



SENTINEL D[®] - Fault Passage Monitoring

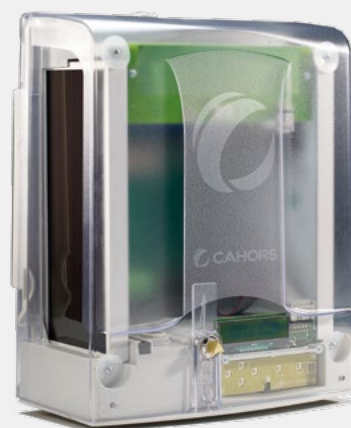
COMMUNICATING DIRECTIONAL FAULT PASSAGE INDICATORS FOR OVERHEAD MV NETWORKS

Installed on poles of overhead lines, the **Overhead-Sentinel-D** range allows locating the fault arisen on the MV network, whether they are single phase to earth, multi-phase, transient or permanent. It allows identifying quickly the failing section of the network, supplying:

- a blinking light for the permanent fault.
- reporting all events counters fault (transient or permanent).

The **Sentinel-D** is a fault indicator for overhead lines, adapted to all the earthing mode of the MV neutral:

- network with arc suppressing coil (Petersen coil),
- network with impedance earthing,
- network with direct earthing,
- network with isolated earthing.



FRENCH PRODUCTION



> DESCRIPTION

Functioning

Directional detection

The **Overhead-Sentinel-D** measures the electromagnetic field and the electric field supplied by the overhead line. The sensor integrated in the indicator provides an image of the residual current. Another sensor provides an image of the residual voltage.

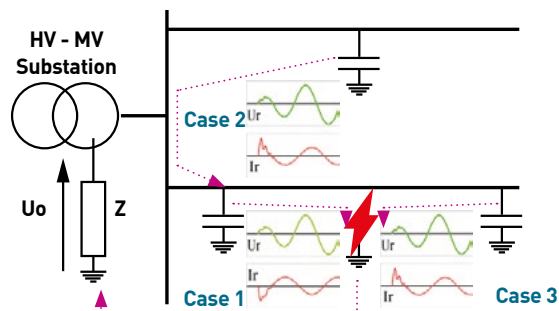
The detection is based on the analysis of the transient residual current and voltage when fault single phase to the earth occurs.

The detector indicates in which geographic direction (downstream, upstream) the defect is located on the network.

A fault passage indicator will flash if the capacitive current downstream to this detector is significant compared with the total capacitive current of the network.

Amperemetric detection

The **Overhead-Sentinel-D** includes a sensor that provides an image of the phase current flowing in the network.

