

FAULT INDICATOR TYPE **FLA3.1L**

and

REMOTE CONTROL TYPE **HS**



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1. Introduction

The fault indicator type FLA3.1L is used in radial overhead line networks. Its function is to survey the net continuously for permanent faults, temporary faults and transient currents.

The indicator can be fully adjusted while in operation with a remote control. Due to this and the various settings this indicator can be applied very versatilely. This document introduces how the fault indicator type FLA3.1L works, how to handle the indicators with the remote control type HS and which settings are possible.

2. Fault indicator type FLA3.1L

2.1 Function overview and settings

The fault indicator type FLA3.1L can detect short-circuits and earth-faults. It can also distinguish between permanent faults, temporary faults and transient currents. Temporary fault and transient current detection are selectable options.

Detailed information on each adjustable value can be found in the following chapters. The following operational values can be adjusted:

short-circuit trip current: (absolute threshold)	fixed value: 20A to 800A (in steps of 10A) or automatically adjusted on basis of line current: 150% to 500% (in steps of 50%)
earth-fault trip current: (di/dt detection)	di: 20ms at 50Hz / 16ms at 60Hz dt: 5A to 100A (in steps of 5A)
response delay:	40ms to 300ms (in steps of 20ms)
reset time:	30min to 720min (in steps of 30min)
automatic reset:	off / by current / by voltage
auto-recloser used:	on / off
auto-recloser time:	1sec to 5sec (in steps of 1 second) and 5sec to 180sec (in steps of 5 seconds)
temporary fault indication:	on / off
transient current indication:	on / off
voltage detection:	20% to 90% of operating voltage in steps of 10%
remote indication:	faults disabled/enabled reset events disabled/enabled current on-off-events or voltage on-off-events disabled/enabled datalogging of current and voltage status on/off

Additionally the remote control can read out the present current of the net and the settings of the indicator. Also a reset or test can be executed.

2.2 Exterior of the fault indicator type FLA3.1L

The fault indicator type FLA3.1L has one ultra-bright red LED with a special lense to distribute the light and a green LED pointing to the bottom for fault fault indications. A fault is indicated by one flash every two seconds (0.5Hz frequency) (figure 1: 2). When a temporary fault was detected, there will be an additional flash of the green LED every two seconds (0.5Hz frequency) (figure 1:3). (Please refer to the chapter 9 for detailed information about temporary fault detection.)

A yellow LED pointing to the bottom (figure 1: 1) signals radio-mode readiness (refer to "4.Communication between remote control and fault indicators"), error states and emergency mode. The bottom LED can send the following signals:

1 flash per second:	The FLA3.1L is in radio-mode. It will receive and respond to commands from the remote control.
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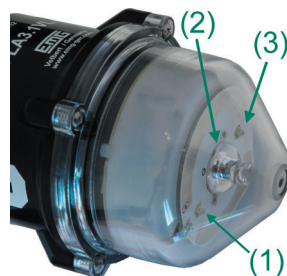


figure 1: LEDs of the indicator

- 1 flash every 3. second: The FLA3.1L signals that the battery is running low.
Please note: All functions of the FLA3.1L are still working.
- 2 flashes per second: The FLA3.1L is in emergency mode. If the battery voltage is below the necessary voltage to measure the current, the FLA3.1L will enter emergency mode.
Please note: Fault detection and radio-mode are disabled.

2.3 Identification code and customer code of the FLA3.1L

The fault indicators have an identification code (ID) in order to program them separately. Therefore, all installed fault indicators within the range of the remote control must have different IDs. A maximum of 9 different IDs can be set.

The ID is programmed and printed on the housing ex works and cannot be changed later. Please consider how many fault indicators will be installed at each site, when placing an order.

Additionally the remote control and the indicators will have a unique code for each customer. This confidential code prevents unwanted changes to the settings of the installed FLA3.1Ls, because it protects the indicators from external remote controls, that do not belong to the owner of the FLA3.1Ls (e.g. remote controls delivered with samples).

3. Remote control type HS

3.1 Exterior and handling

The remote control type HS provides a lighted two-line display and four buttons.

The display provides information needed to control the indicators. The first line (figure 2: 5) shows the menu names and the running operation. The second line (figure 2: 6) contains the single menu items or the values of the settings of the fault indicators.

Directional buttons (figure 2: 1 and figure 2: 2): The menu item and the adjustable settings can be changed with these buttons. The menu items and the adjustable values increment or decrement automatically, when the button is pressed continuously.

OK-Button (figure 2: 3): This button has two functions. The remote control switches on, when the button is pressed for a duration of 1 sec.. In operation, pressing the button will select the displayed menu item or the displayed value.

Cancel-Button (figure 2: 4): This button has also two functions. When the remote control is operating, pressing the button for a duration of 1 sec. will switch the remote control off. The second function cancels the running operation, e.g. sending a wakeup signal, or returns to the last selected menu item.

