Lightning Protection

Edition 2010

HUBER+SUHNER

Excellence in Connectivity Solutions

Always one step ahead

Your partner for system solutions

The HUBER+SUHNER Group is a leading global supplier of components and systems for electrical and optical connectivity.

Four decades of experience in developing and manufacturing coaxial lightning EMP and NEMP protectors are the foundation of the current HUBER+SUHNER RF-protection portfolio.

Our products are designed to meet the stringent requirements of the RF/microwave, telecommunications and wireless industry and cover civil, security and defence applications.

An extensive high-voltage impulse laboratory is established to verify our designs in accordance with the valid international lightning, surge and NEMP standards.
Important inventions are covered by world – wide patents.

HUBER+SUHNER
Excellence in Connectivity Solutions

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Introduction

Introduction

HUBER+SUHNER has been active in the field of coaxial RF components for over 50 years now. This commitment to connector and cable design led to activities for solving technical problems related to coaxial transmission line surges.

In the sixties and seventies, the harmful effects of nuclear weapons on electronic systems became known. The pace at which electronically controlled weapon systems were developed during this «cold war» period triggered a huge surge in the demand for protective devices against NEMPs (Nuclear Electromagnetic Pulses). Cooperating closely with university research departments, HUBER+SUHNER created the know-how required for the development and production of effective NEMP protectors. Closely related is the fact that Switzerland was one of the first countries to make its civil protection and military installations impervious to electromagnetic interference.

The experience gained during this period proved invaluable in later years. As the integration and miniaturization of electronic circuitry increased, the sensitivity of these circuits to overvoltage grew, since ever-smaller energy quantities were sufficient to cause irreversible damage. HUBER+SUHNER responded to this trend by continuously pushing the frontiers of its know-how, and today it is in a position to supply a wide range of lightning EMP protection devices or sometimes refered as LEMP (Lightning Electro Magnetic Pulse Protectors) designed to ensure maximum quality and reliability.

In telecommunications equipment, special attention must be paid to protect against energy interference by lightning. This is a field in which HUBER+SUHNER has developed a wide variety of RF protectors.

They play a particularly important role in the huge number of mobile radio base stations that have been built over the past few years. They are indispensable for effectively minimizing the maintenance and repair requirements of these systems. This is of immense significance to operators who want not only to prevent revenue losses, but also image losses as a result of inadequate availability of their networks.

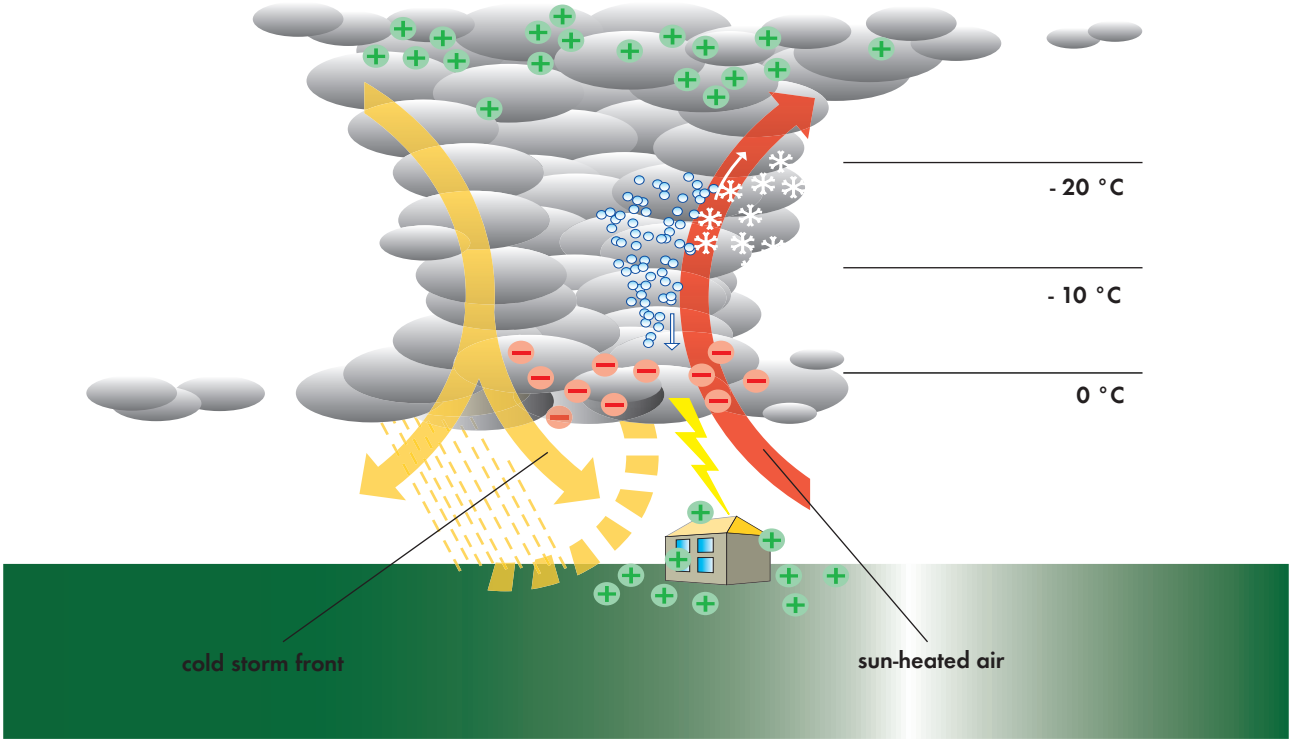
Today, HUBER+SUHNER is in a position to offer a multilevel concept ranging from standard to fine lightning protection devices for RF transmission and symmetric data lines. Sophisticated unique designs meet the most demanding application requirements.

Lightning basics

Creation and threat of lightning

Strokes of lightning kill more people in Europe and North America each year than floods or tornados, causing billions of dollars in damage. The number of lightning-induced forest fires throughout the world alone runs to more than 10'000 annually.

Since the experiments performed by B. Franklin, Romas and other lightning researchers we know that lightning is a physical phenomenon. It is created in thunderstorm cells. The cold storm front, which penetrates a hot area, forces the warm and humid air to rise. Temperature decreases with altitude and the water vapor condenses to small water droplets. This process is accompanied by the creation of heat which accelerates the air current. Reaching altitudes with subzero temperature, the water drops freeze to ice crystals. Again heat is produced simultaneously. The air speed increases once more – reaching a velocity of several hundred km/h – and propels the small ice particles to higher altitudes of up to 12 km. The growing ice crystals convert to hail stones which fall down due to their weight or remain in certain balanced positions. This causes electrons being stripped from the ice crystals. As a result of this process, charges are separated across a wide surface area. With field strengths of several 100 kV/m, discharges may be triggered in the form of cloud-to-cloud or cloud-to-earth lightning strokes, and in rare cases even as earth-to-cloud lightning.

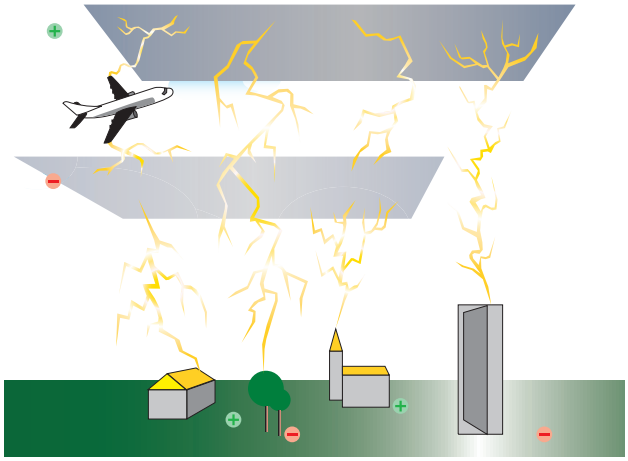


Mechanism of thunderstorms

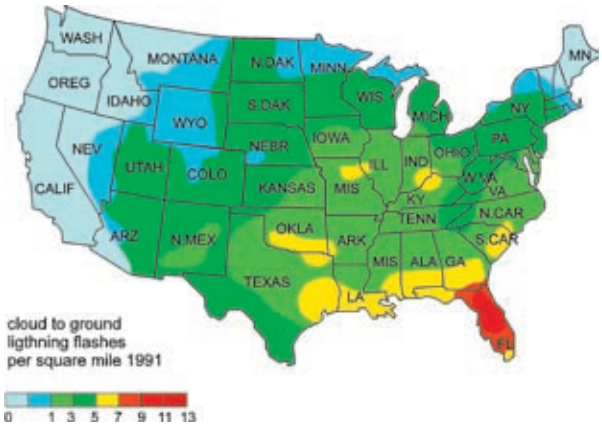
The electrical charge of a lightning stroke may exceed 100 As. It is discharged to the earth within 10 to 100 ms. The temperatures created in the lightning channel are higher than those on the sun's surface. The air is heated so quickly that it expands with the force of an explosion. The resulting sound waves can be heard as «thunder» as far away as 20 km. Lightning flashes may be as long as 50 km, but are only a few millimeters thick.

At any given time, almost 2000 thunderstorms are in progress on earth, and every 1/100 second or 6000 times a minute a bolt of lightning strikes the earth.

For many reasons the world is mapped concerning thunderstorm days – or the ground flash density (GFD) maps – and number of hits per area (square miles, square km, etc.). Also satellite flash event maps are available.



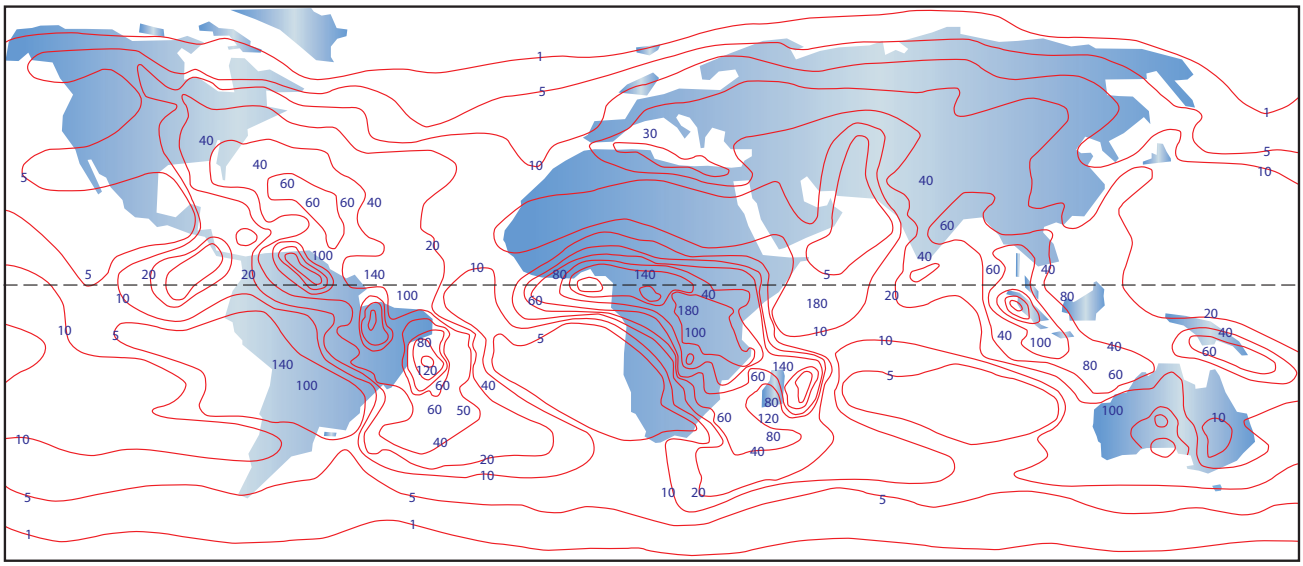
Lightning variants



GFD map of the USA

Thunderstorms occur most frequently in the tropical and subtropical belts surrounding the earth, where the temperatures and the air humidity are very high.

In the USA alone, lightning strikes 40 million times each year. Its occurrence in the USA is greatest within a 100-kilometer-wide strip crossing the state of Florida, called «lightning alley». In this area, thunderstorms can be observed on 90 days every year.



World map of isokeraunic level (annual number of days when thunder is heard)

Such maps are an important tool to determine the hit risk for a certain location. But for a final conclusion a lot more factors have to be considered, and the calculation models consist of complicated formulas. Considerations are altitude, the height of the building, the surrounding profile, buildings in the neighbourhood, the distance to water, earth material and even if a lightning protection system is installed, to name only a few of them. In many cases – especially in the areas of lower altitude, the more northern and southern regions of the world – the theoretically calculated hit risk might look negligible. But hot spots of many countries can have multiple GFD values compared to average (e.g. Germany with more than tenfold values). Network operators have further to multiply the single BTS hit risk by the number of their sites. IEC 62305 provides a calculation formula for a rough estimation.

Interferences of close by hits, which can easily outnumber those of direct ones, have also to be considered.

The lightning hazard to electric and electronic equipment consists in the interferences of direct lightning current injections and high surge voltages induced by the electromagnetic field of nearby lightning channels or down conductors. The damage caused depends on the energy involved and on the sensitivity of the electronic systems. The electric surge pulse generated by lightning is called LEMP (Lightning Electromagnetic Pulse).

Lightning research has produced a large number of suitable protective measures that are reflected in international and national safety standards. These instructions and recommendations for the installation of lightning protection systems together with the application of HUBER+SUHNER lightning EMP protectors provide a high degree of safety for electronic equipment.

The installation of a lightning EMP protector costs only a fraction of today's transceiver equipment. In the case of damage by EM interference in general natural, but also man-made the repair of the equipment but also the loss of revenue and good reputation due to downtime have to be considered.

All in all, there is not left much choice to an operator of mobile communications or other wireless services than to establish the best protection available.

Electrical specifications and effects of earth lightning

Here, we will only consider cloud-to-earth lightning, which has the greatest damage potential. This type of lightning is divided into positive and negative lightning, depending on the polarity of the cloud charge.

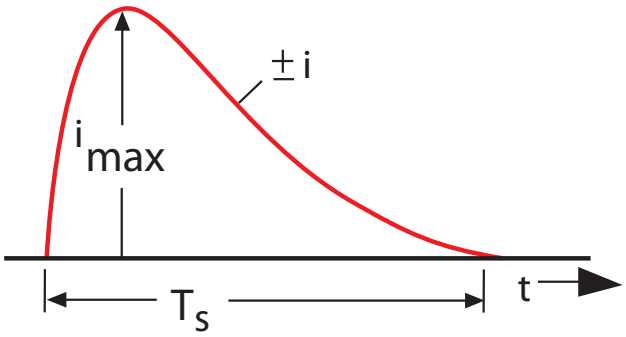
Positive cloud-to-earth lightning is the most critical, due to the duration of the lightning current pulse. With a maximum current of several 10 kA, it may last longer than 2 ms. The electrical charge is typically higher than 50 As.

Negative cloud-to-earth lightning starts with a lightning current pulse whose maximum amplitude amounts also to several 10 kA, but lasts merely 1/10 of the time of a positive one. Its peculiarity lies in the subsequent smaller multiple discharges, which may result in a total duration of the lightning of over one second and a total electrical discharge of over 100 As.

This produces the following basic, schematic lightning current patterns:

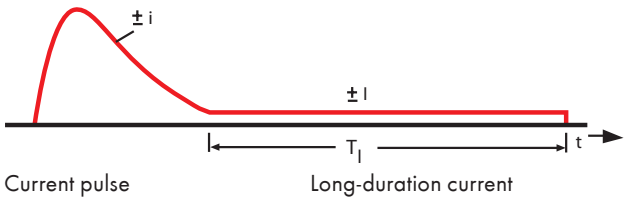
Pattern 1

Positive or negative lightning current pulse of several 10 kA and less than 2 ms duration (T_S).



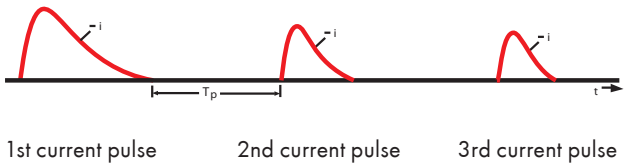
Pattern 2

Positive or negative lightning current pulse as pattern 1, with subsequent long-duration current of about 100 A during a period of less than 500 ms (T_l).



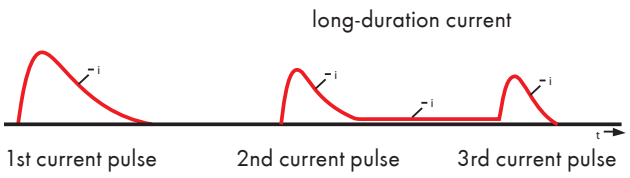
Pattern 3

Sequence of negative lightning currents with a first lightning current pulse according to pattern 1 followed by subsequent lightning currents up to 10 kA. The break times between the lightning current pulses are shorter than 100 ms (T_p).



Pattern 4

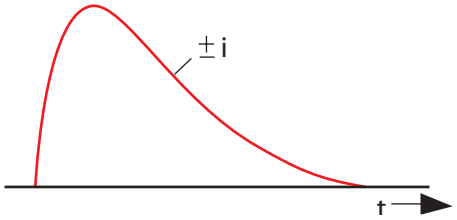
Sequence of negative lightning currents according to pattern 3, with integral long-duration current according to pattern 2.



On the basis of these lightning current patterns, CIGRÉ and IEC 62305 defined 3 groups of laboratory-simulated lightning currents:

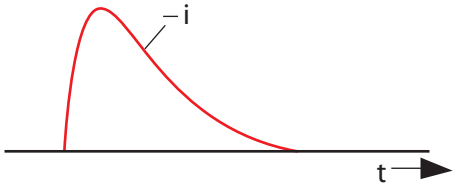
Group 1: first stroke

Lightning current of positive or negative polarity, first stroke – wave form 10/350 µs



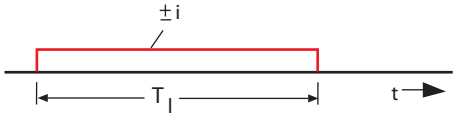
Group 2: subsequent stroke

Lightning current of negative polarity, subsequent stroke – wave form 0.25/100 µs



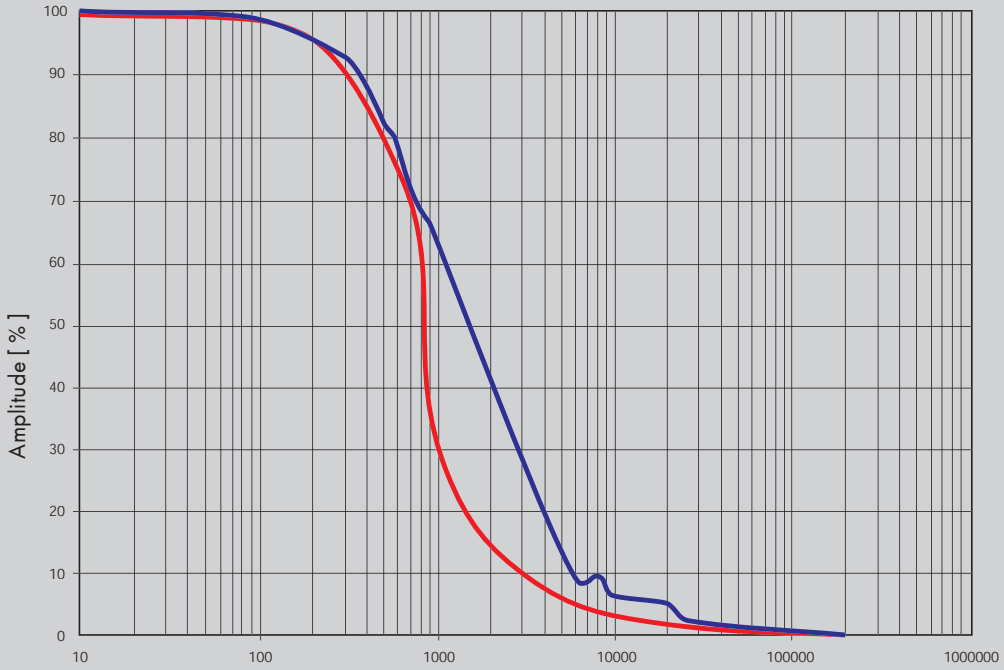
Group 3: long stroke

Lightning current of positive or negative polarity, long-duration stroke – DC 0.5 s



The most important parameters of lightning are the following:

- **Lightning current amplitude** $\hat{i}_L$ – determines the resistive effects mentioned below
- **Average steepness** of the lightning current di_L/dt – determines the resistive and magnetic coupling effects mentioned below
- **Total charge Q** = $\int i_L * dt$ (unit As or C) – determines the energy release/conversion at the hit point
- **Specific energy** (action integral) $W/R = \int i_L^2 * dt$ (unit MJ/Ω or kA^2s) – determines all heating and electrodynamic effects along the down-conducting path.



Comparison of the frequency spectra of a genuine lightning current surge (blue - according to K. Berger) and a test current surge 10/350 µs (red - according to IEC 62305)

The frequency spectrum of the LEMP (Lightning Electro Magnetic Pulse) is also of interest, especially for RF applications. It reaches several 100 kHz (NEMPs about a thousandfold). This is important for certain lightning protection solutions in RF engineering applications described above:

The diagram shows that a 10/350 µs test pulse is a good match to a first-stroke of lightning. This is considered in IEC 62305, protection against lightning. Therefore, it is most suitable to test protective devices. HUBER+SUHNER test their lightning EMP protectors according to this pulse regarding the lightning current resistivity (also called current handling capability). IEC 61000-4-5 defines a combined 1.2/50 µs voltage and 8/20 µs current test pulse for surge protective devices to determine their protection performance. Despite its relevance for general induction and power-switching interferences, this pulse is used for the description of the protection quality also of lightning EMP protectors worldwide. Protection performance data show residual pulse values as a result of a 1.2/50 µs; 8/20 µs combination generator pulse.

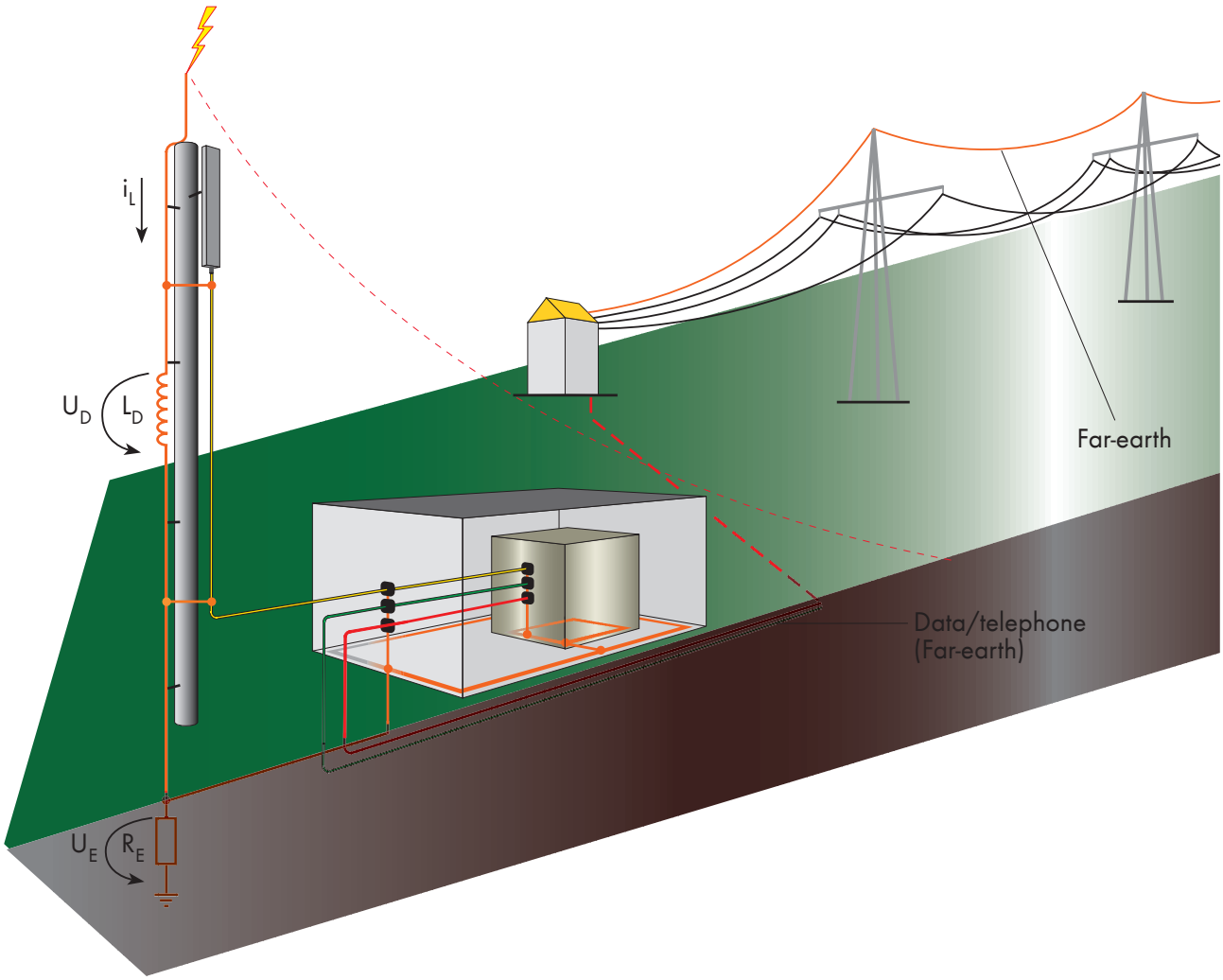
The most interesting effects of lightning on electric and electronic equipment are the following:

Resistive coupling

Partial lightning currents are coupled into all objects which are electrically connected to the lightning path.

This results in:

- Earth potential rise (of the transmitter or building), which is the voltage drop over the earth resistance caused by the lightning current amplitude $U_E = \hat{i}_L * R_E$.
  Assuming realistic values of $\hat{i}_L$ = 100 kA and R_E = 10 Ω (a recommended maximum value), the result will be U_E =1000 kV(!) of potential rise against far-earth (which is the potential of all connected power supply, data and telephone lines).
- Voltage drops over inductances, as each conductor provides, caused by the average steepness of the lightning current $U_D = L_D * di_L/dt$. Assuming realistic values of subsequent lightning current pulses with di/dt = 100 kA/µs and L_D = 10 µH (which is true for a down-conductor length of 10 m along a building or mast, 1 µH/m solid conductor), the result will be U_D =1000 kV(!) potential rise at the top against the ground of a structure.
- Longitudinal voltages over screened and coaxial cables.
- In general potential differences in electronic equipment.

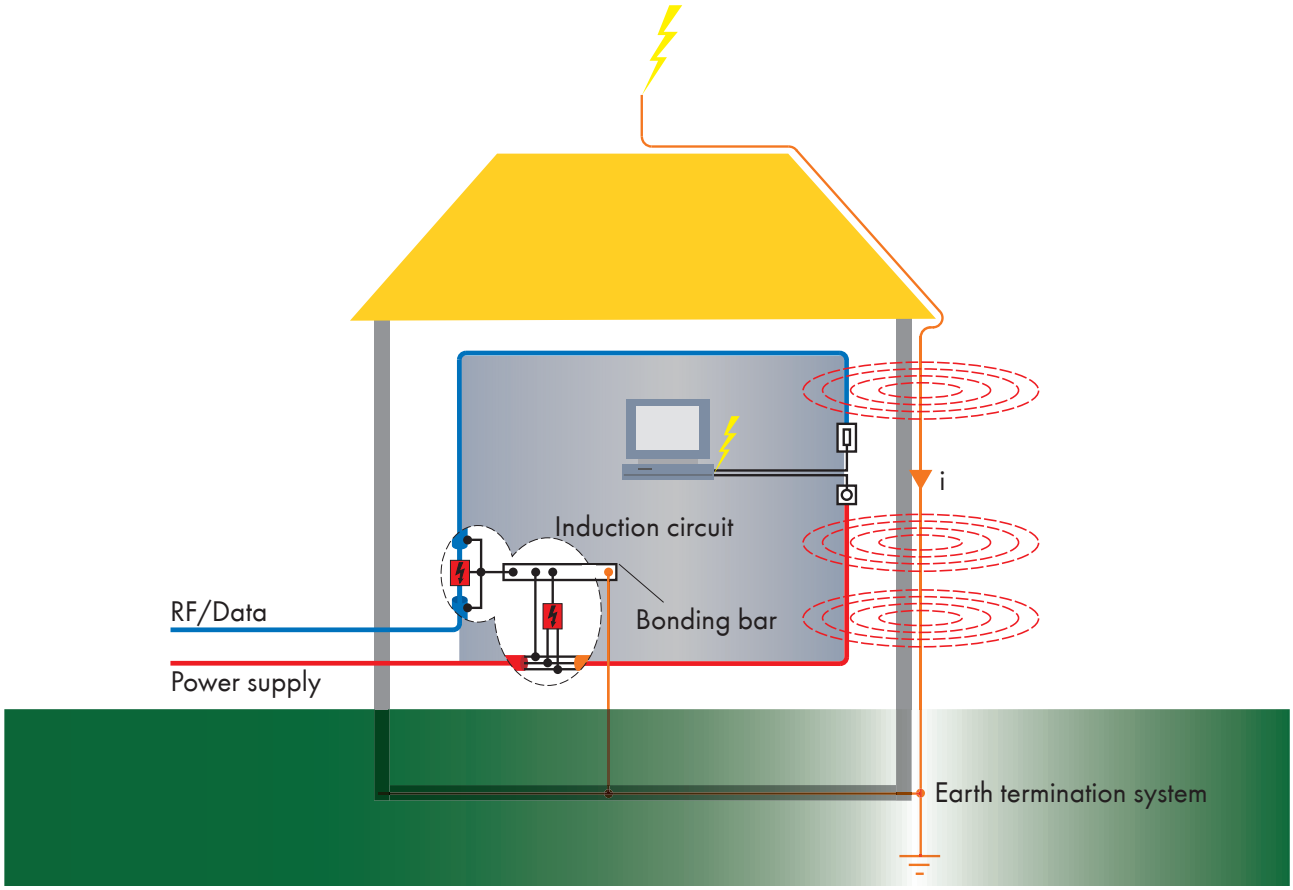


Lightning effects in radio transceivers

Magnetic field coupling

The lightning current of near-hits or even a down-conducted one of the existing LPS (Lightning Protection System) induces surge currents and voltages in any effective electrical loop. This is determined by the average steepness of the lightning current as well and follows the formula:

$U = -M * di_L/dt$ (M for mutual inductance)



Electromagnetic interference of nearby lightning hits or even the LPS itself

Electric field coupling

The effects of the high and changing electrical field strength right before the hit occurs is normally negligible when considering a minimum of protection measures.

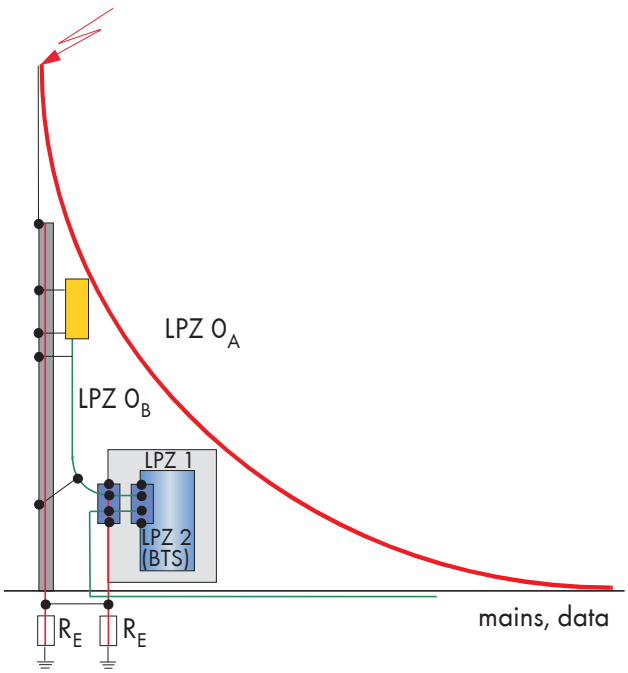
Lightning protection

Basic principles of lightning protection

To protect electronic equipment, several different aspects must be considered.
Well-proven basic principles are shielding (Faraday's cage, armed concrete, screened cables), bonding and grounding. The basic idea is to protect equipment and people against lightning by conducting the lightning current to ground via a separate preferential solid path and reduce the electromagnetic field.
Today a lot of international and national rules exist to employ all well-tried measures to protect life, structures and equipment.
Account must be taken of the most important international standards, such as IEC 62305 protection of

- Structures including their installation and contents as well as persons
- Services connected to a structure against lightning

and others. They all define the proper planning, installation and inspection of effective lightning protection systems (LPS).



The entire installation is classified into different lightning protection zones (LPZ) according to IEC 62305:

LPZ 0_A

The zone where a direct hit is possible and where objects must be capable of carrying the full lightning current. Also, the unattenuated electromagnetic field is very dangerous (lightning current test pulse of first stroke 10/350 µs).

LPZ 0_B

The zone where a direct hit is not possible, but the unattenuated electromagnetic field is present (lightning current test pulse 10/350 µs). This zone is determined by the external lightning protection system consisting of the air termination, down conductor and earth termination system.

LPZ 1

The zone where a direct hit is not possible and the currents in all conductive components are lower than in LPZ 0_A and LPZ 0_B. In this zone, the electromagnetic field is attenuated according to the screening measures applied. RF, signal and supply lines leading into this zone can be protected by surge protective devices (8/20 µs). They may be based on a number of different operating principles.

The transition between LPZ 0 and LPZ 1 is the most important one. At this point all crossing conductive parts must be connected to the bonding bar. Signal and transmission lines have to be equipped with lightning protection devices which are able to carry partial lightning current (10/350 µs).

If a further reduction of the current or of the electric field is necessary, additional subsequent zones must be established (LPZ 2, etc.). Additional surge protective devices applied here form the fine protection system complementing the standard protection ensured by zone LPZ 1.

For optimum protection, all electric supply and signal lines should enter the protected area at one single place. At this point, they must be connected to the bonding bar by surge protective devices. At every interface between one LPZ and the next, the potential equalization must be established like this.
This classifies lightning EMP protectors to be a part of the bonding system. They provide basically an interference event triggered bonding for signal-carrying lines. Special lightning protection principles for RF applications allow a continuous bonding of lines.
The grounding must always be in accordance with IEC 62305.
The grounding of the installed lightning EMP protectors, their connections to the bonding bar of the structure or equipment have to be prepared very carefully to achieve the lowest possible resistance and inductance to ground (refer to section «application notes»).

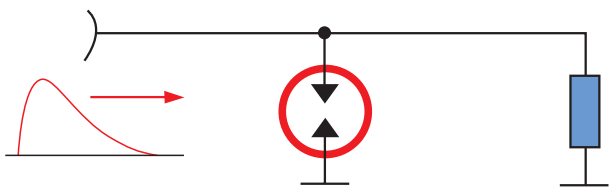
RF lightning EMP protector principles

Overvoltage protection in the field of RF engineering must meet special requirements in comparison with general, low-frequency signal transmission and power supply applications. In particular, coupling capacitances towards ground must be minimized in order to prevent any significant loss of the transmitted RF signals. This essentially rules out the wide-band application of varistors and semiconductor diodes.

There are three principal designs for coaxial lightning EMP protection devices in RF applications:

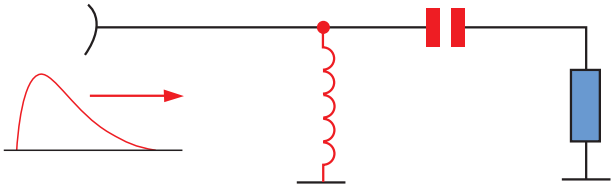
Gas discharge tube (spark gap) type

The well-known principle in electronics for many decades and, in addition, two principles which make use of the limited frequency range of the LEMP and the NEMP (refer to Fig. «Comparison of the frequency spectra of a genuine lightning current surge and a test current surge 10/350 µs on page 9). They allow to transmit only RF signals within a certain specified range:



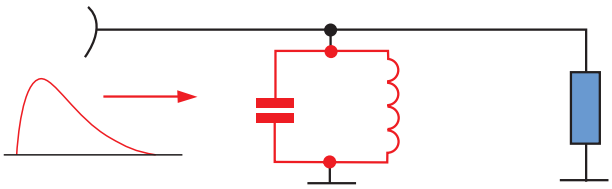
High-pass type

A principle which allows only limited lightning current handling capability but rather large bandwidths and low residual energy.



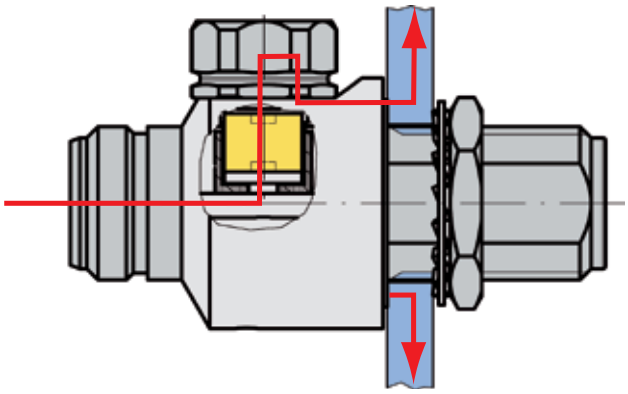
Bandpass type

A very effective principle which HUBER+SUHNER employs with their quarter-wave protectors featuring the lowest possible inductance. The operation frequency band can be properly adjusted to any application.



Lightning EMP protectors with gas discharge tubes

In the event of a voltage surge, a gas section between the inner and the outer conductor of the coaxial transmission line will spark over, resulting in potential equalization to ground. This system works as a voltage-dependent switch that is automatically turned on and off. This design features a special gas-filled gas discharge tube (GDT) also called capsule.



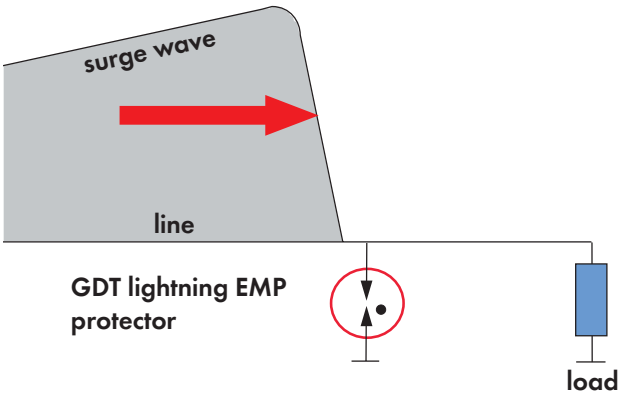
Operating principle of GDT lightning EMP protectors

If lightning strikes the antenna mast or the antenna itself of a transceiver system, a current will flow toward the transceiver. Part of the current will be directly discharged through the antenna mast to the ground, and the other part will flow through the RF cable to the lightning EMP protector installed at the entry point into the building or equipment. An interference voltage may also be induced in the RF cable by a lightning strike in the proximity of the station, causing an interference current to flow toward the equipment.

The GDT incorporated in the lightning EMP protector sparks over (thereby becoming low-ohmic), equalizing the potential between the inner conductor and the ground. The current and thereby the energy of the lightning are discharged to the ground. Care must be taken to ensure that the current will be discharged on the outside of the building or equipment, and not inside. It is therefore important to install the actual surge protective device on the outside, the so-called unprotected side, in order to prevent any interference voltage from being induced in the protected zone. This is also true for other protection principles.

Once the interference subsides, the gas discharge tube will revert to its original condition, i.e., it will again become high-ohmic, and the system will be able to continue operation in the same way as before.

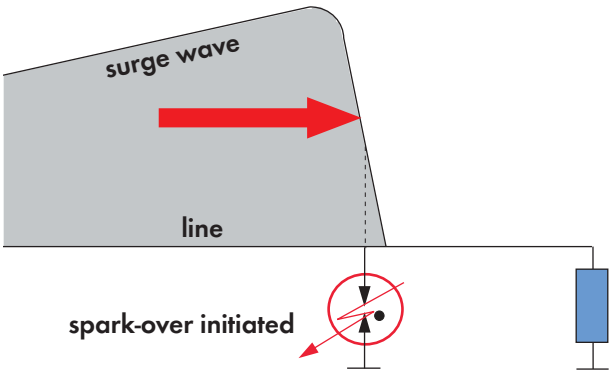
To understand the existing interrelationships and also to compare this system to other principles, let's consider the mode of operation for the gas discharge tube:



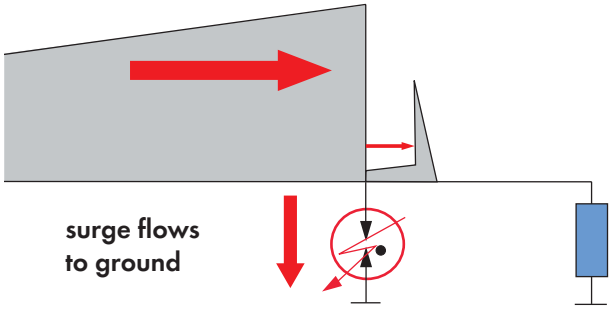
«Load» stands for the electronic equipment that has to be protected. The surge protective device is symbolized by the gas discharge tube.

The gas discharge tube consists of two electrodes that are insulated by a small ceramic tube. It's static sparkover voltage is determined by the gas properties, its pressure, and the electrode gap.

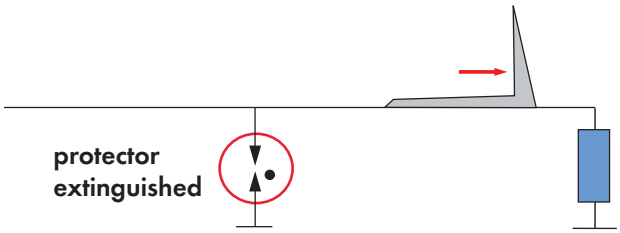
In the event of a surge, a current will flow through the cable to the equipment, represented here as a surge wave.



The voltage across the gas discharge tube then rises very rapidly. When the dynamic spark-over voltage has been reached (typ. 675 V at 1 kV/µs for 230 V GDT), the gas discharge tube will ignite and become conductive. At this moment, the voltage across the GDT (called the glow-arc voltage) is between 72 and 90 V. This collapses to 10 – 20 V (called the arc voltage), as the current rises. The dynamic spark-over voltage of the GDT is a function of the pulse rise time.



The gas discharge tube, once it sparks over, creates a potential equalization between the inner and the outer conductor (ground) of the coaxial transmission line. The current flows along the path of least resistance through the GDT to the ground. Only a very small portion of the energy, the so-called residual pulse, reaches the equipment. Its magnitude is determined by the GDT characteristics, the interference pulse rise time, and the ground conductor impedance (determined by the quality of the lightning protection system).



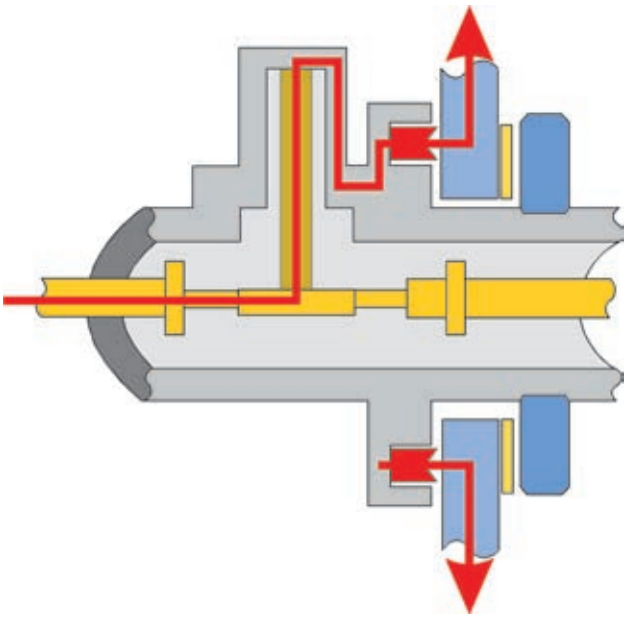
After the interference has subsided, the gas discharge tube is extinguished, reverting to its original high-ohmic condition.

