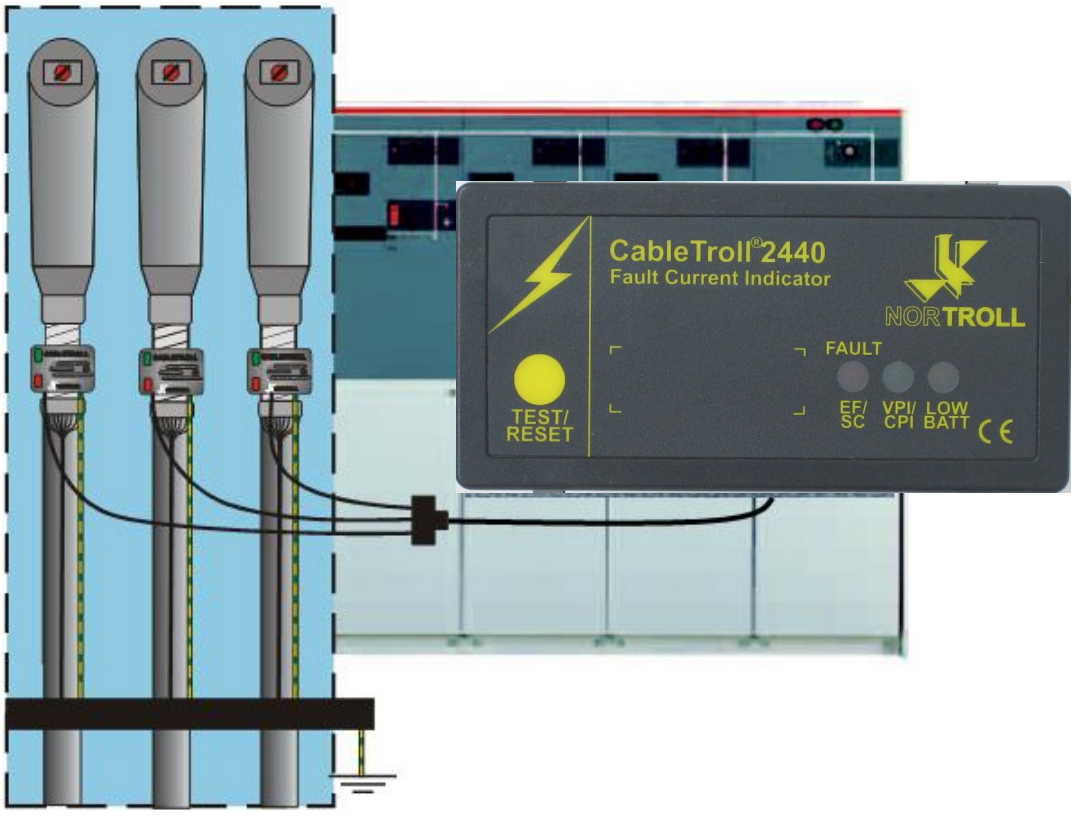
CableTroll 2440

User Manual



CableTroll®

UG CT 2440 April 2011

NORTROLL
FIND FAULTS FAST

This document describes the installation and configuration of the RMU Fault Indicator Product no: 01-2440-00

Rev. 1.0 (07.04.11) / TV Alternative pianodip added

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P.O.Box 133
7601 Levanger
Norway
www.nortroll.no

0. Contents

1. Introduction

The RMU Fault Indicator is a fault current indicator for medium voltage network.
It detects PtE faults (=Phase-to-Earth/Earth Fault) and PtP faults (=Phase-to-Phase/Short Circuit faults).
A complete indicator consists of three phase mounted current sensors for mounting on single core cables, and the main unit with a signal output for connecting to a RTU.

The units is designed according to the DIN 43700 / IEC 61554 and fits into the rectangular hole in front panel on SF_6 insulated Ring Main Units and Compact Switchgear; SafeRing and SafePlus.

The unit is SW-controlled with a field upgradeable microcontroller, hence very flexible for customised functionality.

