ARCTEQ
PART OF ENSTO GROUP

Application Note

Line differential protection

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1 DOCUMENT INFORMATION

This document uses the following notation for the various sections in the AQtivate 200 configuration and setting software as well as the keyboard:

- Navigation paths are in italics (e.g. *Tools → Events and Logs → Event History*).
- Buttons and keys are in bold (e.g. the **Enter** key).
- AQtivate 200 main menus are in all caps (e.g. the PROTECTION menu).
- Tabs are in italics (e.g. the *Line Protection Module* tab).
- Section names within tabs are in single quotation marks (e.g. the 'CB control block' support functionality)
- Parameter names are in bold and italics (e.g. the ***Master node status*** parameter).
- Parameter drop-down menu items and text values are in double quotation marks (e.g. "Sub-unit").

Additionally, this document uses the following notices, cautions, and warnings to highlight information that is especially important for the user.

Table 1. *Highlighting symbols that can be used in this document.*

Symbol	Description
	**NOTICE!** These messages indicate relevant factors and conditions to the concept discussed in the text, as well as other relevant advice.
	**CAUTION!** These messages indicate a potentially hazardous situation which, if not avoided, could result in personal injury, equipment/property damage, or software corruption.
	**DANGER!** These messages indicate a hazardous situation which, if not avoided, could result in serious personal injury or death.

2 INTRODUCTION

This document provides technical guidance and walks you through the configuration process of a line differential protection device. Line differential protection is a highly effective method for detecting faults on transmission lines by comparing current measurements at both ends of the line.

In this application note we will guide you step by step through the setup process, parameter settings, and key considerations to ensure accurate and reliable operation. By the end, you will have a clear understanding of how straightforward it is to configure Arcteq's line differential models.

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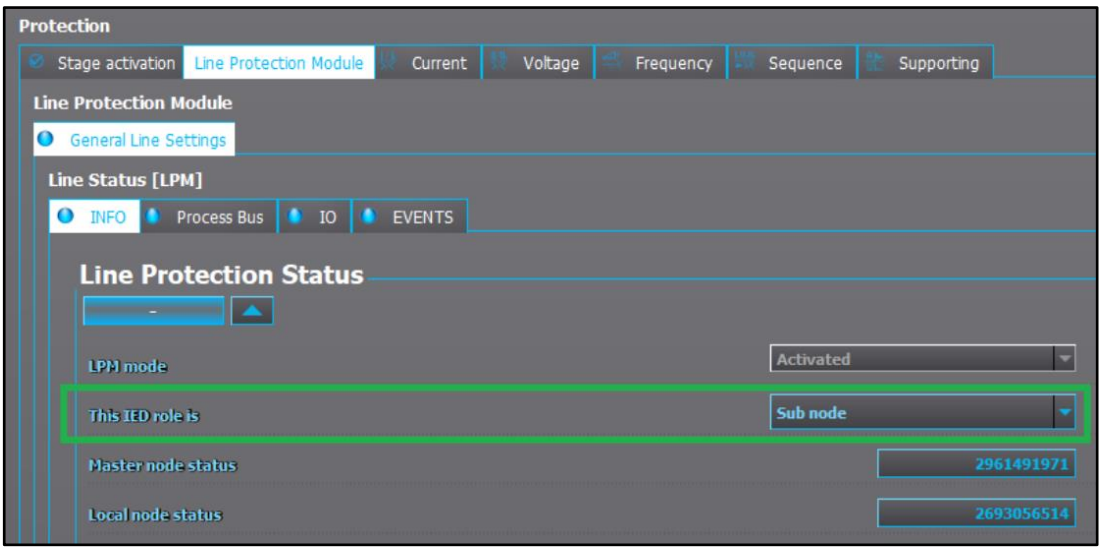
3 UNIT COMMUNICATION

NOTICE!
Role assignment will invoke a protection reset in both devices!

