



hakel®

Hz in Hearts

Rolling stock and infrastructure

monitoring and protection

Assortment of Hakel products

Insulation monitoring devices (IMD)

Surge protection devices (SPD)

Voltage limiting devices (VLD)

Gas discharge tubes for equipotential bonding (GDT)

Surge protection devices + EMI filters (SPD+EMI)

Surge protection devices for IT power supply systems (SPD IT)

Surge protection devices for photovoltaic applications (SPD PV)

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Introduction

You are now receiving a publication with a selected range of Hakel company products for railway infrastructure applications. Our intention is to provide a basic orientation within the industry and our products, specifically in the categories of insulation monitoring devices and surge protection devices. We focus on clarity and user-friendliness without overwhelming you with a summary of data that is otherwise easily accessible.

Those interested in a wider range of continuously updated data can use the QR codes. These will direct you to the online datasheets

of our products, where you can find not only complete data but also additional materials such as schematics, drawings, manuals, etc. We believe that, hand in hand with our web presentation, you will find this catalog a useful tool.

The voltage and frequency levels of various power supply systems mentioned in the text of solutions (pages 2-4, 22-24) are valid in the Czech Republic and thus may differ in other countries.

Hakel spol. s r.o. – company profile

HAKEL spol. s r.o. was founded by Ing. Jaroslav Hudec, Ph.D., on October 18, 1994, in Hradec Kralove. From the very beginning, it has been a purely Czech company, which ranks among the leading manufacturers of surge protection devices and insulation monitoring devices.

We produce surge protection devices not only for residential construction, but they are also used in industry (oil and gas pipelines, photovoltaics, power plants and railways). Our products protect various technologies, machines, appliances and equipment worldwide against overvoltage.

At the same time, we develop and manufacture insulation monitoring devices for isolated IT power supply systems. We provide complete A to Z solutions for insulation monitoring in hospitals, industry and special applications, helping to protect not only equipment, but more importantly human lives.

In addition to its manufacturing and business activities, HAKEL spol. s r.o. supports individuals, foundations, schools, nurseries, theatres and other organisations. Today the company is managed by Bc. Pavel Hudec, son of the founder, as the sole owner.

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Solution for Rail transport – Insulation monitoring devices

When operating rolling stock, very high requirements are placed on the operability and continuity of energy supply from the traction battery. It is also necessary to ensure the full functionality of stationary elements around the railway track. All this is possible by a number of HIG insulation monitoring devices (IMD) made by HAKEL company.

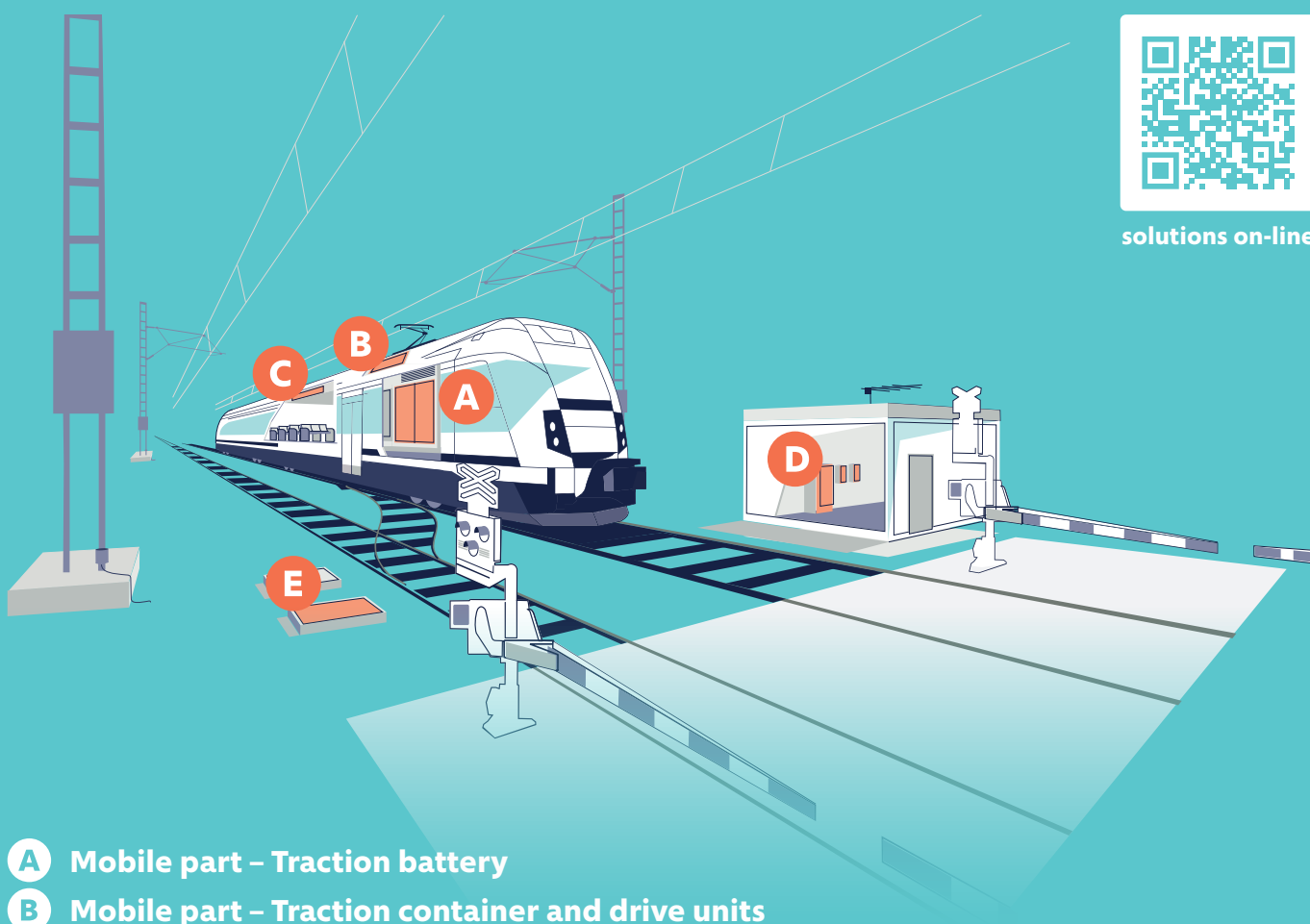
In the case of rolling stock, it is necessary to monitor any emerging insulation breakthrough on the chassis which is then signalled to the vehicle control unit (VCU) well in advance before it may cause a short circuit in the power supply. HIG products for the DC side can be used here. At the same time, it is necessary to solve the traction container, which contains an inverter to drive one or two traction motors. AC/DC insulation monitoring devices are used to monitor the insulation in these cases.

Modern cars, not only for railway, usually generate a voltage of $3 \times 400 \text{ V} / 50 \text{ Hz}$ from the heating coupling distribution. In order to ensure that the supply system is actually separated from the vehicle chassis, insulation monitoring devices are used to alert the emerging insulation breakthrough in advance before the insulation resistance of the system falls below a critical limit.

IT supply systems can be found both in traction rectifier substations and in security technology at rail crossings and signaling. They can be found on both track and station security and communication systems. Voltage conditions on these power supply systems are different, we encounter low DC voltage systems for backup accumulators, but also with a voltage of $3 \times 6000 \text{ V}$ to supply non-traction consumption along the railway track. This means, it is necessary to solve each application individually. HAKEL company has developed a wide range of insulation monitoring devices for these purposes.

Also important is the need to safely operate the railway traffic in the winter months, when it is necessary to deal with the formation of icing and snow layer between the switch blades of railway switch.

To prevent this, switch blade heaters are installed. Because the heating elements are installed directly in the track, a great mechanical stress and insulation degradation occurs here. Therefore, there is a risk of a conductive connection between the heating system and the rail and thus the formation of a dangerous touch voltage.



solutions on-line

- A** Mobile part – Traction battery
- B** Mobile part – Traction container and drive units
- C** Mobile part – Central power source, auxiliary drives and passenger compartment
- D** Stationary part – Security and communication technology
- E** Stationary part – Heating of switches

In the product pages footer, you can find the indication of their classification: solutions **A B C D E**

A Mobile part – Traction battery

Traction battery is an essential element of all rolling stock vehicles. The safety, communication and the most critical vehicle control technology are supplied from the DC voltage of the traction battery. Due to this, very high requirements are placed on the operability and continuity of power supply from the traction battery.

The standard solution to prevent unexpected power supply outages from the traction battery is to operate this power supply system as isolated from the vehicle chassis. Any emerging insulation breakthrough on the vehicle chassis should be monitored and signalled to the vehicle control unit (VCU) well in advance before the insulation breakthrough may cause a short circuit in the power supply.

HAKEL company has developed a range of **HIG*VDC/T (p. 16)** products for traction battery monitoring. These are insulation monitoring devices that meet the requirements of EN 50155 and IEC 61557-8 standards. An interesting feature of these IMDs is that they monitor the insulation resistance in both (the positive and also negative) branches of the IT power supply system. Such IMDs therefore

provide two separate values of the two insulation resistances. This is especially useful when looking for an insulation breakthrough, where the service team can inspect only the specific half of the traction battery voltage distribution.

We distinguish two basic product lines, namely **HIG*VDC/T** and **HIG*VDC-L/T (p. 16)**. These two series differ in the measured range of the insulation resistance. **HIG*VDC/T** product line monitors the insulation resistance in the range of 5 to 990 k Ω , meanwhile **HIG*VDC-L/T** product line monitors the insulation resistance in the range of 2 to 550 k Ω . If the measured resistance value is lower than the measured range “<5” respectively “<2” k Ω is signalled.

HIG*VDC/T devices are intended to monitor 12, 24, 48, 72 and 110 V DC voltage, are powered from the measured system and communication with VCU is possible by using RS485 bus or relay outputs. Devices meet OT3 temperature class (according to EN 50155). If higher temperature class is required, IMD type **HIG99** can be used. **HIG99** meets OT4 temperature class and allows communication with VCU via CAN bus.

B Mobile part – Traction container and drive units

Traction container is a device that usually contains a galvanically isolated unit of a multi-quadrant power converter, which serves to regulate the traction motors of the electric traction vehicle. Usually, the traction container contains one power inverter, which drives one or two traction motors.

Due to higher safety and reduction of EMC/EMI interferences, each traction container is designed as an isolated system, galvanically separated from the vehicle chassis as well as from the input voltage. From the design point of view, an isolated system is created by a high-frequency isolating transformer, followed by a multi-quadrant rectifier, which creates a DC intermediate circuit, and the inverter itself, which supplies the required AC voltage and variable frequency for the traction asynchronous/synchronous motor. The isolated system of the drive unit is therefore in most cases a combined AC/DC isolated system. That is, a system that contains a galvanically connected alternating and direct current sides and insulation fault may occur on both sides.

In these cases, AC/DC type insulation monitoring devices are used to monitor the insulation. These devices are able to detect insulation breakthroughs both on the AC side (i.e., motor side) and on the DC side (i.e., inverter intermediate circuit side).

HAKEL company uses the **HIG99 (p. 6)** insulation monitoring device for these purposes. These are IMDs that meet the requirements of EN 50155 and IEC 61557-8 standard. The measured range of insulation resistance of **HIG99** is 1 k Ω to 10 M Ω and the device is powered by 24 V DC independent low voltage. From the point of view of the measured system, the maximum voltage is 1000 V DC / 710 V AC (10 to 440 Hz). If monitoring of higher IT system voltage is required, it is necessary to use a **HIG-CD 1k8 (p. 18)** coupling unit, which allows up to twice the voltage of the measured system. **HIG99** device allows to inform about the insulation status via signalling relay or **HIG99 KM CAN (p. 7)** communication module can be used for direct connection to the CAN bus with the CAN OPEN protocol.

In terms of installation location of IMDs, we recommend selecting the place where the insulation status fault is most likely to occur. In the case of the traction container, it is the AC side, because the most common cause of insulation fault in the drive unit is usually the traction motor insulation disruption.

C Mobile part – Central power source, auxiliary drives and passenger compartment

Modern cars, not only for railway, usually generate a voltage of 3 \times 400 V / 50 Hz from the heating coupling distribution. This industry standard allows vehicle manufacturers to use common industrial components, for example, frequency converters for ventilation system drives.

3 \times 400 V / 50 Hz supply system is usually created by the so-called central power source. It is a high-frequency transformer, rectifier, DC intermediate circuit and inverter with a fixed frequency of 50 Hz. However, it is also possible to come across different approaches (e.g., low-frequency isolating transformer at the inverter's output). Such formed three-phase system is left as galvanically isolated, both from the input voltage and the vehicle chassis. It is therefore an IT type power supply system. Great advantage of this approach is safety of passengers who are allowed to power their own appliances from this system, through the 230 V socket.

In order to ensure that the power supply system is actually separated from the vehicle chassis, the insulation monitoring devices are used. Such devices must notify any emerging insulation breakthrough in advance, before the insulation resistance of the IT power supply system drops below the critical limit.

HIG99 (p. 6) is the recommended type of an insulation monitoring device. It's the AC/DC type, thus it is able to detect insulation fault even in direct current sides of the central power source. This device can be connected to the train control system via CAN bus, when **HIG99 KM CAN (p. 7)** communication module is used. Then the IMD provides service information about the current level of the insulation resistance.

Another **HIG99** advantage is the possibility to use the function of remote unblocking (disconnection) of the device from the measured system. This is used in cases where it is possible to connect

more train cars (every car has its own central power source) and thus create one galvanically interconnected 3x 400 V / 50 Hz system throughout the whole trainset, where CES work in parallel, or some may be completely turned off. Only one insulation monitoring device must remain active in such cases, other devices must be disconnected from the power supply system. IMD is an active device whose presence affects the measured IT power supply system and mutual operation of multiple insulation monitoring devices within

one IT power supply system is excluded because of unwanted measurement interferences. HIG99 can be unblocked by a command via CAN bus or by a logic input.

It is possible to use **HIG93T** (p. 10) insulation monitoring devices if it is not required to monitor the status of central power source DC part. HIG93T in cooperation with **TL 400T** (p. 20) coupling device also enables monitoring of the 3x 400 V / 50 Hz system.

D Stationary part – Security and communication technology

Railway infrastructure is largely built on isolated power supply systems. IT systems can be found both in traction rectifier substations and in security technology at rail crossings and signalling. They can be found on both track and station security and communication systems.

Voltage conditions on these power supply systems are different, we encounter low DC voltage systems for backup accumulators, but also with a voltage of 3x 6000 V to supply non-traction consumption along the railway track. This means, it is necessary to solve each application individually. HAKEL company has developed a wide range of insulation monitoring devices for these purposes.

We recommend **HIG93** (p. 12) insulation monitoring device for AC systems with the nominal voltage of up to 230 V AC. This device is designed to monitor insulation resistance in the range of 5 to 900 kΩ and is voltage independent of the measured system. This means that the device is able to measure the insulation level of the IT power supply system even in its voltage-free condition. This is typically used on critical infrastructure such as security technology, when it is necessary to verify the fault-free condition of the insulation before switching on the system itself.

If the measuring range is unsuitable, **HIG94** (p. 12) series devices with a measuring range from 200 kΩ to 5 MΩ can be used. Or, on the contrary, **HIG93/L** (p. 12) series is designed for low insulation statuses, i.e. from 0,1 to 90 kΩ.

A series of **TL*** (p. 20) coupling devices is available to the customer, if monitoring of voltages higher than 230V is necessary. These devices allow to connect insulation monitoring devices of HIG93 and HIG94 series to typically 3x 400 V, 3x 500 V or up to 3x 6000 V supply systems.

HIG*VDC (p. 16) series is intended for DC systems, security and communication technology. This series includes devices for 12, 24, 48, 72 and 110 V DC. Measuring range of this series is always 5 to 990 kΩ, eventually 2 to 550 kΩ for **HIG*VDC-L** (p. 16) series.

All devices (AC and DC) are equipped with a display for operation and settings, RS485 bus to read measured values and with signalling relays, for logic information about the insulation resistance status.

E Stationary part – Heating of switches

In order to be able to operate the railway traffic safely even in the winter months, it is necessary to deal with the formation of icing and snow layer between the switch blades. If the icing is not removed, there is a risk that the rail switch blade will not settle to proper position. This would not endanger security itself, but it would lead to a restriction in traffic. To prevent this, switches are equipped with switch heaters. These usually automatically detect icing in the winter months (or at least low temperature and humidity) and in the case of electric heaters of switches removes icing by using resistance heater elements.

There are two ways to power an electric heater. It is either a supply from a non-traction line (typically 3x 6000 V / 50 Hz) or a supply from the overhead line (typically 25 kV / 50 Hz or 3 kV DC). In both cases, the voltage is too high to be safely used to power the heating elements. For this reason, electric heaters with reducing, isolating transformers / galvanically isolated converters are installed in the rail track.

Because the heating elements are installed directly in the track, a great mechanical stress and insulation degradation occurs here.

Therefore, there is a risk of a conductive connection between the heating system and the rail and thus the formation of a dangerous touch voltage. This risk can be monitored well in advance using an insulation monitoring device.

Electric heaters' output voltage is usually single-phase 230 V / 50 Hz. We recommend using devices of **HIG93T** (p. 10) series, if the source is a normal transformer. These devices are certified up to operating temperatures of -25 °C. If the customer requires a higher temperature range, or wants to monitor the DC side of an inverter, **HIG99** (p. 6) device type can be used, which is certified up to -40 °C.

Both of these types of insulation monitoring devices have two fault levels and two output relays. Thanks to this, it is possible to signal at one output relay an information about reduced, but yet faultless insulation resistance. At the second relay it is then possible to signal the fault insulation status. This relay can then, when a fault is detected, disconnect the heating source from the heating elements and bring the electric heater to a safe condition. All this information can be signalled to the control room both by signalling relays and by RS485 bus.

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Insulation Monitoring Devices

The Insulation Monitoring Devices are designed for monitoring the insulation status of DC IT power supply systems. These devices constantly monitor the insulation status of both branches of the IT power supply system against the reference point (PE conductor or vehicle frame).

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Insulation Monitoring Devices for DC systems

HIG*VDC insulation monitoring devices are designed for monitoring the insulation status of DC IT power supply systems. The devices constantly monitor the insulation status of both branches of the IT power supply system against the reference point (PE conductor or vehicle frame).