The indicator has several levels for both PtG and PTP, user-programmable by a micro-switch and 2 rotary switches.
A Normally Open (NO) signalling contact is available for connection to a RTU for remote indication into a SCADA system.

1.1 Definitions

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

Phase-to-Phase Faults	- PtP / Short circuit fault
Phase-to-Earth Faults	- PtE / Earth Faults
Transient Fault	- Intermittent/temporary Fault. Faults cleared within the automatic re-closing
RMU	- Ring Main Units
CB-tripping	- Circuit Breaker trips and the cable is energised

1.2 Typical Fault Situation

In a open ring network or a radial network all indicators between the feeding transformer and the fault will start indicating the passage of the fault current from a PtE or PTP.

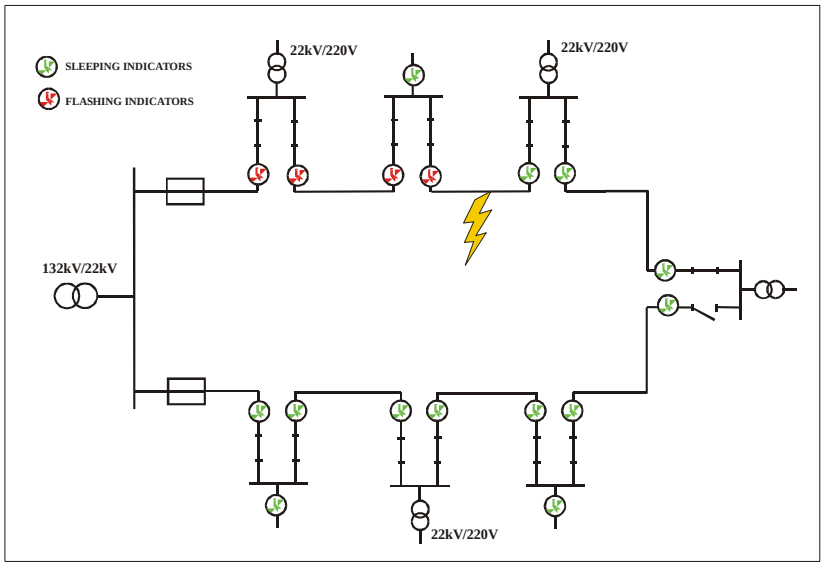
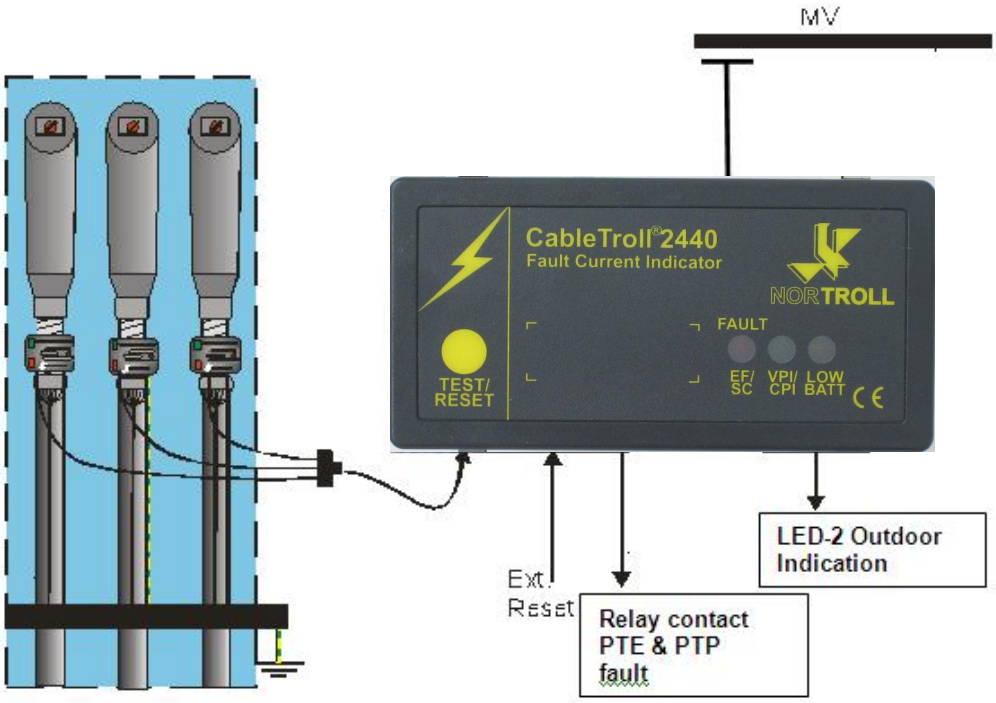


Figure 1. Fault Passage Indication in open ring network.