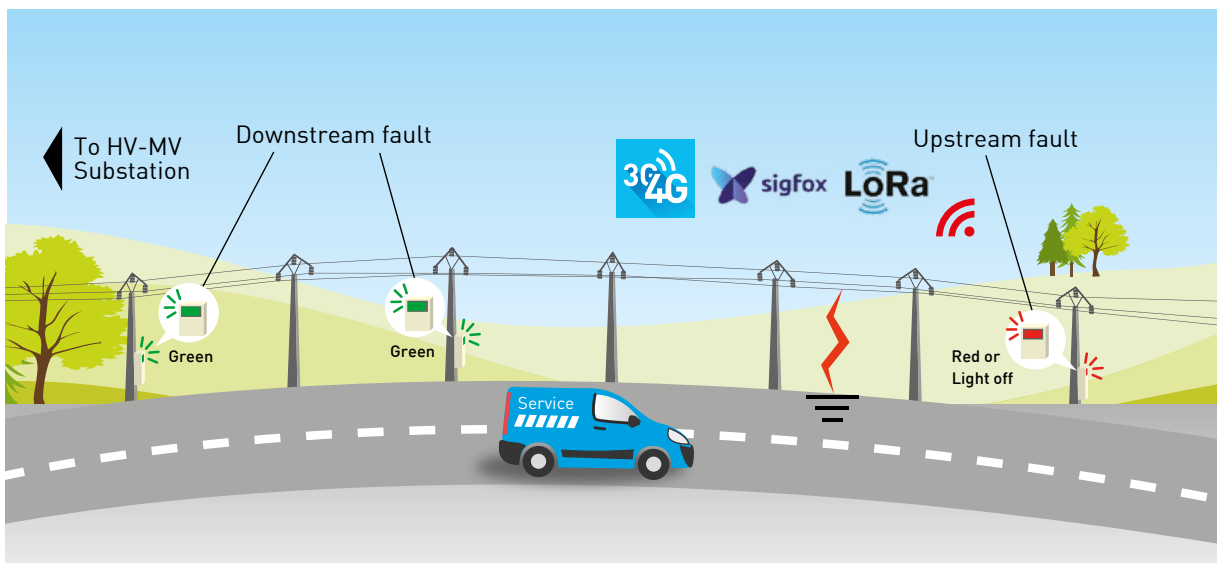


> FAULT LOCALIZATION

Single phase earth faults

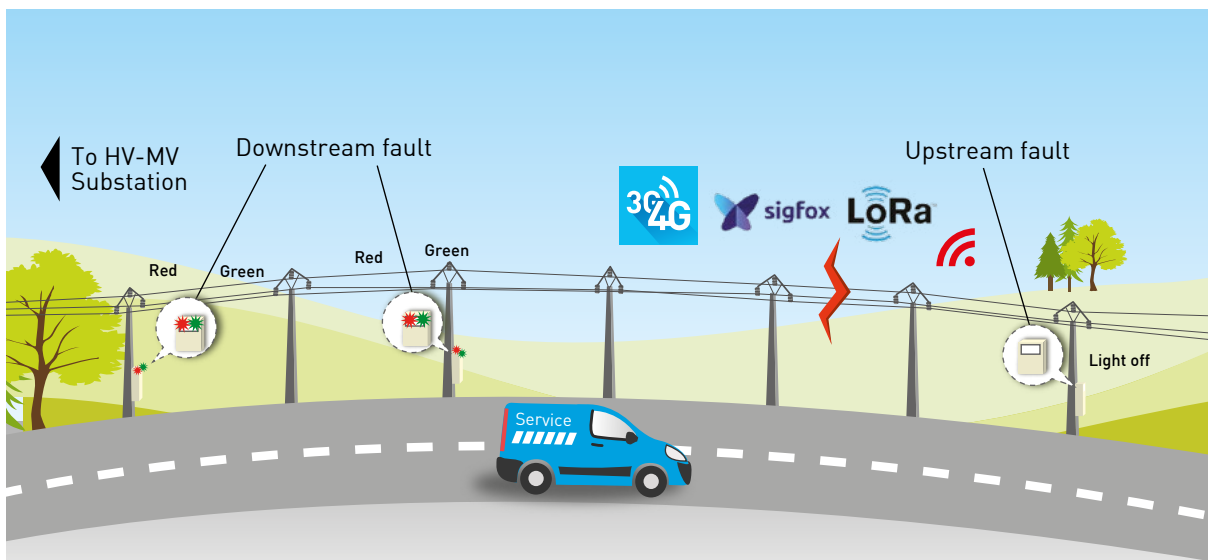
The single-phase earth faults are indicated with only one color light. When all detectors are installed on the same face (ie on the same way that high voltage substation or on the opposite), the fault is located on the network section before the first detector:

- that changes color,
- or is not flashing because of a too low intake of capacitive current of the downstream section.



Dual and multi-phase faults

They differ from other defects by double colors (alternating Red and Green). Only detectors located between the high voltage station and the defect flash. The fault is located on the network section between the last detector whose flashes and the first whose is not flashing.





> SIGNALLING FAULTS

Flashing information

The information of the presence of a fault that led to the definitive trip of feeder is indicated locally by a LED.

The signalling is performed at a rate of one flash per second:

- **red flash** in the event of a single-phase fault (or green if the fault is in the opposite direction)
- **alternately red flash and green flash** in the event of a multi-phase fault or double fault to earth



Flashing dedicated to remote control

Two relay outputs (dry potential free contacts) copy the light signalling. These contacts (NO) allow to bring back fault information to an external application.