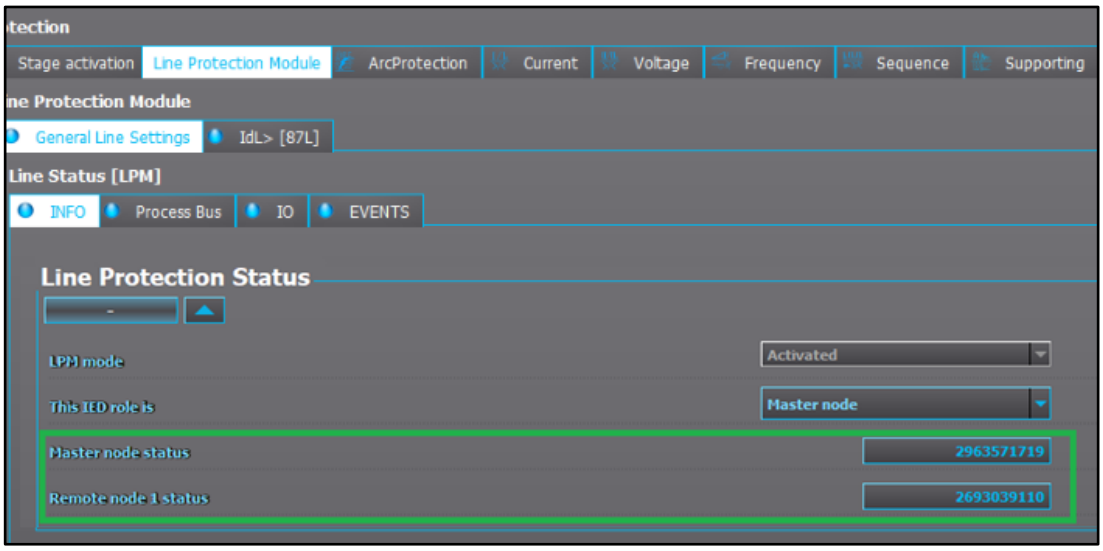
In AQtivate 200, open the sub-unit's PROTECTION menu and activate the line differential stage in the *Stage activation* tab. Then, open the *Line Protection Module* tab and select the *INFO* tab. Change the ***This IED role is*** parameter to "Sub node" (see Figure 1 below).

Figure 1. *Location of the device role assignment in AQtivate 200.*



Next, open the master unit in AQtivate 200. Use the same path to change its ***This IED role is*** parameter to "Master node". After both relays have rebooted, open the status window for both nodes to check the status (see Figure 2 on the following page). Please note that the status of both nodes can be checked from the master node!

Figure 2. *Location of the device status.*



Pressing the parameter values opens a pop-up window for the status signals. The status window for the master node should have the signals “Master node” and “Communication Ok” active, marked with a green circle. Similarly, the sub-node status should show “Communication Ok” as active. Please refer to the figures below:

Figure 3. *Post-reboot status for the master node.*

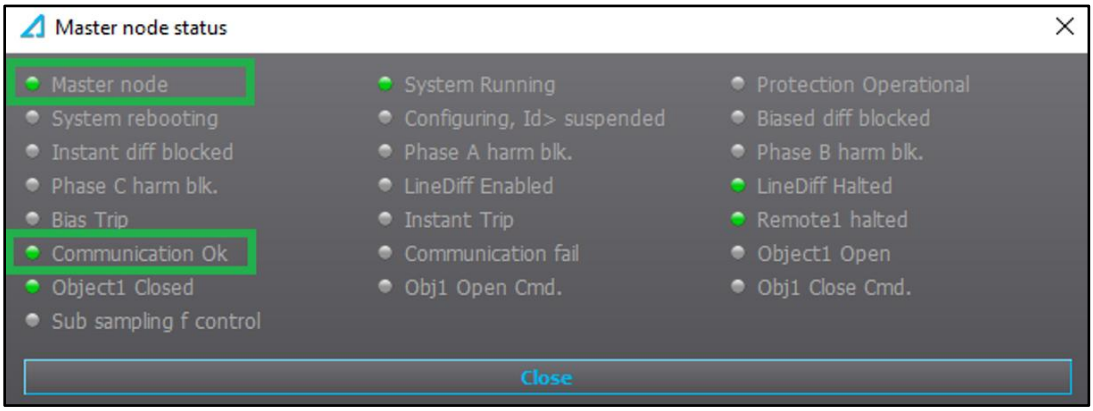
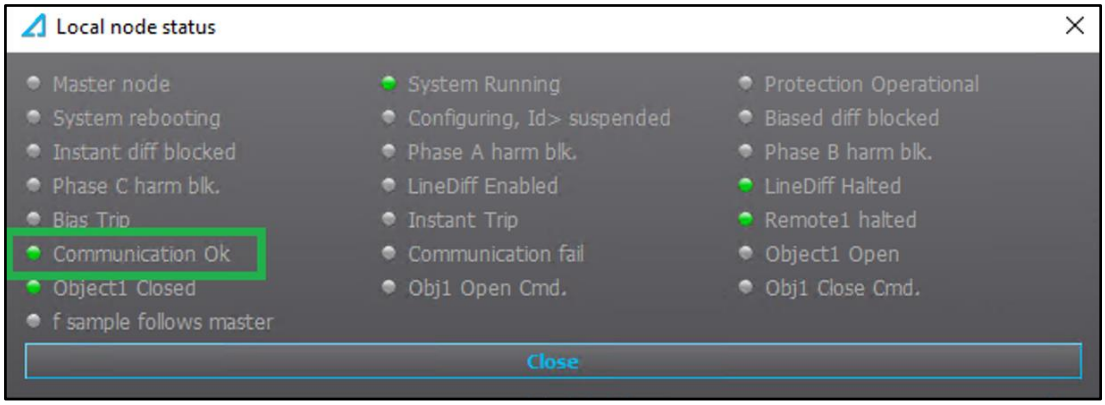


