PCS-985TI

Transformer Relay

PCS-985TI is a kind of high performance numerical transformer protection device, which integrates main and backup protection into one device. It provides complete protection of a transformer in any voltage level, and is typically applied for startup/standby transformer or auxiliary transformer of power plant with multiple branches, and main transformer, etc. It also provides basic protection of a two-winding main transformer and one or two auxiliary transformer.

PCS-985TI provides up to 80 analog input channels including current and voltage inputs. The transformer protections are configurable. Ancillary functions of fault diagnostic, disturbance records, event records and communication function are integrated in the device.

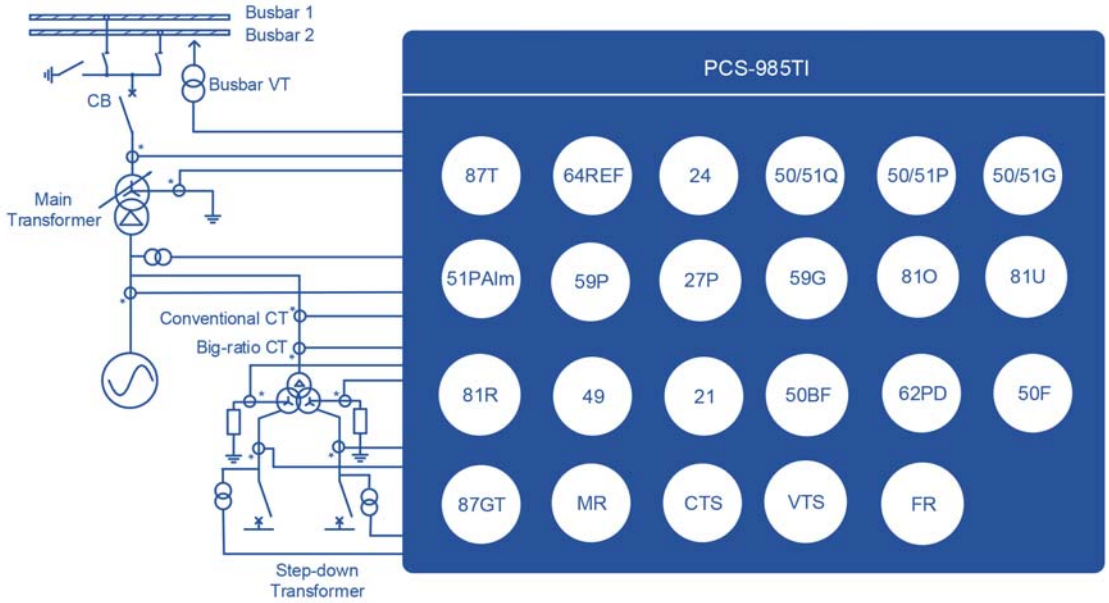

Figure 1 PCS-985TI Functional Block Diagram

Functions

Main Transformer Protection

- Current differential protection (87T)
  Transformer current differential protection is the main protection for the internal short-circuit fault of transformer winding. Biased current differential element consists of sensitive and conventional biased differential elements as well as independent CT saturation criterion. Unrestrained instantaneous differential element provides high speed tripping against internal serious fault. DPFC current differential element can fully reflect the change of differential current and restraint current, and it is not affected by the load current and is sensitive to small internal fault current within the transformer, its performance against CT saturation is also good. Inrush current can be detected via second harmonic restraint principle or waveform distortion discrimination principle. The fifth harmonic of differential current is used as criterion of overexcitation discrimination.

- Transformer restricted earth fault protection (64REF)
  Transformer restricted earth fault protection is the main protection for the internal earth fault of transformer winding. The biased differential element with restraint characteristic is adopted, it consists of sensitive and conventional biased differential elements as well as independent CT saturation criterion.

- Overexcitation protection (24)
  Overexcitation protection is used to check the over-flux phenomenon during operation of the generator and transformer. The ratio of voltage and frequency is adopted to check overexcitation. Definite-time over-excitation protection consists of two stages: one is for alarm, the other is for tripping. Inverse-time over-excitation protection realizes inverse-time characteristic by linear processing on given inverse time operation characteristic, obtaining multiple of over excitation by calculation, and calculating corresponding operation time delay by sectional linear insertion. It reflects heat accumulation and radiation.

- Negative-sequence Overcurrent protection (50/51Q)
  Negative-sequence overcurrent protection is applied as the backup protection for generator. Meanwhile it can be applied to detect the single-phase and two-phase fault, it can also be applied to detect the open fault or polarity error of the CT circuit. Two-stage negative-sequence overcurrent protection with independent logic, current and time delay settings are available. Stage 1 is definite-time characteristic, stage 2 can be selected as definite-time or inverse-time characteristic.