Gas discharge tube protectors can generally be used in wideband applications from DC to over 2.5 GHz, latest designs up to 6.0 GHz. The upper limit for the operating frequency range is determined by the capacitive characteristics of the GDT.

GDT protectors allow DC to be carried and thus tower-mounted electronic equipment to be fed power via the coax line.

Lightning EMP protectors with quarter-wave (λ/4) shorting stub

This technology is based on a quarter-wave transformation line. The coaxial shorting stub applied for this purpose is short-circuited at its end, and its length is matched to the mid-band frequency of the operation band. It thereby forms a bandpass filter. Its bandwidth can be adjusted up to ± 50% of the centre frequency.



Operating principle of quarter-wave lightning EMP protectors

Since lightning interferences have a low frequency spectrum as described above, the shorting stub acts as a short circuit, conducting the current to the ground.

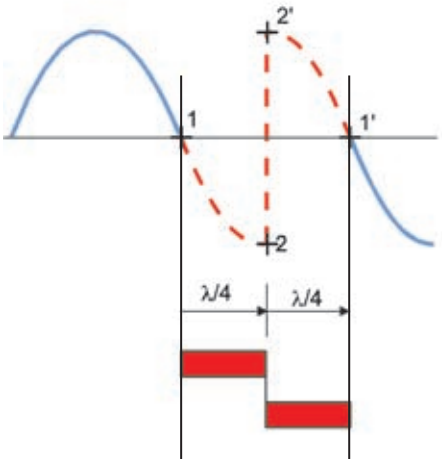
The basic principle for the RF signal transmission through a quarter-wave lightning EMP protector is described in the following:

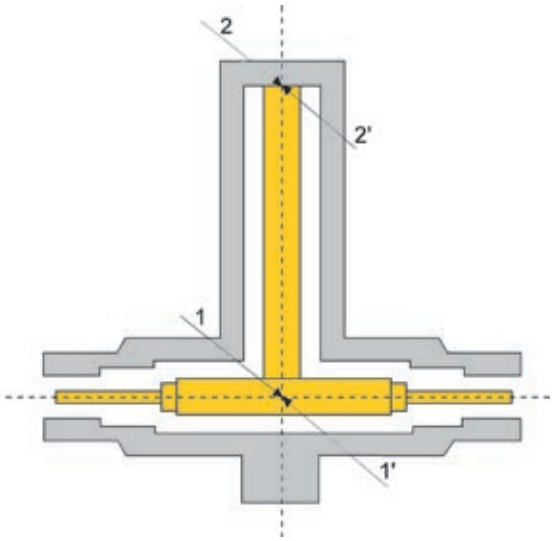
In regular operation, the RF signal reaches the entry of the shorting stub (shown here as point 1). It then runs along the shorting stub up to the short (point 2). This corresponds to a 90° phase shift. At the short, the signal is reflected (point 2') – a sudden phase shift of 180° is created – and flows back to the start of the shorting stub (point 1'), where it arrives after another 90° phase shift. As a result, the reflected signal is again in phase with the arriving signal. Therefore, the RF signal does not «detect» the short.

Standard quarter-wave lightning EMP protectors are limited in bandwidth compared with GDT protectors, but offer considerably lower residual pulses and a high-current-handling capability. This is maintained even under multiple loading.

The operating principle of quarter-wave lightning EMP protectors allows them to be manufactured for operating frequencies ranging from some MHz to more than 20 GHz (basically up to the frequency limit of the coaxial interface of the protector). The lower end of the availability range is determined by the increasing geometric length of the quarter-wave shorting stub.

They can be designed to show very low intermodulation values. The fact that they are maintenance-free is an important advantage for their use in the field.
The residual pulse of the quarter-wave lightning EMP protector has a considerably lower voltage amplitude (and thereby also energy) than that of the GDT protector.
Unlike the gas discharge tube lightning EMP protector, it is not possible to carry any DC here, since the inner conductor is connected directly to the ground.





Our strengths, know-how, quality and reliability

Outstanding know-how ensures optimum technical parameters

The following technical parameters are especially important for users of lightning EMP protection devices in RF engineering applications:

- Operating frequency range
- Reflection characteristics (VSWR or return loss)
- Insertion loss
- Lightning-current-handling capability and residual pulse voltage and energy
- Intermodulation characteristics

The mastery of the first three design feature categories is one of the longest-standing, continuously refined core competencies of HUBER+SUHNER.

HUBER+SUHNER has focused much of its efforts on the problem of passive intermodulation (IM) since the early nineties. This coincides with the increasing importance of this question in the area of mobile radio telecommunications as a result of the growing number of ever-denser mobile radio networks. Today, HUBER+SUHNER belongs to the small circle of companies leading the efforts to push the standardization of intermodulation testing of RF components.

This allows HUBER+SUHNER to supply its lightning EMP protection devices as well as all other RF components such as coaxial connectors, coaxial cable assemblies, filters, power splitters and antennas according to IM specifications.

All areas of competence mentioned up to now are intimately linked with extensive knowledge in the fields of materials technology, surface-plating and metalworking. This is a precondition for ensuring excellent RF and IM characteristics and the power-handling capabilities of these components, their geometric dimensions and special materials of construction in addition to their mechanical stability and resistance against environmental influences.

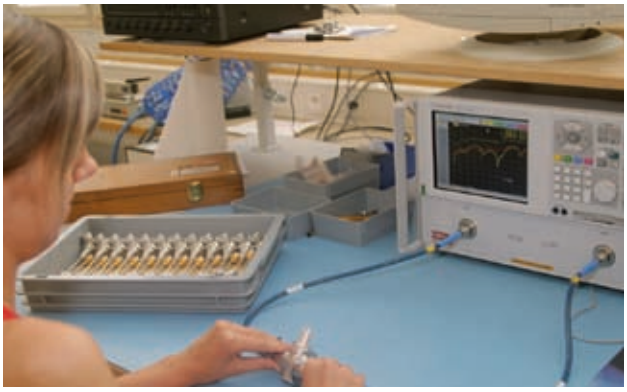
HUBER+SUHNER mainly applies copper alloys for the contact and housing components of its lightning EMP protection devices. Their specific composition is selected on the basis of the loads they are subjected to. Contact surfaces are gold- or silver-plated. Housing surfaces receive the proven HUBER+SUHNER proprietary
SUCOPLATE® surface plating. This is a nickel-free alloy offering both, an excellent contact surface for RF applications – including low IM values – and outstanding corrosion resistance. Detailed information on this plating is included in our data sheet «HUBER+SUHNER SUCOPLATE® Surface Plating for RF Components».

Gas discharge tube lightning EMP protector with SUCOPLATE® surface

The main insulation material used is PTFE. Seals consist of silicone rubber.

Important test procedures and test facilities ensure quality and reliability

On the basis of what has been said above, we will now look at the most important related tests:



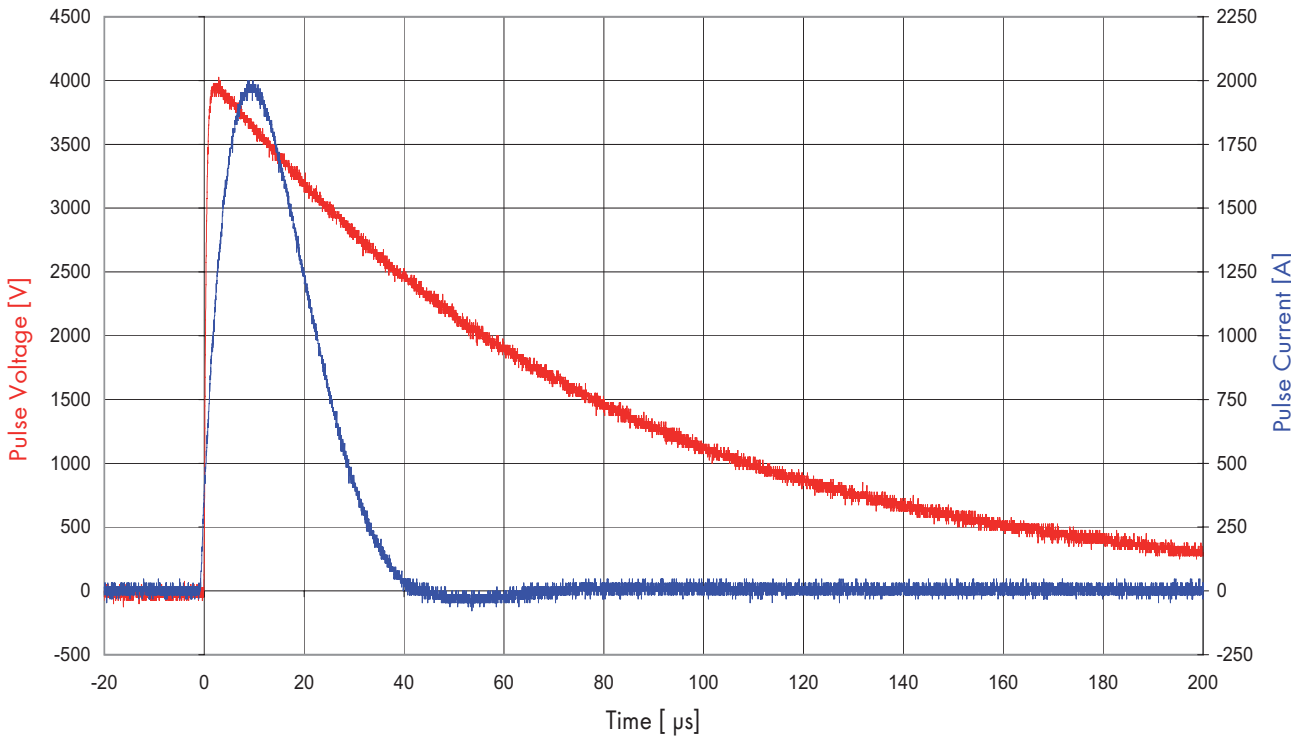
Measurement of the RF characteristics

State-of-the-art network analyzers are available for measuring the RF characteristics. They allow the precise testing of the return loss (VSWR) and insertion loss.

Measurement of the residual pulse voltage and lightning current resistance

Standardized test pulses are applied for the simulation of the surge and lightning currents.

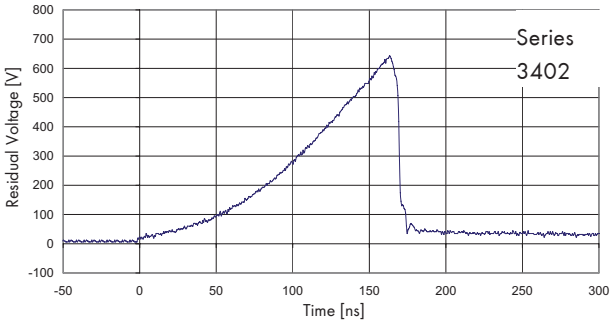
The following diagrams show test pulses and typical residual pulses of lightning EMP protection devices when a 1.2/50 µs, 8/20 µs hybrid pulse is applied (surge according to IEC 61000-4-5):

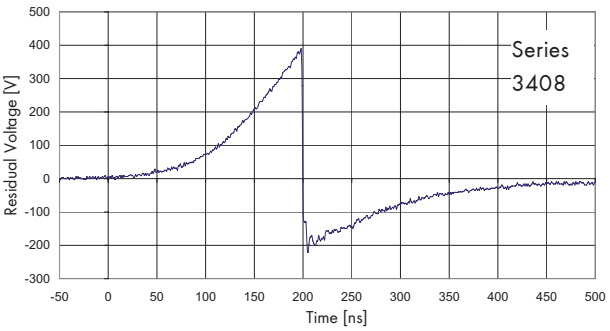


Voltage and current test pulse of the combined 1.2/50 µs, 8/20 µs standard surge test pulse

Typical residual pulse characteristic of HUBER+SUHNER protector series

Gas discharge tube lightning EMP protectors

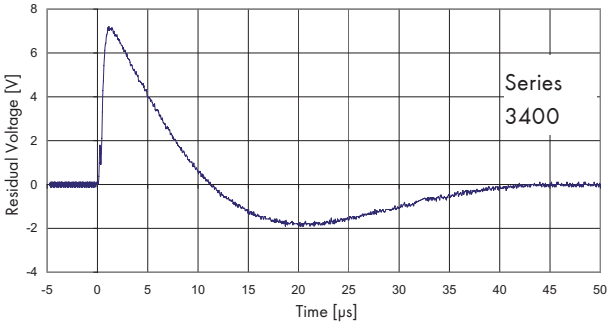


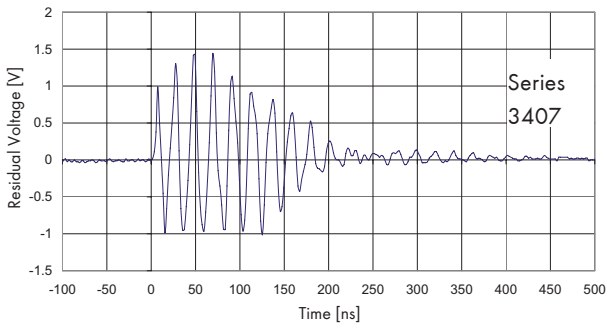


Residual pulse of gas discharge tube lightning EMP protectors series 3401/3402 and series 3408 with high-pass filter (both with 230V gas discharge tube)

The residual voltage of the series 3402 is approx. 650 V. However, the residual energy is very low compared with the input energy. In the case of the series 3408, the residual voltage is yet again reduced by about 40%. This results in a residual energy of approx. 60% compared with the series 3402.

Quarter-wave stub lightning EMP protectors

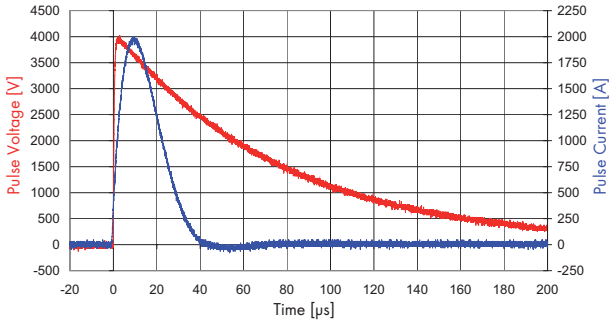




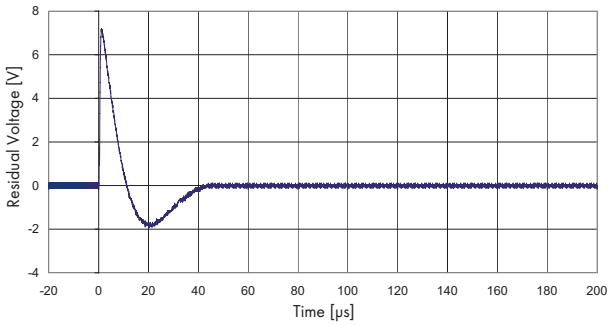
Residual pulse of quarter-wave lightning EMP protectors series 3400 and series 3407 with high-pass filter (both GSM band types)

The quarter-wave lightning EMP protector does not require any response time. With its filter characteristic, it reduces the standardized input pulse (1.2/50 µs with 4 kV) to approx. 7 V. This translates into a residual energy that is 70 times lower than that of GDT protectors without high-pass filter. Quarter-wave lightning EMP protectors with high-pass filter have a residual voltage that is 80% a further lower. The most important fact, however, is the residual energy reduction factor of 2000, which means a reduction factor by 100000 compared to a standard GDT protector.

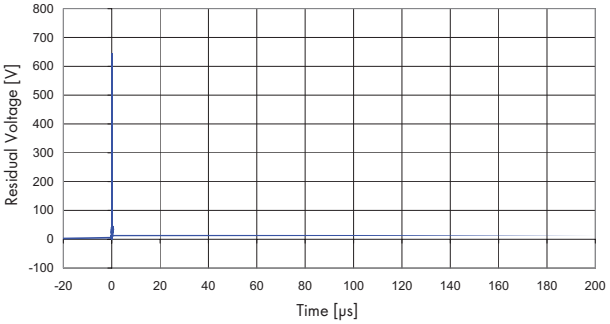
The protection effectiveness is most clearly illustrated by considering the input surge pulse and the resulting residual pulse at the output of the lightning EMP protector on an identical time scale.



Input surge pulse



Residual pulse (quarter-wave protector)



Residual pulse (gas discharge tube protector)

HUBER+SUHNER has standardized generators for generating surge currents with amplitudes up to 25 kA, for 10/350 µs test pulses (first stroke) and up to 100 kA for 8/20 µs test pulses.

NEMP can also be tested up to 12 kV, 5/200 ns.

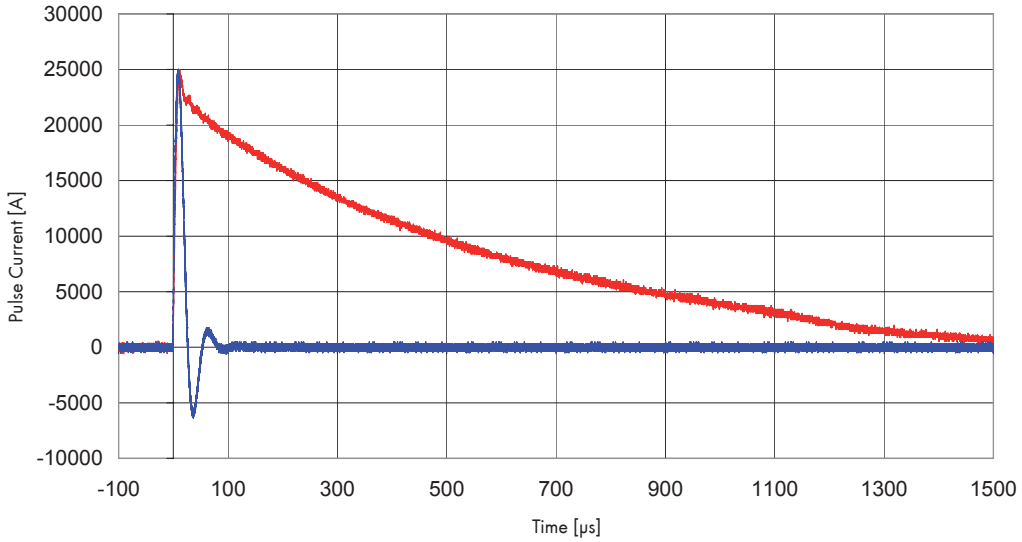
To determine the lightning current handling capability of lightning protection devices, HUBER+SUHNER also benefits from the services of external test laboratories with surge current generators up to 100 kA (10/350 µs pulse).

The lightning protection zone determines the required current-handling capability. The following table shows the surge current handling capability of

HUBER+SUHNER lightning EMP protection devices on the basis of the standardized test pulses:

Principle	Series	Connector interface	Surge current handling capability with	
			test pulse 10/350 µs	test pulse 8/20 µs
Gas discharge tube	3401, 3402, 3403, 3408, 3409, 3410	N and DIN 7/16	8 kA	30 kA
Gas discharge tube	3406	all interfaces	2.5 kA	10 kA
Quarter-wave stub	3400, 3407	DIN 7/16	50 kA	100 kA
Quarter-wave stub	3400, 3407	N	25 kA	50 kA

Test pulse 10/350 µs vs. 8/20 µs



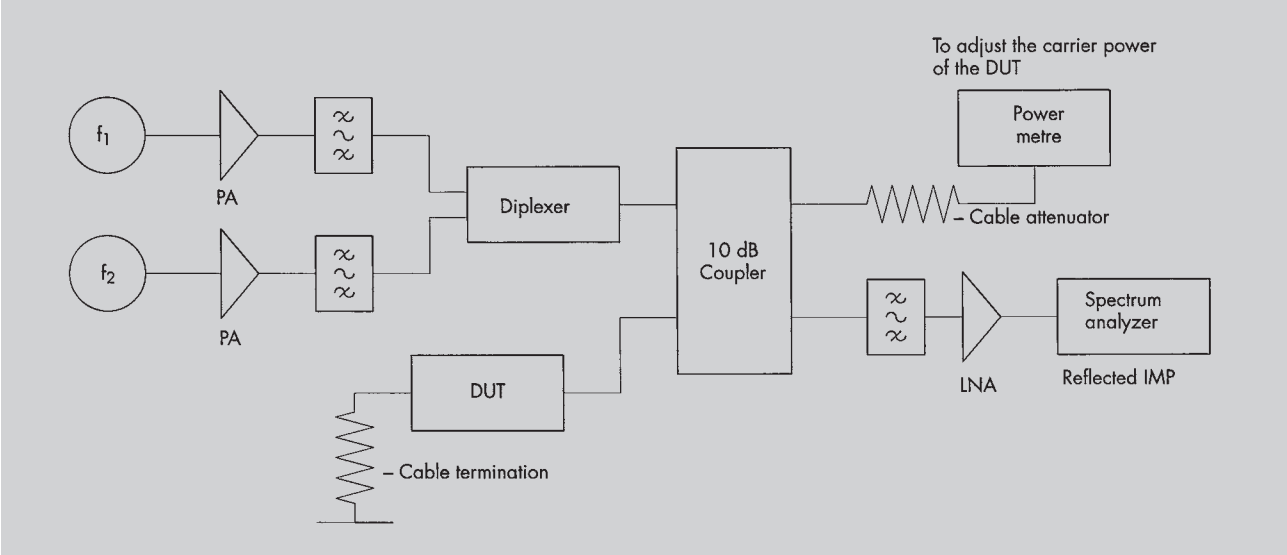
Comparison of the test pulses 10/350 µs (real lightning current – red) and 8/20 µs (surge current - blue) concerning electrical charge and specific energy (destructive potential) for equal current amplitudes

Test pulse shape	10/350 µs			8/20 µs		
I max (kA)	100	50	25	100	50	25
Q (As)	50	25	12.5	1.74	0.87	0.44
W/R (kJ/Ω)	2570	642	160	122	30.4	7.6

Measurement of passive intermodulation

The intermodulation characteristics of lightning EMP protection devices are determined in a special, complex test set up. It is used for measuring the ratio of the 3rd-order IM products to the carrier power with a carrier power of 2 x 20 watts (2 x 43 dBm, 46 dBm in total).

The following figure shows the basic design of the setup:



Tests can be performed for the following bands: TETRA, GSM900/1800, PCS1900 and UMTS

Other available tests

Additional technical specifications are possible on the basis of the testing classes of the relevant IEC or MIL standards:

- Operation temperature range
- Temperature shock
- Humidity
- Corrosion (salt mist, industrial atmosphere)
- Vibration
- Shock
- IP rating (protection against dust and water)

References and company approvals

HUBER+SUHNER lightning EMP protection devices have been approved by the following leading OEMs of telecommunications equipment:

- Alcatel Lucent
- Cisco
- Ericsson
- Motorola
- Nokia Siemens Network
- Nortel

Operators of analog and digital mobile radio networks TETRA, LTE, GSM850/900 - 1800/1900, UMTS, IMS bands 2.4/5.7, WiMAX, WLAN and homeland security in the following countries apply HUBER+SUHNER lightning EMP protectors:

Australia, Austria, Belgium, Canada, China, France, Germany, Hong Kong, Hungary, India, Israel, Japan, Kuwait, Malaysia, Morocco, Netherlands, Norway, Philippines, Poland, Portugal, Singapore, South Africa, South Korea, Spain, Sweden, Thailand, USA.

ISO certificate

High-quality products and supplier relationships have always been a top priority for HUBER+SUHNER. After having already been confirmed by the Swiss forerunner movement, the HUBER+SUHNER quality system was very soon acknowledged by the international ISO quality certificate. This much sought-after certificate according to ISO 9001, which must be earned over and over again, has been awarded to HUBER+SUHNER without interruption since 1990. The fact that HUBER+SUHNER is also prepared to meet specific customer quality standards exceeding those of ISO 9001 is amply proved by a large number of successfully passed customer audits.

Compliances to international standards

CE Conformity

HUBER+SUHNER lightning EMP protectors comply with legal regulations, as stated in the European Union Directive 2006/95/EC. The directive demands that surge protective devices, like our EMP protectors, comply with the safety provisions of harmonised standards and shall indicate their conformity with the CE mark. This standard is IEC 61643-21: Low voltage surge protective devices (SPD) – Part 21: Surge protective devices connected to telecommunications and signalling networks – Performance requirements and testing methods.

EMP protectors of the series 3401, 3402 or 3408 which are delivered ex-works without an inserted gas discharge tube, fall outside of the directive and are therefore not labelled with the CE marking.

RoHS Conformity

The HUBER+SUHNER companies aim to comply with all relevant legal requirements at all time. This also holds true for the European Union Directive 2002/95/EC restriction of the use of certain hazardous substances in electrical and electronic equipment commonly referred to as the Restriction of Hazardous Substances Directive or RoHS. We are proud to state that we are able to supply components fully compliant with the RoHS directive.

This directive restricts the use of six hazardous materials: Lead (Pb), Mercury (Hg), Cadmium (Cd), hexavalent Chromium (Cr VI), and two types of brominated flame retardants, Polybrominated Biphenyls (PBB) and Polybrominated Diphenyl Ethers (PBDE) in the manufacture of various types of electronic and electrical equipment to reduce generation of toxic waste from discarded electrical and electronic equipment

10 Years warranty for lightning protectors

HUBER+SUHNER AG warrants that this product will provide lightning EMP protection during a period of 10 years after its purchase according to the protection specifications and characteristics given in the applicable product specification. Such warranty is subject to the proper maintenance of the product and its parts, technical expert installation and the parts' regular replacement (e.g. gas discharge tube, other parts with limited resistance to wear and tear, etc.), if necessary, in accordance with the relevant product specifications.

Buyer's sole remedy and manufacturer's sole obligation in the event of any breach of this warranty due to a failure of lightning protection is limited to the repair or the replacement of the damaged lightning EMP protector or to the refund of its purchase price, at the sole discretion of the manufacturer.

This warranty does not, with the exclusion of the warranty for lightning protection as specified herein, alter or affect the warranty and liabilities specified for this product in the general conditions of supply of HUBER+SUHNER Switzerland

(applicable specifically to the Wireless Division). The product in all other aspects remains subject to the entirety of provisions set out herein. In particular, this limited warranty does provide neither for a liability for consequential damages nor for any liability for personal injuries whatsoever.

Multiple benefits for HUBER+SUHNER customers

- HUBER+SUHNER offers you comprehensive, well founded know-how covering all manufacturing and testing procedures in the fields of lightning protection and RF engineering.
- Comprehensive stock of standard items.
- Broad range of lightning EMP protection devices, coaxial connectors, coaxial cables and microwave components from a single source.
- Specialist for all RF interconnection and microwave components for mobile radio applications, including antennas.
- High flexibility in meeting customer-specific requirements.
- Maximum quality and reliability of products and services.
- HUBER+SUHNER's philosophy is based on TQRDCE, denoting strengths in: Technology, Quality, Responsiveness, Dependability, Cost and Environment. It is carried into effect by competent and motivated employees, who are focused on customer satisfaction, and a modern corporate structure.
- Excellent customer support service ensured by the worldwide HUBER+SUHNER distribution network.

AUSTRALIA

BRASIL

CHINA

DENMARK

FRANCE

GERMANY

GREAT BRITAIN

HONGKONG

INDIA

MALAYSIA

POLAND

RUSSIA

SINGAPURE

SWEDEN

SWITZERLAND

THAILAND

UNITED ARABIAN EMIRATES

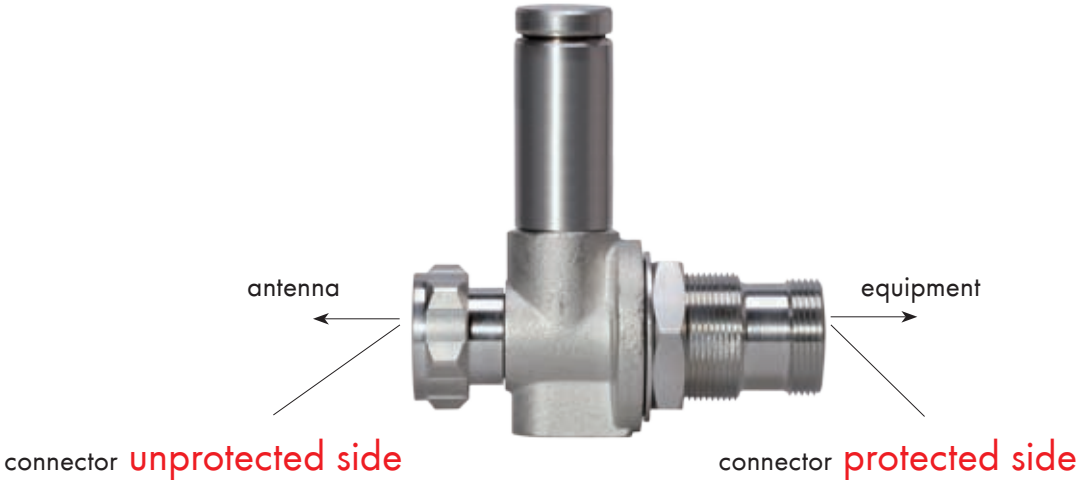
USA

Definitions and terms

Product configuration

The design of HUBER+SUHNER lightning EMP protectors allows for distinguishing between the «protected» (equipment) and «unprotected» (antenna) side.

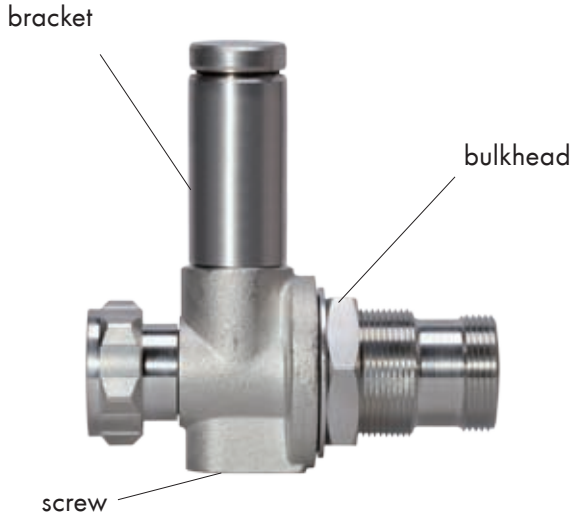
Products with a feed-through design guarantee a low contact resistance due to its circumferential closed ground connection.



Mounting and grounding options

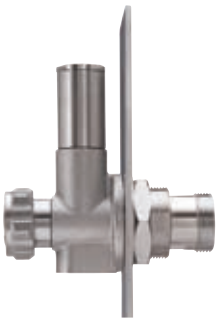
There are different mounting options available which can be used both for grounding and mounting purposes. Mounting and grounding/bonding of the protectors can be done simultaneously, employing one mounting facility only or several facilities at different places on the component.

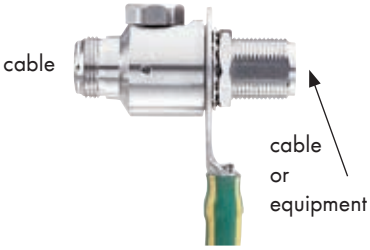
All protectors featuring N and DIN 7/16 connectors are waterproof and therefore can be installed outdoor partially or completely. HUBER+SUHNER bulkhead mounting provides waterproof panel sealing.



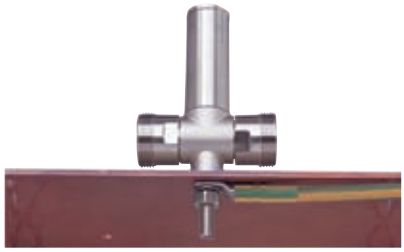
Most frequently used mounting and grounding options

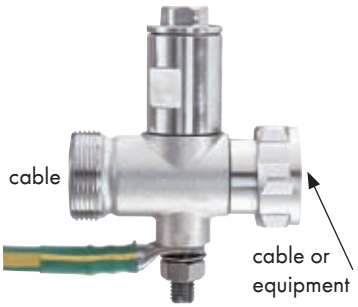
Bulkhead





Screw





Bracket

Connector interfaces

HUBER+SUHNER lightning EMP protectors generally employ coaxial designs. For interconnection to any component or system, the well-proven internationally specified coaxial interfaces are used.
They conform to the following international standards:

Connector interface*	Standards	Coupling nut torque force
N	IEC 60169-16, MIL-STD-348/304	0.68 Nm ... 1.13 Nm/6.0 ... 10.0 in-lbs
DIN 7/16	IEC 60169-4	25 Nm ... 30 Nm/221 ... 260 in-lbs
TNC	IEC 60169-17, MIL-STD-348/313	46 Ncm ... 69 Ncm/4.1 ... 6.1 in-lbs
BNC	IEC 60169-8, MIL-STD-348/301	7 Ncm ... 28 Ncm/0.6 ... 2.5 in-lbs
SMA	IEC 60169-15, MIL-STD-348/310	0.8 Nm ... 1.1 Nm/7.1 ... 9.7 in-lbs
F	IEC 60169-24, ANSI/SCTE 02	35 in-lbs ... 40 in-lbs

* illustrations on pages 31 - 32

For others refer to the HUBER+SUHNER Coaxial Connectors General Catalogue. It also includes the complete interface dimensions. Selected direct cable entries are available as well.

Male connector (m) or plug

«A male connector features the coupling nut of the coupling mechanism»

Female connector (f) or jack

«A female connector features the coupling mechanism complementary to the male connector»

Interface standard	Male connector abbreviation (m)	Female connector abbreviation (f)
DIN 7/16 IEC 60169-4	 7/16 (m)	 7/16 (f)
N IEC 60169-16 MIL-STD-348/304	 N (m)	 N (f)
QN Quick Lock Formula (QLF)	 QN (m)	 QN (f)
TNC IEC 60169-17 MIL-STD-348/313	 TNC (m)	 TNC (f)

Interface standard	Male connector abbreviation (m)	Female connector abbreviation (f)
BNC IEC 60169-8 MIL-STD-348/301	 BNC (m)	 BNC (f)
SMA IEC 60169-15 MIL-STD-348/310	 SMA (m)	 SMA (f)
F IEC 60169-24 ANSI/SCTE 02		 F (f)

RF Power and DC ratings of coaxial interfaces

Valid for coaxial interface only, reductions for several special-protectors solutions according to specification – e.g. DC injection, high-pass, high-power, standard gas discharge tube lightning EMP protectors limited by gas discharge tube, IM specifications according to carrier definitions, etc.

Interface	RF power [kW] for VSWR = 1, sea level and 40 °C			DC current [A]
	100 MHz	900 MHz	1900 MHz	
N	4.6	1.0	0.6	6
DIN 7/16	10.5	3.0	2.0	13

Plating

HUBER+SUHNER lightning EMP protectors feature well-proven platings equivalent to HUBER+SUHNER RF coaxial connectors for all metal parts to ensure low and stable contact resistances, good RF conductivity, low intermodulation, high corrosion resistivity and attractive appearance.

Standard platings	Thickness	
	Contacts	Housings
Silver (Ag)	3.0 µm/120 µin	3.0 µm/120 µin
Gold (Au)	1.3 µm/50 µin	0.8 µm/30 µin
SUCOPLATE®	0.5 µm/20 µin over 2.0 mm/80 µin Ag	2.0 µm/80 µin

HUBER+SUHNER SUCOPLATE® high-quality surface plating for RF components

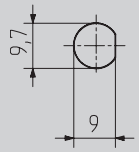
SUCOPLATE® is a special tri-metallic HUBER+SUHNER plating. For more than 20 years it has been used to protect RF components in both indoor and outdoor applications. SUCOPLATE® gives the majority of HUBER+SUHNER products their proven properties and their bright-metal appearance. SUCOPLATE® provides not only an attractive finish but also the following important properties for RF components:

- Excellent electrical conductivity
- Non-magnetic
- Negligible passive intermodulation products equal to silver
- Consistent plating thickness distribution
- High abrasion resistance
- Low surface friction
- Excellent adhesion and ductility
- Tarnish-resistant
- High corrosion resistance
- Non-allergenic plating

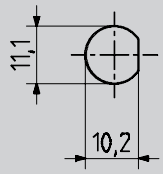
For more detailed information refer to www.plating.ch

Mounting holes

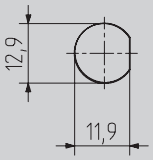
Mounting holes (MH) used with bulkhead mounted protectors (all dimensions in mm)



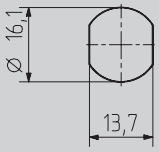
MH 2



MH 3



MH 4



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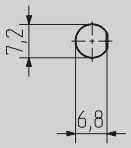
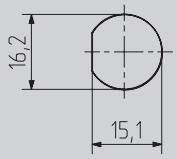
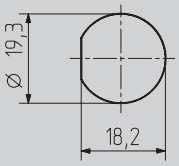


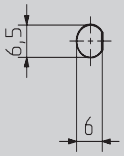
MH 20



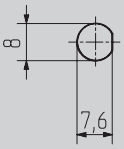
MH 24



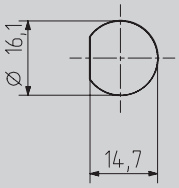
MH 25



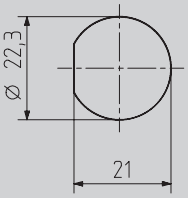
MH 35



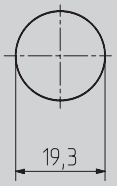
MH 38



MH 50

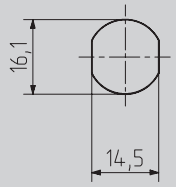


MH 69

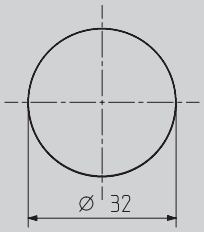


MH 70

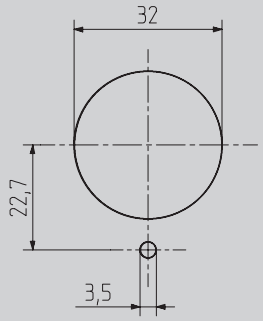
Mounting holes (MH, all dimensions in mm)



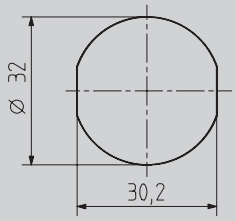
MH 71



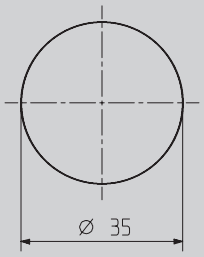
MH 72



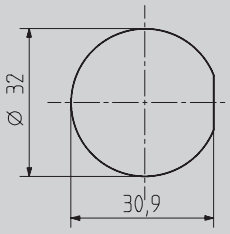
MH 73



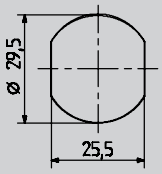
MH 74



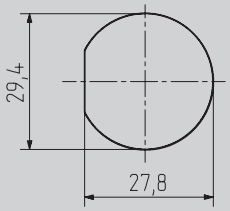
MH 80



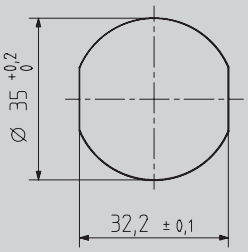
MH 101



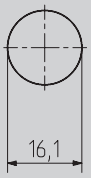
MH 110



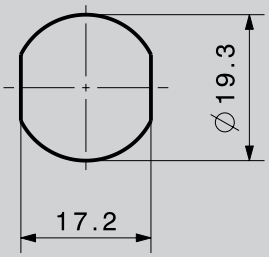
MH 116



MH 118



MH 119

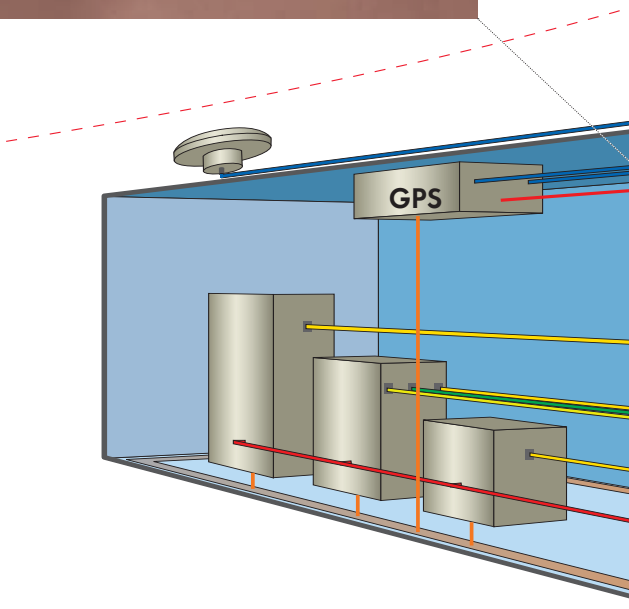


MH 170

Quick selection guide

Basic application scheme

Select your basic application purpose from the general scheme of a radio transmitter configuration for mobile and fixed systems, but also general wireless applications. Rooftop installations follow similar considerations. All protectors provide protection against direct and indirect interferences of lightning, but also NEMP (Nuclear Electromagnetic Pulse) and other surge signals. Miniature surge protectors for indoor protection of electronic equipment are not shown here – refer to series 3404 (page 78).



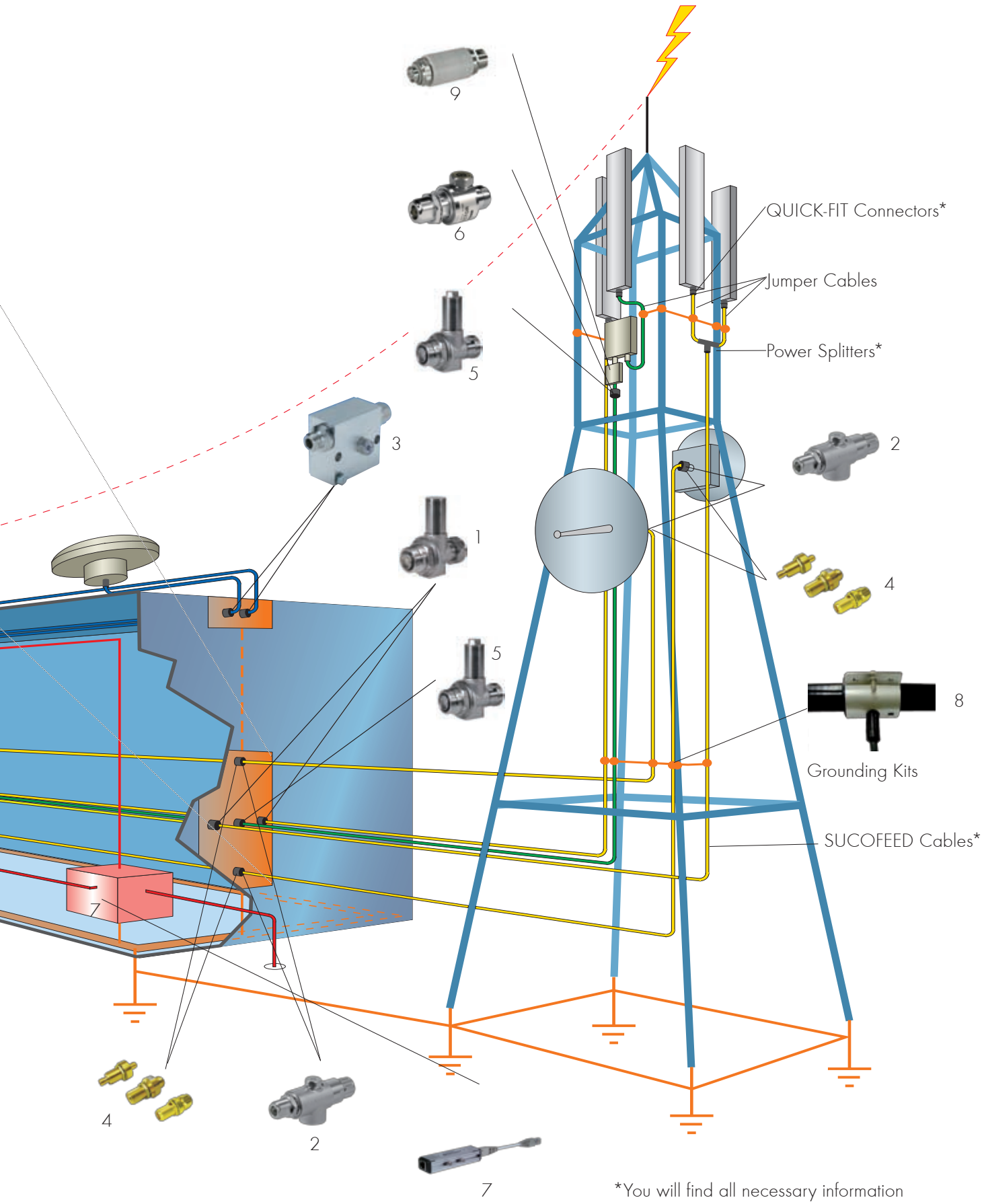
Installation recommendation

- Ideally mounted directly on a wall feed-through sheet metal which is properly connected to the bonding/grounding system to establish a protection zone LPZ 1 or higher according to IEC 62305.
- Protection unit – shorting stub or gas discharge tube – to be arranged outside of the protected room not to cause any interferences by any surge current conducted to ground (all N and DIN 7/16 products are waterproof).
- Integrated in a bonding bar right behind the wall as an alternative.