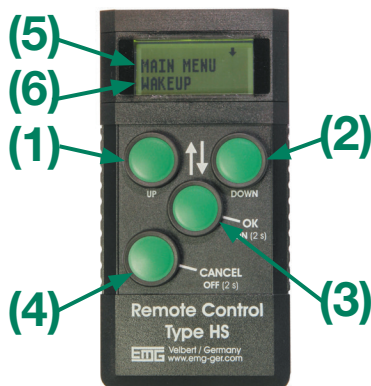


figure 2: overview of remote control type HS

To save power the remote control will switch off the display light after 30 seconds. After 3 minutes the remote control will be switched off completely.

Please note: The remote control saves the adjusted settings, when it is switched off. This makes the programming of a large number of fault indicators much easier as there is no need to choose the desired settings each time the remote control is switched on.

3.2 Changing the battery

When the battery power is too low for normal operation, a warning will be displayed after switching on the remote control. The remote control will not operate then until the battery is replaced.

On the back of the remote control there is a battery case that can be opened by pushing the cap downwards (see figure 3).

The battery can be simply exchanged by detaching the old battery from the cable and attaching the new battery to the cable. The battery will only fit in the right polarity.



figure 3: exchanging the battery

Please note: The battery used is a standard 9V block battery.

4. Communication between remote control and fault indicators

The communication between remote control and fault indicators follows a procedure:

Step 1: wake up all indicators to enter radio-mode

Step 2: test and reset all indicators in range

or program the adjustable settings of one indicator

or measure the present net current of one indicator

or get the adjusted settings of one indicator

The wake-up signal is sent continuously to all FLA3.1L in range. To reduce power consumption every FLA3.1L checks in a cycle of 20 seconds for a wake-up signal. Depending on the distance and disturbances the indicator could need more than one cycle to detect a wake-up signal.

The FLA3.1L will signal the radio-mode via a yellow LED in the bottom with one flash per second. The sending of the wake-up signal can be cancelled by pressing the "cancel"-button. Three minutes after the reception of the last command the indicator will leave the radio-mode.

Important: All commands described below belong to step 2 of the communication procedure (see above). They will only be received and processed by FLA3.1Ls which indicate radio-mode readiness via the blinking LED.

Please note: When an FLA3.1L is in radio-mode, fault detection is disabled!

Summary of the facts:

wake-up check:	every 20 seconds (wake-up detection may take more than one cycle)
radio-mode indication:	1 flash per second of the LED in the bottom
radio-mode duration:	3 minutes after reception of the last command

4.1 Test, reset and standby commands

After choosing the menu item "MAIN MENU - test" all FLA3.1L in range will switch into indication status. The reset timer is started and the indicators will reset after expiration of the adjusted reset time or with recovering net voltage, if the auto-reset-mode is enabled.

Choosing the menu item "MAIN MENU - reset" will send a reset command to all FLA3.1L in range. All FLA3.1L, that indicate a fault, will reset the indication. Additionally, all indicators will leave the radio-mode immediately after the reception of the reset command.

Choosing the menu item "MAIN MENU - standby" will send a command to all FLA3.1L in range to leave radio mode immediately and return to standby mode. Differently to the reset command, the indicators will not reset the indication if there is any.

All commands are sent continuously until the "cancel"-button is pressed.

Remark: The standby command is not available on older remote controls.

4.2 Programming the settings

The "PROGRAM" menu is entered by choosing the menu item "MAIN - program". In the "PROGRAM" menu all settings for the function of the indicator can be adjusted.

- PROGRAM ALL:** All settings are adjusted and programmed in one transmission.
- SC TRIP CURR:** The short-circuit trip current of the FLA3.1L can be adjusted and programmed. A fixed trip current value or an automatically adjusted trip current can be selected. For detailed information please refer to "6.The automatic mode of the FLA3.1L".
- EF TRIP CURR:** The earth-fault trip current of the FLA3.1L can be adjusted and programmed. For detailed information please refer to "6.The automatic mode of the FLA3.1L".
- RESPONSE DEL:** The response delay of the FLA3.1L can be adjusted and programmed.
- RESET TIME:** The reset time of the FLA3.1L can be adjusted and programmed.
- AUTO RESET:** Choosing "off" means, that the automatic reset on recovering network is disabled. Reset will be performed after expiration of the reset time or after manual reset. With choosing "current" the FLA3.1L will additionally reset automatically after recovering net current. With choosing "voltage" the FLA3.1L will additionally reset automatically after recovering net voltage. Reset by current or by voltage are mutually exclusive.
- AUTO RECLOSE:** When auto-reclosers are used in the net, this option can be switched on. When switched on, two more options can be chosen to prevent false indication in a net with auto-reclosers.
- RECLOSER TIME:** Only available when recloser setting is switched on: this time setting should be adjusted to the same time when the last reclosing attempt will take place. For detailed information about the reclosing settings please refer to "9. Autorecloser settings".
- TEMP FAULT:** Only available when recloser setting is switched on: when a temporary fault situation occurs, the FLA3.1L will not indicate this as a fault, when "T FAULT" is switched off. For detailed information about temporary fault indication please refer to "5.4 Temporary faults".
- TRANSIENT:** When switched on, the transient detection is enabled. For detailed information about the transient detection please refer to "5.5 Transient currents".
- VOLT DETECT:** A value can be specified at which voltage level of the operating voltage a voltage loss is detected. For detailed information please refer to "8. Voltage detection".

