2010 IEEE C37.90.2 :2004 20 V/m | 20V/m |
| Electrical fast transient/burst immunity | CEI 61000-4-4 :2004 IEEE C37.90.1 | ±4kV |
| Surge immunity | CEI 61000-4-5 :2005 Niveau 3 et 4 | ±4 kV L-PE ±2kV L-L ALIM : ±2 kV L-PE ±1 kV L-L |
| Immunity to conducted disturbances | CEI 61000-4-6 :2008 | 20V |
| Power frequency magnetic field immunity | CEI 61000-4-8-2009 | 100 A/m for 60s 1000 A/m for 3s (50Hz and 60Hz) |
| Pulsed magnetic field immunity | CEI 61000-4-9 :1993 A1 :2000 Niveau 5 | 1000 A/m |
| Damped oscillatory magnetic field immunity | CEI 61000-4-10 :1993 A1 : 2000 Niveau 5 | 100 A/m for 2s (0.1MHz and 1MHz) |
| Voltage dips immunity | CEI 61000-4-11 :2004 CEI 61000-4-29 :2000 | DC Supply 40% for 200 ms 70% for 500 ms |
| Voltage interruptions on power supply voltage immunity | CEI 61000-4-11 :2004 CEI 61000-4-29 :2009 | DC Supply 100% short-circuit for 5s 100% open-circuit for 5s |
| Gradual shut-down/start-ups | CEI 60255-26 :2013 | 60s ramp |
| Immunity at the power frequency on the DC inputs | CEI 61000-4-16 :2002 | Digital input : 300 Vrms L-PE for 10s 60Hz 150 Vrms L-L for 10s 60Hz |
| DC Ripple immunity at power input | CEI 61000-4-17:2009 | 25% |
| Damped oscillatory wave immunity | CEI 61000-4-18:2006 A1:2011 | 2.5kV L-PE 1kV L-L IRIG-B : 1kV L-PE 0.5kV L-L 100kHz et 1MHz |
| Surge Withstand capability | IEEE C37.90.1:2002 | 2.5kV L-PE 2.5kV L-L |

| AC CURRENT INPUTS | |
|-----------------------------------|---|
| Nominal current | 1 A or 5 A |
| Continuous maximum current | 20 A |
| Measurable maximum current | 40 A (1 A nominal) 200 A (5A nominal) |
| Maximum current (1 sec thermal) | 500 A |
| Maximum current (1 cycle thermal) | 1250 Ac (peak) |
| Frequency response (-3dB) | 1500 Hz |
| Burden | < 0.15 VA |
| Individual inputs | Inter-circuit isolation of 2800Vdc for 1 min |

PHYSICAL LAYOUT AND DIMENSION



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AC VOLTAGE INPUT

| | |
|----------------------------------|--|
| Nominal voltage | 70 V |
| Continuous maximum voltage | 250 V |
| Measurable maximum voltage | 300 V |
| Maximum voltage (10 sec thermal) | 350 V |
| Frequency | 40 – 75 Hz |
| Accuracy | 5 – 300 V : 0,1% ± 10mV |
| Frequency response (-3dB) | 1500 Hz |
| Burden | < 0,15 VA |
| Individual inputs | Inter-circuit isolation of 2800Vdc for 1 min |

DC DIGITAL INPUTS

| | |
|---------------------------|--|
| Operating nominal voltage | 125 Vdc |
| Operation maximum voltage | 145 Vdc |
| Minimum pickup voltage | 102 Vdc |
| Nominal cutoff voltage | 85 Vdc |
| Input impedance | 30 kΩ |
| Input consumption | 0,5 W |
| Individual inputs | Inter-circuit isolation of 2800Vdc for 1 min |

DIGITAL OUTPUTS

| | |
|--------------------------------|--|
| Operating nominal voltage | 125 Vdc |
| Operation maximum voltage | 160 Vdc |
| Minimum pickup voltage | 20 Vdc |
| Continuous maximum current | 5 A |
| Nominal closure power | 30 A @ 125 Vdc |
| Nominal resistive cutoff power | 0,3 A @ 125 Vdc |
| Nominal cutoff power | 0,3 A @ 125 Vdc (L/R = 40 ms) |
| Pickup time | < 9 ms |
| Cutoff time | < 25 ms |
| Electrical operations | >1 E 6 @ 125Vdc, I=0.3A, L/R=40ms |
| Individual outputs | Inter-circuit isolation of 2800Vdc for 1 min |

HIGH-SPEED HIGH-POWER DIGITAL OUTPUTS

| | |
|--------------------------------|--|
| Operating nominal voltage | 125 Vdc |
| Operation maximum voltage | 160 Vdc |
| Minimum pickup voltage | 20 Vdc |
| Continuous maximum current | 10 A |
| Nominal closure power | 30 A @ 125 Vdc |
| Nominal resistive cutoff power | 10 A @ 125 Vdc |
| Nominal cutoff power | 10 A @ 125 Vdc (L/R = 40 ms) |
| Pickup time | < 2 μs |
| Cutoff time | < 25 ms |
| Electrical operations | >50 000@125Vdc, I=10A, L/R=40ms |
| Individual outputs | Inter-circuit isolation of 2800Vdc for 1 min |

Since 1959, Gentec is specialized in developing custom cutting edge technology electronic and electrical products. Our sustained effort to exceed utility requirements is one of the reasons why our ingenious and robust solutions are renowned around the world. Constantly look for getting ahead in the electrical industry trend.

Gentec is the perfect partner for you!