2. Functional description



2.1 Operational sequence

2.1.1 Permanent faults (PtE or PtP)

A 5 sec inrush blocking prohibits the indicator to incorrectly detect and indicate when the cable is energised.
When a fault occurs; exceeding the threshold for PtE or PtP, followed by a CB-tripping the indicator will start the indication; flashing the corresponding LED's on the front panel and the external LED-2 (if connected) and close the relay contact.
The indication will continue until it resets automatically due to voltage return or after a preset time from the internal timer.

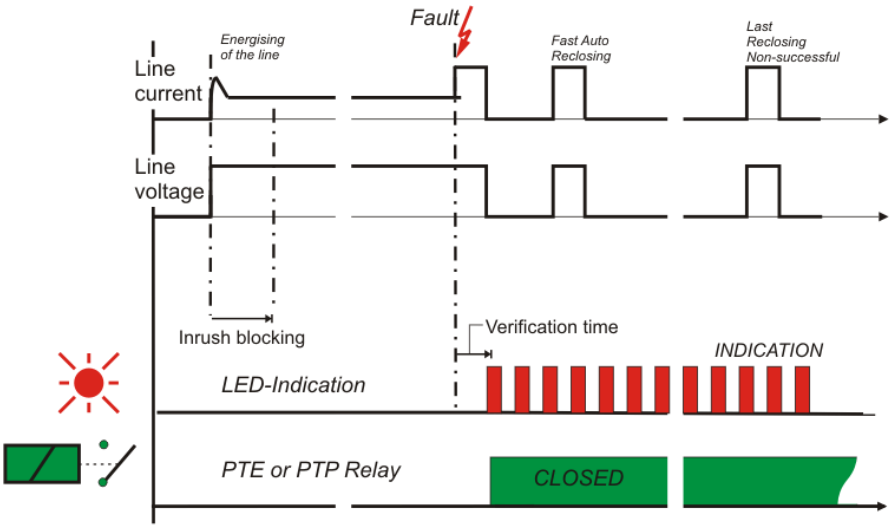


Diagram 1: Permanent faults PtE/PtP

2.1.2 Non-permanent (temporary) faults

If any of the automatic re-closings were successful, the indication will reset; LED stop flashing and the relay contact opens.