Figure 4. *Post-reboot status for the sub-node.*



4 PROTECTED OBJECTS IN LINE (OPTIONAL INLINE TRANSFORMER)

All configuration of the general line settings is done on the master node, and no changes are required in the configuration of the sub-node.

The configuration mode is enabled in the master node by default, and protection is halted on both devices (see Figure 5 below). Additionally, AQtivate 200 assumes that the protected zone only includes the line (see Figure 6 further below).

Figure 5. *Configuration is enabled by default.*

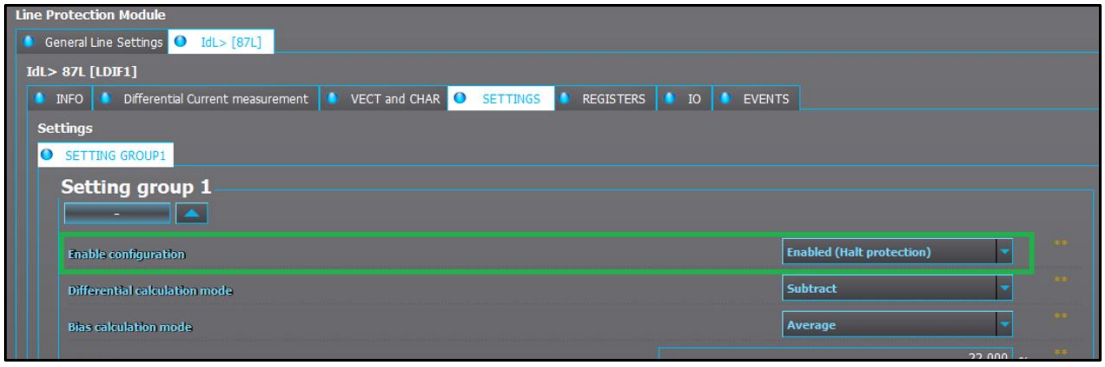


Figure 6. *Only line is in protected zone by default.*

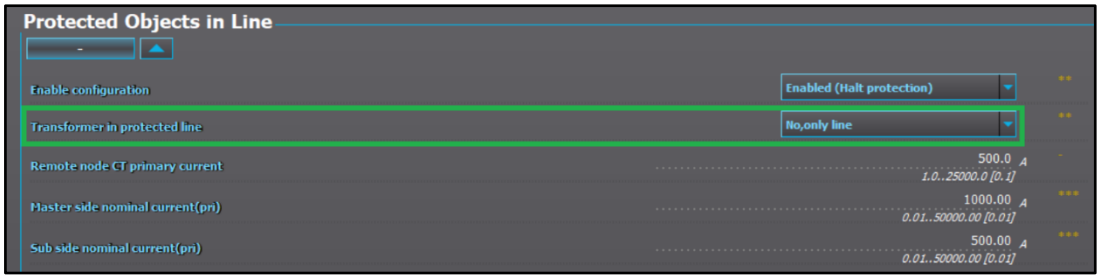
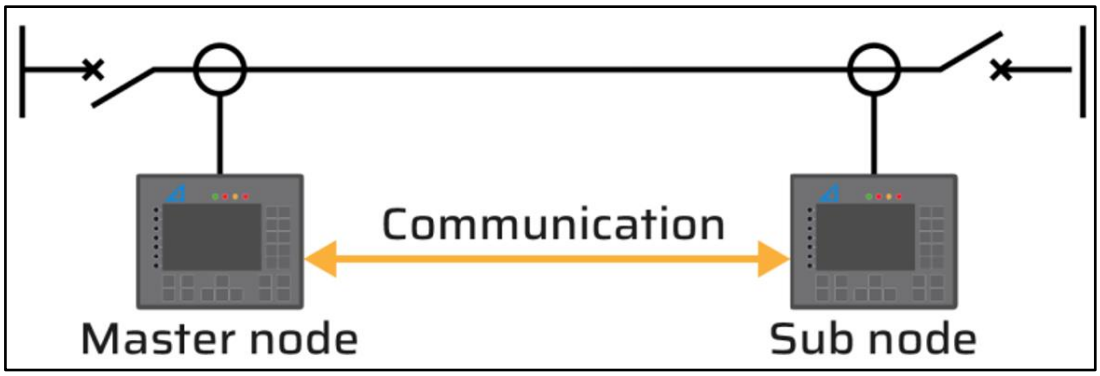


Figure 7. *Protected zone with only a line.*



If your application includes an inline transformer, as in Figure 8 below, you can set the transformer's parameters in AQtivate 200 (see Figure 9 further below):

