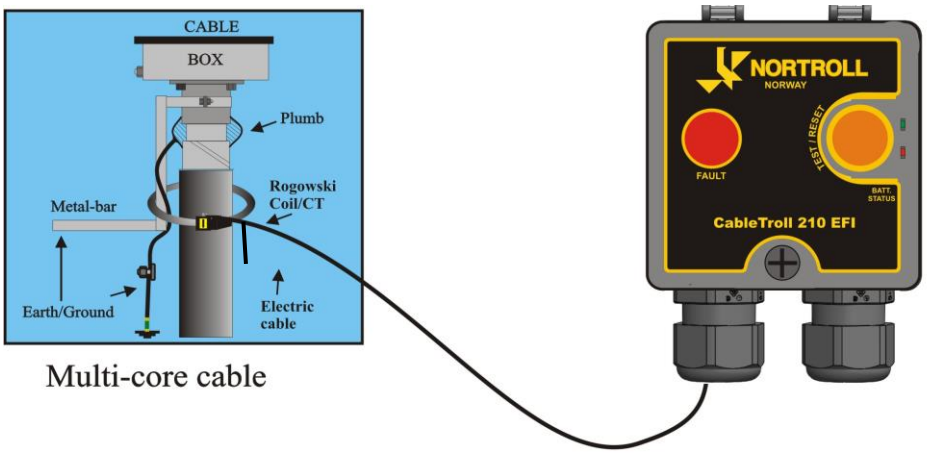
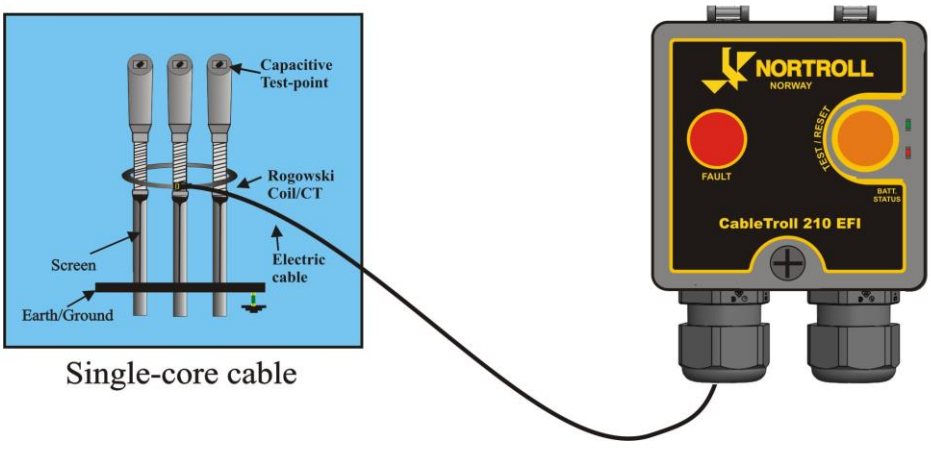
CableTroll® 210

User Guide for product nr. 01021000/11/12/13



Multi-core cable



Single-core cable

CableTroll®

NORTROLL
FIND FAULTS FAST

This document describes the installation and configuration of the CableTroll 210, product number: 01021000, 01021011, 01021012 and 01021013 fault indicator for underground cable networks.

Revision no	Date	Description
1st Draft	09.03.18	Spec generation 5 EFI, TNB specification
1	01.04.18	Correction of connection diagram
2	23.04.18	Correction of text page 5 & 14
3	19.12.18	New illustration front page
4	23.07.19	PCB drawing corrected
5	19.08.19	Illustrations updated
6	20.09.19	Programming table updated
7	25.09.19	Technical drawing with dimensions updated
8	15.09.19	Updated with Rogowski coil sensor
9	28.01.20	Pictures updated with black Rogowski coil
10	02.03.20	Illustrations and pictures updated

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Contents

1. Introduction

The CableTroll 210 is a fault current detector for the underground medium voltage distribution network (6-36kV). It is used to detect earth faults according to the functional principles in chapter 3. It can be installed on most types of cable terminations and suitable for use in tropical weather conditions with high humidity of 65% to 95%. The CableTroll 210 will indicate earth faults locally by a flashing diode, and remotely through a relay contact.