Recommended HUBER+SUHNER protector group

	Quick selection page	Full range page
1. Quarter-wave protectors series 3400 + 3407	44, 45	54, 86
2. Gas discharge tube protectors series 3401/02 + 3408	46	60, 66, 92
3. Fine protectors series 3403	50	74
4. Slim line gas discharge tube protectors series 3406	47	82
5. High-power/low IM series 3409 + 3410 (DC injection)	48, 49	94, 100
6. SEMPER™ GDT protectors	--	113
7. Signal/data line protectors series 3414	--	104
8. Grounding kits		143
9. High voltage DC block series 9077	--	124

For more familiarity with our protection principles and configuration definitions refer to the «General selection guidance» on the next pages.



*You will find all necessary information about these products in our QUICK-FIT connectors (648137) and RF and Microwave Components (84068668) catalogues.

General selection guidance

Basic properties of available HUBER+SUHNER protection principles

Quarter-wave stub protectors
series 3400, 3407

Quick selection page 44, 45

- Broadband and narrowband units available
- Maintenance-free
- Highest surge current handling capability
  - N: 50 kA (8/20 µs test pulse)
  - DIN 7/16: 100 kA (8/20 µs test pulse)
- Lowest residual surge pulse voltage and energy
- Best IM performance
- DC/AC powering via coax not possible
- Products with integrated high-pass filter with even further reduced residual pulse (series 3407) available

Detailed data: series 3400 on page 54
series 3407 on page 86

Gas discharge tube protectors
series 3401, 3402

Quick selection page 46

Broadband operation
- series 3401: DC up to 1 GHz
- series 3402: DC up to 2.5 GHz

- DC/AC powering via coax cable (not 3408)
- Surge current handling capability 30 kA once and 20 kA multiple
- Gas discharge tube replaceable
- Easy maintenance
- Gas discharge tube has to be selected according to RF power
- Products with integrated high-pass filter and DC injection offering a further reduced residual pulse (series 3408) available
- DC injection port can be added

Detailed data: series 3401 on page 62
series 3402 on page 68
series 3408 on page 92

Fine protectors series 3403

Quick selection page 50

- Broadband operation
- Essentially increased protection compared to standard gas discharge tube protectors
- DC/AC powering via coax possible (bypass feature)
- Surge current handling capability 30 kA once and 20 kA multiple / 20 kA once and 10 kA multiple (see page 74)
- Residual surge pulse energy reduced by about factor 100 compared to standard gas discharge tube protector

Detailed data: series 3403 on page 74

Slim line gas discharge tube protectors series 3406

Quick selection page 47

- Wide-band operation DC up to 5.8 GHz
- Surge current handling 10 kA once and 5 kA multiple
- Gas discharge tube fix installed
- slim inline design
- DC/AC powering via coaxial cable
- Bulkhead mounting/grounding

Detailed data: series 3406 on page 82

High-power/low IM gas discharge tube protectors series 3409, 3410

Quick selection page 48, 49

- Broadband and narrowband units available
- Gas discharge tube protector working independent of transmitted RF power
- DC/AC powering via coaxial cable
- Surge current handling capability 30 kA once and 20 kA multiple
- Lowest available residual pulse voltage and energy compared to other high-power gas discharge tube protectors
- Lowest IM for any gas discharge tube protector available in the market
- Products with integrated high-pass filter offering a further reduced residual pulse (series 3410) available
- DC injection port can be added

Detailed data: series 3409 on page 94

series 3410 on page 100

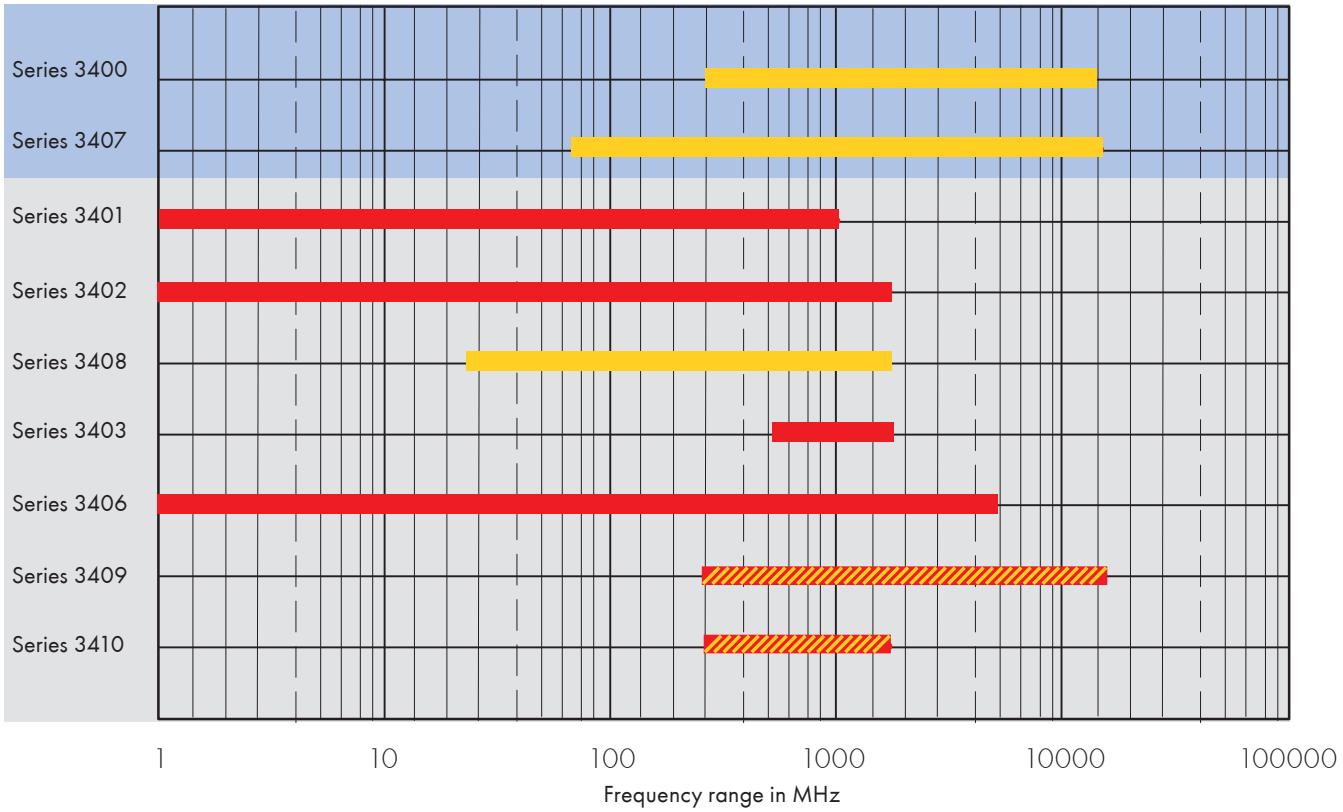
Data line protectors series 3414

- Data line coarse and fine protection solution for high speed data transmission on STP / UTP lines
- Different DLP units available up to Class D (CAT5)
- Different interconnections available
- For high speed Ethernet data transmission units
- Available for indoor and outdoor applications up to waterproof rating IP68
- Rugged metal housing
- Maintenance free
- PoE «Power over Ethernet» acc. IEEE 802.3.af for high speed Ethernet data transmission equipment

Detailed data: series 3414 on page 105

Map of protector series vs. frequency range (protection solutions)

The chart below shows our product series and technologies with their typical operation frequency range. For specific operating frequency ranges please refer to the detailed product specification.



Quarter-wave technology

Gas discharge tube technology

DC/AC powering via coaxial cable possible

Products available within this frequency range but with limited bandwidth (according to shown product detail specification)

DC/AC powering via coaxial cable possible and products available within this frequency range but with limited bandwidth (according to shown product detail specification)

Quarter-wave protectors

Standard quarter-wave stub technology
Series 3400

Important

- Standard quarter-wave protectors can also be installed reversely («backwards») without any impact on performance.
- All products feature low PIM design.

Applications and product range

System	System frequency range (MHz)	Connectors Unprotected/protected side If bulkhead mount version, side of bulkhead marked «b».	Mounting/ grounding MH - hole for «b» M - screw	HUBER+SUHNER Type	Further product info Page
TETRA, TETRAPOL	380-512	N(m)-N(f), b	MH74, M8	3400.17.0388	56
		7/16(f)-7/16(f), b	MH74, M8	3400.41.0196	56
		7/16(m)-7/16(f), b	MH74, M8	3400.41.0203	56
LTE* AMPS/NADC, TACS,TETRA,GSM GPS DCS, PCS, DECT UMTS	690 824-894 860-960 1565-1586 1710-1900 1885-2200	N(m)-N(f)	M8	3400.17.0377	57
		N(m)-N(f), b	MH110, M8	3400.17.0420	57
		7/16(m)-7/16(f)	M8	3400.41.0204	57
		7/16(f)-7/16(f)	M8	3400.41.0216	57
		7/16(m)-7/16(f), b	MH74, M8	3400.41.0217	57
		7/16(m)-7/16(f), b	MH110, M8	3400.41.0241	57
		7/16(m)-7/16(f), b	**MH 110, M8**	**3400.41.0257**	**57**
		7/16 (m)-7/16(f), b	**MH 110, M8**	**3400.41.0263***	**57**
GPS	1565 - 1586	N(m)-N(f), b	MH12, M8	3400.17.0280	59
WLL/WLAN BWA	2400-3600 2300-2700 3400-4200 2000-6000	N(m)-N(f), b	MH50, M8	3400.17.0247	60
		TNC-R(f)-TNC-R(m), b	MH25	3400.99.0005	60
		N(f)-N(f), b	MH69	3400.17.0189	60
		N(m)-N(f)	M8	3400.17.0410	60
		N(f)-N(f), b	**MH170**	**3400.17.0426**	**60**
		N(m)-N(f), b	**MH170**	**3400.17.0428**	**60**
Microwave Radio	6000-18000	N(f)-N(f), b	MH69	3400.17.0380	60

* LTE - for detailed information please see page 120

Quarter-wave stub technology with integrated high-pass filter
Series 3407

Important

- Quarter-wave protectors with integrated high-pass filter cannot be installed reversely («backwards») without any impact on performance.
- All products feature low PIM design.

Applications and product range

System	System frequency range (MHz)	Connectors Unprotected/protected side If bulkhead mount version, side of bulkhead marked «b».	Mounting/ grounding MH - hole for «b» M - screw	HUBER+SUHNER Type	Further product info Page
ILS	74-180	N(f)-N(f), b	MH74, M8	3407.17.0022	88
PMR, Paging	146-174	N(m)-N(f), b	MH12, M8	3407.17.0054	88
VHF Broadcasting	174-280	N(m)-N(f), b	MH74, M8	3407.17.0026	88
TETRA, TETRAPOL	380-512	7/16(m)-7/16(f)	M8	3407.41.0038	89
AMPS/NADC and TACS (N+E) and TETRA and GSM, IMT-2000/UMTS	824-894 860-949 870-925 880-960 1885-2500	N(f)-N(f), b	MH110, M6	3407.17.0067	90
		N(m)-N(f), b	MH110, M6	3407.17.0068	90
		7/16(m)-7/16(f), b	MH110, M6	3407.41.0039	90
		7/16(f)-7/16(f), b	MH110, M6	3407.41.0042	90
BWA	2000-6000	**N(m)-N(f), b**	**MH170**	**3407.17.0085**	**90**

All mounting holes are shown on pages 34 – 35.

Gas discharge tube protectors

Standard gas discharge tube technology
Series 3401, 3402

Important

- Standard gas discharge tube protectors can also be installed reversely («backwards») without any impact on performance.
- Gas discharge tube normally to be selected and ordered separately – refer to page 134 – 137)

Applications and product range

System	System frequency range (MHz)	Connectors Unprotected/protected side If bulkhead mount version, side of bulkhead marked «b».	Mounting/ grounding MH - hole for «b» M - screw	HUBER+SUHNER Type	Further product info Page
PMR, Paging and TETRA and NMT 450 AMPS/NADC and TACS (N+E) and TETRA and GSM and Point-to-Point MW-Radios IF	146-174 380-512 453-468 824-894 860-949 870-925 880-960 up to 1000	N(f)-SMA(f), b	MH12	3401.00.0022	64
		BNC(f)-BNC(f), b	MH12	3401.01.A	64
		BNC(m)-BNC(f), b	MH12	3401.01.C	64
		N(f)-N(f), b	MH12, M8	3401.17.0033	64
		N(f)-N(f), b	MH12	3401.17.A	64
		N(m)-N(f), b	MH12	3401.17.C	64
		TNC(f)-TNC(f), b	MH12	3401.26.A	64
		TNC(m)-TNC(f), b	MH12	3401.26.C	64
		N (f)-N(f)	MH12	3401.17.0048-EX*	64
		TNC(f)-TNC(f)	MH12	3401.26.0012-EX*	64
GPS and DCS 1800 and PCS 1900 and DECT and IMT-2000/ UMTS and WLL/WLAN	1565-1586 1710-1880 1850-1990 1880-1900 1885-2200 2300-2500	7/16(f)-N(f), b	MH12, M8	3402.00.0032	70
		N(m)-N(f), b	MH12, M8	3402.17.0043	70
		N(f)-N(f), b	MH12, M8	3402.17.0044	70
		N(f)-N(f), b	MH25	3402.17.A	70
		N(m)-N(f), b	MH25	3402.17.C	70
		7/16(m)-7/16(f), b	MH74, M8	3402.41.0037	70
		7/16(f)-7/16(f), b	MH74, M8	3402.41.0038	70
		7/16(f)-7/16(f), b	MH72	3402.41.A	70
		N(f)-N(f)	MH25	3402.99.0003	70
		7/16(f)-7/16(f)	MH25	3402.17.0072-EX*	70
		7/16(f)-7/16(f)	MH72	3402.41.0056-EX*	70

* SEMPER™ type GDT unit included - for detailed information see page 113

Slim line gas discharge tube technology
Series 3406

Important

- Permanently installed gas discharge tube

Applications and product range

System	System frequency range (MHz)	Connectors Unprotected/protected side If bulkhead mount version, side of bulkhead marked «b».	Mounting/ grounding MH - hole for «b» M - screw	HUBER+SUHNER Type	Further product info Page
PMR, Paging	146–174	BNC(m)-BNC(f), b	MH4	3406.01.0003	84
and TETRA	380–512	N(f)-N(f), b	MH24	3406.17.0009	84
and NMT 450	453–468	N(m)-N(f), b	MH24	3406.17.0012	84
AMPS/NADC	824–894	SMA(F)-SMA(f), b	MH3	3406.19.0003	84
and TACS(N+E)	860–949	SMA(m)-SMA(f), b	MH3	3406.19.0004	84
and TETRA	870–925	TNC(m)-TNC(f), b	MH4	3406.26.0004	84
and GSM	880–960				
and Point-to-Point MW-Radios IF	up to 1000				
GPS	1565–1586				
and DCS 1800	1710–1880				
and PCS 1900	1850–1990				
and DECT	1880–1900				
and IMT-2000/ UMTS	1885–2200				
and WLL/WLAN	2300–2500				
and ISM	5200–5800				
BWA	DC-4000	N(f)-N(f), b	MH24	3406.17.0027	84
		N(m)-N(f), b	MH24	3406.17.0028	84

All mounting holes are shown on pages 34 – 35.

Standard high-power/low-IM gas discharge tube hybrid technology
Series 3409

Important

- Standard high-power/low-IM protectors can also be installed reversely («backwards») without any impact on performance.
- All products feature low PIM design
- Replaceable gas discharge tube included

Applications and product range

System	System frequency range (MHz)	Connectors Unprotected/protected side If bulkhead mount version, side of bulkhead marked "b".	Mounting/ grounding MH - hole for "b" M - screw	HUBER+SUHNER Type	Further product info Page
TETRA, TETRAPOL	380-512	N(m)-N(f), b	MH74, M8	3409.17.0032-EX	96
		7/16(m)-7/16(f)	M8	3409.41.0054-EX	96
LTE** AMPS/NADC, TACS,TETRA,GSM GPS DCS, PCS, DECT UMTS WLL/WLAN	690 824-894 860-960 1565-1586 1710-1900 1885-2200 2300-2500	N(f)-N(f), b	MH74, M8	3409.17.0031-EX*	98
		N(m)-N(f)	M8	3409.17.0027-EX*	98
		7/16(f)-7/16(f)	M8	3409.41.0051-EX*	98
		7/16(f)-7/16(f), b	MH74, M8	3409.41.0052-EX*	98
		7/16(m)-7/16(f)	M8	3409.41.0044-EX*	98
		7/16(m)-7/16(f), b	MH74, M8	3409.41.0053-EX*	98
		7/16(m)-7/16(f), b	**MH170, M8**	**3409.41.0084***	**98**
		7/16(m)-7/16(f), b	**MH74, M8**	**3409.41.0085*/****	**98**

* Optimised for 2.176 MHz AISG carrier

** LTE - for detailed information please see page 120

All mounting holes are shown on pages 34 – 35.

High-power/low-IM gas discharge tube hybrid technology with integrated high-pass filter and DC injection Series 3410

Important

- High-power/low-IM protectors with integrated high-pass filter cannot be installed reversely («backwards») without any impact on performance.
- All products feature low PIM design
- Replaceable gas discharge tube included

Applications and product range

System	System frequency range (MHz)	Connectors Unprotected/protected side If bulkhead mount version, side of bulkhead marked «b».	Mounting/ grounding MH - hole for «b» M - screw	HUBER+SUHNER Type	Further product info Page
TETRA, TETRAPOL	380-512	7/16(m)-7/16(f)*	M8	3410.41.0009-EX	102
AMPS/NADC and TACS(N+E) and TETRA and GSM DCS 1800 and PCS 1900 and DECT IMT-2000/UMTS WLL/WLAN	824–894 860–949 870–925 880–960 1710–1880 1850-1990 1880-2200 2500	N(f)-N(m)*	M8	3410.17.0012-EX	103
		7/16(m)-7/16(f)*	M8	3410.41.0017-EX	103
		7/16(f)-7/16(f)**	M8	3410.41.0020	103

* DC injection port TNC (f)

** DC injection port SMB (f)

All mounting holes are shown on pages 34 – 35.

Fine protectors
Series 3403

Important

- Fine protectors with integrated high-pass filter cannot be installed reversely («backwards»)
- All listed Fine Protectors are multi-band products (650/800-2500 MHz)
- Gas discharge tube included

Applications and product range

System	System frequency range (MHz)	Connectors Unprotected/protected side If bulkhead mount version, side of bulkhead marked «b».	Mounting/ grounding MH - hole for «b» M - screw	HUBER+SUHNER Type	Further product info Page
AMPS/NADC and TACS(N+E) and TETRA and GSM DCS 1800 and PCS 1900 and DECT IMT-2000/UMTS WLL/WLAN	824–894 860–949 870–925 880–960 1710–1880 1850–1990 1880–1900 2400–2200 2500	N(f)-N(f)	2xM4	3403.17.0042*	76
		N(f),b-N(m)	MH119, 2xM4	3403.17.0049*	76
		N(f)-N(f), b	MH119, 2xM4	3403.17.0050*	76
		N(f)-N(f), b	MH12	3403.17.0060**	76
		N(m)-N(f), b	MH12	3403.17.0063**	76

* Bypass voltage 15 V and GDT replaceable (cube design)

** Bypass voltage 6 V with permanently installed GDT (barrel design)

All mounting holes are shown on pages 34 – 35.

Space for your notes

Lightning EMP protection products

Series 3400 lightning EMP protectors

Quarter-wave stub technology

Description

HUBER+SUHNER quarter-wave lightning EMP protectors offer the best lightning protection available in the market, as they form a short for surge signals basically. They have been established as a worldwide industry standard by HUBER+SUHNER as the original manufacturer.
The products are maintenance-free and feature the best protection performance with both the highest surge current handling capability and the lowest residual pulse amplitude. Also, their RF performance is superior to other designs, including passive intermodulation. HUBER+SUHNER lightning EMP protectors series 3400 offer a large variety of products and can be adapted to any application. Besides connectorization and mounting principle, the frequency range has to be selected properly due to their generally limited bandwidth.

Features

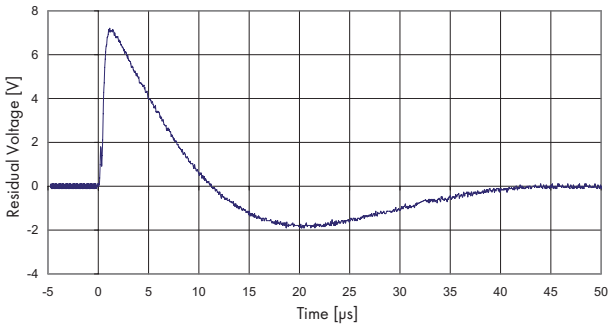
- Broadband
- Available within 380 MHz to 18 GHz max. (N, SMA)
- Best PIM performance
- Highest current-handling capability up to 100 kA max.
- Maintenance-free

Specification

Electrical data	Requirements
RF:	
Impedance	50 Ω
Frequency range	according to product detail specification (data sheet)
RL	20 dB min.
IL	0.1 dB max. (0.2 dB max. for f ≥ 3 GHz)
PIM	according to product detail specification (data sheet) (specified products –150 dBc max.)
RF power transmission	refer to data in section Definitions and Terms «RF power and DC ratings» and product detail specification (data sheet)
Protection:	
Surge current handling capability	N: 50 kA, DIN 7/16: 50 to 100 kA multiple (8/20 µs test pulse) N: 25 kA, DIN 7/16: 50 kA (10/350 µs test pulse) refer to product detail specification (data sheet)
Residual pulse voltage and energy	for typical values refer to the following diagram

Typical residual pulse for series 3400 (for GSM band), test pulse acc. to IEC 61000-4-5 1.2/50 µs 4 kV; 8/20 µs 2 kA:

Residual pulse voltage: typ. 7 V
Residual pulse energy: typ. 5 µJ



Mechanical data	Requirements
Coupling nut torque force	according to IEC/MIL (refer to page 30)
Durability (matings)	500 min. / 100 min. for H+S types made of aluminium
Bulkhead mounting torque force: Mounting hole diameter 19 mm/ 3/4" max. Larger than 19 mm	 20 Nm (14.7 ft-lb) min. / 25 Nm (18.4 ft-lb) max. 35 Nm (25.8 ft-lb) min. / 44 Nm (32.3 ft-lb) max.

Environmental data	Requirements/test conditions
Operation temperature range	- 40 °C...+ 85 °C/ - 40 °F...+ 185 °F
Waterproof degree (IEC 60529)	IP 65 min., according to shown product specification, data refer to the coupled state
Temperature shock	MIL-STD-202, Meth. 107, Cond. B
Moisture resistance	MIL-STD-202, Meth. 106
Vibration	MIL-STD-202, Meth. 204, Cond. D

The product is designed to meet the cited test procedures. Any additional or different requirements arising from specific applications or environmental conditions not covered by the test specifications mentioned above are subject to request and need to be confirmed by the single product detail specification.
We recommend additional taping for long term outdoor applications in any case.

Material data Component part	Material	Plating
Housings	brass or aluminium	SUCOPLATE® or passivated
Male contacts	brass	gold or silver plating
Female contacts	CuBe2	gold or silver plating
Insulators	PTFE	
Gaskets	elastomer rubber	

All mounting holes are shown on pages 34 - 35.

Series 3400

Frequency range 380 MHz to 512 MHz

H+S type	Frequency range (MHz)	Connectors Unprotected/protected side* If bulkhead mount version, side of bulkhead marked «b».	Mounting/ grounding MH - hole for «b» M - screw	RL min.	IL max.	Water-proof	Weight	Figure
3400.17.0388	380-512	N(m)-N(f), b	MH74,M8	20 dB	0.1 dB	IP65	325 g	Fig. 1
3400.41.0196	380-512	7/16(f)-7/16(f), b	MH74,M8	20 dB	0.1 dB	IP65	354 g	Fig. 2
3400.41.0203	380-512	7/16(m)-7/16(f), b	MH74,M8	20 dB	0.1 dB	IP67	580 g	Fig. 3

* Recommendation only, reverse installation possible without any impact on performance

All dimensions in mm

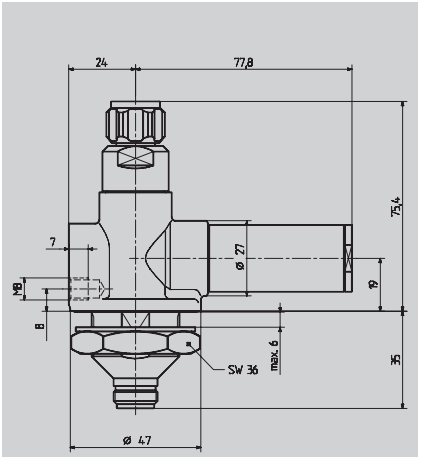


Fig.1

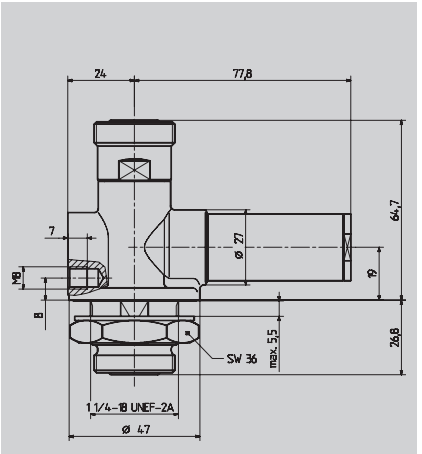


Fig. 2

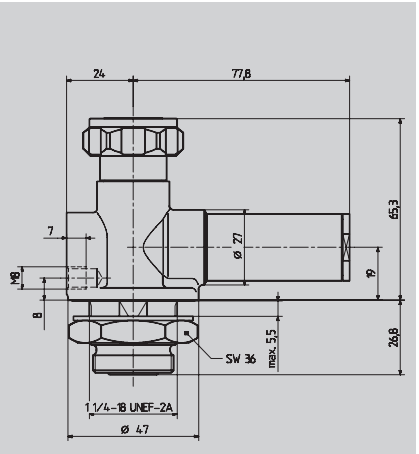


Fig. 3

All mounting holes are shown on page 34 – 35.

Series 3400

Broadband, frequency range 800 MHz to 2500 MHz

H+S type	Frequency range (MHz)	Connectors Unprotected/protected side* If bulkhead mount version, side of bulkhead marked «b».	Mounting/ grounding MH - hole for «b» M - screw	RL min.	IL max.	Water-proof	Weight	Figure
3400.17.0377	806-2500	N(m)-N(f)	M8	20.8 dB	0.15 dB	IP65	400 g	Fig. 1
	806-960			26.0 dB				
	1710-2500			26.0 dB				
3400.17.0420**	806-2200	N(m)-N(f), b	MH110, M8	20.8 dB	0.10 dB	IP65	480 g	Fig. 2
	824-960			23.0 dB				
	1710-2200			23.0 dB				
3400.41.0216	806-2500	7/16(f)-7/16(f)	M8	20.8 dB	0.15 dB	IP65	431 g	Fig. 3
	806-960			26.0 dB				
	1710-2500			26.0 dB				
3400.41.0204	806-2500	7/16(m)-7/16(f)	M8	20.8 dB	0.15 dB	IP65	415 g	Fig. 4
	806-960			26.0 dB				
	1710-2500			26.0 dB				
3400.41.0217	806-2500	7/16(m)-7/16(f), b	MH74, M8	20.8 dB	0.15 dB	IP65	515 g	Fig. 5
	806-960			26.0 dB				
	1710-2500			26.0 dB				
3400.41.0241**	806-2200	7/16(m)-7/16(f), b	MH110, M8	20.8 dB	0.10 dB	IP68	480 g	Fig. 6
	824-960			24.0 dB				
	1710-2200			24.0 dB				
3400.41.0257***	800-2500	7/16(m)-7/16(f), b	MH110, M8	20.8 dB	0.10 dB	IP68	240 g	Fig. 7
	824-960			24.0 dB				
3400.41.0263****	1710-2200 690–2000	7/16(m)-7/16(f), b	MH110, M8	24.0 dB 23 dB	0.15 dB	IP67	460 g	Fig. 8
	690–960			26 dB				
	1700–2200			26 dB				

* Recommendation only, reverse installation possible without any impact on performance

** Inline design

*** Material: aluminium

**** LTE - for detailed information please see page 120

All mounting holes are shown on pages 34 – 35.

All dimensions in mm

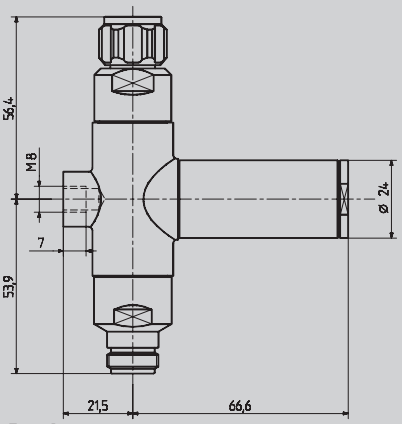


Fig. 1

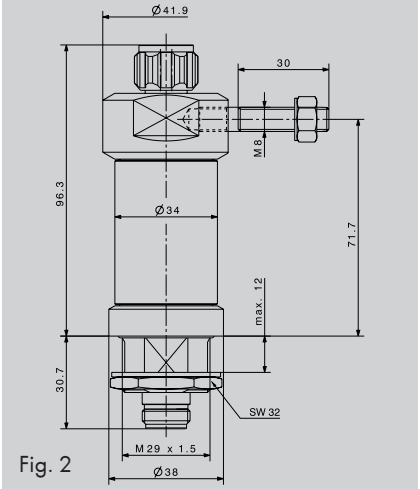


Fig. 2

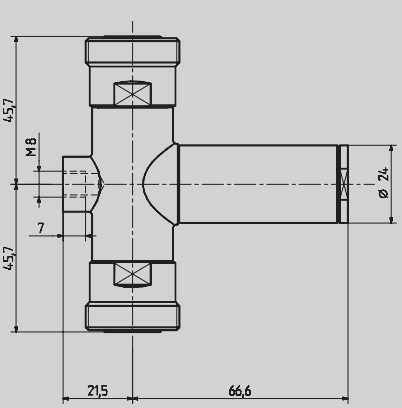


Fig. 3

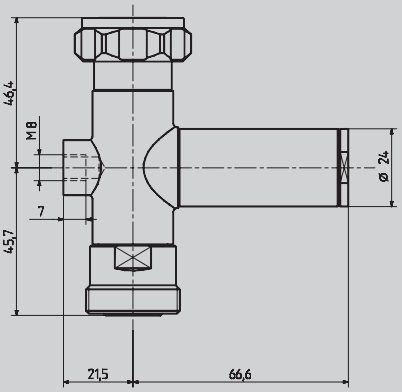


Fig. 4

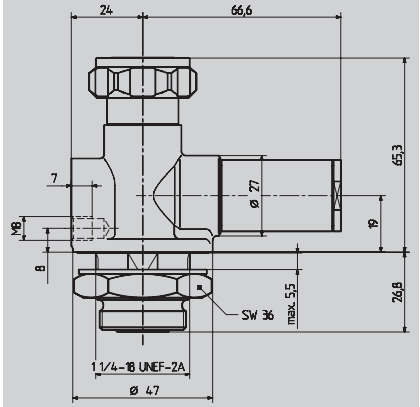


Fig. 5

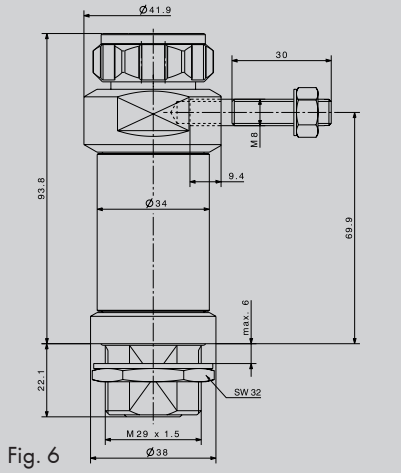


Fig. 6

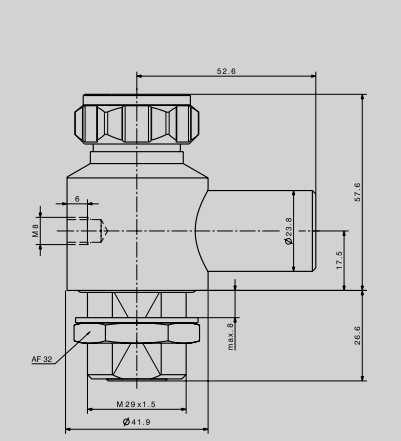


Fig. 7

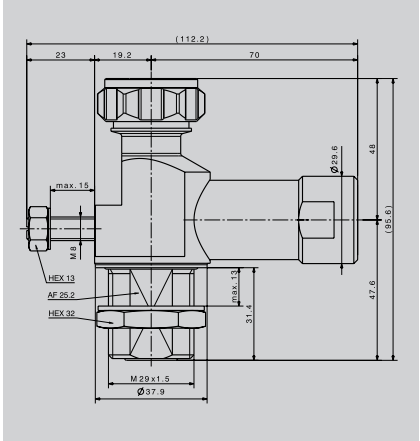


Fig. 8

All mounting holes are shown on page 34 – 35.

Series 3400

Frequency range 1000 MHz to 1700 MHz

H+S type	Frequency range (MHz)	Connectors Unprotected/protected side* If bulkhead mount version, side of bulkhead marked «b».	Mounting/ grounding MH - hole for «b» M - screw	RL min.	IL max.	Water-proof	Weight	Figure
3400.17.0280	1565-1586	N(m)-N(f), b	MH12, M8	20 dB	0.1 dB	IP65	270 g	Fig. 1

* Recommendation only, reverse installation possible without any impact on performance

All dimensions in mm

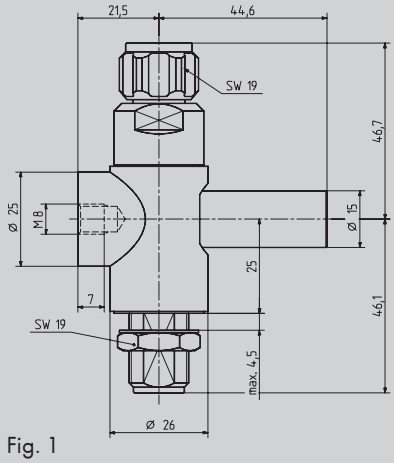


Fig. 1

All mounting holes are shown on pages 34 – 35.

Series 3400

Frequency range 2000 MHz to 18000 MHz

H+S type	Frequency range (MHz)	Connectors Unprotected/protected side* If bulkhead mount version, side of bulkhead marked «b».	Mounting/ grounding MH - hole for «b» M - screw	RL min.	IL max.	Water-proof	Weight	Figure
3400.17.0189	3400–4200	N(f)-N(f), b	MH69	19 dB	0.10 dB	IP65	200 g	Fig. 1
3400.17.0247	2400–3600	N(m)-N(f), b	MH50, M8	20 dB	0.15 dB	IP66	290 g	Fig. 2
3400.17.0380	6000–18000	N(f)-N(f), b	MH69	20 dB	0.30 db	IP65	225 g	Fig. 3
3400.17.0410	2000–6000	N(m)-N(f)	M8	20 dB	0.20 dB	IP65	290 g	Fig. 4
3400.17.0426**	2000–6000	N(f)-N(f), b	MH170	20 dB	0.20 dB	IP68	80 g	Fig. 5
3400.17.0428**	2000–6000	N(m)-N(f), b	MH170	20 dB	0.20 dB	IP68	85 g	Fig. 6
3400.99.0005	2300–2700	TNC-R(f)-TNC-R(m), b	MH25	20 dB	0.15 dB	IP20	120 g	Fig. 7

* Recommendation only, reverse installation possible without any impact on performance

** Material: aluminium

All mounting holes are shown on page 34 – 35.

All dimensions in mm

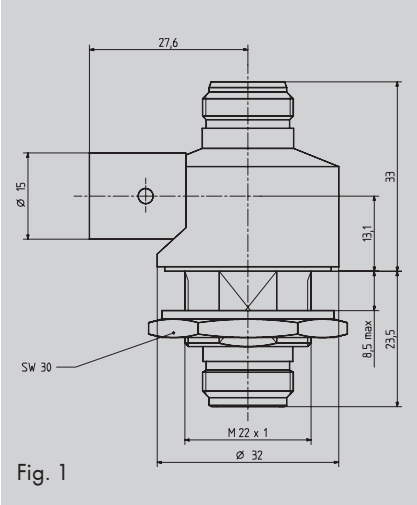


Fig. 1

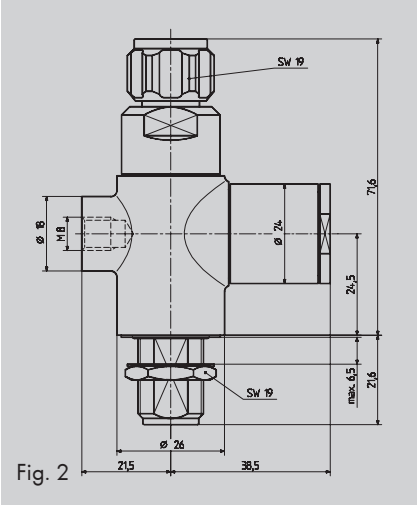


Fig. 2

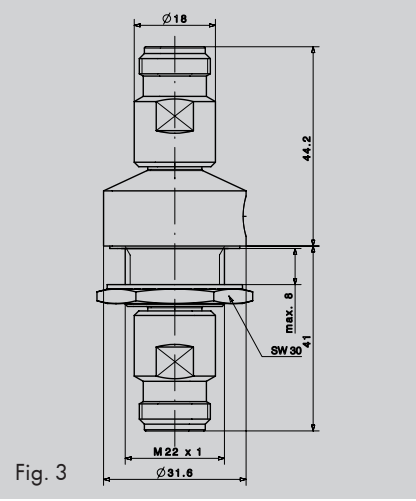


Fig. 3

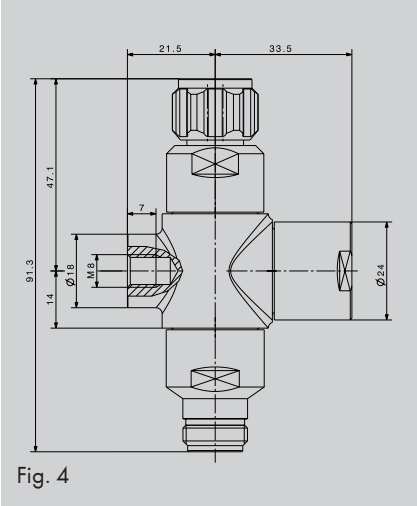


Fig. 4

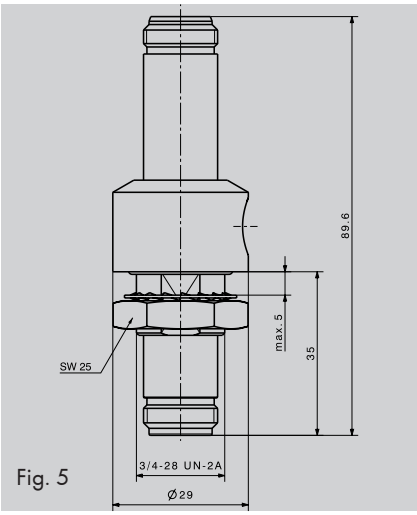


Fig. 5

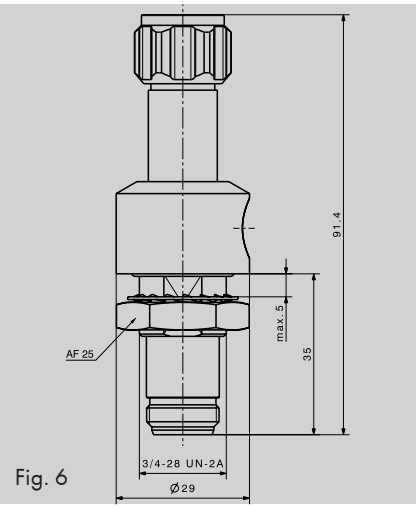


Fig. 6

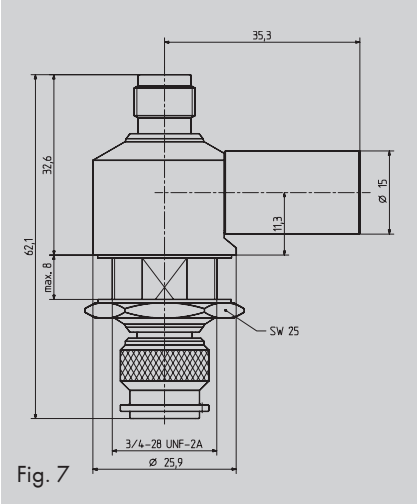


Fig. 7

All mounting holes are shown on pages 34 – 35.

Series 3401 lightning EMP protectors

Gas discharge tube (GDT) technology up to 1.0 GHz

Description

HUBER+SUHNER gas discharge tube protectors make the best of the traditional spark gap protection principle for general applications in electronics and adapt it perfectly to RF coaxial line applications. At their heart are specially designed gas discharge tubes. The available product range of gas discharge tubes enables a selection according to the RF transmission power with an optimum protection performance.
A very important feature of the GDT protectors is the possibility to DC/AC power outdoor equipment via coaxial cable.

Series 3401 products can be used broadband from DC up to 1000 MHz.
They are generally designed as coaxial feed-throughs which allow the customer to build up a protected area according to the recommended and well-proven protection zone principle of IEC 62305.
HUBER+SUHNER GDT protectors are designed such that the gas discharge tubes can be easily exchanged for new operation conditions or replaced in the case of a necessary service.

Features

- Broadband DC up to 1 GHz
- DC transmission
- Gas discharge tube replaceable
- Easy maintenance
- SEMPER™ self-extinguishing functionality optional (see page 113)

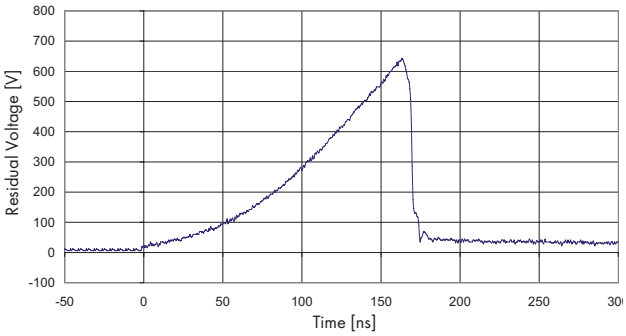
Specifications

Electrical data	Requirements
RF:	
Impedance	50 or 75 Ω
Frequency range	DC – 1000 MHz
RL*	20 dB min.
IL*	0.2 dB max.
RF power transmission	according to selected gas discharge tube – refer to page 134
Protection:	
Surge current handling capability	30 kA once and 20 kA multiple (8/20 µs test pulse) 8 kA (10/350 µs test pulse)
Residual pulse voltage and energy	for typical values refer to the following diagram

* With 230 V gas discharge tube (9071.99.0547)

Typical residual pulse for series 3401*,
test pulse acc. to IEC 61000-4-5
1.2/50 µs 4 kV; 8/20 µs 2 kA:

Residual pulse voltage: typ. 650 V
Residual pulse energy: typ. 350 µJ



* With 230 V gas discharge tube (9071.99.0547)

Mechanical data	Requirements
Coupling nut torque force	according to IEC/MIL (refer to page 30)
Durability (matings)	500 min.
Bulkhead mounting torque force: Mounting hole diameter 19 mm/ 3/4" max. Larger than 19 mm	 20 Nm (14.7 ft-lb) min. / 25 Nm (18.4 ft-lb) max. 35 Nm (25.8 ft-lb) min. / 44 Nm (32.3 ft-lb) max.

