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# Instructions for Use

## SMART NAVIGATOR



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**General Information!**

Before installing and operating this instrument carefully read and understand the contents of this manual.

Store this manual in a safe place for any possible questions in the future. Please, enter the type and ordering number of the device here: \_\_\_\_\_.

You will find all data on the name plate attached to the housing of the instrument.

The content of this operating manual reflects the current state of the art at the date of printing. We reserve the right to make technical changes at any time and without prior notice as necessary in the framework of ongoing developments. Please visit your local representative to get updated versions of our operating manuals. This technical documentation becomes invalid when a new issue appears.

## COMPLIANCE STATEMENTS

### REGULATORY INFORMATION FOR THE UNITED STATES OF AMERICA

Warning	Installation, connection and commissioning of the SMART NAVIGATOR must be carried out exclusively by a skilled/qualified electrician observing the applicable safety rules and regulations.
Attention	This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation
Warning	Changes or modifications to the SMART NAVIGATOR not expressly approved by Dipl.-Ing. H. Horstmann GmbH could void the user's authority to operate the equipment.

SMART NAVIGATOR FCC ID: **YQVHHH001**

### REGULATORY INFORMATION FOR CANADA

Warning	Installation, connection and commissioning of the SMART NAVIGATOR must be carried out exclusively by a skilled/qualified electrician observing the applicable safety rules and regulations.
Attention	Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation
Warning	Changes or modifications to the SMART NAVIGATOR not expressly approved by Dipl.-Ing. H. Horstmann GmbH could void the user's authority to operate the equipment.

SMART NAVIGATOR IC: **9199A-HHH001**

### REGULATORY INFORMATION FOR EUROPE

This instrument is in conformity with the requirements of the EC Electromagnetical Compatibility (EMC) Directive and the EC Low Voltage (LVD) Directive in the current state of issue.

If required, the **CE**-Declaration of Conformity may be obtained from the following address:



**Dipl.-Ing. H. Horstmann GmbH**  
**Humboldtstraße 2**  
**42579 Heiligenhaus**  
**info@horstmannmbh.com**

# PART 1 - INTRODUCTION

## 1.1 INTRODUCTION

This manual describes how to install, operate and troubleshoot the SMART NAVIGATOR Faulted Circuit Indicator for distribution voltage overhead lines. It covers the following part number:

43-XXXX-XXX SMART NAVIGATOR

The manual consists of 4 main parts:

Part 1 – Introduction

Gives an overview of the Navigator / SMART NAVIGATOR overhead line fault indicator

Part 2 – Functionality

Describes the functionality of the Navigator / SMART NAVIGATOR

Part 3 – Installation & Operation

Describes how to install, operate and troubleshoot the Navigator / SMART NAVIGATOR

Part 4 – Technical Data

Contains the technical data of the Navigator / SMART NAVIGATOR

## 1.2 ABBREVIATIONS

Abbreviation	Definition
DA	Distribution Automation
FCI	Faulted Circuit Indicator
ISM	Industrial / Scientific / Medical
RF	Radio Frequency
RTU	Remote Terminal Unit

## 1.3 INTENDED USE

The SMART NAVIGATOR is an overhead faulted circuit indicator that is designed and engineered for Smart Grid – Distribution Automation applications. The SMART NAVIGATOR is installed on overhead distribution circuits and transmits event based fault information in addition to continuous circuit status information. The SMART NAVIGATOR is integrated into an existing Smart Grid system and can operate in different WAN environments such as cellular, radio, etc. A pole mounted concentrator, either the SMART RECEIVER or SMART CONTROLLER acts as WAN access point.

## 1.4 PRODUCT OVERVIEW

Designed for overhead distribution circuits, the SMART NAVIGATOR fault indicator quickly and accurately aids trouble crews in determining the status of the system and the location of faults. Installed directly on the overhead conductor the unique design allows easy installation and/or removal with a hot stick.

The SMART NAVIGATOR is specially designed and engineered for Smart Grid – Distribution Automation (DA) applications. The SMART NAVIGATOR indicates a fault locally by LED and also over a wireless radio link. The wireless link is established with a SMART NAVIGATOR compatible concentrator that makes this information available for remote monitoring via a RTU. The fast SCADA room availability of FCI status information helps drastically saving time for the identification of the faulty line section. This substantially speeds up the process of restoring the power supply to the utility customers.