1.1 Definitions

As the terminology may differ from country to country, we will throughout this presentation use the following definitions:

Earth fault: - Single phase to ground fault (PtG)

1.2 Typical Fault Situation

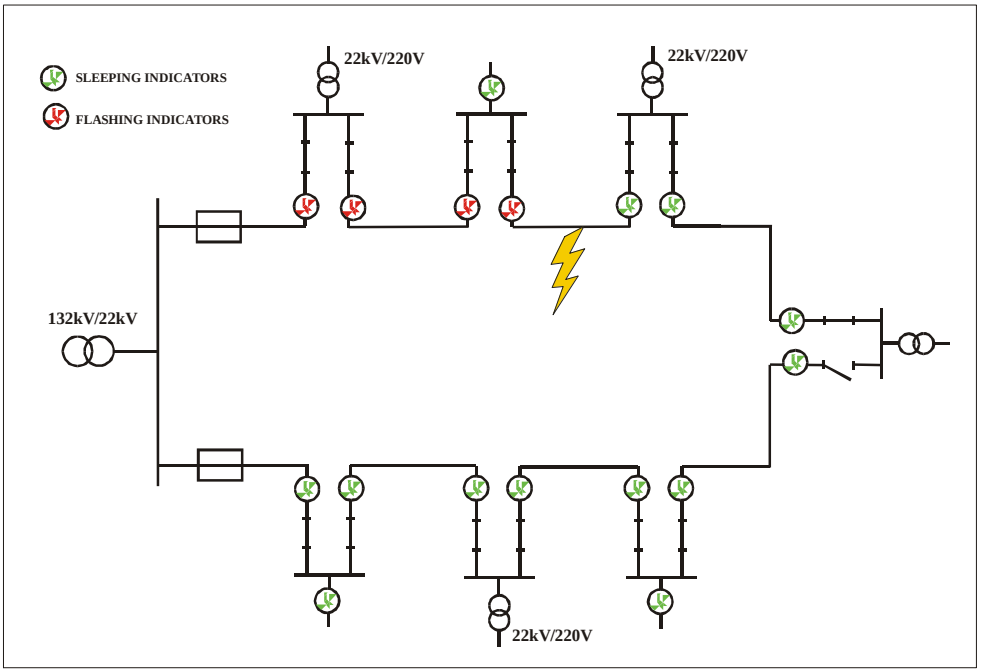


Figure 1. Fault indicator status following a fault

2. Technical description

2.1 General description

The indicator comprises one pcb cards mounted in an enclosure with hinched front cover (consist of 3 LED's) for access to terminal blocks, battery and dip switches. Both control & signalling is combined in one box.

Prod. Nr 01021000/11/12/13

2.2 Indication

One main high visibility red LED (visibility >10meters) for earth fault indication.
2 additional smaller LED's (Green & Red/Amber) for battery status indication.

2.3 Remote contact

Relay contacts (for remote signalling) for Earth fault and Low battery
Latched voltage free contact relay. One Normally Open (NO) and one Normally closed (NC)
Pulse relay may be available from factory on request.

2.4 Rogowski coil/Current Transformer (CT)/ Earth-fault element

The indicator uses one direct type Rogowski coil for detection of earth faults only.

2.5 Housing

Housing designed for outdoor mounting.

2.6 Glands

Two cable glands gland are included with the indicator.

2.7 Resetting Indication options

Programmable timer (DIP Switch)
Automatic reset by voltage (230VAC) or from CT (imbalance > 3A)
Supervisory Reset from SCADA (Immediate/2sec)
Manual reset by a push-button located on the front of the indicator.

2.8 Power Supply

Internal 3,6Ah/3,6V long life lithium battery for up to 10 years operation

2.9 NFC, Near Field Communication

The CT 210 has NFC for collecting info from the indicator such as Firmware version, Serial Number, Programming/Dip-switch settings, battery status, fault counter and link to valid Mounting Instruction.

3. Functional description

3.1 Fault currents in cable network

The short circuit current magnitude is mainly given by voltage level, type of transformer, primary feeding network and the distance from the feeding transformer to the fault location.

A cable short circuit will normally cause a fault current in the kA-range. When short circuit appears near the end of a long line, the fault current is most likely to be of a significantly lesser value.