Environmental data	Requirements/test conditions
Operation temperature range	- 40 °C...+ 85 °C/ - 40 °F...+ 185 °F
Waterproof degree (IEC 60529)	according to shown product specification, data refer to the coupled state
Temperature shock	MIL-STD-202, Meth. 107, Cond. B
Moisture resistance	MIL-STD-202, Meth. 106
Vibration	MIL-STD-202, Meth. 204, Cond. D

The product is designed to meet the cited test procedures. Any additional or different requirements arising from specific applications or environmental conditions not covered by the test specifications mentioned above are subject to request and need to be confirmed by the single product detail specification.

We recommend additional taping for long term outdoor applications in any case.

Material data Component part	Material	Plating
Housings	brass	SUCOPLATE®
Male contacts	brass	gold or silver plating
Female contacts	CuBe2	gold or silver plating
Insulators	PTFE	
Gaskets	elastomer rubber	

Series 3401

Coaxial, characteristic impedance 50 Ω

Gas discharge tube normally to be selected and ordered separately – refer to page 134 - 137

H+S type	Frequency range (MHz)	Connectors Unprotected/protected side* If bulkhead mount version, side of bulkhead marked «b».	Mounting/ grounding MH - hole for «b» M - screw	RL min.	IL max.	Water-proof	Weight	Figure
3401.00.0022	DC-1000	N(f)-SMA(f), b	MH12	20 dB	0.2 dB	IP66	95 g	Fig. 1
3401.01.A	DC-300	BNC(f)-BNC(f), b	MH12	26 dB	0.1 dB	IP20	75 g	Fig. 2
	300-1000			19 dB	0.1 dB			
3401.01.C	DC-300	BNC(m)-BNC(f), b	MH12	26 dB	0.1 dB	IP20	90 g	Fig. 3
	300-1000			19 dB	0.1 dB			
3401.17.0033	DC-1000	N(f)-N(f), b	MH12, M8	20 dB	0.2 dB	IP65	230 g	Fig. 4
3401.17.0048-EX**	DC - 1000	N-jack/N-jack	MH12	24 dB	0.1 dB	IP65	87 g	Fig. 5
3401.17.A	DC-1000	N(f)-N(f), b	MH12	26 dB	0.1 dB	IP65	87 g	Fig. 6
3401.17.C	DC-1000	N(m)-N(f), b	MH12	26 dB	0.1 dB	IP65	90 g	Fig. 7
3401.26.A	DC-300	TNC(f)-TNC(f), b	MH12	26 dB	0.1 dB	IP64	77 g	Fig. 8
	300-1000			19 dB	0.1 dB			
3401.26.C	DC-300	TNC(m)-TNC(f), b	MH12	26 dB	0.1 dB	IP20	90 g	Fig. 9
	300-1000			19 dB	0.1 dB			
3401.26.0012-EX**	DC - 1000	TNC(f)/TNC(f)	MH12	19 dB	0.1 dB	IP64	77 g	Fig. 10

* Recommendation only, reverse installation possible without any impact on performance

** SEMPER™ type, GDT unit included – for detailed information see page 113

All mounting holes are shown on pages 34 – 35.

All dimensions in mm

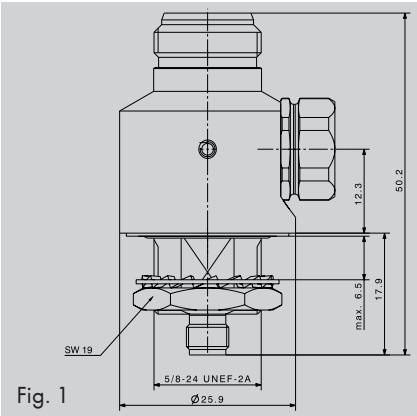


Fig. 1

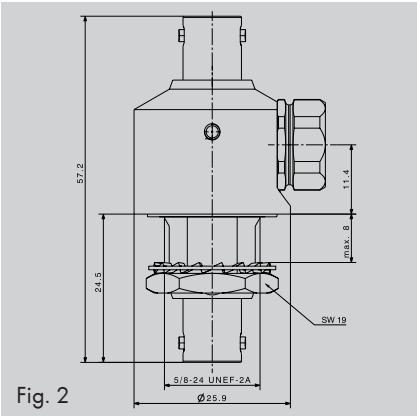


Fig. 2

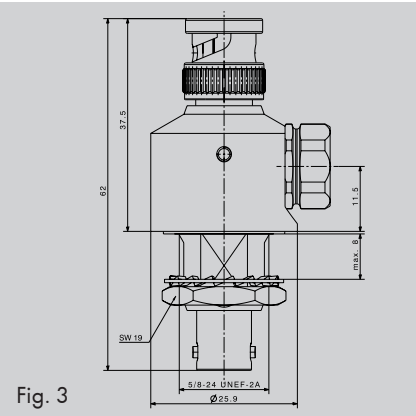


Fig. 3

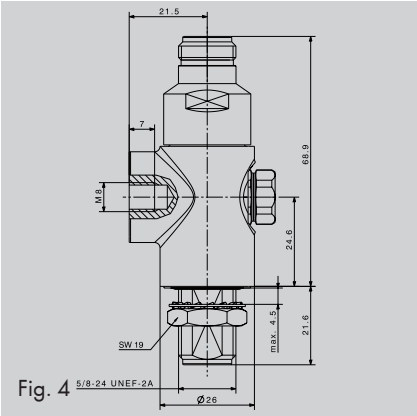


Fig. 4

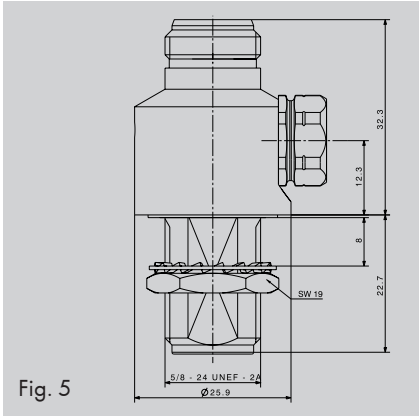


Fig. 5

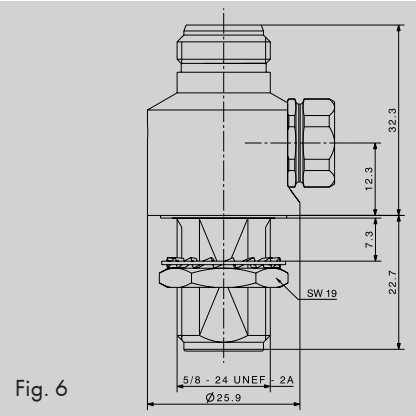


Fig. 6

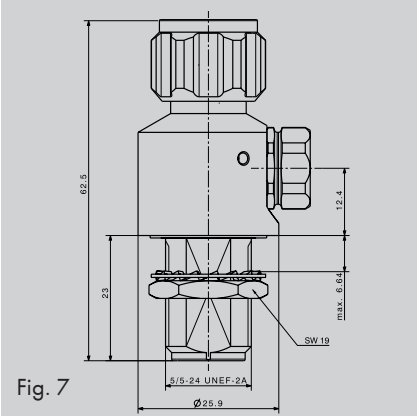


Fig. 7

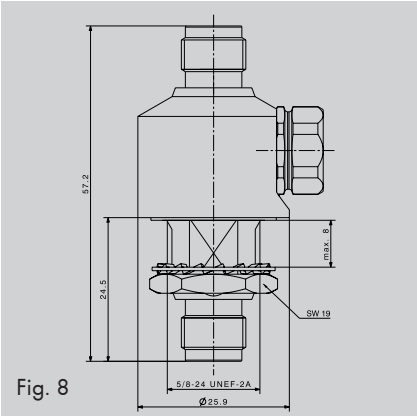


Fig. 8

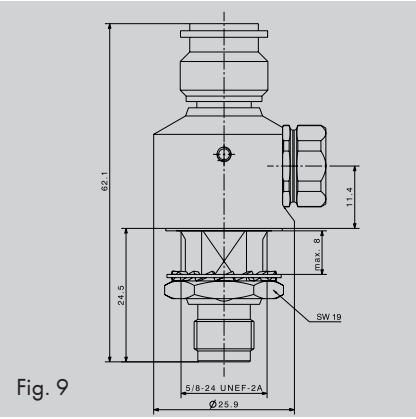


Fig. 9

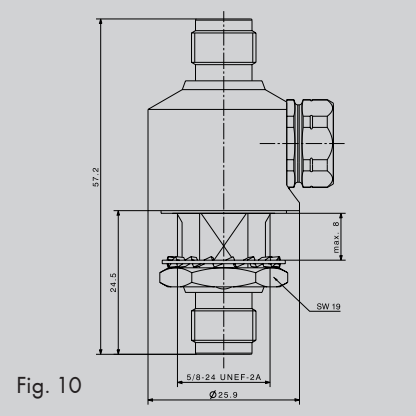


Fig. 10

All mounting holes are shown on pages 34 – 35.

Series 3401

Coaxial, characteristic impedance 75 Ω

Gas discharge tube normally to be selected and ordered separately – refer to page 134 - 137

H+S type	Frequency range (MHz)	Connectors Unprotected/protected side* If bulkhead mount version, side of bulkhead marked «b».	Mounting/ grounding MH - hole for «b» M - screw	RL min.	IL max.	Water-proof	Weight	Figure
3401.02.A	DC–400	BNC(f)-BNC(f), b	MH 12	20 dB	0.1 dB	IP20	79 g	Fig. 1
	400-1000			15 dB	0.2 dB			
3401.18.A	DC-500	N(f)-N(f), b	MH12	20.8 dB	0.1 dB	IP65	92 g	Fig. 2
3401.99.0020**	DC-1000	F(f)-F(f), b	MH 12	–	0.2 dB	IP65	73 g	Fig. 3

* Recommendation only, reverse installation possible without any impact on performance

** Gas discharge tube included (230 V, 9071.99.0547)

All dimensions in mm

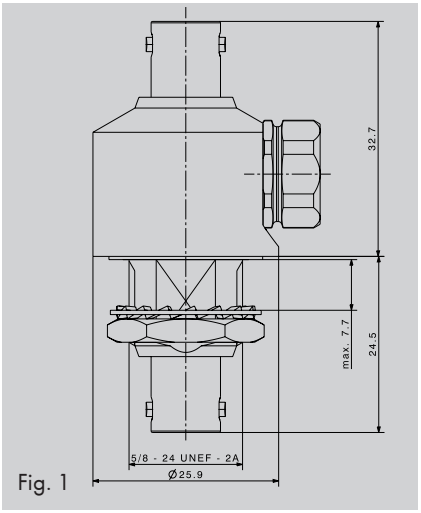


Fig. 1

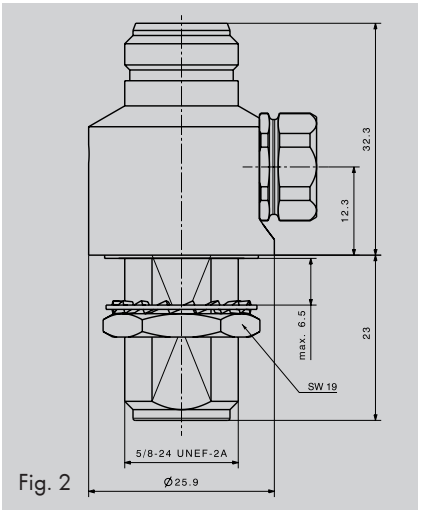


Fig. 2

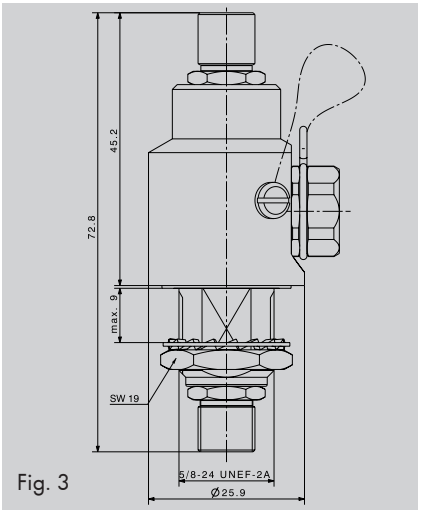


Fig. 3

All mounting holes are shown on pages 34 – 35.

Series 3401

Triaxial, characteristic impedance 50 Ω

Gas discharge tube normally to be selected and ordered separately – refer to page 134 - 137

H+S type	Frequency range (MHz)	Connectors Unprotected/protected side* If bulkhead mount version, side of bulkhead marked «b».	Mounting/ grounding MH - hole for «b» M - screw	RL min.	IL max.	Water-proof	Weight	Figure
3401.17.L	DC–1000	N(f)-N(f), b	MH74	20 dB	0.1 dB	IP20	330 g	Fig. 1

* Recommendation only, reverse installation possible without any impact on performance

All dimensions in mm

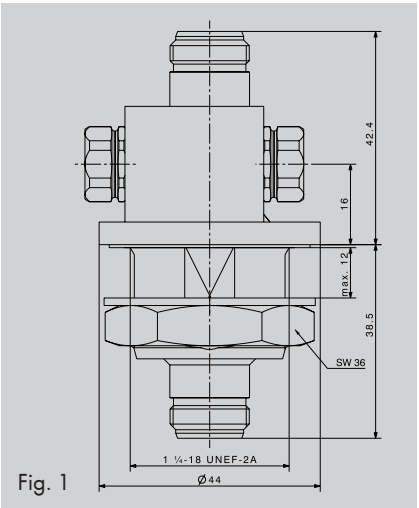
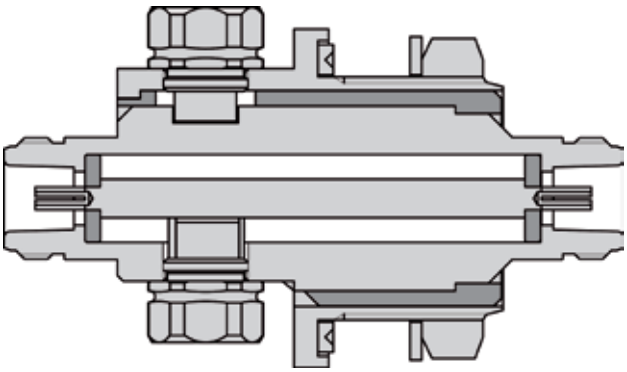


Fig. 1

Triaxial structure illustration



All mounting holes are shown on pages 34 – 35.

Series 3402 lightning EMP protectors

Gas discharge tube (GDT) technology up to 2.5 GHz

Description

HUBER+SUHNER gas discharge tube protectors make the best of the traditional spark gap protection principle for general applications in electronics and adapt it perfectly to RF coaxial line applications.
At their heart are specially designed gas discharge tubes. The available product range of GDT's enables a selection according to the RF transmission power with an optimum protection performance.
A very important feature of the GDT protectors is the possibility to DC/AC power outdoor equipment via coaxial cable.

Series 3402 products can be used broadband from DC to 2 GHz or even higher.
They are generally designed as coaxial feed-throughs which allow the customer to build up a protected area according to the recommended and well-proven protection zone principle of IEC 62305.
HUBER+SUHNER GDT protectors are designed such that the gas discharge tubes can be easily exchanged for new operation conditions or replaced in the case of a necessary service.

Features

- Broadband DC to 2.5 GHz
- DC transmission
- Gas discharge tube replaceable
- Easy maintenance
- SEMPER™ self-extinguishing functionality optional (see page 113)

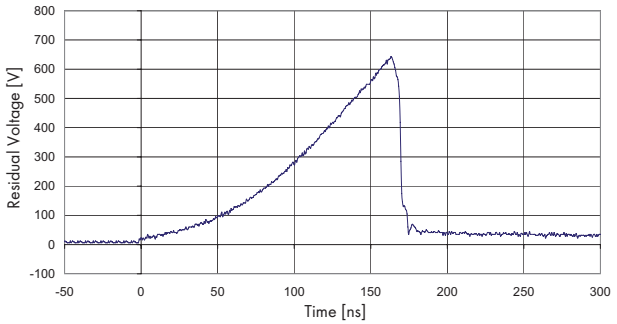
Specifications

Electrical data	Requirements
RF:	
Impedance	50 or 75 Ω
Frequency range	DC – 2.5 GHz (some types different according to shown specification, but 2 GHz min.)
RL*	20 dB min. (exception F connectors)
IL*	0.2 dB max. (exception F connectors)
RF power transmission	according to selected gas discharge tube – refer to page 134
Protection:	
Surge current handling capability	30 kA once and 20 kA multiple (8/20 µs test pulse) 8 kA (10/350 µs test pulse)
Residual pulse voltage and energy	for typical values refer to the following diagram

* With 230 V gas discharge tube (9071.99.0547)

Typical residual pulse for series 3402*,
test pulse acc. to IEC 61000-4-5
1.2/50 µs 4 kV; 8/20 µs 2 kA:

Residual pulse voltage: typ. 650 V
Residual pulse energy: typ. 350 µJ



* With 230 V gas discharge tube (9071.99.0547)

Mechanical data	Requirements
Coupling nut torque force	according to IEC/MIL (refer to page 30)
Durability (matings)	500 min.
Bulkhead mounting torque force: Mounting hole diameter 19 mm/ 3/4 " max. Larger than 19 mm	 20 Nm (14.7 ft-lb) min. / 25 Nm (18.4 ft-lb) max. 35 Nm (25.8 ft-lb) min. / 44 Nm (32.3 ft-lb) max.

Environmental data	Requirements/test conditions
Operation temperature range	- 40 °C...+ 85 °C/ - 40 °F...+ 185 °F
Waterproof degree (IEC 60529)	according to shown product specification, data refer to the coupled state
Temperature shock	MIL-STD-202, Meth. 107, Cond. B
Moisture resistance	MIL-STD-202, Meth. 106
Vibration	MIL-STD-202, Meth. 204, Cond. D

The product is designed to meet the cited test procedures. Any additional or different requirements arising from specific applications or environmental conditions not covered by the test specifications mentioned above are subject to request and need to be confirmed by the single product detail specification.

We recommend additional taping for long term outdoor applications in any case.

Material data Component part	Material	Plating
Housings	brass	SUCOPLATE®
Male contacts	brass	gold or silver plating
Female contacts	CuBe2	gold or silver plating
Insulators	PTFE	
Gaskets	elastomer rubber	

Series 3402

Characteristic impedance 50 Ω

Gas discharge tube normally to be selected and ordered separately – refer to page 134 - 137

H+S type	Frequency range (MHz)	Connectors Unprotected/protected side* If bulkhead mount version, side of bulkhead marked «b».	Mounting/ grounding MH - hole for «b» M - screw	RL min.	IL max.	Water-proof	Weight	Figure
3402.00.0032	DC-2000	7/16(f)-N(f), b	MH12, M8	20 dB	0.2 dB	IP65	190 g	Fig. 1
3402.17.0043	DC-2500	N(m)-N(f), b	MH12, M8	20 dB	0.2 dB	IP65	230 g	Fig. 2
3402.17.0044	DC-2500	N(f)-N(f), b	MH12, M8	20 dB	0.2 dB	IP65	230 g	Fig. 3
3402.17.0072-EX**	DC-2500	7/16(f)-7/16(f)	MH25	20 dB	0.2 dB	IP65	126 g	Fig. 4
3402.17.A	DC-2500	N(f)-N(f), b	MH25	20 dB	0.2 dB	IP65	126 g	Fig. 5
3402.17.C	DC-2500	N(m)-N(f), b	MH25	20 dB	0.2 dB	IP65	155 g	Fig. 6
3402.41.0037	DC-2500	7/16(m)-7/16(f), b	MH74, M8	20 dB	0.2 dB	IP65	450 g	Fig. 7
3402.41.0038	DC-2500	7/16(f)-7/16(f), b	MH74, M8	20 dB	0.2 dB	IP65	450 g	Fig. 8
3402.41.0056-EX**	DC-2500	7/16(f)-7/16(f)	MH72	20 dB	0.2 dB	IP65	390 g	Fig. 9
3402.41.A	DC-2500	7/16(f)-7/16(f), b	MH72	20 dB	0.2 dB	IP65	387 g	Fig. 10
3402.99.0003	DC-2500	N-R(f)-N-R(f)***	MH25	20 dB	0.2 dB	IP65	126 g	Fig. 11

* Recommendation only, reverse installation possible without any impact on performance

** SEMPER™ type, GDT unit included – for detailed information see page 113

*** Reverse interface (inner conductor pin, outer conductor as standard N(f))

All mounting holes are shown on pages 34 – 35.

All dimensions in mm

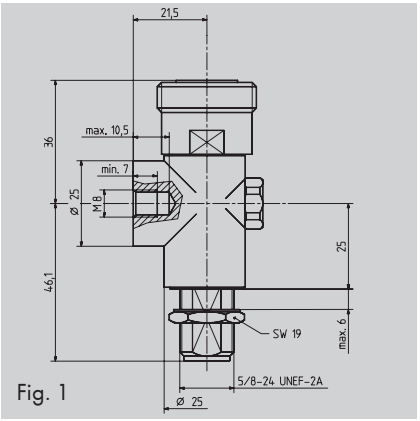


Fig. 1

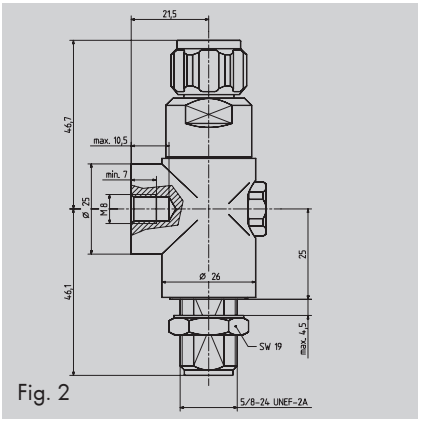


Fig. 2

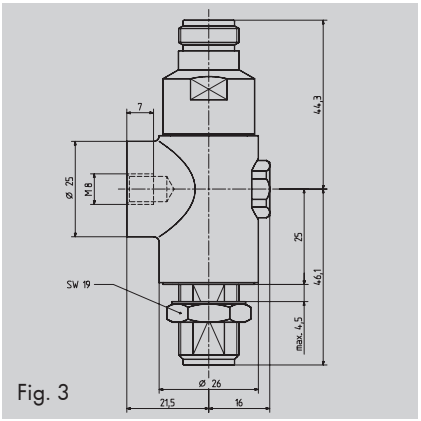


Fig. 3

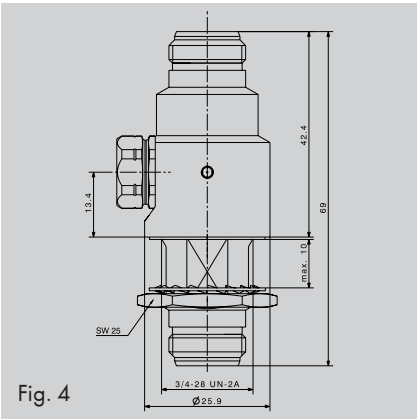


Fig. 4

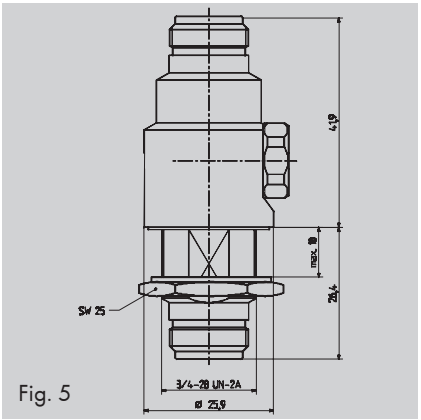


Fig. 5

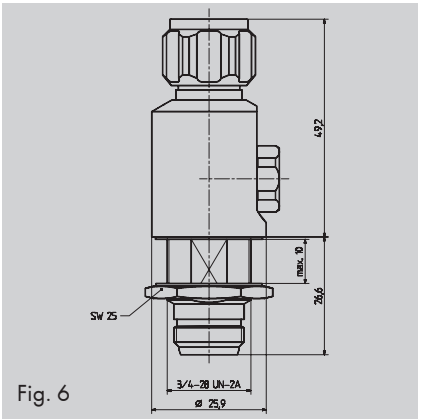


Fig. 6

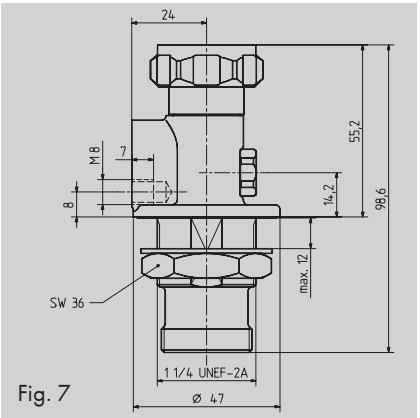


Fig. 7

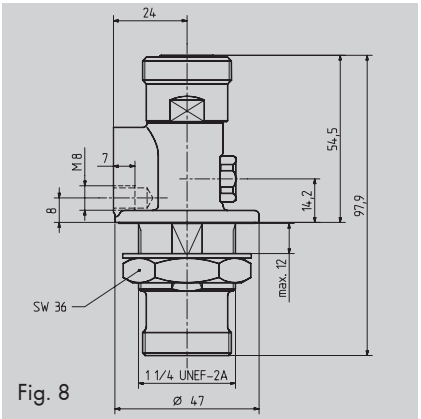


Fig. 8

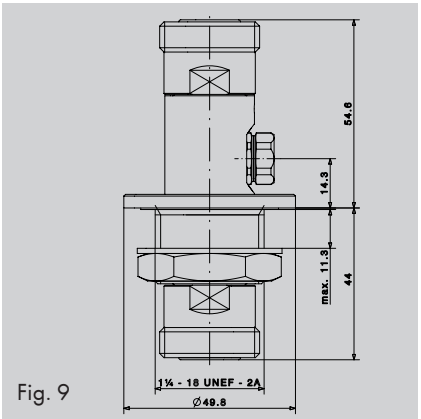


Fig. 9

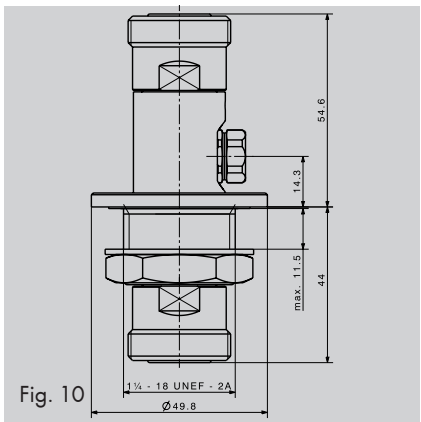


Fig. 10

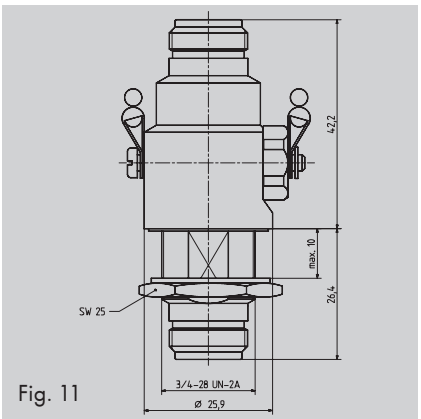


Fig. 11

Series 3402

Characteristic impedance 75 Ω

Gas discharge tube normally to be selected and ordered separately – refer to page 134 - 137

H+S type	Frequency range (MHz)	Connectors Unprotected/protected side* If bulkhead mount version, side of bulkhead marked «b».	Mounting/ grounding MH - hole for «b» M - screw	RL min.	IL max.	Water-proof	Weight	Figure
3402.18.A	DC–1500	N(f)-N(f), b	MH25	16.5 dB	0.2 dB	IP65	126 g	Fig. 1
	1500-2000			15.5 dB	0.2 dB			
3402.27.0001	DC–1500	TNC(f)-TNC(f), b	MH25	16.5 dB	0.2 dB	IP65	195 g	Fig. 2
	1500-2000			15.5 dB	0.2 dB			
3402.99.0004	0–1500	F(f)-F(f), b	MH25	--	0.5 dB	IP54	126 g	Fig. 3

* recommendation only, reverse installation possible without any impact on performance

All dimensions in mm

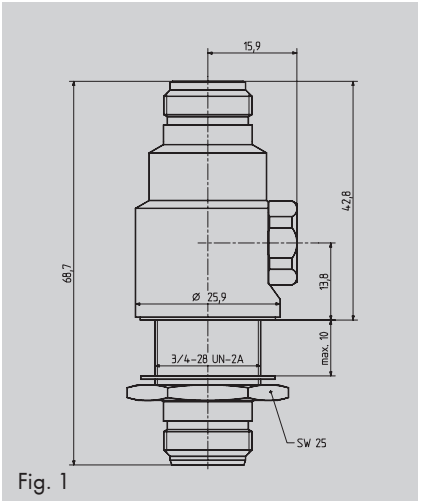


Fig. 1

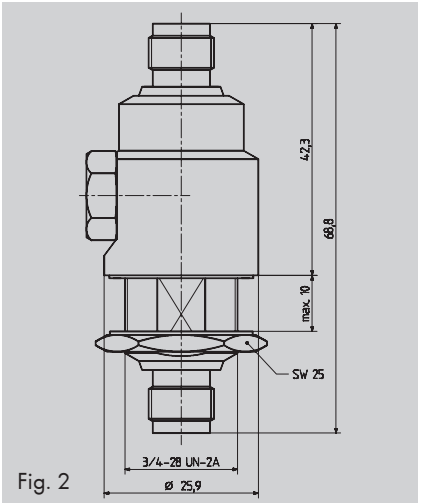


Fig. 2

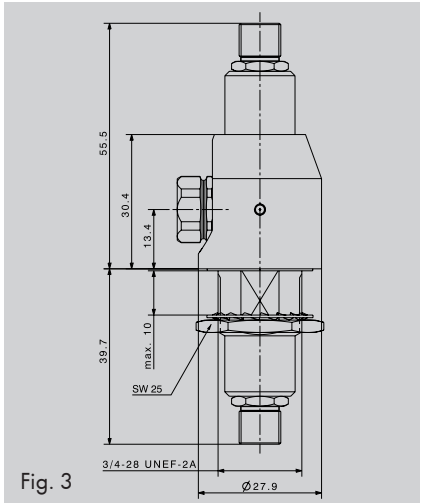


Fig. 3

All mounting holes are shown on pages 34 – 35.

Space for your notes

Series 3403 lightning EMP protectors

Fine protector hybrid technology

Description

HUBER+SUHNER fine protectors are a very special group of lightning EMP protectors which provide a very high degree of protection, especially for applications with DC powering via coaxial cable. They offer an extremely effective surge pulse reduction, which makes them suitable to protect even very sensitive microelectronic circuits, e.g. GPS timing systems for CDMA mobile communications systems.

Features

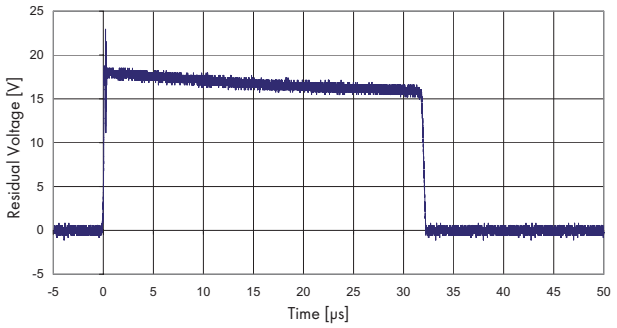
- Rugged, stable and reliable fine protectors with very low residual pulse energy
- DC bypass function
- Easy installation – screw or bulkhead
- Full lightning protection as standard gas discharge tube (GDT) protectors
- Gas discharge tube included
- Waterproof IP 65

Specifications

Electrical data	Requirements
RF:	
Impedance	50 Ω
Frequency range	650 to 2500 MHz
RL	20 dB min.
IL	0.5 dB max.
RF power transmission	50 W max.
DC bypass voltage	6 or 15 V, according to product detail specification (data sheet)
DC bypass current	3 A max.
DC bypass resistance	1 Ω max.
Protection:	
Surge current handling capability	30 kA once and 20 kA multiple (8/20 µs test pulse) for cube design 8 kA (10/350 µs test pulse) 20 kA once and 10 kA multiple (8/20 µs test pulse) for barrel design
Residual pulse energy	for typical values refer to the following diagram

Typical residual pulse for series 3403,
test pulse acc. to IEC 61000-4-5
1.2/50 µs 4 kV; 8/20 µs 2 kA:

Residual pulse voltage: bypass voltage +20 %
Residual pulse energy: typ. 6 µJ



Mechanical data	Requirements
Coupling nut torque force	according to IEC/MIL (refer to page 30)
Durability (matings)	500 min. / 100 min. for H+S types where interface material is of aluminium
Bulkhead mounting torque force: Mounting hole diameter 19 mm/ 3/4" max.	20 Nm (14.7 ft-lb) min. / 25 Nm (18.4 ft-lb) max.

Environmental data	Requirements/test conditions
Operation temperature range	- 40 °C...+ 85 °C/ - 40 °F...+ 185 °F
Waterproof degree (IEC 60529)	IP 65 min., according to shown product specification, data refer to the coupled state
Temperature shock	MIL-STD-202, Meth. 107, Cond. A, - 55 °C/+ 85 °C
Moisture resistance	MIL-STD-202, Meth. 106, 10 cycles
Vibration	MIL-STD-202, Meth. 204, Cond. A, 10 G, 10-500 Hz

The product is designed to meet the cited test procedures. Any additional or different requirements arising from specific applications or environmental conditions not covered by the test specifications mentioned above are subject to request and need to be confirmed by the single product detail specification.

We recommend additional taping for long term outdoor applications in any case.

Material data Component part	Material	Plating
Housing	aluminium	passivated
Connector bodies	brass	SUCOPLATE®
Male contacts	brass	gold or silver plating
Female contacts	CuBe2	gold or silver plating
Insulators	PTFE	
Gaskets	elastomer rubber	

Series 3403

H+S type	Bypass voltage (V)	Connectors Unprotected/protected side If bulkhead mount version, side of bulkhead marked «b».	Mounting/ grounding MH - hole for «b» M - screw	RL min.	IL max.	Water-proof	Weight	Fig-ure
3403.17.0060**/***b)	6	N(f)-N(f), b	MH12	26 dB	0.3 dB	IP67	85	Fig. 1
3403.17.0063**/***b)	6	N(f), b-N(m)	MH12	26 dB	0.3 dB	IP67	90	Fig. 2
3403.17.0042*c)	15	N(f)-N(f)	2xM4	20.8 dB	0.5 dB	IP65	330 g	Fig. 3
3403.17.0049* c)	15	N(m)-N(f), b	MH119, 2xM4	20.8 dB	0.5 dB	IP65	330 g	Fig. 4
3403.17.0050* c)	15	N(f)-N(f), b	MH119, 2xM4	20.8 dB	0.5 dB	IP65	330 g	Fig. 5

Important:

* Gas discharge tube included (90 V, 9071.99.0548)

** Permanently installed GDT

*** Material: aluminium

b) = barell design, frequency range 800 - 2500 MHz

c) = cube design, frequency range 650 - 2500 MHz

All mounting holes are shown on pages 34 – 35.

All dimensions in mm

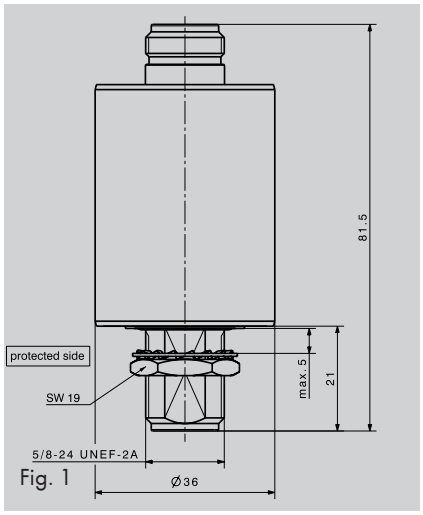


Fig. 1

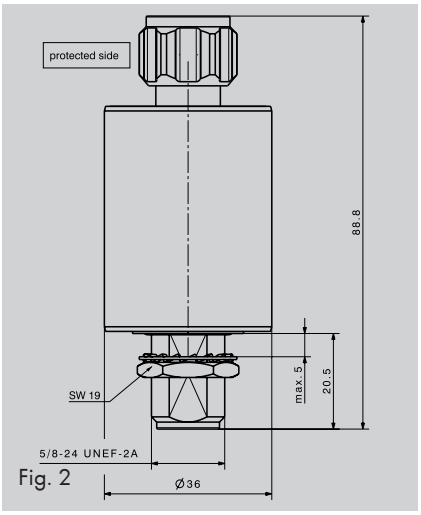


Fig. 2

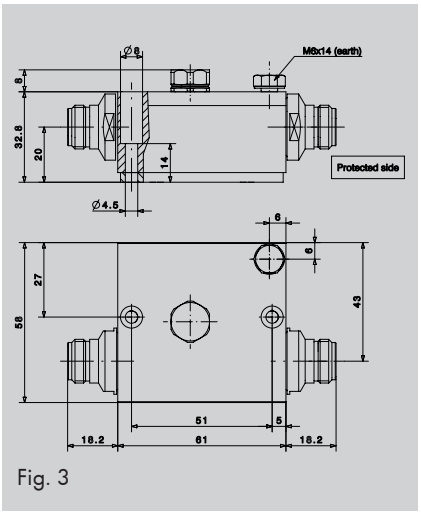


Fig. 3

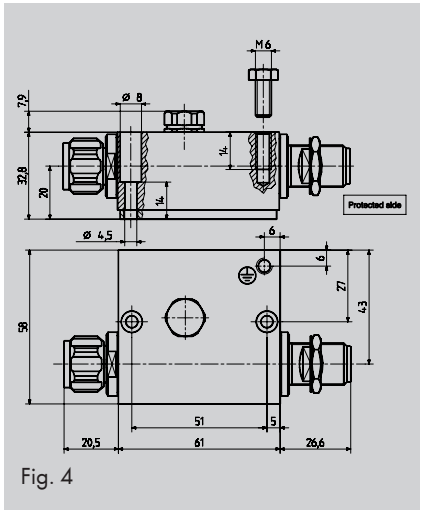


Fig. 4

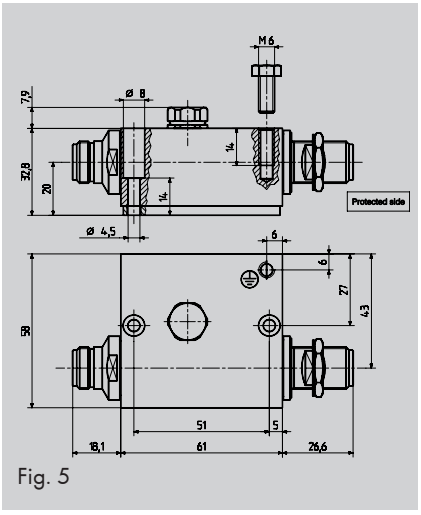


Fig. 5

All mounting holes are shown on pages 34 – 35.

Series 3404 lightning EMP protectors

Miniature gas discharge tube (GDT) technology

Description

HUBER+SUHNER miniature gas discharge tube protectors are designed to protect against NEMP (Nuclear Electromagnetic Pulse) and other electromagnetic interferences.
The special design guarantees an excellent dynamic protection performance. It includes a fixed integrated gas discharge tube.

Miniature GDT protectors have a bulkhead feed-through design and can be easily installed instead of a standard waterproof bulkhead coaxial connector to harden existing equipment.
For lightning protection there have to be applied different or at least additional further protectors.

Features

- Broadband DC to 2.0 GHz
- DC transmission
- Surge current handling capability 2.5 kA
- Easy in-line or panel installation
- Turn-on-time < 2 ns (1 kV/ns)

Specifications

Electrical data	Requirements
RF:	
Impedance	50 Ω
Frequency range	DC to 2 GHz, according to product detail specification
RL	according to product specification (data sheet)
IL	according to product specification (data sheet)
DC + RF power transmission	DC: 50 W max. 1 GHz: 25 W max. 2 GHz: 12 W max.
Protection:	
Surge current handling capability	2.5 kA multiple (8/20 µs test pulse)

Mechanical data	Requirements
Coupling nut torque force	according to IEC/MIL
Durability (matings)	500 min.
Bulkhead mounting torque force: Mounting hole diameter 19 mm/ 3/4" max.	20 Nm (14.7 ft-lb) min. / 25 Nm (18.4 ft-lb) max.

Environmental data	Requirements/test conditions
Operation temperature range	- 40 °C...+ 85 °C/ - 40 °F...+ 185 °F
Waterproof degree (IEC 60529)	according to shown product specification, data refer to the coupled state
Temperature shock	MIL-STD-202, Meth. 107, Cond. B
Moisture resistance	MIL-STD-202, Meth. 106
Vibration	MIL-STD-202, Meth. 204, Cond. D

The product is designed to meet the cited test procedures. Any additional or different requirements arising from specific applications or environmental conditions not covered by the test specifications mentioned above are subject to request and need to be confirmed by the single product detail specification.

Material data Component part	Material	Plating
Housings	brass	SUCOPLATE®
Male contacts	brass	gold plating
Female contacts	CuBe2	gold plating
Insulators	PTFE	
Gaskets	elastomer rubber	

Series 3404

H+S type	Frequency range (MHz)	Connectors Unprotected/protected side* If bulkhead mount version, side of bulkhead marked «b».	Mounting/ grounding MH - hole for «b» M - screw	RL min.	IL max.	Water-proof	Weight	Figure
3404.00.0006	DC-1000	TNC(f)-MCX(f), b	MH4	26 dB	0.3 dB	IP20	12 g	Fig. 1
	1000-2000			17 dB	0.6 dB			
3404.26.0002	DC-1000	TNC(f)-TNC(f), b	MH4	23 dB	0.2 dB	IP20	28 g	Fig. 2
	1000-2000			17 dB	0.3 dB			

* Recommendation only, reverse installation possible without any impact on performance

All dimensions in mm

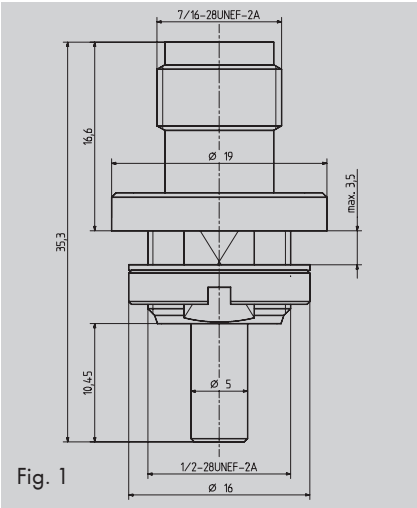


Fig. 1

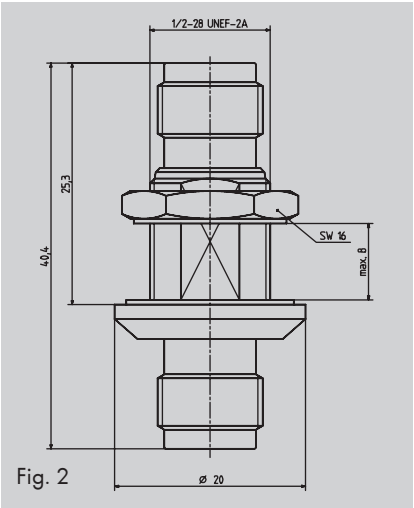


Fig. 2

All mounting holes are shown on pages 34 – 35.

Space for your notes

Series 3406 lightning EMP protectors

Slim line gas discharge tube (GDT) technology

Description

HUBER+SUHNER series 3406 Slim line protectors provide surge protection for any electronic equipment connected to coaxial lines up to 5.8 GHz. The gas discharge tube protection principle supports simultaneous transmission of RF, data and DC. The gas discharge tubes are fixed integrated. The protectors can handle any induced surge signals but partial lightning current up to the specified current handling capability only. For higher lightning current handling refer to our gas discharge tube (GDT) protector series 3401 and 3402. Multi-carrier applications with high RF peak power and special passive intermodulation requirements are covered by series 3409.

