SAMPLE SPECIFICATIONS

REB670

REB670 typical 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 the common protection, control, monitoring functionalities please refer to 1MRG033842_en_Sample_specification_Common_functions_Relion_670 document.

The IED shall support protection and control functionality. Control functionalities are described in 1MRG033840_en_Sample_specification_Bay_control_REC670.

For a complete overview of the functions available in this device, please refer to the Product Guide. For more details about the design of the functions and their applications, please refer to the Technical Manual and the Application Manual respectively.

General description for busbar protection

The IED shall be applicable for installation in medium-voltage (MV), high-voltage (HV) and extra high-voltage (EHV) substation installations at a power system frequency of 50Hz or 60Hz. The IED shall have phase-segregated measurement and provide fast and selective protection for the protected object. The IED shall be dynamically adaptable to most common busbar configurations and should be capable of efficient merging of differential zones when required by substation topology during zone interconnection or during load-transfer conditions. The built-in software-based zone selection shall provide dynamic linking between CT inputs and differential protection zones, while selectively routing back zone trip signals to individual bay circuit breakers. The IED shall be able to include or exclude measured currents from differential zones, and the differential protection is integrated with so-called dynamic zone selection to adapt dynamically to the changing topology of the substation for multi-zone applications.

The IED shall be intended for protection and monitoring of busbar, T-connection and meshed corner, and shall provide selective, reliable and fast fault clearance for all types of internal phase-to-phase and phase-to-earth faults in solidly earthed or low-impedance earthed power systems, as well as all internal multi-phase faults in isolated or high-impedance earthed power systems. For detection of earth-faults in low impedance grounded systems, the IED shall include a separate sensitive differential protection which should, for example, be released from open delta voltage, and be blocked at heavy phase to phase faults. In high impedance grounded systems, the IED shall detect multi-phase faults. The IED shall be equipped with differential element measuring zones and a check zone as well as the possibility of integrating breaker failure protection and end-fault protection for every CT input. It shall be possible to select the CTs which should be connected to the check zone and it shall also be possible, by setting, to switch off the check zone. The IED shall have an option to connect VT inputs for enabling voltage-based protections and directional features.

IED requirements on the main current transformers shall be low, and no interposing CT shall be necessary. It shall be possible to have a ratio difference of up to ten for the CTs connected to the same protection zone. No switching in CT secondary circuits is allowed. The IED shall include a function for fast detection of open or shorted CT secondary circuits and it shall be possible to set the function to block the differential protection zone, or to switch it off. The relay shall have an automatic detection feature, and selective busbar protection blocking for trouble in CT secondary circuits.

Zone selection should also handle load transfer for double busbars and the routing of trip commands from differential protection and breaker failure backup trips to all breakers connected to the fault zone. Selective operation of busbar differential protection will ensure tripping of only the faulty part of the busbar system. The operate time for internal faults shall be typically below 15 ms, and the differential protection shall be stable for through faults even at heavy CT saturation, and also at maximum remanence in a CT core and during auto-reclosing. The breaker failure protection shall have fast resetting, allow single- and/or three-phase start-
The busbar protection shall include the following features:

- **Busbar differential protection**
  
  The IED shall contain busbar differential protection of the low impedance type. The IED shall be used for protection of a single, double and triple busbar with or without transfer bus, double-circuit breaker or one-and-a-half circuit breaker stations. The IED shall be designed for selective, reliable and fast differential protection of the busbar scheme. The busbar protection shall be flexible, with software-based dynamic zone selection for easy and fast adaptation to various busbar arrangements, and should be provided with a restrain feature. It should be able to support acquiring currents from both conventional type CTs, or via merging units. It shall also be able to easily integrate with conventional or digital substations.

  The IED shall include an internal, permanent memory-based disconnector replica logic and bay tripping logic. Supervision of disconnector status shall be included, and an alarm signal shall be issued after a settable time delay in case of a deviating position for the primary contact. The IED shall have a software-based zone selection. It shall also be possible protect with only one set of CTs at the bus section, or at the bus-coupler.

  The offered relay shall support a maximum of up to:

<table>
<thead>
<tr>
<th>1 device</th>
<th>Two zones, three phase 8 bays, 1 device solution</th>
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<tbody>
<tr>
<td>3 devices</td>
<td>Up to six zones, single phase 24 bays, 3 devices (as per scheme requirement)</td>
</tr>
<tr>
<td></td>
<td>Two zones, single phase 24 bays, 3 devices</td>
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  The busbar differential protection function should consist of a differential protection algorithm; a sensitive differential protection algorithm; a check zone algorithm; an open CT algorithm and two supervision algorithms; selective tripping for the busbar and breaker failure protection. The adaptation for different CT ratios should be supported by the offered relay.