In networks with directly earthed neutral an earth fault is equivalent to a phase-to-earth short circuit. The current magnitude will in this case be almost equal to the fault current of a phase-to-phase short circuit.

For networks that do not have a directly earthed neutral, the magnitude of the singular earth fault current is determined by the size of the galvanically interconnected network, the voltage level, type of cable and the neutral equipment.

The magnitude of a fault current during a dual earth fault will be almost equal to a short circuit in networks that do not have a directly earthed neutral.

IMPORTANT:

As the sensor principle is of the threshold type, correct use of the indicator is subject to calculations of earth fault currents and capacitive discharge currents through the sensor element (seen from the feeder).

The capacitive discharge current from behind the Rogowski coil/CT/earth fault element must not exceed the trip level setting of the indicator.

The capacitive discharge current will vary between the different types of cable, and the cable supplier should be consulted about the data for your specific type in order to make the correct calculations.

In compensated networks, the earth fault detection may not be possible in certain locations depending on the degree of compensation.

3.2 Capacitive Discharge Currents

The CableTroll 210 series indicators is not directional, (see CableTroll 3500 for directional) it therefore detects current without discriminating its direction. In case of an earth fault, the network capacitive energy discharges in the fault point.

It should be checked that the capacitive discharge current downstream the indicator is below pre-set trip level in order to avoid the indicator erroneously activating upon earth faults. If the total capacitive current exceeds the trip level, it is advisable to change the trip level or install the indicators in the branching points instead of in the main line.

The capacitive discharge of a branching point is limited by its own capacitance, while in the main line the capacitive current of all the branches downstream the indicator is added.

Underground cables have larger capacitance than overhead lines. This must be considered when an overhead line feeds an underground cable and vice versa.

The following simplified formula may be used to estimate the capacitive discharge current of a line:

$$Ic = \frac{U * La}{300} + \frac{U * Lc}{K}$$

Ic = Capacitive current in A
U = Nominal voltage in kV
La = Overhead line length in km
Lc = Cable length in km
K = 10 for oil impregnated cables
5 for PEX cables
3 for PVC cables

In order to avoid that the CableTroll 210 is activated by an earth fault downstream of the indicator, the following criterion must be met.

Ic < It

where

Ic = capacitive current down-stream of the indicator.

It = CableTroll 210 programmed trip-level sensitivity.

To estimate the capacitive discharge current at any line point, you must calculate the contribution from all the overhead lines and underground cables lengths only beyond (down-stream) that point.

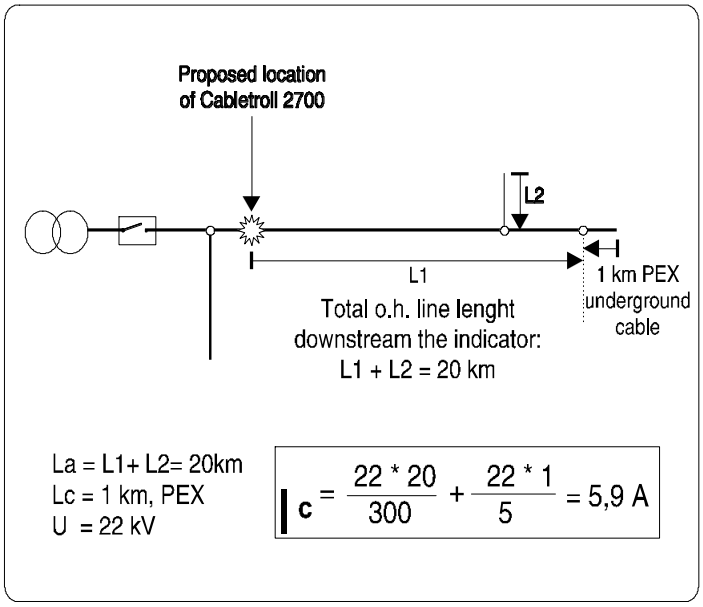


Figure 3. Capacitive discharge current calculation example

The indicator will start to flash when a current exceeding the programmed overcurrent threshold occurs.