Features

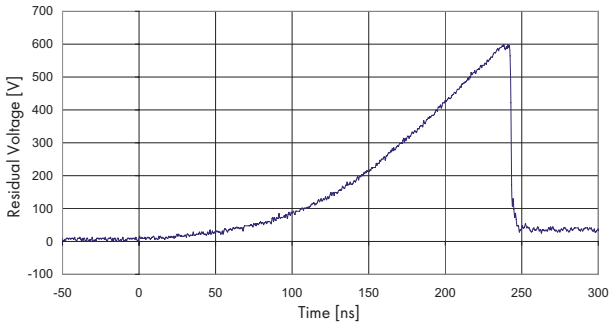
- Broadband operation from DC up to 5.8 GHz (BNC = DC up to 4 GHz)
- DC transmission for outdoor powering
- Slim inline design
- Permanently installed gas discharge tube
    - GDT static sparkover voltage typ. 150 to 250 V (100 V/s)
    - GDT dynamic sparkover voltage typ. ≤ 700 V (1 kV/µs)

Specifications

Electrical data	Requirements
RF:	
Impedance	50 Ω
Frequency range	generally DC to 5.8 GHz, but refer to product detail specification (data sheet)
RL	according to product detail specification (data sheet)
IL	according to product detail specification (data sheet)
RF power transmission	60 W max.
Protection:	
Surge current handling capability	10 kA once and 5 kA multiple (8/20 µs test pulse) 2.5 kA (10/350 µs test pulse)
Residual pulse voltage and energy	for typical values refer to the following diagram

Typical residual pulse for series 3406,
test pulse acc. to IEC 61000-4-5
1.2/50 µs 4 kV; 8/20 µs 2 kA:

Residual pulse voltage: typ. 600 V
Residual pulse energy: typ. 350 µJ



Mechanical data	Requirements
Coupling nut torque force	according to IEC/MIL (refer to page 30)
Durability (matings)	500 min.
Bulkhead mounting torque force: Mounting hole diameter 19 mm/ 3/4" max.	20 Nm (14.7 ft-lb) min. / 25 Nm (18.4 ft-lb) max.

Environmental data	Requirements/test conditions
Operation temperature range	- 40 °C...+ 85 °C/ - 40 °F...+ 185 °F
Waterproof degree (IEC 60529)	according to shown product specification, data refer to the coupled state
Temperature shock	MIL-STD-202, Meth. 107, Cond. B
Moisture resistance	MIL-STD-202, Meth. 106
Vibration	MIL-STD-202, Meth. 204, Cond. D

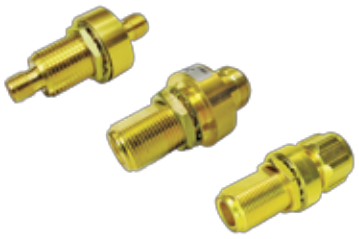
The product is designed to meet the cited test procedures. Any additional or different requirements arising from specific applications or environmental conditions not covered by the test specifications mentioned above are subject to request and need to be confirmed by the single product detail specification.

We recommend additional taping for long term outdoor applications in any case.

Material data Component part	Material	Plating
Housings	brass	silver/gold or SUCOPLATE
Male contacts	brass	gold plating
Female contacts	CuBe2	gold plating
Insulators	PTFE	
Gaskets	elastomer rubber	

Series 3406

Broadband, frequency range DC - 5800 MHz



H+S type	Frequency range (GHz)	Connectors Unprotected/protected side* If bulkhead mount version, side of bulkhead marked «b».	Mounting/ grounding MH - hole for «b» M - screw	RL min.	IL max.	Water-proof	Weight	Figure
3406.01.0003	DC-4.0	BNC(m)-BNC(f), b	MH4	20 dB	0.2 dB	IP20	45 g	Fig. 1
3406.17.0027	DC-4.0	N(f)-N(f), b	MH24	20 dB	0.2 dB	IP68	75 g	Fig. 2
3406.17.0028	DC-4.0	N(m)-N(f), b	MH24	20 dB	0.2 dB	IP68	75 g	Fig. 3
3406.17.0009	DC-5.8	N(f)-N(f), b	MH24	20 dB	0.2 dB	IP65	90 g	Fig. 4
3406.17.0012	DC-5.8	N(m)-N(f), b	MH24	20 dB	0.2 dB	IP65	95 g	Fig. 5
3406.19.0003	DC-5.8	SMA(f)-SMA(f), b	MH3	20 dB	0.2 dB	IP65	50 g	Fig. 6
3406.19.0004	DC-5.8	SMA(m)-SMA(f), b	MH3	20 dB	0.2 dB	IP65	50 g	Fig. 7
3406.26.0004	DC-5.8	TNC(m)-TNC(f), b	MH4	20 dB	0.2 dB	IP20	45 g	Fig. 8

* Recommendation only, reverse installation possible without any impact on performance

All mounting holes are shown on pages 34 – 35.

All dimensions in mm

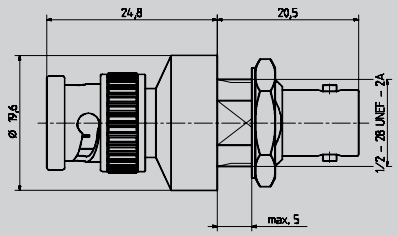


Fig. 1

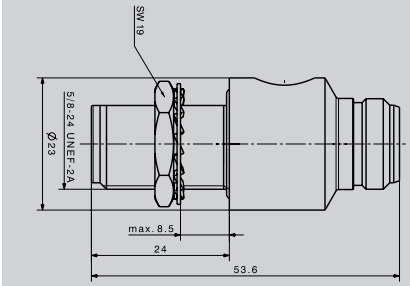


Fig. 2

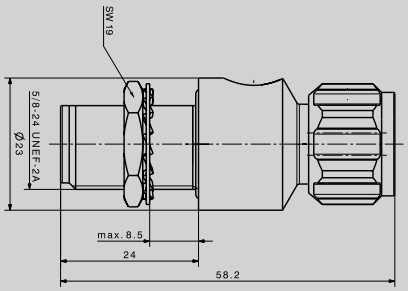


Fig. 3

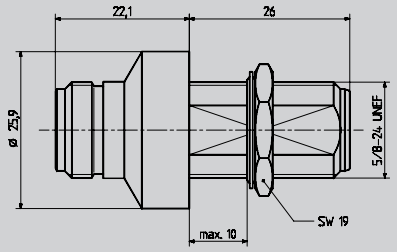


Fig. 4

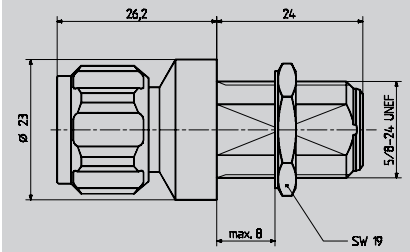


Fig. 5

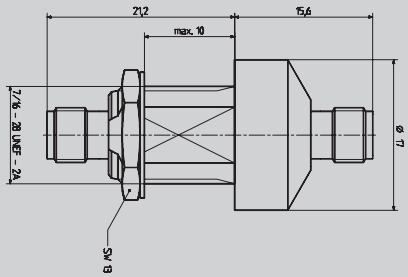


Fig. 6

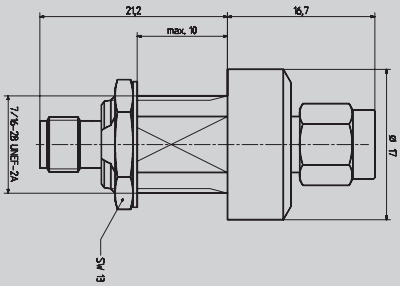


Fig. 7

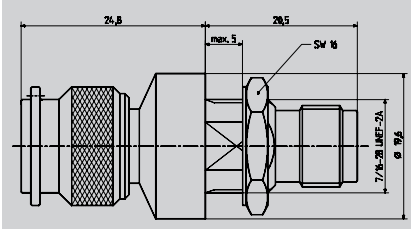


Fig. 8

Series 3407 lightning EMP protectors

Quarter-wave stub technology with integrated high-pass filter

Description

HUBER+SUHNER quarter-wave lightning protectors with integrated high-pass filter feature an added useful RF component to the proven premium standard quarter-wave protector design. Thus, they can offer an essentially improved protection performance.

Features

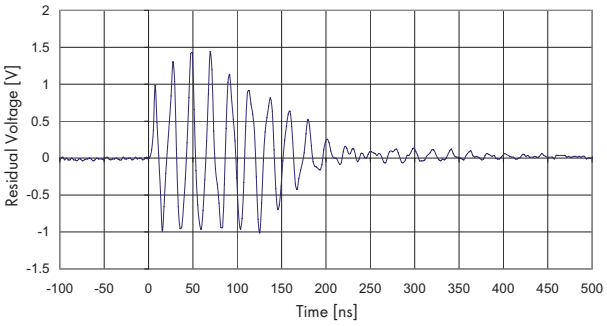
- Residual voltage reduced by 80% compared to standard types of series 3400
- Residual energy reduced up to factor 2000 (more than 99.9%) compared to the series 3400
- DC-blocking on protected side of the device (galvanic isolation)
- Available within 70 MHz to 18 GHz max. (N, SMA)

Specification

Electrical data	Requirements
RF:	
Impedance	50 Ω
Frequency range	according to product detail specification,
RL	20 dB min.
IL	0.2 dB max.
PIM	according to product detail specification (data sheet)
RF power transmission	refer to data in section Definitions and Terms «RF power and DC ratings» and product detail specification (data sheet)
Protection:	
Surge current handling capability (stub design)	N: 50 kA, DIN 7/16: 50 to 100 kA multiple (8/20 µs test pulse) N: 25 kA, DIN 7/16: 50 kA (10/350 µs test pulse) refer to product detail specification (data sheet)
Residual pulse voltage and energy	for typical values refer to the following diagram

Typical residual pulse for series 3407 (for GSM band), test pulse acc. to IEC 61000-4-5
1.2/50 µs 4 kV; 8/20 µs 2 kA:

Residual pulse voltage: typ. 1.5 V
Residual pulse energy: typ. 3 nJ



Mechanical data	Requirements
Coupling nut torque force	according to IEC/MIL (refer to page 30)
Durability (matings)	500 min. / 100 min. for H+S types made of aluminium
Bulkhead mounting torque force: Mounting hole diameter 19 mm/ 3/4" max. Larger than 19 mm	 20 Nm (14.7 ft-lb) min. / 25 Nm (18.4 ft-lb) max. 35 Nm (25.8 ft-lb) min. / 44 Nm (32.2 ft-lb) max.

Environmental data	Requirements/test conditions
Operation temperature range	- 40 °C...+ 85 °C/ - 40 °F...+ 185 °F
Waterproof degree (IEC 60529)	IP 65 min., according to shown product specification, data refer to the coupled state
Temperature shock	MIL-STD-202, Meth. 107, Cond. B
Moisture resistance	MIL-STD-202, Meth. 106
Vibration	MIL-STD-202, Meth. 204, Cond. D

The product is designed to meet the cited test procedures. Any additional or different requirements arising from specific applications or environmental conditions not covered by the test specifications mentioned above are subject to request and need to be confirmed by the single product detail specification.

We recommend additional taping for long term outdoor applications in any case.

Material data Component part	Material	Plating
Housings	brass or aluminium	SUCOPLATE® or passivated
Male contacts	brass	gold or silver plating
Female contacts	CuBe2	gold or silver plating
Insulators	PTFE	
Gaskets	elastomer rubber	

Series 3407

Frequency range 60 MHz to 300 MHz

H+S type	Frequency range (MHz)	Connectors Unprotected/protected side If bulkhead mount version, side of bulkhead marked «b».	Mounting/ grounding MH - hole for «b» M - screw	RL min.	IL max.	Water-proof	Weight	Figure
3407.17.0022	74–180	N(f)-N(f), b	MH74,M8	20 dB	0.15 dB	IP 66	580 g	Fig. 1
3407.17.0054	140–180	N(m)-N(f), b	MH12,M8	20 dB	0.20 dB	IP 65	380 g	Fig. 2
3407.17.0026	174–280	N(m)-N(f), b	MH74,M8	20 dB	0.10 dB	IP 65	550 g	Fig. 3

All dimensions in mm

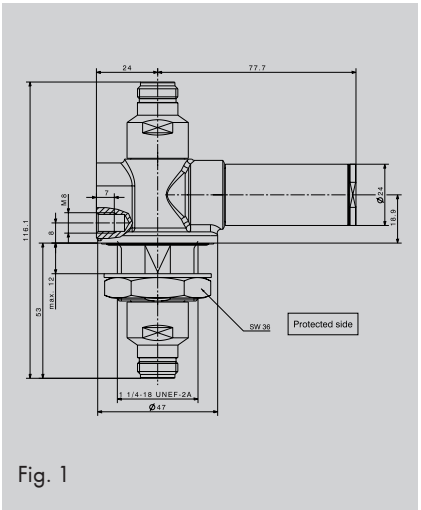


Fig. 1

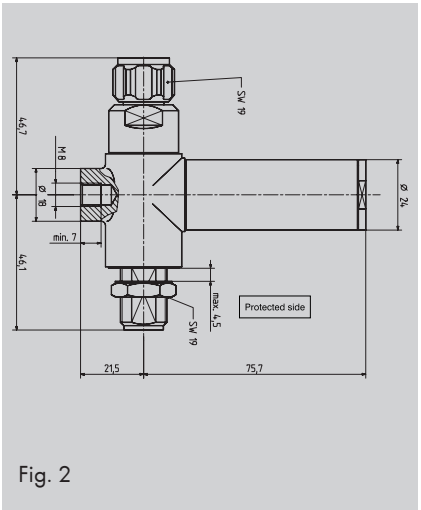


Fig. 2

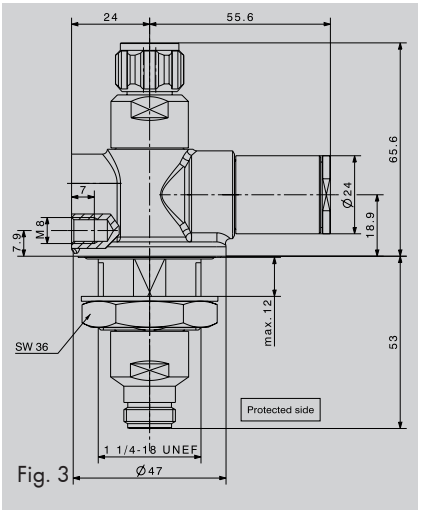


Fig. 3

All mounting holes are shown on pages 34 – 35.

Series 3407

Frequency range 300 MHz to 800 MHz

H+S type	Frequency range (MHz)	Connectors Unprotected/protected side If bulkhead mount version, side of bulkhead marked «b».	Mounting/ grounding MH - hole for «b» M - screw	RL min.	IL max.	Water-proof	Weight	Figure
3407.41.0038	380–512	7/16(m)-7/16(f)	M8	20 dB	0.2 dB	IP 65	400 g	Fig. 1

All dimensions in mm

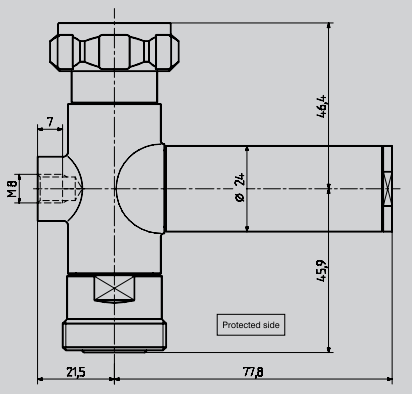


Fig. 1

All mounting holes are shown on pages 34 – 35.

Series 3407

Broadband, frequency range 800 MHz to 6000 MHz

H+S type *	Frequency range(MHz)	Connectors Unprotected/protected side If bulkhead mount version, side of bulkhead marked «b».	Mounting/ grounding MH - hole for «b» M - screw	RL min.	IL max.	Water-proof	Weight	Figure
3407.17.0067	806-2500	N(f)-N(f), b	MH110, M6	26.0 dB	0.10 dB	IP65	460 g	Fig. 1
3407.17.0068	806-2500	N(m)-N(f), b	MH110, M6	26.0 dB	0.10 dB	IP65	440 g	Fig. 2
3407.17.0085**	2000-6000	N(m)-N(f), b	MH170	20 dB	0.2 dB	IP68	85 g	Fig. 3
3407.41.0039	806-2500	7/16(m)-7/16(f), b	MH110, M6	26.0 dB	0.10 dB	IP65	450 g	Fig. 4
3407.41.0042	806-2500	7/16(f)-7/16(f), b	MH110, M6	26.0 dB	0.10 dB	IP65	590 g	Fig. 5

* Inline design
** Material: aluminium

All mounting holes are shown on pages 34 – 35.

All dimensions in mm

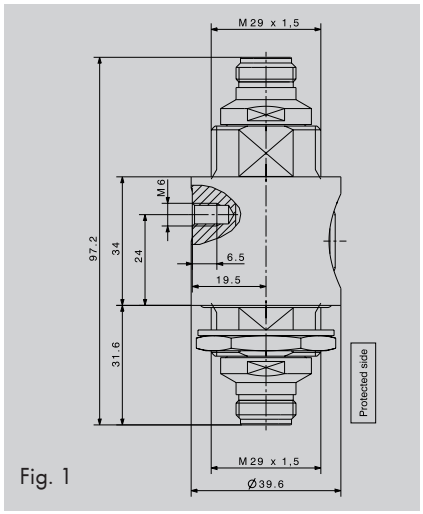


Fig. 1

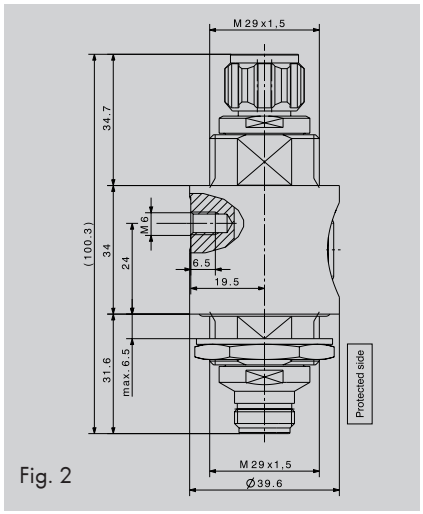


Fig. 2

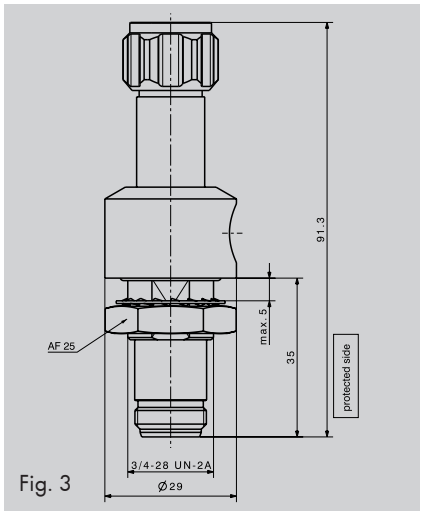


Fig. 3

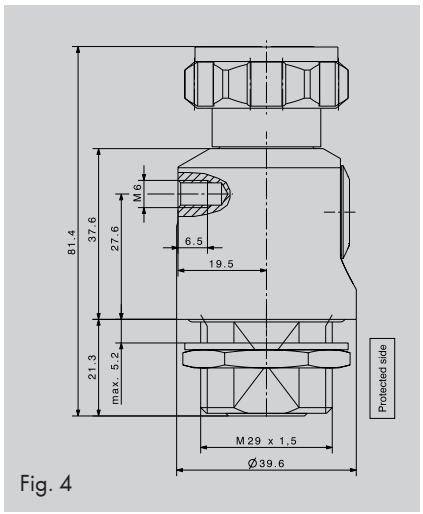


Fig. 4

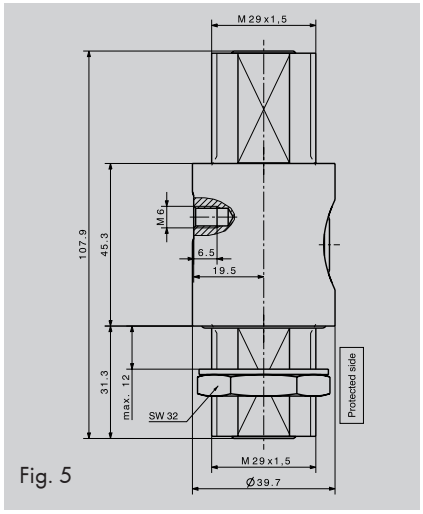


Fig. 5

Series 3407

Series 3408 lightning EMP protectors

Gas discharge tube (GDT) technology with integrated high-pass filter

Description

HUBER+SUHNER gas discharge tube (GDT) protectors with inte-grated high-pass filter feature an added useful RF component to the proven standard GDT protectors. Thus, they offer a much better protection performance.

The design allows a DC injection facility to be integrated as well.
Gas discharge tubes can be easily exchanged for new operation conditions or replaced in the case of a necessary service.

Features

- Residual voltage reduced by 40% compared to standard GDT protectors of series 3401/3402
- Residual energy reduced by approx. 60 % compared to the series 3401/3402
- Decoupling between protector and possibly deployed, succeeding surge protective device or electronic components like a transient voltage suppressor (diode or MOV)
- DC-blocking on protected side of the device (galvanic isolation)

Specifications

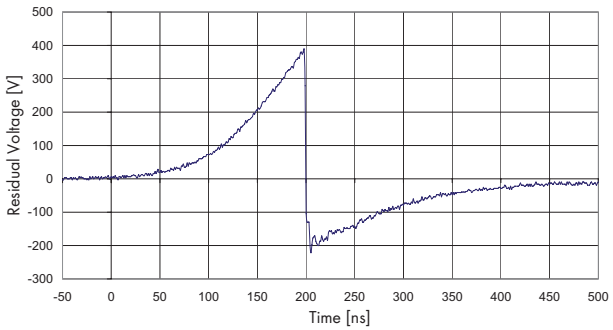
Electrical data	Requirements
RF:	
Impedance	50 Ω
Frequency range	25 – 1000 MHz or 2000 MHz min.
RL*	20 dB min.
IL*	0.2 dB max.
RF power transmission	according to selected gas discharge tube – refer to page 134 - 137
Protection:	
Surge current handling capability	30 kA once and 20 kA multiple (8/20 µs test pulse) 8 kA (10/350 µs test pulse)
Residual pulse voltage and energy	for typical values refer to the following diagram

* With 230 V gas discharge tube (9071.99.0547)

Typical residual pulse for series 3408*,
test pulse acc. to IEC 61000-4-5
1.2/50 µs 4 kV; 8/20 µs 2 kA:

Residual pulse voltage: typ. 400 V
Residual pulse energy: typ. 150 µJ

* with 230 V gas discharge tube (9071.99.0547)



Mechanical data	Requirements
Coupling nut torque force	according to IEC/MIL (refer to page 30)
Durability (matings)	500 min.
Bulkhead mounting torque force: Mounting hole diameter 19 mm/ 3/4" max. Larger than 19 mm	 20 Nm (14.7 ft-lb) min. / 25 Nm (18.4 ft-lb) max. 35 Nm (25.8 ft-lb) min. / 44 Nm (32.2 ft-lb) max.

Environmental data	Requirements/test conditions
Operation temperature range	- 40 °C...+ 85 °C/ - 40 °F...+ 185 °F
Waterproof degree (IEC 60529)	according to shown product specification, data refer to the coupled state
Temperature shock	MIL-STD-202, Meth. 107, Cond. B
Moisture resistance	MIL-STD-202, Meth. 106
Vibration	MIL-STD-202, Meth. 204, Cond. D

The product is designed to meet the cited test procedures. Any additional or different requirements arising from specific applications or environmental conditions not covered by the test specifications mentioned above are subject to request and need to be confirmed by the single product detail specification.
We recommend additional taping for long term outdoor applications in any case.

Material data Component part	Material	Plating
Housings	brass	SUCOPLATE®
Male contacts	brass	gold or silver plating
Female contacts	CuBe2	gold or silver plating
Insulators	PTFE	
Gaskets	elastomer rubber	

These products are available on request.

Series 3409 lightning EMP protectors

High-power/low-IM gas discharge tube (GDT) hybrid technology

Description

HUBER+SUHNER series 3409 high-power gas discharge tube (GDT) protectors are a new generation of ultimate GDT protectors – suitable to meet the demanding high RF performance and protection requirements of future mobile communications transceivers with DC powering of outdoor equipment.
The customer is freed from any RF power and IM performance considerations.
Thus the protectors are especially suitable for multicarrier systems.
The availability of this kind of GDT protectors concerning frequency range is not limited by the gas discharge tube (as it is the case with standard GDT protectors which are limited to applications below about 2.5 GHz).
In addition, the protection performance is superior to existing standard GDT protectors.

Features

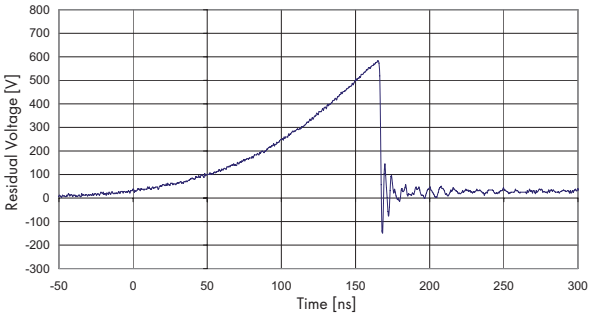
- RF peak power not limited by gas discharge tube
- Superior RF performance, PIM level lower – 150 dBc available
- Availability for applications from 380 MHz to 18 GHz (N interface)
- Safe extinguishing of gas discharge tube under the influence of RF power
- Up to 99% reduced residual pulse energy
- Waterproof IP 65 min.
- SEMPER™ self-extinguishing functionality included (see page 113)
- Gas discharge tube installed (90 V, 9071.99.0748)
- AISG transmission capability (optional)

Specifications

Electrical data	Requirements
RF:	
Impedance	50 Ω
Frequency range	according to product detail specification (data sheet)
RL	20 dB min., refer to product detail specification (data sheet)
IL	0.2 dB max., refer to product detail specification (data sheet)
PIM	according to product detail specification (data sheet) (specified products –150 dBc max.)
RF power transmission	refer to data in section Definitions and Terms «RF Power and DC Ratings» and product detail specification (data sheet)
Protection:	
Surge current handling capability	30 kA once and 20 kA multiple (8/20 µs test pulse) 8 kA (10/350 µs test pulse)
Residual pulse voltage and energy	for typical values refer to the following diagram

Typical residual pulse for series 3409
test pulse acc. to IEC 61000-4-5
1.2/50 µs 4 kV; 8/20 µs 2 kA:

Residual pulse voltage: typ. 580 V
Residual pulse energy: typ. 300 µJ



Mechanical data	Requirements
Coupling nut torque force	according to IEC/MIL (refer to page 30)
Durability (matings)	500 min. / 100 min. for H+S types made of aluminium
Bulkhead mounting torque force: Mounting hole diameter 19 mm/ 3/4" max. Larger than 19 mm	 20 Nm (14.7 ft-lb) min. / 25 Nm (18.4 ft-lb) max. 35 Nm (25.8 ft-lb) min. / 44 Nm (32.2 ft-lb) max.

Environmental data	Requirements/Test conditions
Operation temperature range	- 40 °C...+ 85 °C/ - 40 °F...+ 185 °F (lightning protection functionality) - 20 °C...+ 85 °C/ - 4 °F...+ 185 °F (SEMPER™ functionality)
Waterproof degree (IEC 60529)	according to shown product specification, data refer to the coupled state
Temperature shock	MIL-STD-202, Meth. 107, Cond. B
Moisture resistance	MIL-STD-202, Meth. 106
Vibration	MIL-STD-202, Meth. 204, Cond. D

The product is designed to meet the cited test procedures. Any additional or different requirements arising from specific applications or environmental conditions not covered by the test specifications mentioned above are subject to request and need to be confirmed by the single product detail specification.

We recommend additional taping for long term outdoor applications in any case.

Material data Component part	Material	Plating
Housings	brass	SUCOPLATE®
Male contacts	brass	gold or silver plating
Female contacts	CuBe2	gold or silver plating
Insulators	PTFE	
Gaskets	elastomer rubber	

Series 3409

Frequency range 380 MHz to 512 MHz

H+S type	Frequency range (MHz)	Connectors Unprotected/protected side* If bulkhead mount version, side of bulkhead marked «b».	Mounting/ grounding MH - hole for «b» M - screw	RL min.	IL max.	Water-proof	Weight	Figure
3409.17.0032-EX	380-512	N(m)-N(f), b	MH74,M8	20 dB	0.1 dB	IP65	595 g	Fig. 1
3409.41.0054-EX	380-512	7/16(m)-7/16(f)	M8	20 dB	0.1 dB	IP65	415 g	Fig. 2

* Recommendation only, reverse installation possible without any impact on performance

All mounting holes are shown on pages 34 – 35.

All dimensions in mm

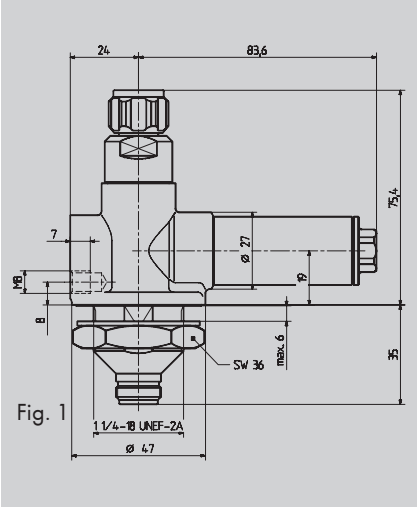


Fig. 1

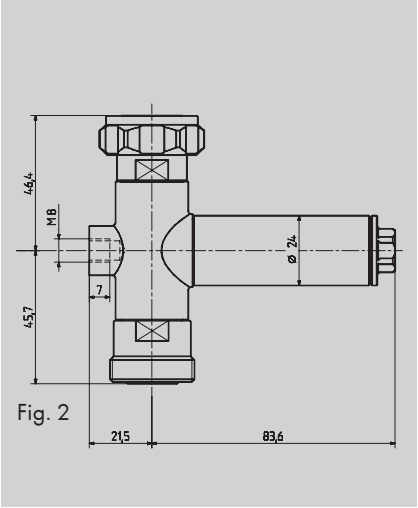


Fig. 2

All mounting holes are shown on pages 34 – 35.

Series 3409

Broadband, frequency range 806 MHz to 2500 MHz

H+S type **	Frequency range (MHz)	Connectors Unprotected/protected side* If bulkhead mount version, side of bulkhead marked «b».	Mounting/ grounding MH - hole for «b» M - screw	RL min.	IL max.	Water-proof	Weight	Figure
3409.17.0027-EX	806-2500	N(m)-N(f)	M8	20.8 dB	0.15 dB	IP65	402 g	Fig. 1
	806-960			26 dB				
	1710-2500			26 dB				
3409.17.0031-EX	806-2500	N(f)-N(f), b	MH74,M8	20.8 dB	0.15 dB	IP65	425 g	Fig. 2
	806-960			26 dB				
	1710-2500			26 dB				
3409.41.0044-EX	806-2500	7/16(m)-7/16(f)	M8	20.8 dB	0.15 dB	IP65	375 g	Fig. 3
	806-960			26 dB				
	1710-2500			26 dB				
3409.41.0051-EX	806-2500	7/16(f)-7/16(f)	M8	20.8 dB	0.15 dB	IP65	375 g	Fig. 4
	806-960			26 dB				
	1710-2500			26 dB				
3409.41.0052-EX	806-2500	7/16(f)-7/16(f), b	MH74,M8	20.8 dB	0.15 dB	IP65	515 g	Fig. 5
	806-960			26 dB				
	1710-2500			26 dB				
3409.41.0053-EX	806-2500	7/16(m)-7/16(f)	MH74,M8	20.8 dB	0.15 dB	IP65	515 g	Fig. 6
	806-960			26 dB				
	1710-2500			26 dB				
3409.41.0084***	690-2200	7/16(m)-7/16(f), b	MH110, M8	22 dB	0.15 dB	IP67	450 g	Fig. 7
	690-960			24 dB				
	1700-2200			24 dB				
3409.41.0085****	820-2500	7/16(f)-7/16(f), b	MH74, M8	20.8 dB	0.10 dB	IP65	260 g	Fig. 8
	820-970			23.2 dB				
	1700-2500			23.2 dB				

* Recommendation only, reverse installation possible without any impact on performance

** Optimized for 2.176 MHz AISG carrier

*** LTE - for detailed information see page 120

**** Material: aluminium

All mounting holes are shown on pages 34 – 35.

All dimensions in mm

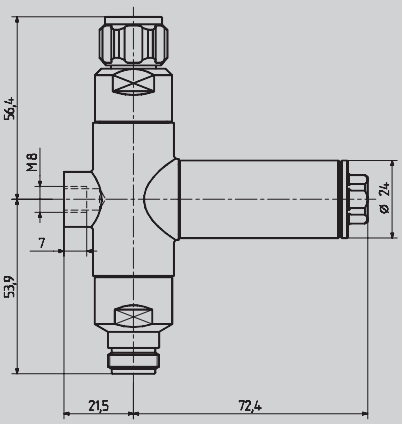


Fig. 1

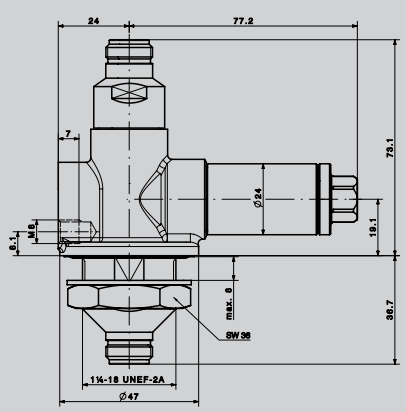


Fig. 2

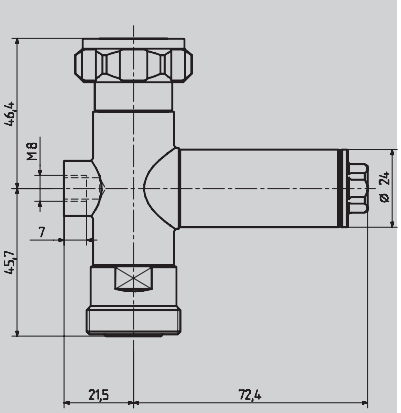


Fig. 3

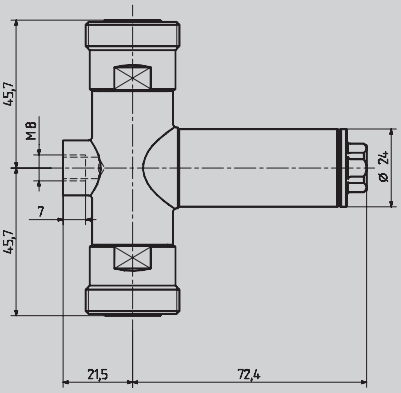


Fig. 4

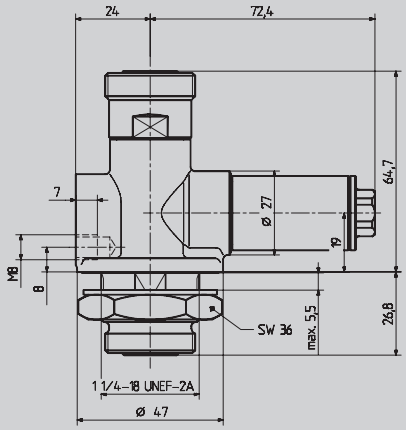


Fig. 5

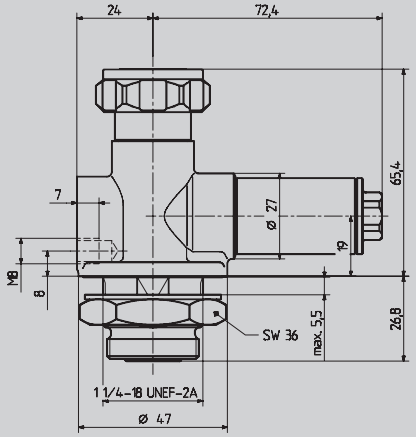


Fig. 6

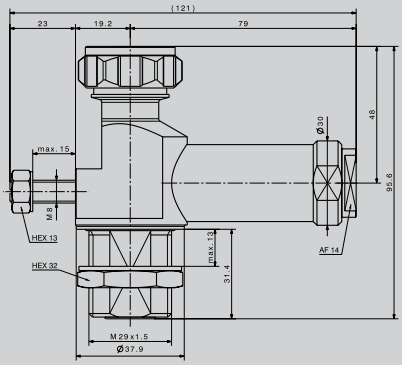


Fig. 7

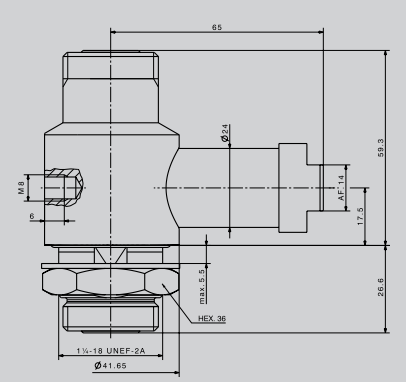


Fig. 8

All mounting holes are shown on pages 34 – 35.

Series 3410 lightning EMP protectors

High-power/low-IM gas discharge tube (GDT) hybrid technology with Bias-T

Description

HUBER+SUHNER series 3410 high-power gas discharge tube (GDT) protectors with integrated high-pass filter and DC injection port belong to the family of ultimate GDT protectors – suitable to meet the demanding high RF performance and protection requirements of future mobile communications transceivers with DC powering of outdoor equipment.
The customer is freed from any RF power and IM performance considerations.

Thus, the protectors are especially suitable for multicarrier systems.
The integrated high-pass provides an improved protection performance to series 3409 protectors. As the high-pass filter means a DC-blocking on the protected side of the component, this design is especially suitable for products with integrated DC injection facility.

Features

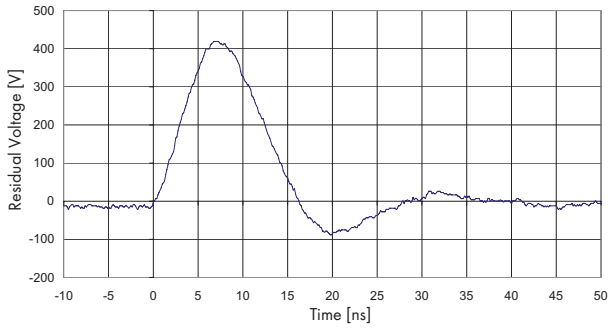
- RF peak power not limited by gas discharge tube
- Superior RF performance, PIM level lower –150 dBc available
- Availability for applications from 380 MHz to 2500 MHz
- Safe extinguishing of gas discharge tube under the influence of RF power
- Waterproof IP 65
- Gas discharge tube installed (90 V, 9071.99.0548 for SEMPER™ 9071.99.0747)
- DC-blocking on protected side of the device (galvanic isolation)
- DC injection up to 48 V
- AISG transmission capability (optional)
- SEMPER™ self-extinguishing functionality (optional, see page 113)

Specifications

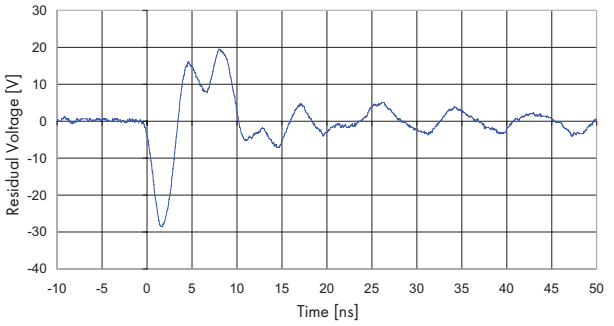
Electrical data	Requirements
RF:	
Impedance	50 Ω
Frequency range	according to product detail specification (data sheet)
RL	20 dB min., refer to product detail specification (data sheet)
IL	0.2 dB max. refer to product detail specification (data sheet)
PIM	according to product detail specification (data sheet) (specified products –150 dBc max.)
RF power transmission	500 W min., refer to product detail specification (data sheet)
Protection:	
Surge current handling capability	30 kA once and 20 kA multiple (8/20 µs test pulse) 10 kA (10/350 µs test pulse)
Residual pulse voltage and energy	according to product detail specification

Typical residual pulse for series 3410,
test pulse acc. to IEC 61000-4-5
1.2/50 µs 4 kV; 8/20 µs 2 kA:

Stub design:
Residual pulse voltage: typ. 450 V
Residual pulse energy: typ. 30 µJ



Cube design:
Residual pulse voltage: typ. 30 V
Residual pulse energy: typ. 0.1 µJ



Mechanical data	Requirements
Coupling nut torque force	according to IEC/MIL (refer to page 30)
Durability (matings)	500 min.
Bulkhead mounting torque force: Mounting hole diameter 19 mm/ 3/4" max. Larger than 19 mm	 20 Nm (14.7 ft-lb) min. / 25 Nm (18.4 ft-lb) max. 35 Nm (25.8 ft-lb) min. / 44 Nm (32.2 ft-lb) max.

Environmental data	Requirements/test conditions
Operation temperature range	- 40 °C...+ 85 °C/ - 40 °F...+ 185 °F (lightning protection functionality) - 20 °C...+ 85 °C/ - 4 °F...+ 185 °F (SEMPER™ functionality)
Waterproof degree (IEC 60529)	according to shown product specification, data refer to the coupled state
Temperature shock	MIL-STD-202, Meth. 107, Cond. B
Moisture resistance	MIL-STD-202, Meth. 106
Vibration	MIL-STD-202, Meth. 204, Cond. D

The product is designed to meet the cited test procedures. Any additional or different requirements arising from specific applications or environmental conditions not covered by the test specifications mentioned above are subject to request and need to be confirmed by the single product detail specification.

We recommend additional taping for long term outdoor applications in any case.

Material data Component part	Material	Plating
Housings	brass	SUCOPLATE®
Male contacts	brass	gold or silver plating
Female contacts	CuBe2	gold or silver plating
Insulators	PTFE	
Gaskets	elastomer rubber	

Series 3410 with DC injection

Frequency range 380 MHz to 512 MHz

H+S type	Frequency range (MHz)	Connectors Unprotected/protected side If bulkhead mount version, side of bulkhead marked «b».	Mounting/ grounding MH - hole for «b» M - screw	RL min.	IL max.	Water-proof	Weight	Figure
3410.41.0009-EX	380-512	7/16(m)-7/16(f)*	M8	20 dB	0.15 dB	IP66	510 g	Fig. 1

* DC injection port TNC (f)

All dimensions in mm

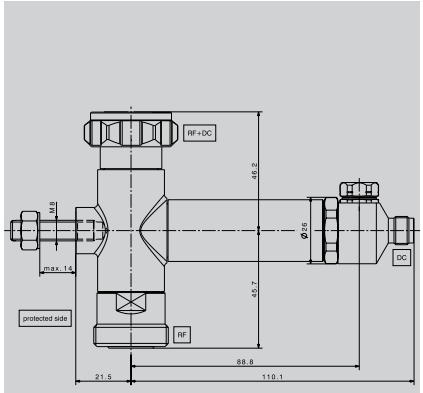


Fig. 1

All mounting holes are shown on pages 34 – 35.