Figure 8. *Protected zone with an inline transformer.*

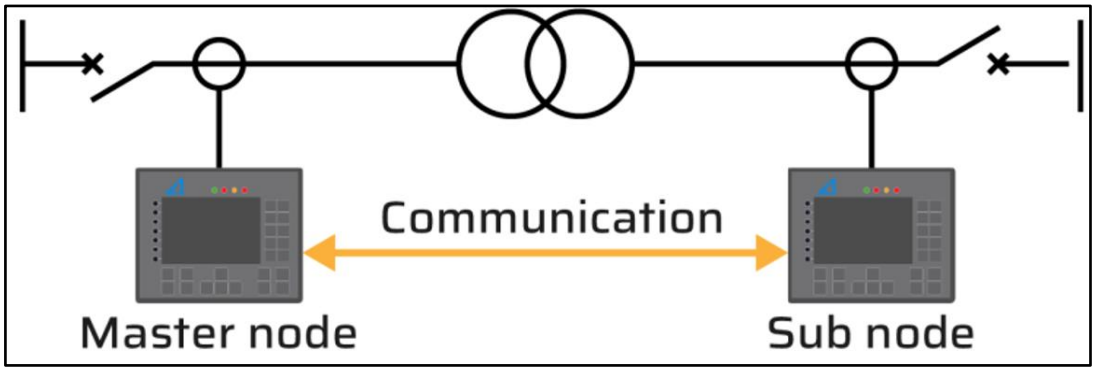


Figure 9. *Parameters for an inline transformer in AQtivate 200.*

The device will automatically match the nominal current and the vector group. Make sure that the displayed nominal currents match your installation. For further details on the transformer parameters please refer to the AQtivate 200 manual, available on our website at arcteq.com/documents-and-software.

5 SETUP

5.1 Setting up general master and sub-node parameters

Before you can enable the line differential protection function, you must commission the sub-node and the master node normally. This is especially critical for the current transformers (CTs) and the objects used for line differential protection.

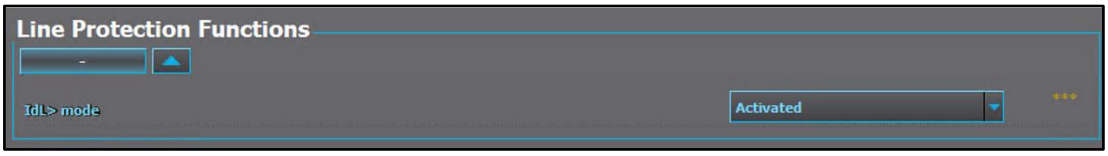
Please refer to the device manuals for more details on the objects and the CTs, available on our website at arcteq.com/documents-and-software.