These contacts are activated for 100 ms to the appearance of transient fault then, if the fault becomes permanent, the contacts are activated for the duration of the light signalling.

Flashing of alarm « Equipment fault »

A third relay output provides to an external application, information on the correct operation of the fault passage indicator. Two dry contacts («normally open» and «normally closed») are activated from the loss of supply of the fault passage indicator (end of autonomy of the rechargeable element - ultra capacitor - end of battery life) or in the event of processor failure (watchdog).

It indicates that the detector is no longer operational:

- the “NO” contact opens
- the “NC” contact closes

> COMMUNICATION

As an option, the overhead line fault passage indicator **Sentinel-D** can be equipped with a communication module that transmits the information from the remote FPI directly to the operator or control room system responsible for network management.

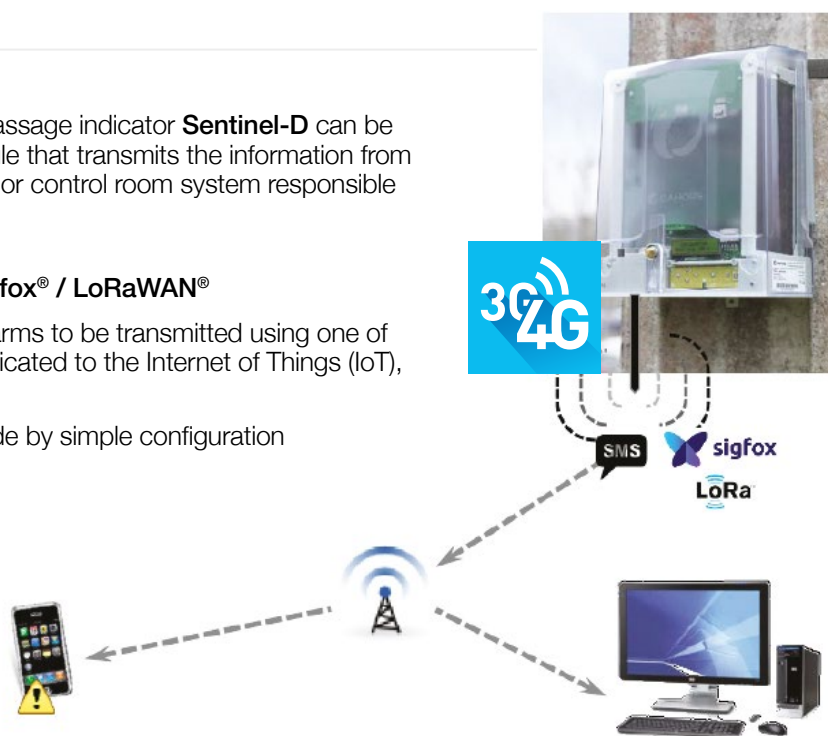
LPWAN communication module Sigfox® / LoRaWAN®

This communication module allows alarms to be transmitted using one of the new communication networks dedicated to the Internet of Things (IoT), Sigfox® or LoRaWAN®

The choice of the network used is made by simple configuration of the Fault Passage Indicator.

Cellular communication module

With this communication module, alarm messages are sent to the operator by SMS (Short Message Service) via GSM/2G/3G/4G/4G cellular networks.



> HUMAN MACHINE INTERFACE

The overhead line fault passage indicator **Sentinel-D**, in addition to the basic functions of detecting and signalling the faults that led to the final tripping of the outgoing circuit-breaker, counts and returns the number of fugitive, semi-permanent and permanent faults of the various types (single-phase and multi-phases).

As an option, the FPI **Sentinel-D** has a local machine interface to access the same menu as the remote control.

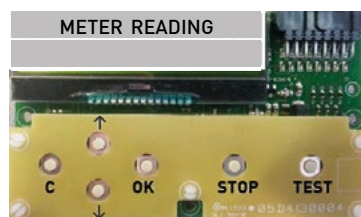
A Bluetooth® radio remote control and/or an Android Sentinel-RMT application allows you to remotely consult and configure the **Sentinel-D**. With a range of about 20 meters, these tools facilitate the configuration and reading of FPI:

- without getting out of the vehicle
- in hard-to-reach areas
- when the detector is placed more than 2 m high.