In addition the SMART NAVIGATOR continuously monitors and transmits circuit status information which helps to identify distribution grid capacity, improves grid planning and supports analysis of predictive or post-fault switching decisions.

A SMART NAVIGATOR compatible concentrator as located within a SMART RECEIVER connects with up to 12 SMART NAVIGATOR FCIs. Communication between the concentrator and the SMART NAVIGATOR uses wireless radio frequency technology in the world-wide license-free 2.4GHz band.

Application Example: The figure below shows a typical application for the SMART Navigator.

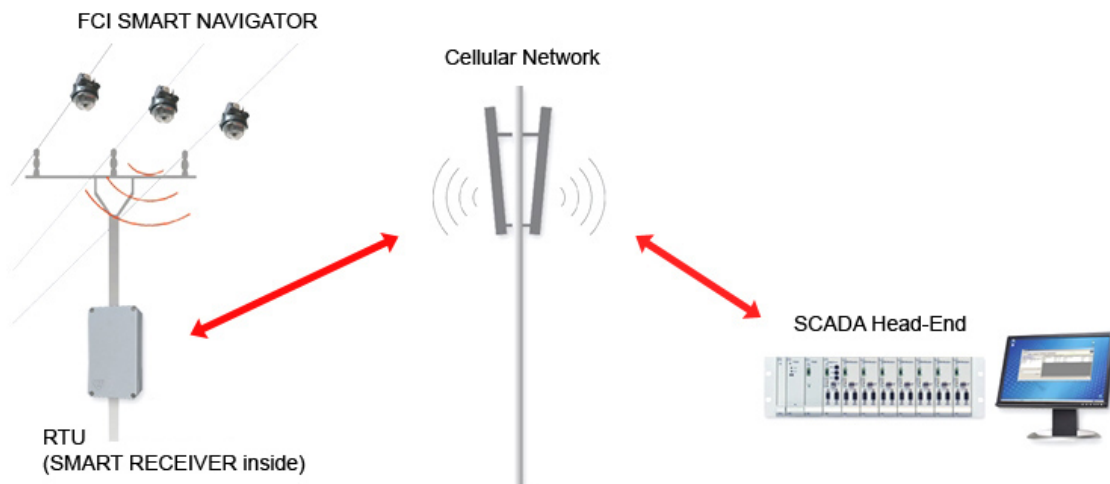


Figure 1.1: Application example for SMART RECEIVER

Status information about the overhead line is sent from the SMART NAVIGATORS to the SMART RECEIVER which resides inside a pole mounted RTU. The SMART RECEIVER relays the information to the RTU which itself transmits it over a network, e.g. cellular GSM network, to a SCADA head-end for the network control room integration.