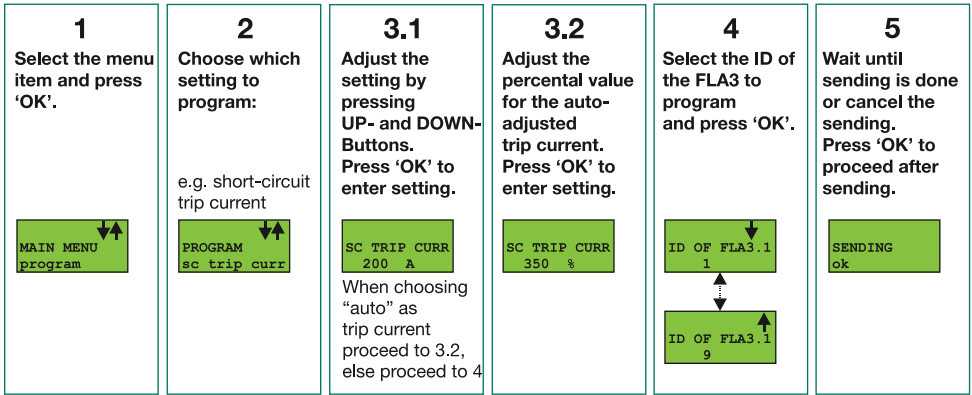


figure 4: programming the trip current

Each setting can be altered by pressing the directional buttons and can be set by pressing the "OK"-Button. After altering one or all settings the procedure of programming one or more FLA3.1Ls is the same (please refer to the example in figure 4). The ID of the FLA3.1L must be selected. The choice is set by pressing the "OK"-Button again. Depending on disturbances and distance, the sending of the settings can vary in time, but will normally last less than 10 seconds. The sending can be canceled by pressing the "cancel"-button.

Please note: The FLA3.1L confirms the reception of a setting-command in two ways. First of all, it blinks one time with the ultra-bright indication LED. Secondly, the FLA3.1L sends a confirmation back to the remote control. After finishing the sending the result of the successful programming will be displayed by an "OK".

After the sending, another FLA3.1L can be chosen by its ID. It will be programmed with the same settings like the FLA3.1L before.

4.3 Measure current

The present current of one core can be read out by choosing the menu item "MAIN - current" (refer to figure 5). Therefore, the ID of the FLA3.1L, which is installed on the core to read the current from, must be chosen.

The remote control receives the current of the core continuously and shows the results of the measurements on the display. The measurement of the current can be cancelled by pressing the "cancel"-button.

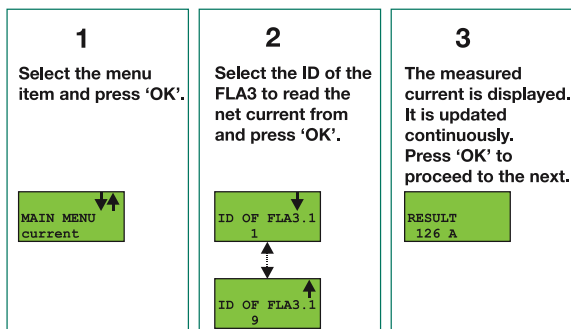


figure 5: receive network current

4.4 Measure temperature

The temperature of the circuit board can be read out by choosing the menu item "MAIN MENU - temperature". The ID of the indicator to be read out must be selected similar to the current read out. (Please refer to chapter "4.3 Measure current").

Please note: The temperature value does not reflect the temperature of the conductor but the internal temperature of the indicator.