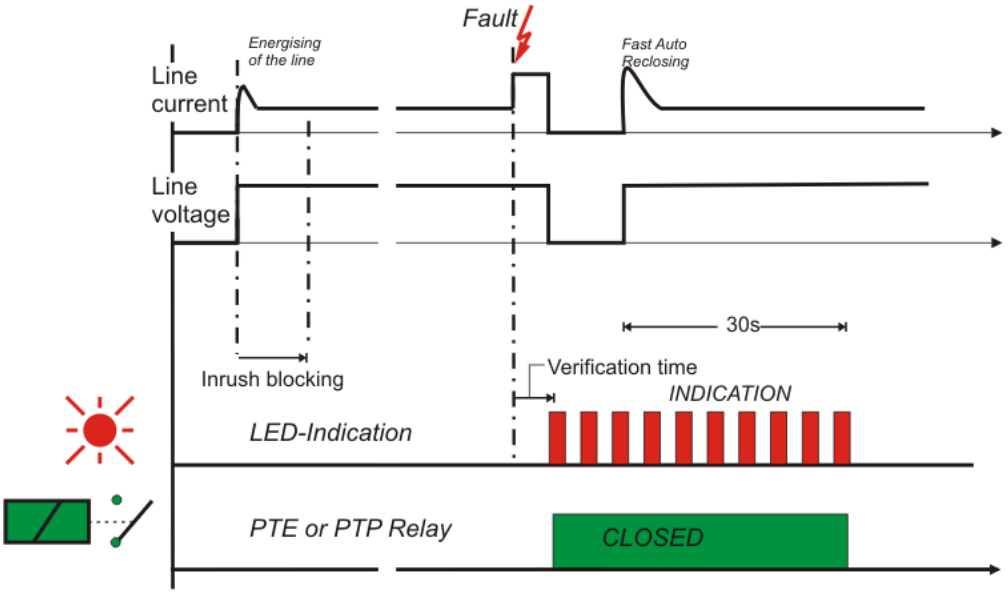


Diagram 2: Temporary (transient) faults PtE/PtP

2.2 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 galvanicaly 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 earth fault element must not exceed the trip level setting of the indicator. The capacitive discharge current will wary 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.

CAPACITIVE DISCHARGE CURRENTS

The CT2440 Fault Indicator is not 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 preset 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 has to be taken into account 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 and or cable:

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

I_C = 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

Basic rules for setting the trip level I_T is:

1. To avoid incorrect detection because of capacitive current from the network down-streams the indicator:

   $I_C < I_T$: where I_C = capacitive current down-streams of the indicator.

2. To ensure correct detection the following has to be met:

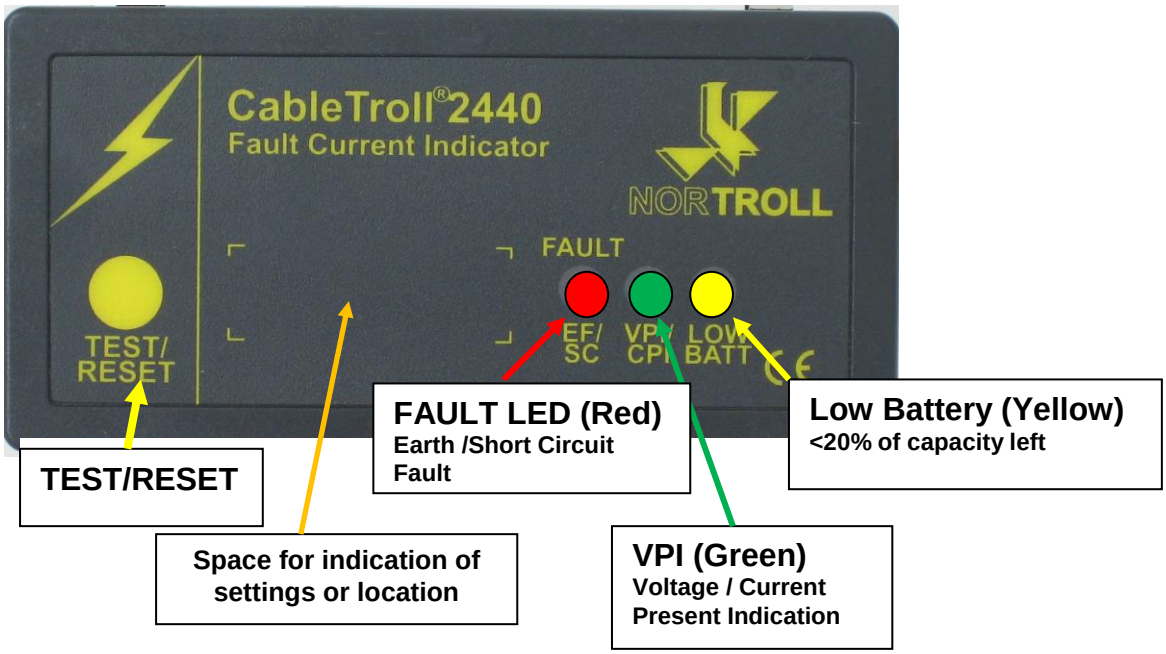
   $I_T < I_{PTG} - I_C$ where I_{PTG} = the networks total Earth Fault current.