Select the required parameters

Rated voltage of monitored IT system (DC)
 ☒ Yes ☐ No

Measuring range of insulation resistance

Use for traction

550 kΩ × 990 kΩ × Yes × [Cancel all filters](#)

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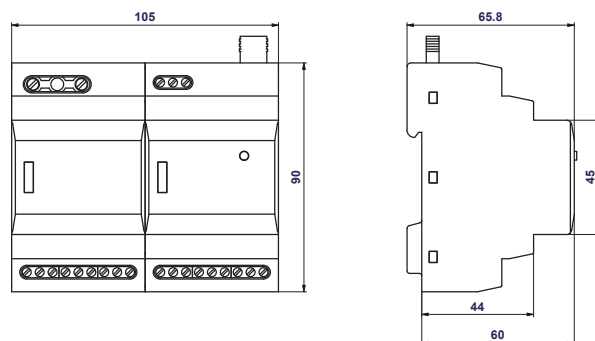
HIG24VDC/T
Article number: 70 933/T

HIG24VDC-L/T
Article number: 70 933L/T

HIG48VDC/T
Article number: 70 935/T

HIG110VDC/T
Article number: 70 934/T

HIG72VDC-L/T
Article number: 70 942L/T



HIG99*

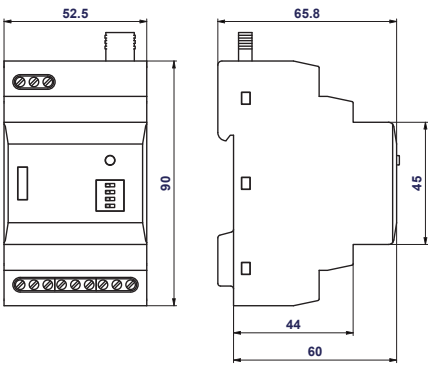
- The HIG99 line of insulation monitoring devices is designed for monitoring DC, AC and combined IT systems.
- The devices monitor the insulation resistance in the range from 1 kΩ to 10 MΩ and are equipped with two output relays, for signaling the failure of two independent levels of insulation resistance.
- The IMDs are powered by an independent low voltage source and have an integrated function of monitoring the correct voltage value of the isolated system.
- The devices are designed for primary supervision of IT systems in industry and traction systems, both on stationary and mobile parts.
- The HIG99 series is designed and tested according to the standards of the EN 50155 series.
- Communication with HIG99 is possible using modern digital buses, using expansion communication modules for the HIG99 KM series.
- The maximum operating voltage of the monitored IT network can be increased by using specific coupling units from the HIG-CD series.
- **Designed according to standards:** IEC 61557-8:2014; IEC 61557-1:2007; IEC 60664-1:2007; EN 50155:2017; EN 45545-2:2013; EN 50121-3-2:2016; EN 50125-1:2014; IEC 61373:2010;
- **Application standards:** HD 60364-4-41:2017

| Type | | HIG99 | HIG99/3k6 | HIG99/3k6-24 |
|---|-----------------|--|------------|---------------|
| Monitored IT power supply system type according to IEC 61557-8 | | AC, DC, AC/DC | | |
| Measuring range of insulation resistance | R _F | 1 ÷ 10 000 kΩ | | |
| Adjustable range of critical insulation resistance | R _{an} | 1 ÷ 2 500 kΩ | | |
| Number of insulation resistance fault levels (R _{an}) | | 2 | | |
| Rated voltage of monitored IT system (DC)* | U _n | 1 000 V | 170 V | |
| Rated voltage of monitored IT system (AC)* | U _n | 710 V | 120 V | |
| IMD power supply | | From independent power source | | |
| Nominal supply voltage DC | U _s | 24 V | 110 V | 24 V |
| Measuring input's internal impedance* | Z _i | > 1 000 kΩ | > 300 kΩ | |
| Internal DC resistance* | R _i | > 1 000 kΩ | > 300 kΩ | |
| System leakage capacitance | C _e | 10 μF | 1 μF | |
| Electrical strength against internal circuits | | 3 000 V | | |
| Communication interface for user | | Using communication modules of the HIG99 KM series | | |
| Usable with coupling units | | HIG-CD 1k8 | HIG-CD 3k6 | |
| Operating temperature | ϑ | -40 ÷ 70 °C | | |
| Modular width | | 6 TE | | |
| Use for traction | | Yes | | |
| Recommended back-up fuse | | 6 A/gG | | |
| Operation type | | Permanent | | |
| Article number | | 70 970 | 70 970/3k6 | 70 970/3k6-24 |

* Without the HIG-CD coupling unit

Note: The picture shows the HIG99; the HIG99/3k6 and HIG99/3k6-24 are in the same housing.





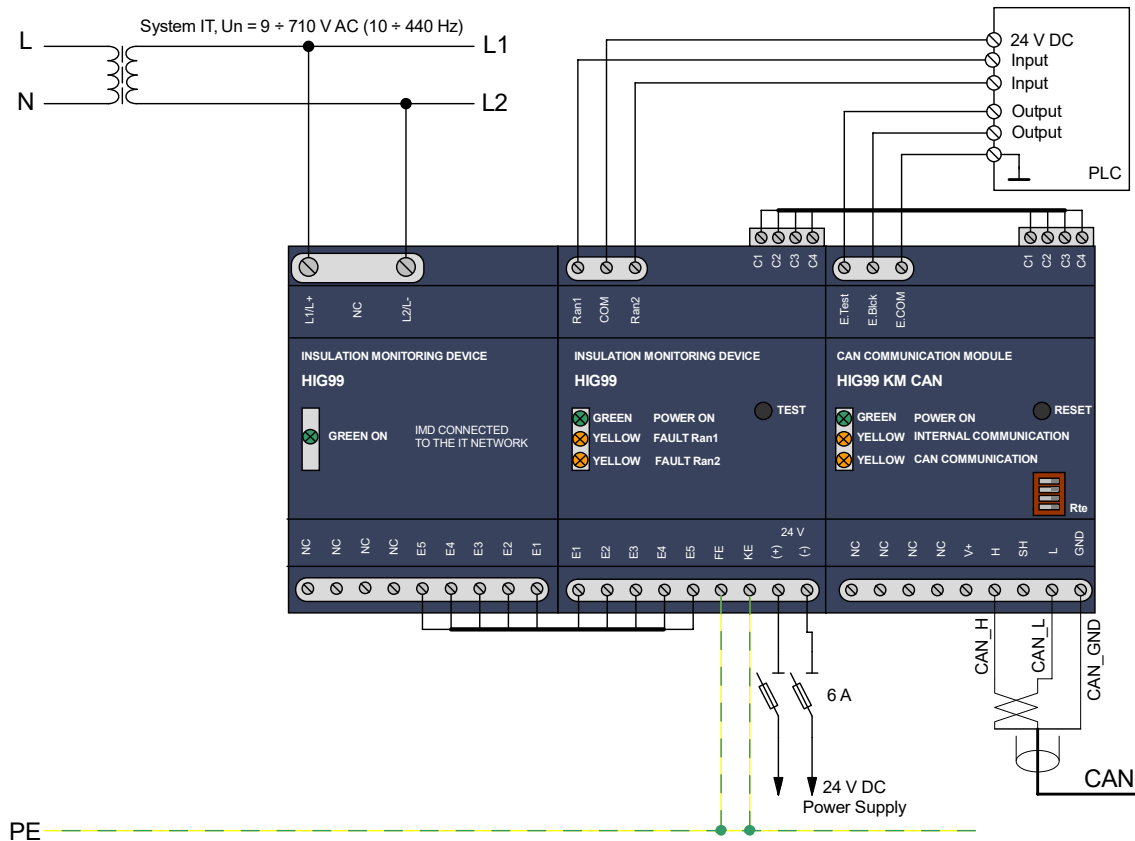
HIG99 KM CAN

- The HIG99 KM communication modules are used to connect a series of HIG99 insulation monitoring devices to a superior system using a digital bus.
- The communication modules further extend the HIG99 series with digital inputs that can be used to remotely test or block the insulation monitoring device.
- The communication module is powered by the HIG99 insulation monitoring device.
- The HIG99 KM communication modules are designed and tested according to the set of EN 50155 standards for use in rolling stock.
- **Designed according to standards:** IEC 61557-1:2007; IEC 60664-1:2007; EN 50155:2017; EN 45545-2:2013; EN 50121-3-2:2016; EN 50125-1:2014; IEC 61373:2010

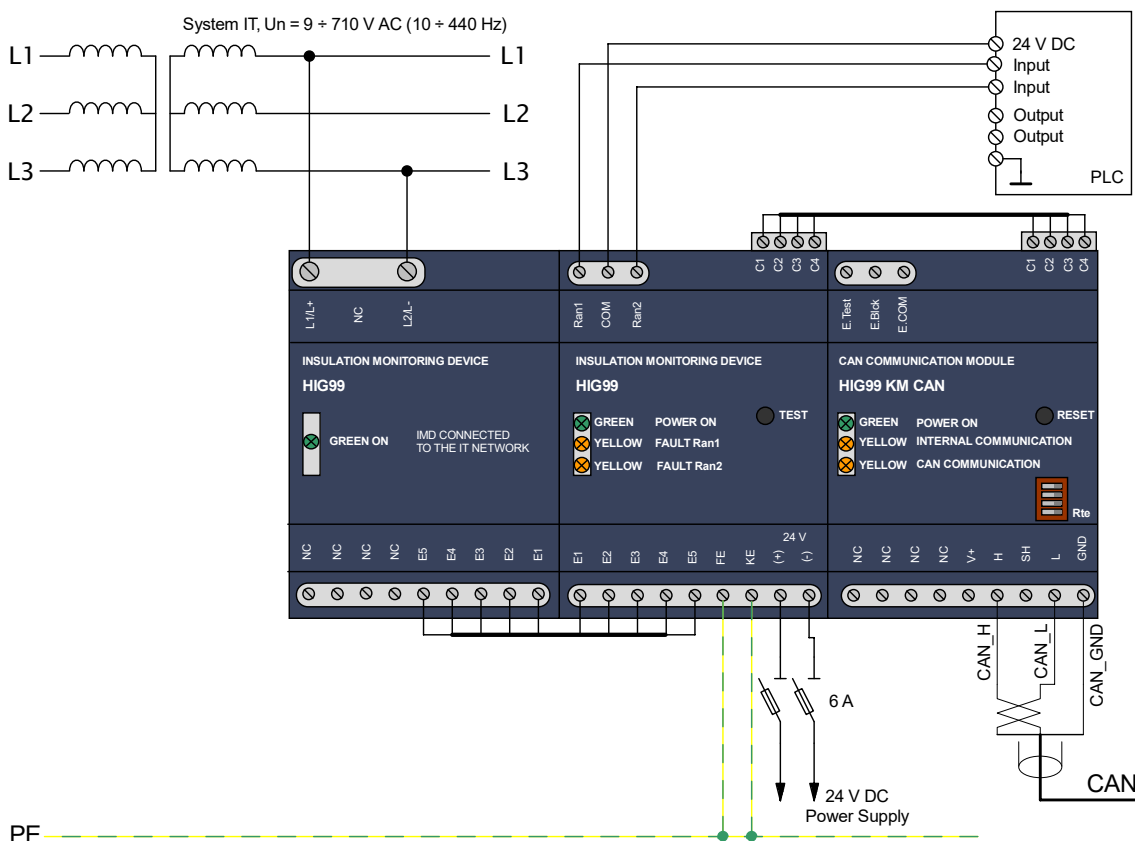
| Type | | HIG99 KM CAN |
|---|---|-------------------|
| Module power supply | | Provided by HIG99 |
| Communication interface for user | | CAN bus |
| Communication protocol | | CAN OPEN 2.0 |
| Degree of protection of front panel | | IP40 |
| Degree of protection except the front panel | | IP20 |
| Operating temperature | θ | -40 ÷ 70 °C |
| Recommended cross-section of connected conductors | S | 1 mm² |
| Article number | | 70 972 |



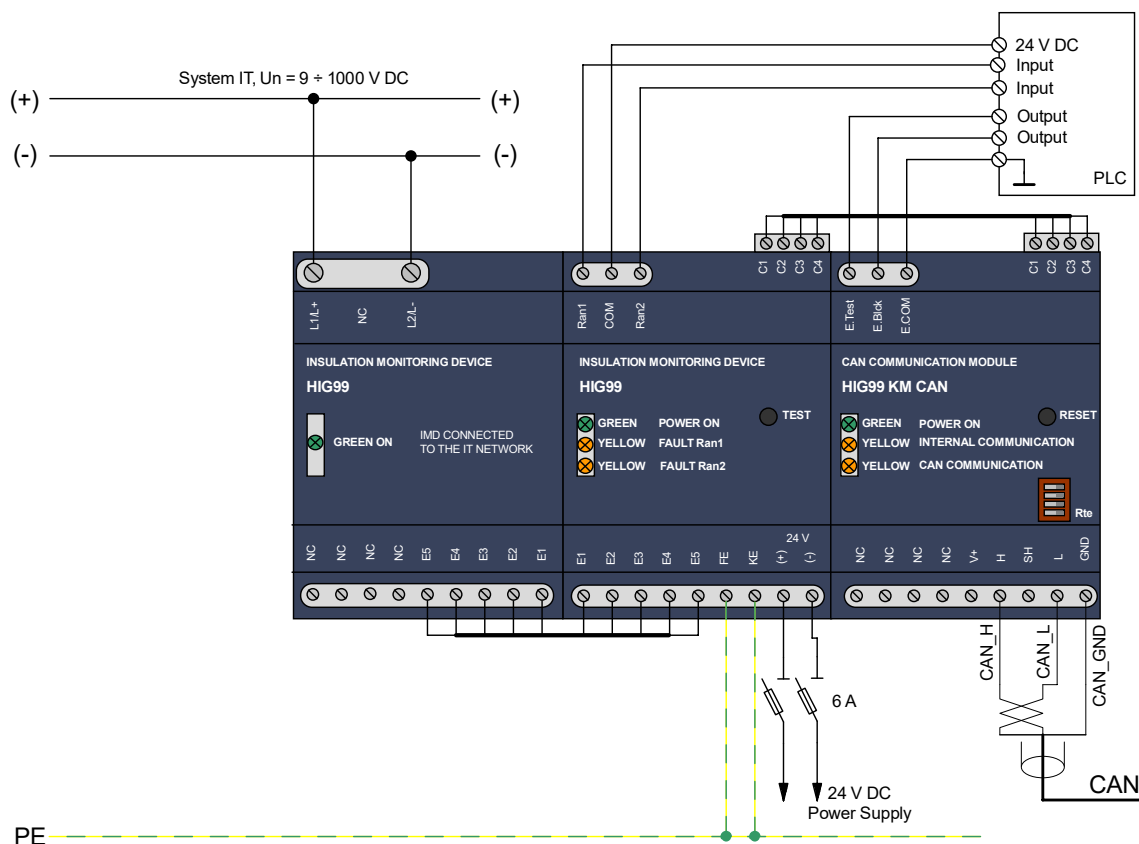
Application wiring diagram (installation) of HIG99 and HIG99 KM CAN for single phase IT power supply monitoring



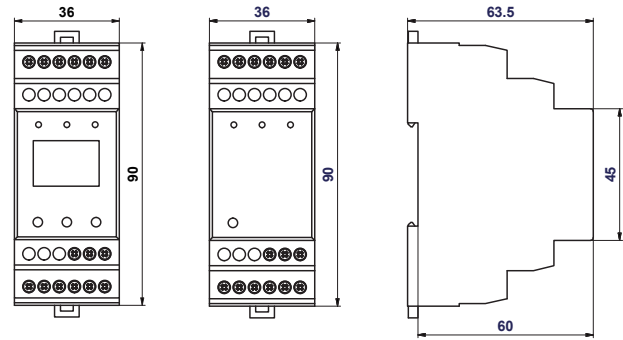
Application wiring diagram (installation) of HIG99 and HIG99 KM CAN for three phase/multiphase IT power supply monitoring



Application wiring diagram (installation) of HIG99 and HIG99 KM CAN for DC IT power supply monitoring

**Notes:**

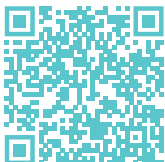
1. FE and KE terminals must be connected by separate conductors to the PE bridge.
2. NC (Not Connected) terminals remain unconnected.
3. X2.5-9 terminals and X4.1-5 (E1-E5) terminals are connected by the producer. This connection cannot be changed.
4. X5 connector, 1-4 terminals and X7 connector, 1-4 (C1-C4) terminals are connected by the producer. This connection cannot be changed.
5. CAN bus termination is set by Rte switch.
6. Follow the CAN bus line connection, any taps are not allowed.
7. When using a shielded cable for the CAN bus, bus shielding has to be connected across whole length and grounded at one point.
8. Install only one cable type along the whole length of the bus. Use twisted shielded pair for connection.
9. Programming manual for communication with the CAN bus is available upon request.
10. The KM module is used to connect the insulation monitoring device to the communication bus/PC.
11. For higher voltages of the monitored IT power supply system it is necessary to use the CD module.



HIG93T*

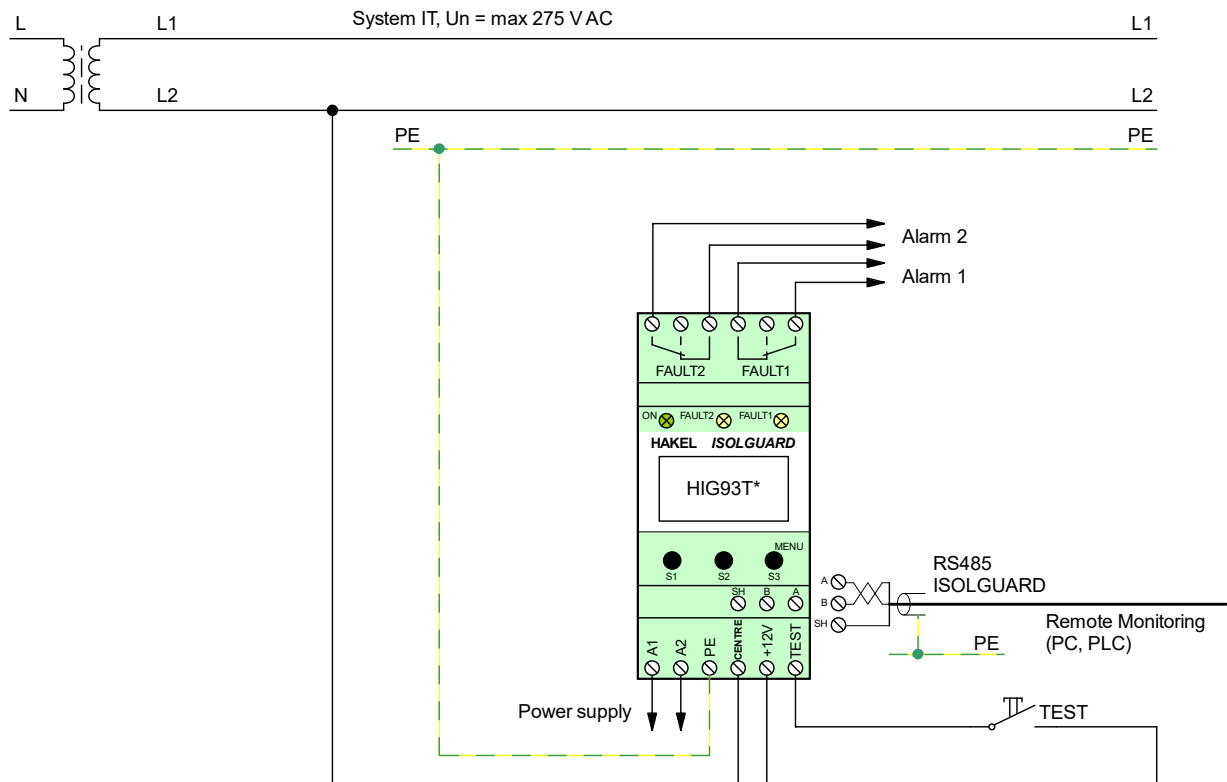
- HIG93T are a series of insulation monitor devices (IMDs) for insulated systems (IT systems) in rolling stock.
- The IMDs are designed according to the EN 50155 standard and are prepared for measuring insulation resistance in trains, trams, and trolleybuses.
- The IMDs are usually applied with a range of TL*T coupling devices, which allow monitoring of the usual operating voltages of 3 x 400 V or 3 x 500 V.
- **Designed according to standards:** IEC 61557-1:2007; IEC 61557-8:2014; IEC 60664-1:2007; EN 50155:2017; EN 50121-3-2:2016; IEC 61373:2010; EN 45545-2:2013
- **Application standards:** HD 60364-4-41:2017

| Type | | HIG93T | HIG93T/L | HIG93T/N24.1 | HIG93T/24.1 | HIG93T/24L.1 |
|---|-----------------|--|-------------|-------------------------------|-------------|--------------|
| Monitored IT power supply system type according to IEC 61557-8 | | AC | | | | |
| Measuring range of insulation resistance | R _F | 5 ÷ 900 kΩ | 0.1 ÷ 90 kΩ | 5 ÷ 900 kΩ | | 0.1 ÷ 90 kΩ |
| Adjustable range of critical insulation resistance | R _{an} | 5 ÷ 300 kΩ | 0.1 ÷ 90 kΩ | 5 ÷ 300 kΩ | | 0.1 ÷ 90 kΩ |
| Number of insulation resistance fault levels (R _{an}) | | 2 | | | | |
| Rated voltage of monitored IT system (AC) | U _n | 275 V | | | | |
| IMD power supply | | From measured IT system, from independent power source | | From independent power source | | |
| Nominal supply voltage AC | U _s | 90 ÷ 265 V | | 10 ÷ 26 V | | |
| Nominal supply voltage DC | U _s | N/A | | 11 ÷ 38 V | | |
| Measuring voltage | U _m | 12 V | | | | |
| Measuring current | I _m | < 0.6 mA | | | | |
| Equipped with display | | Yes (OLED technology) | | | No display | |
| Supported module of distant signalisation (MDS) | | MDS-D, MDS-DELTA | | | | |
| Communication interface for user | | RS485 bus | | | | |
| Communication protocol | | ISOLGUARD, PROFIBUS | | | | |
| External control inputs | | Test start | | | | |
| Operating temperature | ϑ | -25 ÷ 60 °C | | | | |
| Use for traction | | Yes | | | | |
| Article number | | 70 927 | 70 927/L | 70 927/N24.1 | 70 927/24.1 | 70 927/24L.1 |

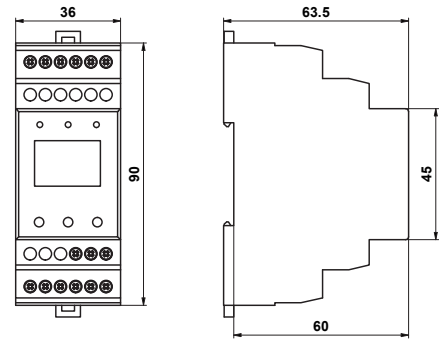


Note: The first picture shows the HIG93T; the HIG93T/L and HIG93T/N24.1 are in the same housing. The second picture shows the HIG93T/24.1; the HIG93T/24L.1 is in the same housing (without display).