Equipped with a display and push buttons, the remote control allows the user to make:

- the consultation of messages in clear text
- the visualization of the numbers and fault types (counters)
- the configuration of the various parameters and setting thresholds

It uses standard commercial batteries (2 x LR06 alkaline AA 1.5V batteries)



> KEY BENEFITS

AMPEREMETRIC OR DIRECTIONAL FAULT PASSAGE INDICATORS FOR OVERHEAD MV NETWORKS.

- No contact with Medium Voltage line during installation
- Electrical field sensor technology without line contact for FPI (Fault Passage Indicator)
- Communication facilities for fast fault localization with Sigfox, LoraWan or GSM telecom technologies
- A local blinking light for the permanent fault localization
- Reporting all events counters (transient or permanent) for analysis
- Power supply with integrated solar panel or batteries



> INSTALLATION

The **Overhead-Sentinel-D** is designed to be installed on electric poles of overhead lines. The supports can be concrete, wood or metal.

The box is fixed to the pole height **between 3 m and 6 m** (5 m being the default position).

The height between the floor and the lowest of the line wire shall be **between 7 m and 14 m**.

The pole must be free of all vegetation high on **a radius of 3 meters around the support**.



Warning:

To maintain its sensitivity, the **Overhead-Sentinel-D** should not be installed:

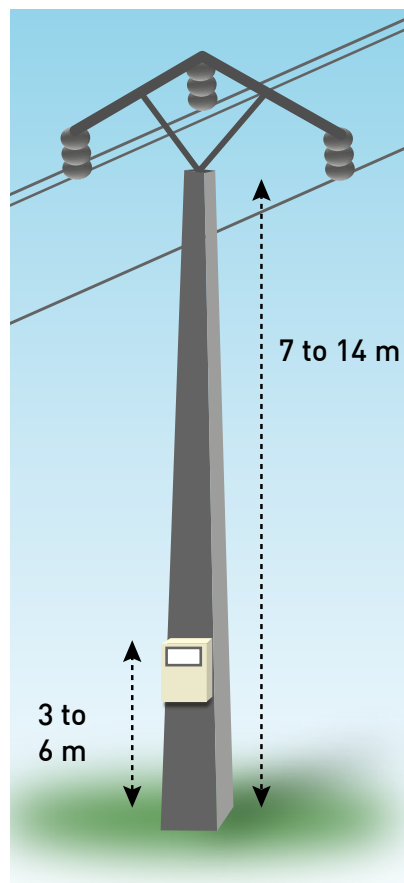
- less than 50 m from another MV line,
- less than 200 m from HV line (<100kV) or railway,
- less than 500 m from HV line (>100kV),
- less than 50 m from an overhead-underground connection.



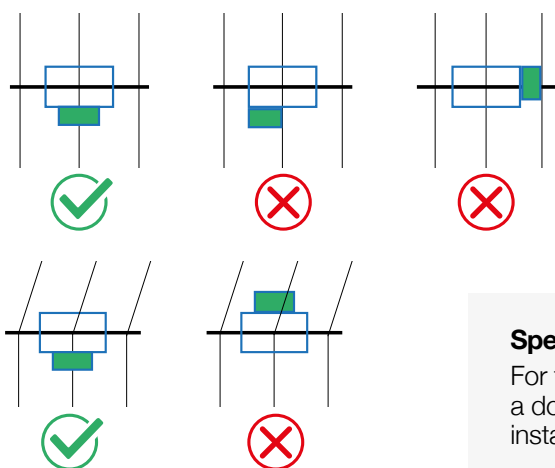
Warning:

The **Overhead-Sentinel-D** should not be installed in the following cases:

- on cross supports,
- on overhead-underground connection,
- on mix supports (with multiple networks HV, LV).

