Relion 670
Relion 670 common functions

The IED shall comprise hardware, time synchronization, monitoring, communication capabilities and other specifications as described in the 1MRG033843_en_Sample_specification_General Specifications_Relion_670 document.

For a complete overview of Relion 670 series product functions available, please refer to the applicable Product Guides. For more details about the design of the functions and their applications, please refer to the Technical Manual and the Application Manual respectively.

This specification applies to the following 670 series products
REB670: Centralized busbar protection
REC670: Bay control
RED670: Line differential protection
REG670: Generator protection
REL670: Line distance protection
RES670: Wide area monitoring
RET670: Transformer protection

Common protection functions in 670 series
The functions specified in this document are common for the 670 series. Availability of a function per product type is listed in the comments under each description.

Instantaneous phase overcurrent protection
The IED shall include instantaneous phase overcurrent function for short tripping time during high fault current conditions. This shall be used as high set short-circuit protection function.

In 670 series, this function is available in the following product types: REC670, RED670, REG670, REL670 and RET670.

Directional phase overcurrent protection
The IED shall include directional overcurrent protection with at least four steps, each with separate inverse (IDMT) and definite (DT) time delay characteristics for each step. IDMT curves shall be available as specified in IEC 60255-151/IEEE C37.112, and with a user-defined time characteristic. The accuracy of the IDMT curve and the DT element shall be at least ± 2.0% or ± 35 ms whichever is greater.

The operating current shall be settable between 5 – 2,500% of the rated current (IΔ).
The function shall be set as directional or non-directional, independently for each of the steps. The directional function shall require voltage as reference quantity for polarization. To enable directional measurement at close-in faults, causing a low measured voltage, the polarization voltage shall be a combination of the apparent voltage and a memory voltage. The directionality criterion shall have an accuracy of at least ± 2.0 degrees.

Instantaneous, IEC and IEEE reset curves according to IEC 60255-151/IEEE C37.112 shall be available.

In order to avoid unwanted operation of the protection function during transformer energization, the IED shall have a restrain feature based on the second harmonic measurement. It shall be possible to set the second harmonic restrain individually for each step. It shall be possible for the IED to raise the current pick-up level with a multiplication factor by a binary input signal.

The IED shall have the option of selecting the number of phases required for operation; 1 out of 3 phases, 2 out of 3 phases, or 3 out of 3 phases.

*In 670 series, this function is available in the following product types: REB670, REC670, RED670, REG670, REL670, RES670 and RET670.*

**Instantaneous residual overcurrent protection**

The IED shall have instantaneous earth-fault protection. It shall be possible to calculate the residual current by summarizing the three phase currents or by taking the input from a neutral point CT.

*In 670 series, this function is available in the following product types: REC670, RED670, REG670, REL670 and RET670.*

**Directional residual overcurrent protection**

The IED shall include time delayed directional earth fault protection with at least 4 steps, each with inverse (IDMT) and definite (DT) time delay characteristics separately for each step. IDMT curves shall be available as specified in IEC 60255-151 / IEEE C37.112 and with a user defined time characteristic. The accuracy of the IDMT curve and the DT element shall be at least ± 2.0% or ± 35 ms whichever is greater.

It shall be possible to calculate the residual current by summing the three phase currents or by taking the input from a neutral point CT. The operating current shall be settable between 1 – 2,500% of the rated current (IR).

It shall be possible to set the function to directional or non-directional, independently for each of the steps. The polarization quantity available shall be voltage polarization, current polarization or dual polarization.

A second harmonic restrain functionality shall be available individually for each step. The second harmonic restrain can be set to seal-in until residual current disappears.

The function shall have the possibility of raising the current pick-up level with a multiplication factor by a binary input signal.