Application wiring diagram (installation) of HIG93T*

**Notes:**

1. Terminals +12 V and TEST are intended only for test push-button connection. These terminals cannot be used for any other equipment connection.
2. To monitor a three-phase IT power supply system, the insulation monitoring device must be connected using a TL* series coupling unit.
3. Communication is via RS485 bus and MDS modules can be connected to the insulation monitoring devices.
4. Follow the RS485 bus line connection, any taps are not allowed.
5. When using a shielded cable for the RS485 bus, bus shielding has to be connected across whole length and grounded at one point.
6. Install only one cable type along the whole length of the bus. Use twisted shielded pair for connection.



HIG93*, HIG94, HIG935*

- The HIG93 and HIG94 series are a series of insulation monitoring devices for industrial isolated systems (IT systems). They can also be used in stationary parts of the railway.
- The maximum operating voltage of the IT system is 275 V AC. This voltage can be increased up to 6 kV when using coupling devices from the TL series.
- IMDs are equipped with two adjustable error levels R_{an} for the insulation resistance R_F .
- As standard, the IMD measure R_F in the range of 5 kΩ to 900 kΩ (HIG93 series), alternatively in the range of 200 kΩ to 5 MΩ (HIG94). Special IMDs are also available for different measuring ranges of insulation resistance.
- IMDs are equipped with digital processing of the measured signal, which offers the user numerical information about the measured insulation resistance.
- IMDs are designed with independent power supply. That means that these insulation monitors can be powered from a different system than the one they measure. This has the significant effect that the IMDs are able to measure even de-energized system.
- The power supply of the device is AC as standard, for a nominal voltage of 230 V to 110 V / 50 Hz. However, versions with a 24 V DC supply are also available.
- All IMDs are equipped with a digital bus, which allows information to be transmitted to the master system. For signaling of the IMD status, panels from the MDS-D series can also be used (variant with RS485).
- **Designed according to standards:** IEC 61557-8:2014; IEC 61557-1:2007; IEC 60664-1:2007
- **Application standards:** HD 60364-4-41:2017

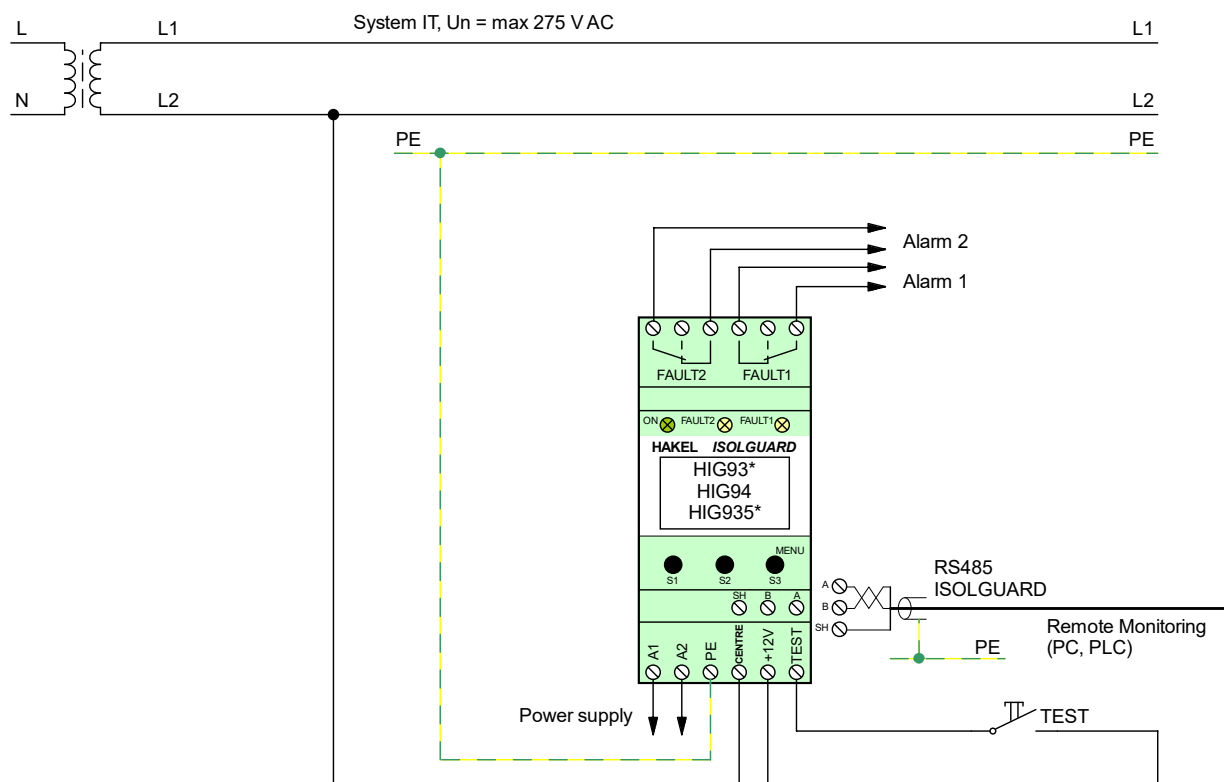
| Type | | HIG93 | HIG94 | HIG93/L | HIG93/CL400 | HIG93/CL500 |
|--|-------------|--|----------------|-------------|-------------|--------------|
| Monitored IT power supply system type according to IEC 61557-8 | | AC | | | | |
| Measuring range of insulation resistance | R_F | 5 ÷ 900 kΩ | 200 ÷ 5 000 kΩ | 0.1 ÷ 90 kΩ | 5 ÷ 900 kΩ | 1 ÷ 900 kΩ |
| Adjustable range of critical insulation resistance | R_{an} | 5 ÷ 300 kΩ | 200 ÷ 900 kΩ | 0.1 ÷ 90 kΩ | 5 ÷ 300 kΩ | 1 ÷ 80 kΩ |
| Number of insulation resistance fault levels (R_{an}) | | 2 | | | | 1 |
| Rated voltage of monitored IT system (AC) | U_n | 275 V | | | | |
| IMD power supply | | From measured IT system, from independent power source | | | | |
| Nominal supply voltage AC | U_s | 90 ÷ 265 V | | | | |
| Nominal supply voltage DC | U_s | 90 ÷ 370 V | | | | |
| Measuring voltage | U_m | 12 V | | | | 24 V |
| Measuring current | I_m | < 0.6 mA | | | | < 1 mA |
| Equipped with display | | Yes (OLED technology) | | | | |
| Supported module of distant signalisation (MDS) | | MDS-D, MDS-DELTA | | | | None |
| Communication interface for user | | RS485 bus | | | | Current loop |
| Communication protocol | | ISOLGUARD, PROFIBUS | | | | 4 ÷ 20 mA |
| External control inputs | | Test start | | | | |
| Operating temperature | ϑ | -25 ÷ 60 °C | | | | |
| Use for traction | | No | | | | |
| Article number | | 70 915 | 70 917 | 70 915/L | 70 931 | 70 932 |



Note: The picture shows the HIG93; all other products on this double page are in the same housing.

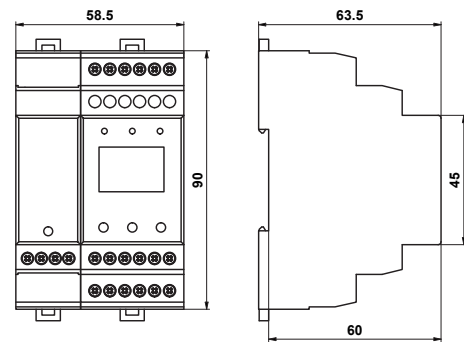
| Type | | HIG935 | HIG935/N24.1 | HIG93/N24.1 | HIG93L/N24.1 | HIG93L/N48.1 |
|--|-------------|--|-------------------------------|---------------------|----------------|----------------|
| Monitored IT power supply system type according to IEC 61557-8 | | AC | | | | |
| Measuring range of insulation resistance | R_F | 1 000 ÷ 51 000 k Ω | 5 ÷ 900 k Ω | 0.1 ÷ 90 k Ω | | |
| Adjustable range of critical insulation resistance | R_{an} | 1 000 ÷ 51 000 k Ω | 5 ÷ 300 k Ω | 0.1 ÷ 90 k Ω | | |
| Number of insulation resistance fault levels (R_{an}) | | 2 | | | | |
| Rated voltage of monitored IT system (AC) | U_n | 275 V | | | | |
| IMD power supply | | From measured IT system, from independent power source | From independent power source | | | |
| Nominal supply voltage AC | U_s | 90 ÷ 265 V | 10 ÷ 26 V | 16 ÷ 55 V | | |
| Nominal supply voltage DC | U_s | 90 ÷ 370 V | 11 ÷ 38 V | 22 ÷ 77 V | | |
| Measuring voltage | U_m | 25 V | 12 V | | | |
| Measuring current | I_m | < 1.2 mA | < 0.6 mA | | | |
| Equipped with display | | Yes (OLED technology) | | | | |
| Supported module of distant signalisation (MDS) | | MDS-D, MDS-DELTA | | | | |
| Communication interface for user | | RS485 bus | | | | |
| Communication protocol | | ISOLGUARD, PROFIBUS | | | | |
| External control inputs | | Test start | | | | |
| Operating temperature | ϑ | -25 ÷ 60 °C | | | | |
| Use for traction | | No | | | | |
| Article number | | 70 921 | 70 921/N24.1 | 70 915/N24.1 | 70 915/L/N24.1 | 70 915/L/N48.1 |

Application wiring diagram (installation) of HIG93*, HIG94, HIG935*



Notes:

1. Terminals +12 V and TEST are intended only for test push-button connection. These terminals cannot be used for any other equipment connection.
2. To monitor a three-phase IT power supply system, the insulation monitoring device must be connected using a TL* series coupling unit.
3. Communication is via RS485 bus and MDS modules can be connected to the insulation monitoring devices.
4. Follow the RS485 bus line connection, any taps are not allowed.
5. When using a shielded cable for the RS485 bus, bus shielding has to be connected across whole length and grounded at one point.
6. Install only one cable type along the whole length of the bus. Use twisted shielded pair for connection.



HIG93/E*, HIG94/E

- The HIG93 and HIG94 series are a series of insulation monitoring devices for industrial isolated systems (IT systems). They can also be used in stationary parts of the railway.
- The maximum operating voltage of the IT system is 275 V AC. This voltage can be increased up to 6 kV when using coupling devices from the TL series.
- IMDs are equipped with two adjustable error levels R_{an} for the insulation resistance R_F .
- As standard, the IMD measure R_F in the range of 5 kΩ to 900 kΩ (HIG93 series), alternatively in the range of 200 kΩ to 5 MΩ (HIG94). Special IMDs are also available for different measuring ranges of insulation resistance.

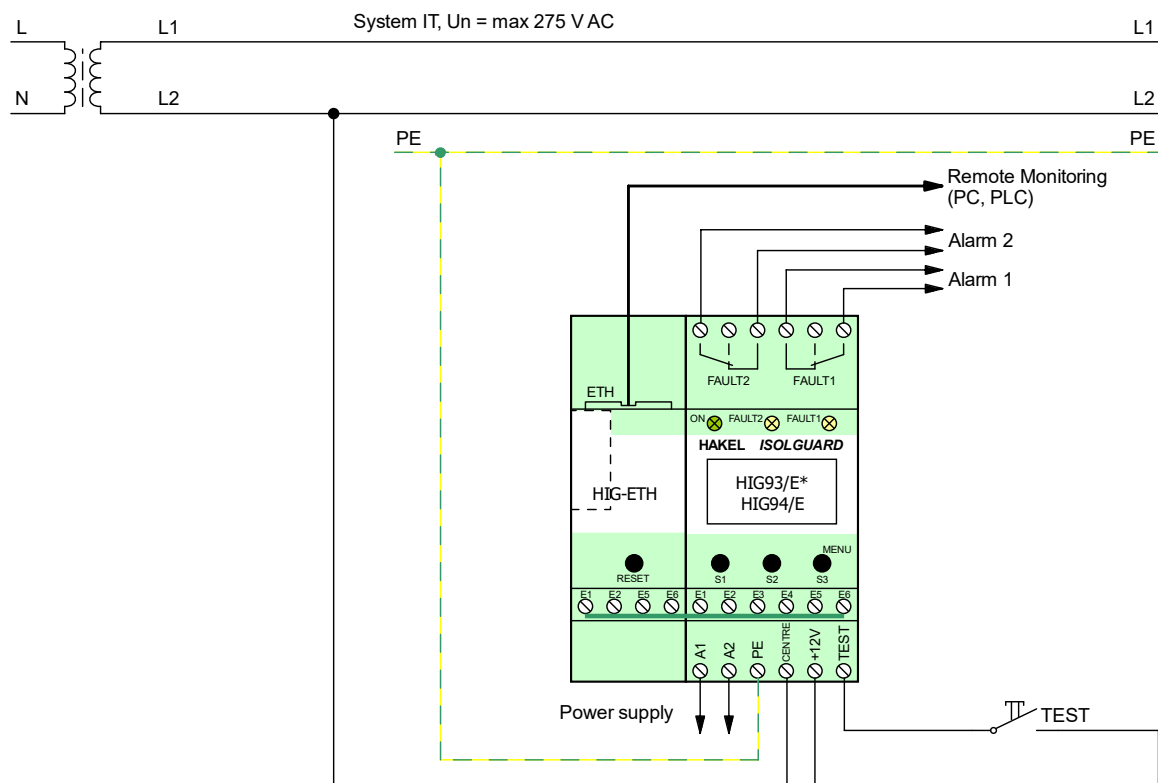
- IMDs are equipped with digital processing of the measured signal, which offers the user numerical information about the measured insulation resistance.
- IMDs are designed with independent power supply. That means that these insulation monitors can be powered from a different system than the one they measure. This has the significant effect that the IMDs are able to measure even de-energized system.
- The power supply of the device is AC as standard, for a nominal voltage of 230 V to 110 V / 50 Hz. However, versions with a 24 V DC supply are also available.
- **Designed according to standards:** IEC 61557-8:2014; IEC 61557-1:2007; IEC 60664-1:2007
- **Application standards:** HD 60364-4-41:2017

| Type | | HIG93/E | HIG94/E | HIG93/E/N24.1 |
|--|-------------|--|----------------|-------------------------------|
| Monitored IT power supply system type according to IEC 61557-8 | | AC | | |
| Measuring range of insulation resistance | R_F | 5 ÷ 900 kΩ | 200 ÷ 5 000 kΩ | 5 ÷ 900 kΩ |
| Adjustable range of critical insulation resistance | R_{an} | 5 ÷ 300 kΩ | 200 ÷ 900 kΩ | 5 ÷ 300 kΩ |
| Number of insulation resistance fault levels (R_{an}) | | 2 | | |
| Rated voltage of monitored IT system (AC) | U_n | 275 V | | |
| IMD power supply | | From measured IT system, from independent power source | | From independent power source |
| Nominal supply voltage AC | U_s | 90 ÷ 265 V | | 10 ÷ 26 V |
| Nominal supply voltage DC | U_s | 90 ÷ 370 V | | 11 ÷ 38 V |
| Measuring voltage | U_m | 12 V | | |
| Measuring current | I_m | < 0.6 mA | | |
| Equipped with display | | Yes (OLED technology) | | |
| Supported module of distant signalisation (MDS) | | None | | |
| Communication interface for user | | Ethernet bus, Webserver | | |
| Communication protocol | | MODBUS TCP, SMTP, HTTP GET, SNMP | | |
| External control inputs | | Test start | | |
| Operating temperature | ϑ | -25 ÷ 60 °C | | |
| Use for traction | | No | | |
| Article number | | 70 924 | 70 926 | 70 924/N24.1 |

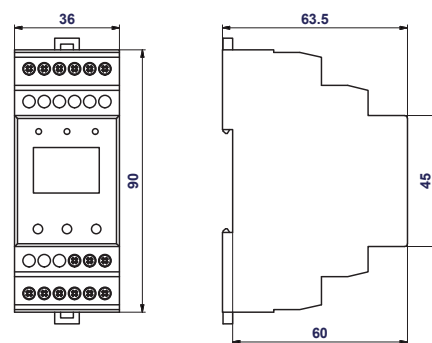
Note: The picture shows the HIG93/E; the HIG94/E and HIG93/E/N24.1 are in the same housing.



Application wiring diagram (installation) of HIG93/E*, HIG94/E

**Notes:**

1. The insulation monitoring device can always be powered from an independent power supply.
2. Terminals +12 V and TEST are intended only for test push-button connection. These terminals cannot be used for any other equipment connection.
3. To monitor a three-phase IT power supply system, the insulation monitoring device must be connected using a TL* series coupling unit.
4. Terminals E1 to E6 are intended only for device modules connection. These terminals cannot be used for any other equipment connection.
5. Programming manual for communication with the MODBUS TCP is available upon request.
6. IP address is preset to 192.168. 1. 254



HIG*VDC(-L)/T, HIG*VDC(-L)

- Insulation monitoring devices HIG*VDC(-L) are designed for the monitoring of the insulation status of DC IT systems with nominal voltage 12, 24, 48, 72 or 110 V DC.
- The device continuously monitors the insulation status of both branches of the isolated IT system against a reference point. For stationary equipment this is usually the PE conductor, for mobile equipment it is the vehicle frame.
- If the insulation condition in the positive branch R+ or negative branch R- is faulty, this condition is signalled by setting relay KA1/KA2. The fault condition is also indicated by LEDs on the front panel.