## PART 2 - FUNCTIONALITY

### 2.1. DEVICE DESCRIPTION

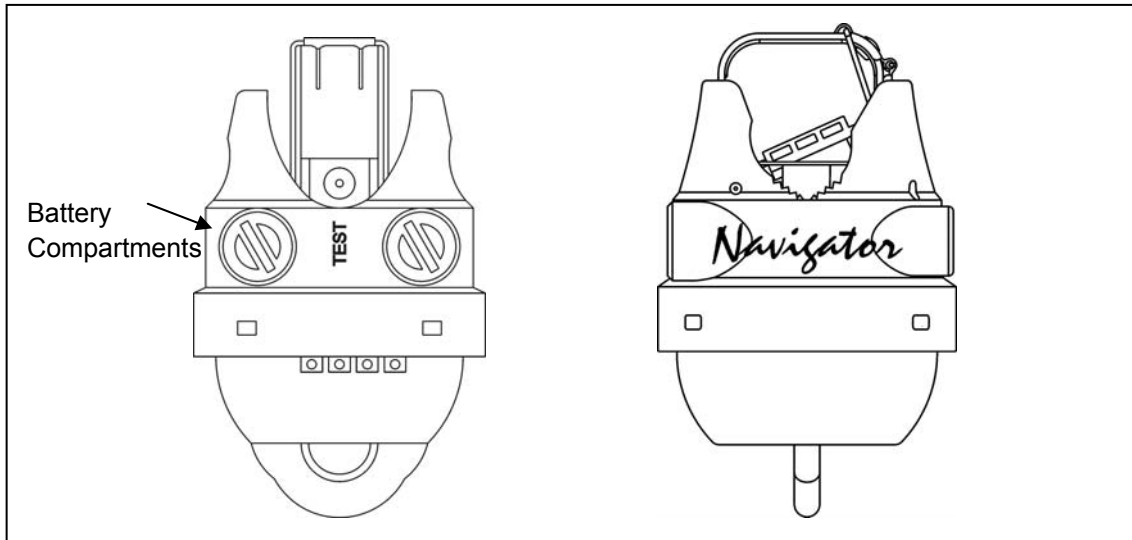


Figure 2.1: NAVIGATOR 2D View

## 2.2. FAULT DETECTION, INDICATION AND RESET

### 2.2.1 FAULT DETECTION

The SMART NAVIGATOR constantly monitors the load current on the conductor and electronically adjusts the trip curve position accordingly. This self adjustment is defined as load tracking function. The initial or out of the box setting is the most left trip curve, the reference trip setting is displayed in the figure below. Its location is described by the time - current coordinates @200ms.

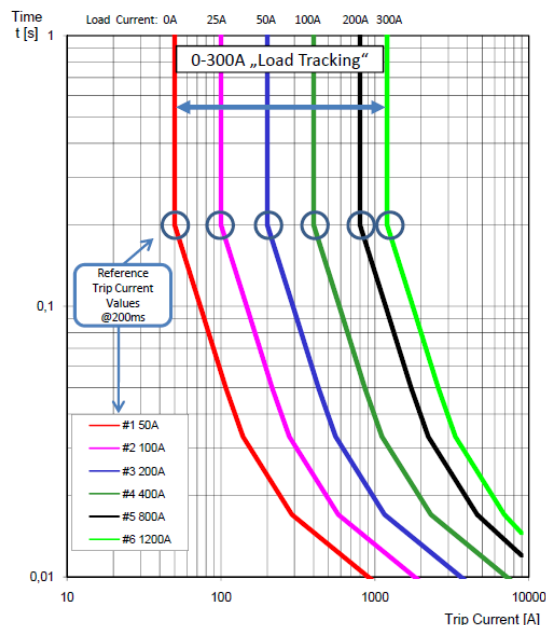


Figure 2.2: NAVIGATOR Load Tracking / Self adjusting function

### 2.2.2 FAULT INDICATION AND RESET

The SMART NAVIGATOR features one ultra bright RED LED that provides fault information.

LED Status	Meaning
Off	Normal status of FCI
1 RED LED Flashing	Fault Indication

Fault detection is indicated by an extremely bright flashing LED, giving excellent focused visibility.

Upon detection of a fault, the LED of the indicator begins to flash. After a predefined delay, a current sensor is enabled that will check if line current is present or not. If no current is detected, the fault is classified as “permanent fault” and the LED will continue to flash until reset by current or by time or by magnet, whichever occurs first.

If after the predefined delay a current is detected, the fault is classified as “momentary fault” and the red LED will be turned off.

Local manual reset and testing is done with a permanent magnet.



## 2.2.3 FAULT INDICATION AND LINE MONITORING BY RADIO SIGNAL

Once the SMART NAVIGATOR identifies fault current above its trip rating threshold, the SMART NAVIGATOR sends a short range radio message to the SMART RECEIVER. This event based message contains the status of the overhead line and other system data. Events can also be triggered other status changes like a loss of current:

Event based reports:

- Fault detection
- Momentary vs. permanent fault detection
- Low battery

In addition the SMART NAVIGATOR also monitors parameters of the overhead line. These functions are provided by a 15 minute communication interval.

Continuous reports:

- Routine call every 15 minutes for status updates
- Average load current
- Ambient temperature

## 2.3. WIRELESS COMMUNICATION

The SMART NAVIGATOR FCIs communicate with the SMART RECEIVER via low power RF wireless technology using the world-wide available 2.4GHz ISM (Industrial/Scientific/Medical) frequency band. The range between the SMART RECEIVER and a SMART NAVIGATOR can extend up to 100ft (30m).

The SMART CONTROLLER concentrator within a SMART RECEIVER always acts as the short range radio network master controlling the communication with all the FCIs. Every SMART NAVIGATOR needs to pass an initial registration procedure to successfully register at the SMART CONTROLLER before any communication can start.

