The IED shall comprise hardware, time synchronization, monitoring, communication capabilities and other specifications as described in the 1MRG033852_en_Sample_specification_General_specifications_Relion_650 document. For the common protection, control, monitoring functionalities please refer to 1MRG033851_en_Sample_specification_Common_functions_Relion_650 document.

The IED shall support protection and control functionality. Control functionalities are described in 1MRG033849_en_Sample_specification_Bay_control_REC650.

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.

The functions listed below are most typically specified in RED650, but are available for selection in other types as well, as per the comments under each description.

### Line differential protection for up to three line ends

The IED shall include line differential protection with four separate CT inputs, applicable for two line end or three line end applications.

For applications with more than two line ends, the protection shall have the possibility of applying a master-master principle or a master-slave principle:

- in a master-slave principle, only one IED has all analog data available and only one IED will perform the program code
- in a master-master principle, all IEDs at the different ends of the protected zone have all analog data available and will all execute exactly the same program code; for the master-master principle, if one of the communication links is lost, the protection shall automatically switch to the master-slave principle

The line differential protection characteristic shall contain three sections; the first shall have the constant operating level independent from the bias current, while the other two sections shall have settable slopes; the minimum operating differential current as well as the section ends shall be freely settable.

The line differential protection characteristic shall have a settable temporary threshold level, with a settable time duration to desensitize for transient charging currents during switching on the line.

The line differential protection shall have a settable threshold for unrestrained operation. The unrestrained operation shall be dependent solely on the differential current exceeding this set limit.

It shall be possible for the line differential protection to add time delay to a lower part of the characteristic, which shall be defined by a parameter setting. Time delay shall be settable by a parameter setting, either as an inverse characteristic, or as definite time.

If a substantial amount of the second or fifth harmonic is detected, the restrained operation of the function shall be blocked. The levels of second or fifth harmonic required for blocking the operation shall be settable by the end-user.

The line differential protection shall have the negative sequence internal/external fault discriminator, with settable operating angle, and with settable minimum required negative sequence current level.
It shall be possible for the line differential protection to calculate and report the negative sequence differential current magnitude, as well as calculate and report the angle between local and remote negative sequence currents.

Open CT detection shall be available, with the possibility of either blocking operation of the line differential protection and issuing an open CT condition alarm, or only issuing an open CT condition alarm and not preventing the line differential protection from operating.

The line differential protection shall have an algorithm for charging current compensation, with the possibility of reporting the amount of compensated charging current. The activation of charging current compensation shall be settable by a parameter.

It shall also be possible for the line differential protection to include up to two, two-winding power transformers or one, three-winding power transformer in the line differential protection zone. All in-zone transformers shall be correctly represented in the algorithm with rated voltage per winding and vector group compensations. These values shall be settable in the parameter settings. Zero sequence current elimination shall also be available in the parameter settings.

Communication module for line differential protection:

The IED shall support remote-end communication for transfer of up to 3 analog signals and 8 binary signals in each direction simultaneously using one communication module in each IED, utilizing the IEEE/ANSI C37.94 standard format.

The remote-end communication module using ANSI/IEEE C37.94 communication protocol shall be applicable for the following distances, with the speed of 64 kbit/s:

- up to 3 km using multi-mode fiber
- up to 80 km using single-mode fiber

In 650 series, this function is available only in RED650.