*In 670 series, this function is available in the following product types: REB670, REC670, RED670, REG670, REL670, RES670 and RET670.*

**Directional negative phase sequence overcurrent protection**

The IED shall include negative phase sequence overcurrent protection with at least 4 steps, each with inverse (IDMT) and definite (DT) time delay characteristics separately for each step. IDMT curves shall be available as specified in IEC 60255-151 / IEEE C37.112 and with a user-defined time characteristic. The accuracy of the IDMT curve operate time shall be at least ± 2.0% or ± 40 ms, whichever is greater. The accuracy of the DT element shall be at least ± 0.2 % or ± 35 ms, whichever is greater.

The operating current shall be settable between 5 – 2,500% of the rated current (IR).

It shall be possible to set the function to directional or non-directional, independently for each of the steps. The directional function shall require voltage as reference quantity for polarization. To enable directional measurement at close-in faults, causing a low measured voltage, the polarization voltage shall be a combination of the apparent voltage and a memory voltage. The directionality criterion shall have accuracy of at least ± 2.0 degrees.

Instantaneous, IEC and IEEE reset curves according to IEC 60255-151 / IEEE C37.112 shall be available. The accuracy of the IDMT curve reset time shall be at least ± 2.0% or ± 40 ms, whichever is greater.
It shall be possible for the function to raise the current pick-up level with a multiplication factor by a binary input signal.

In 670 series, this function is available in the following product types: REB670, REC670, RED670, REG670, REL670, RES670 and RET670.

**Thermal overload protection, one time constant, temperature in Celsius**

The IED shall include thermal overload protection with an $I^2t$ characteristic, a heating and cooling time constant and a thermal memory. The temperature shall be displayed in degrees Celsius. The function shall be able to measure the ambient temperature using a milliamperc input and compensate for variations. The function shall have the possibility to issue a lockout for closing the breaker until the heat content reduces below a lockout reset level setting. The heating time constant, cooling time constant, two separate alarms, warning and trip level shall be settable. The initial heat content shall be settable by the end user.

In 670 series, this function is available in the following product types: REC670, RED670, REL670, RES670 and RET670.

**Thermal overload protection, one time constant, temperature in Fahrenheit**

The IED shall include thermal overload protection with an $I^2t$ characteristic, a heating and cooling time constant and a thermal memory. The temperature shall be displayed in degrees Fahrenheit. The function shall be able to measure the ambient temperature using a milliamperc input and compensate for variations. It shall be possible for the function to issue a lockout for closing the breaker until the heat content decreases below a lockout reset level setting. The heating time constant, cooling time constant, two separate alarms, warning and trip level shall be settable. The initial heat content shall be settable by the end user.

In 670 series, this function is available in the following product types: REC670, RED670, REL670, RES670 and RET670.

**Thermal overload protection, two time constants**

The IED shall include a thermal overload protection that measures three-phase current RMS values, and calculates the projected temperature rise from the largest of the three phase currents, based on a thermal heating constant.

The function shall contain two settable heating time constants, one of which is applied when the transformer is cooled naturally, and the other one when the transformer is forcibly cooled.

The function shall be able to issue two separate alarms, a warning and a trip signal. It shall also be possible for the function to issue a lockout signal until the thermal memory is reset, based on a thermal cooling time constant. The levels for the alarms, warning, trip and the lockout shall be settable by the end user.

The initial heat content shall be settable by the end user.

In 670 series, this function is available in the following product types: REB670, REC670, REG670 and RET670.

**Breaker failure protection**

The IED shall include breaker failure protection, to ensure fast backup tripping of the surrounding breakers in case the own breaker fails to open. It shall be current-based, contact-based or an adaptive combination of these two conditions. A current check with an extremely short reset time shall be used in order to achieve high security against unwanted operation. The reset time shall be 15ms maximum.

The operating current shall be settable between 5 – 200% of the rated current ($I_r$). The accuracy of the operating current shall be at least ± 1.0% of $I_r$.

A contact check criterion can be used where the fault current through the breaker is small. Breaker failure protection shall be single or three-phase initiated. Initiation shall be from an internal or external protection trip signal. The start signal can be phase selective or general (for all three phases).