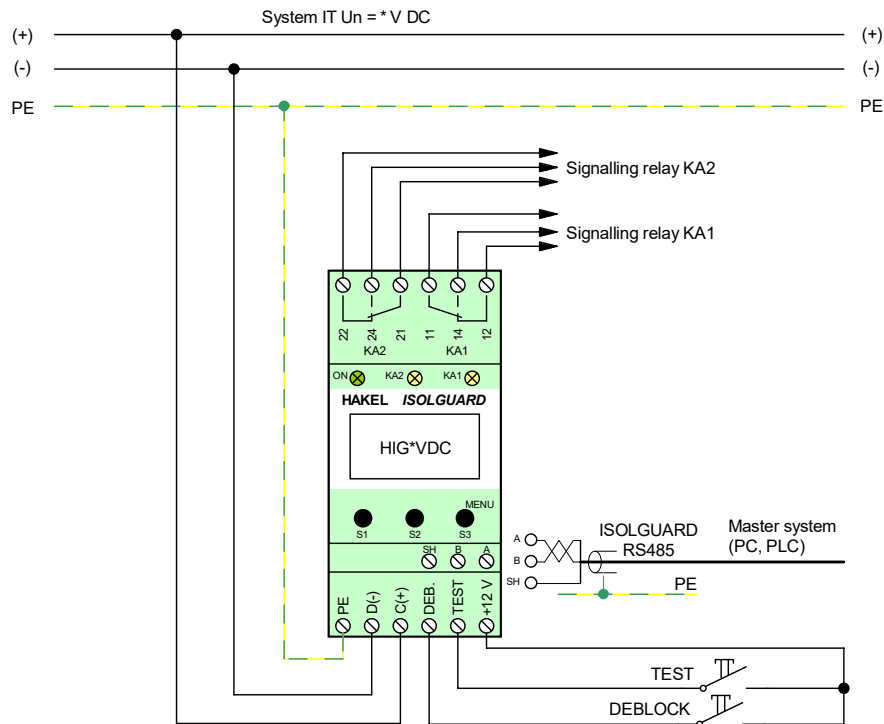
- These devices are equipped with a display for showing the currently measured values. The display, together with the buttons is also used to set the device.
- HIG24VDC(-L)/T, HIG48VDC(-L)/T, HIG72VDC(-L)/T, HIG110VDC(-L)/T are designed for railway use (EN 50155) to monitor the insulation condition of DC IT systems.
- Designed according to standards:** IEC 61557-8:2014; IEC 61557-1:2007; IEC 60664-1:2007; EN 50155:2017; IEC 61373:2010; EN 45545-2:2013; EN 50121-3-2:2016
- Application standards:** HD 60364-4-41:2017

| Type | | HIG*VDC/T | HIG*VDC | HIG*VDC-L/T | HIG*VDC-L |
|--|-------------|--|------------------|----------------------|--------------------|
| Monitored IT power supply system type according to IEC 61557-8 | | DC | | | |
| Measuring range of insulation resistance | R_F | 5 ÷ 990 kΩ | | 2 ÷ 550 kΩ | |
| Adjustable range of critical insulation resistance | R_{an} | 5 ÷ 500 kΩ | | 2 ÷ 500 kΩ | |
| Number of insulation resistance fault levels (R_{an}) | | 1 | | | |
| Rated voltage of monitored IT system (DC) | U_n | 12 V, 24 V, 48 V, 72 V, 110 V (see table footer) | | | |
| IMD power supply | | From measured IT system | | | |
| Equipped with display | | Yes (OLED technology) | | | |
| Supported module of distant signalisation (MDS) | | MDS-D, MDS-DELTA | | | |
| Communication interface for user | | RS485 bus | | | |
| Communication protocol | | ISOLGUARD | | | |
| External control inputs | | Test start, deblocking function | | | |
| Electrical strength against internal circuits | | 3 750 V | | | |
| Operating temperature | ϑ | -25 ÷ 70 °C | | | |
| Recommended back-up fuse | | 6 A/gG | | | |
| Use for traction | | Yes | No | Yes | No |
| Type $U_n = 12 \text{ V}, 24 \text{ V}$ | | HIG24VDC/T | HIG24VDC | HIG24VDC-L/T | HIG24VDC-L |
| Article number | | 70 933/T | 70 933 | 70 933L/T | 70 933L |
| Type $U_n = 48 \text{ V}$ | | HIG48VDC/T | HIG48VDC | HIG48VDC-L/T | HIG48VDC-L |
| Article number | | 70 935/T | 70 935 | 70 935L/T | 70 935L |
| Type $U_n = 72 \text{ V}$ | | HIG72VDC/T | HIG72VDC | HIG72VDC-L/T | HIG72VDC-L |
| Article number | | 70 942/T | 70 942 | 70 942L/T | 70 942L |
| Type $U_n = 110 \text{ V}$ | | HIG110VDC/T | HIG110VDC | HIG110VDC-L/T | HIG110VDC-L |
| Article number | | 70 934/T | 70 934 | 70 934L/T | 70 934L |



Note: The picture shows the HIG24VDC/T;
all other above-mentioned products are in the same housing.

Application wiring diagram (installation) of HIG*VDC(-L)/T, HIG*VDC(-L)

**Notes:**

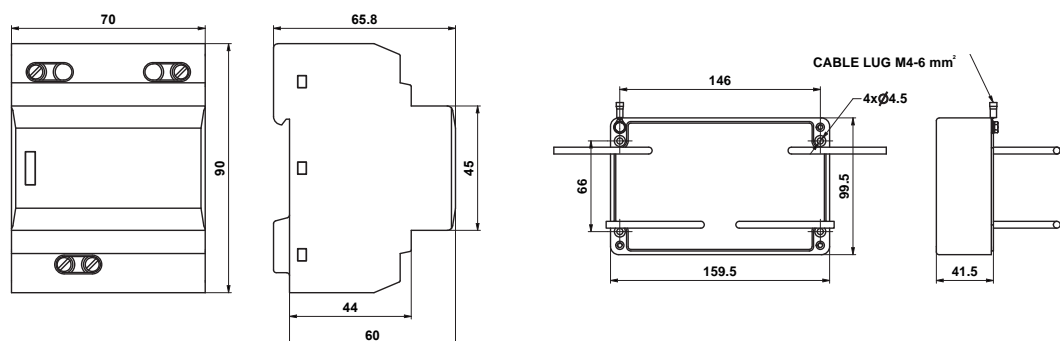
1. The insulation monitoring device is powered from monitored IT power supply system.
2. To use HIG*VDC device in railway applications, the set is supplied under the designation HIG24VDC-L/T, HIG48VDC-L/T, HIG72VDC-L/T, HIG110VDC-L/T.
3. Terminals +12 V, TEST and DEBLOCK are intended only for test push-button connection. These terminals cannot be used for any other equipment connection.
4. Communication is via RS485 bus and MDS modules can be connected to the insulation monitoring devices.
5. Follow the RS485 bus line connection, any taps are not allowed.
6. When using a shielded cable for the RS485 bus, bus shielding has to be connected across whole length and grounded at one point.
7. Install only one cable type along the whole length of the bus. Use twisted shielded pair for connection.



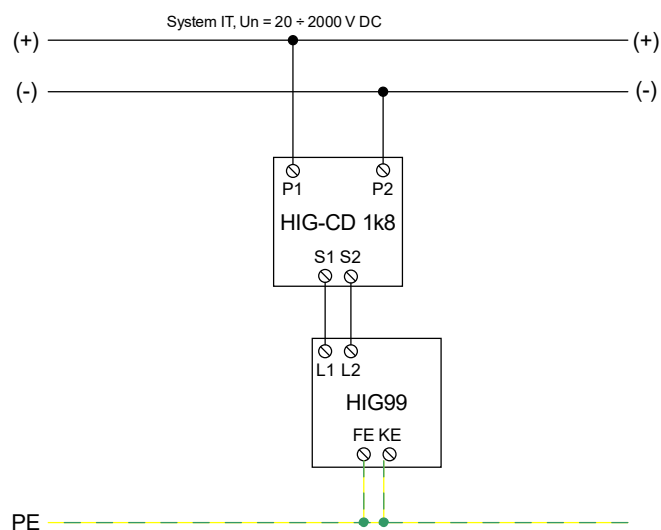
HIG-CD 1k8, HIG-CD 3k6

- The coupling devices HIG-CD are used to adapt the input circuits of the insulation monitoring device to a higher operating voltage than the operating voltage of the IMD directly.
- It is necessary to observe the use of the appropriate coupling unit for the specific insulation monitoring device.
- The coupling devices are connected between the insulated system and the insulation monitoring device.
- **Designed according to standards:** IEC 61800-5-1:2007; EN 45545-2:2013

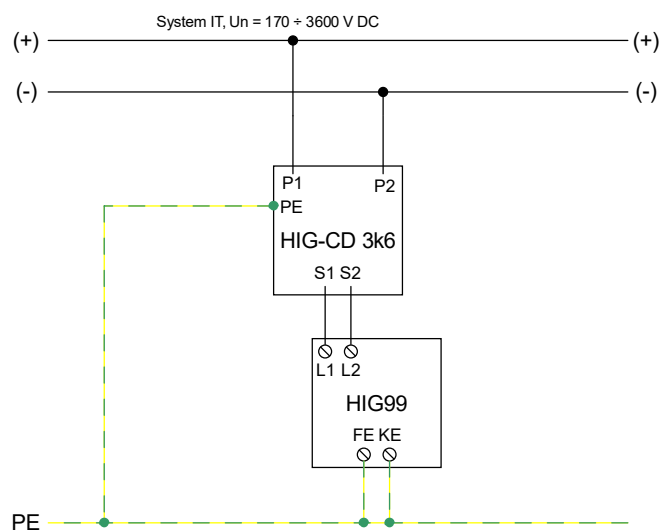
| Type | | HIG-CD 1k8 | HIG-CD 3k6 |
|--|-------------|-----------------------------|-------------------------|
| Rated operating AC voltage | U_N | 1 250 V | 2 500 V |
| Rated operating DC voltage | U_N | 1 800 V | 3 600 V |
| Maximum continuous operating voltage AC | U_C | 1 400 V | 2 500 V |
| Maximum continuous operating voltage DC | U_C | 2 000 V | 3 600 V |
| Designed for insulation monitoring device | | HIG99 | HIG99/3k6, HIG99/3k6-24 |
| Operating temperature | ϑ | $-40 \div 70^\circ\text{C}$ | |
| Clamp fastening range (solid conductor) | | $2.5 \div 16 \text{ mm}^2$ | |
| Clamp fastening range (stranded conductor) | | $2.5 \div 10 \text{ mm}^2$ | |
| Installation | | On DIN rail 35 mm | On the mounting plate |
| Use for traction | | Yes | |
| Article number | | 70 981 | 70 984 |



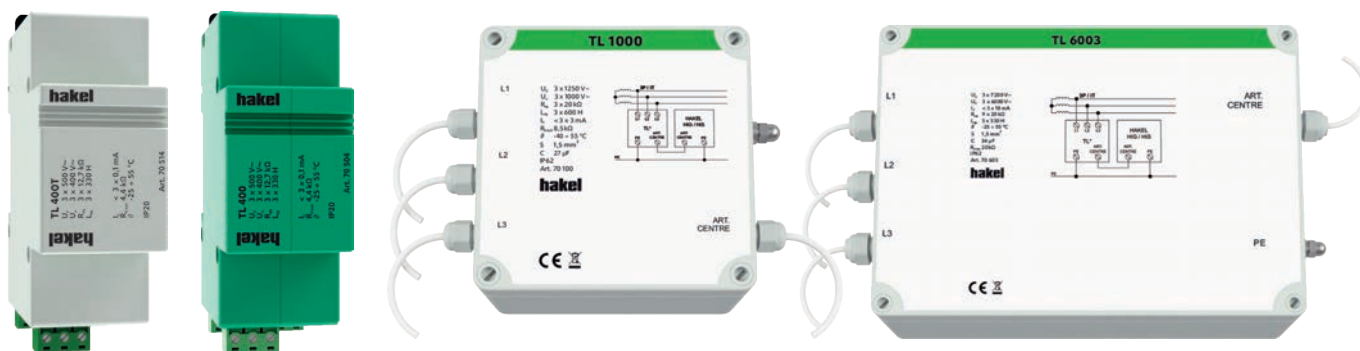
Application wiring diagram (installation) of HIG-CD 1k8



Application wiring diagram (installation) of HIG-CD 3k6

**Note:**

A special version of the insulation monitoring device HIG99/3k6 or HIG99/3k6-24 is required for the application of the coupling unit HIG-CD 3k6.



TL *(T)

- The coupling devices TL* are used to adapt the input circuits of the insulation monitoring device to a higher operating voltage than the operating voltage of the IMD directly.
- The coupling units are connected between IT power supply system and insulation monitoring device.
- Products designated with "T" are intended for installation in traction vehicles.
- Designed according to standards:** IEC 60664-1:2007; IEC 61558-1:2005

| Type | | TL 400T | TL 400 | TL 500T | TL 500 | TL 600T | TL 600 |
|---|--------------|----------------------------|--------|---------|--------|---------|--------|
| Rated operating AC voltage | U_N | 400 V | | 500 V | | 600 V | |
| Maximum continuous operating voltage AC | U_C | 500 V | | 600 V | | 720 V | |
| Designed for insulation monitoring device | | HIG93, HIG91, HIG92, HIG94 | | | | | |
| Maximal operating current AC | I_C | < 3 × 0.1 mA | | | | | |
| Internal resistance | R_{IN} | 3 × 12.7 kΩ | | | | | |
| Internal inductance | L_{IN} | 3 × 330 H | | | | | |
| Offset for insulation monitoring device | $R_{tl ext}$ | 4.4 kΩ | | | | | |
| Recommended cross-section of connected conductors | S | 1.5 mm ² | | | | | |
| Installation | | On DIN rail 35 mm | | | | | |
| Use for traction | | Yes | No | Yes | Yes | Yes | No |
| Article number | | 70 514 | 70 504 | 70 515 | 70 501 | 70 516 | 70 601 |

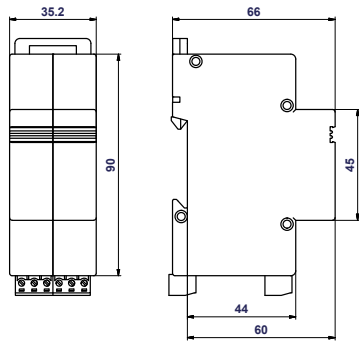
Note: The products TL 500(T) and TL 600(T) are in the same housings as the pictured TL 400(T).



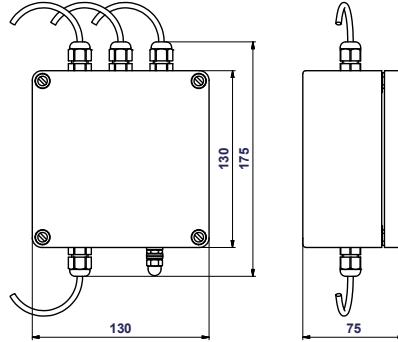
| Type | | TL 1000 | TL 1200 | TL 6003 |
|---|--------------|----------------------------|------------|----------------------------|
| Rated operating AC voltage | U_N | 1 000 V | 1 200 V | 6 000 V |
| Maximum continuous operating voltage AC | U_C | 1 250 V | 1 440 V | 7 200 V |
| Designed for insulation monitoring device | | HIG93, HIG91, HIG92, HIG94 | HIG97 | HIG93, HIG91, HIG92, HIG94 |
| Maximal operating current AC | I_C | < 3 × 3 mA | | |
| Internal resistance | R_{IN} | 3 × 20 kΩ | 3 × 6.9 kΩ | 9 × 20 kΩ |
| Internal inductance | L_{IN} | 3 × 600 H | 3 × 300 H | 9 × 330 H |
| Filtration capacitance | C | 27 μF | N/A | 34 μF |
| Offset for insulation monitoring device | $R_{tl ext}$ | 8.5 kΩ | 2.3 kΩ | 20 kΩ |
| Recommended cross-section of connected conductors | S | 1.5 mm ² | | |
| Installation | | On the mounting plate | | |
| Use for traction | | No | | |
| Article number | | 70 100 | 70 120 | 70 603 |

Note: The TL 1200 product is in the same housing as the pictured TL 1000.

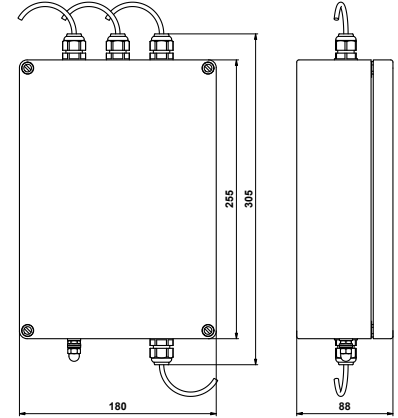




TL 500(T), TL 600(T), TL 400(T)

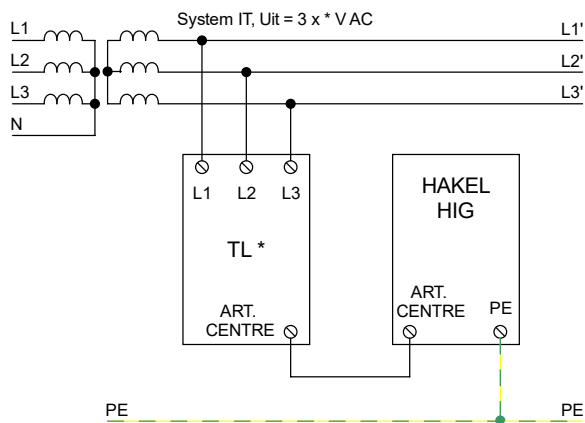


TL 1000, TL 1200

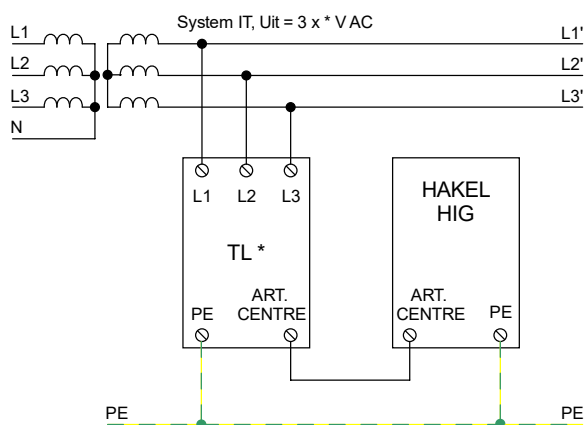


TL 6003

Application wiring diagram (installation) of TL 400-600(T)