⇨ **These two rules can be summarised as follows:**

$$I_C < I_T < I_{PTG} - I_C$$

3. User Interface

Frontpanel, LED's for indication and Test/reset buttons:



3.1 TEST/RESET:

This is a multifunction pushbutton, depending on the status of the product and the duration the button is pressed: The fault LED will indicate when the indicator change status

Duration of pressing	Operation	Fault LED & Ext LED	VPI/ CPI *)	Low Batt. LED	Relay operation
< 0,5s	**TEST** of VPI/CPI	1 flash	2s *)		
0,5 – 3s	**RESET** Flash all LED's (code for SW-rev.) Reset all flashes	2 flash			
3 – 5 s	**TEST** of Fault Simulate a fult	3 flashes – Cont. to indicate a fault (until reset)			1s pulse of Fault Relay
>5s	**TEST** of fault and Low battery	After 4 flashes; release the test button!		Flash 1s	1s pulse of Fault & Low batt relays. See § 3.3

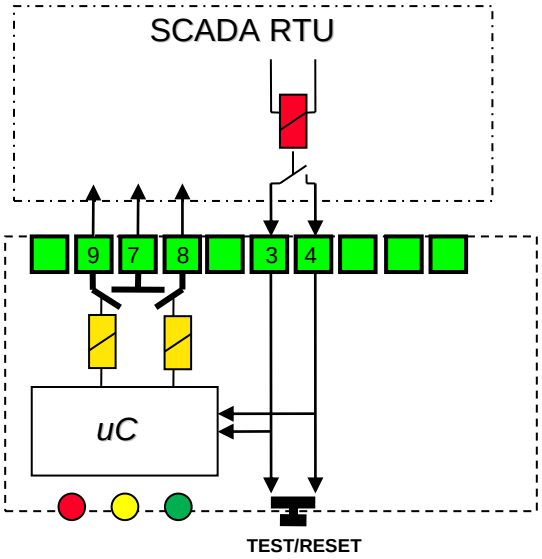
*) Flashes if:

a) Voltage for reset is connected to term 10&11 and "Voltage = ON" (SW#2dip4=off)
OR
b) "Current" = ON (SW#2dip4=on) and Current in sensor L1 measure a current above 10% of setting for I>>; 250, 500, 750 or 1000A.

3.2. Test from SCADA:

The Test/Reset button is connected in parallel with the Ext.Reset terminals #3 & 4,

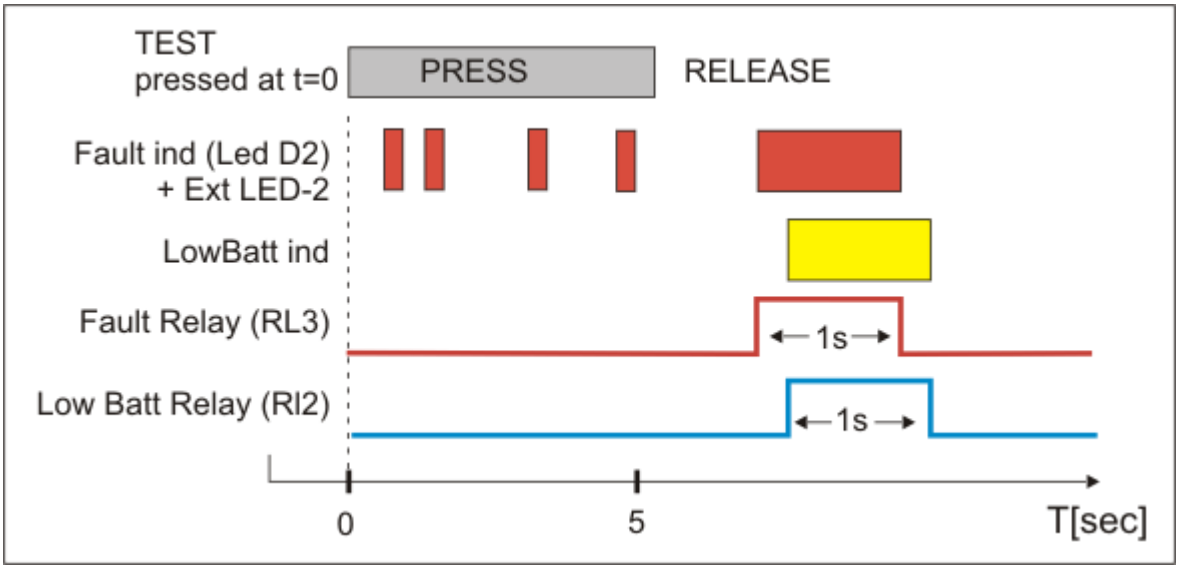
→ Test of the indicator, relay-operations and the communication can be executed from the SCADA-system via the RTU