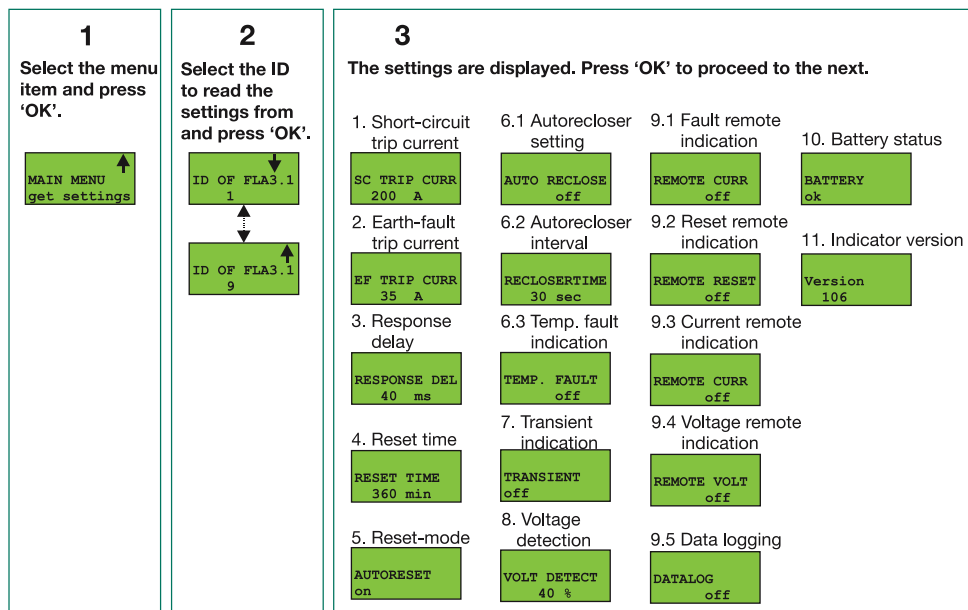


figure 6: get settings and sequence of response

Step 1

MAIN MENU
wake up

Wake up all FLA3.1L
in range.

Step 2

MAIN MENU
reset

Reset all FLA3.1L
in range.

MAIN MENU
standby

Set all FLA3.1L in
standby mode without
resetting.

MAIN MENU
test

Test all FLA3.1L in range.
Reset timer will be started.

MAIN MENU
program

Enter PROGRAM menu.

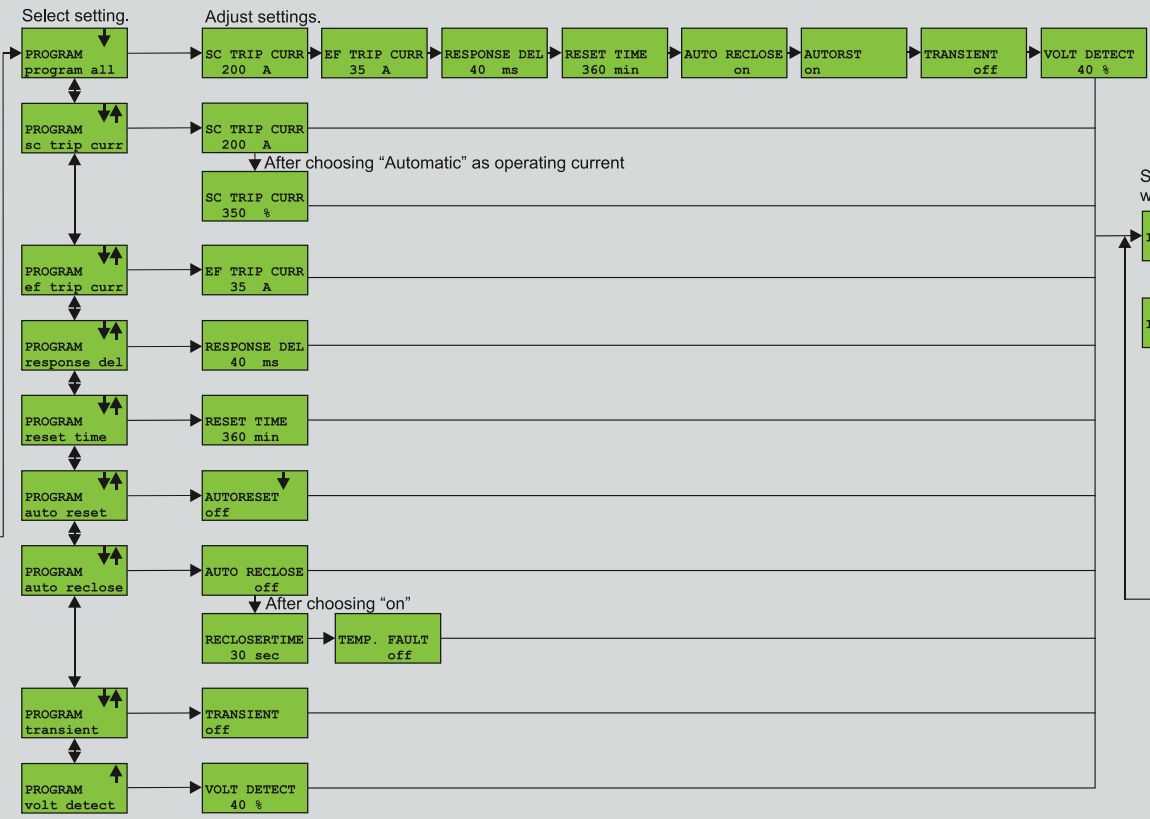
MAIN MENU
current

MAIN MENU
temperature

MAIN MENU
remote ind

Enter REMOTE menu.