Application wiring diagram (installation) of TL 1000-6003



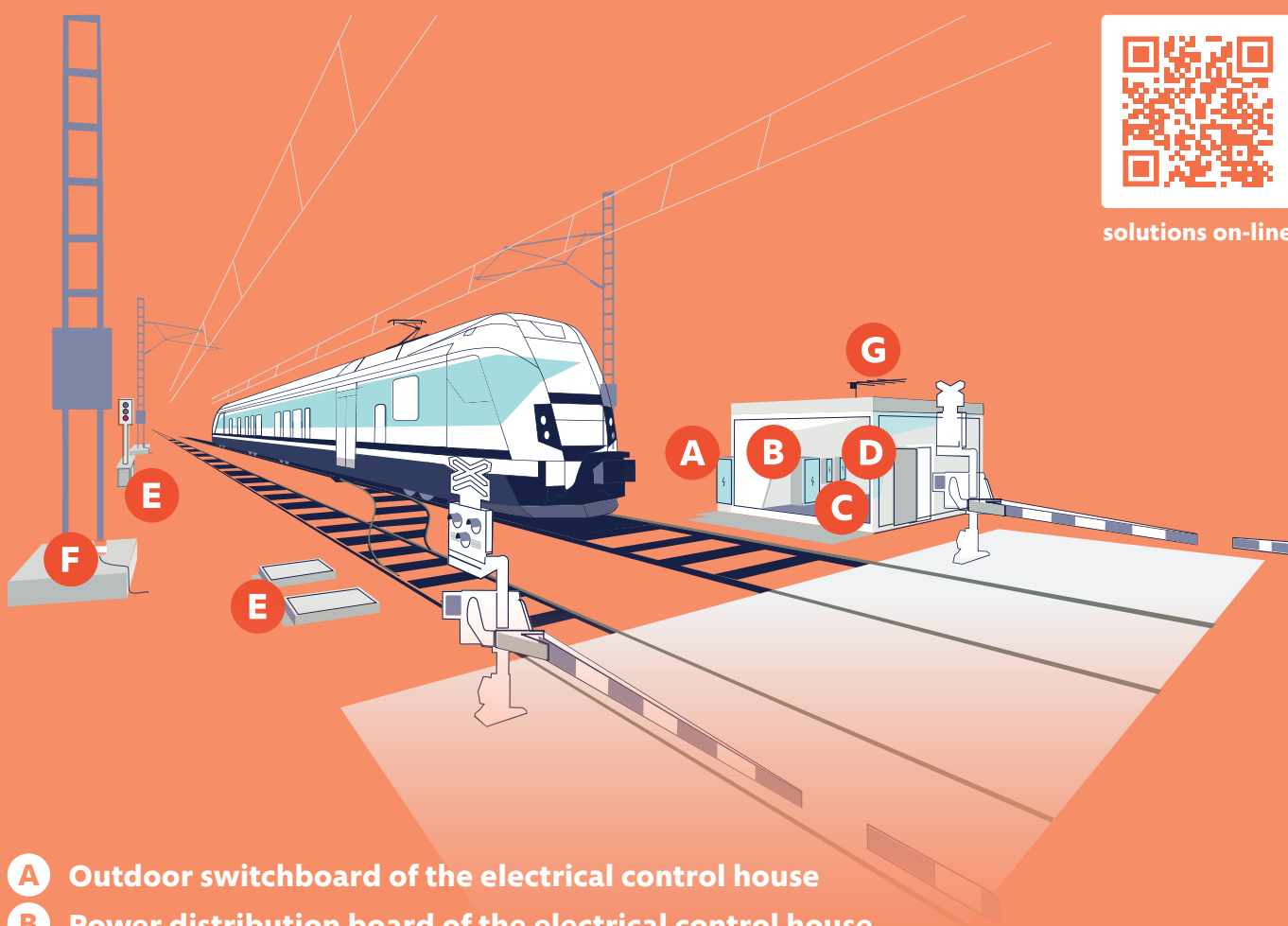
Solutions for Railway infrastructure – Surge protections

Transport infrastructure powered or controlled by electricity, especially rolling stock, is a segment that experiences overvoltage and other undesirable phenomena more often than anywhere else. To make the operation of trains, trams, trolleybuses and other traction vehicles and their equipment even more reliable, these systems need to be protected, and not only with surge protection devices.

Traction systems are no longer just used to power traction sets, but provide electrical power to various equipment along the track, some with sensitive electronics. These include, for example, switch turnouts and their heating, line safety equipment, light and sound signalling of level crossings, power supply of Electrical Control House and, last but not least, power supply of

ticket vending machines, information boards and stop lighting in public transport systems. The power supply of these devices has always been problematic, not only with regard to atmospheric influences, but also in particular with transients and switching phenomena causing voltage peaks, e.g. when crossing of track section dividers, during recuperation, or when connecting and disconnecting sections in rectifier substations.

To ensure that the operation of these devices and thus the entire system is always fully functional, the installation of surge protection and voltage limiting devices is an important step. That is why HAKEL also develops products for this sector and offers comprehensive solutions for the entire system.



- A** Outdoor switchboard of the electrical control house
- B** Power distribution board of the electrical control house
- C** Battery protection
- D** Low-current switchboard of the electrical control house
- E** Equipment in the railroad track
- F** Protection of non-energized parts
- G** Antenna systems

A Outdoor switchboard of the electrical control house

The outdoor switchboard is used to connect the internal wiring of the electrical control house. The incoming power supply system to this switchboard is usually a three-phase isolated 3x 6 000 V IT, which runs along the train corridor from the rectifier substation. In such switchboard, the incoming IT system is then transformed to 230 V and earthed to form a TN-S system. A single-phase system is used as an industry standard. The switchboard is also prepared for the connection of an alternative power supply, usually in the form of a diesel generator feeders and also contains inputs and outputs for remote monitoring.

In this switchboard it is advisable to install a lightning and surge arrester type T1+T2+T3 on the TN system side, e.g. **HLSA25-275/2+0 S (p. 28)** with a remote status indication marked with the letter S. The potential-free contact of this signalling is then connected to the control system (typically as an input of a control PLC), where it continuously informs the supervisory workplace about the status of the surge protection device without the need for a physical inspection of the switchboard.

B Power distribution board of the electrical control house

The power distribution board of the electrical control house primarily provides power for its own consumption, which includes lighting, service outlets or heating, but it also supplies the sockets of the backup batteries and is also a source for other potential distribution boards. The switchboard itself is connected from the outdoor switchboard via a 230 V / 50 Hz TN-S power supply. Due to the close location of the two switchboards, it is sufficient to install a surge arrester type T2, e.g. **HSA-275/2+0 S (p. 30)** with remote status indication marked with the letter S. If the cable distance between the outdoor switchboard and the power distribution board inside the house is less than 10 m, a decoupling inductor with the appropriate rated current, e.g. **HI32**

(p. 36) with a rated current of 32 A, must be installed between T1 and T2 SPD. This is the only way to maintain coordination and proper operation of the surge protection devices.

To protect the battery backup chargers, that may contain intelligent control sensitive to high-frequency interference, it is advisable to add T3 SPD with EMI/RFI filter, e.g. **HSAF16 S (p. 32)** with a rated current of 16 A for 230 V AC. Alternatively, another type with a higher rated current up to 160 A can be used. Due to the location in one switchboard, the installation of a decoupling inductor is necessary in this case.

C Battery protection

Battery operating voltage levels vary. The most common is 12 V DC or 24 V DC, but 110 V DC is no exception. For all these and other levels, we offer a comprehensive range of surge arresters type T3 either with EMI/RFI filter – HSAF series, or without the filter – HSAD series.

For 24 V DC, **HSAD16/24VDC S (p. 32)** product with remote status indication marked with the letter S and a rated current of 16 A is a suitable choice.

D Low-current switchboard of the electrical control house

It is advisable to protect the switchboard of a low-current system, which is powered from a high-current switchboard with SPD type T3, in the way that the SPD is as close as possible to the switchboard, ideally directly inside of it. Due to problematic operation, we recommend SPD type T3 with a high frequency (EMI/RFI) filter. In a normal low-power operation, **HSAF16 (p. 32)** with a rated current of 16 A for 230 V AC is sufficient, or another type with a higher rated current up to 160 A can be used. There are again options to use versions with potential-free contact of remote signalling marked as S. However, pay attention to the coordination of SPDs, i.e. to the minimum distance between individual types, which may not be kept in cases of a small building. In such case, it is necessary to include decoupling inductors of the HI series with the appropriate rated current, e.g. **HI16 (p. 36)**, between SPD type T2+T3 in the high-current switchboard and type T3 in the low-current switchboard. This will ensure the correct operation of the entire SPD cascade. The recommended installation location is directly in the switchboard prior to HSAF16.

In the low-current switchboard, it is also necessary to protect the inputs of the control PLC, which evaluates data from various sensors for controlling the air conditioning and heating unit or for the

Electronic Security System (ESS) of the building or Fire Safety Solution (FSS) detectors. But also PLC outputs, over which the data is usually sent to the monitoring workplace, for example, via a GSM antenna or Ethernet. In these cases, for the correct design of surge protection devices, it is necessary to appropriately determine the rated voltage of the SPD, the rated current, the type of data communication, its operating frequency, and the interface. Commonly used in these applications are data protectors for 6 or 24 V DC, which have a rated current of 500 mA, an operating frequency of 1 MHz, and the data conductors are connected to screw terminals. SPD types **HDT2/6B** or **HDT2/24B (p. 39)**, that have the option of connecting two data pairs, meet these parameters.

The dedicated **HDSP (p. 39)** series is designed for such typical applications with the possibility of variable connection according to the specific solution. You can choose versions for various communication buses such as RS-485, RS-422, CAN, CIB, but also for analog systems such as sensors, current loops, etc. The HDSP series uses appropriately selected breakdown voltage and low-capacitance protection diodes to achieve full communication speed and maximum protection of data communication devices.

E Equipment in the railroad track

There are end devices along the railway lines that may be exposed to lightning current effects or transients and switching phenomena. These may negatively affect the operational function of the equipment or even cause its destruction. The consequences can be tragic. Therefore, it is important to protect end devices such as switch turnouts and their heating, signalling lamps, line safety equipment so called autoblocks and others with surge protection devices. In tramway or other public transport systems, this may include switches, track lubricators, power supply for camera systems, ticket vending machines or tram stop lighting.

The main power supply system along the line is usually provided as 3x 6000 V IT, which is then transformed to lower voltage or further rectified to DC voltage. This modified voltage is an isolated system (IT) with different voltage levels. The end devices can be supplied from a 3x 400 V IT distribution system, for which SPD type T1+T2 **HLSA12,5-440/3+1 S IT** (p. 34) is suitable. If the equipment is situated within the protective angle (e.g. the protective angle of the Electrical Control House) and there is no risk of a direct lightning strike, it is possible to install an SPD type T2, e.g. **HSA-440/3+1 S IT** (p. 35) with remote status indication – marked with the letter S. Another option is the power supply from the single-phase 230 V IT mains, where **HLSA12,5-275/2+1 S IT** (p. 35) is installed, or only the T2 type **HSA-275/2+1 S IT** (p. 35). End devices equipped with electronics sensitive to high-frequency interference, in the range of hundreds of kHz to tens of MHz, can also be equipped with a surge arrester type T3 with EMI/RFI filter. This is a serial protection so it is dimensioned for the rated current of the protected equipment or for its back-up fuse. A suitable type of protection is **HSAF16 S IT** (p.35) for 230 V IT with a rated load current of 16 A, including remote signalling.

For devices supplied with a TN-S system, e.g. single-phase AC voltage of 230 V, we can install SPD type T1+T2, such as **HLSA25-275/2+0 S** (p. 28) with remote status signalling – marked with the letter S. If SPD type T2+T3 is sufficient, we can choose e.g. **HSA-275/2+0 M S** (p. 30) with exchangeable modules – products marked with the letter M and remote status signalling – marked with the letter S. In case of a different voltage level, e.g. 75 V, products from the same product range can be selected. For example **HSA-75/2+0 M S** (p. 31) is the right SPD type T2+T3 for that voltage. If surge arrester type T3 is needed, we can choose e.g. the parallel protection for 230 V AC, model **HSAD-P M S** (p. 33), which is also available with exchangeable modules in addition to remote signalling. Alternatively, a surge arrester type T3 with EMI/RFI filter of the HSAF series can be installed.

DC voltage distribution is no exception in railway systems. For these installations we offer surge arresters type T3 with EMI/RFI filter of the HSAF*VDC series. The most common representative of this series is **HSAF16/24VDC S** (p. 33) for 24 V DC with a rated load current of 16 A, containing a remote status signalling marked with the letter S. If the equipment is not sensitive to EMI/RFI interference a common surge arrester type T3 can be installed, e.g. **HSAD16/24VDC S** (p. 33). Both of these series offer voltage levels up to 220 V DC.

F Protection of non-energized parts

For the protection of non-energized parts of metallic structures in AC or DC traction systems, isolating gas discharge tubes are used to balance the potentials between non-energized parts that are not conductively connected for the sake of operating conditions. This provides effective protection for persons who may come into contact with these parts in the event of lightning strikes or faults in the catenary. They are installed directly on the protected metal building structure using two M12 screws so that in the event of a gas discharge tube activation, a conductive connection is made between the structure and the railroad track. Once there is a voltage increase, whether due to lightning current or e.g. a fallen overhead lines on the protected structure, the isolating gas discharge tube short-circuits the unwanted current to the track. By connecting the structure to the track, the reaction of the quick-disconnect switch is enabled which interrupts the power supply to overhead lines. The main representative of this product line is **HGS 100 RW** (p. 27), which has an ignition voltage between 300 and 500 V, or **HGS 100 RW 250V** (p. 27) with an ignition voltage between 200 and 300 V.


For tramway systems, low-voltage limiting devices (VLDs) are used, whose nominal triggering DC voltage is typically around 120 V DC. In principle, they provide the same protection as the HGS series, but use different protection elements. They are also installed directly onto the protected metal building structure using two M12 screws. When the voltage rises, the VLD is activated. First by fast-acting varistors and then by high-performance thyristors, which are able to discharge this current until the line's fast switches react. **HL120** (p. 26) is one of the representatives of such products, that can discharge current up to 105 A for 60 minutes.

G Antenna systems

The communication between the monitoring workplace and the Electrical Control House can be achieved via a GSM antenna. To select the right surge protection device, it is important to know the type of connector, the power of the protected system, its frequency range and, of course, the permissible value of the insertion loss.

A typical representative of surge protectors for coaxial lines is **KO - 3GN** (p. 40) with N connector and frequency band up to 3 GHz, which can also be installed outdoors, or **KO - 9P** (p. 40) with F connector and frequency band up to 2 GHz. For Wi-Fi connection, we recommend **HT-NET PoE+ 6cat 802.3at** (p. 38).

Easy selection of SPD according to categories



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AC Surge Protection


Protection against the effects of light provided by lightning arresters type T in the power supply system are very f a significant risk of damage to applia sensitive electronics.


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AC Surge Protection Devices



DC Surge Protection Devices



Insulation Monitoring Devices



Data transmission SPDs



Voltage Limiting Devices



Equipotential bonding



Measuring equipment



Lightning arresters T1



Lightning and surge arresters T1+T2 (+T3)



Surge arresters T2+T3


Terminal equipment protection T3



Surge arrester with EMI/RFI filter



Lightning and surge arresters for IT systems



Gas Discharge Tubes for N-PE



Decoupling inductors


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Z-A


HLSA12,5-275/3+0 M S
Article number: 16 093



HLSA25G-255/3+0 S
Article number: 10 468


HLSA25G-255/4+0 S
Article number: 10 469


HLSA12,5-275/4+0 M
Article number: 16 085


HSA-275/3+1 M S
Article number: 27 094

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Equipotential bonding

HGS series products contain separating high power gas discharge tubes which are designed to equalize potentials in case of overvoltage on installation parts of buildings or technological units that are not galvanically connected to each other in normal operation.

Select the required parameters

Certified for explosive areas

Installation

Impulse discharge current (10/350)


☒ 100 kA


☒ 150 kA


No
100 kA
150 kA


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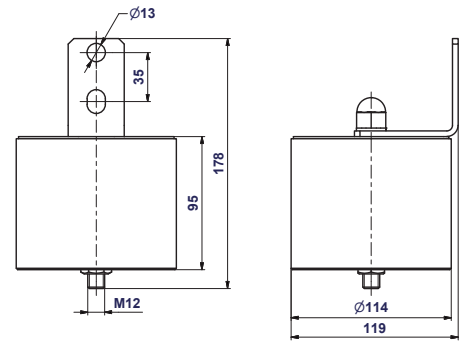
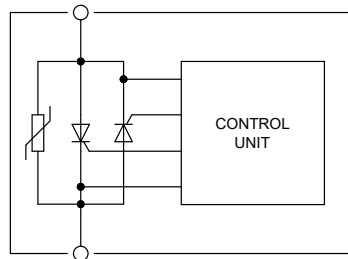

HGS 100 RW
Article number: 10 002


HGS 100
Article number: 10 005


HGS 100 EB
Article number: 10 009


HGS 100 RW 250V
Article number: 10 003


HGS 100 CC
Article number: 10 202

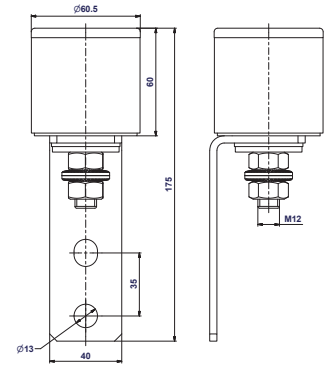
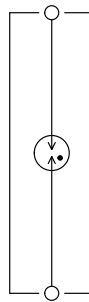


HL120

- Voltage limiting device class 2.2 for AC or DC traction systems public transportation as are tram or trolleybus systems.
- Intended for the protection of non-live parts of metal structures.
- Ensure the equipotential bonding between inactive parts, which are not conductively interconnected due to the operating conditions.
- Used for effective protection of persons who may get in touch with these parts in the event of a lightning strike or traction line failure.
- Installed directly on the protected construction structure with connection to the track.
- In the event of a fault by short-circuiting the structure with the track, a quick-release switch will react and interrupt the power supply of the traction line.
- Resistant to vandalism, acid rain and mechanical damage.
- **Designed according to standards:** EN 50122-1:2011; EN 50526-2:2014; IEC 61643-11:2011; IEC 60099-4:2014

| Type | | HL120 |
|---|--------------|----------------------|
| Class of VLD according EN 50526-2 | | 2.2 |
| Type of VLD according EN 50122-1:2011 | | VLD-F, VLD-O |
| Maximum non-triggering AC voltage | U_W | 60 V |
| Nominal triggering DC voltage | U_{Tn} | 120 V |
| Short time withstand current DC (25 ms repeatable) | I_W | 4.7 kA |
| Short time withstand current DC (100 ms unrepeatable) | I_W | 20 kA |
| Rated current DC (60 min) | I_r | 105 A |
| Lightning current impulse (8/20) | I_{imp-n} | 40 kA |
| High charge impulse (10/350) | I_{imp-hc} | 40 kA |
| Varistor voltage DC at 1 mA | U_V | 180 V |
| Residual voltage at I_{imp-n} | U_{res} | ≤ 500 V |
| Response time at lightning current impulse | t_R | < 25 ns |
| Response time of thyristor | t_R | < 1.2 ms |
| Operating temperature | ϑ | $-40 \div 55$ °C |
| Altitude | | Without limits |
| Tightening moment | | 16 Nm |
| Degree of protection | | IP67 |
| Installation | | Using two M12 screws |
| Operating position | | Vertical |
| Product placement environment | | External |
| Article number | | 10 240 |





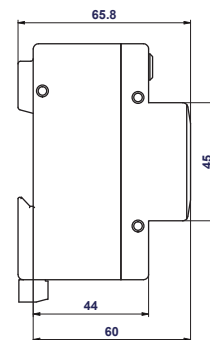
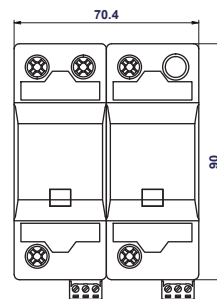
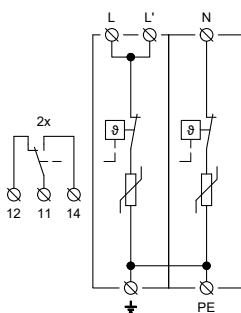
HGS 100 RW, HGS 100 RW 250V

- High power gas discharge tubes are intended for equipotential bonding between inactive parts, which are not conductively interconnected due to the operating conditions.
- In case of origin of potential difference between those parts, the high power gas discharge tube ignites and conductively interconnects both insulated parts for a transient time.
- High protection degree of the housing allows using indoors, outdoors and also in the underground.
- They can be used, e.g. between utility pipelines and external lightning protection systems, between pipelines and other inactive metal parts, or between insulated flanges used on pipelines.
- The RW variant is primarily designed for railway systems where it provides effective protection for persons who may come into contact with inanimate parts of metallic structures in the event of lightning strikes or catenary failures.
- High power gas discharge tubes are able to discharge the highest lightning impulse currents, which ranks them in the class H – for heavy loads.
- **Designed according to standards:** IEC 62561-3:2017
- **Application standards:** IEC 62305:2010

| Type | | HGS 100 RW | HGS 100 RW 250V |
|---|-------------|--------------------|--|
| Certified for explosive areas | | | No |
| Installation according to EN 50122-1:2011 for the protection of railway equipment | | | Yes |
| Class according to EN 62561-3, IEC 62561-3 | | | H (for heavy loads) |
| DC ignition voltage | | 300 ÷ 500 V | 200 ÷ 300 V |
| AC ignition voltage (50/60 Hz) | U_{aw} | $\geq 250 V_{rms}$ | $\geq 175 V_{rms}$ |
| Maximum discharge current (8/20) | I_{max} | | 200 kA |
| Nominal discharge current (8/20) | I_n | | 150 kA |
| Rated impulse sparkover voltage | $U_{r imp}$ | < 1 200 V | < 1 000 V |
| Impulse discharge current (10/350) | I_{imp} | | 150 kA |
| Charge | Q | 75 As | |
| Specific energy | W/R | | 5 625 kJ/Ω |
| Short-circuit withstanding current / 100 msec (AC mode) | | | $\leq 8 kA_{rms}$ |
| Short-circuit withstanding current / 30 msec (DC mode) | | | $\leq 20 kA_{rms}$ |
| Behaviour after substantial overloading | | | Internal short circuit inside HGS body |
| Insulation resistance at 100 V DC | R_i | | > 1 GΩ |
| Capacitance at 1 MHz | C | | < 35 pF |
| Housing material | | | Stainless steel |
| Degree of protection | | | IP66 |
| Operating temperature | θ | | -40 ÷ 90 °C |
| Climatic category according to IEC 60068-1:2013 | | | 40/90/21 |
| Operating position | | | Vertical |
| Installation | | | On the flange |
| Article number | | 10 002 | 10 003 |

Note: The picture shows the HGS 100 RW; the HGS 100 RW 250V is in the same housing.