Series 3410 with DC injection

Broadband, frequency range 800 MHz to 2500 MHz

H+S type	Frequency range (MHz)	Connectors Unprotected/protected side If bulkhead mount version, side of bulkhead marked «b».	Mounting/ grounding MH - hole for «b» M - screw	RL min.	IL max.	Water-proof	Weight	Figure
3410.17.0012-EX[s)]	800-2200	N(f)-N(m)*	M8	19.0 dB	0.15 dB	IP65	440 g	Fig. 1
3410.41.0017-EX[s)]	800-2200	7/16(m)-7/16(f)*	M8	19.0 dB	0.15 dB	IP65	440 g	Fig. 2
3410.41.0020[c)]	800-2500	7/16(f)-7/16(f)**	M8, MH 110	20.0 dB	0.15 dB	IP54	420 g	Fig. 3
	1700-2200			23.0 dB				
	1850-1990			25.0 dB				

* DC injection port TNC (f)

** DC injection port SMB (f)

s) stub design

c) cube design

All dimensions in mm

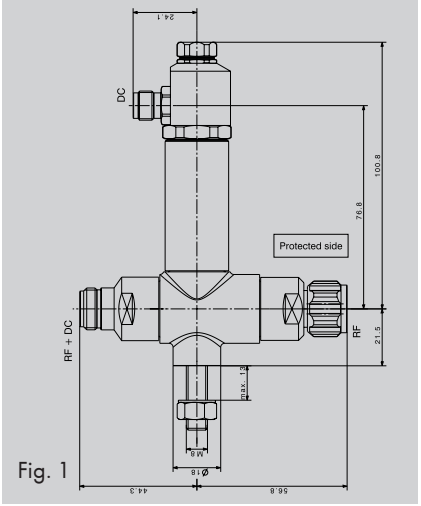


Fig. 1

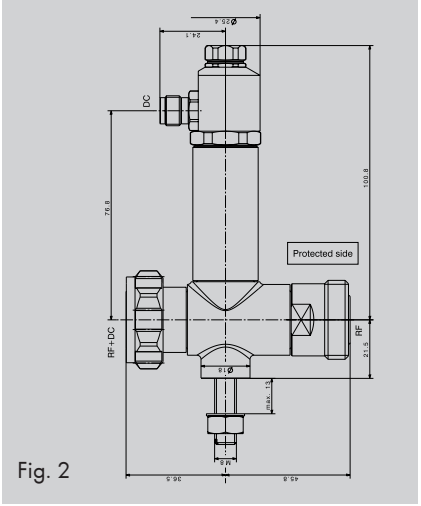


Fig. 2

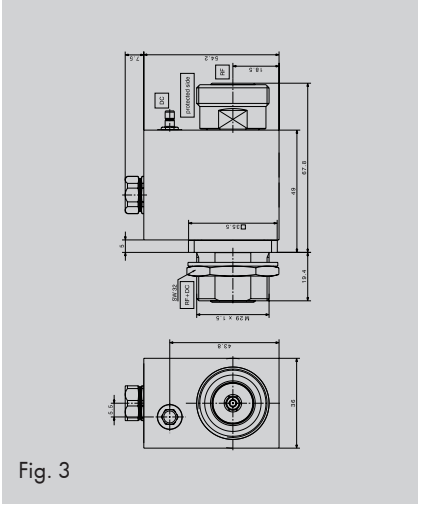


Fig. 3

All mounting holes are shown on pages 34 – 35.

Series 3414 lightning EMP protectors

Data line protectors

Description

Protective devices for symmetric twisted pair data lines

HUBER+SUHNER data line protectors have been designed to protect sensitive high speed data-, voice and multimedia application over copper lines against damaging transients caused by natural events such as lightning or man made surges. The protectors have been optimized to provide data transmission for several physical layers (with bandwidth up to Class D, Cat-5). Possible interconnections are made via the industrial standard RJ11, RJ45, RJ48, D-Sub and IEC 60130-9 connector, and the devices are suitable for screened (STP) or unscreened (UTP) twisted pair cables or multi-core cables. Some protectors are suitable for use with Power over Ethernet (PoE acc. IEEE 802.3af).

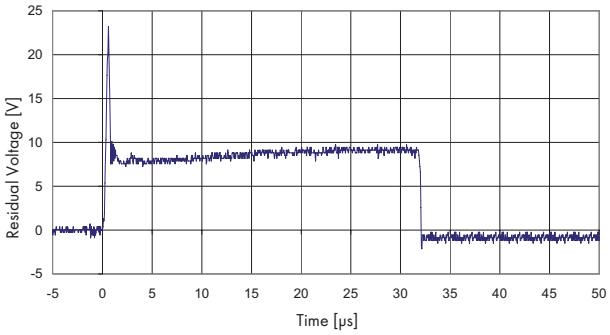
Applications

Series 3414 are designed for the protection of current and future sensitive data networks. The most important and frequently used devices are switches, multiplexers and cross-connects, hubs (also WLAN hubs), modems and network interface cards. The placement of DLP is in series between the incoming data line and I/O port of the equipment to be protected. For an effective protection we recommend to install the DLP on both ends of data lines.

- Ethernet lines
- AISG based antenna systems

Typical residual pulse for series 3414
test pulse acc. to IEC 61000-4-5
1.2/50 µs 4 kV; 8/20 µs 2 kA:

Residual pulse voltage: typ. 25 V
Residual pulse energy: typ. 50 µJ



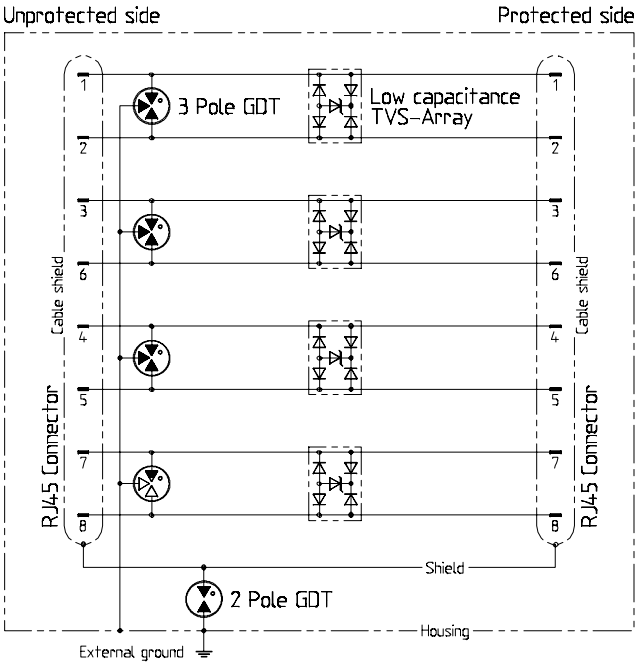
Protectors for ethernet lines

Description

The optimized 3414 data line protectors can be used in state of the art Ethernet twisted pair systems class D channel link (Cat 5e), xDSL and other high speed data transmission applications. Series 3414 includes hybrid units which integrate first stage and fine protection components.

Features

- Coarse and fine protection
- Fast response time
- Conform to installation class D (Cat 5e) (ISO/IEC 11801, ANSI/TIA/EIA-586-B, EN 50173)
- Suitable for Ethernet 10 to 1000 Base-T
- Supports «Power over Ethernet» (PoE acc. IEEE 802.3af)
- Interface RJ45
- All eight lines protected
- Shield and housing/grounding separated
- Shield through-connected
- Several grounding and mounting options
- Waterproof versions up to IP rating IP68 (according to product detail specification)
- Easy mountable
- Maintenance free



Specifications

Electrical data	
DC/RF:	
Data transmission rate	1000 Mbps
Frequency range	DC - 100 MHz
Impedance	100 Ω
Voltage rating: - line - line (pair) - line - ground	 ±6 V ±60 V
Current rating (per line)	1.5 A
Connector interfaces	RJ45 jack
Protection:	
Surge current handling capability: - shield - ground - line - ground - line - line (pair)	(8/20 µs test pulse) 6 kA 2.5 kA 100 A
Response time	2 ns

Environmental data	
Operating temperature range	-40 °C to +85 °C

Series 3414 ethernet lines

H+S type	Waterproof	Mounting/grounding	Description	Option	Figure
3414.99.0003*	IP20	wire, screw	general purpose		Fig. 1
3414.99.0008	IP68	wire, screw, clamp (incl.)	water proof metal housing for permanent outdoor installations		Fig. 2
3414.99.0009	IP68	bulkhead	rugged metal housing for temporary outdoor installations	optional interconnect accessories	Fig. 3

* patch cable 12 cm (4.72 in.) included

All dimensions in mm

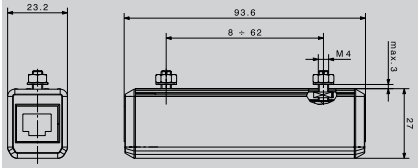


Fig. 1

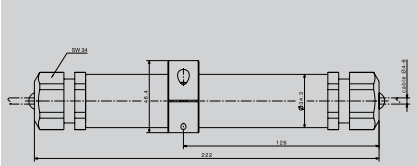


Fig. 2

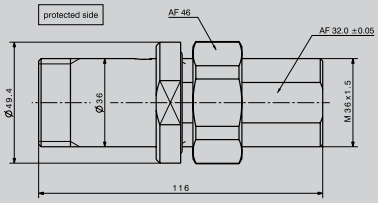


Fig. 3

Accessories for 3414.99.0009 data line protector

H+S type	Description	Figure
9073.99.0002	RJ45 plug kit, field assembly	Fig. 4
9073.99.0004	protective cap for data line protector	Fig. 5
9073.99.0003	protective cap for RJ45 plug kit	Fig. 6

All dimensions in mm

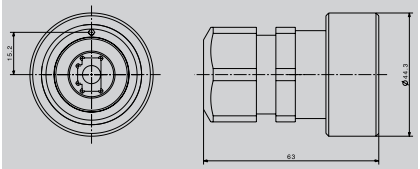


Fig. 4

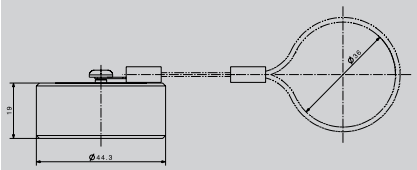


Fig. 5

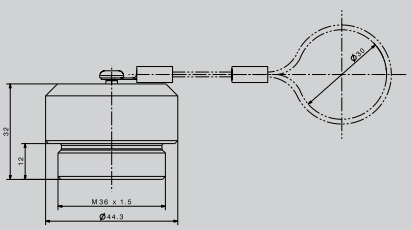


Fig. 6

Protectors for AISG based antenna systems

Description

HUBER+SUHNER data line protection solutions for AISG based Antenna Systems are hybrid designs offering coarse and fine protection in one. This makes them suitable for the protection of sensitive digital remote control and monitoring units of RF infrastructure with EIA-485 interface. These protectors are fully compliant to AISG EIA-485 Layer-1 and protect Data- and DC-lines.

Applications

Data line protection for multicore cable of antenna systems with remote electrical tilt (RET) technology:

- AISG compliant antenna control units (ACU) and tower mount amplifiers (TMA)
- AISG compliant control network interfaces (CNI)

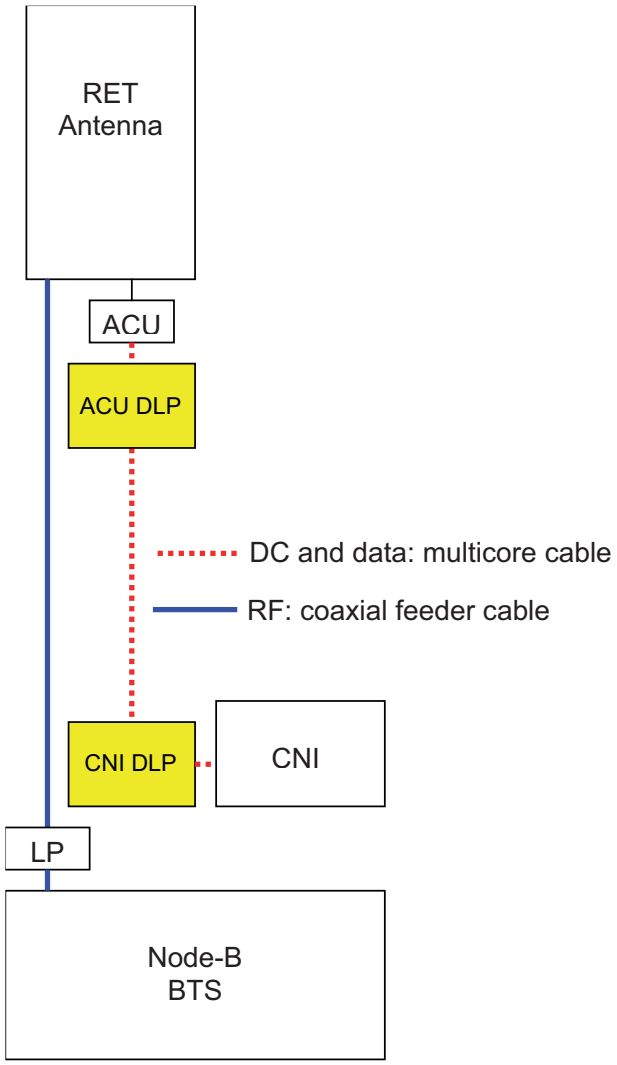
Features

- Multistage protected data lines
- Pins individually protected
- Integrated decoupling elements
- Fully compliant to AISG EIA-485 physical layer
- 8-pin circular connector IEC 60130-9
- Metallic housing
- Environmental protection class IP67
- Easy mountable
- Maintenance free

AISG based antenna system configuration

ACU (Antenna Control Unit) Data Line Protector, placed at the tower top equipment side (Antenna / Tower Mounted Amplifier)

CNI (Control Network Interface) Data Line Protector, placed at the ground equipment side (Base Station)



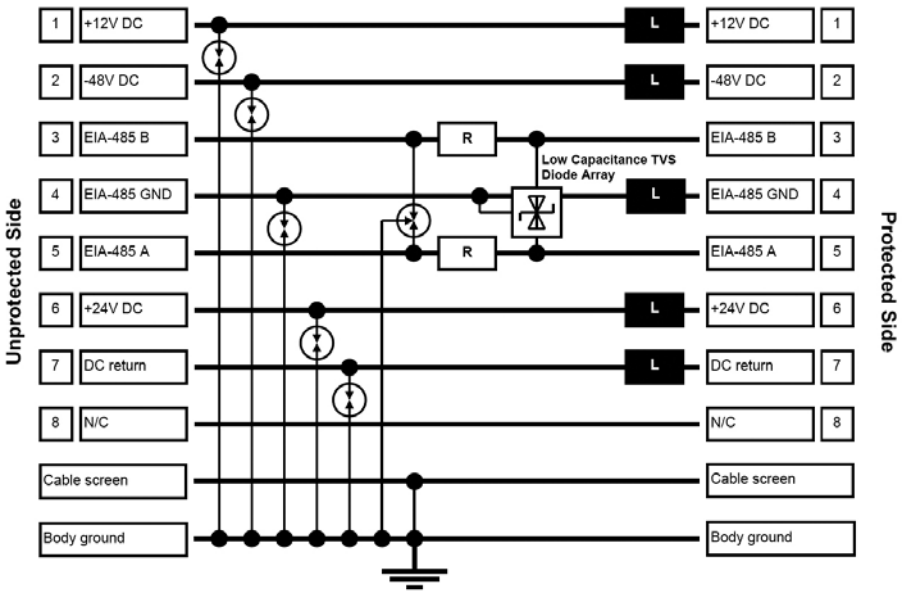
Specifications

Electrical data	
DC/RF:	
Data transmission rate: - EIA-485 data lines	 115.2 kb/s (acc. to AISG1 Issue1.1)
Voltage rating / current rating / DC resistance: - EIA-485 A/B data lines (pin 3, pin 5) - power lines (pin 1, pin 2, pin 6, pin 7)	 ±6 V / 0.5 A / 4.7 Ω ±60 V / 5 A at +50 °C / < 1Ω
Connector interfaces	8 pin circular according to IEC 60130-9 with screw ring locking
Protection:	
Coarse and fine protection for EIA-485 data lines (pin 3, pin 5)	
Decoupling of all lines to other protection equipment excl. pin 8	
Shield directly connected to ground	
Unused pin 8 not protected	
Surge current handling capability: - EIA-485 data lines to ground - power lines to ground - shield to ground	(8/20 µs test pulse) 6.5 kA 6.5 kA 50 kA

Environmental data	
Waterproof degree (IEC 60529)	IP67
Operating temperature range	-40 °C to +85 °C

Material data	
Housing	aluminium diecast coated (RAL7035, light grey)
Connector panel	aluminium chromated
Dimensions	see outline drawing

Circuit diagram



Series 3414 AISG based antenna systems

H+S type	Connectors Unprotected/protected side	Mounting/grounding	Description	Figure
3414.99.0010	male connector / female connector	clamp / screw and wire	ACU side	Fig. 1
3414.99.0013	female connector / male connector	clamp / screw and wire	CNI side	Fig. 2

All dimensions in mm

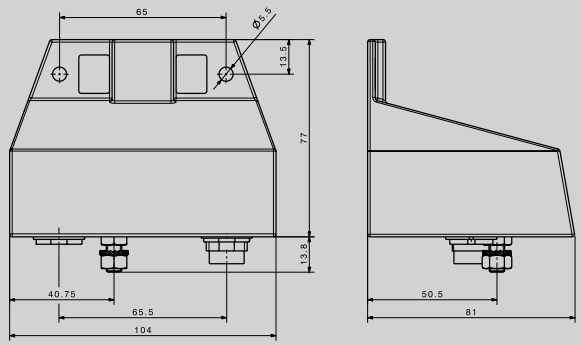


Fig. 1

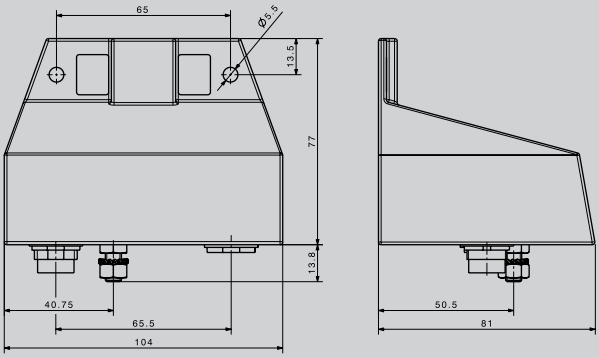


Fig. 2

Space for your notes

Special products

The intention of this section is to present products which are based on protector design constraints but featuring either special or additional functions.
These have been selected from a variety of RF components which make use of the comprehensive HUBER+SUHNER RF and material know-how.
More and more multifunctional products are created which help our customers to solve special system requirements of RF applications more neatly and cost effectively.

SEMPER™ - self-extinguishing gas discharge tube (GDT) protector

Description

The patent pending SEMPER concept enhances the safety and reliability of the well known and proven gas discharge tube (GDT) protector principle impressively. It eliminates the risk of gas discharge tube "hold on" due to DC line powering or high powered RF signals, which will render the system inoperable and can destroy the discharge tube.

HUBER+SUHNER offers two basic concepts of self-extinguishing GDT protectors:

- Mechanical version, named SEMPER
- Electronic version

The unique and patent pending SEMPER solution is realised as a simple unit which enables the use of the comprehensive range of HUBER+SUHNER GDT protectors with a replaceable capGDTsule. An easy retrofit of existing GDT protectors is possible or available as complete SEMPER protectors in a variety of configurations.

The electronic version is realised with the protector series 3405 and is available on request. The main different characteristic will be found in the faster switching time.

Whereas many applications generally benefit from the enhanced safety and reliability that the SEMPER concept offers, applications using DC line power for remote signal amplification and processing and those using high RF power will find self-extinguishing lightning EMP protectors of specific interest.

Applications

- Feeding DC over coax
- Transmitting high RF power
- Tower mount amplifiers/repeaters
- GPS receivers
- Point to point / multi-point radios
- Defence/security radios
- Remote installations
- Uninterruptible surveillance radio control or navigation systems

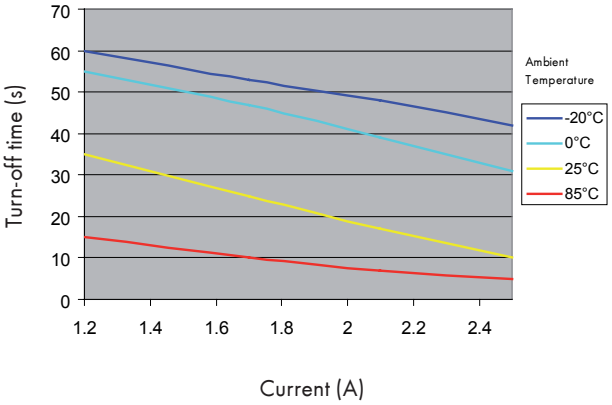
Features and benefits

- Self-extinguishing gas discharge tube with automatic recovery
- Extinguishing under any coaxial line condition including:
- Malfunction of electronic fused DC supplies
- Malfunction of RF line monitoring
- Absence of any such mechanism
- Can be employed for any HUBER+SUHNER GDT protectors with exchangeable gas tube
- Field replacement allows cost-effective system upgrades
- Product options ensure availability for any application
- Higher safety
- Negligible system downtime

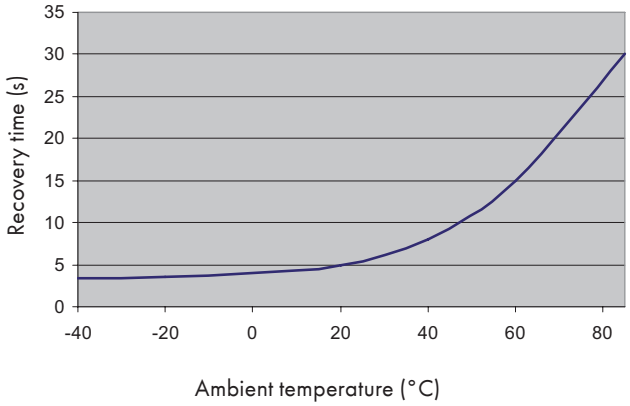
Specifications

Electrical data	
DC current	≤ 2.5 A
Turn-off time	20 sec. typically at 2.0 A and 25°C ambient temperature < 40 sec. typically below 1 A and 25°C ambient temperature
Recovery time	7 sec. at 25°C ambient temperature

Turn-off performance at 25 °C



Recovery performance at 25 °C



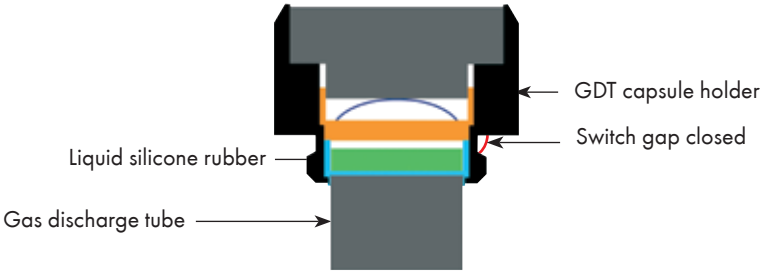
Environmental data	Requirements/test conditions
Operation temperature range	-40 °C +85 °C (lightning protection functionality) -20 °C +85 °C (SEMPER functionality)
Waterproof degree (IEC 60529)	IP 65min., refer to shown product specification, data refer to the coupled state
Temperature shock	MIL-STD-202, Meth. 107, Cond. B
Moisture resistance	MIL-STD-202, Meth. 106
Vibration	MIL-STD-202, Meth. 204, Cond. D

Material data SEMPER protector Piece parts	Material	Surface plating
Body	brass	SUCOPLATE®
Female contacts	copper beryllium alloy	gold or silver plating
Male contacts	brass	gold or silver plating
Dielectric	PTFE	
Gasket	MVQ (silicone rubber)	

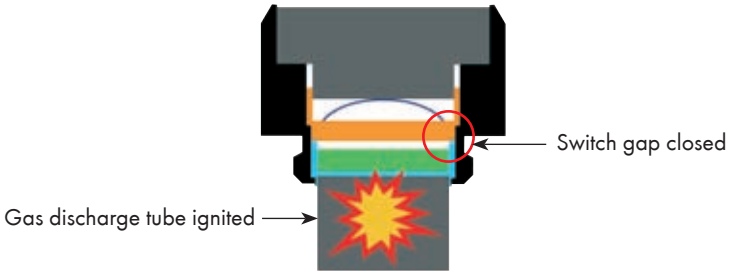
Material data SEMPER unit Piece parts	Material	Surface plating
Body	brass	SUCOPLATE® or gold
Contact	copper beryllium alloy or brass	silver plating
Insulator	PTFE / AL_2O_3	
Gasket	NBR (acrylonitrile butadiene elastomeric)	
Insert	MVQ (silicone rubber)	

Basic working principle

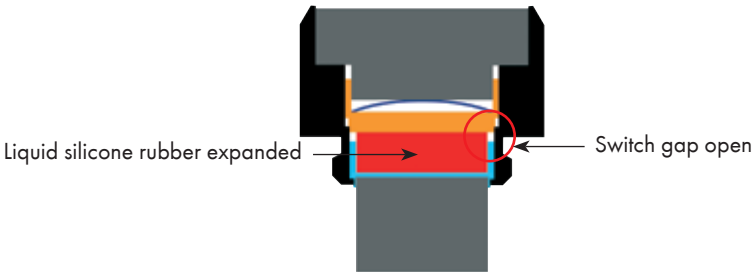
Normal state before lightning strike and after recovery time



Gas discharge tube ignited after lightning strike



Activated state, gas discharge tube extinguished



SEMPER™ product range

By offering both, complete SEMPER protector and replaceable SEMPER GDT unit solutions, HUBER+SUHNER are able to provide lightning protection solutions to a wide range of both civil and military applications and system upgrades.

H+S type	Frequency range (MHz)	Connector configuration	Static spark-over voltage	GDT unit included	Figure
3401.17.0048-EX	DC – 1000	N-jack/N-jack	230 V	9071.99.0647	Fig. 1
3401.26.0012-EX	DC – 1000	TNC-jack/TNC-jack	230 V	9071.99.0647	Fig. 2
3402.17.0072-EX	DC – 2500	N-jack/N-jack	230 V	9071.99.0647	Fig. 3
3402.41.0056-EX	DC – 2500	7/16-jack/7/16-jack	230 V	9071.99.0647	Fig. 4

All dimensions in mm

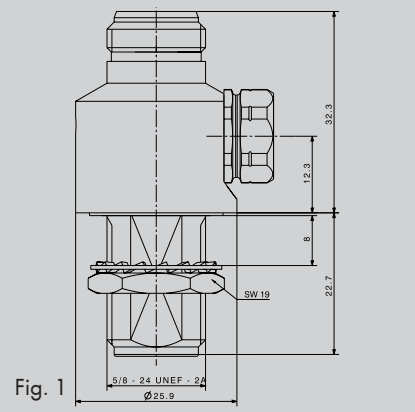


Fig. 1

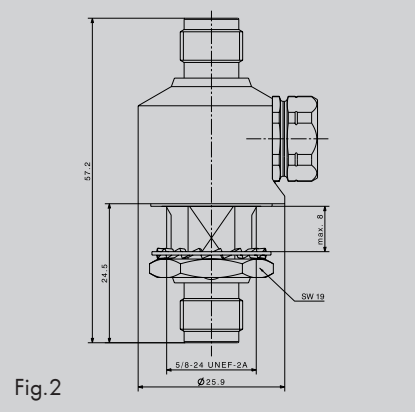


Fig.2

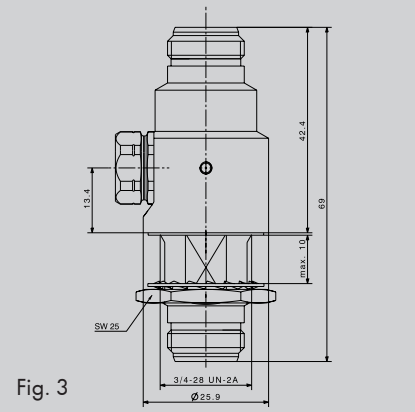


Fig. 3

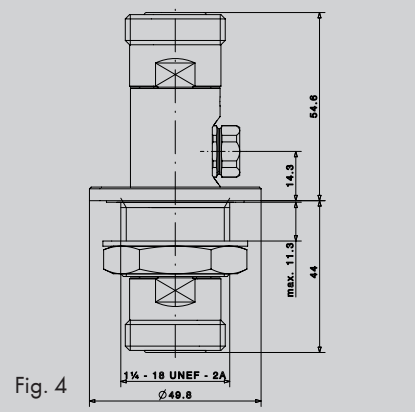


Fig. 4

SEMPER GDT units for retrofit and replacement see page 136.

Series 3405, self extinguishing gas discharge tube (GDT) protector - electronic version

Description

For some applications the turn-off time of the SEMPER concept might be too long or the demand for DC current is higher. The protector series 3405 which is based on an electronic switching functionality can fill this gap. The major differences to the SEMPER products are:

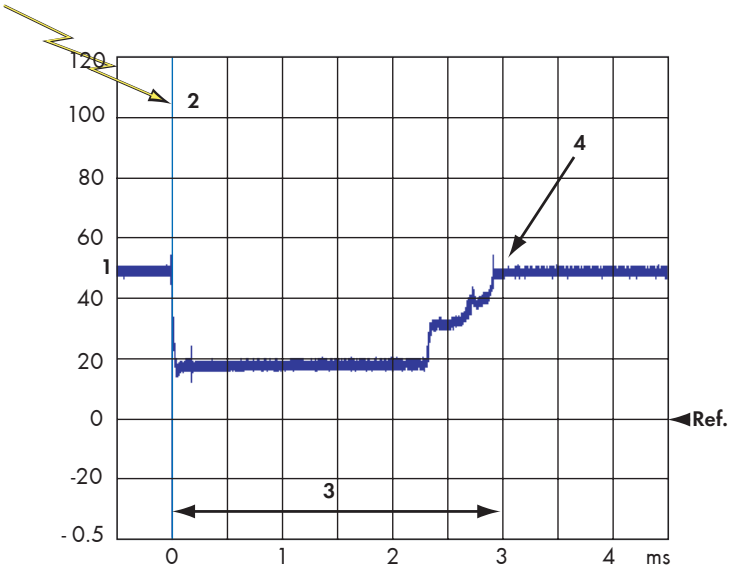
- Short extinguishing time
- No recovery time
- High DC current

More information about the series 3405 is available on request.

Electronic extinguishing protector

Features

- Extinguishing time of 4 milliseconds typically
- No recovery time
- Self-extinguishing of the gas discharge tube under RF and DC conditions
- Broad and single band units in the frequency range within 380 MHz and 2.5 GHz
- Low passive intermodulation product, typically -150 dBc
- High RF-CW/average and peak power
- For voltages up to 48 V and power supply short circuit currents up to 7 A



Typical switching performance of an electronic extinguishing protector

Legend:

1 Normal state
2 Surge occurs and gas discharge tube ignites
3 Extinguishing phase
4 Return to normal state

These products are available on request.

Protectors for Broadband Wireless Access (BWA) applications

Description

This HUBER+SUHNER lightning EMP protectors are designed according to the different frequency spectra utilised in conjunction with the many application in the broadband wireless access (BWA) field like WiMax (acc. IEEE 802.16), Industrial Scientific and Medical (ISM) radio bands (acc. ITU-R article 5) like license-free communications applications such as wireless LANs and many others like WiFi (IEEE 802.11)

Features

- Quarter-wave for lowest residual disturbances from 2 to 6 GHz
- Gas discharge tube technology for remote equipment powering from DC up to 6 GHz
- Connector interface series in N, DIN 7/16 available
- Optional high-pass functionality for even reduced residual voltages combined with quarter-wave technology
- Aluminium light weight designs available

H+S type	Frequency range (MHz)	Connectors Unprotected/protected side* If bulkhead mount version, side of bulkhead marked «b».	Mounting/ grounding MH - hole for «b» M - screw	RL min.	IL max.	Water-proof	Weight	Figure
3400.17.0426**	2000-6000	N(f)-N(f), b	MH170	20 dB	0.2 dB	IP68	80 g	Fig. 1
3400.17.0428**	2000-6000	N(m)-N(f), b	MH170	20 dB	0.2 dB	IP68	85 g	Fig. 2
3407.17.0085	2000-6000	N(m)-N(f), b	MH170	20 dB	0.2 dB	IP68	85 g	Fig. 3
3406.17.0027	DC-4000	N(f)-N(f), b	MH24	20 dB	0.2 dB	IP68	85 g	Fig. 4
3406.17.0028	DC-4000	N(m)-N(f), b	MH24	20 dB	0.2 dB	IP68	85 g	Fig. 5

* Recommended only, reverse installation possible without any impact on performance

** Material: aluminium

Frequency spectrum allocations

	Standardisation body	Center frequency
ISM	ITU-R 5	433 MHz, 915 MHz, 2.45 GHz, 5.8 GHz
WLAN, WiFi	IEEE 802.11	2.4 GHz, 3.6 GHz, 5.8 GHz
WiMAX	IEEE 802.16	2.3 GHz, 2.5 GHz and 3.5 GHz licenced bands 5.x GHz unlicenced band (uncomplete)

All dimensions in mm

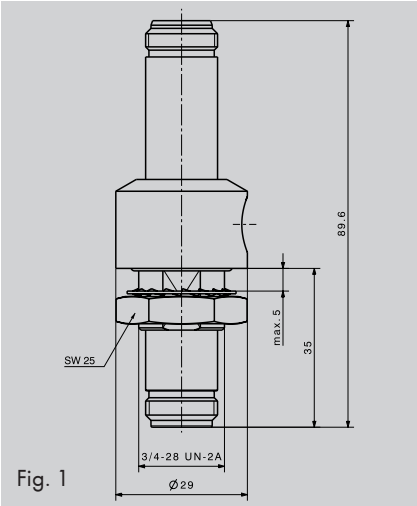


Fig. 1

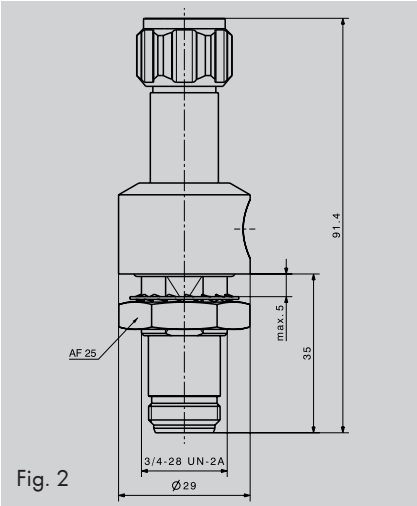


Fig. 2

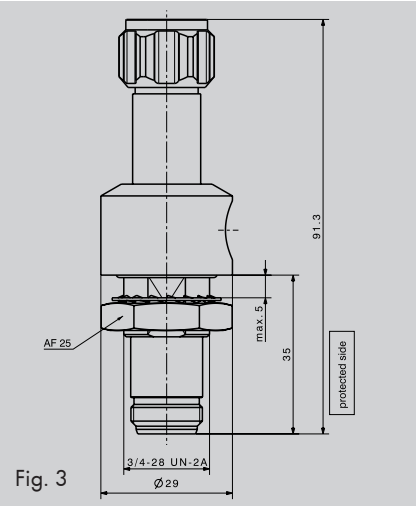


Fig. 3

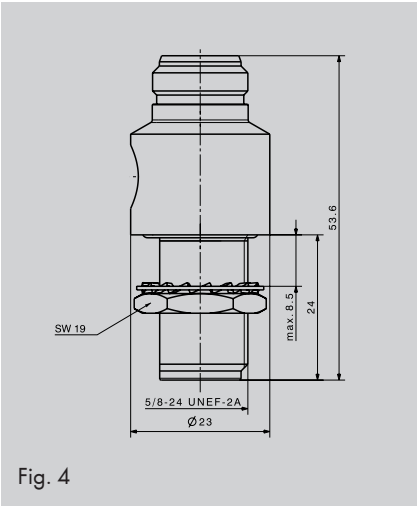


Fig. 4

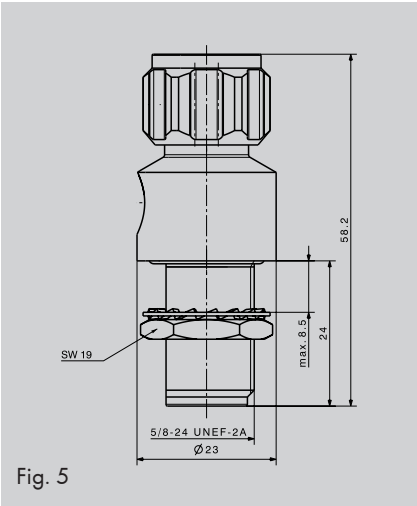


Fig. 5

Protectors for Long Term Evolution (LTE) applications

Description

This HUBER+SUHNER lightning EMP protectors are designed according to the specific frequency spectra utilised for the LTE implementation.

Features

- Frequency range from 690 up to 2200 MHz
- Quarter-wave for lowest residual disturbances from 690 MHz to 2.2 GHz
- High power/low-IM gas discharge tube protector technology for remote equipment powering
- AISG option for 3409
- Aluminium light weight designs available

H+S type	Frequency range (MHz)	Connectors Unprotected/protected side* If bulkhead mount version, side of bulkhead marked «b».	Mounting/ grounding MH - hole for «b» M - screw	RL min.	IL max.	Water-proof	Weight	Figure
3400.41.0263	690-2000	7/16(m)-7/16(f), b	MH110, M8	23 dB	0.15 dB	IP67	470 g	Fig. 1
	690-960			26 dB				
	1700-2200			26 dB				
3409.41.0084**	690-2000	7/16(m)-7/16(f), b	MH110, M8	22 dB	0.15 dB	IP67	450 g	Fig. 2
	690-960			24 dB				
	1700-2200			24 dB				

* Recommended only, reverse installation possible without any impact on performance

** Optimized for 2.167 MHz AISG carrier

All dimensions in mm

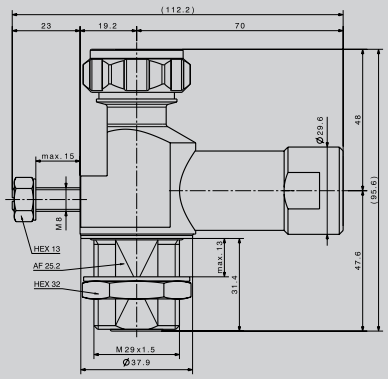


Fig. 1

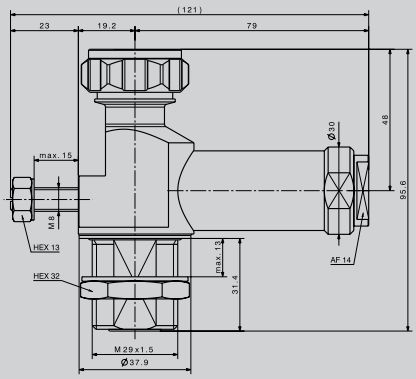


Fig. 2

Series 9070 - DC injectors (Bias-T)

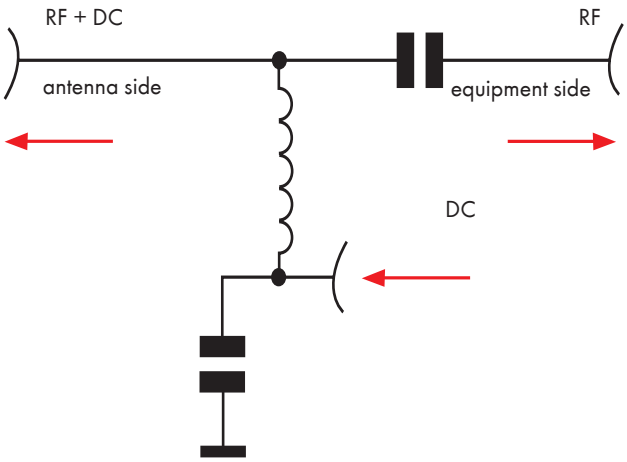
Description

HUBER+SUHNER DC injectors have a Bias-T design. They can be easily inserted in a coaxial transceiver line, thus permitting any active electronic equipment to be powered without additional cabling.
These products include a high-pass filter which provides a DC-blocking on the equipment side meeting the system requirements of RF applications more neatly and cost effectively. They play especially an important role for reconfigurations of transceivers to enhance capacity.

Features

- DC injection up to 48 V/2 A
- Easy insertion into an existing coaxial line

Principle



Specifications

Electrical data	Requirements
RF:	
Impedance	50 Ω
Frequency range	300 to 2000 MHz
RL	20 dB min.
IL	0.2 dB max.
RF power transmission	100 W CW max.
DC:	
Injection current	2 A max.
DC supply voltage	48 V max.

Mechanical data	Requirements
Coupling nut torque force	according to IEC/MIL (refer to page 30)
Durability (matings)	500 min.

Environmental data	Requirements/test conditions
Operation temperature range	- 40 °C...+ 85 °C / - 40 °F...+ 185 °F
Waterproof degree (IEC 60529)	refer to product detail specification (data sheet)
Temperature shock	MIL-STD-202, Meth. 107, Cond. B
Moisture resistance	MIL-STD-202, Meth. 106
Vibration	MIL-STD-202, Meth. 204, Cond. D

The product is designed to meet the cited test procedures. Any additional or different requirements arising from specific applications or environmental conditions not covered by the test specifications mentioned above are subject to request and need to be confirmed by the single product detail specification.
We recommend additional taping for long term outdoor applications in any case.

Material data Component part	Material	Plating
Housings	brass	SUCOPLATE®
Male contacts	brass	gold or silver plating
Female contacts	CuBe2	gold or silver plating
Insulators	PTFE	
Gaskets	elastomer rubber	

These products are available on request.

Series 9077 - high voltage DC blocks

Description

The HUBER+SUHNER DC Block product line include DC blocks (inner conductor disconnected) and DC-DC blocks (inner and outer conductor disconnected) for galvanic isolation up to 15 kV. They block high-amplitude and low-frequency surge voltages e.g. occurring during regular electric railway operation along railway lines. They provide sufficient safety even in the worst case scenario if the overhead high voltage lines fall to the ground.

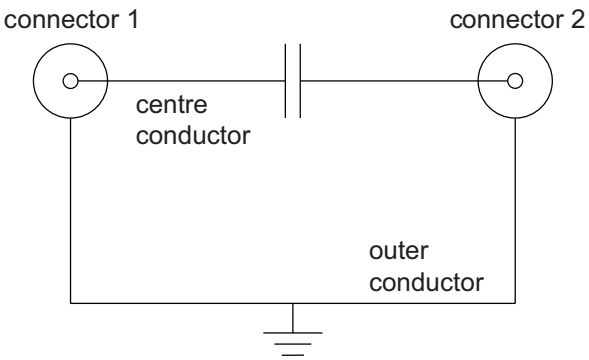
Applications

Generally used along railway tracks and in road and train tunnels enabling safe and uninterrupted communication support for critical services and operation like rescue, police, fire brigades and public radio services such as broadcasting, mobile telephony and WLAN. Tunnel specific radio systems transmit and receive via radiating coaxial cables acting as antennas.