3.3 Earth fault detection

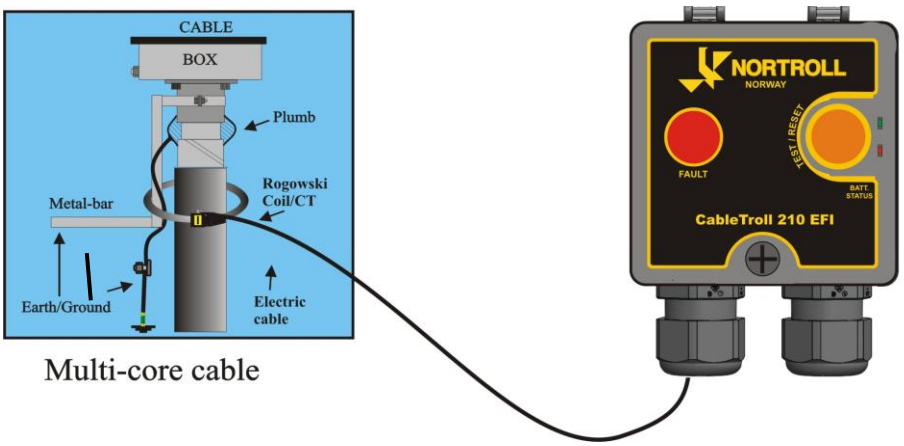
When the vectoral sum of the cable currents exceeds the trip level setting. (With no earth fault this sum is close to zero). Both transient and permanent faults are treated in the same way.

4. Application/Mounting

4.1 Sensor Mounting

The Rogowski Coil/Current transformer should be mounted between the end termination and the point where the cable screen is extracted. The CT may be mounted on the screened part of the cable. The screen should then be fed back through the Rogowski Coil/CT to prevent earth fault currents or screen transients exceeding the trip level setting and activating the indicator erroneously.

Product number: 01021000/11/12/13



Rogowski Coil/Current Transformer Mounting.

5. Battery Status

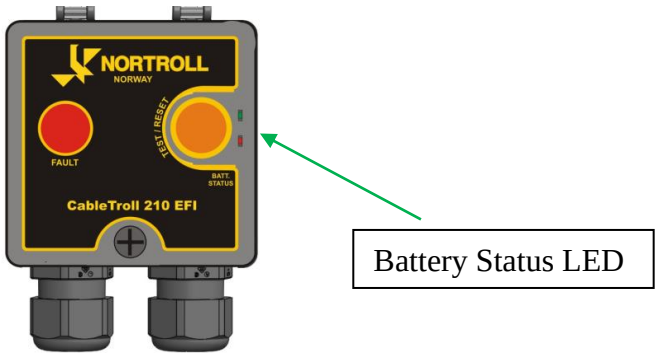
5.1 Low battery (Lithium battery)

When there is less than 20% remaining capacity on the battery, the low battery relay will close and remain closed until battery counter is reset.

Pushing the Test-/Reset button for less than 1 sec., the battery status LED will indicate the status of the Lithium battery.

Alternating Red and Green flash:	Battery OK
Red flash only:	Less than 20% remaining capacity.

The power consumption during idle and flashing is stored in the EFI and can be read with a cellphone with a NFC function (Near Field Communication).



5.2 To Replace the Battery

The internal battery should be changed every 10 years/1000 hours or if Battery Status LED is illuminated Red/Amber when pressing the test button. If so, battery should be changed immediately.

1. Open front cover.
2. Remove battery.
3. Fit new battery into place **NOTE: Notice battery polarity**
4. Reset battery counter (ref section 5.3)