MAIN MENU
get settings

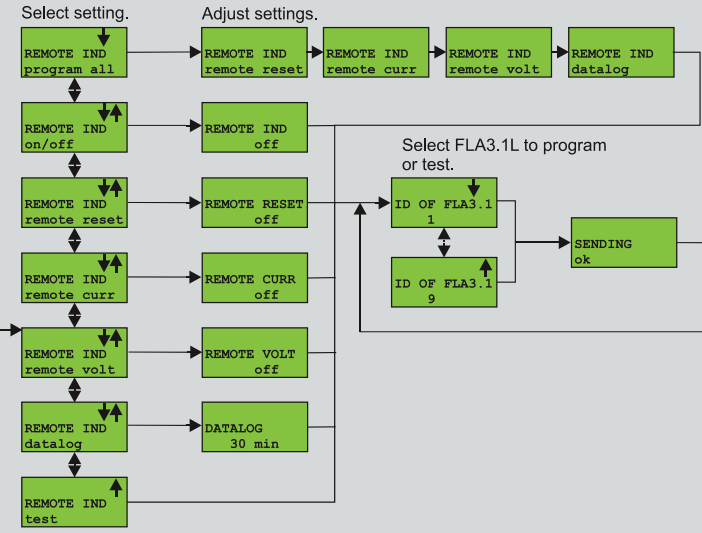


Select FLA3.1L to program
with the adjusted setting.

ID OF FLA3.1
1

ID OF FLA3.1
9

SENDING
ok



Select FLA3.1L to read
the net current / temperature from.

ID OF FLA3.1
1

ID OF FLA3.1
9

Display of the result.
Continuously updated.

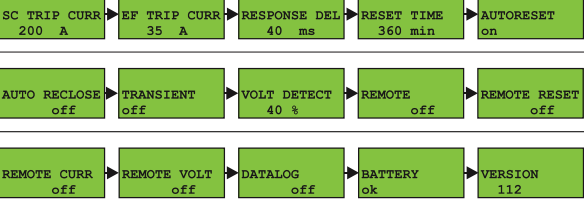
RESULT
126 A

Select FLA3.1L to read
the setting from.

ID OF FLA3.1
1

ID OF FLA3.1
9

Display of the setting.
Press 'OK' to proceed.



4.5 Get settings

The settings of one FLA3.1L can be read out by the remote control. Therefore, the menu item "MAIN - get set" must be chosen. After the selection the ID of the FLA3.1L, the remote control receives the settings of the fault indicator. The settings are displayed in the sequence shown in figure 6. Pressing the "OK"-Button or "Cancel"-Button will display the next received setting.

5. Fault detection and indication with the FLA3.1L

The fault indicator type FLA3.1L is able to detect short-circuits and earth-faults. It uses different criteria for the detection of short-circuits and earth-faults which are described below.

The FLA3.1L is also able to detect or ignore different types of faults which may occur in overhead line networks with equipped auto-reclosers. Detailed information can be found below.

5.1 Short-circuit detection

The short-circuit detection works as a fault passage detection with a fixed or automatically adjusted trip current setting. When a current exceeds the adjusted or automatically adjusted trip current and lasts longer than the adjusted response delay the FLA3.1L will detect a short-circuit (please refer to figure 7).

It is possible to disable the short-circuit detection when choosing a trip current. To disable the short-circuit detection the trip current value must be decreased until "off" appears in the display.

For detailed information about the automatically adjusted trip current please refer to "6. Automatic mode".

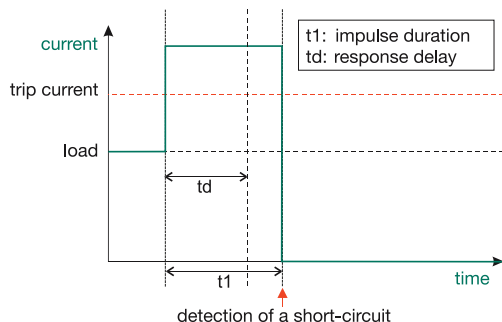


figure 7: detection of a short-circuit

5.2 Earth-fault detection

The earth-fault detection works with a di/dt measurement algorithm. Once the current load changes within 20ms ($= dt$) above a selected value (e.g. $di = 30A$) and this heightened current lasts longer than the 40ms the indicator will start analyzing the network voltage. If the voltage drops within one second after the heightened current was measured the indicator will detect an earth-fault (please refer to figure 8.)

It is possible to disable the earth-fault detection when choosing a trip current. To disable the earth-fault detection the trip current value must be decreased until "off" appears in the display.

