PS - 003

Step-up Substation Protection Module

Overview

In the design of electrical power systems, the ANSI Standard Device Numbers ANSI/IEEE Standard denote what features a protective device supports such as a relay or circuit breaker. These types of devices protect electrical systems and components from damage when an unwanted event occurs, such as an electrical fault. Device numbers are used to identify the functions of devices. This module is used to provide protection to Step Up / Synchronization Substation Module and introduce trainees to how to use the different protection relays and their connections



Specifications

- Negative sequence/ unbalanced line-current protection (ANSI Standard: 46)
- Transformer in-rush and overload protection (ANSI Standard: 49)
- Non-directional definite-time overcurrent protection (ANSI Standard: 51P)
- Earth fault definite-time overcurrent protection (ANSI Standard: 51TN)
- Phase over-voltage protection (ANSI Standard: 59P)
- Inter-turn fault protection (ANSI Standard: 87T)
- Under-frequency protection (ANSI Standard: 81U)

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Technical Data

Negative sequence/ unbalanced line-current protection (ANSI Standard: 46)

- A three phase current balance protection relay continuously monitors a three phase AC current through current transformers, tripping upon an unbalanced load condition.
- The output relay trips when the monitored current is outside of the user adjustable limit and the LED ceases to illuminate indicating a fault condition.
- The relay also has a built-in time delay, used to avoid nuisance tripping.
- The output relay is set to de-energize in the unbalanced condition ensuring the protection relay is failsafe.
- The relay requires an auxiliary supply to operate.
- The unbalance trip point is adjustable from 3% to 20% of the nominal current
- The set point is adjusted through the front control knob.
- The time delay is adjustable from 0.1 to 10 seconds
- Relay output: Single change-over contact
- Contact rating: 250V AC, 5A (resistive)

Transformer in-rush and overload protection (ANSI Standard: 49)

- Differential thermal overload relay
- Phase failure sensitive
- Reset mode can either be manual or automatic.
- Pushbutton for simulating relay tripping
- Pushbutton for “Stop” and manual Reset
- Trip flag indicating overload relay tripped.
- Rated operational voltage: 0…400V AC
- Thermal protection adjustment range: 1.6A…2.5A AC
- Phase failure sensitivity tripping current: 130 % of “In” on two phase, the last phase at 0 current or 30 % of “In” on one phase, the others at “In”.
- Auxiliary contact: 1 NO + 1 NC
- Tripping threshold: (1.14 +/- 0.06) x In

Non-directional definite-time overcurrent protection (ANSI Standard: 51P)

- protection of generators against over-currents .
- The relay measures the highest of the 3-phase currents, providing an RMS measurement at sinusoidal currents.
- The measurement is based on average values for measured current.
- The set point values are set on the front of the relays by means of potentiometers.
- If a current exceeds a set point, the output is activated.
- If exceeded, a fault signal is generated, and the associated yellow LED is lit.
- Measurement of 3-phase currents
- LED indication of fault condition
- Timer-controlled tripping
- LED indication for activated relay
- When the set point is exceeded, its timer starts and will run as long as the fault condition prevails.
- If the fault disappears, the timer is reset. When the timer expires, the contact is activated and the associated red LED is lit.
- Over-current setting: 0.5 to 1.5 × In
- Tripping delay time for over-current: 0 to 20sec
- Number of contacts: Single change-over switch per relay type
- Contact ratings: 250 V AC/24 V DC, 8 A (200,000 change-overs at resistive load)

Earth fault definite-time overcurrent protection (ANSI Standard: 51TN)

- Stator earth fault relay protects genset operators against electric shock in case of earth faults in the generator’s stator.
- The relay also protects against loss of excitation in case of earth fault in the stator.
- Protects the voltage source and load networks against earth fault in a solid-earth, or a low-resistance TN system.