3.3 TEST:

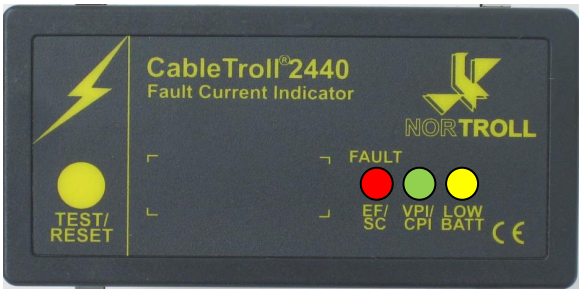
If TEST button is pressed > 5 sec:

After 4 flashes in the FAULT-LED, release the button! The Fault relay will close and the Fault LED flash for 1s. 100ms later, the same opreation on the Low Batter relay and the Low Battery LED, see drawing below.



Test-mode flashing and relay operation

3.4 RESET / POWER UP



When RESET is pressed, or the CT2601 is powered up by connecting the battery, the following indication can be seen:

Light all 3 Led's for 1 sec and THEN IF:

1. Low Battery: THEN Yellow Led will light for 5 sec

2. Auto Reset AND (Voltage or Current is > resp. thresholds)
   THEN Green Led will light for 5 sec.

3.5 LOW BATTERY INDICATION

The CT2440 has an internal battery-counter that will alarm (Low Battery) if the remaining capacity of the battery is less than 20% or the battery have been in service for more than 8 years.

If Low Battery occur; the signalling relay RL2, (Low Battery) will close, and the Yellow LED will start flashing once every 15 sec.

3.6 RESETTING OF LOW BATTERY COUNTER

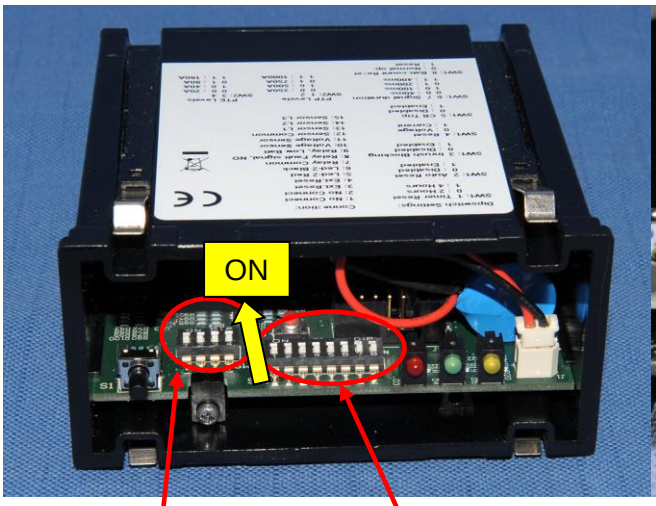
To reset the battery counter, put SW2[8] in ON position and press RESET (0,5 – 3sec)

The Yellow LED will flash until the SW2[8] is switched back to OFF position. All LED's flash twice and the indicator is ready .

Then replace the battery.