Phase selective start signal shall enable a single pole retrip function. The retrip function can be done with or without current check and also with or without contact position check. With the current check, the retrip shall only be performed if the current through the circuit breaker is larger than the set operating current level. The retrip timer shall be settable.
A backup trip shall be initiated if the current and/or contact detection has not detected the breaker opening before the back-up timer has elapsed. The timers for the backup trip and the second back up trip shall be settable. The circuit breaker failure function shall be single or three phase initiated to allow use with single phase tripping applications.

In 670 series, this function is available in the following product types: REB670, REC670, RED670, REG670, REL670 and RET670.

**Stub protection function**

The IED shall include stub protection which covers the zone between the current transformers and the open disconnector in multi-breaker arrangements. Stub protection shall be a phase overcurrent protection, fed from the two current transformer groups feeding the object taken out of service. The three-phase instantaneous overcurrent function shall be activated only from an auxiliary contact.

The operating current shall be settable between 5 – 2,500% of the rated current (Iₚ).

In 670 series, this function is available in the following product types: REC670, RED670, REL670 and RET670.

**Pole discordance protection function**

The IED shall include pole discordance protection. The function shall operate based on information from auxiliary contacts of the circuit breaker for the three phases, with additional criteria from unsymmetrical phase currents when required. Each phase current through the circuit breaker shall be measured.

If the difference between the phase currents is larger than the set unsymmetrical phase current threshold, this is an indication of pole discordance, and the protection shall operate. The operating current shall be settable between 0 – 100% of the rated current (Iₚ).

In 670 series, this function is available in the following product types: REC670, RED670, REG670, REL670 and RET670.

**Under-power protection function**

The IED shall include a directional under-power protection function with at least two steps. The function shall be able to check the direction of active or reactive power flow in the power system. The operating power shall be settable between 0 – 500% of the rated power (Sᵣ). The accuracy of the operating power shall be at least ± 1.0% of Sᵣ.

It shall be possible to use the function for forward or reverse directional applications by selecting an appropriate characteristic angle setting. The directionality criterion shall have an accuracy of at least ± 2.0 degrees.

The IED shall have a definitive time delay (DT) setting for delayed tripping. The accuracy of the DT element shall be at least ± 0.2 % or ± 40 ms, whichever is greater.

This function is available in the following product types: REB670, REC670, RED670, REG670, REL670, RES670 and RET670.

**Over-power protection function**

The IED shall include a directional over-power protection function with at least two steps. The function shall be able to check the direction of active or reactive power flow in the power system. The operating power shall be settable between 5 – 500% of the rated power (Sᵣ). The accuracy of the operating power shall be at least ± 1.0% of Sᵣ.

It shall be possible for the function to be used for forward or reverse directional applications by selecting an appropriate characteristic angle setting. The directionality criterion shall have an accuracy of at least ± 2.0 degrees.

The IED shall have a definitive time delay (DT) setting for delayed tripping. The accuracy of the DT element shall be at least ± 0.2 % or ± 40 ms, whichever is greater.

This function is available in the following product types: REB670, REC670, RED670, REG670, REL670, RES670 and RET670.

**Two-step undervoltage protection function**

The IED shall include undervoltage protection with at least two steps, each with inverse or definite time delay. The accuracy of the time delay element shall be at least ± 0.2 % or ± 40 ms, whichever is greater.
The operating voltage shall be settable between 1.0 – 100.0% of the rated voltage (U_r). The function shall have a settable reset ratio. The absolute hysteresis shall be settable between 0.0 and 50.0% of U_r. The hysteresis shall have an accuracy of at least ±0.5% of U_r.

The undervoltage protection function shall have the option of selecting the number of phases required for operation as 1 out of 3, or 2 out of 3, or 3 out of 3.

In 670 series, this function is available in the following product types: REB670, REC670, RED670, REG670, REL670, RES670 and RET670.

**Two-step overvoltage protection function**

The IED shall include overvoltage protection with at least two steps, each with inverse or definite time delay. The accuracy of the time delay element shall be at least ± 0.2 % or ± 45 ms, whichever is greater.