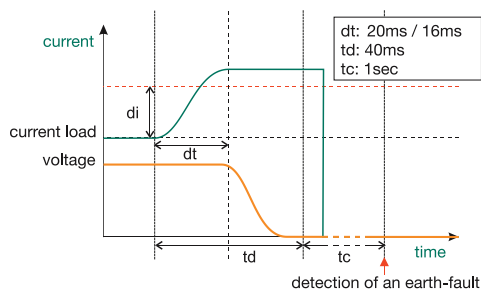


figure 8: detection of an earth-fault

5.3 Permanent faults

The FLA3.1L is able to distinguish different fault types after detecting a short-circuit or earth-fault. If the network is permanently switched off (no current flow) the indicator will detect a permanent fault (please refer to figure 9.)

If the autorecloser setting RECLOSE is disabled any detected fault will be indicated as permanent fault.

Permanent faults are indicated by 1 blink every two seconds.

5.4 Temporary faults

Temporary faults are fault situations where a fault current leads to a power failure that can be fixed by switching it on again. When the autorecloser settings are enabled the FLA3.1L will also be able to detect temporary faults (refer to figure 10).

When the "T FAULT" setting is switched on, a temporary fault will be indicated by two blinkings every two seconds.

When "T FAULT" is off, the temporary fault will not lead to any indication.

Please refer to "9. Autorecloser settings" for detailed information about the possibilities how to detect, indicate or ignore temporary fault conditions.

Please note: When the autorecloser settings are disabled ("RECLOSE" is off), the FLA3.1L will identify this situation as a permanent fault due to the characteristics of the first pulse (refer to "5.3 Permanent faults").

Please note: Sometimes this type of fault is also referred to as transient fault. This should not be confused with the transient detection described in "5.5 Transient detection".

5.5 Transient detection

Transient currents are very short voltage peaks that exceed the adjusted trip current. These current peaks usually have a duration of about 20ms and are therefore below the adjusted response delay. Transient currents can be a sign for a faulty cable, that still works under most conditions, but could be a cause of defect in the future.

The FLA3.1L provides an option to detect these currents. This option can be programmed with the remote control. (Please refer to "4.2 Programming the settings".)

When a transient current is detected, it is indicated via the LEDs above the flag indication. (Please refer to figure 11.) To distinguish the indication of a transient current from a temporary fault the FLA3.1L will blink with two pulses every 3 seconds.

Please note: It is strongly recommended to use transient detection only for analysis purposes because a single pulse exceeding the trip current triggers the indication. Especially with low trip currents, the FLA3.1L is very sensitive and will indicate very often, which lowers battery life considerably.

Please note: For fault indicators type FLA3.1L with a version of 109 or higher the transient detection is automatically switched off after 7 days.

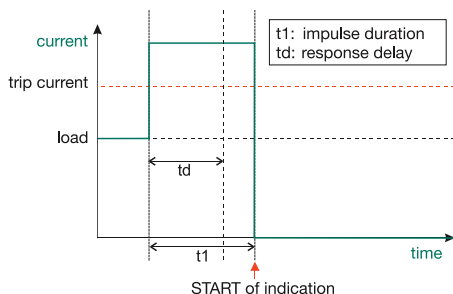


figure 9: permanent fault

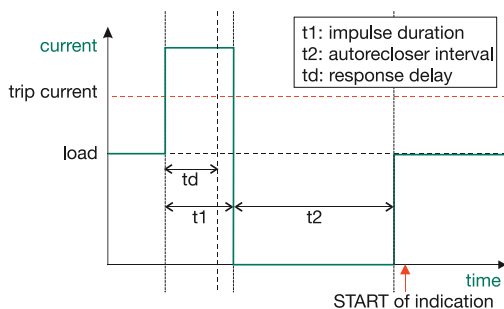


figure 10: temporary fault

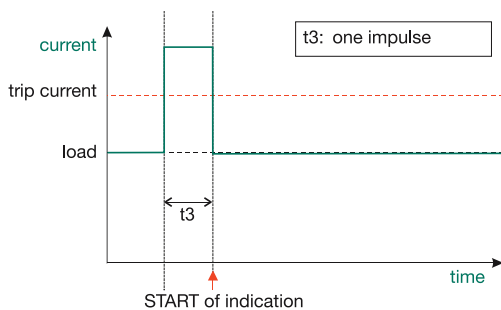


figure 11: transient current

6. The automatic mode of the FLA3.1L

When selecting the short-circuit trip current of the FLA3.1L, there is also the option for an automatically calculated trip current. To choose the automatic mode the trip current on the display has to be decreased until "auto" appears on the display. After choosing the automatic mode by pressing the "OK"-Button, a percentaged value can be selected.

The principle of operation of the automatic mode is that the trip current is automatically and constantly adjusted on basis of the measured operating current and the selected percentaged value. The FLA3.1L collects the measured current values continuously and calculates a new trip current every 10 seconds (see figure 12).