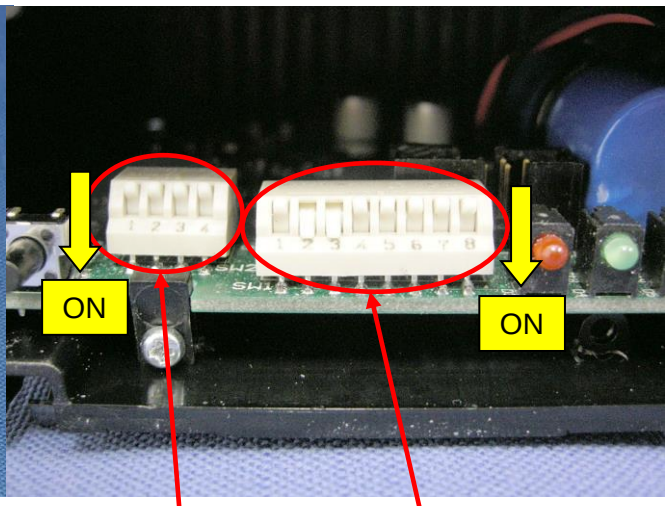
4. Settings/Programming

The programming switches are accessible behind the front panel.
Note! Two different programming switches has been used for this product



Switch bank #1

Switch bank #2



Switch bank #1

Switch bank #2

4.1 Programming of detection levels, PtP and PtE:

Switch bank #1:

Dip	1	2			3	4	
Function	**PtP-fault level I>>**				**PtG fault level Io**		
	OFF	OFF	250 A		OFF	OFF	20 A
	OFF	ON	500 A		OFF	ON	40 A
	ON	OFF	750 A		ON	OFF	80 A
	ON	ON	1000 A		ON	ON	160 A

Switch bank #2:

Dip #	1	2	3	4	5	6	7		8
Function/ Position	**Timer reset**	**Auto Reset**	**Inrush Blocking *)**	**Auto Reset/ Inrush blocking by**	**CB-trip**	**Fault Duration [ms]**			**Reset Battery ctr.**
OFF	2h	OFF	OFF	Voltage	OFF	OFF	OFF	40	Normal
ON	4 h	ON	ON	Current **)	ON	OFF	ON	100	Reset
Note *) If Inrush Blocking = OFF => No function on AutoReset and CB-trip! **) Level for current reset depends on setting of I>>: (approx 20A for I>> = 250A)						ON	OFF	200	
						ON	OFF	300	

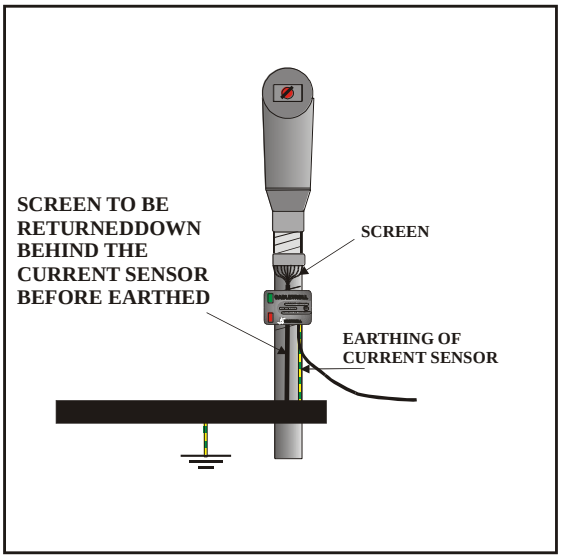
NOTE: TEST/RESET-BUTTON must be pressed if the switch-settings are changed after power-up, in order to initialise the new settings.

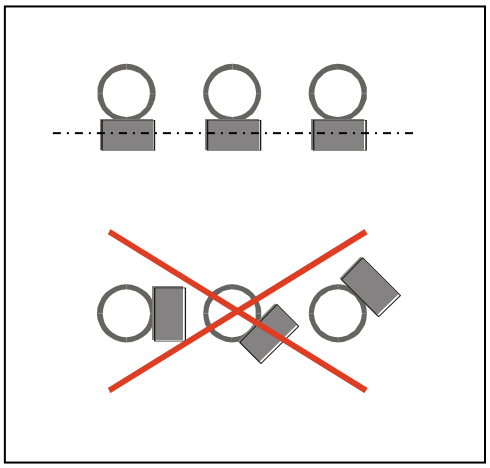
5. Mounting of current sensors

The current sensors should be mounted on the cable termination one on each phase.
IMPORTANT:

Orientation of the sensors: To ensure correct function of the indicator, the sensors must be mounted with their green coloured spot pointing towards the bus-bar in the station (normally upwards), the red spot pointing towards next station.