Features

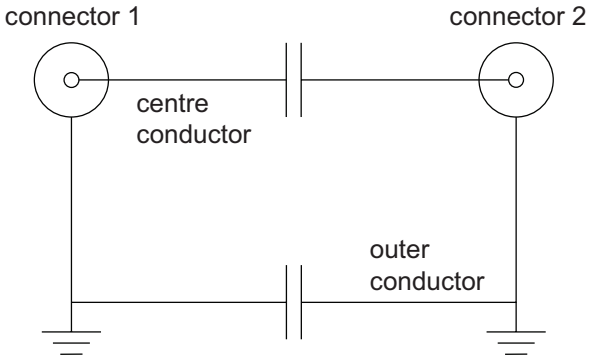
- Galvanic isolation of the RF signal path
- Protects from effects caused by ground potential rise
- Provides ground potential separation
- Protects against electrolytic corrosion caused by parasitic current
- DC blocking configuration on centre and/or outer conductor
- Blocking DC voltage up to 15 kV
- Broadband operation up to 2500 MHz
- Low intermodulation performance
- Bulkhead mounting and grounding
- Waterproof design
- Maintenance free
- Protects against electromagnetic interference caused by traction return current

DC block



Only centre conductor disconnected

DC-DC block



Centre and outer conductor disconnected

Series 9077 - 4 kV broadband high voltage DC block

Specifications

Electrical Data	Requirements
RF:	
Impedance	50 Ω
Frequency range	from 140 MHz to 2500 MHz
RL	16 dB min. from 140 MHz to 200 MHz 20 dB min. from 200 MHz to 2500 MHz
IL	0.5 dB max.
PIM	-150 dBc typ.
RF power transmission	80 W CW
DC:	
Leakage current	50 µA
Test leakage current	100 µA
Blocking voltage	4000 V (only centre conductor disconnected)

Mechanical data	Requirements
Weight	refer to product detail specification
Mounting hole	MH 110, see page 34 - 35

Environmental data	Data requirements
Operating temperature range	- 40 °C...+ 85 °C
Waterproof degree (IEC 60529)	IP65 min., data refer to the coupled state
Temperature shock	MIL-STD-202, Meth. 107, Cond. B
Moisture resistance	MIL-STD-202, Meth. 106
Vibration	MIL-STD-202, Meth. 204, Cond. D

Material data Component part	Material	Plating
Housings	brass	SUCOPLATE®
Male contacts	brass	gold or silver plating
Female contacts	copper beryllium or bronze	gold or silver plating
Insulators	PTFE	
Gaskets	elastomer rubber	

H+S type *	Connectors port 1 - port 2 side of bulkhead marked «b».	Mounting/grounding MH - hole for «b»	Weight	Figure
9077.17.0015	N (f), b - N(f)	110	380 g	Fig. 1
9077.17.0016	N (m) - N(f), b	110	380 g	Fig. 2
9077.41.0015	7/16 (f), b - 7/16(f)	110	400 g	Fig. 3
9077.41.0016	7/16 (m) - 7/16(f), b	110	400 g	Fig. 4

* suitable mounting bracket 9075.99.0095

All dimensions in mm

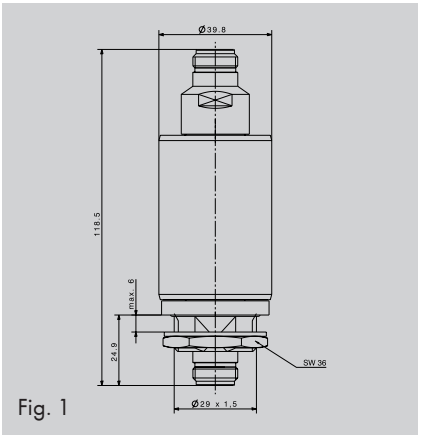


Fig. 1

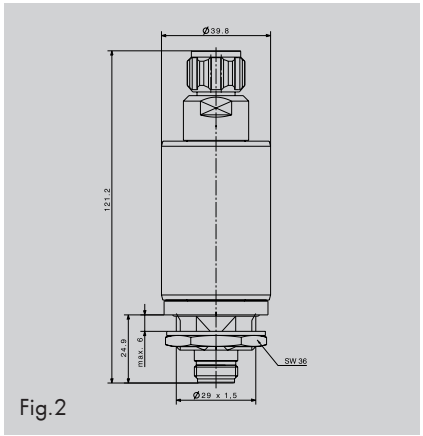


Fig.2

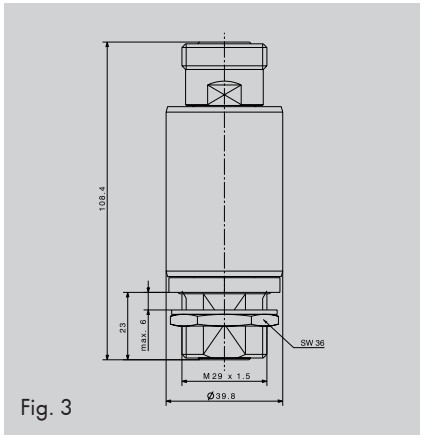


Fig. 3

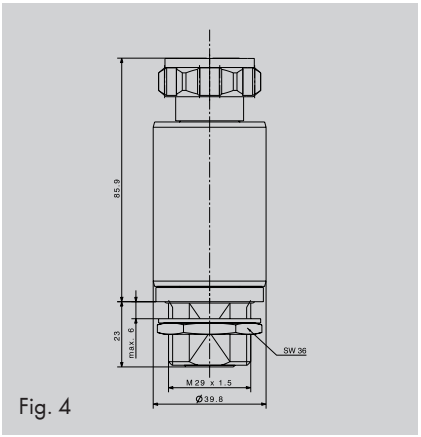


Fig. 4

Series 9077 - 4 kV broadband high voltage DC-DC block

Specifications

Electrical Data	Requirements
RF:	
Impedance	50 Ω
Frequency range	from 160 MHz to 2500 MHz
RL	22 dB min. from 160 MHz to 300 MHz 26.4 dB min. from 300 MHz to 2500 MHz
IL	0.1 dB max.
PIM	-150 dBc typ.
RF power transmission	500 W CW
DC:	
Leakage current	5 µA
Test leakage current	10 µA
Blocking voltage	4000 V (centre and outer conductor disconnected)

Mechanical data	Requirements
Weight	refer to product detail specification
Mounting hole	MH 110, see page 34 - 35

Environmental data	Data requirements
Operating temperature range	- 40 °C...+ 85 °C
Waterproof degree (IEC 60529)	IP65 min., data refer to the coupled state
Temperature shock	MIL-STD-202, Meth. 107, Cond. B
Moisture resistance	MIL-STD-202, Meth. 106
Vibration	MIL-STD-202, Meth. 204, Cond. D

Material data Component part	Material	Plating
Housings	brass	SUCOPLATE®
Male contacts	brass	gold or silver plating
Female contacts	copper beryllium or bronze	gold or silver plating
Insulators	PTFE	
Gaskets	elastomer rubber	

H+S type *	Connectors port 1 - port 2 side of bulkhead marked «b».	Mounting/grounding MH - hole for «b»	Weight	Figure
9077.17.0031	N (f), b - N(f)	110	456 g	Fig. 1
9077.17.0030	N (m) - N(f), b	110	459 g	Fig. 2
9077.41.0031	7/16 (f), b - 7/16(f)	110	459 g	Fig. 3
9077.41.0032	7/16 (m) - 7/16(f), b	110	466 g	Fig. 4

* suitable mounting bracket 9075.99.0095

All dimensions in mm

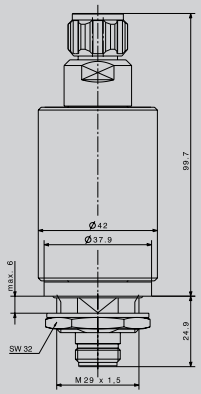


Fig. 1

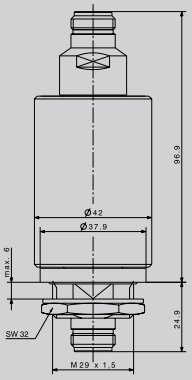


Fig. 2

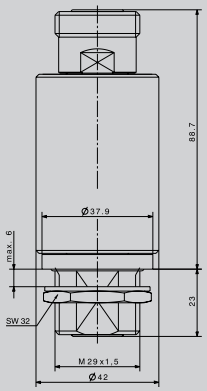


Fig. 3

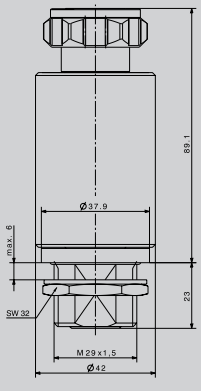


Fig. 4

Series 9077 - 15 kV broadband high voltage DC-DC block

Specifications

Electrical Data	Requirements
RF:	
Impedance	50 Ω
Frequency range	from 180 MHz to 2500 MHz
RL	16 dB min. from 180 MHz to 380 MHz 20 dB min. from 380 MHz to 2500 MHz
IL	0.5 dB max.
PIM	-150 dBc typ.
RF power transmission	80 W CW
DC:	
Leakage current	50 µA
Test leakage current	100 µA
Blocking voltage	15000 V (centre and outer conductor disconnected)

Mechanical data	Requirements
Weight	refer to product detail specification
Mounting hole	MH 110, see page 34 - 35

Environmental data	Data requirements
Operating temperature range	- 40 °C...+ 85 °C
Waterproof degree (IEC 60529)	IP65 min., data refer to the coupled state
Temperature shock	MIL-STD-202, Meth. 107, Cond. B
Moisture resistance	MIL-STD-202, Meth. 106
Vibration	MIL-STD-202, Meth. 204, Cond. D

Material data Component part	Material	Plating
Housings	brass	SUCOPLATE®
Male contacts	brass	gold or silver plating
Female contacts	copper beryllium or bronze	gold or silver plating
Insulators	PTFE	
Gaskets	elastomer rubber	

Series 9077

H+S type *	Connectors port 1 - port 2 side of bulkhead marked «b».	Mounting/grounding MH - hole for «b»	Weight	Figure
9077.17.0022	N (f), b - N(f)	110	657 g	Fig. 1
9077.17.0006	N (m) - N(f), b	110	660 g	Fig. 2
9077.41.0009	7/16 (f), b - 7/16(f)	110	660 g	Fig. 3
9077.41.0010	7/16 (m) - 7/16(f), b	110	667 g	Fig. 4

* suitable mounting bracket 9075.99.0095

All dimensions in mm

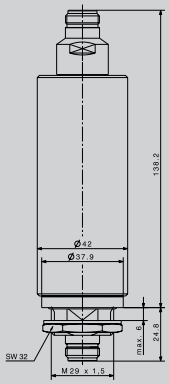


Fig. 1

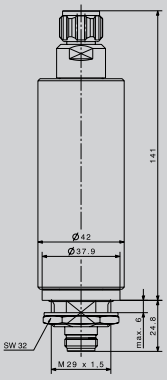


Fig. 2

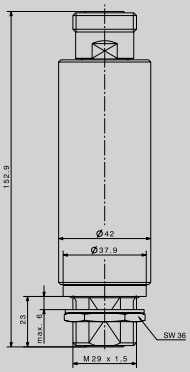


Fig. 3

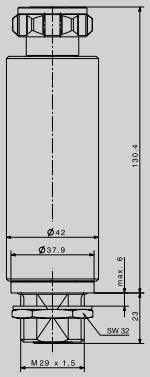


Fig. 4

Product accessories

Gas discharge tube (GDT)

HUBER+SUHNER gas discharge tube protectors are normally delivered without gas tube some times called gas capsule. This allows the customer to select the appropriate GDT according to his application conditions, especially the maximum operation signal voltage amplitude.
Exceptions: All protectors of the following series are supplied with properly installed gas discharge tube.

Protectors with replaceable gas discharge tube
- Series 3403 - fine protectors (for cube design types)
- Series 3409 - high-power/low-IM protectors
- Series 3410 - high-power/low-IM protectors with integrated high-pass filter and DC injection

Protectors with fix installed gas discharge tube (no replacement possible)
- Series 3403 - fine protectors (for barrel design types)
- Series 3404 - miniature gas discharge tube protectors
- Series 3406 - slim line gas discharge tube protectors
- Series 3414 - data line protectors

Specification	Requirements	Limits
Insulation resistance	100 V (50 V for 9071.99.0X48)	10^{10} Ω
Glow voltage	10 mA	~70 V
Arc voltage	>1 A	~10 V
Glow-arc transition current		< 0.5 A
Capacitance	1 MHz	<1 pF typ.
Impulse discharge current	30 kA, 8/20 µs 20 kA, 8/20 µs 8 kA, 10/350 µs 500 A, 10/1000 µs 100 A, 10/1000 or 10/700 µs	1 operation minimum >10 operations 1 operation minimum >400 operations >1000 operations
Alternating discharge current	65 A_{rms}, 11 cycles 10 A_{rms}, 1 s	1 operation minimum > 10 operations
Operating temperature		-40 to +85°C -55 to +125°C GDT only

Notes:
- Designed for operations exceeding 25 years
- GDT specification acc. international standard ITU-L K.12

Gas discharge tubes

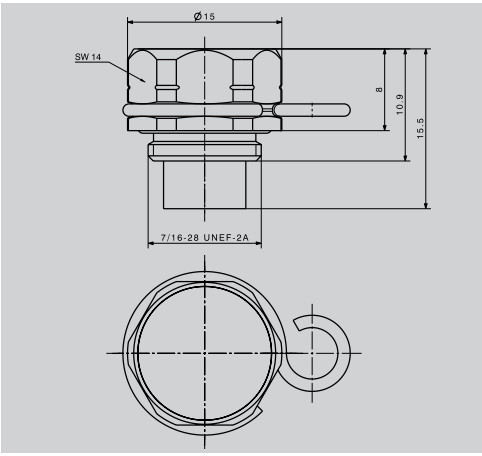
H+S type	U_{Zstat} (V)	U_{Zdyn} max. (V)	I_S 8/20 µs (kA)	I_{SG} 8/20 µs (kA)	U_{ARC} (V)	Dim. (mm)
9071.99.0547	230 ±15 %	675	20	30	10 - 15	6x8
9071.99.0548	90 ±20 %	500	20	30	10 - 15	6x8
9071.99.0549	350 ±15 %	875	20	30	10 - 15	6x8
9071.99.0550	470 ±15 %	1000	20	30	10 - 15	6x8
9071.99.0551	600 ±15 %	1100	20	30	10 - 15	6x8

Suitable for the following installed GDT holders:

Gas discharge tubes together with capsule holder

H+S type	U_{Zstat} (V)	U_{Zdyn} max. (V)	I_S 8/20 µs (kA)	I_{SG} 8/20 µs (kA)	U_{ARC} (V)	Dim. (mm)
9071.99.0447	230 ± 15 %	675	20	30	10 - 15	*
9071.99.0448	90 ± 20 %	500	20	30	10 - 15	*
9071.99.0449	350 ± 15 %	875	20	30	10 - 15	*
9071.99.0450	470 ± 15 %	1000	20	30	10 - 15	*
9071.99.0451	600 ± 15 %	1100	20	30	10 - 15	*

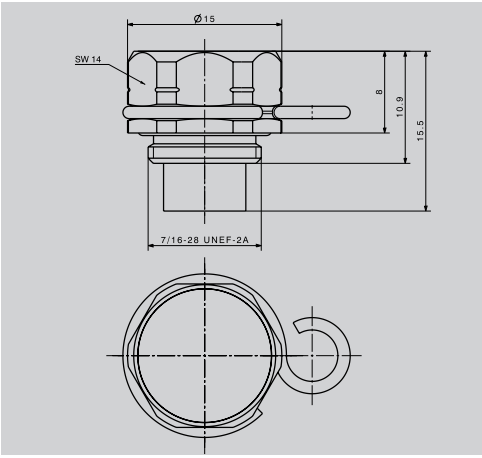
* 6x8 mm gas discharge tube same as of the tabel above together with holder with groove



Suitable for the following installed GDT holders:

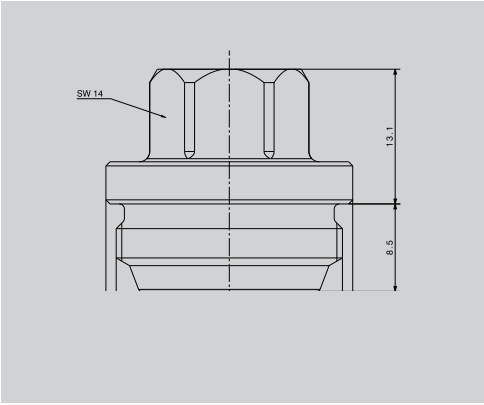
SEMPER™ GDT units for retrofit and replacement for series 3401 and 3402

H+S type	U_{Zstat} (V)	U_{Zdyn} max. (V)	I_S 8/20 µs (kA)	I_{SG} 8/20 µs (kA)	U_{ARC} (V)
9071.99.0647	230 ± 15 %	675	20	30	10 - 15
9071.99.0648	90 ± 20 %	500	20	30	10 - 15
9071.99.0649	350 ± 15 %	875	20	30	10 - 15
9071.99.0650	470 ± 15 %	1000	20	30	10 - 15
9071.99.0651	600 ± 15 %	1100	20	30	10 - 15



SEMPER™ GDT units for retrofit and replacement for series 3409

H+S type	U_{Zstat} (V)	U_{Zdyn} max. (V)	I_S 8/20 µs (kA)	I_{SG} 8/20 µs (kA)	U_{ARC} (V)	Figure
9071.99.0747	230 ± 15 %	675	20	30	10 - 15	Fig. 2
9071.99.0748	90 ± 20 %	500	20	30	10 - 15	



Definitions

U_{Zstat}

Static spark-over voltage – voltage which ignites the GDT in the case of a voltage rise of less than 100 V/ms. (acc. ITU-T K.12)

U_{Zdyn}

Dynamic spark-over voltage – max. voltage which ignites the GDT in the case of a voltage rise of 1 kV/µs. (acc. ITU-T K.12)

I_S

Impulse discharge current – peak value of a defined current pulse which is allowed to be applied at least ten times at intervals of 30 seconds without causing any significant changes of the spark-over voltage specification. Values are given for current pulse shape definitions of 8/20 µs (rise time/half-value period).

I_{SG}

Maximum pulse current – peak value of a defined single current pulse which can be conducted to ground once. For pulse shape refer to I_S.

U_B

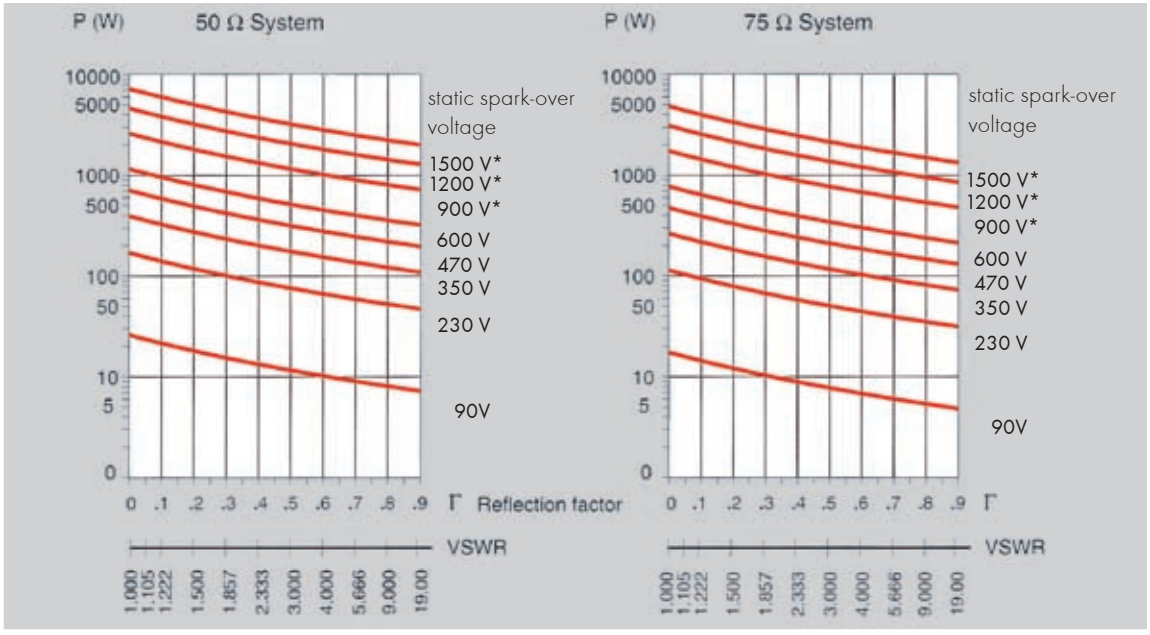
Glow discharge voltage – residual voltage across the GDT capsule when the discharge current operates the GDT in the glow state, typically at 10 mA.

U_{ARC}

Arc voltage – increasing current drives the GDT capsule into the arc state. The resulting voltage across the GDT is the arc voltage.

Selection of a suitable gas discharge tube

According to RF power transmission



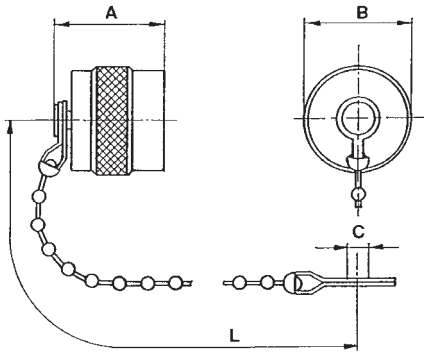
Diagrams of permissible RF power (CW or PEP) for 50 Ω and 75 Ω systems

* non standard values.

A calculation method for VSWR = 1 is explained in section 4, «How to select the right product», page 148.
For maintenance requirements please refer to page 156.

Accessories

Protective Caps



H+S type	Suitable for connector interface	Dimensions (mm/in)			
		A	B	C	L
62_BNC-0-0-15*	BNC (f)	17.0/0.67	14.5/0.57	4.0/0.16	≈ 62.0/2.44
62_TNC-0-0-1*	TNC (f)	17.0/0.67	16.0/0.63	4.0/0.16	≈ 62.0/2.44
62_N-0-0-9*	N (f)	21.0/0.83	20.5/0.81	4.0/0.16	≈ 115.0/4.53
62_7/16-0-0-1*/**	7/16 (f)	34.0/1.34	32.1/1.26	4.3/0.17	≈ 120.0/4.72

* Waterproof in connected condition

** Black plastic-coated steel cable

Mounting screw sets

Sets of stainless steel for screw mounting of protectors composed of:

- Screw
- Nut
- Tooth washer

H+S type	Thread size	Screw length	Wall thickness max.
9075.99.0096	M6	20 mm/0.79 in	4 mm/0.16 in
9075.99.0012	M8	20 mm/0.79 in	4 mm/0.16 in
9075.99.0023	M8	30 mm/1.18 in	14 mm/0.55 in
9075.99.0017	M8	40 mm/1.57 in	24 mm/0.94 in
9075.99.0108*	M8	30 mm/1.18 in	12 mm/0.47 in.

* with additional washer recommended for protectors made of aluminium

Mounting washer nut sets

Standard sets without O-ring composed of:
- Washer
- V-washer (soft copper)
- Nut

according to protector design and original delivery

H+S type	Suitable for protectors with mounting hole (MH dimensions refer to page 34 – 35)
9075.99.0036	MH12, MH24, MH50, MH71, MH119 (nut thickness 4.75 mm / 3/16")
9075.99.0043	MH25, MH70
9075.99.0074	MH72, MH74, MH101
9075.99.0086	MH80, MH118
9075.99.0085	MH69

Special sets composed of:
- Washer
- V-washer (soft copper)
- Nut
- With O-ring

according to protector design and original delivery

H+S type	Suitable for protectors with mounting hole (MH dimensions refer to page 34 – 35)
9075.99.0039	MH80, MH118
9075.99.0040	MH72, MH74
9075.99.0041	MH12, MH24, MH50, MH71 (nut thickness 3.30 mm / 1/8")
9075.99.0042	MH12, MH24, MH50, MH71 (nut thickness 4.75 mm / 3/16")

Blanking plugs

Blanking plugs can be used to seal bulkheads or panels, where optional lightning EMP protectors are not yet installed.

The included soft-copper washer provides both water/dust protection and excellent RF shielding.

H+S type	Suitable for mounting hole (MH dimensions refer to page 34–35	Thread length
9075.99.0056	MH12, MH24, MH50, MH71	11.5 mm/0.453 in
9075.99.0058	MH72	23.6 mm/0.929 in
9075.99.0061	MH74	23.6 mm/0.929 in
9075.99.0064	MH12, MH50	22.4 mm/0.882 in

Grounding rings
cable terminals for HUBER+SUHNER lightning EMP protectors with N and TNC interface

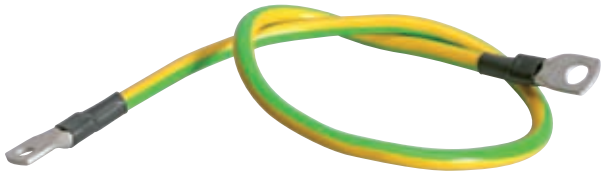
To be applied directly on the bulkhead fixation thread of the protector, if it is not possible to provide a proper bonding/grounding via bulkhead. Installation outside of the protected area recommended.

H+S type	Suitable for mounting hole or screw diameter	Mounting hole
9075.99.0026*	< 17 mm/ 0.669 in	MH12, MH24, MH50, MH71, MH119
9075.99.0027*	17...20 mm/ 0.669 ... 0.787 in	MH25, MH70
9075.99.0031*	screw 6 mm/ 0.236 in (1/4")	
9075.99.0032*	screw 8 mm/ 0.315 in	

* Recommended grounding wire size AWG 6 (16 mm^2)

Grounding cables

Customized grounding cables made from grounding wire AWG 6 and fitted with cable terminals are available on request.



Mounting brackets

Brackets for bulkhead mounting of protectors

- Right angle design made from # 8 gauge (3.3 to 4.2 mm) copper sheet
- Each face features 4 wall mounting holes of size 6.7 mm/0.265 in diameter
- Dimensions:
  - large hole face: 76x76 mm (3.00x3.00 in)
  - small hole face: 50x76 mm (2.00x3.00 in)

H+S type	Suitable for protectors with mounting hole – face 1 – face 2	Figure
9075.99.0028	MH 69 MH 12, 24, 50, 71, 119	Fig. 1
9075.99.0030	MH 80, 118 MH 25, 70	Fig. 2
9075.99.0095	MH110	Fig. 3
9075.99.0105*	MH12, MH24, MH50, MH71, MH119	Fig. 4
9075.99.0106*	MH25, MH50, MH70, MH170	Fig. 5

* Material: aluminium

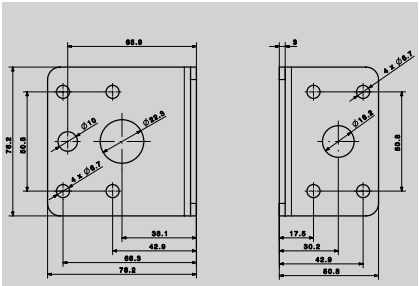


Fig. 1

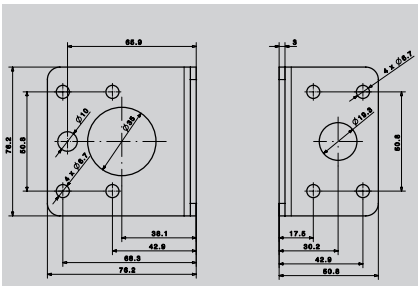


Fig. 2

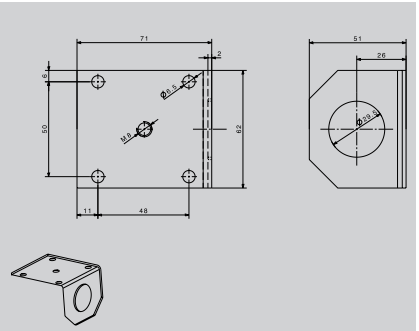


Fig. 3

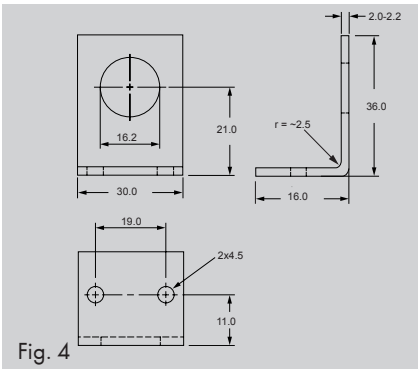


Fig. 4

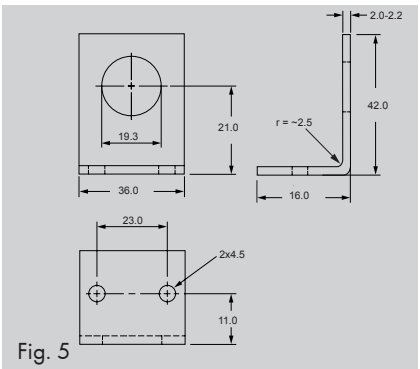


Fig. 5

Grounding kits for coaxial cables

HUBER+SUHNER series 9076 grounding kits enable reliable grounding of today's usual corrugated copper tube and RG cables for radio transmitter antenna installations.

Features

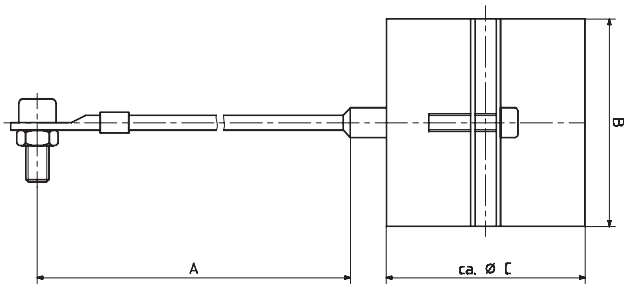
- Quick and easy installation
- No loose piece parts
- Low contact transition resistance (1 mΩ max.)
- Grounding cable AWG6 (16 mm2)
- Current handling capability 100 kA 8/20 µs, 25 kA 10/350 µs
- Waterproof IP67
- Corrosion resistant

Material data

Component part	Material
Metal mounting parts	stainless steel
contact part	copper
Gasket	EPDM

Grounding kit N-style

Straight grounding cable connection
Right angle to corrugated copper tube cable

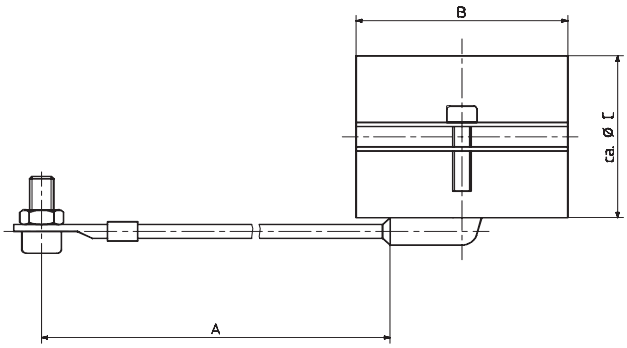


H+S type	For cable size Sucofeed,Andrew,Nokia,Kabelmetal, RFS,Eupen,etc.	"A" (mm)	"B" (mm)	"C" (mm)	Stripping length	Grounding screws	Weight (g)	Cable diameter (mm)
9076.99.N014	1/4", RG213/214*	840	50	28	26	M8	250	10 - 11
9076.99.N038	3/8"	840	50	28	26	M8	250	12 - 13
9076.99.N013	1/2" highflex	840	50	32	26	M8	260	13 - 14
9076.99.N012	1/2"	840	50	32	26	M8	260	16 - 17
9076.99.N078	7/8" / 7/8" highflex	840	50	44	26	M8	290	26 - 28
9076.99.N114	1 - 1/4"	840	70	59	26	M8	500	38 - 40
9076.99.N158	1 - 5/8"	840	70	69	30	M8	530	50 - 52

* Including 3/8" highflex

Grounding kit P-style

Parallel grounding cable connection
Alligned to corrugated copper tube cable

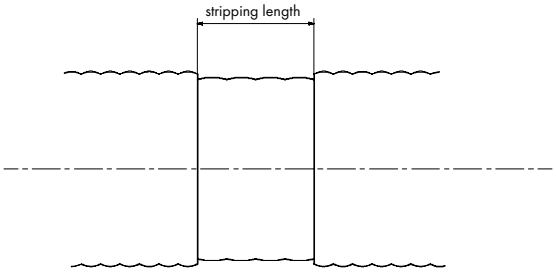


H+S type	For cable size Sucofeed,Andrew,Nokia,Kabel metal,RFS,Eupen,etc.	"A" (mm)	"B" (mm)	"C" (mm)	Stripping length (mm)	Grounding screws	Weight (g)	Cable diameter (mm)
9076.99.P014	1/4", RG213/214*	840	50	28	26	M8	250	10 - 11
9076.99.P038	3/8"	840	50	28	26	M8	250	12 - 13
9076.99.P013	1/2" highflex	840	50	32	26	M8	260	13 - 14
9076.99.P012	1/2"	840	50	32	26	M8	260	16 - 17
9076.99.P078	7/8" / 7/8" highflex	840	50	44	26	M8	290	26 - 28
9076.99.P114	1 - 1/4"	840	70	59	26	M8	500	38 - 40
9076.99.P158	1 - 5/8"	840	70	69	30	M8	530	50 - 52

* Including 3/8" highflex

Stripping dimensions

Concerning the necessary cable jacket length which has to be removed, refer the tables above, column «stripping length». Select according to type number.



The mounting instruction is shipped with every kit.
It can also be obtained as download from our homepage (LP accessories) or the catalogue CD-ROM.

Space for your notes

Application notes

Application notes

How to select the right product

Most important decision criteria are the following:

- Transmission frequency range
- DC on the line (or DC injection), e.g. for powering of remote/outdoor equipment
- Protection requirements (surge current handling capability, residual pulse)
- RF requirements (RL, IL, PIM)
- Environmental requirements (outdoor operation)
- Dimensions
- Interfaces
- Mounting/grounding requirements
- Selection of the gas discharge tube for GDT lightning EMP protectors

These criteria have to be considered within the provided selection flow chart on the inner back cover.
(For special applications contact HUBER+SUHNER AG via your local representative,
Internet www.hubersuhner.com or the headquarter Switzerland.)

Selection according to surge-current-handling capability

The following table shows the surge-current-handling capability of HUBER+SUHNER lightning EMP protection device on the basis of the standardized test pulses:

Principle	Series	Connector interface	Surge current handling capability with	
			test pulse 10/350 µs	test pulse 8/20 µs
Gas discharge tube	3401, 3402, 3403, 3408, 3409, 3410	N and DIN 7/16	8 kA	30 kA
Gas discharge tube	3406	all interfaces	2.5 kA	10 kA
Quarter-wave stub	3400, 3407	DIN 7/16	50 kA	100 kA
Quarter-wave stub	3400, 3407	N	25 kA	50 kA

Selection of the surge protection gas discharge tube

RF power

A total of eight GDT with different static spark-over voltages are available. To select the correct GDT, the following criteria must be known:

- Max. RF transmission power P (CW or PEP)
- Supply voltage U_{DCsup} if used for remote powering
- System impedance Z
- Max. allowable VSWR (system adjustment)

The required static spark-over voltage (refer to tables on pages 131 and 132, consider the lowest possible voltage from the tolerance range!) is 1.5 times of the total peak voltage on the transmission line. The following formula is applicable for the peak voltage, if VSWR=1.

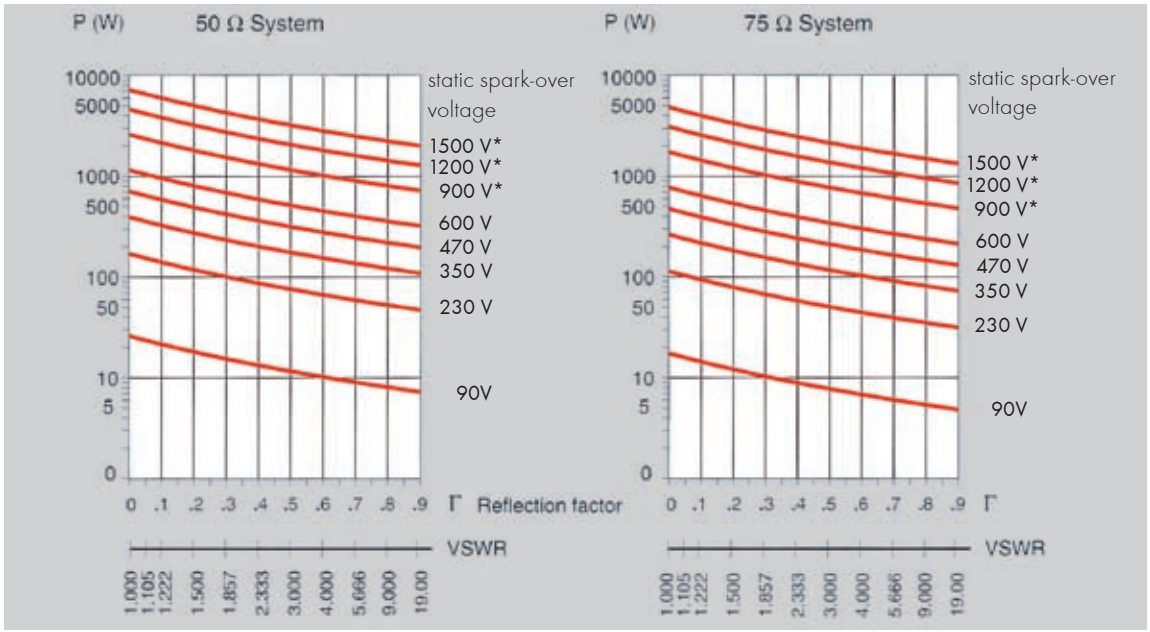
$$U_{zstat} \geq 1.5\ \hat{U}_{max.} \qquad \hat{U}_{max.} = \sqrt{2\,PZ}\ \ (1 + \Gamma) + U_{DCsup}$$

For multicarrier systems, the (inphase) peak voltage must be calculated as the total of all single peak voltages:

$$\hat{U}_{max.} = (\hat{U}_1 + \hat{U}_2 + \ldots\ \hat{U}_n)(1 + \Gamma) + U_{DCsup} = \left(\sqrt{2\,P_1Z} + \sqrt{2\,P_2Z} + \ldots + \sqrt{2\,P_nZ}\right)(1 + \Gamma) + U_{DCsup}$$

This consideration does not involve effects of the modulation. They have to be added according to the selected modulation principle.

The admissible RF power transmission (CW or PEP) versus the VSWR is shown in the following diagram for HUBER+SUHNER gas discharge tube.



Diagrams of permissible RF power (CW or PEP) for 50 Ω and 75 Ω systems
* non standard values

Basic installation and grounding rules

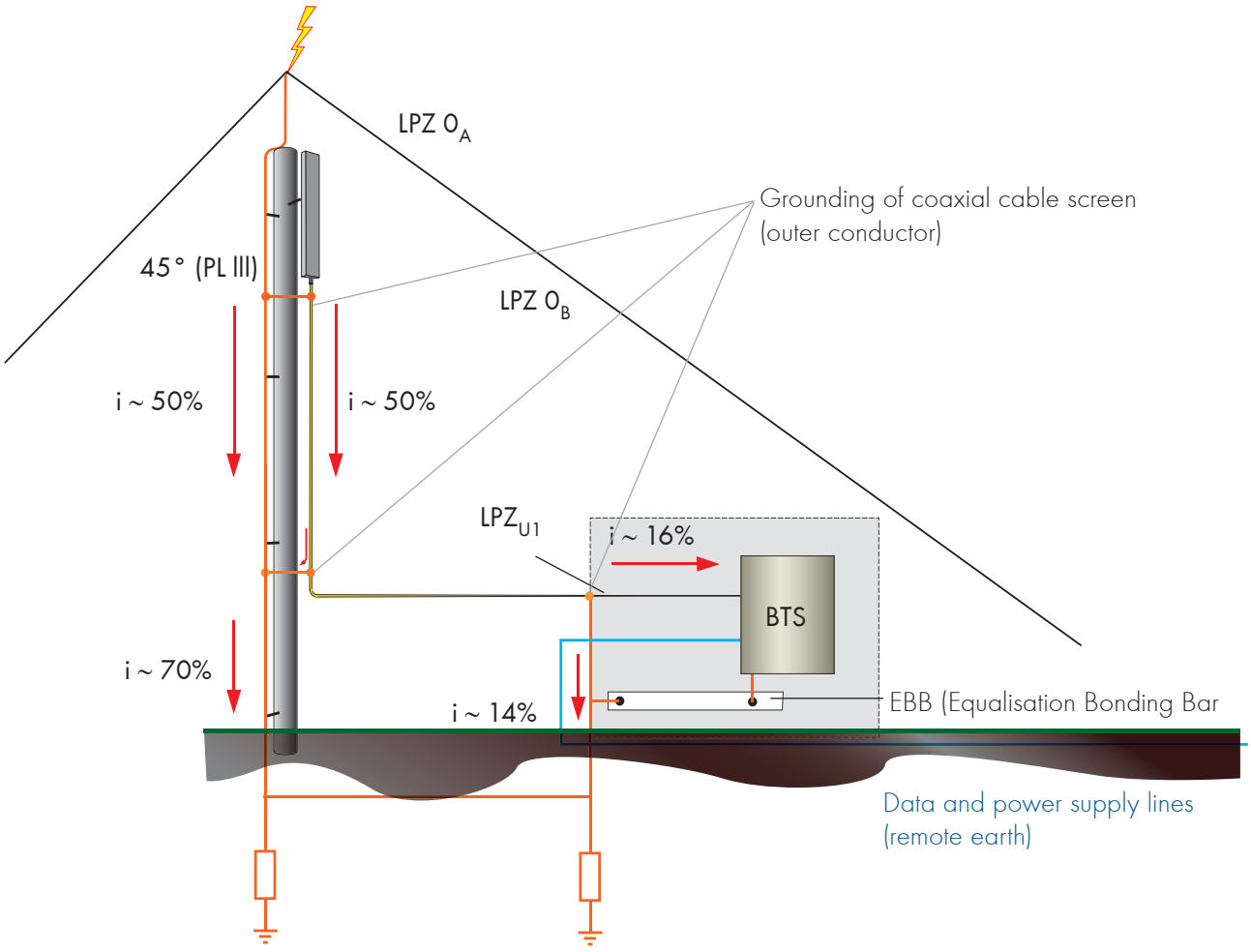
General protection recommendations

Model base station antenna system

Direct and indirect lightning strokes are mainly accompanied by resistive and magnetic coupling processes of their electrical energy. Capacitve coupling effects of surge energy by the high and fast-changing electrical field just before the lightning stroke occurs are negligible, if the system is well bonded to earth (electrical charge equalization).

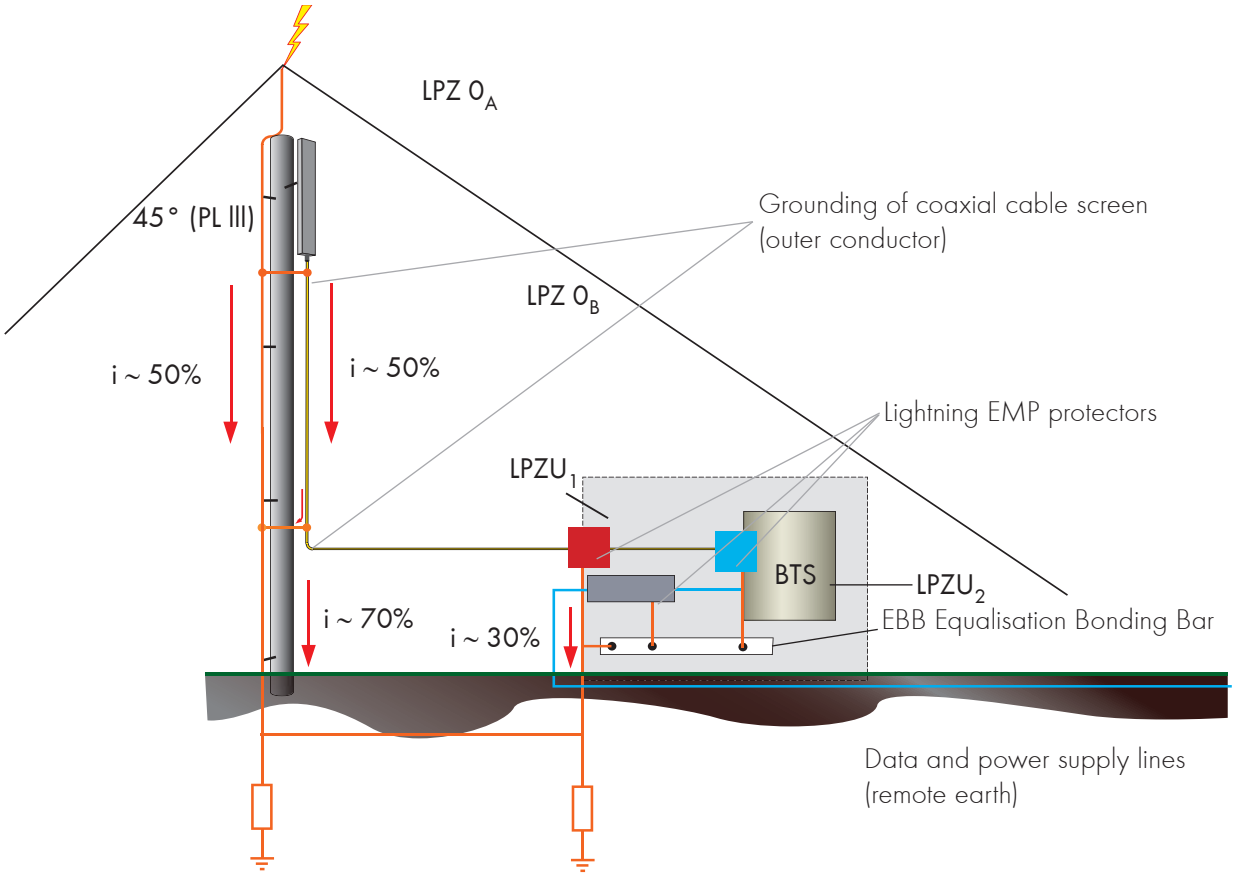
The following figure shows the lightning current distribution after a stroke into the antenna mast, respectively into the lightning protection system, caused by resistive coupling (equal current distribution as proven assumption according to IEC 62305, protection against lightning:

Current distribution without application of lightning EMP protection device



LPZ: Lightning protection zone
PL: Protection level (according to IEC 62305)

The following illustrates the resistive current distribution with lightning EMP protection device (e.g. quarter-wave shorting stub protectors) in detail:



Recommendations

Antennas or radio equipment should be located within the protection zone of the external lightning protection system (LPS)(according to IEC 62305, protection against lightning: air-terminations, down-conductors and earth-termination) – LPZ 0_B. It is established as a 45° area downwards, related to the highest point of the air-termination as shown (assumption for a mast height up to
20 m and the protection level PL III according to IEC 62305).
LPZ 0_B can principally be evaluated by the application of the sphere model according to IEC 62305, which allows to determine LPZ 0_B for even more complicated structures.