HLSA25-275/2+0 (S)

- Lightning impulse current and surge arresters type T1+T2+T3.
- The products consist of varistors with big discharge ability.
- HLSA* in configurations 1+1, 3+1 and HLSA* G are additionally combined with a gas discharge tube which provides zero leakage current through the PE conductor..
- HLSA25 is suitable for objects with considerable levels of protection LPL I and LPL II, while HLSA12,5 is suitable for levels of protection LPL III and LPL IV.
- Installed at the boundaries of LPZ 0 – LPZ 1 and higher zones, closest to where overhead line enters the building i.e. in the main distribution boards.
- In case of the installation of a type T1+T2+T3 in the main switchboard, it is also necessary to install type T2 and T3 in any additional distribution boards in the electrical installation.
- If the product contains two PE (or PEN) terminals, it must not be used as a PE (PEN) bridge.
- **S** indication specifies a version with remote monitoring.
- **Designed according to standards:** IEC 61643-11:2011; UL 94
- **Application standards:** IEC 62305:2010; HD 60364-5-53:2022; CLC/TS 61643-12:2009

| Type | | HLSA25-275/2+0 | HLSA25-275/2+0 S |
|--|-------------|----------------|------------------------|
| Test class according to EN 61643-11:2012 (IEC 61643-11:2011) | | | T1, T2, T3 |
| System | | | TN-S |
| Number of poles | | | 2 |
| Rated operating AC voltage | U_N | | 230 V |
| Maximum continuous operating voltage AC | U_C | | 275 V |
| Maximum discharge current (8/20) | I_{max} | | 50 kA |
| Impulse discharge current for class I test (10/350) | I_{imp} | | 25 kA |
| Charge | Q | | 12.5 As |
| Specific energy for class I test | W/R | | 156 kJ/Ω |
| Total discharge current (10/350) L+N->PE | I_{Total} | | 50 kA |
| Total discharge current (8/20) L+N->PE | I_{Total} | | 100 kA |
| Nominal discharge current for class II test (8/20) | I_n | | 25 kA |
| Open circuit voltage of the combination wave generator | U_{OC} | | 6 kV |
| Voltage protection level at I_n | U_p | | < 1.2 kV |
| Temporary overvoltage test (TOV) for $t_T = 5$ s | U_T | | 337 V |
| Temporary overvoltage test (TOV) for $t_T = 120$ min | U_T | | 440 V |
| Maximal back-up fuse | | | 250 A gL/gG |
| Maximal back-up fuse („V“ connection) | | | 125 A gL/gG |
| Residual current | I_{PE} | | ≤ 1 400 μA |
| Short-circuit current rating at maximum back-up fuse | I_{SCCR} | | 80 kA _{rms} |
| Housing material | | | Polyamid PA6, UL94 V-0 |
| Degree of protection | | | IP20 |
| Operating temperature | θ | | -40 ÷ 70 °C |
| Humidity range | RH | | 5 ÷ 95 % |
| Article number | | 10 452 | 10 458 |

Note: This is an example of a suitable representative of this product group. On the opposite page, we present five complete lines of products in the category.



| HLSA25G-255* | art. no. | system | U _c | I _{imp} (10/350) | I _{Total} (10/350) | I _n (8/20) | U _p | modular width |
|-----------------|----------|----------|----------------|---------------------------|-----------------------------|-----------------------|----------------|---------------|
| HLSA25G-255 | 10 462 | TN | 255 V AC | 25 kA | — | 25 kA | < 1.25 kV | 2TE |
| HLSA25G-255/2+0 | 10 463 | TN-S, TT | | | 50 kA | | | 4TE |
| HLSA25G-255/3+0 | 10 464 | TN-C | | | 75 kA | | | 6TE |
| HLSA25G-255/4+0 | 10 465 | TN-S, TT | | | 100 kA | | | 8TE |

| HLSA25-275* | art. no. | system | U _c | I _{imp} (10/350) | | I _{Total} (10/350) | I _n (8/20) | | U _p | modular width |
|----------------|----------|----------|----------------|---------------------------|---------------|-----------------------------|-----------------------|--------|--------------------------------|---------------|
| HLSA25-275 | 10 450 | TN | 275 V AC | 25 kA | | — | 25 kA | | < 1.2 kV | 2TE |
| HLSA25-275/1+1 | 10 451 | TN-S, TT | | 25 kA (L/N) | 50 kA (N/PE) | 50 kA | 25 kA | 50 kA | < 1.2 kV (L/N) < 1.3 kV (N/PE) | 4TE |
| HLSA25-275/2+0 | 10 452 | TN-S | | 25 kA | | 50 kA | 25 kA | | < 1.2 kV | 4TE |
| HLSA25-275/3+0 | 10 453 | TN-C | | 25 kA | | 75 kA | 25 kA | | < 1.2 kV | 6TE |
| HLSA25-275/3+1 | 10 454 | TN-S, TT | | 25 kA (L/N) | 100 kA (N/PE) | 100 kA | 25 kA | 100 kA | < 1.2 kV (L/N) < 1.3 kV (N/PE) | 8TE |
| HLSA25-275/4+0 | 10 455 | TN-S | | 25 kA | | 100 kA | 25 kA | | < 1.2 kV | 8TE |

| HLSA12,5G-255* | art. no. | system | U _c | I _{imp} (10/350) | I _{Total} (10/350) | I _n (8/20) | U _p | modular width |
|-------------------|----------|----------|----------------|---------------------------|-----------------------------|-----------------------|----------------|---------------|
| HLSA12,5G-255 | 10 246 | TN | 255 V AC | 12.5 kA | — | 25 kA | < 1.1 kV | 1TE |
| HLSA12,5G-255/2+0 | 10 249 | TN-S | | | 25 kA | | | 2TE |
| HLSA12,5G-255/3+0 | 10 269 | TN-C | | | 37.5 kA | | | 3TE |
| HLSA12,5G-255/4+0 | 10 267 | TN-S, TT | | | 50 kA | | | 4TE |

| HLSA12,5-275* | art. no. | system | U _c | I _{imp} (10/350) | | I _{Total} (10/350) | I _n (8/20) | | U _p | modular width |
|------------------|----------|----------|----------------|---------------------------|--------------|-----------------------------|-----------------------|--------------|--------------------------------|---------------|
| HLSA12,5-275 | 10 058 | TN | 275 V AC | 12.5 kA | | — | 25 kA | | < 1.2 kV | 1TE |
| HLSA12,5-275/1+1 | 10 059 | TN-S, TT | | 12.5 kA (L/N) | 25 kA (N/PE) | 25 kA | 25 kA (L/N) | 30 kA (N/PE) | < 1.2 kV (L/N) < 1.4 kV (N/PE) | 2TE |
| HLSA12,5-275/2+0 | 10 060 | TN-S | | 12.5 kA | | 25 kA | 25 kA | | < 1.2 kV | 2TE |
| HLSA12,5-275/3+0 | 10 062 | TN-C | | 12.5 kA | | 37.5 kA | 25 kA | | < 1.2 kV | 3TE |
| HLSA12,5-275/3+1 | 10 063 | TN-S, TT | | 12.5 kA (L/N) | 50 kA (N/PE) | 50 kA | 25 kA (L/N) | 50 kA (N/PE) | < 1.2 kV (L/N) < 1.3 kV (N/PE) | 4TE |
| HLSA12,5-275/4+0 | 10 065 | TN-S | | 12.5 kA | | 50 kA | 25 kA | | < 1.2 kV | 4TE |

| HLSA12,5-275* M | art. no. | system | U _c | I _{imp} (10/350) | | I _{Total} (10/350) | I _n (8/20) | | U _p | modular width |
|--------------------|----------|----------|----------------|---------------------------|--------------|-----------------------------|-----------------------|--------------|---------------------------------|---------------|
| HLSA12,5-275 M | 16 080 | TN | 275 V AC | 12.5 kA | | — | 25 kA | | < 1.25 kV | 1TE |
| HLSA12,5-275/1+1 M | 16 081 | TN-S, TT | | 12.5 kA (L/N) | 25 kA (N/PE) | 25 kA | 25 kA (L/N) | 30 kA (N/PE) | < 1.25 kV (L/N) < 1.4 kV (N/PE) | 2TE |
| HLSA12,5-275/2+0 M | 16 082 | TN-S | | 12.5 kA | | 25 kA | 25 kA | | < 1.25 kV | 2TE |
| HLSA12,5-275/3+0 M | 16 083 | TN-C | | 12.5 kA | | 37.5 kA | 25 kA | | < 1.25 kV | 3TE |
| HLSA12,5-275/3+1 M | 16 084 | TN-S, TT | | 12.5 kA (L/N) | 50 kA (N/PE) | 50 kA | 25 kA (L/N) | 50 kA (N/PE) | < 1.25 kV (L/N) < 1.3 kV (N/PE) | 4TE |
| HLSA12,5-275/4+0 M | 16 085 | TN-S | | 12.5 kA | | 50 kA | 25 kA | | < 1.25 kV | 4TE |

The “M” in the group name HLSA12,5-275* M specifies a type of construction with **removable modules**.

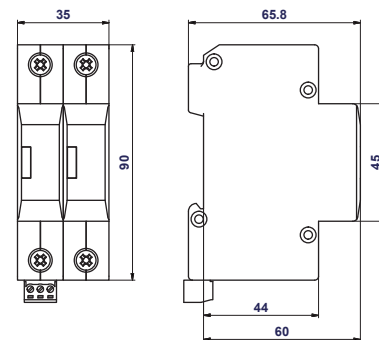
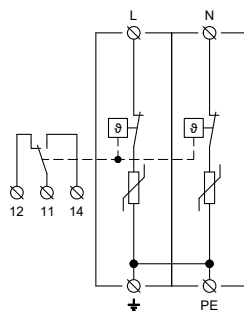
The HLSA12,5-* series (**solid version**) offers **U_c 75, 150, 320, 385, 440 and 600 V AC** voltage levels in addition to the mentioned **U_c 275**.

The HLSA25-* series also offers **U_c 150 and 320 V AC** voltage levels in addition to the mentioned **U_c 275**.

All products mentioned above are also available with **remote monitoring** – indicated by an “S” in the product name.

The QR code points to **the complete production of T1+T2(+T3) lightning and surge arresters** with all details available at **hakel.com**





HSA-275/2+0 (S)

- Surge arresters type T2+T3 ensure the equipotential bonding and reduce switching, induced and residual overvoltage in LV power supply systems.
- The products consist of varistors with big discharge ability.
- Configurations 1+1 and 3+1 are additionally combined with a gas discharge tube which ensures zero leakage current through the PE conductor.
- Installed at the boundaries of LPZ 1 – LPZ 3 into subsidiary switchboards and control panels.
- If the product contains two PE (or PEN) terminals, it must not be used as a PE (PEN) bridge.
- **M** indication specifies a type of construction with removable module.
- **S** indication specifies a version with remote monitoring.
- **Designed according to standards:** IEC 61643-11:2011; UL 94
- **Application standards:** IEC 62305:2010; HD 60364-5-53:2022; CLC/TS 61643-12:2009

| Type | | HSA-275/2+0 | HSA-275/2+0 S |
|--|-------------|-------------|------------------------|
| Test class according to EN 61643-11:2012 (IEC 61643-11:2011) | | | T2, T3 |
| System | | | TN-S |
| Number of poles | | | 2 |
| Rated operating AC voltage | U_N | | 230 V |
| Maximum continuous operating voltage AC | U_C | | 275 V |
| Maximum discharge current (8/20) | I_{max} | | 50 kA |
| Nominal discharge current for class II test (8/20) | I_n | | 20 kA |
| Open circuit voltage of the combination wave generator | U_{OC} | | 6 kV |
| Total discharge current (8/20) L+N->PE | I_{Total} | | 100 kA |
| Voltage protection level at I_n | U_p | | < 1.2 kV |
| Voltage protection level at U_{OC} | U_p | | < 0.8 kV |
| Temporary overvoltage test (TOV) for $t_T = 5$ s | U_T | | 337 V |
| Temporary overvoltage test (TOV) for $t_T = 120$ min | U_T | | 440 V |
| Maximal back-up fuse | | | 160 A gL/gG |
| Residual current | I_{PE} | | $\leq 600 \mu A$ |
| Short-circuit current rating at maximum back-up fuse | I_{SCCR} | | 60 kA _{rms} |
| Housing material | | | Polyamid PA6, UL94 V-0 |
| Degree of protection | | | IP20 |
| Operating temperature | ϑ | | -40 ÷ 70 °C |
| Humidity range | RH | | 5 ÷ 95 % |
| Article number | | 24 529 | 24 522 |

Note: This is an example of a suitable representative of this product group. On the opposite page, we present two lines of products in the category.



| HSA-275* | art. no. | system | U _c | I _{max} (8/20) | I _{Total} (8/20) | I _n (8/20) | U _p | modular width |
|-------------|----------|----------|----------------|-------------------------|---------------------------|-----------------------|-----------------------------------|---------------|
| HSA-275 | 24 527 | TN | 275 V AC | 50 kA | — | 20 kA | < 1.2 kV | 1TE |
| HSA-275/1+1 | 24 528 | TN-S, TT | | | 50 kA | | < 1.2 kV (L/N) < 1.4 kV (N/PE) | 2TE |
| HSA-275/2+0 | 24 529 | TN-S | | | 100 kA | | < 1.2 kV | 2TE |
| HSA-275/3+0 | 24 530 | TN-C | | | 150 kA | | < 1.2 kV | 3TE |
| HSA-275/3+1 | 24 531 | TN-S, TT | | | 50 kA | | < 1.2 kV (L/N) < 1.4 kV (N/PE) | 4TE |
| HSA-275/4+0 | 24 532 | TN-S | | | 200 kA | | < 1.2 kV | 4TE |

| HSA-275* M | art. no. | system | U _c | I _{max} (8/20) | I _{Total} (8/20) | I _n (8/20) | U _p | modular width |
|---------------|----------|----------|----------------|-------------------------|---------------------------|-----------------------|------------------------------------|---------------|
| HSA-275 M | 27 080 | TN | 275 V AC | 50 kA | — | 20 kA | < 1.25 kV | 1TE |
| HSA-275/1+1 M | 27 081 | TN-S, TT | | | 50 kA | | < 1.25 kV (L/N) < 1.4 kV (N/PE) | 2TE |
| HSA-275/2+0 M | 27 082 | TN-S | | | 100 kA | | < 1.25 kV | 2TE |
| HSA-275/3+0 M | 27 083 | TN-C | | | 150 kA | | < 1.25 kV | 3TE |
| HSA-275/3+1 M | 27 084 | TN-S, TT | | | 50 kA | | < 1.25 kV (L/N) < 1.4 kV (N/PE) | 4TE |
| HSA-275/4+0 M | 27 085 | TN-S | | | 200 kA | | < 1.25 kV | 4TE |

The “M” in the group name HSA-275* M specifies a type of construction with **removable modules**.

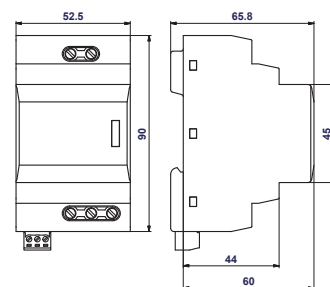
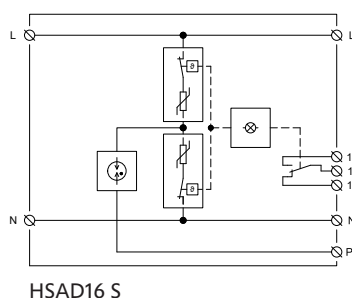
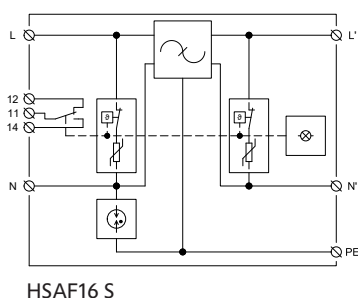
We also offer this series with U_c **75, 150, 320, 385, 440** and **600 V AC**.

The HSA-275* series (**solid version**) also offers U_c **720** and **850 V AC** voltage levels in addition to the mentioned above.

All products mentioned above are also available with **remote monitoring** – indicated by an “S” in the product name.