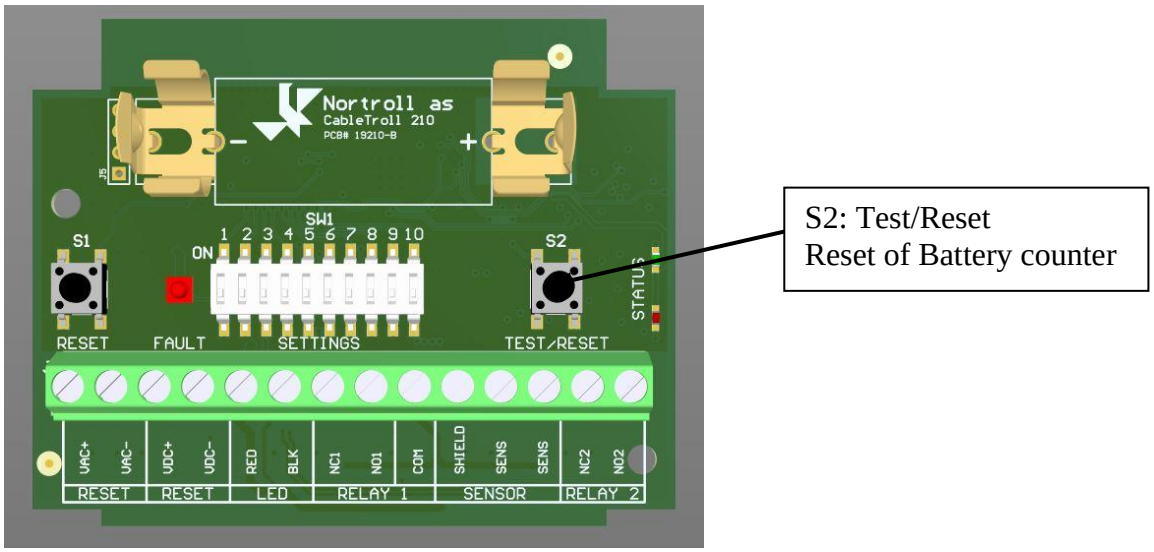
5.3 Resetting battery counter

When the battery has been replaced the battery counter must be reset. This is done by pushing the Test-/Reset button and hold it pressed for more than 30 seconds.

Observe the following sequence:

- Push the Test-/Reset button and hold for 30 seconds.
- During the 30 seconds the green Led will flash after 0.5sec, 2sec, 5sec. and after 30 seconds.
- Release the Test-/Reset button.
- The Red/Amber and Green LED light up simultaneously.
- Within 5 sec., push and release the Test-/Reset button again.
- Successful resetting of battery counter will be indicated by Red/Amber and Green LED flashing simultaneously for some time (more than 5 seconds).

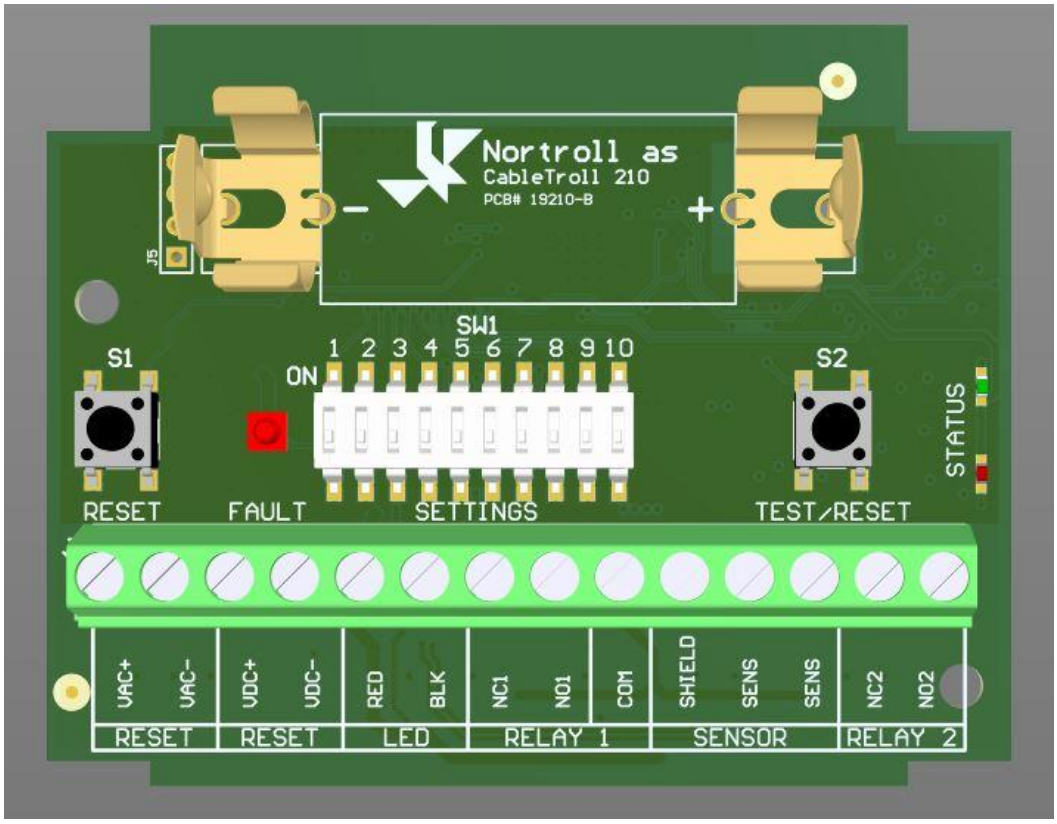
The battery counter has now been reset.