The automatically adjusted trip current can be read out with the remote control after one adjustment period of 10 seconds (refer to "4.4 Get settings").

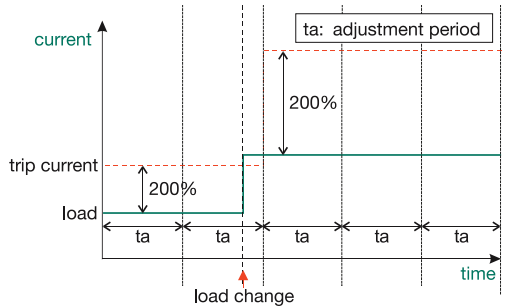


figure 12: automatic adjustment of trip current

Please note: The FLA3.1L collects current values only on a powered net. Therefore, the FLA3.1L needs at least 10 seconds on a powered net to automatically adjust a trip current after programming the automatic mode or after a battery change. For further technical details on the operating modes of the FLA3.1L please refer to technical note "technical_note_FLA3_normal_and_automatic_mode".

7. Remote indication

7.1 Remote indication of events

The fault indicator type FLA3.1L can be retrofitted with the remote indication system type RIS. This system provides interfaces to RTUs in various specifications. The remote indication system collects the information from the FLA3.1Ls and forwards it by relay outputs or serial interfaces. (For detailed information about the remote indication system please refer to the instruction manuals and data sheets for the remote indication system type RIS.)

The FLA3.1L can forward various events to the remote indication system. To alter the remote indication settings the menu item "MAIN - remote" must be selected.

In the "REMOTE" menu the following items can be selected:

PROGRAM ALL: All settings are adjusted and programmed in one transmission.

REMOTE: General setting. Enables or disables the remote indication of faults.

Remark: If this setting is off, all other settings below are ignored.

REMOTE RESET: Enables or disables the remote indication of a reset event. Once the indicator performs a reset this event will be remotely indicated. It does not matter if the reset is done manually or automatically by time or by recovering network to trigger the remote indication.

REMOTE CURR: Enables or disables the remote indication of current on/off events. In case a network is switched off the FLA3.1L can forward this event via the remote indication system. Once the network is powered up again the FLA3.1L will forward this event, too. The detection of the on/off switching events is based on current measuring.

REMOTE VOLT: Enables or disables the remote indication of voltage on/off events. This function is similar to the REMCURR-setting. The difference is that the detection of on/off switching events is based on voltage measuring.

DATALOG: Enables or disables the data logging feature of the FLA3.1L. Please see "7.2 Data logging" for more details.)

TEST: The ID of an FLA3.1L can be selected to perform a test of the remote indication. Once selected the FLA3.1L will simulate the remote indication of a permanent fault.

Please note: The remote indication of current and voltage on/off events are mutually exclusive. E.g. if the remote indication of current on/off events is selected the remote indication of voltage on/off events is disabled automatically.

7.2 Data logging

The FLA3.1L can be adjusted to transmit current read-outs and the voltage status of the line to the remote indication interface type RIS-FS in preadjusted intervals. The remote indication interface type RIS-FS will store one current read-out and voltage status until the next transmission of the FLA3.1L takes place. The current read-out and voltage status can be requested from the RIS-FS via serial interface. (For more details on the serial interface please refer to the datasheet and technical notes of the remote indication interface type RIS-FS.)

Please note: This feature is only available for the remote indication interface type RIS-FS with Modbus protocol. When this feature is enabled the RIS-FS will have an increased power consumption. The RTU must be suitable to support this. RTUs with non-rechargeable battery power supply are not recommended.

The interval is adjustable in the following steps:

OFF	disables the data logging features
1min - 10min	in steps of 1min
10min - 120min	in steps of 10min
120min - 1440min	in steps of 60min

Important: Using this feature has an impact on battery lifetime of the FLA3.1L. It is strongly recommended to disable this feature when there is no remote indication interface type RIS-FS in range that can receive the data logging transmissions. It is also recommended to use as long intervals as possible to reduce power consumption.

8. Voltage detection

The criterion to detect a voltage loss can be adjusted by the remote control in the "VOLT DETECT"-menu item in the "PROGRAM" menu. It can be configured at which voltage level of the operating voltage the FLA3.1L is detecting a voltage loss. The operating voltage is automatically detected by the FLA3.1L.

Selectable values are: 20% - 90% of the operating voltage in steps of 10%

The voltage detection is used to automatically reset the indicator by voltage (if enabled) and to verify the voltage status after detection of an earth-fault. (Please refer to "5.2 Earth-fault detection" for more details how the earth-fault detection works.)

9. Autorecloser settings

If autoreclosers are equipped in the monitored net the FLA3.1L can be adjusted to their settings to provide an optimized fault detection. Different types of faults can occur, if there are autoreclosers equipped in the network:

- 1. Permanent fault: A fault causes the net to switch off. The autoreclosers are not able to re-energize the net. (Please refer to figure 9.)
- 2. Temporary fault: A fault causes the net to switch off. But the net is energized after the autoreclosers performed switching operations. (Please refer to figure 10.)