The SMART NAVIGATOR will be the part that initiates radio contact with the SMART CONTROLLER.

### 2.3.1 PRIORITY EVENTS COMMUNICATE BY EXCEPTION

If a SMART NAVIGATOR detects a priority event such as a fault alarm it will initiate communication immediately. Therefore the SMART NAVIGATOR will initiate contact with the SMART CONTROLLER and transmit such events immediately.

### 2.3.2 REPORTS COMMUNICATE BY ROUTINE INTERVAL

Every 15 minutes each SMART NAVIGATOR establishes its communication to the SMART CONTROLLER to update its analog and status data.

## 2.4. TEST/RESET CONTACTS

The SMART NAVIGATOR features two reed contacts marked TEST and RESET that can be activated with a magnet.

### 2.4.1 TEST & RESET MAGNET

The test & reset magnet is a permanent magnet retained by a specially designed housing allowing it to fit universal and shot gun type hot sticks. This allows testing of faulted circuit indicators on live circuits following proper hot stick procedures. The purpose is to introduce a magnetic field that will influence individually the 'TEST' and 'RESET' switches of electronic faulted circuit indicators.



Figure 2.5:

### 2.4.2 TEST & RESET MAGNET ALLOCATED FUNCTIONS

- 1) The TEST contact position is located on the housing between the front battery compartments and is marked by a label "TEST". Activating the reed contact TEST with a magnet for >0,2s does test the local indication and radio link:  
  
It turns the FCI ON and activates a local fault indication (LED flashing). The unit will be flashing until reset by magnet, elapsed reset time or current depending of occurrence.  
In addition the SMART NAVIGATOR sends out radio signal TEST (FCI ON).
- 2) The RESET contact position is located on the housing between the front battery compartments and is marked by a label "RESET". The reed contact RESET has three functions:
  - Local and radio communication RESET (FCI OFF):  
Closing the reed contact RESET with a magnet for >0,2s shuts off a flashing FCI (Reset of Indication). In addition the SMART Navigator sends out a radio signal FCI RESET (FCI OFF).
  - Start radio link registration procedure:  
Holding the Magnet on a silent (=not flashing) Navigator for >5s continuously activates the Smart Navigator registration sequence. This can only be performed if before a SMART CONTROLLER/RECEIVER within radio range has been activated in its registration mode (see chapter installation).

## 2.5. ENERGY SUPPLY

The SMART NAVIGATOR is powered by an internal battery. For the function of current measuring the unit is also energy harvesting from the overhead line.

The field replaceable battery provides operational power. Not only dependent on line current or voltage for its power, the fault indicator is constantly “armed & ready” to register switching into faults at any time.

The SMART NAVIGATOR is designed for an operational time of 15 years. If it detects that its battery is approaching the end of its service life, the SMART NAVIGATOR will activate the low battery event.

## PART 3 - INSTALLATION & OPERATION

### 3.1. SAFETY INSTRUCTIONS

Installation should be carried out observing appropriate safety regulations and the use of proper protective equipment such as hot sticks. Operators must maintain safe clearance from electrical power lines in accordance with applicable utility and government rules and regulations.