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- The relay measures the leakage or a short circuit from one or more of the phases to earth.
- In order to obtain a short response time on a fault condition, the measurement is based on peak values.
- The earth fault current protection is obtained by connecting an external current transformer in the star point of the protected voltage source.
- In order to prevent malfunction due to 3rd harmonic, the relay is equipped with a special filter cutting off frequencies higher than 50/60 Hz.
- The set point values for ground currents are set on the front of the relay by means of potentiometers.
- If exceeded, a fault signal is generated, and the associated yellow LED is lit.
- The relay is provided with two outputs with contacts either normally energized or normally de-energized based on the supplied auxiliary power.
- Earth fault protection at two levels (instantaneous and definite-time ground-fault protection)
- Built-in filter for 3rd harmonic
- LED indication of fault condition
- Timer-controlled tripping
- LED indication for activated relay
- Earth leakage current setting: 2…20% of In
- Tripping delay time for leakage current: 0 to 20sec
- Earth short-circuit current setting:10...100% of In
- Tripping delay time for short-circuit current: 0 to 1sec
- Relay contact: 1 change-over switch per relay type
- Contact voltage rating: Max. 250V AC, 8A

Phase over-voltage protection relay (ANSI Standard: 59P)

- Continuously monitors the three-phase output voltage of synchronous generator to warn against over-voltage condition to warn against over-excitation condition
- If measured voltage moves above the set point limit, the relay contacts will change-over after the selected "Delay-OFF" has elapsed, giving an alarm or initiation signal.
- If voltage measured falls below threshold (set point), the relay contacts will return to original state only after the reset time ("Delay-ON") has elapsed.
- Can be used in 3-wire and 4-wire network
- User can adjust trip point (set point) and time delay settings.
- The set point adjustment for over-voltage is in the range of 25%
- As soon as the monitored signal moves outside of the set point limit, the time delay is activated, after which a trip will occur. The time delay prevents the relay from tripping for a predetermined period to prevent nuisance tripping.
- The relay is automatically reset once the monitored voltage falls below the set point.
- Adjustable off-delay: 0.1 …20sec
- Adjustable reset-delay: 0.1…20sec
- Adjustable over-voltage trigger range: 105% …130% (corresponding to 410V…510V AC)
- LED indicators for relay activation during over-voltage condition
- Relay output: Single change-over contact
- Contact rating: 250V AC, 8A

Inter-turn fault protection (ANSI Standard: 87T)

- Protects the synchronous generator against leakage currents in the windings of the generator.
- The relay compares the differential current of each of the three phases, providing an RMS measurement at sinusoidal currents.
- The differential currents are obtained by connecting the external current transformers for each winding in parallel with inverse polarity.
- The measurement is not stabilized, implying that the relay contact is activated for disconnection of the supervised unit when the differential

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current of the individual phases exceeds its set point, irrespective of the amperage of these.

» The three differential currents are measured by the relay and the highest of these is selected. If this exceeds the set point, the output is activated.

» The set point value is set on the front of the relay by means of a potentiometer. If exceeded, a fault LED illuminates, however, contacts are not yet energized.

» When the set point is exceeded, if delay is set, its timer starts and will run as long as the fault condition prevails. If the fault disappears, the timer is reset.

» When the timer expires, the contact is activated and the associated relay LED indicator is lit.

» Differential current setting: 0.04 to 0.4 × In

» Tripping delay setting: 0 to 1sec

» Maximum input current: 4x In

» Relay output: 2x change-over contacts

» Contact rating: 250V AC, 8A

Under-frequency protection (ANSI Standard: 81U)

» Frequency protectors offer user adjustable frequency trip point (set point)

» The set point adjustment range is centered around the nominal 50Hz or 60Hz system frequency.

» If the measured frequency moves outside the set point limit, the relay will operate, giving an alarm or initiation signal.

» The unit draws their operating power from the measuring inputs. No separate power supply is required

» When the monitored frequency falls below the set point, the relay will energize and the LED indicator will illuminate to indicate the trip condition.

» The tripping action can be delayed through an adjustable delay knob

» The relay will automatically reset once the monitored frequency exceeds the set point

» When monitoring relay is reset, the LED will extinguish and the relay contacts de-energizes.

» Operating (monitored) voltage: 220-240V AC

» Adjustable Power-on delay range: 1…10sec

» Adjustable tripping delay range: 1…10sec

» Relay output: Single change-over contact

» Contact rating: 250V AC, 8A

» Frequency setting: 40 to 60 Hz

Experiments

- Transformer Magnetizing Inrush current setting
- Inter-turn faults protection for a three-Phase Power Transformer
- Earth Fault Protection of a Three-Phase Power Transformer

Scope of Delivery

- Step-up Substation Protection Module (PS - 003)

Required for Operation

- Step-UP Substation Module (PS - 001.3)

Options

- Digital content (BI-01)

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