The operating voltage shall be settable between 1.0 – 200.0% of the rated voltage (U_r). The function shall have a settable reset ratio. The absolute hysteresis shall be settable between 0.0 and 50.0% of U_r. The hysteresis shall have an accuracy of at least ± 0.5% of U_r.

The overvoltage protection function shall have the option of selecting the number of phases required for operation as 1 out of 3, or 2 out of 3, or 3 out of 3.

In 670 series, this function is available in the following product types: REB670, REC670, RED670, REG670, REL670, RES670 and RET670.

**Two-step residual overvoltage protection function**

The IED shall include residual overvoltage protection with at least two steps, each with inverse or definite time delay. The function shall be able to calculate the residual voltage from a three-phase voltage input transformer, or measure it directly from a single voltage input transformer fed from an open delta or neutral point voltage transformer.

The operating voltage shall be settable between 1.0 – 200.0% of the rated voltage (U_r). The function shall have a settable reset ratio. The absolute hysteresis shall be settable between 0.0 and 50.0% of U_r. The hysteresis shall have an accuracy of at least ± 0.5% of U_r.

The overvoltage protection function shall have the option of selecting the number of phases required for operation as 1 out of 3, or 2 out of 3, or 3 out of 3.

In 670 series, this function is available in the following product types: REB670, REC670, RED670, REG670, REL670, RES670 and RET670.

**Voltage differential protection function**

The IED shall include voltage differential monitoring, which shall compare the voltages from two three-phase sets of voltage transformers and shall offer an alarm step and a trip step with a definite time delay (DT). The accuracy of the time delay element shall be at least ± 0.2 % or ± 40 ms, whichever is greater.

The voltage difference for alarm and trip shall be settable between 2.0 and 100.0% of U_r.

This function is available in the following product types: REB670, REC670, RED670, REG670, REL670 and RET670.

**Loss-of-voltage check function**

The IED shall include a loss-of-voltage check. This function shall issue a three-pole trip command to the circuit breaker if all three-phase voltages fall below the set value for a time interval longer than the set time, and the circuit breaker remains closed. The operate time delay shall be settable. The accuracy of the operate time delay element shall be at least ± 0.2 % or ± 35 ms, whichever is greater.

The function shall include a time delay for enabling the function after restoration, which shall be settable. The accuracy of the time delay element shall be at least ± 0.2 % or ± 35 ms, whichever is greater.

The operation of the loss-of-voltage check function shall be supervised by the fuse failure supervision.

In 670 series, this function is available in the following product types: REB670, REC670, RED670, REL670 and RET670.
**Underfrequency protection function**

The IED shall include underfrequency protection. The function shall have separate definite time delays for operate and reset, and shall be provided with undervoltage blocking. The operation shall be based on positive sequence voltage measurement and require two phase-phase or three phase neutral voltages to be connected.

The operate value shall be settable between 35.00 and 75.00 Hz. The accuracy of the operate element shall be ± 2.0 mHz. The start time at \( f_{set} + 0.02 \) Hz to \( f_{set} - 0.02 \) Hz shall reliably be below 95ms for 50Hz, and 80ms for 60Hz.

The operate time delay shall be settable. The accuracy of the operate time delay element at \( f_{set} + 0.02 \) Hz to \( f_{set} - 0.02 \) Hz shall be at least ± 0.2 % or ± 100 ms, whichever is greater.

The reset time delay shall be settable. The accuracy of the reset time delay element at \( f_{set} + 0.02 \) Hz to \( f_{set} - 0.02 \) Hz shall be at least ± 0.2 % or ± 120 ms, whichever is greater.

In 670 series, this function is available in the following product types: REB670, REC670, RED670, REG670, REL670, RES670 and RET670.

**Overfrequency protection function**

The IED shall include overfrequency protection. The function shall have separate definite time delays for operate and reset, and shall be provided with undervoltage blocking. The operation shall be based on positive sequence voltage measurement and require two phase-phase or three phase neutral voltages to be connected.