### 3.2. MECHANICAL INSTALLATION

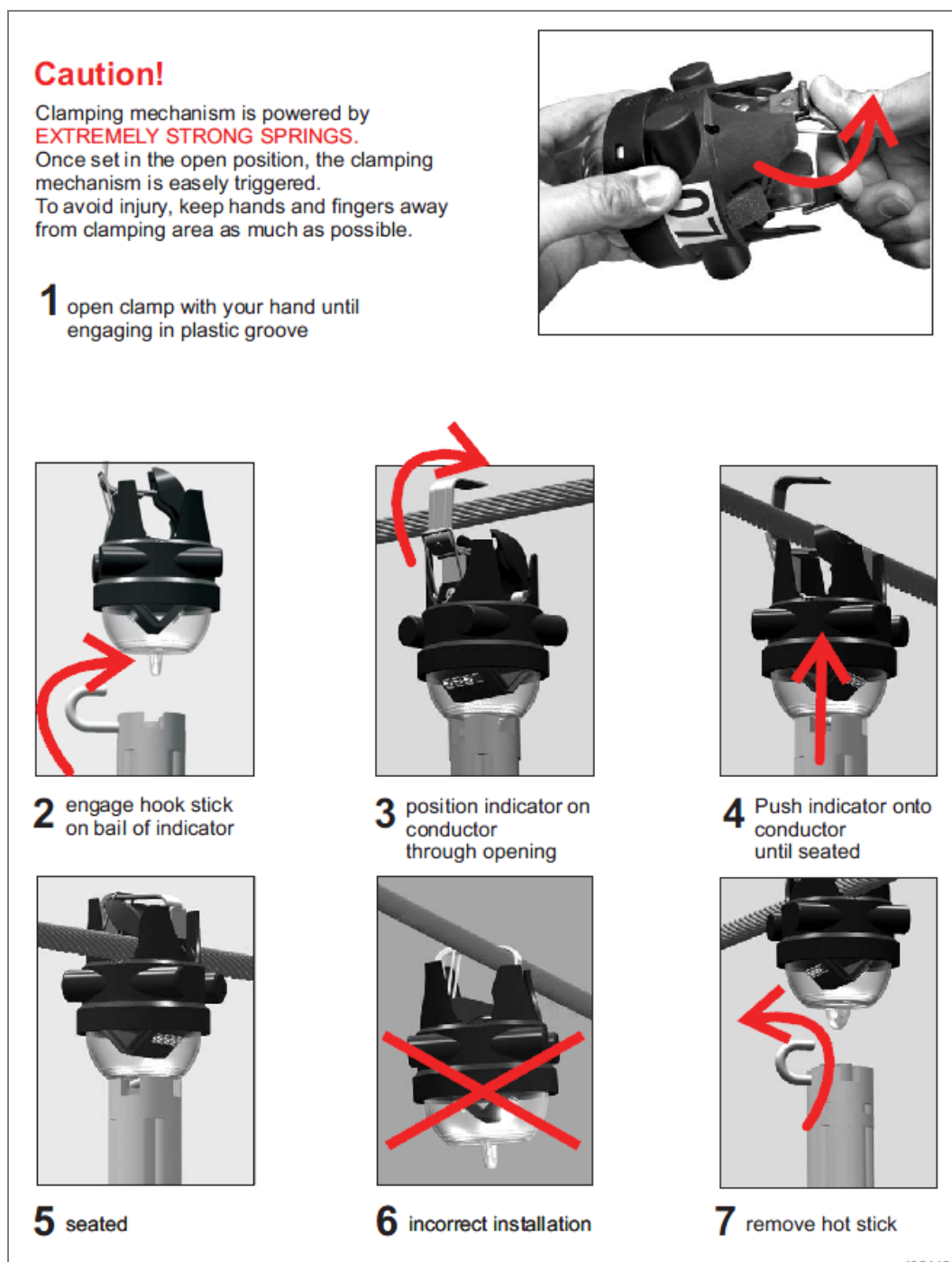


Figure 3.1:

### 3.3. SMART NAVIGATOR - OPERATION

The SMART NAVIGATOR sends the following information to the SMART CONTROLLER/RECEIVER.

#### 3.3.1 PRIORITY EVENTS = REPORT BY EXCEPTION

The SMART NAVIGATOR does report by exception within after an event was registered.

1. Fault alarm:  
Whenever a SMART NAVIGATOR senses an over-current, i.e. a fault on the overhead line; it sends the notification "fault alarm".
2. Fault classification (permanent fault or momentary fault):  
Whenever a Smart Navigator has detected a fault it will decide after a predefined delay whether this fault was a momentary fault or a permanent fault (Evaluation of post fault circuit condition). A momentary fault is classified based on the decision that the fault has already been cleared and the overhead line returned to normal status. A permanent fault is classified as one which still exists. Depending on this decision, a SMART NAVIGATOR either sends "permanent" or "momentary" fault information.
3. Low battery:  
Whenever a SMART NAVIGATOR detects that its battery is approaching its end-of-life it sends the "Low Battery" information.
4. Test (FCI ON):  
Activating the reed contact TEST with a magnet for >0,2s activates a local fault indication and the SMART NAVIGATOR sends out a Radio Test Signal "FCI On".
5. Reset (FCI OFF):  
If the LED indication of the SMART NAVIGATOR stops either by current, time or manual (by magnet) the SMART NAVIGATOR sends out a Reset signal (FCI off).