6. Connection Diagram

6.1 Main PCB

Remove the screw to open front cover. The front cover is hinged and will remain upright when the cables are connected, and the dip switches are set.



Connection diagram CT210

Terminal from left:

1: Mains reset (220-240VAC)
2: Mains reset (220-240VAC)
3: SCADA reset (9-110VDC) Hot/+
4: SCADA reset (9-110VDC) Ground/-
5: LED-6 Red (+)
6: LED-6 Black (-)
7: Earth fault Relay 1 (NC1)
8: Earth fault Relay 1 (NO1)
9: Relay Common
10: Shield/Screen
11: CT/Rogowski coil current sensor
12: CT/Rogowski coil current sensor
13: Low battery Relay 2, (NC2)
14: Low battery Relay 2, (NO2)

S1: Reset button (hard reset)
S2: Test/Reset
SW1: Trip Level/Settings/programming

7. Settings/Programming CT 210

Settings for trip level and other parameters are done with the dip-switches on the printed circuit board.

7.1 Setting trip level.

The trip level is normally factory set to 120A.
As the Earth Fault Indicator is of the threshold type, the trip level should be set according to your system requirements.

Pre-set trip levels:

For user convenience, the fault current trip level can be set to 1 out of 6 fixed nominal values of 40A, 60A, 80A, 120A, 160 and 240A For details, refer to table 1.

Select Trip-Level, dip 1, 2 and 3

1	2	3	Trip-Level
0	0	0	40A fixed trip level
1	0	0	60A fixed trip level
0	1	0	80A fixed trip level
1	1	0	120A fixed trip level
0	0	1	160A fixed trip level
1	0	1	240A fixed trip level

Table 1: Switch setting overview, trip level.

NOTE:
NORTROLLs Earth Fault Indicator and Earth Fault Element are tuned in to constitute a complete Earth Fault Current Sensing System. If any 3rd party Earth Fault Element is used the system is most likely to malfunction. The indicator may also be damaged.

The Earth Fault Element detects differences between the earth fault current (eventually compensated earth fault current) and the charge current through the element (seen from the feeding point).
This differential must exceed the trip level of the Earth Fault Indicator to give an indication.
Please observe that the trip level should be set to a value exceeding the maximum charge current from the net behind the Earth Fault Element to avoid false indications. To calculate the charge current from the network, a network analysis must be carried out.

7.2 Setting Response time/Signal time delay.

Select signal length/Response time, dip 4 and 5

(0 = OFF, 1 = ON).

4	5	Function
0	0	50ms
1	0	80ms
0	1	100ms
1	1	150ms

Table 2: Switch overview, Signal length

7.3 Setting Timer reset.

Select timer reset, dip 6 and 7

(0 = OFF, 1 = ON).

6	7	Reset time
0	0	4 hours
1	0	8 hours
0	1	16 hours
1	1	32 hours

Table 3: Switch overview, reset time settings.

7.4 Setting Auto reset.

Select Auto Reset with switch number 8.

(0 = OFF, 1 = ON).

8	Auto reset
0	Auto reset. Disabled
1	Auto reset. Enabled (15 sec)

Table 4: Switch overview, Auto reset (15 sec)

7.5 Setting CB Tripping and Inrush blocking.

Select CB trip with switch number 9.

(0 = OFF, 1 = ON).

9	CBTripping/Inrush blocking
0	Disabled
1	Enabled (5 sec)

Table 5: Circuit Breaker Tripping and Inrush blocking

NB: If Circuit Breaker trip and inrush blocking, Dip-9, is enabled the dip 8 Auto Reset must also be ON/Enabled.