5.2 Setting up line differential function on master-node

The configuration of the line differential protection function is done on the master node, and all relevant settings are transferred to the sub-node automatically.

Begin the configuration process by enabling the line differential function (IdL>) on both devices with the ***IdL> mode*** parameter (see Figure 10 below):

Figure 10. *AQtivate 200 where the line differential protection function has been enabled.*



As mentioned previously, the configuration mode is on by default (the ***Enable configuration*** parameter is set to "Enabled (Halt protection)"), and this halts the protection on both devices (please refer to Figure 6, p. 7).

Next, enter the required settings for your installation in their specific parameters. Please make sure that the following aspects are also considered when setting the parameters:

- The CT measurement accuracy.
- Accuracies of the protection devices on both sides.
- A safety margin.

Once you have done the configuration, you can enable the line differential protection stage by disabling the configuration mode noted in Figure 5 (p. 7).

CAUTION!
Do not change the protection settings while the line differential protection function is in operation! When the function is in operation, the ***Enable configuration*** parameter is set to "Disabled".

You can see all the active settings in the *INFO* tab (*Line Protection Module → IdL> [87L] → INFO*), as shown in Figure 11 below.

Figure 11. *Active settings for the line differential protection function in the INFO tab.*

The real-time status of the protection function can be seen in the 'Line Protection Status' section in the INFO tab (please refer to Figure 2, p. 5). The status of both the master node and the sub-node shows that both "LineDiff Enabled" and "Protection Operational" signals are active (see Figures 12 below and Figure 13 on the following page):

Figure 12. *Status of the master node when the line differential protection function is enabled.*

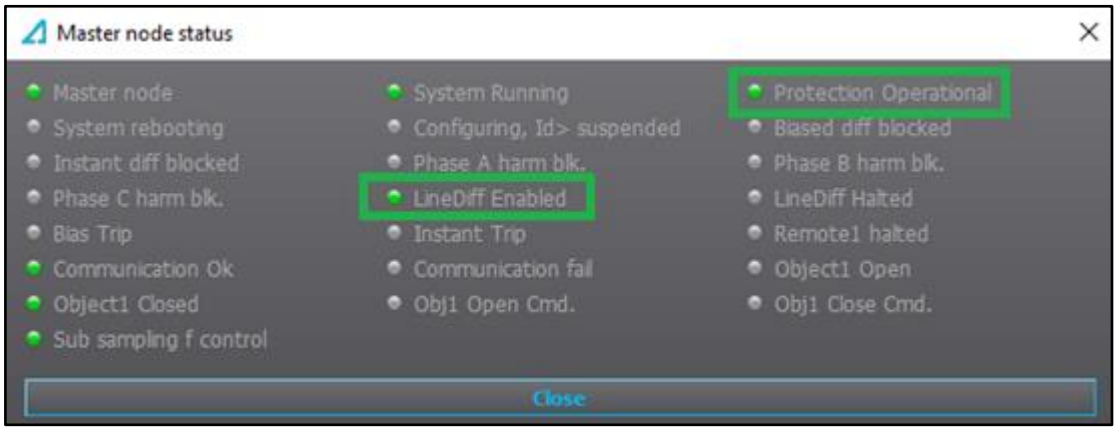
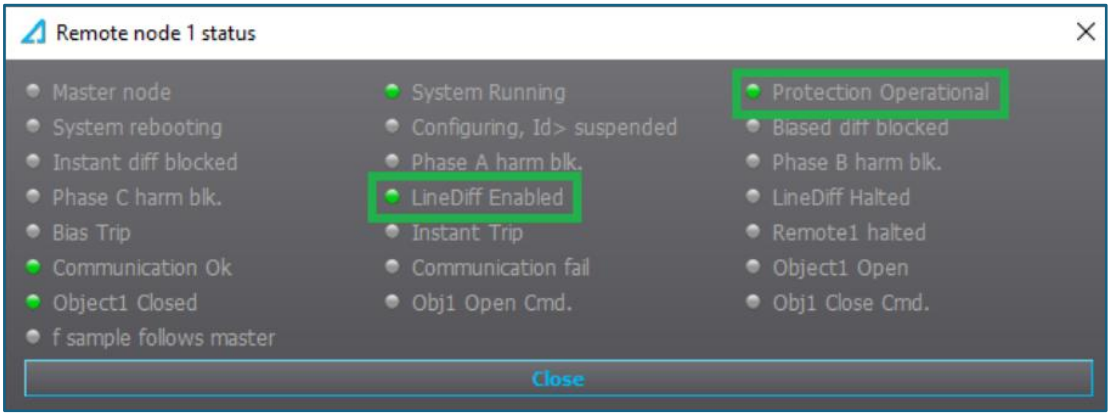