  The IED shall be able to handle analog quantities that are obtained via conventional analog measurements or IEC 61850 9-2LE sampled values. The conventional analog measurements and IEC 61850 9-2LE sampled values can be combined in the same device.

- **Differential protection**

  The IED shall be based on the well-proven percentage restraint stabilization principle, with an extra stabilization feature to deal with very heavy CT saturation. Stability for external faults shall be guaranteed if a CT is not saturated for at least two milliseconds during each power system cycle. All current inputs shall be indirectly provided with a restraint feature. The busbar differential protection function shall be intended for fast and selective tripping of faults within the protected zones. The busbar differential protection function shall operate based on the difference between incoming and outgoing current. The zone association status of each bay CT can also be monitored from the local HMI.

- **Sensitive differential busbar protection**

  The IED shall have sensitive differential protection to detect internal busbar earth faults in low impedance earthed power systems (i.e. power systems where the earth fault current is limited to a certain level, typically between 300A and 2000A primary by a neutral point reactor or resistor). For increased security, the sensitive differential protection must be externally enabled by a binary signal (e.g. start signal from external open delta VT overvoltage relay or external power transformer neutral point overcurrent relay). It shall
have an option to set time delay before the trip signal from the sensitive differential protection is issued. This sensitive level can be alternatively used in special applications when high sensitivity is required from busbar differential protection (i.e. energizing of dead bus via a long line).

Operation and operating characteristics of the sensitive differential protection shall be set independently from the operating characteristics of the main differential protection. However, the sensitive differential level shall be blocked as soon as the total incoming current exceeds the preset level, or when differential current exceeds the set minimum pickup current for the usual differential protection. Therefore, by appropriate settings it can be ensured that this sensitive level is blocked for all external multiphase faults, which can cause CT saturation.

- **Check zone**

  The IED shall have an integrated overall differential zone, a so-called check zone as an inbuilt feature to secure the stability of the busbar differential protection mainly for multiple busbar stations. At the same time, this check zone feature shall avoid unwanted operation of the differential protection scheme. The built-in check zone current measurement shall not be dependent on the disconnector status; this feature shall ensure stability of busbar differential protection even for completely wrong status indication from the busbar disconnectors, or in the event of problems with disconnector auxiliary contacts, or wiring problems. The overall check zone shall only supervise the usual differential protection operation. The external trip commands, breaker failure backup-trip commands and sensitive differential protection operation are not supervised by the overall check zone. The overall check zone shall have a simple current operating algorithm, which ensures the check zone operation for all internal faults regardless of the fault current distribution. The check zone operation principle shall have a slightly different operating characteristic from the usual discriminating zones. The outgoing currents shall be used as stabilizing current instead of total incoming current, in order to guarantee check zone operation for all possible operating conditions in the station.

  The check zone minimum differential operational level shall be kept equal to or less than the corresponding operating level of the usual discriminating zones. The check zone operation shall have the option to activate externally by a binary signal. The inbuilt check zone feature shall be more essential for busbar protection in stations with double or triple busbars when dynamic zone selection is needed.

- **Open CT detection**

  The IED shall have an innovative measuring algorithm to provide stability during open or short-circuited main CT secondary circuits. Start current level for open CT detection can usually be set to detect the open circuit condition for the smallest CT. The IED shall have slow and fast algorithms to prevent false open CT conditions during abnormalities in the CT secondary circuits. The built-in feature allows the protection to be set at a very sensitive level, and even to a lower value than the maximum CT primary rating in the station. The differential protection can be instantly blocked and an alarm given if problems are detected in CT secondary circuits. Alternatively, the differential protection can be automatically desensitized in order to ensure busbar differential protection stability during normal through-load condition. When problems in CT secondary circuits have been found and associated error has been corrected, the IED shall have provision to manually reset the open CT alarm condition, directly from the local HMI or from the binary input or communication link.

- **Differential protection supervision**

  Dual monitoring of differential protection status is available. The first monitoring feature operates after settable time delay when differential current is higher than the user settable level. For example, this feature can be used to design automatic reset logic for the previously described open CT detection feature. The second monitoring feature operates immediately when the busbar through-going current is bigger than the user settable level. Both of these monitoring features are phase segregated and they give out binary signals, which can either be used to trigger the disturbance recorder, or for alarm purposes.

