

# P50 Agile P652



## Transformer Protection Relay

The P652 protection relay is the latest offering from GE's P50 Agile series serving the distribution and industrial markets. Thanks to its versatility and richness of features, it is easy to apply.

The P652 is an economical choice, designed for deployment in volume, for system voltages typically up to 66/69 kV. The P652 Agile relay is the ideal choice for optimised protection and monitoring for two-winding transformers.

The P652's main protection is high-speed differential using a triple slope characteristic, also incorporating high-set differential elements. This operates in combination with transformer inrush restraint, and through fault stabilisation. Restricted earth fault (REF) protection is provided per winding, delivering fast fault clearance even in the event of internal faults with moderate fault current flowing. REF may be applied in either high or low impedance modes. The extensive set of protective functions also includes thermal, backup overcurrent/earth fault protection (HV and LV side) for uncleared external faults, negative sequence overcurrent (HV and LV), and breaker failure detection (HV and LV breakers).

Amplitude and vector group matching is done just by entering the nominal values of the power transformer and the protection CTs in the scheme. The relay can compensate for all standard transformer vector connections and for different CT ratios across the transformer, without the need for secondary interposing CTs.

The P652 offers supervision, measurement, monitoring and recording functions. Communication protocols are available for transmitting data to a supervisory control system via serial communication networks. The intuitive operator interface permits easy reading of measured values and simple configuration of the relay. PC software simplifies the configuration process and provides access to all the stored information for monitoring, maintenance and troubleshooting purposes. The P652 relay is housed in a robust metal case suitable for panel mounting.

## Key Benefits

- Supports all typical two-end (winding) applications
- Cost effective
- Measurement, protection and monitoring in one box
- Front USB port for local communication
- MODBUS, IEC 60870-5-103 and DNP3.0 SCADA options
- Diagnostics and maintenance facilities



## Application

The P652 is a dedicated transformer protection relay which can be applied for protection of two winding transformers installed in MV/LV industrial installations, public distribution networks and substations.

## Measurements

- Phase currents for each winding
- Neutral currents for each winding
- Measurement of thermal state
- Positive, negative and zero sequence currents for each winding
- Bias currents for each phase
- Differential currents for each phase
- REF bias current for each winding
- REF differential current for each winding
- True RMS phase currents for each winding
- Breaker operation counter
- Breaker trip counter
- Breaker operating time

## Recording and Post-fault Analysis

- Up to 5 fault records
- Up to 512 time tagged event records
- Up to 5 disturbance records

## Protection and Control

- Biased differential protection with harmonic restraint
- Biased differential high-set
- Integral current amplitude and vector group compensation
- Inrush blocking
- Restricted earth fault (REF – high and low impedance mode selection)
- Through fault monitoring
- Thermal overload
- Timed and instantaneous phase and earth fault protection (3 independent stages)
- Wide range of IEC/IEEE curves
- Negative sequence overcurrent
- Circuit breaker fail
- Trip circuit supervision
- 6 digital inputs
- 6 digital outputs (changeover type, form-C)
- Latching of output contacts
- Universal auxiliary power supply range
- 2 setting groups
- Password protection
- Self-supervision and internal diagnostics
- Watchdog function
- Commissioning/maintenance facilities

| ANSI                       | Function Overview  | P652                    |
|----------------------------|--|-------------------------|
| <b>Transformer</b>         |  |                         |
| 87                         | Transformer Differential (2 windings)                      | •                       |
| 64                         | Restricted earth fault (low or high impedance) – HV and LV | •                       |
| 50                         | Definite time overcurrent                                  | •                       |
| 50N                        | Neutral/Earth definite time overcurrent                    | •                       |
| 51                         | IDMT overcurrent   | •                       |
| 51N                        | Neutral/Earth IDMT overcurrent                             | •                       |
| 68                         | Inrush blocking  | •                       |
| 49                         | Thermal overload   | •                       |
| 46                         | Negative sequence overcurrent                              | •                       |
| 50BF                       | Circuit breaker fail                                       | •                       |
| 86                         | Latching of output contacts (Lockout)                      | •                       |
| <b>Control Functions</b>   |  |                         |
| 74                         | Trip circuit supervision                                   | •                       |
|                            | Watchdog function  | •                       |
|                            | Self monitoring & diagnostics                              | •                       |
|                            | Test/Commissioning facilities                              | •                       |
| <b>HMI</b>                 |  |                         |
|                            | Back-lit LCD display                                       | •                       |
|                            | 8 x Touch keys   | •                       |
|                            | 8 x Status LEDs  | •                       |
| <b>Communication</b>       |  |                         |
|                            | USB port   | •                       |
|                            | Modbus/IEC 60870-5-103 (RS485)(or)                         | •                       |
|                            | DNP 3.0 (RS485)  | •                       |
| <b>Binary Input/Output</b> |  |                         |
|                            | Binary Input   | 6                       |
|                            | Binary Output  | 6 (C/O)                 |
| <b>Analog Input</b>        |  |                         |
|                            | Phase current input  | 6 CTs                   |
|                            | Earth current input  | 2 CTs                   |
| <b>General</b>             |  |                         |
|                            | Setting groups   | 2                       |
|                            | Measurements   | •                       |
|                            | Event records  | •                       |
|                            | Fault records  | •                       |
|                            | Disturbance records  | •                       |
|                            | Configurable BI/BO/LEDs                                    | •                       |
| <b>Hardware</b>            |  |                         |
|                            | Auxiliary supply   | 24-230 V AC/DC          |
|                            | Climatic conditions - Operating :                          | - 25°C to + 55 °C       |
|                            | - Storage :  | -25°C to + 70 °C        |
|                            | Housing  | Front IP52<br>Rear IP20 |