8. Test and Reset

8.1 Test-Reset Button:

The function of the Test-/Reset button is dependent of operating mode (idle- or indication mode) and of how long the Test-/Reset button is pressed.

When EFI in Idle Mode:

Less than 1 sec press:

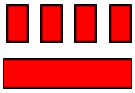
- Alternating Amber/Red and Green LED: Indicate battery status OK.
- Only Amber/Red LED: Indicate battery status below 20%.

Press between 1 sec and 5 sec:

Press the test/Reset button less than 1 sec:

The indicator shows status of Auto Reset signal from the CT/sensor:

- **Auto Reset from sensor Inactive: Fault LED flashes rapidly in burst**
- **Auto Reset from sensor Active: Fault LED illuminates constant.**



Press longer than 5 sec:

Simulated fault indication with both relays closed for 15 min.
SCADA reset possible. Manual reset with button also possible.
Auto Reset (230 VAC- or Sensor-Reset) not possible.

When EFI in Indication Mode:

If the EFI is in indication mode (after a fault), a press on the Test-/Reset button will reset indication and EFI will go back to idle mode.

8.2 Remote reset

Reset is immediately after 2 sec pulse of 9-110VDC supervisory reset from a SCADA RTU.

8.3 Auto reset

Automatic reset by voltage (230VAC) or from Rogowski coil/CT (imbalance > 3A) if dip 8 is enabled.
Reset time is 15 seconds.

9. Technical Specifications

APPLICATION AREA: Indoor or outdoor cable distribution network, single-core cables.
Network voltage range: 6-36 kV.

CURRENT SENSORS.: Sensing Method-***Direct*** by Rogowski Coil/Current Transformer (CT),

Mounting: CT/Rogowski coil for three-core and Single-core cables
For three-core cables: 130mm diameter (short coil),
For single-core cables: 300mm diameter (long coil)
The Rogowski coil/CT is mounted on the cable with Cable-ties.

INDICATOR:

Grounding system: Isolated, resistor and solidly grounded

Trip level PTG fault: Earth fault range: 40, 60, 80, 120, 160 or 240A (DIP Switch)

Duration signal length: 50, 80, 100 or 150 msec (DIP Switch)

Inrush blocking: 5 sec (with dip 9 in pos ON).

Tolerance: < 4%

Reset: Automatic, by return of voltage 230VAC/Current Transformer (CT)
Timer: 4, 8, 16, or 32 hours. (DIP Switch)
Manual: Reset button
Remote SCADA supervisory reset 9-110VDC

Indication: Red High intensity LED's for earth-fault.
Red/Amber and Green LED for battery status

External indic. LED-6

Remote/Low battery: Permanent Dry relay contacts (NO and NC.)

Maximum switching current:	2A
Maximum switching voltage:	125Vdc, 250Vac
Maximum switching capacity:	30W, 62.5VA

Firmware: 1.0

NFC Tag TypeA: Near Field communication for collecting information from the indicator

- Firmware version
- Serial Number
- Programming/Dipswitch setting
- Battery status
- Fault counter
- Download link to valid Mounting Instruction

Power supply: 1 Lithium Cell A size 3,6Ah/3,6V
Lithium Battery change: Every 1000 hours flashing/up to 10 years

Operating temp range: - 40º to +74ºC

Housing: ASA, PU and PC, UV stabilized

Dimension: Main unit: 85x85 (94mm with hinges) x52 mm (exclusive cable glands)
Main unit: 124x85x52mm with M20 cable glands.

Weight: 0,97kg including sensor and packaging.