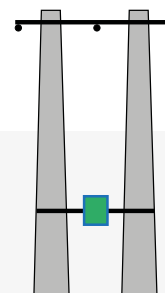


The **Overhead-Sentinel-D** must be installed at the center of the pole in the center of the overhead line:



Special case

For the use of **Overhead-Sentinel-D** on a double support, the detector must be installed on a crossbar between two poles.



> OPERATION

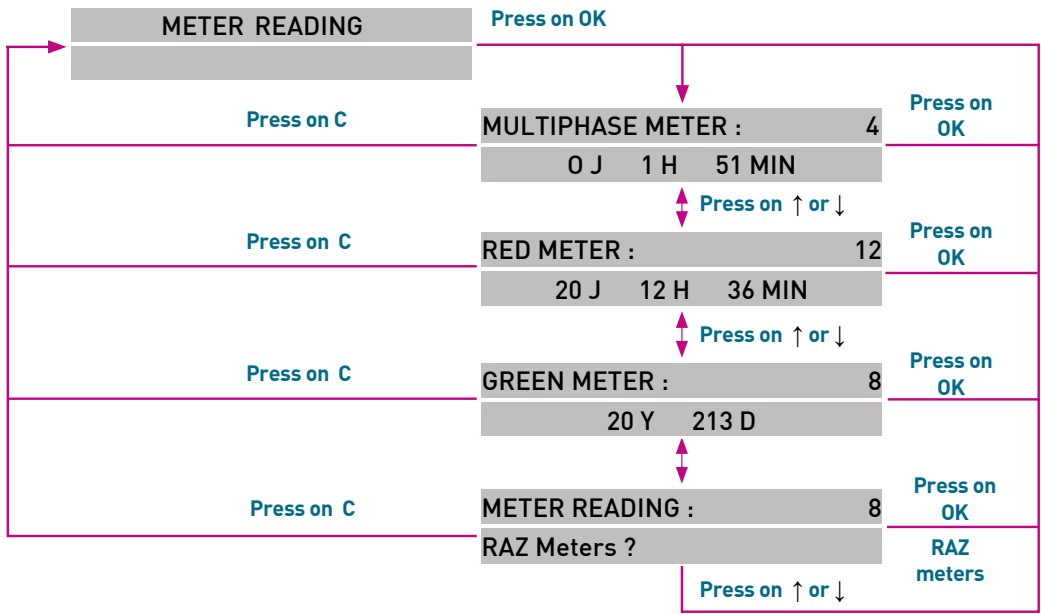
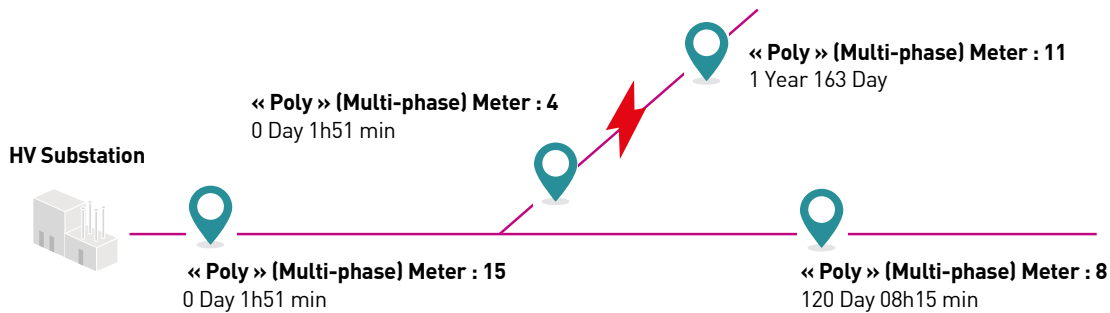
Display of fault counters

The buttons "↑" and "↓" allow scrolling the display of 3 fault counters. Once these were read, the user has the ability to perform their reset.

In addition to the default counters, the **Overhead-Sentinel-D** indicates the time since the last increment of each counter. This additional information:

- allows to know, after the extinction of the signals, if the **Overhead-Sentinel-D** has seen the fault.
- provides assistance for preventive maintenance of the HV line. When an unusual increase in the number of transient faults occurs, the **Overhead-Sentinel-D** provides valuable information on the section of the HV network causing these transient faults. With fault counters and this time information, it is possible to know which fault passage indicators have seen these faults and so, to identify the fault location before it causes a definitive trip.