- **Zone selection**

  Typically, all CT secondary circuits from every bay in the station are connected to the busbar protection. The IED shall have a built-in software feature called “zone selection,” which provides simple but efficient control over the connected CTs to the busbar protection IED in order to supply a fully operational differential protection scheme for multi-zone applications on both small and large buses.
Switch status monitoring

The IED shall have inbuilt switch status monitoring. The information about the busbar disconnector position in every bay is crucial information for busbar protection for stations with complex primary layout. The positions of these disconnectors actually determine which CT input (that is, bay) is connected to which differential protection zone. For some more advanced features, such as end-fault or blind-spot protection, the actual status of the circuit breaker in some or even all bays can be vital information for busbar protection as well. The switch function block shall be used to take the status of two auxiliary contacts from the primary device, evaluate them and then deliver the device primary contact position to the rest of the zone selection logic. For such applications typically two auxiliary contacts (that is, normally open and normally closed auxiliary contacts) from each relevant primary switching object shall be connected to the IED, and then the status for every individual primary switching object will be determined. The IED shall have a time-delayed disconnector/circuit breaker status supervision alarm. The behavior of integrated differential protection zones when the disconnector alarm appears shall be freely configurable in the IED. It shall be possible by a parameter setting to override the primary object status as either permanently open or permanently closed.

Bay functionality

The IED shall have option for each CT input to be allocated to one dedicated bay function block. This function block shall be used to provide complete user interface for all signals from and towards this bay. It shall be used to influence bay measured current. It shall have the option in parameter settings or in the dedicated logical scheme for selected CT connection to either connect or disconnect the CT input in the bay function block; hence, the associated differential functions evaluate the current information accordingly. This shall be applicable for simple substation layouts like one-and-a-half breaker stations, or double busbar stations.

The IED shall have various options for each bay feeder CT to include, exclude, invert or permanently connect to a respective zone, or for each bay the end user shall select one of the following five alternatives:

- permanently connect this bay current to zone A (that is, ZA)
- permanently connect this bay current to zone B (that is, ZB)
- permanently connect this bay current to zone A and inverted bay current to ZB (that is, ZA and -ZB)
- connect this bay current to ZA or ZB depending on the logical status of the two input binary signals available on this bay function block; these two input signals will include measured current to the respective zone when their logical value is one; this option is used together with above described switch function blocks in order to provide complete zone selection logic
- connect the bay current to ZA or ZB, depending on the logical status of the two input binary signals available on this bay function block; these two signals will include measured current to the respective zone when their logical value is zero (control excludes); this option is typically used when only normally closed auxiliary contacts from the busbar disconnector are available to the zone selection logic

The IED shall incorporate an additional feature for instantaneous or time-delayed disconnection or even inversion of the connected bay current via a separate logical signal. This feature shall be provided in order to facilitate bus-section or bus-coupler CT disconnection for tie-breakers with a CT on only one side of the circuit breaker. This feature shall ensure correct and fast fault clearance of faults between the CT and the circuit breaker within these bays. The IED shall offer the best possible coverage for these special faults between CT and circuit breaker in feeder and bus-section/bus-coupler bays.

The same feature can be individually used in any feeder bay to optimize busbar differential protection performance, when the feeder circuit breaker is open. Thus, the end-fault protection for faults between the circuit breaker and the CT is available. However, to use this feature circuit breaker auxiliary contacts and closing command to the circuit breaker shall be wired to the binary inputs of the IED.

For six zone busbar differential protection, the IED shall support low impedance differential protection for up to six zones in complex application layouts. In general, six zone busbar differential protection shall be applicable for systems with following restrictions:

- can provide protection and monitoring for up to six freely configurable zones
- protection and monitoring for up to 24 freely configurable single-phase CT inputs

For busbar IED configuration, six types of function blocks are available:

- up to six independent protection zones
- up to 24 CT inputs (depends on selected IED hardware)
- up to 24 feeder bays
- up to five bus interconnector (i.e. bus-ties) bays
- one check zone function
- **End-fault protection**
  
  Due to CT locations in feeder bays, busbar protection will detect all primary faults located within the measuring boundary determined by CT locations; however, its operation will only completely clear faults within the clearing boundary determined by CB locations. Obviously, the primary faults between these two boundaries do pose certain practical problems. The IED shall have an end-fault feature to identify and trip for faults occurring between the CT and CB, for applications where the CT is located after the CB.

- **Zone interconnection (load transfer)**
  
  The IED shall have a feature of zone interconnection. When this feature is activated, the two integrated differential protection zones shall merge into one common overall differential zone. This feature shall be applicable in double busbar stations, when in any of the feeder bays both busbar disconnectors are closed at the same time (that is, load transfer). This feature can be started automatically (when the zone selection logic determines that both busbar disconnectors in one feeder bay are closed at the same time), or externally via dedicated binary signal. If this feature is active for long, the IED shall issue an alarm signal at pre-set time.

*This function is available only in REB670.*