#### 3.3.2 OTHER EVENTS

Other non priority events are not sent by exception. Therefore their status change will be notified within the next 15 minute routine interval call or any earlier initiated communication:

1. Battery changed:  
A change of battery will be reported if total power is lost and routine was conducted as described in the instructions.

#### 3.3.3 ANALOG DATA

In addition to event based fault identification, the SMART NAVIGATOR also can report analog readings. Continuous Reporting is done based on a 15 minute routine call interval cycle.

1. Average load current: Average load current of last call interval (15 minute average)
2. Temperature: Temperature at SMART NAVIGATOR

### 3.5 SMART NAVIGATOR @SMART RECEIVER REGISTRATION PROCEDURE

The registration of other end devices like a SMART CONTROLLER embedded in an RTU might differ in registration steps, please refer to the specific end devices user manual.

Before a SMART NAVIGATOR can transmit data to a SMART RECEIVER it has to initially once register at and with the SMART RECEIVER. If registration was successful and the SMART RECEIVER loses power supply the registration data remains safe and communication ability recovers after the power returns. Please refer to communications section. The registration requires 4 steps as follows:

#### **Step 1**

Confirm that the SMART NAVIGATOR is NOT flashing and that the SMART RECEIVER is powered ("ON" LED is active).

#### **Step 2**

Hold a magnet close to the reed switch until TX and I/O LEDs light up. This may take up to 10 seconds. A time window of 3 minutes is now open for pairing with a SMART NAVIGATOR.

#### **Step 3**

Hold the magnet close to the RESET point of the SMART NAVIGATOR until a yellow LED in the SMART NAVIGATOR lights up twice. If after a maximum of 10 seconds either a red LED or no LED has flashed at all, the registration procedure has failed (Please retry in such case).

For an overview about the meaning of the SMART NAVIGATOR LEDs refer to the following table:

<b>Yellow LED flashing twice</b>  → SMART NAVIGATOR completed registration successfully
<b>Red LED flashing twice</b>  → Communication Error → Repeat procedure from step 1 → 12 SMART NAVIGATORS already registered with SMART RECEIVER → Check installation plan
<b>No LED flashing</b>  → SMART RECEIVER not in registration mode → Check TX and I/O LED are active → Repeat procedure from step 1 → Either device defect → Return for repair

#### **Step 4**

Check that the SMART RECEIVER has turned off the I/O and TX LEDs. This means that the SMART RECEIVER completed the registration procedure successfully, too.

If this does not happen, press the push button for about 1 second and start from step 1.

#### **Step 5 (Optional)**

Repeat steps 1-4 in order to register up to 12 SMART NAVIGATORS per SMART RECEIVER.

## PART 4 - TECHNICAL DATA

TECHNICAL DATA	
<b>Electrical Data:</b>	Corresponding to ANSI / IEEE Std 495-2007
Trip current (unleveled)	50 A - 1200 A / 200 ms
Local indication / Flashing frequency	Super bright red LED / 30 per minute
Current reading range	3 A to 10 kA
Load tracking	Initiated with load current $\geq 20$ A
Temperature range	-30 up to +70 °C (ANSI test -40 up to +85 °C passed)
Trip Current Accuracy	$\pm 10$ % @100 A @ 20 °C
Trip factor	4 times load current @ 200ms
Level delay	60 sec.
Level memory	72 hours
Function test / reset	by use of permanent magnet
Automatic time reset	4 hours
Current reset	$\geq 3$ A
Power source	1 Lithium - Battery, replaceable, 15 years shelf life
Maximum operating voltage / Frequency	46 kV / 60Hz
Current withstand	25 kA / 1s
<b>Transmitter Part:</b>	
Frequency / Power / Modulation	2.4 GHz / 1 mW / 2-FSK
Range	> 100 ft. (30 m) installed on overhead
Distinction of different units	Up to 12 addressable units
<b>Mechanical Data:</b>	
Cable diameter range	0,31-1,15" (8-29mm)
Housing material	PA / PC; UV stable
Current transformer	Closed core
Weight	420 g
EMI	IEC 1000-4-2 (ESD), IEC 1000-4-3 (HF)
<b>Catalog No.:</b>	43-xxxx-xxx

## 4.1. PRODUCT FOTO & LABEL INFORMATION



Label with

- FCC ID
- IC ID