Figure 13. *Status of the sub-node when the line differential protection function is enabled.*



6 SUPPORT FUNCTIONALITIES

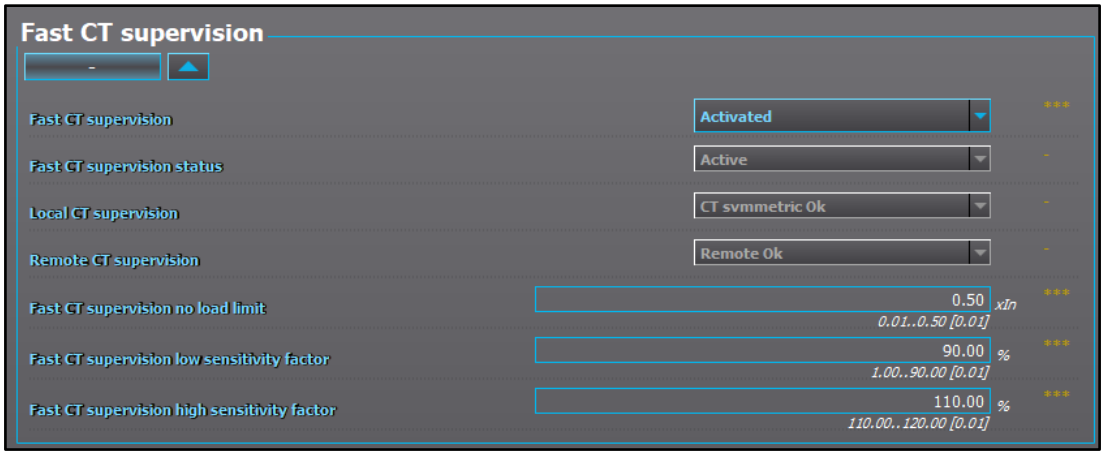
You can find all the support functionalities and their settings in the *INFO* tab (*Line Protection Module → General Line Settings → INFO*).

6.1 Fast CT supervision

Fast current transformer (CT) supervision is a support functionality that is located in the 'Fast CT supervision' section. It monitors the condition of both local and remote current transformers. If an asymmetric current or overload is detected, the line differential protection is blocked to prevent incorrect operation.

Figure 14 (below) shows all the settings available for the fast CT supervision functionality.

Figure 14. *Settings for the fast CT supervision support functionality.*

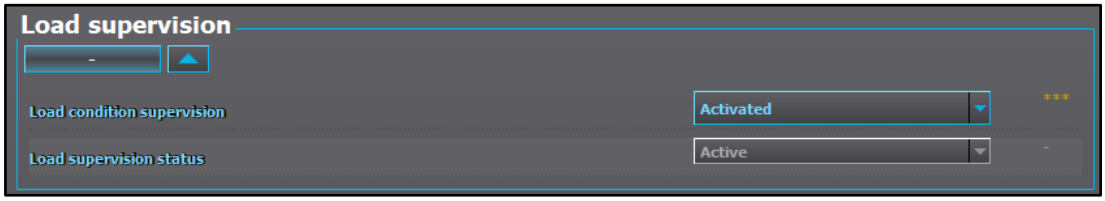


6.2 Load supervision

Load supervision is a support functionality that is located in the 'Load supervision' section. Load supervision prevents the line differential protection from tripping during significant load variations that do not indicate a fault. Load supervision should be enabled if the load changes frequently.

Figure 15 (below) shows all the settings available for the load supervision functionality.