The screen of the cable must be returned behind the current sensor before it is earthed.



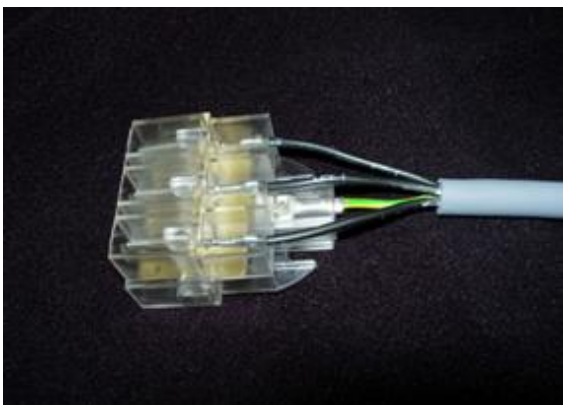


The 3 sensors should be aligned on a line in order to reduce the interference from adjacent phases as well as adjacent feeders

6. Connections

Con. #	Description
1	No Connect
2	No Connect
3	External Reset + (Short Circuit 3 & 4)
4	External Reset - (Short Circuit 3 & 4)
5	Ext LED (-) Led-2 black wire
6	Ext LED (+) Led-2 red wire
7	Relay Common
8	Relay Fault (NO)
9	Relay Low Battery (NO)
10	Voltage Sensor ("Hot" in case of TN) 12-250VAC
11	Voltage Sensor
12	Sensor Common
13	Sensor L1
14	Sensor L2
15	Sensor L3

When connecting the current sensors, the enclosed interface cable with polarised contacts for the Current Sensor must be used.



7. Technical specifications

Application: Integration in Ring main Units
(DIN 43 700 / IEC 61554)

Fault detection principle: 50Hz steady state current detection

Phase-to-Earth fault level *Io*: 20, 40, 80, 160 A

Phase-to-Phase fault level *I*>> : 250, 500, 750, 1000 A

Inrush blocking*): 5 sec

CB-tripping*): 2 sec, can be switched OFF

*) NB! Voltage reset signal connected necessary for both inrush & CB-trip!

Verification time: 40, 100, 200, 300msec

Indication:

Local: 3 LED's:
- PtE- & PtP-Faults (0,5Hz)
- Low battery (1/15Hz if fault 0,5Hz)
- Voltage (Current) Present Indication Capacitive testvoltage (>1pF @ 20kV) or Low Voltage, 12 – 250V AC

External: Output for ext. LED-2 (outdoor indication)

Remote: 1 NO relay contacts common for both PtP and PtE

VPI/CPI: 1 LED indicating energized cable – signal from
Controls the Inrush blocking and auto-reset

Mains power: 1 LED indicating presence of 230VAC

Reset:

Automatic reset; Return of voltage (if VPI connected) delay: 30 sec
Min load current for reset is 10% of the I>> settings;
e.g. I>> = 500A, then load current must be > 50A.

Timer reset: 2 or 4 hours,

Manual: Push button on frontpanel

Remote Closing contact from SCADA-RTU

Power Supply:

Battery Lithium 3,6V – 3,8Ah

Current consumption: Idle: 31uA, Indication: 300uA

Lifetime battery > 1500h flashing hours,
8 year and 1500h flashing hours (30% margin)

Housing:

DIN modular case DIN 43 700 / IEC 61554 (96x48x86mm)
PolyCarbonate, UV resistant

Protection degree:

Main Unit: IP 51

Current Sensors: IP 23

External indicator: IP 54

Ordering information:

Prod Number	Product
01-2440-00	CT 2440 Indicator including battery
2240	LED-2, external indication LED
07-1057-00	Replcament battery (KBB-15) 3.6V, 3,8Ah Lithium