The QR code points to **the complete production of T2+T3** surge arresters at **hakel.com**



HSAF16 (S), HSAD16 (S)

- Two-port type surge protection devices T3 for serial connection.
- Compared to the HSAD, the two-stage surge arrester HSAF also includes a high-frequency filter.
- Intended for protection of electronic appliances against the effects of switching, induced and residual overvoltage generated in LV power supply systems.
- Contain an improved thermal fuse, which ensures timely disconnection of HSAF/HSAD from the power grid during the MOV's overheating and thus prevents damage to the HSAF/HSAD.
- Installed at the boundaries of LPZ 2 – LPZ 3, as close to the device to be protected as possible (no further than 5 m).
- In front of HSAF/HSAD must be installed a lightning current and surge arrester T1 and T2 from HAKEL company.
- **S** indication specifies a version with remote monitoring.
- **Designed according to standards:** IEC 61643-11:2011; EN 55017:2011 / CISPR 17:2011; UL 94
- **Application standards:** IEC 62305:2010; HD 60364-5-53:2022; CLC/TS 61643-12:2009

| Type | | HSAF16 | HSAF16 S | HSAD16 | HSAD16 S |
|---|--------------------|--------------------------------|----------|-----------|----------|
| Test class according to EN 61643-11:2012 (IEC 61643-11:2011) | | T3 | | | |
| System | | TN-C-S, TN-S | | | |
| Number of poles | | 2 | | | |
| Rated operating AC voltage | U _N | 230 V | | | |
| Maximum continuous operating voltage AC | U _C | 275 V | | | |
| Rated load current | I _L | 16 A | | | |
| Open circuit voltage of the combination wave generator | U _{OC} | 6 kV (L/N, L/PE), 10 kV (N/PE) | | | |
| Voltage protection level at U _{OC} (L/N) | U _p | < 0.75 kV | | < 0.95 kV | |
| Voltage protection level at U _{OC} (L/PE) | U _p | < 1 kV | | < 1.4 kV | |
| Voltage protection level at U _{OC} (N/PE) | U _p | < 1.5 kV | | < 1.4 kV | |
| Nominal discharge current for class II test (8/20) L/N, L/PE | I _n | 3 kA | | | |
| Nominal discharge current for class II test (8/20) N/PE | I _n | 5 kA | | | |
| Total discharge current (8/20) L+N->PE | I _{Total} | 6 kA | | | |
| Asymmetrical attenuation of filter at f = 4 MHz | | > 80 dB | | N/A | |
| Asymmetrical attenuation of filter at f = 0.15 ÷ 30 MHz | | > 40 dB | | N/A | |
| Temporary overvoltage test (TOV) for t _r = 5 s (L/N) | U _T | 337 V | | | |
| Temporary overvoltage test (TOV) for t _r = 120 min (L/N) | U _T | 440 V | | | |
| Temporary overvoltage test (TOV) for t _r = 0.2 s (N/PE) | U _T | 1 200 V | | | |
| Power dissipation | P _z | < 3.5 W | | N/A | |
| Maximal back-up fuse | | 16 A | | | |
| Residual current | I _{PE} | ≤ 5 μA | | | |
| Short-circuit current rating at maximum back-up fuse | I _{SCCR} | 6 kA _{rms} | | | |
| Housing material | | Polyamid PA6, UL94 V-0 | | | |
| Degree of protection | | IP20 | | | |
| Operating temperature | ϑ | -40 ÷ 55 °C | | | |
| Humidity range | RH | 5 ÷ 95 % | | | |
| Article number | | 30 161 | 30 171 | 30 360 | 30 361 |

Note: The picture shows the HSAF16 S; the HSAD16 S is in the same housing. These are examples of suitable representatives of this product group. On the opposite page, we provide a broader list of products in this category.



Surge arresters T3 with EMI/RFI filters for AC systems

| HSAF* (V AC) | art. no. | system | U _N | U _c | I _L | U _p (L/N) | asymmetrical attenuation of filter (band-stop filter) | modular width |
|--------------|----------|-----------------|----------------|----------------|----------------|----------------------|---|---------------|
| HSAF10 | 30 160 | TN-C-S, TN-S | 230 V AC | 275 V AC | 10 A | < 0.75 kV | > 80 dB at 4 MHz > 35 dB at 0.15 ÷ 30 MHz | 3TE |
| HSAF16 | 30 161 | | | | 16 A | | | |
| HSAF25 | 30 196 | | | | 25 A | < 0.8 kV | | 4TE |
| HSAF32 | 30 198 | | | | 32 A | | | |

Surge arresters T3 with EMI/RFI filters for DC systems

| HSAF* V DC | art. no. | system | U _N | U _c | I _L | U _p (+/-) | asymmetrical attenuation of filter (band-stop filter) | modular width |
|---------------|----------|--------|----------------|----------------|----------------|----------------------|---|---------------|
| HSAF10/6VDC | 30 149 | DC | 6 V DC | 7.2 V DC | 10 A | < 0.35 kV | > 80 dB at 4 MHz > 35 dB at 0.15 ÷ 30 MHz | 3TE |
| HSAF10/12VDC | 30 150 | | 12 V DC | 14.4 V DC | | < 0.35 kV | | |
| HSAF10/24VDC | 30 157 | | 24 V DC | 28.8 V DC | | < 0.4 kV | | |
| HSAF10/48VDC | 30 158 | | 48 V DC | 57.6 V DC | | < 0.5 kV | | |
| HSAF10/60VDC | 30 159 | | 60 V DC | 72 V DC | | < 0.55 kV | | |
| HSAF10/120VDC | 30 162 | | 120 V DC | 144 V DC | | < 0.9 kV | | |
| HSAF10/220VDC | 30 163 | | 220 V DC | 264 V DC | | < 1.3 kV | | |
| HSAF16/6VDC | 30 142 | | 6 V DC | 7.2 V DC | 16 A | < 0.35 kV | | |
| HSAF16/12VDC | 30 143 | | 12 V DC | 14.4 V DC | | < 0.35 kV | | |
| HSAF16/24VDC | 30 144 | | 24 V DC | 28.8 V DC | | < 0.4 kV | | |
| HSAF16/48VDC | 30 145 | | 48 V DC | 57.6 V DC | | < 0.5 kV | | |
| HSAF16/60VDC | 30 146 | | 60 V DC | 72 V DC | | < 0.55 kV | | |
| HSAF16/120VDC | 30 147 | | 120 V DC | 144 V DC | | < 0.9 kV | | |
| HSAF16/220VDC | 30 148 | | 220 V DC | 264 V DC | | < 1.3 kV | | |

Surge arresters T3 for AC systems (without filter)

| HSAD* (V AC) | art. no. | system | U _N | U _c | I _L | U _p (L/N) | T3 without filter | modular width |
|---------------|----------|-----------------|----------------|----------------|----------------|----------------------|-------------------|---------------|
| HSAD16 | 30 360 | TN-C-S, TN-S | 230 V AC | 275 V AC | 16 A | < 0.95 kV | N/A | 3TE |
| HSAD16/110VAC | 30 362 | | 110 V AC | 132 V AC | | < 0.6 kV | | |
| HSAD-S M S | 30 370 | | 230 V AC | 275 V AC | 10 A | < 1 kV | | 1TE |
| HSAD-P M S | 30 380 | | | | N/A | | | |

Surge arresters T3 for DC systems (without filter)

| HSAD* V DC | art. no. | system | U _N | U _c | I _L | U _p (+/-) | T3 without filter | modular width |
|---------------|----------|--------|----------------|----------------|----------------|----------------------|-------------------|---------------|
| HSAD16/6VDC | 30 250 | DC | 6 V DC | 7.2 V DC | 16 A | < 0.2 kV | N/A | 3TE |
| HSAD16/12VDC | 30 251 | | 12 V DC | 14.4 V DC | | < 0.2 kV | | |
| HSAD16/24VDC | 30 252 | | 24 V DC | 28.8 V DC | | < 0.25 kV | | |
| HSAD16/48VDC | 30 253 | | 48 V DC | 57.6 V DC | | < 0.3 kV | | |
| HSAD16/60VDC | 30 254 | | 60 V DC | 72 V DC | | < 0.35 kV | | |
| HSAD16/120VDC | 30 255 | | 120 V DC | 144 V DC | | < 0.5 kV | | |
| HSAD16/220VDC | 30 256 | | 220 V DC | 264 V DC | | < 0.8 kV | | |

All products mentioned above are also available with **remote monitoring** – indicated by an “S” in the product name.

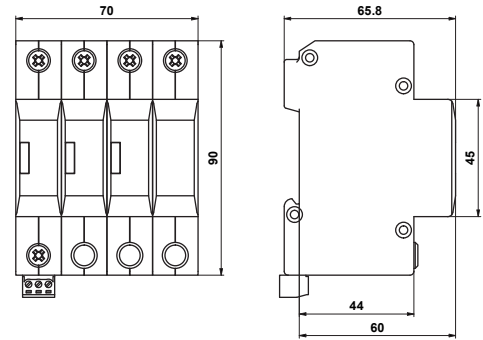
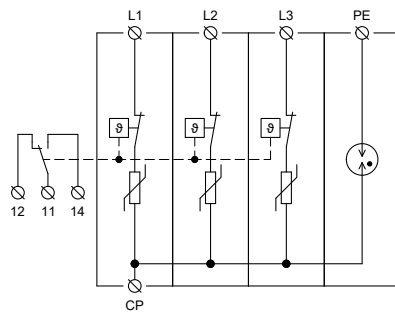
The surge arresters **HSAD-S M S** and **HSAD-P M S** with removable modules have remote monitoring by default. (HSAD-P M S is only a single-port protection and thus an exception to the above.)



◀ HSAF (T3 with filter) | (T3 without filter) HSAD ▶

The QR code points to **the complete production** of T3 surge arresters at **hakel.com**





HLSA12,5-440/3+1 (S) IT

- Lightning impulse current and surge arresters type T1+T2 ensure the equipotential bonding, eliminate the effects of lightning current and reduce switching, induced and residual overvoltage in single-phase and three-phase IT power supply systems.
- The products consist of varistors with big discharge ability in the combination with gas discharge tube they ensure zero leakage current in the PE conductor.
- Installed at the boundaries of zones LPZ 0 – LPZ 1 and higher, closest to where the overhead line enters the building i.e. in the main distribution boards.
- Suitable for objects with considerable levels of protection LPL III and LPL IV.
- **S** indication specifies a version with remote monitoring.
- **Designed according to standards:** EC 61643-11:2011; UL 94
- **Application standards:** IEC 62305:2010; HD 60364-5-53:2022; CLC/TS 61643-12:2009

| Type | | HLSA12,5-275/3+1 IT | HLSA12,5-275/3+1 S IT |
|--|-------------|---------------------|---------------------------|
| Test class according to EN 61643-11:2012 (IEC 61643-11:2011) | | | T1, T2 |
| System | | | IT |
| Number of poles | | | 4 |
| Nominal line voltage | U_N | | 230 V |
| Maximum continuous operating voltage AC | U_C | | 275 V |
| Maximum discharge current (8/20) L/PE | I_{max} | | 50 kA |
| Impulse discharge current for class I test (10/350) L/CP | I_{imp} | | 12.5 kA |
| Charge (L/CP) | Q | | 6.25 As |
| Specific energy for class I test (L/CP) | W/R | | 39 kJ/Ω |
| Impulse discharge current for class I test (10/350) CP/PE | I_{imp} | | 50 kA |
| Charge (CP/PE) | Q | | 25 As |
| Specific energy for class I test (CP/PE) | W/R | | 625 kJ/Ω |
| Total discharge current (10/350) L1+L2+L3+CP->PE | I_{Total} | | 50 kA |
| Total discharge current (8/20) L1+L2+L3+CP->PE | I_{Total} | | 100 kA |
| Nominal discharge current for class II test (8/20) L/PE | I_n | | 25 kA |
| Nominal discharge current for class II test (8/20) CP/PE | I_n | | 50 kA |
| Voltage protection level at I_n | U_p | | < 1.2 kV |
| Temporary overvoltage test (TOV) for $t_T = 5$ s (L/CP) | U_T | | 337 V |
| Temporary overvoltage test (TOV) for $t_T = 0.2$ s (L/PE) | U_T | | 1455 V |
| Response time (L/CP) | t_A | | < 25 ns |
| Response time (CP/PE) | t_A | | < 100 ns |
| Maximal back-up fuse | | | 160 A gL/gG |
| Short-circuit current rating at maximum back-up fuse | I_{SCCR} | | 60 kA _{rms} |
| Lightning protection zone | | | LPZ 0-1, LPZ 1-2, LPZ 2-3 |
| Housing material | | | Polyamid PA6, UL94 V-0 |
| Degree of protection | | | IP20 |
| Operating temperature | ϑ | | -40 ÷ 70 °C |
| Article number | | 27 804 | 27 810 |

Note: This is an example of a suitable representative of this product group. On the opposite page, we present three categories of IT systems surge arresters.



Lightning and surge arresters T1+T2 for IT systems

| HLSA*/2+1 IT | art. no. | U _C | U _N | U _p | I _{imp} (10/350) | | I _n (8/20) | | modular width |
|---------------------|----------|----------------|----------------|----------------|---------------------------|---------------|-----------------------|---------------|---------------|
| HLSA12,5-275/2+1 IT | 27 574 | 275 V AC | 230 V IT | < 1.2 kV | 12.5 kA (L/PE) | 50 kA (CP/PE) | 25 kA (L/PE) | 50 kA (CP/PE) | 3TE |
| HLSA12,5-440/2+1 IT | 27 584 | 440 V AC | 400 V IT | < 1.8 kV | | | | | 5TE |
| HLSA12,5-600/2+1 IT | 27 586 | 600 V AC | 500 V IT | < 2.4 kV | | | | | |
| HLSA7-720/2+1 IT | 27 588 | 720 V AC | 600 V IT | < 2.6 kV | 7 kA (L/PE) | 25 kA (CP/PE) | 25 kA (L/PE) | 30 kA (CP/PE) | 7TE |
| HLSA7-850/2+1 IT | 27 590 | 850 V AC | 720 V IT | < 3.3 kV | | | | | |

| HLSA*/3+1 IT | art. no. | U _C | U _N | U _p | I _{imp} (10/350) | | I _n (8/20) | | modular width |
|---------------------|----------|----------------|----------------|----------------|---------------------------|---------------|-----------------------|---------------|---------------|
| HLSA12,5-275/3+1 IT | 27 804 | 275 V AC | 3× 230 V IT | < 1.2 kV | 12.5 kA (L/PE) | 50 kA (CP/PE) | 25 kA (L/PE) | 50 kA (CP/PE) | 4TE |
| HLSA12,5-440/3+1 IT | 27 824 | 440 V AC | 3× 400 V IT | < 1.8 kV | | | | | 7TE |
| HLSA12,5-600/3+1 IT | 27 844 | 600 V AC | 3× 500 V IT | < 2.4 kV | | | | | |
| HLSA7-720/3+1 IT | 27 864 | 720 V AC | 3× 600 V IT | < 2.6 kV | 7 kA (L/PE) | | | | 10TE |
| HLSA7-850/3+1 IT | 27 884 | 850 V AC | 3× 720 V IT | < 3.3 kV | | | | | |

| HLSA*/3+1 M IT | art. no. | U _C | U _N | U _p | I _{imp} (10/350) | | I _n (8/20) | | modular width |
|---------------------|----------|----------------|----------------|----------------|---------------------------|-------|-----------------------|---------------|---------------|
| HLSA21-600/3+1 M IT | 16 191 | 600 V AC | 3× 500 V IT | < 2.2 kV | 21 kA | 65 kA | 20 kA (L/PE) | 50 kA (CP/PE) | 10TE |

Surge arresters T2 for IT systems

| HSA-*/2+1 IT | art. no. | U _C | U _N | U _p at I _n | U _p at U _{OC} | I _{max} (8/20) L/CP | I _n (8/20) L/CP | modular width |
|----------------|----------|----------------|----------------|----------------------------------|-----------------------------------|------------------------------|----------------------------|---------------|
| HSA-275/2+1 IT | 27 572 | 275 V AC | 230 V IT | < 1.2 kV | < 0.8 kV | 50 kA | 20 kA | 3TE |
| HSA-440/2+1 IT | 27 576 | 440 V AC | 400 V IT | < 1.7 kV | < 1.4 kV | | | |
| HSA-600/2+1 IT | 27 578 | 600 V AC | 500 V IT | < 2.1 kV | < 1.7 kV | | | |
| HSA-720/2+1 IT | 27 580 | 720 V AC | 600 V IT | < 2.6 kV | < 2.0 kV | | | |
| HSA-850/2+1 IT | 27 582 | 850 V AC | 720 V IT | < 3.3 kV | < 2.5 kV | | | |

| HSA-*/3+1 IT | art. no. | U _C | U _N | U _p at I _n | U _p at U _{OC} | I _{max} (8/20) L/CP | I _n (8/20) L/CP | modular width |
|----------------|----------|----------------|----------------|----------------------------------|-----------------------------------|------------------------------|----------------------------|---------------|
| HSA-275/3+1 IT | 27 604 | 275 V AC | 3× 230 V IT | < 1.2 kV | < 0.8 kV | 50 kA | 20 kA | 4TE |
| HSA-440/3+1 IT | 27 624 | 440 V AC | 3× 400 V IT | < 1.7 kV | < 1.4 kV | | | |
| HSA-600/3+1 IT | 27 644 | 600 V AC | 3× 500 V IT | < 2.1 kV | < 1.7 kV | | | |
| HSA-720/3+1 IT | 27 664 | 720 V AC | 3× 600 V IT | < 2.6 kV | < 2.0 kV | | | |
| HSA-850/3+1 IT | 27 684 | 850 V AC | 3× 720 V IT | < 3.3 kV | < 2.5 kV | | | |

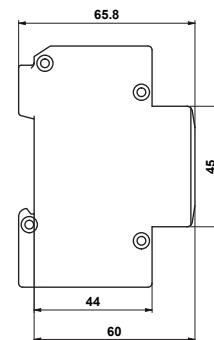
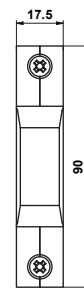
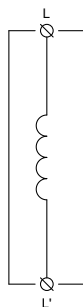
Surge arresters T3 with EMI/RFI filter for AC IT systems

| HSAF* IT | art. no. | U _C | U _{OC} | I _L | U _p at U _{OC} | | asymmetrical attenuation of filter (band-stop filter) | modular width |
|-----------|----------|----------------|-----------------|----------------|-----------------------------------|----------------|---|---------------|
| HSAF16 IT | 30 500 | 275 V AC | 6 kV | 16 A | < 1400 V (L1/L2) | < 900 V (L/PE) | > 80 dB at 4 MHz > 35 dB at 0.15 ÷ 30 MHz | 3TE |

All products mentioned above are also available with **remote monitoring** – indicated by an “S” in the product name.
(The “M” in the name HLSA21-600/3+1 M IT specifies a type of construction with removable modules.)

The QR code points to **the complete production**
of surge arresters for **IT systems**
at **hakil.com**





HI16

- Ensure the energy coordination between the arresters type T1 and T2 or the arresters type T2 and T3, especially in the places where there is no adequate distance between the arresters.
- If the energy coordination of surge protection is not observed, the excessive energy of passing impulse may cause a damage to the subsequent stage of the protective cascade.
- If there is at least 5 m distance between two successive arrester types (in case of two successive arrester types in two different switchboards), it is possible to omit the decoupling element.