The FLA3.1L can be configured to react on each type of fault with a distinct kind of indication. The autorecloser settings can be adjusted by selecting the “reclose”-menu item in the “PROGRAM” menu. The following settings can be made:

- AUTO RECLOSE: General setting. Enables or disables the autorecloser function of the FLA3.1L.
Remark: If this setting is off, all other settings below are ignored.
- RECLOSER TIME: Autorecloser interval. This time should be set to the time of the last reclosing attempt of the autorecloser units (see figure 13).
- TEMP FAULT: With this setting temporary faults can be indicated in a distinct way or can be ignored.

The following table summarizes how the settings can be adjusted to indicate temporary faults in the same way like permanent faults, in a distinct manner or ignore them completely.

Indication of different fault types			
FLA3.1L setting		Permanent fault	Temporary fault
AUTO RECLOSE: OFF		1 bright red flash (0.5Hz)	1 bright red flash (0.5Hz)
	TEMP FAULT: OFF	1 bright red flash (0.5Hz)	none
AUTO RECLOSE: ON	TEMP FAULT: ON	1 bright red flash (0.5Hz)	1 bright red flash (0.5Hz) and 1 alternating green flash pointing down

Example: The autoreclosers of a net are set to several reclosing attempts, of which the last one takes place 10 seconds after the fault current. The “RECTIME” of the FLA3.1L should be set to 10 seconds then. After the detection of a fault current and after the last reclosing attempt the FLA3.1L will analyse the monitored net and will make an indication according to the status of the net (switched on or off) and the settings of the FLA3.1L (refer to table above).

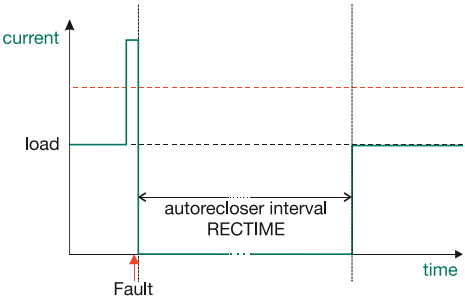


figure 13: Autorecloser interval

Please note: When the “AUTO RECLOSE” option is on, the FLA3.1L will indicate a fault after the expiration of the interval adjusted in the “RECLOSER TIME” option, because the type of fault can only be identified accurately after the last reclosing attempt. Therefore there will be a certain indication delay with enabled “AUTO RECLOSE” option. (See also figure 10.)

10. Fault localization

The fault indicator type FLA3.1L enables to find faults in radial overhead line networks quickly. It is recommend to install the fault indicators at each branch of the network. In case of a fault the installed indicators at each branch can be used to track down the faulty part easily.

10.1 Normal situation

Figure 1 shows the normal situation in a radial overhead line network. All lines are powered. There are two sets of fault indicators type FLA3.1L installed on each branch. (Please see figure 14.)

10.2 Fault situation

In case of a fault all indicators between the fault location and the transformer trip. To locate the fault you just have to follow the indicating FLA3.1Ls. The fault happened between the last indicating and the first not indicating FLA3.1L. (Please see figure 15.)

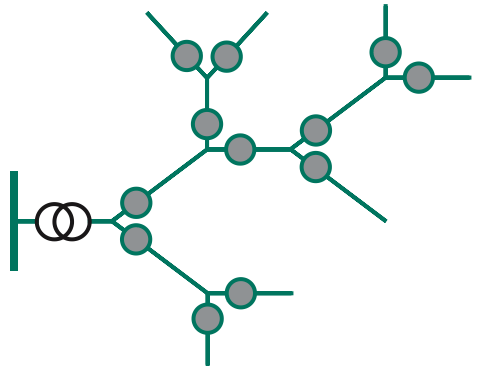


figure 14: normal situation, all lines powered, indicators installed on branches

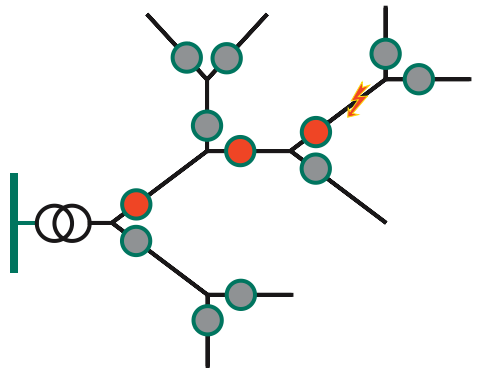


figure 15: fault situation, indicating fault indicators show the path to the fault location

-  transformer
-  powered line
-  unpowered line
-  fault location
-  fault indicator in standby mode
-  indicating fault indicator

figure 16 - legend

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