The operating value shall be settable between 35.00 and 75.00 Hz. The accuracy of the operating element shall be ± 2.0 mHz. The start time at \( f_{set} + 0.02 \) Hz to \( f_{set} - 0.02 \) Hz shall reliably be below 95ms for 50Hz, and 80ms for 60Hz.

The operate time delay shall be settable. The accuracy of the operate time delay element at \( f_{set} + 0.02 \) Hz to \( f_{set} - 0.02 \) Hz shall be at least ± 0.2 % or ± 100 ms, whichever is greater.

The reset time delay shall be settable. The accuracy of the reset time delay element at \( f_{set} + 0.02 \) Hz to \( f_{set} - 0.02 \) Hz shall be at least ± 0.2 % or ± 120 ms, whichever is greater.

In 670 series, this function is available in the following product types: REB670, REC670, RED670, REG670, REL670, RES670 and RET670.

**Rate-of-change of frequency protection function**

The IED shall include rate-of-change of frequency protection. The function shall be used to detect fast power system frequency changes at an early stage as an indication of a main disturbance in the system. The operation shall be based on positive sequence voltage measurement, and requires two phase-phase or three phase-neutral voltages to be connected.

The operating value shall be settable between -10.00 and 10.00 Hz/s. The accuracy of the operating element shall be ± 10.0 mHz/s.

The operating time delay shall be settable. The accuracy of the operating time delay element shall be at least ± 0.2 % or ± 120 ms, whichever is greater.

The reset time delay shall be settable. The accuracy of the reset time delay element shall be at least ± 0.2 % or ± 250 ms, whichever is greater.

This function shall discriminate between a positive or negative rate of change of frequency. A definite time delay shall be provided with an undervoltage blocking, in order to avoid an unwanted trip due to uncertain frequency measurement at low voltage magnitude. If the frequency recovers, a restore signal shall be issued. The restoration time delay shall be settable. The accuracy of the restoration time delay element shall be at least ± 0.2 % or ± 100 ms, whichever is greater.

In 670 series, this function is available in the following product types: REB670, REC670, RED670, REG670, REL670, RES670 and RET670.

**High-impedance differential protection**

The high-impedance differential protection function shall be used when the involved CT cores have the same turn ratios and similar magnetizing characteristics. It shall utilize an external summation of the currents in the
interconnected CTs, a series resistor and a voltage-dependent resistor which are mounted externally and connected to the IED. The vendor shall be able to offer the external resistor unit. The function shall provide single-phase differential protection. A separate low-level alarm with an independent time delay is included.

In 670 series, this function is available in the following product types: REC670, RED670, REG670, REL670 and RET670.

**Synchrophasor measurements**

The IED shall support synchrophasor measurement and reporting phasors.

The IED shall support the following IEEE synchrophasor standards:

- IEEE 1344-1995 (both measurements and data communication)
- IEEE Std C37.118-2005 (both measurements and data communication)
- IEEE Std C37.118.1--2011 and C37.118.1a-2014 (measurements)
- IEEE Std C37.118.2-2011 (data communication)

The IED shall stream phasors as rectangular and/or polar values.

The IED shall stream phasors as single phase and/or symmetrical components.

The IED shall be able to calculate units such as active and reactive power for streaming as analog values.

The synchrophasor reporting rates shall be: 10-200 fps (50 Hz), 10-240 fps (60Hz).

The IED shall be able to perform synchrophasor reporting for up to 8 clients over TCP and/or 6 UDP group clients for multicast or unicast.

The IED shall be able to report synchrophasors for analog quantities that are obtained via conventional analog measurements or IEC 61850 9-2LE sampled values.

*Number of synchrophasor measurements per product type:*

- REC670: up to 32 synchrophasors
- RET670: up to 24 synchrophasors
- REG670: up to 16 synchrophasors
- REL670: up to 8 synchrophasors
- RED670: up to 8 synchrophasors
- REC670: up to 8 synchrophasors