Example of using the fault counters to find the section causing transient faults. With timers, it is easy to identify the faulty section:

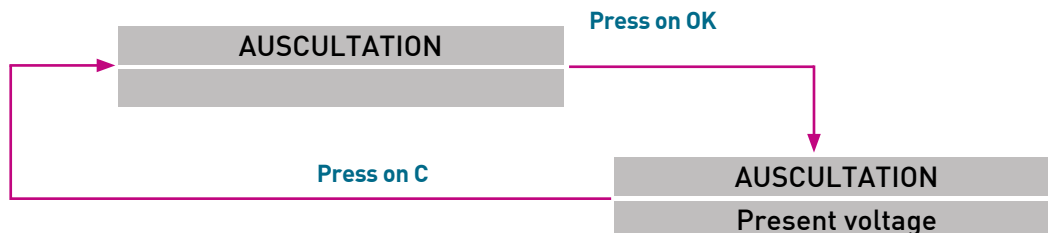


Fault display

While fault searching,, the alphanumeric display can provide the operator, additional assistance by indicating clearly the type of fault, "multiphase", "double", "red phase" or " green phase ".

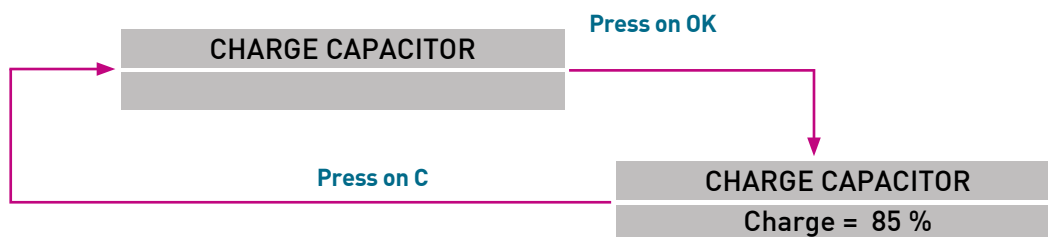
The fault is stored as long as the MV voltage is absent.

In the absence of fault, the **Overhead-Sentinel-D** indicates the presence or absence of MV voltage.



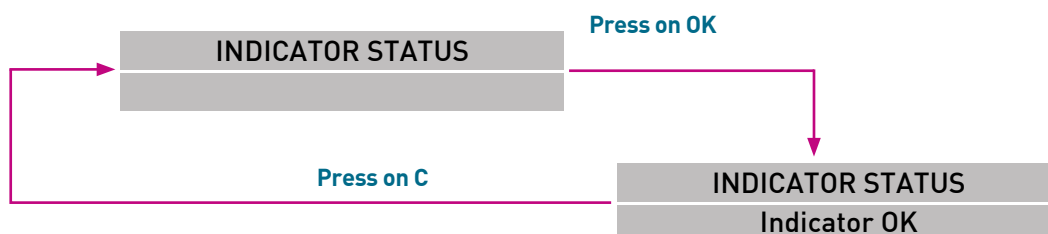
Charge level of the ultra-capacitor (depending on model)

Use this menu to check the charge level of the ultra-capacitor associated with photovoltaic panels.



Status of the fault passage indicator

The «fault passage indicator status» menu allows for a diagnosis in an event of equipment failure of **Overhead-Sentinel-D**.