- **Designed according to standards:** IEC 61643-11:2011; UL 94
- **Application standard:** IEC 62305:2010; CLC/TS 61643-12:2009



| Type | | HI16 |
|---|-------------|--------------------------|
| Rated operating AC voltage | U_N | 500 V |
| Rated load current | I_L | 16 A |
| Inductance $\pm 10\%$ | L | 6 μ H |
| DC resistance | R | < 0.01 Ω |
| Maximal back-up fuse | | 16 A gL/gG |
| Thermal class of insulation | | A (105 °C) |
| Housing material | | Polyamid PA6, UL94 V-0 |
| Degree of protection | | IP20 |
| Operating temperature | ϑ | -40 ÷ 70 °C |
| Humidity range | RH | 5 ÷ 95 % |
| Recommended cross-section of connected conductors | S | 6 mm ² |
| Clamp fastening range (stranded conductor) | | 1.5 ÷ 16 mm ² |
| Installation | | On DIN rail 35 mm |
| Operating position | | Any |
| Article number | | 30 400 |

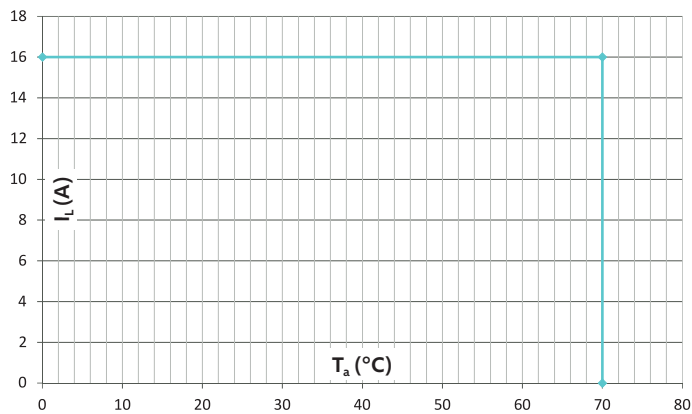
| HI* | art. no. | U_N | I_L | L ($\pm 10\%$) | R (DC resistance) | thermal class of insulation | ϑ | modular width |
|---------|----------|----------|-------|------------------|-------------------|-----------------------------|-------------|-----------------|
| HI16 | 30 400 | 500 V AC | 16 A | 6 μ H | < 0.01 Ω | A (105 °C) | -40 ÷ 70 °C | 1 TE |
| HI16/15 | 30 401 | | | 15 μ H | | | | |
| HI32 | 30 402 | | 32 A | 6 μ H | | | | |
| HI32/15 | 30 403 | | | 15 μ H | | | | |
| HI50/15 | 30 405 | | 50 A | | | | | 4 TE |
| HI63 | 30 404 | | 63 A | 6 μ H | | F (155 °C) | -40 ÷ 70 °C | 2 TE |
| HI80 | 30 406 | | 80 A | 4 μ H | | | | |
| HI-120 | 30 120 | | 120 A | 6 μ H | | A (105 °C) | -40 ÷ 60 °C | non-modular box |



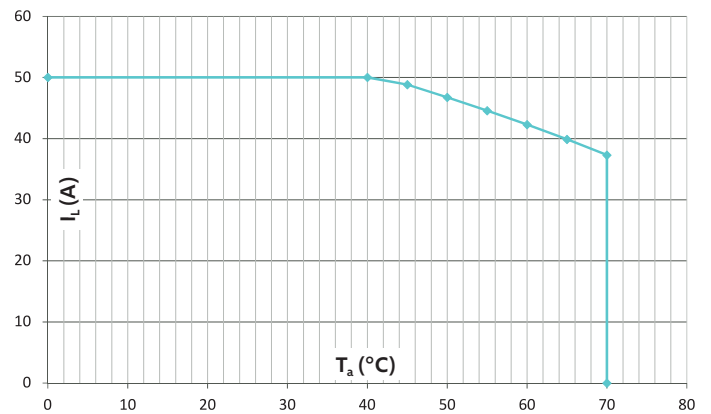
The QR code points to the complete production of decoupling inductors at hake!.com

Charts of dependence of nominal current on ambient temperature

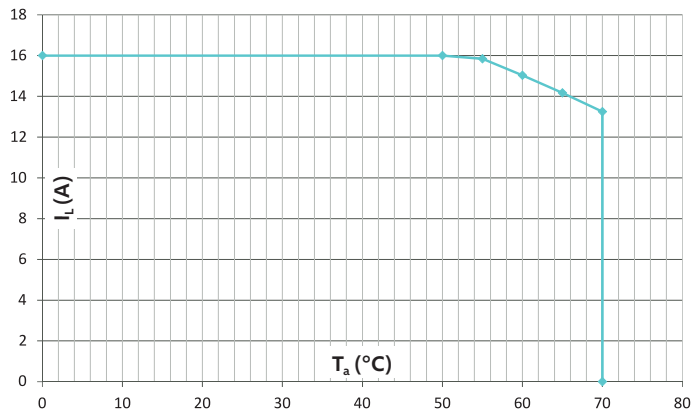
HI16 – Thermal insulation class A



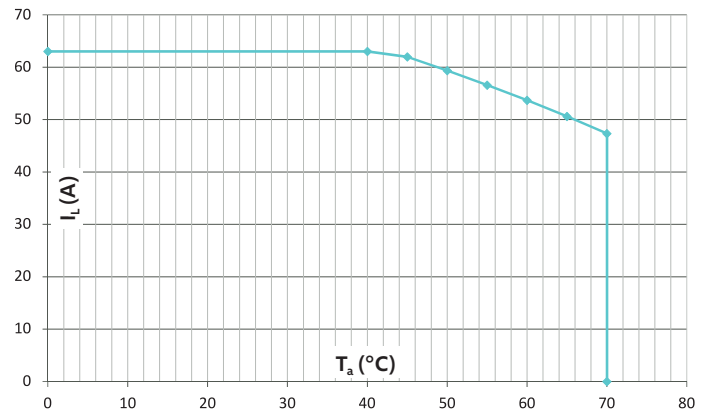
HI50/15 – Thermal insulation class A



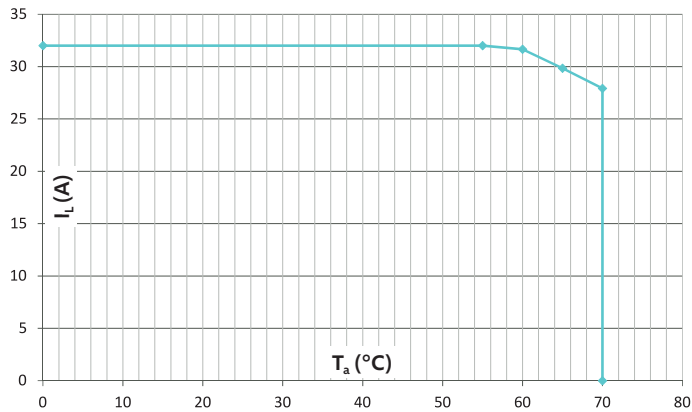
HI16/15 – Thermal insulation class A



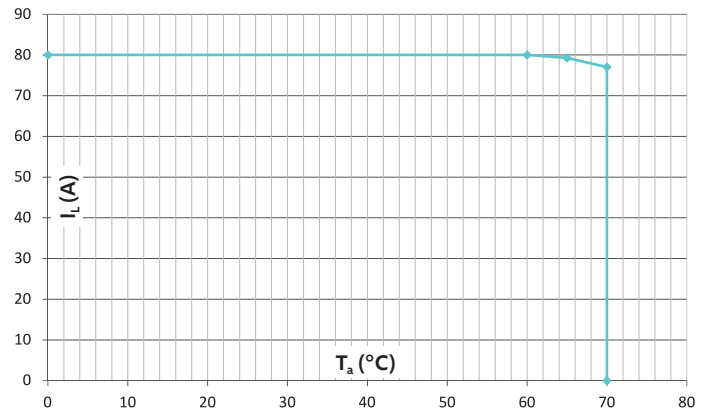
HI63 – Thermal insulation class A



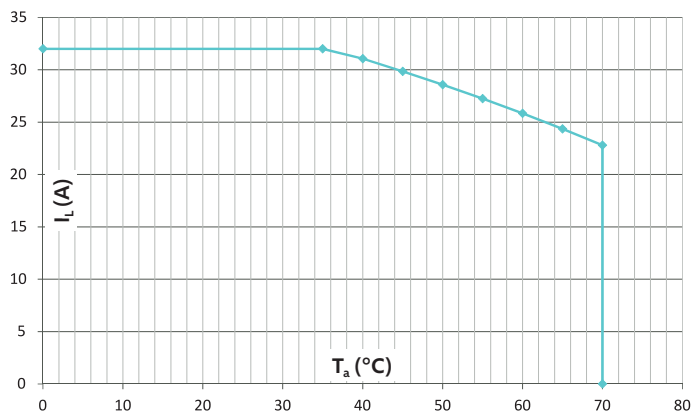
HI32 – Thermal insulation class A



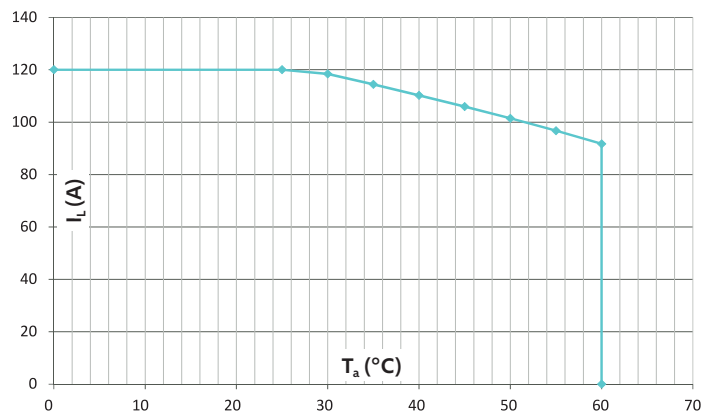
HI80 – Thermal insulation class F

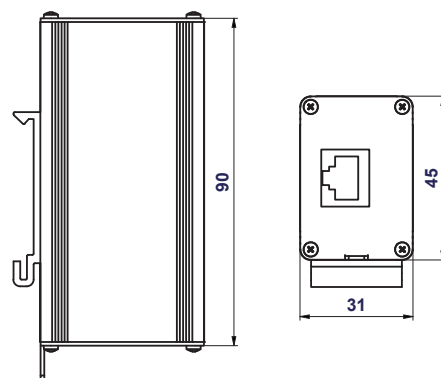
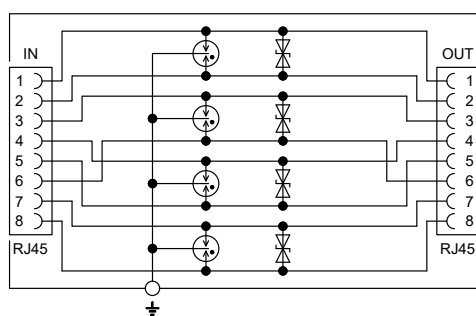


HI32/15 – Thermal insulation class A



HI120 – Thermal insulation class A with ventilation holes





HT-NET PoE+ 6cat 802.3at

- Designed for protection and faultless data transmission within computer networks category 6, normative conformity with category 6A / EA, ISO / IEC 11801.
- Possibility to use PoE + according to IEEE 802.3at.
- Protect input electronic circuits of network cards against damage caused by surge effects in the LPZ Concept at the boundaries of LPZ 1 – LPZ 3.
- It is recommended to use at the input of protected equipment.
- Connection via RJ45 connector.
- High transmission speed 500 Mbit/s.
- **Designed according to standards:** IEC 61643-21:2000
- **Application standards:** IEC 62305:2010

| Type | | HT-NET PoE+ 6cat 802.3at |
|--|-------------|--------------------------------------|
| Testing category according to IEC 61643-21:2000 and EN 61643-21:2001 | | C1, C2, C3 |
| Connector type | | RJ45 |
| Rated operating DC voltage | U_N | $0 \div 48 \text{ V}$ |
| Maximum continuous operating voltage DC | U_C | 58 V |
| Maximum continuous operating voltage AC | U_C | 41 V |
| Rated load current | I_L | 1 A |
| C1 Nominal discharge current (8/20) line/line | I_n | 0.15 kA |
| C2 Nominal discharge current (8/20) | I_n | 1 kA |
| C2 Voltage protection level at I_n (line/line) | U_p | < 150 V |
| C2 Voltage protection level at I_n (line/PE) | U_p | < 700 V |
| C3 Voltage protection level at 1 kV/ μ s | U_p | < 120 V |
| Data rate | | 500 Mbit/s |
| Bandwidth | B | $0 \div 500 \text{ MHz}$ |
| Lightning protection zone | | LPZ 1-2, LPZ 2-3 |
| Housing material | | AlMgSi (EN AW 6060) |
| Degree of protection | | IP20 |
| Operating temperature | ϑ | $-40 \div 70 \text{ }^\circ\text{C}$ |
| Installation | | On DIN rail 35 mm |
| Operating position | | Any |
| Signalling at the device | | None |
| Remote signalling | | No |
| Normative conformity | | Kat. 6A/EA, ISO/IEC 11801 |
| PoE | | IEEE 802.3at |
| Article number | | 57 102 |

Note: It is an example of a product from this category, suitable for protecting antenna systems with Wi-Fi connection.



Surge protection devices in a slim module – “Hakel data slim protection”

| Type | art. no. | communication bus / application | number of data line pairs | U_c of data line | U_c of power line | I_L | width |
|------------------------|----------|--------------------------------------|---------------------------|--------------------|---------------------|-------------|--------|
| HDSP RS485 | 56 054 | RS 485 – Half duplex | 1 | -7 ÷ 12 V DC | – | 0.2 A | 7.5 mm |
| HDSP RS485P | 56 055 | RS 485 – Half duplex with power line | 1 | -7 ÷ 12 V DC | 30 V DC | 0.2 A / 5 A | |
| HDSP RS485/422 | 56 056 | RS 485 – Full duplex | 2 | -7 ÷ 12 V DC | – | 0.2 A | |
| HDSP CAN/12 | 56 052 | CAN | 1 | 15 V DC | – | 0.5 A | |
| HDSP CANP/12/24 | 56 053 | CAN – with power line | 1 | 15 V DC | 30 V DC | 0.5 A / 5 A | |
| HDSP CIB | 56 057 | CIB | 1 | 36 V DC | – | 1 A | |

| Type | art. no. | communication bus / application | U_c of the line | I_L | width |
|--------------------|----------|---------------------------------|-------------------|-------|--------|
| HDSP 2WS/24 | 56 050 | two-wire systems | 30 V DC | 0.5 A | 7.5 mm |
| HDSP 3WS/24 | 56 051 | three-wire systems | | | |

Testing category according to IEC 61643-21:2000 and EN 61643-21:2001: C2, C3, B3

Surge protection devices for data transmission

| Type | number of data line pairs | U _c | I _L | I _n | data rate | series impedance | pluggable version | modular width |
|-----------|---------------------------|----------------|----------------|----------------|-----------|------------------|-------------------|---------------|
| HDT*/A | * | 48 V DC | 5 A | 15 kA | 100 Mbit | – | YES | 1TE |
| HDT**/B | * | ** | 0.5 A | | 1 Mbit | 0.8 Ω | | |
| HDT**/C | * | ** | | | 100 Mbit | | | |
| HDT**/D | * | ** | 0.1 A | 1 kA | 1 Mbit | 2.2 Ω | NO | |
| DTE** | * | ** | | | | | | |
| HT-D 4/** | 4 | ** | | | | | | |

Testing category according to IEC 61643-21:2000 and EN 61643-21:2001: C1, C2, C3, D1

Product nomenclature (according to the values): * **1 or 2** (= number of data line pairs) ** **6, 12, 24** or **48 V DC**

Surge protection devices for power supply lines

| Type | number of power line pairs | U_c | I_L | I_n | series inductance | pluggable version | modular width |
|-------------------|----------------------------|-------|-------|-------|-------------------|-------------------|---------------|
| HDTNV**/B | * | ** | 1.5 A | 15 kA | 2.2 μ H | YES | 1TE |
| HDTNV**/C | * | ** | | | | | |
| DTNVE**/** | * | ** | *** | 1 kA | 4.7 μ H | NO | |

Testing category according to IEC 61643-21:2000 and EN 61643-21:2001: C1, C2, C3, D1

Product nomenclature (according to the values): * **1 or 2** (= number of power line pairs) ** **6, 12, 24, 30** (DTNVE only) or **48 V DC** *** **0.5** or **5 A**

The above list of products is only partial. The complete production by category can be found at hakel.com:

surge protections
in a slim module



surge protections
for data transmission



surge protections
for power supply lines





KO - *

- Designed for protection of equipment connected to an aerial system by means of coaxial cables.
- The products consist of gas discharge tube with high discharge ability, thanks to which ensure a reliable protection of the receiving and transmitting systems even against a lightning stroke nearby.
- Wide range of products, various connector types and transmission power grades.

- Recommended for use in the Lightning Protection Zones at the boundaries of LPZ 0 – LPZ 1 and higher.
- **Designed according to standards:** IEC 61643-21:2000
- **Application standards:** IEC 62305:2010

| Type | KO - * – common parameters | |
|--|----------------------------|-------------|
| Testing category according to IEC 61643-21:2000 and EN 61643-21:2001 | C1, C2, C3, D1 | |
| C2 Nominal discharge current (8/20) | I_n | 5 kA |
| Maximum discharge current (8/20) | I_{max} | 10 kA |
| Return loss | | > 20 dB |
| Operating temperature | ϑ | -30 ÷ 70 °C |
| Article numbers (and other parameters) | See table below | |

| KO - * | art. no. | connector type | U _c | I _L | U _p | I _{imp} | B | max. power | insertion loss | Z ₀ | IP code |
|----------------|----------|----------------|----------------|----------------|----------------|------------------|--------------|------------|----------------|----------------|---------|
| KO - 1G | 55 001 | BNC | 90 V DC | 2.5 A | < 600 V | 2 kA | 0 ÷ 1 GHz | 50 W | < 0.2 dB | 50 Ω | IP20 |
| KO - 2G | 55 002 | | 200 V DC | | | | | 400 W | | | |
| KO - 11G | 55 011 | UHF | 90 V DC | 5 A | | | 0 ÷ 0.3 GHz | 50 W | < 1.5 dB | | |
| KO - 1P | 55 007 | BNC | 200 V DC | 2.5 A | | | 0 ÷ 1 GHz | 400 W | < 0.2 dB | | |
| KO - 2P | 55 015 | | | | | | | | | | |
| KO - 9P | 55 016 | F | 90 V DC | 0.5 A | | | 0 ÷ 2.15 GHz | 50 W | < 0.5 dB | 75 Ω | |
| KO - 10P | 55 017 | TV | | | | | 0 ÷ 1 GHz | | < 1.2 dB | | |
| KO - 3GN (F/F) | 55 018 | N | | 350 V DC | 5 A | < 850 V | 0 ÷ 3 GHz | 400 W | < 0.65 dB | 50 Ω | IP65 |
| KO - 3GN (F/M) | 55 019 | | | | | | | | | | |
| KO - 4GN (F/F) | 55 020 | | | | | | | | | | |
| KO - 4GN (F/M) | 55 021 | | | | | | | | | | |
| KO - 6GN (F/F) | 55 126 | | 135 V DC | < 500 V | | 1 kA | 0 ÷ 5.8 GHz | 50 W | < 0.2 dB | | |
| KO - 6GN (F/M) | 55 026 | | | | | | | | | | |

Explanatory notes: U_p = C3 voltage protection level at 1 kV/μs B = frequency bandwidth Z_0 = characteristic impedance

Note: Dimensional drawings can be found on the individual product cards on hakel.com, both separately and as part of the datasheets.



The QR code points to **the complete production** of **coaxial protection** at **hakel.com**

Did you know...

that with the **GIGATEST PRO** digital instrument, you can easily measure the condition of SPDs, insulation resistance and voltage (AC and DC)



- Simple control by several multifunction buttons.
- The principle of measuring the condition of surge protection devices consists in a linear voltage increase with the measurement of the so-called milliampere point at varistors and ignition voltage at gas discharge tubes.
- Automatically evaluates the type of the measured element (varistor or gas discharge tube).
- Possibility to illuminate the measured object by a bright LED light and charge the battery right in the instrument.
- **The internal memory contains an extended database of surge protection devices, not only for HAKEL products.**



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