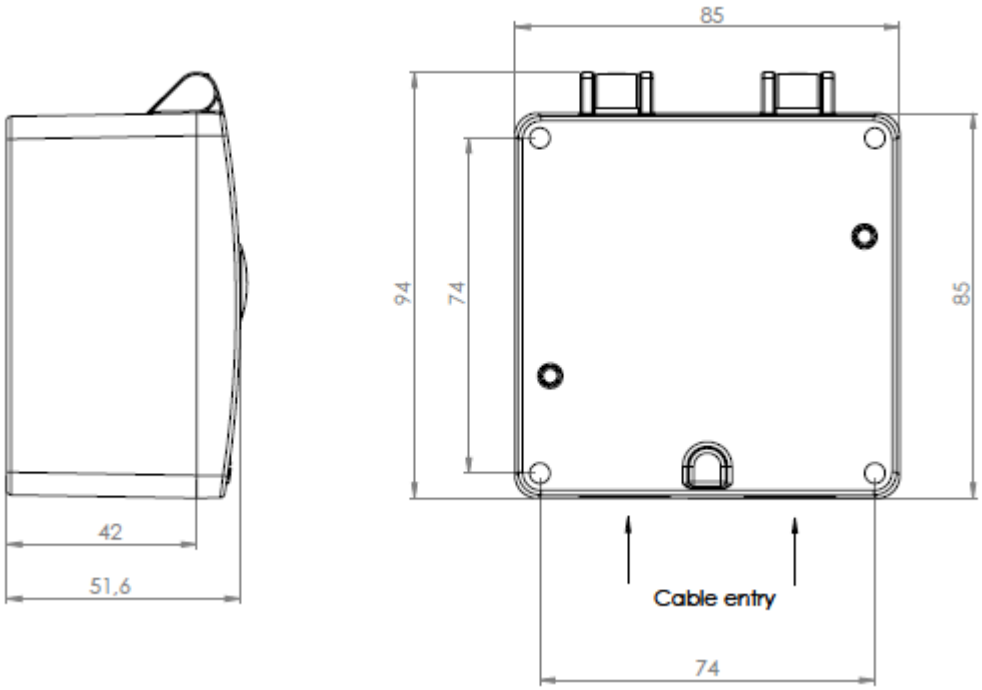
Degree of protection: IP65 (limited by the cable glands)

11 Dimensions

11.1 Housing

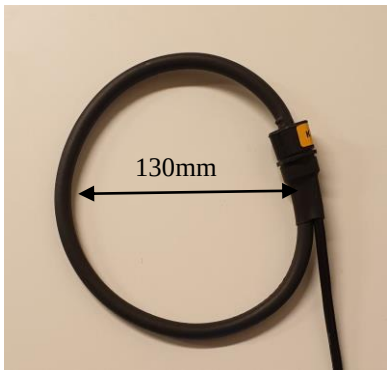
Overall dimensions 85 x 94 x 51,6 mm

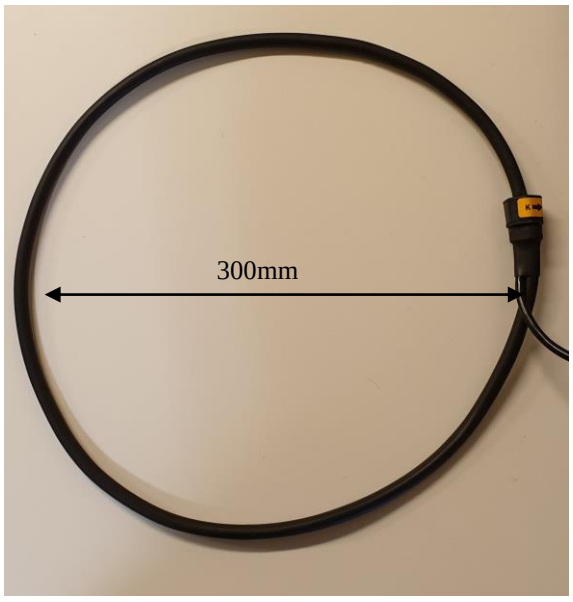
4 x 4.2mm Mounting holes on 74 x 74 mm centres as shown below.



11.2 Split-core Rogowski coil/CT

Overall dimensions 40x45x28 mm (short band diameter: 130mm, long band diameter: 300mm)





11.3 Mounting the Split-core Rogowski coil/CT on the cable

The Rogowski coil/CT is mounted on the cable with cable ties.

12. Ordering Information

Prod no:	01021000	CT210 with Lithium battery, CT, 3m cable and short coil
Prod no:	01021011	CT210 with Lithium battery, CT, 16m cable and short coil
Prod no:	01021012	CT210 with Lithium battery, CT, 3m cable and long coil
Prod no:	01021013	CT210 with Lithium battery, CT, 16m cable and long coil

Prod no:	xxxxxxxxx	LED-6 External indication (not yet available)
Prod.no:	07105701	Replacement battery (KBB-15) 3,8 Ah/3,6V