- Phase overcurrent protection (50/51P)
  Three-stage transformer phase overcurrent protection with independent logic, current and time delay settings are available. Stage 1 and stage 2 are definite-time characteristic, stage 3 can be selected as definite-time or inverse-time characteristic. Voltage controlled element and direction element (no direction, forward direction and reverse direction) can be selected to control each stage of transformer phase overcurrent protection. Second harmonic blocking element can be enabled or disabled for each stage.

- Phase overcurrent alarm elements (51PAlm)
  When load current exceeds the transformer limit load current, phase overcurrent alarm elements can be applied to issue alarm signals to remind field operators. Phase overcurrent alarm elements can also be applied to initiate cooling system and blocking OLTC function.

- Ground overcurrent protection (50/51G)
  Three-stage ground overcurrent protection with independent logic, current and time delay settings are available. Stage 1 and stage 2 are definite-time characteristic, stage 3 can be selected as definite-time or inverse-time characteristic. Residual voltage, direction element and second harmonic blocking element can be selected to control each stage of ground overcurrent protection.

- Phase overvoltage protection (59P)
  Stage 1 of phase overvoltage protection for tripping and the phase overvoltage protection for alarm are definite-time overvoltage protection fixedly, stage 2 of phase overvoltage protection for tripping can be configured as inverse-time or definite-time overvoltage protection. Phase-to-phase voltage instead of phase-to-earth voltage is selected for overvoltage protection calculation, it can prevent the overvoltage protection from mal-operation due to single phase earthing for ungrounded system.

- Phase undervoltage protection (27P)
  Stage 1 of phase undervoltage protection for tripping and the phase undervoltage protection for alarm are definite-time undervoltage protection fixedly, stage 2 of phase undervoltage protection for tripping can be configured as inverse-time or definite-time undervoltage protection. Phase-to-phase voltage instead of phase-to-earth voltage is selected for undervoltage protection calculation, it is insensitive to asymmetric voltage decline, but it is sensitive to system stability problem.

- Residual overvoltage protection (59G)
  One-stage residual overvoltage protection for tripping and one-stage residual overvoltage protection for alarm are available. The residual overvoltage protection for alarm is definite-time residual overvoltage protection fixedly, the residual overvoltage protection for tripping can be configured as inverse-time or definite-time residual overvoltage protection.

- Overfrequency protection (81O)
  Four stages of overfrequency protection and overfrequency band accumulate protection are available, and each stage has respective frequency setting, time setting and logic setting. Each stage can be configured to issue alarm signal or trip.

- Underfrequency protection (81U)
  Four stages of underfrequency protection and underfrequency

band accumulate protection are available, and each stage has respective frequency setting, time setting and logic setting. Each stage can be configured to issue alarm signal or trip.

- Rate-of-frequency-change protection (81R)
  Four stages of rate-of-frequency-change protection are available with separate rate-of-frequency-change setting, time delay and logic setting. Each stage can be configured as frequency increase protection or decrease protection. Low voltage blocking function is available.

- Thermal overload protection (49)
  Thermal overload protection can reflect the average heating condition of transformer winding, and it can prevent the transformer from overheating caused by overload and asymmetric overload. Thermal overload protection can operate to trip or alarm (with independent setting and logic setting). One binary input signal can be used to clear the thermal accumulation.

- Impedance protection (21)
  Impedance protection includes phase-to-phase and phase-to-earth protection. Positive polarity of CT is at busbar side, and direction settings should be set according to the principle. The device adopts power swing blocking releasing to avoid mal-operation of impedance protection due to power swing.

- Breaker failure protection (50BF)
  When there is an internal fault of the transformer, the protection operates to trip but the breaker fails, it needs to initiate breaker failure protection and trip adjacent breakers in time. Breaker failure protection has following two criteria: current criterion and circuit breaker auxiliary contact criterion. The internal logic between the two criteria can be “And” or “Or”.

- Pole disagreement protection (62PD)
  There are two current criteria for pole disagreement protection: residual current criterion and negative-sequence current criterion. The two current criteria can be enabled or disabled independently. Pole disagreement position input signal is used to initiate pole disagreement protection.

- Breaker flashover protection (50F)
  For the large-scale generator-transformer unit in higher voltage level system, during the process of preparation synchronization or just out of operation, flashover in circuit breaker is possible when phase angle difference between the voltages of two sides of the circuit breaker is around 180°. Breaker flashover protection is used in case of this situation, and one phase and two phase flashover are considered. Breaker flashover protection includes two criteria: circuit breaker position auxiliary contact criterion and current criteria. The internal logic between the above two criteria is “And”.