> ELECTRICAL CHARACTERISTICS

| MV NETWORK | SENTINEL - D |
|--|--|
| Rated voltage U_N | Until 36 kV |
| Rated frequency | 50 Hz |
| Detection of single- phase earth faults | |
| Detection principle | Directional (Transitory phenomenon analysis) |
| Sensitivity (Amplitude of the transient) | Two threshold choices Residual current transient detection threshold (peak) : «Jeu1 : 30A», «Jeu2 : 60A»* Residual voltage transient detection threshold (peak) : «Jeu1 : 0.25Un», «Jeu2 : 0.55Un»* Validation voltage threshold (rms) : «Jeu1 : 0.1Un», «Jeu2 : 0.2Un»* |
| Signalling | RED or GREEN depending on the direction |
| Detection of dual single phase faults | |
| Detection principle | Amperemetric (Max of current within a specified deadline) |
| Phase current detection threshold | 250 A |
| Handling time | 100 ms |
| Signalling | RED or GREEN |
| Detection of multi-phase faults | |
| Detection principle | Amperemetric (Max of current within a specified deadline) |
| Phase current detection threshold | 450 A |
| Handling time | 100 ms |
| Signalling | RED or GREEN |
| Time delays | |
| Before a fault is counted (T delay) | 0.34 sec, 0.8 sec, 3 sec |
| Before the indication of a permanent fault (T permanent) | 1 sec, 10 sec, 20 sec ou 70 sec |
| Voltage MV presence for «setting» the directional detection | 5 sec |
| MV voltage return for clearing the current fault | 5 sec |
| Indication | |
| External indicator light | High brightness flashing LEDs |
| External contact | Closing dry contact |
| Indication stopped | |
| Clearing the fault Through MV voltage return Voltage level Delay | 0.5 Un 5 s |
| Stop of signalling with fault ever stored Through a front panel pushbutton Automatically after a time delay | 2h, 4h, 12h, 24h |
| Communication | |
| Sigfox™ Network Technology Frequency Protocol | Radio Ultra Narrow Band 868 MHz ISM Band Sigfox™ |
| LoRaWAN™ Network Technology Frequency Protocol | LoRa Radio 868 MHz ISM Band LoRaWAN™ |
| Cellular network Technology Protocol | 2G/3G/4G GSM SMS |

* «Jeu 1» and «Jeu 2» correspond to the threshold values that specify the single phase earth fault.
For a 15 kV network, the current threshold decrease for one fourth. : «Jeu 1 : 22.5A», «Jeu2 : 45A».

> ENVIRONMENTAL CONDITIONS

| | NORMS | OVERHEAD-SENTINEL-D |
|--|------------------------------------|--|
| Mechanical | | |
| Dimensions (W x H x D) | | 320 x 260 x 140 mm |
| Protection rating | NF EN 60529 NF EN 62262 | IP 54 IK 09 |
| Vibrations | NF EN 68068-2-6 | Acceleration : 2g/ displacement : 0,15 mm (peak value) 10 Hz to 500 Hz |
| Climatical | | |
| Operating temperature | NF EN 60068-2-1 NF EN 60068-2-2 | - 25° C to + 55° C |
| Storage temperature | NF EN 60068-2-14 | - 40° C to + 70° C |
| Relative humidity | NF EN 60068-2-3 | Tests Ca - 93% à 40°C 96h closed box, 4h opened box |
| Salt mist | NF EN 60068-2-11 | 178 h |
| Dielectric strength | | |
| Input voltage 12 V and dry contact outputs compared to the box | CEI 60255-5 | 2 kV - 50 Hz (1 mn) 5 kV shock (1,2/50 µs) |
| Electromagnetic | | |
| Dampened oscillating waves | NF EN 61000-4-12 | 2.5 kV un common mode (100 kHz et 1 MHz) 1 kV in differencial mode (100 kHz et 1 MHz) |
| Fast transients | NF EN 61000-4-4 | 4 kV on power circuits 2 kV on other circuits |
| Shock waves | NF EN 61000-4-5 | 1 kV coupling between wires 2 kV coupling wire /ground |
| Electrostatic discharges | NF EN 61000-4-2 | Harshness 4 (8 kV contact discharge, 15 kV air discharge) |
| Electromagnetic field-amplitude | NF EN 61000-4-3 | 10 V / m 27 MHz to 6 GHz |
| Power supply | | |
| Battery self-sufficiency | | 3 lithium batteries 13Ah format D (not included) |
| External supply 12V DC | | 12 V + 30% - 10% |
| Solar panels save by ultra-capacitor | | 2.5 V maintenance free (15 years) |

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