## Vector Group Compensation

The relay can compensate for all standard transformer winding connections and for different CT ratios across the transformer, without the need for secondary interposing CTs.

## Biased Differential Protection

The algorithm has a triple slope percentage bias restraint as shown in figure 1 below. An internal fault will generate differential current. The bias current is that which merely flows through the protected unit, as a load or through fed external fault. The initial characteristic is flat, for ease of commissioning, rising then to bias slope (K1). K1 is a low gradient slope for sensitivity to faults whilst allowing for mismatch when the transformer is at the limits of its tap changer range, in addition to any current transformer ratio errors. At currents above the rated, extra errors may be gradually introduced as a result of CT saturation; hence the bias slope increases to K2.

Energization of a transformer causes magnetising inrush current to flow in one winding only and the differential elements may need stabilising whilst the inrush persists. A proven second harmonic current ratio scheme is used.

The differential protection may also be restrained to avoid instantaneous tripping during transient fluxing. This restraint is conditioned by the percentage of fifth harmonic current presence.

Two high-set instantaneous differential elements, not subject to harmonic restraint, are provided to ensure rapid clearance of high current faults.

## Restricted Earth-fault Protection

Restricted Earth Fault (REF) protection can be applied on transformers to detect earth-faults on a given winding more sensitively than the overall transformer differential protection is able to achieve. A separate element per winding is provided. Low impedance (biased differential) and high impedance REF is available, to suit the customers' application preference.

Figure 2 shows a typical restricted earth fault application. Biased REF is shown in this example, to avoid the need for an external stabilising resistor and varistor/Metrosil. REF elements can operate independently of inrush detection, potentially offering faster tripping for low or moderate fault currents, in addition to enhanced sensitivity.