Figure 15. *Settings for the load supervision support functionality.*



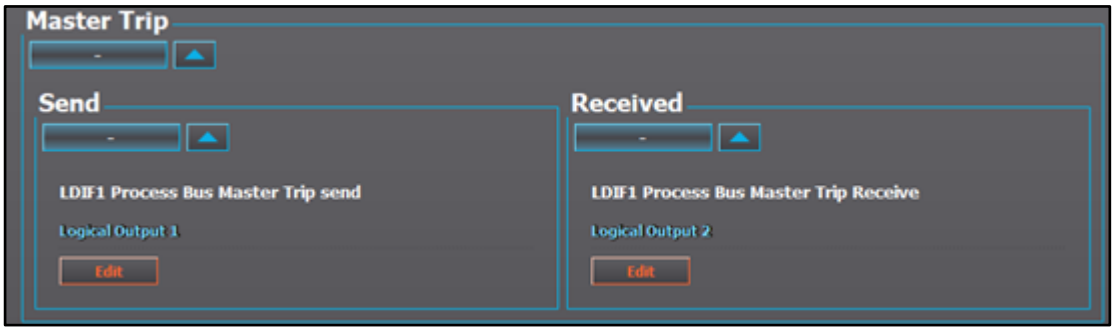
6.3 Master trip

Master trip is a support functionality that is located in the 'Master trip' section. The line differential trip signal is multiplied internally between the line end devices. The master trip signals allow the transmission of additional trip commands to the remote end.

CAUTION!
If the support functionality line breaker control is in use, the request signals "Breaker open" and "Breaker close" are connected internally. This means that remote breaker commands should **not** be connected here!

Figure 16 (below) shows all the settings available for the master trip functionality.

Figure 16. *Settings for the master trip support functionality.*



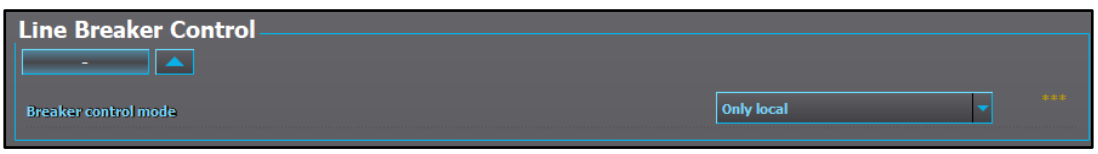
6.4 Line breaker control

Line breaker control is a support functionality that is located in the 'Line Breaker Control' section. It has only one setting parameter: the ***Breaker control mode*** parameter determines whether only the local breaker or both the local and the remote breakers are operated from either end of the line.

NOTICE!
This setting does **not** affect the trip, which is always operated at both ends of the protected line at the same time!

Figure 17 (below) shows all the settings available for the line breaker control functionality.

Figure 17. *Settings for the line breaker control support functionality.*

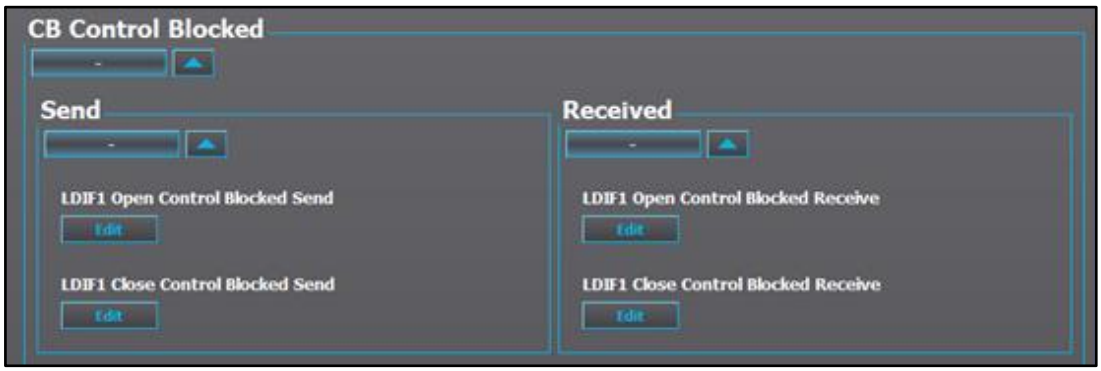


6.5 CB control blocked

Circuit breaker (CB) control blocked is a support functionality that is located in the 'CB Control Blocked' section. It sends a block signal to control the opening or closing of a circuit breaker. The signal can be sent or received from the other end of the line.

Figure 18 (below) shows all the settings available for the line breaker control functionality.

Figure 18. *Settings for the CB control blocked support functionality.*



7 CONTACT INFORMATION

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