- Current differential protection of generator-transformer unit (87GT)
  Generator-transformer unit current differential protection is the main protection for the internal short-circuit fault of generator and transformer winding. Biased current differential element consists of sensitive and conventional biased differential elements as well as independent CT saturation criterion. Unrestrained instantaneous differential element provides high speed tripping against internal serious fault. Inrush current can be detected via second harmonic restraint principle or waveform distortion discrimination principle. The fifth harmonic of differential current is used as criterion of overexcitation discrimination.

- Mechanical protection (MR)
  Transformer mechanical protection can repeat these binary input signals to send alarm signals, tripping directly or tripping with a time delay. By this way the output signal of some mechanical protection (such as gas protection and etc.) can be coupled to the microprocessor-based protection device, then these signals can be repeated through high-power relays to improve the anti-inference ability of the protection.

Step-down Transformer Protection

- Current differential protection (87T)
  The same to that of main transformer.

- Transformer restricted earth fault protection (64REF)
  The same to that of main transformer.

- Phase overcurrent alarm elements (51PAlm)
  The same to that of main transformer.

- Residual overvoltage protection (59G)
  The same to that of main transformer.

- Step-down transformer HV side phase overcurrent protection (50/51P)
  Three-stage phase overcurrent protection with independent logic, current and time delay settings are available. Stage 1 and stage 2 are definite-time characteristic, stage 3 can be selected as definite-time or inverse-time characteristic. Voltage controlled element can be selected to control each stage of phase overcurrent protection.

- Step-down transformer LV side phase overcurrent protection (50/51P)
  Two-stage phase overcurrent protection with independent logic, current and time delay settings are available. Stage 1 is definite-time characteristic, stage 2 can be selected as definite-time or inverse-time characteristic. Voltage controlled element can be selected to control each stage of phase overcurrent protection.

- Step-down transformer LV side ground overcurrent protection (50/51G)
  Two-stage ground overcurrent protection with independent logic, current and time delay settings are available. Stage 1 is definite-time characteristic, stage 2 can be selected as definite-time or inverse-time characteristic. Residual voltage controlled element can be selected to control each stage of ground overcurrent protection.

Miscellaneous

- Fault detector (FR)
- Voltage and current drift auto adjustment.
- VT circuit supervision (VTS)
- CT circuit supervision (CTS)
- CT saturation detection
- Self diagnostic
- GPS clock synchronization
- Fault recorder
- IEC61850 MMS & GOOSE for station bus
- IEC60870-5-103 protocol
- MODBUS protocol
- DNP 3.0 protocol

Features

- Configurable function
  Modules of the device adopt intelligent design, amount of input and output modules and module slot position are configurable. User can increase or decrease the amount of AC input module, binary input module and binary output module, and terminals of those modules can be defined according to actual requirement. Besides, configurability is also reflected in software design of device, which means that user can hide the protective element not used or add new protective module not in standard configuration.

- Parallel calculation of double DSP system
  The hardware of the device comprises a 32-bit microprocessor and two 32-bit digital signal processors (DSP). Those processors can operate in parallel companied by fast A/D converter. The 32-bit microprocessor performs logic calculation and the DSP performs the protection calculation. High performance hardware ensures real time calculation of all protection relays within a sampling interval.
  On the premise of 24 samples per cycle, all data measurement, calculation and logic discrimination could be done within one sampling period. The event recording and protection logic calculation are completed simultaneously.

- Independent fault detector
  Independent fault detectors in fault detector DSP module for connecting power supply of output relays. The relay can drive a tripping output only when protection element on protection DSP module operates with the fault detector in the fault detector DSP module operating simultaneously. This kind of independent supervision of tripping outputs using fault detectors can avoid any mal-operation possibly caused by any hardware component failure. This highly increases the security.

- Configurable tripping output
  The tripping output contacts can be configured by tripping matrix and suitable to any mode of tripping.

- Fault recording function
  Event records include 1024 binary input events and 1024 alarm events. Disturbance records including 64 fault reports, and 64 disturbance waveforms, and file format of waveform is compatible with international COMTRADE91 and COMTRADE99 file. Analog inputs and binary inputs can be recorded, and three oscillography triggering mode are supported, which are protection pickup triggering, manual triggering on keypad of device, and remote triggering through PCS-Explorer software.

- Powerful PC tool software
  Powerful PC tool software (PCS-Explorer) can fulfill protection function configuration, modify setting and waveform analysis.

- Integration of main and backup protection
  Main and backup protection are integrated in one set of protection device. Protection information is shared by all parts. The device can record all relevant waveforms of any fault.

- Reliable CT Saturation Detection
  Based on the operation sequence of DPFC restraint current element and DPFC differential current element of differential protection, external fault with CT saturation or internal fault can be distinguished correctly.