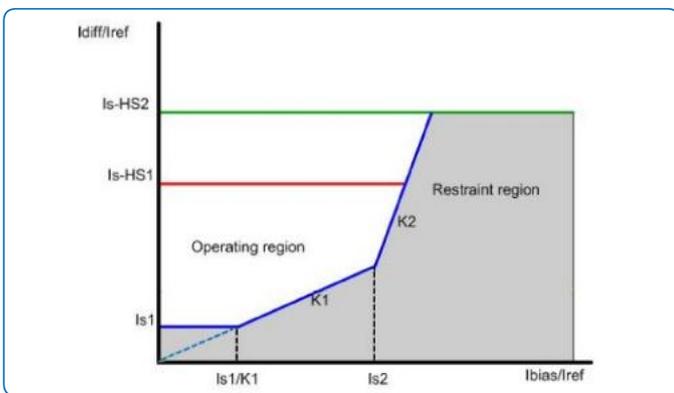


Figure 1: Biased differential protection characteristics

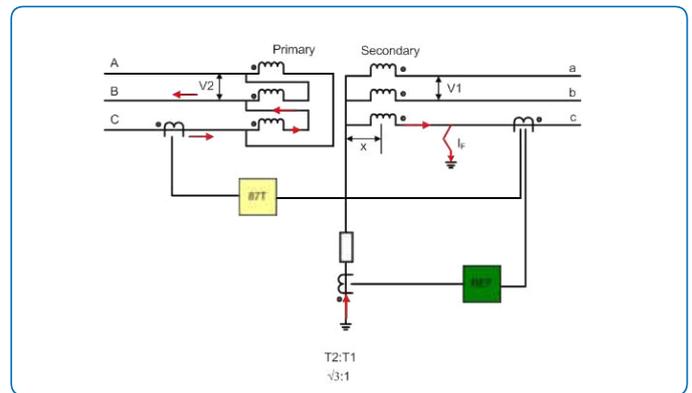
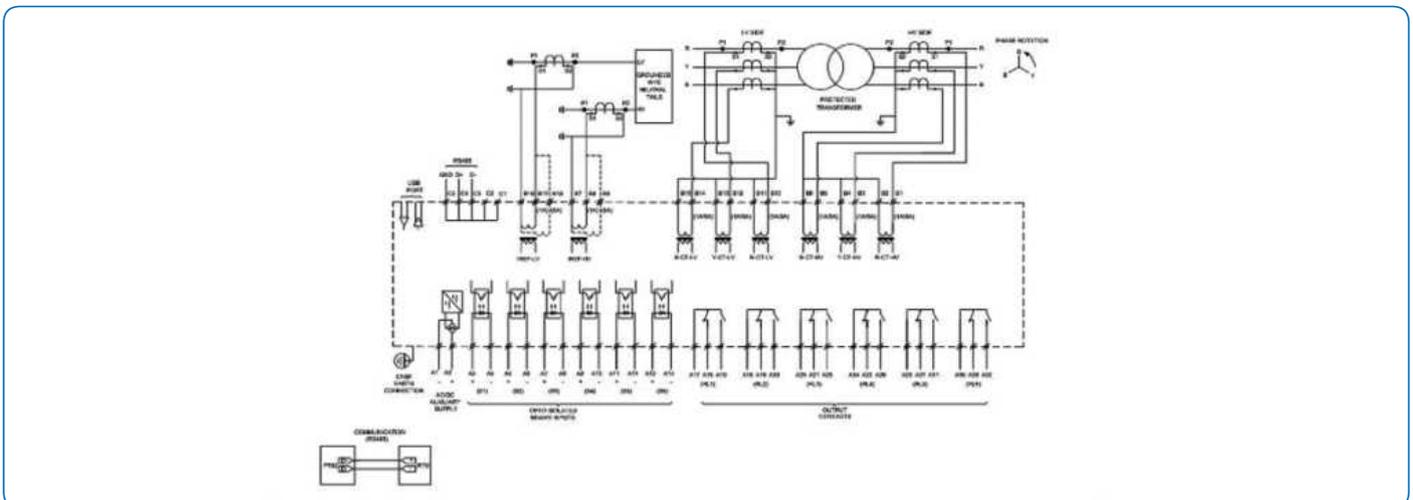


Figure 2: Restricted Earth Fault application

## Connection Diagram P652



## Relay Configuration Software

(For setting, viewing & parameterisation)

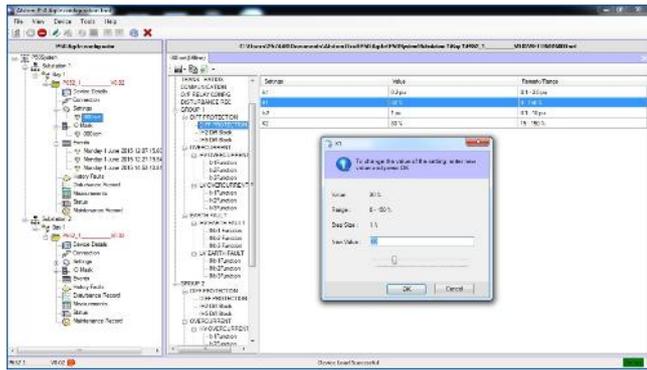


Figure 3: Relay configuration software – PC screenshot illustrating editing of a threshold

## Binary Input/Output and LED Assignment

P652 offers 6 inputs, 6 outputs and 4 programmable LEDs, with the ability to customize their assignment and function in the application scheme.

All the output contacts are changeover type and can be configured as SR (self-reset) or HR (hand reset) through the I/O configuration setting via the front panel or using the relay setting software.

## Front Panel Interface

- Eight LEDs for status indication
- Back-Lit LCD display (16x2 characters)
- Eight navigation keys for setting and interrogation

## Logic Equations

P652 supports up to 4 independent Boolean equations. Each equation offers the possibility to use an AND logical gate. Up to 12 parameters can be used for each equation. Each equation result can be time-delayed, reused in another equation or assigned to any output relays, trip, trip latching and/or HMI LEDs. This function facilitates customisation of the product based on the customer's application.

## Circuit Breaker Command

The P652 has a menu option to allow the operator to issue open/close commands to the HV and LV circuit breakers through the relay HMI.

## Communications

- Front USB port for relay access, setting and download actions.
- Rear RS485 port for SCADA communication
- Protocol options – MODBUS / IEC60870-5-103 (user selectable) or DNP3.0 (ordering option)

## Commissioning

P652 provides a suite of commissioning / maintenance assistance facilities:

- Binary input/output status monitoring
- Test mode - allows secondary injection testing to be performed on the relay without operation of the trip contacts
- Binary output contacts test
- LED test

For more information please contact  
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### Worldwide Contact Center

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