Thus, the antenna or radio equipment is protected against direct lightning strokes with a probability of 90% (PL III according to IEC 62305). But the electromagnetic field still acts unattenuated!

By the bonding of the antenna earth, radio equipment or upper-cable end screen to the down-conductor of the mast or the building surge voltages caused by magnetic coupling of direct and near lightning strokes into loops through earth can be avoided. If not done, the cables would have to be protected magnetically by iron tubes (which would also protect the inner conductor of coaxial cables).

Low-frequency short-circuit connection of antennas against down-conductor (e.g. shunt-fed antennas or application of quarter-wave protectors). This helps avoiding a high surge voltage and therefore a possible undefined breakdown in the cable due to magnetic coupling of direct and near lightning strokes into loops across earth or remote earth). Direct-stroke-initiated partial lightning currents over the coaxial cable screen would otherwise cause together with the measure of the previous section undefined cable breakdown by the voltage drop against earth (as the inner conductor can have zero potential).

Bonding of the cable screen to the down-conductor where it leaves the mast and with higher masts every 20 m. Thus, a potential equalization is achieved and the current over the cable screen to earth is reduced, as the down conductor has a lower impedance.

Application of coaxial cables with low DC resistance over inner and outer conductor (e.g. corrugated copper tube cables of as large size as possible – larger size means also higher dielectric withstanding voltage).

Application of reliable lightning EMP protection devices at the entry of LPZ 1. Thus, high partial lightning and induced currents (test pulse 10/350 µs according to IEC 62305) can be led to earth and overvoltages are reduced to a low level (potential equalization). HUBER+SUHNER ran several tests to evidence the necessity of this measure. The cables RG 213, LMR 400, LDF 4-50A (1/2") and LDF 5-50A (7/8") were measured in the case of a resistive/inductive equipment input:

Measurement of the longitudinal voltage over the inner conductor

- Here a test surge current of pulse shape 8/20 µs and 10/350 µs was sent into a 1 m piece of cable, inner and outer conductor connected at the input, output screen connected to earth and inner conductor to the oscilloscope input.
- Most important result: applying the 8/20 µs test pulse with 25 kA amplitude (half of the assumed load of the model antenna system, as 100 kA is the total lightning current according to PL III) leads to a calculated (if a cable lengths of 10 m is assumed, for example) longitudinal voltage of:
  RG 213: 867 V
  LMR 400: 1438 V
  LDF 4-50A: 356 V
  LDF 5-50A: 133 V

The longitudinal voltage is proportional to cable length and partial lightning current amplitude!

Measurements with lightning currents of pulse shape 10/350 µs resulted as expected in longitudinal voltages of smaller amplitude (due to the lower rise time) but much higher pulse energy.

In case of DC selection over the coaxial cable to supply power for remote active electronic circuits in the antenna system, only gas discharge tube lightning EMP protectors can be employed. The residual pulse voltage behind the protector reaches up to several hundred volts over some nanoseconds, dependent on the selected gas discharge tube.

This requires additional protective devices for sensitive input circuits of electronic equipment. They can be located directly behind the gas discharge tube lightning EMP protector (or be a combined arrangement), if the equipment to be protected is nearby. Normally they should be placed at the entry of next protection zone, if a consequent zone concept is being followed (e.g. LPZ 2 – according to IEC 62305 every zone transition requires a separate lightning/surge protection device). The additional protector – here called surge suppressor due to its function – reduces the surge pulse voltage to a well-tolerated extent of only a few volts (e.g. HUBER+SUHNER fine protectors).

Coaxial cable

Such a surge suppressor is not only required due to the leftover residual pulse of the gas discharge tube lightning EMP protector, but also due to magnetic coupling into the possible loop which the antenna cable length between the lightning EMP protector and the equipment is part of (within zone LPZ 1). This is illustrated by the following:

Thirty meters of coaxial cable can form together with other signal, energy or bonding connections large induction circuits, which produce induced voltages of several hundred kV. Already the coaxial cable alone can act as an induction circuit for the strong magnetic fields of near lightning strokes, if not specially screened.

The induced voltage can be calculated with the following formula:

$U = - M_2 * di/dt$ (M_2 – mutual inductance of the loop, i – lightning current).

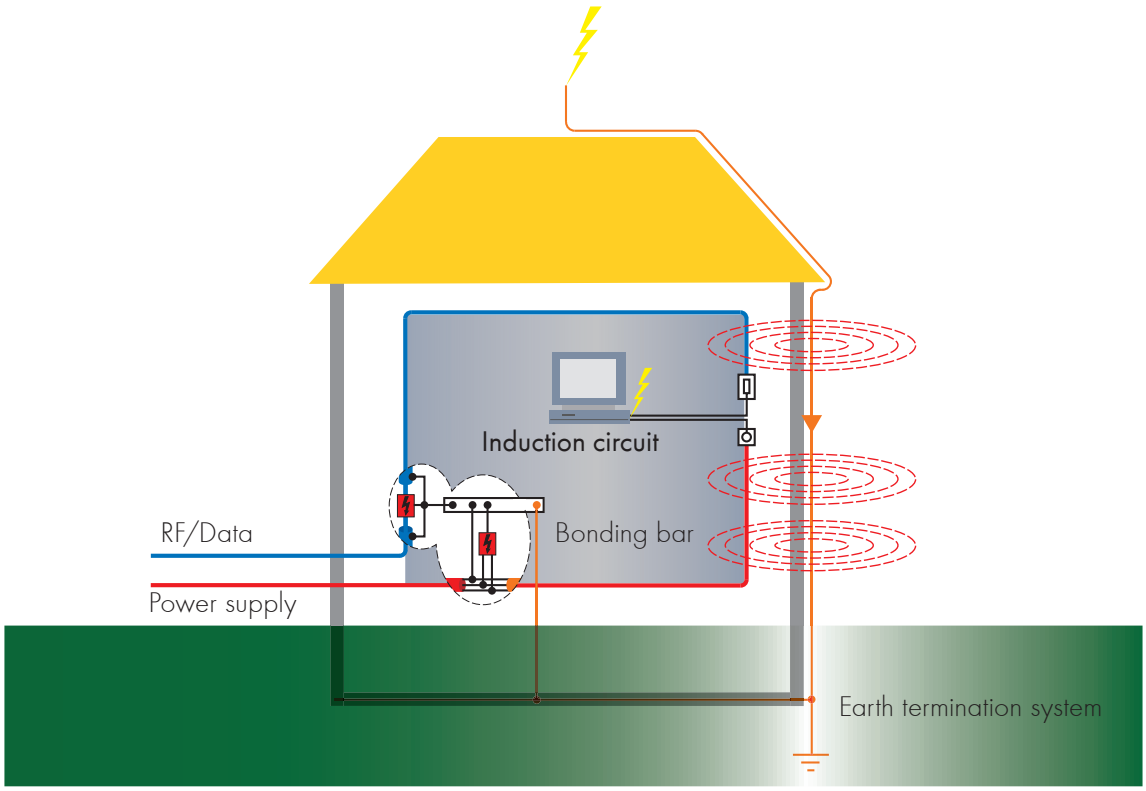
First partial lightning strokes show a current rate of change of up to 20 kA/µs, subsequent lightning strokes even of up to 200 kA/µs. The loop inductivity depends on the loop circumference and on the distance to the lightning stroke channel. Larger loops – e.g. 40 m – possess a M_2 of about 1.5 mH at a distance of 10 m; with a distance of 1 m it increases to about 5 mH. Therefore, induced voltages ranging from 24 to 1000 kV can be produced.

Measures to minimize or compensate in-house lightning induction effects:

- Application of surge protectors and suppressors
- Short cable lengths
- Magnetic screening of cables (steel tubes/cable tunnels)
- Magnetic screening of the complete structure (Faraday shield)
- Distance to the possible lightning current channel as large as possible
- Hybrid earth-grounding system – single-point grounding, suitable line routing

Active electronic circuits in the antenna and additional line amplifiers have to be protected against surge pulses supplied from the connected coaxial cables (application of lightning EMP protectors and surge suppressors, high-pass not allowed with DC injection) and if possible also against magnetic coupling. Concerning the otherwise occurring surge load refer to section application of reliable lightning EMP protection devices.

For a complete lightning/surge protection of a base station, you must consider all further connected signal and power supply lines. They have to be protected under similar considerations. HUBER+SUHNER can recommend certain reliable lightning protection solutions for these purposes.



Mounting and grounding recommendations

The HUBER+SUHNER lightning EMP protector product range offers a high flexibility to meet mounting and grounding requirements in the field. Basically all mounting options are simultaneously suitable for grounding purposes.

HUBER+SUHNER offers:

Bulkhead mounting

Preferred mounting/grounding!

- Protection zone principle
- Lowest contact resistance
- Corrosion-resistant contact zone
- Waterproof wall sealing
- RF leak-proofness
- Vibration resistance

- Screw mounting and
- Bracket mounting

For best protection according to IEC 62305 when establishing protection zones consequently, it is recommended to deploy bulkhead mounting facilities. Thus the protectors can be installed as wall feed-through directly in the wall of the protected room. Doing so, the protectors should be installed consequently with the surge down conducting part – quarter-wave stub or gas discharge tube – outside of the protected area not to cause any unnecessary interferences when dissipating surges. (This is reflected by the recommendations and definitions for «unprotected and protected side» of the device tables. Bulkhead mounting types and all high-pass filter types are marked accordingly.)

The special HUBER+SUHNER bulkhead fixation design automatically enables a good long-term performance concerning a waterproof bulkhead transition, a corrosion-resistant (gas-tight) contact area resulting in a stable contact to the bulkhead ground-plane, a low transition resistance and a vibration-resistant mounting of the protector (assuming the right sufficient torque forces are applied as shown in the supplied assembly instructions).

This is true for standard sheet metal bulkheads such as stainless steel, copper or passivated aluminium with standard surface roughness and mounting holes according to the related HUBER + SUHNER product mounting hole specification.

For other mounting solutions care has to be taken for minimum interference. But generally all mounting options can carry the specified surge current when properly installed.

Grounding/bonding rules!

For a good grounding respectively bonding the following has to be considered:

- During installation, the lightning EMP protection device must be connected with the central grounding point of the equipment (EBB Equalisation Bonding Bar) in a low-resistance and low-inductance way. Inadequate grounding concepts with ground loops, insufficiently sized grounding cables (smaller than 16 mm^2/AWG 6), poor connections, etc., will increase the residual energy behind the lightning EMP protector as a result of high impedance (ohmic resistance by length and size and in addition inductance by length).

- The contact points of the ground connection must offer good electrical conductivity (contact points must be bare and free from dirt, dust and moisture).

- When threaded contacts are tightened (bulkhead grounding, GDT capsule holder), the minimum torque specified by the manufacturer must be observed in order to minimize the contact resistance and to establish the effects mentioned above.

- The lightning EMP protection devices should wherever possible be located in the unprotected zone in order to rule out inductive interference.

- HUBER+SUHNER lightning EMP protection devices are characterized by their quick, easy, and at the same time reliable installation methods. The preferred variant is single-hole mounting as wall feedthrough. They can be applied with round or with D- or H-shaped also called double-D-shaped mounting holes to prevent rotation. The mounting hole size is matched to the connector size and thereby to the forces acting on the device.

All this is crucial for achieving the lowest possible residual surge pulse (voltage and energy) on the protected side and with it keeping the interference load for the equipment as low as possible.

All HUBER+SUHNER lightning EMP protection devices are supplied along with an installation instruction describing the proper installation procedure.

For more detailed information on mounting and grounding please see page 166.

Maintenance requirements

Quarter-wave lightning EMP protectors

Quarter-wave lightning EMP protectors are basically maintenance-free. However, we recommend customers to check the condition of the grounding/bonding system connections and of the connector interfaces in the context of routine system maintenance. But connector interfaces which are heavily damaged by lightning current overload (in excess of specification) will lead to increased reflections and will be detected by the return loss tracing circuit of the transmitter anyway. Field experience shows that lightning EMP protectors are not the only devices which can be affected in such cases of direct hits.

Gas discharge tube lightning EMP protectors

Gas discharge tube protectors use different technology, but are still very reliable products. The MTBF value determined by the carefully selected HUBER+SUHNER gas discharge tube is about 10 FIT (FIT: Failure in Time, 1 FIT is defined as 10^{-9} h^{-1}) – one failure within 10^8 hours. This is true, as long as no events of critical surge current load occur.

A degradation of the gas discharge tube is possible due to surge current overload and multiple loads at the specification limit. But a lot of tests previously conducted reveal that there is a large safety margin built in to HUBER+SUHNER gas discharge tubes. Even with excessive overload the GDT maintain at least their dynamic switching performance (dynamic spark-over voltage specification) which determines the residual pulse amplitude left by transient surges of lightning events.

Any destruction of the GDT due to a heavy overload would lead to a short, due to its unique and special design, and therefore shutdown the transmitter. This will be recognised immediately. But this is most probably not the only system damage in such cases and a service will be necessary anyway. HUBER+SUHNER protectors feature an easy access to the GDT and the exchange is quickly made.

Generally, inspection and maintenance schedules depend on the grade and frequency of surge loads. This is determined by the isokeraunic level (number of thunderstorm days, which decreases with latitude) of the operation area and several factors which determine the exposure of the equipment (e.g. altitude, country profile, nearby structures, water, etc., and even the existence of a lightning protection system). This is the reason that only the operator or his local consultant can judge the inspection requirements of their equipment (e.g. BTS), according to the actual exposure.

Recommendation!

We recommend as a general rule to test the static spark-over voltage of the gas discharge tube in the course of a routine inspection every 5 years and to exchange the failing parts. A suitable test unit can be supplied by HUBER+SUHNER (type 9075.99.0053).

As an alternative, a general overall replacement without testing might be more cost-effective in certain situations.

After a direct hit which caused damages in the antenna system, the GDT of the gas discharge tube protectors involved should be exchanged during the service in any case.

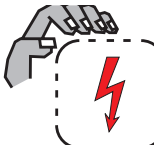
IP Dust and water protection rating

This section is intended to provide a short overview and essentials of the classification only. For more details refer to the latest original publication IEC 60529 (direct ordering or list of local sources via Internet www.iec.ch).

IP rating (IP XY)

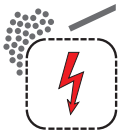
First number X
Protection against ingress of solid objects

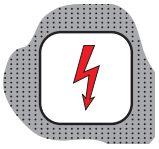
0  No protection

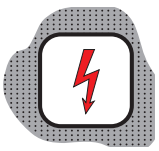
1  Protection against objects larger than 50 mm diameter

2  Protection against objects larger than 12.5 mm diameter

3  Protection against objects larger than 2.5 mm diameter

4  Protection against objects larger than 1.0 mm diameter

5  Protection against dust (limited ingress, not harmful)

6  Protection against dust (dust-tight, no ingress)

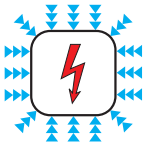
Second number Y
Protection against ingress of water

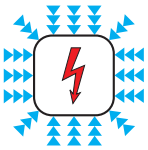
0  No protection

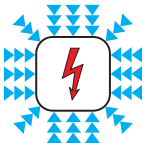
1  Vertically dripping water

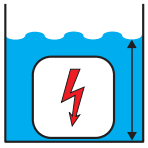
2  Dripping water, 15° tilted

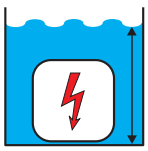
3  Spraying water

4  Splash water

5  Water jets

6  Powerful water jets

7  Temporary immersion (test 1 m, 30 min.)

8  Continuous immersion (test to be agreed, but exceeding no. 7)

Passive intermodulation issues

All PIM-specified HUBER+SUHNER lightning EMP protectors and their piece parts are designed according to the latest knowledge of PIM theory and practice. This is a continuous, progressive process.

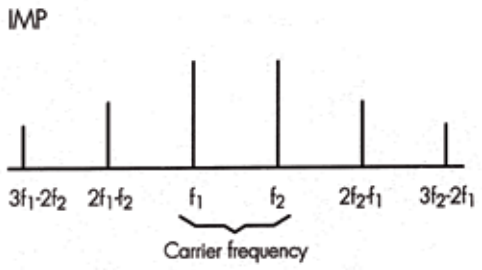
Generation of Passive Intermodulation Products (PIM)

- Non-linear behaviour of elements in signal path used with more than one carrier generates IM.
- The occurring spectral lines of the IMP can be described as:

$$f_{IM}x = mf_1 + mf_2 + \ldots + y\,f_m$$

where $f \ldots f_m$ are the used carrier frequencies
$m \ldots y$ are pos. or neg. integers
f_{IMx} =frequency of one generated IMP

IM spectrum by use of two carrier frequencies

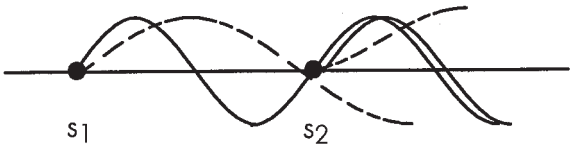


- Absolute linearity exists only as a mathematical idealization – passive elements are all weakly non-linear.
- Problem with PIM only occurs by:
  - High transmit levels
  - High receiver sensitivity
  - Several transmit channels and
  - Where only one antenna for transmission and receive path is used.
- Once in receive band, PIM cannot be reduced by filtering.
- In passive elements there are some dominant contributors of non-linearity:
  - Similar or dissimilar metal-to-metal joints
  - Plasma effects (local high fields causing
  - Corona)
  - Magnetic non-linear effects
  - High-current density
- For cable and connectors the metal-to-metal joints are the most significant PIM contributors.
- Gold, silver, copper, brass and copper-beryllium joints generate low PIM; steel, aluminium, stainless-steel-joints generate higher PIM.

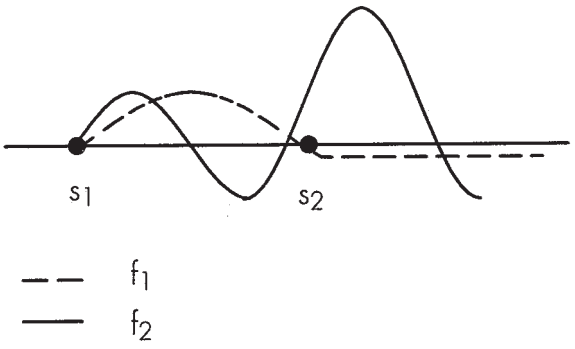
In practice:

- The IM level generated over the whole signal path is a result of many IM sources. The value of the resulting IM level depends on the phase relation of all these sources (constructive or destructive interference). This phase relation varies with frequency.

IMP of two sources



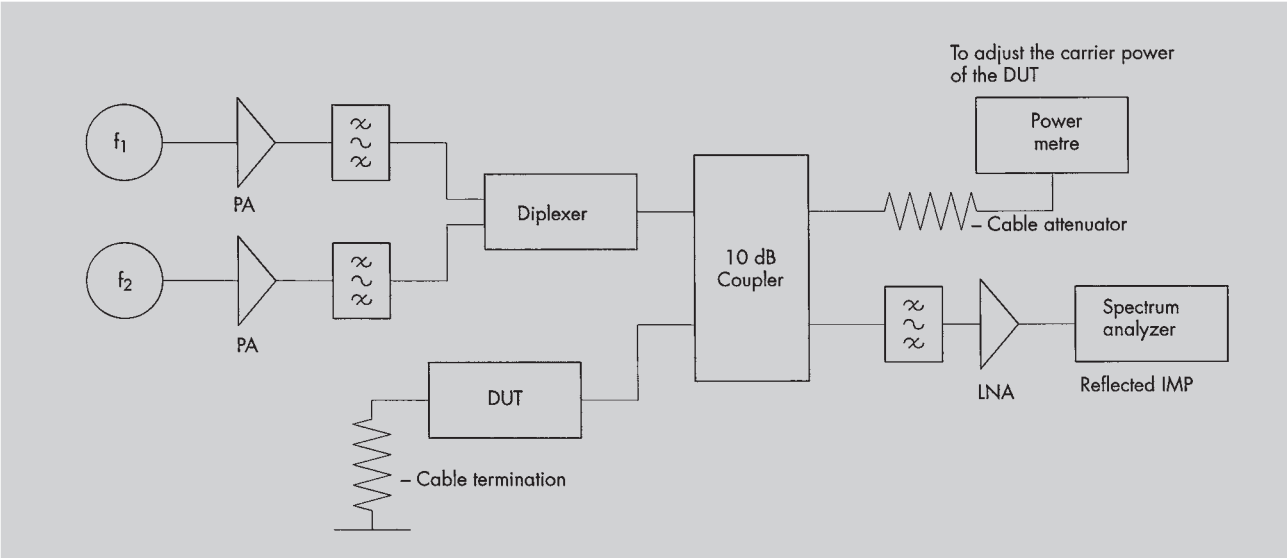
Resulting product



Relation between frequency and IM level

- IMP's of different order have different frequencies, and hence the resulting product does not have a constant amplitude.
- PIM's of different measurement setups are not exactly comparable (because of the different phase relations).
- The 3rd order IMP's have the higher value and normally are used to describe the IM behaviour of the device under test (DUT).
- In theory the IM level increases 3 dB per 1 dB power increase of the carriers. So, it is important when comparing different measured IM levels to consider the input power level. A standard value for input power is 2 x 20 W or 2 x 43 dBm.
- All elements in the measurement setup generate IM. This ground level limits the measurement range (-120 dBm ⇔ -120 dBm - 43 dBm = -163 dBc).
- It is not possible to measure a single connector. Only assemblies can be measured.
- The measured level can vary up to 40 dB by vibration or bending of the cable. So we have to know if the application of the assembly is mechanically static or dynamic.
- It is difficult to give a typical value for a connector. It depends on the method of mounting (remove cable isolation, crimping, clamping, soldering and contamination).

HUBER+SUHNER measurement setup



Electrochemical potential differences – outdoor applications

General consideration

When installing and grounding lightning EMP protection device, consideration must be given to the electrochemical potential difference existing between the metallic housing parts of the device and the mounting walls or other fastening and contact elements.

According to MIL-F-14072, the magnitude of the potential difference should not exceed 250 mV in order to minimize possible electrochemical corrosion. The following table shows the associated potential differences of the most important metals and galvanically applied metal surfaces for the applications under consideration.

Magnitude of the electrochemical potential difference between different surface metals Values in V	Gold	Silver	Nickel	SUCOPLATE® and commercial alloys of copper	Stainless steel	Chromium	Tin	Aluminium
Gold	0.00	0.15	0.30	0.40	0.50	0.60	0.65	0.75
Silver	0.15	0.00	0.15	0.25	0.35	0.45	0.50	0.60
Nickel	0.30	0.15	0.00	0.10	0.20	0.30	0.35	0.45
SUCOPLATE® and commercial alloys of copper	0.40	0.25	0.10	0.00	0.10	0.20	0.25	0.35
Stainless steel	0.50	0.35	0.20	0.10	0.00	0.10	0.15	0.25
Chromium	0.60	0.45	0.30	0.20	0.10	0.00	0.05	0.15
Tin	0.65	0.50	0.35	0.25	0.15	0.05	0.00	0.10
Aluminium	0.75	0.60	0.45	0.35	0.25	0.15	0.10	0.00

Important

The classification according to ASTM D1141-90 conforms to MIL-F-14072 and has proved convenient for contacting metals in electronics. It must not be confused with the academic consideration of chemistry textbooks. The tables shown there refer to a gas reference electrode and a salt solution of the specimen metal between the electrodes.

Special case consideration – transition of lightning EMP protectors to bulkheads and panels made from steel or aluminium.

Concerning the electrical and mechanical performance of the flange mount version of HUBER+SUHNER lightning EMP protectors, the following two issues are of significance:

- Impedance of the link between lightning EMP protector and ground bar/entry plate.

The transfer resistance between lightning EMP protector and panel is not the only contributor to the total impedance of the connection to the ground bar. Much more important is the inductance formed by other parts of the link, as lightning strikes cause transient voltages and currents with rise times of only a few microseconds.

In general every contribution to the impedance should be as low as possible. This means that for the transition between lightning EMP protector and panel, one needs to use materials of very good conductivity and to be very careful when assembling (clean contact areas).

HUBER+SUHNER supplies with all its bulkhead versions a corrosion-protected soft-copper washer with the well-proven SUCOPLATE coating. This washer features a V profile, which is pressed into the mating material with a very high force when the fixation nut is tightened. Thus, several effects occur:

- The soft copper washer adjusts to the surface of the bulkhead material and levels any customary production surface roughness.
- Thin surface plating is broken, and a direct material contact between the copper of the washer and the base metal of the panel is created.
- Water-protected contact areas are established.
- The transition is made simultaneously RF-tight.

This yields the following for cold rolled steel, zinc- plated and chromated entry plates:

The brittle chromate layer is usually less than 0.1 mm thick (typically about 0.02 mm) and the zinc layer is only a few µm thick. Upon assembly, both layers are broken up, and a contact between copper and steel is formed.

Aluminium sheet metal with similar plating behaves equally, and contact between copper and aluminium is produced.

In tests it is shown that the contact resistance of such transitions is generally below 1 mΩ. The resistive contribution to the total impedance is negligible and does not affect the conduction of lightning currents to ground.

When conducting away lightning currents, assurance needs to be given that a good conductive path is created, even when a reduced number of active contact points at the transition are present. Due to the high currents caused by a lightning strike, conductive paths are created (melted open) in a sufficient way.

- Corrosion at the bulkhead transition

The corrosion performance under the influence of water is determined by the electrochemical potential difference between the metals being in contact (refer to the table shown in the previous section).

As a result of some studies it can be concluded, that thin metal layers of only a few µm do not change the potential differences of the contacting base materials significantly. Moreover, the influence of the plating is reduced by the effects described under section one.

Therefore, an effective potential difference of 0.10 V can be assumed at the transition to cold-rolled steel plates (between copper and stainless steel). Thus, the material combination is both from theoretical and practical aspects not susceptible to electrochemical corrosion under the influence of moisture. (For low-alloy steel, the potential difference increases slightly.)

At the transition to aluminium, the permitted range is exceeded based on a potential difference of 0.35 V. Testing performed by HUBER+SUHNER have shown, however, that the MIL standard allows for a very high safety margin. Transitions of copper alloy plated with SUCOPLATE to passivated aluminium were tested according to:

- MIL 202, Method 6, 10 days at high humidity and temperatures of 25 °C and 50 °C, followed by
- MIL 202, Method 100, Condition B, salt mist and afterwards followed again by
- MIL 202, Method 6, 10 days at high humidity and temperatures of 25 °C and 50 °C.

As a result, neither the contact resistance changed significantly nor essential effects of corrosion occurred. The chromate layer obviously fulfils its corrosion-inhib-iting function excellently.

In this context another fact is important for the maintenance of a low contact resistance. Through the soft-copper washer, which is provided by HUBER+SUHNER, a water-protected contact area is formed according to the effects mentioned in the previous section. Thus, electrochemical corrosion is prevented within the important contact zone. Therefore, a corrosion-inhibited degradation of the contact resistance at the bulkhead transition is not possible. This can be expected obviously only under the condition that the fixation nut is tightened applying the appropriate torque force.

Taking into account the theoretical aspects of electrochemical corrosion, we recommend steel panels over aluminium panels for long-term outdoor applications to achieve a safe and reliable long-term stability (mechanically and, ultimately, electrically). In addition, safety increases with wall thickness.

Material selection and design of HUBER+ SUHNER products take these effects into consideration and provide a long-term safety and reliability.

Lightning EMP protectors made of aluminium

The trend towards industrial solutions which are expected to ensure optimum performance while minimizing weight is increasing steadily. The scarcity of raw materials is becoming more acute as a result of the rapid development of global markets. Stringent environmental requirements ranging from production to disposal are bringing into question conventional products of plated brass. In view of these conditions, aluminium as an engineering material offers opportunities for developing ideal products. HUBER+SUHNER have identified their customers' needs and developed a new generation of lighting EMP protection systems. Further details are discussed in our White Paper Aluminium. This paper is available upon request (refer to DOC-0000324906).

Galvanic corrosion is the most frequent form of aluminium corrosion. A humid environment in combination with sea salt will further accelerate galvanic corrosion. Aluminium is a highly reactive metal in the electrochemical series. As a result of galvanic corrosion, aluminium will act as an anode and thus corrode when in contact with other, nobler metals.

For a sustainable use and prolonged life span some simple but effective measures can be applied.

In case of outdoor application conditions the following is recommended to avoid galvanic corrosion:

- Unprotected aluminium components may only be in direct contact with: other aluminium alloys, stainless steel, zinc or tin.
  Selected mounting material which prevents forbidden metal combinations is supplied by H+S together with the lightning EMP protector, see figure 1 (i.e. stainless steel washers, nuts and bolts).
- If it is not possible to comply with the above recommendation it is mandatory to protect the contact areas between forbidden metal combinations from moisture ingress. This can emerge when an aluminium EMP lightning protector is contacted to a connector interface made of other material. Narrow gaps and treads where humidity can penetrate must be protected by means of appropriate measures like taping, coating or sealing, see figure 2 (i.e. wrapping with self vulcanizing tape).

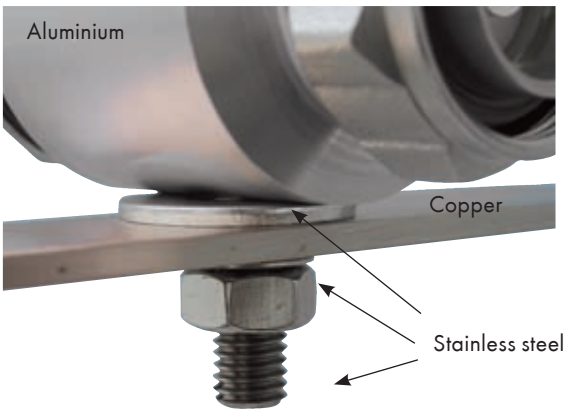


Fig. 1

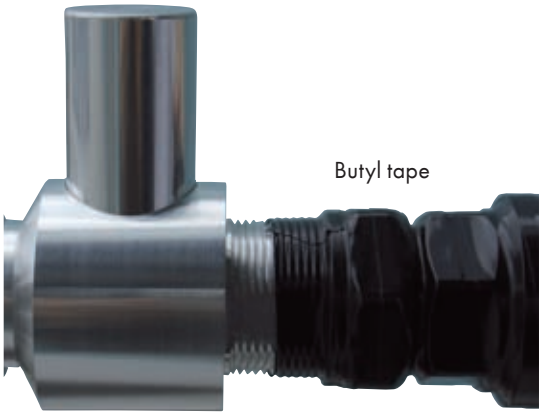


Fig. 2

In practice, the following material pairs have proven their worth.

	Aluminium alloys	Copper	Stainless steel	Galvanised steel	Tin
Aluminium alloys	OK	X	OK	OK	OK
Copper	X	OK	OK	X	OK
Stainless steel	OK	OK	OK	OK	OK
Galvanized steel	OK	X	OK	OK	OK
Tin	OK	OK	OK	OK	OK

In order to minimise contact corrosion of metal components in outdoor applications, the difference between the electrochemical potentials of unprotected connections must not be higher than 300 mV, and for well protected connections not more than 600 mV.

General information

General mounting and grounding instructions

(refer to DOC-0000176104)

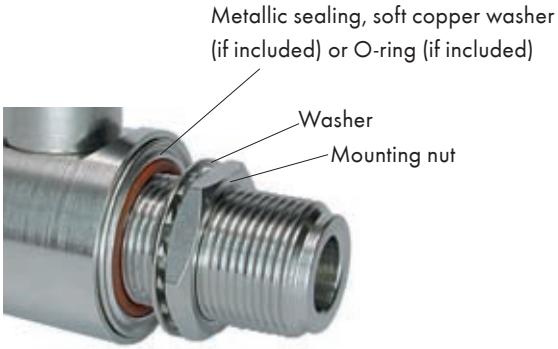
CE Series 3400, 3401*, 3402*, 3403, 3404, 3405, 3406, 3407, 3408*, 3409 and 3410 are compliant to the international standard IEC 61643-21.

*Products delivered ex works without inserted gas discharge tubes are not subject to EC directives and are therefore not marked.

HUBER+SUHNER EMP protectors provide reliable protection against dangerous surge signals on coaxial lines. This includes all kinds of interference e.g. resistive, magnetic field and electric field coupling caused by lightning strikes, switching and other natural or man made electrical effects.

Integration of protective devices

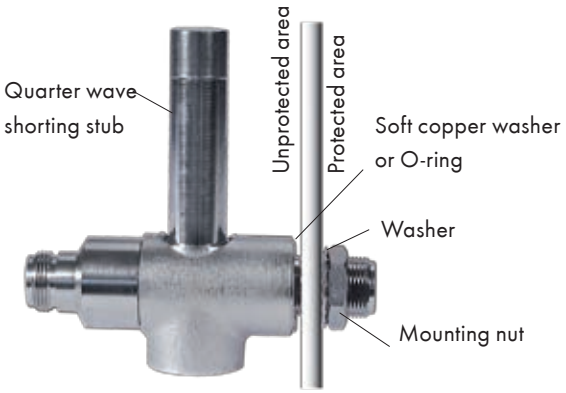
The international standard IEC 62305 describes protection against lightning. According IEC 62305 the protective device integration is based on the lightning protection zone (LPZ) concept with bonding and shielding.



1. Preferred installation

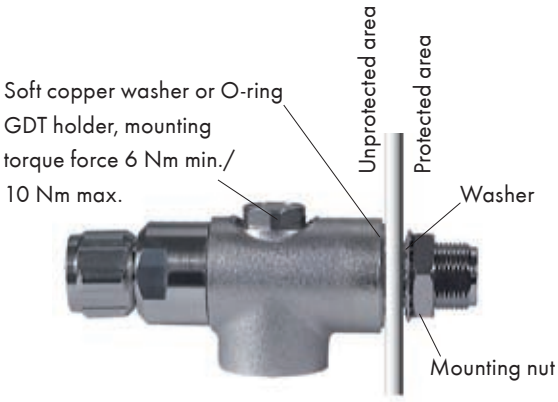
The protection zone principle favours the feed-through installation in a well conductive and grounded panel which is simultaneously the boundary to the higher protection zone containing the equipment to be protected. It is recommended to place quarter-wave (QW) or gas discharge tube (GDT) protective devices as follows: at the line entrance into the structure or alternatively close to the equipment to be protected.

Protectors without GDT
Series 3400, 3407



Well conducting and grounded bulkhead

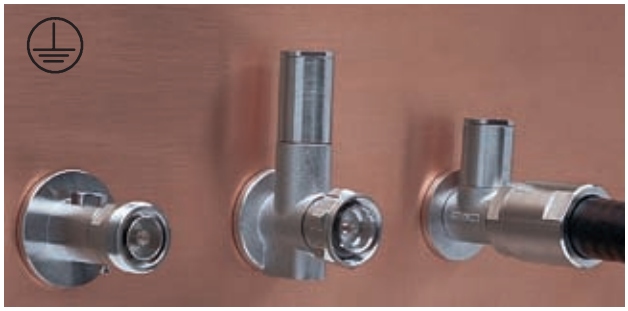
Protectors with GDT
Series 3401, 3402, 3403, 3404, 3405, 3406, 3408, 3409, 3410



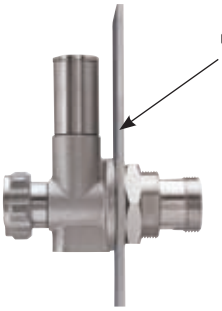
Well conducting and grounded bulkhead

Mounting torque:	AF 19 mm (3/4") max.:	20 Nm (14.7 ftlb) min./25 Nm (18.4 ftlb) max.
For mounting nut size:	AF larger 19 mm (3/4"):	35 Nm (25.8 ftlb) min./44 Nm (32.3 ftlb) max.

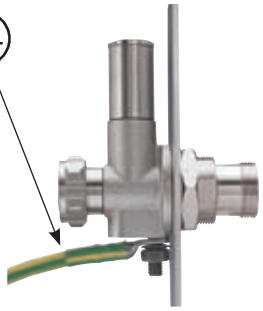
Recommendations for bulkhead mounting:



Preferred installation view to the unprotected side



Well grounded panel



Additional grounding measures are necessary if the panel is poorly grounded

These variants avoid any surge currents which are down conducted by the protector to flow inside of the protected area where they could induce secondary surge signals.

2. Alternative installation possibilities

The protectors can alternatively be installed to the equipotential bonding bar (EBB). The following shows the most common variants:

If this is not possible then the protectors should be connected to the bonding facility by a sufficiently sized grounding cable (AWG 6/16 mm2 min.) as short distant as possible (0.5 m max.)

Via screw to EBB

Via screw and grounding cable to EBB

Via grounding lug and cable to EBB

3. Further general recommendations and hints

- The protector should be grounded directly if any possible (not via the connected cable screen) to keep the ground connection as short as possible.
- Take care for clean and smooth contact transitions when installing. This is also important for waterproof bulkhead installations.
- Torque for bulkhead mounting/grounding for mounting nut size:
  - AF 19 mm (3/4") max.:
    20 Nm (14.7 ftlb) min./25 Nm (18.4 ftlb) max.
  - AF larger 19 mm (3/4") max.:
    35 Nm (25.8 ftlb) min./44 Nm (32.3 ftlb)
- Waterproof installations require suitable IEC/MIL conform counter connectors (male connectors include sealing ring) which must be properly tightened.
- With GDT protectors of series 3401, 3402, and 3408 (normally delivered without GDT) select and insert the suitable GDT according to RF power.

Coupling nut torque forces must not exceed IEC standard or manufacturer detail specifications (IEC: DIN 7/16 - 30 Nm (22.1 ftlb) max. and N - 1.13 Nm (0.8 ftlb) max.).

- Select the GDT with the lowest suitable static sparkover voltage to achieve best protection. Generally the minimum value of the static sparkover voltage must not be lower than 1.5 times the peak voltage $\hat{u} = \sqrt{2}PZ \cdot (1 + \Gamma) + U_{DC\_SUP}$ (RF and DC supply voltage) on the line.
- Recommended GDT holder torque force:
  6 Nm (4.4 ftlb)
- Series 3403, 3404, 3405, 3406, 3409 and 3410 products are shipped with GDT included.
- When connecting cables the protector has to be counter-held by a spanner across existing flats on the protector head:
- The bending moment created by connected cables must not exceed specified values (DIN 7/16 - 50 Nm (36.6 ftlb) max. and N - 1 Nm (0.7 ftlb) max.).
- If exposed to extreme environmental conditions, especially icy conditions or polluted atmosphere, the protector should be covered with a self-vulcanising tape or a cold shrink tube.
- Especially protectors made of aluminium mated with connectors made of copper-alloy base material and trimetal or nickel plating must be taped to improve long-term durability.
- When installing and grounding EMP protection devices the electrochemical potential between different metallic contacts should not exceed 300 mV. If exceeding the contact area must be taped, coated or sealed in order to minimize electrochemical corrosion.
- Any liability or responsibility for the result of improper installation is disclaimed.

Warning

Disconnect or switch off in-line equipment when installing, checking, disconnecting and connecting EMP protectors. This includes also the exchange of gas discharge tubes. Keep back from such activities during thunderstorms.
Be aware that only a complete protection system according to IEC 62305 can protect your equipment and personnel against the impact of lightning.
This includes an external lightning protection system with air terminal, down conductor and grounding system and bonding of all incoming and outgoing lines (e.g. protectors for mains, data and telephone lines) - not RF lines only.
With gas discharge tube protectors take care that the GDT has been properly installed before putting the equipment into operation.

Radio frequency bands

Band	Nomenclature	Frequency
ELF	Extremely Low Frequency	3 - 30 Hz
SLF	Super Low Frequency	30 - 300 Hz
ULF	Ultra Low Frequency	300 - 3000 Hz
VLF	Very Low Frequency	3 - 30 kHz
LF	Low Frequency	30 - 300 kHz
MF	Medium Frequency	300 - 3000 kHz
HF	High Frequency	3 - 30 MHz
VHF	Very High Frequency	30 - 300 MHz
UHF	Ultra High Frequency	300 - 3000 MHz
SHF	Super High Frequency	3 - 30 GHz
EHF	Extremely High Frequency	30 - 300 GHz

Selected radio and microwave application

ILS, Back Course Marker	75 MHz
ILS, Runway Localizer	108 - 118 MHz
PMR, Paging	146 - 174 MHz
ILS, Glide Slope Transmitter	328 - 335 MHz
Tetra, Tetrapol	380 - 512 MHz
LTE, Long Term Evolution	700 MHz band USA
GSM 850	824 - 894 MHz
GSM 900	890 - 960 MHz P-GSM 880 - 960 MHz E-GSM 876 - 960 MHz R-GSM
TACS (N+E)	860 - 949 MHz
Tetra	870 - 925 MHz
DME	960 - 1215 MHz
ASR	1030 - 1090 MHz
IFF	1030 MHz
GNSS	1215 - 1240 MHz
GPS L2	1227.6 MHz
PDC	1429 - 1501 MHz
GNSS	1559 - 1610 MHz
GPS L1	1575.4 MHz
GSM 1800	1710 - 1880 MHz DCS 1800
GSM 1900	1850 - 1990 MHz DCS 1900
DECT	1880 - 1900 MHz
IMT-2000 / UMTS	1885 - 2200 MHz
WCDMA / TD-SCDMA	1850 - 2025 MHz
ISM	2400 - 2500 MHz
WLL (IEEE 802.11)	2400 - 5825 MHz
ASR	2700 - 2900 MHz
MLS	5030 5150 MHz
ISM	5725 - 5875 MHz

Glossary

Important terms and abbreviations of wireless communications and lightning protection.

A

Ampere
Unit of electrical current.

AC
Alternating Current – refers to power supply applications with frequencies of e.g. 50 or 60 Hz normally.

AMPS
Advanced Mobile Phone Service – US analog mobile phone standard.

ANSI
American National Standards Institute
Co-ordinator of US voluntary national standards and US representative within ISO and IEC.

Arc Voltage
Increasing current drives the gas discharge tube (GDT) into the arc state. The resulting voltage across the GDT is the arc voltage (UARC).

ASR
Airport Surveillance Radar.

Attenuation (α)
The decrease of a signal with the distance in the direction of propagation. Attenuation may be expressed as the scalar ratio of the input power to the output power, or as the ratio of the input signal voltage to the output signal voltage.

AWG
American Wire Gauge.
US standard for wire sizes.

B

Bandwidth
The range of frequencies for which performance falls within specified limits.

BLIDS
Lightning information service provided by Siemens.

BNC (Bayonet Navy Connector)
Coaxial connector interface definition, miniature size.

Body
Central part and housing of coaxial components or devices, as e.g. coaxial lightning protectors.

Bonding
All measures for a proper potential equalization.

Bonding Bar
Potential equalization facility – part of the LPS.

BS
British Standards Institute.

Bulkhead
A term used to define a mounting style of connectors. Bulkhead connectors are designed to be inserted into a panel cutout from the rear (device side) or front side of the panel.

BSC
Base Station Controller.

BTS
Base Transceiver Station – main part of cellular mobile communications networks, radio transceiver for communications with mobile phones.

BWA
Broadband Wireless Access

C

C – Coulomb
Unit of electrical charge (1 C = 1 As).

C (connector)
Coaxial connector interface definition, standard size.

Capacitance
The property of an electrical conductor (dielectric in a capacitor) that permits the storage of energy as a result of electrical displacement. The basic unit of capacitance is the Farad, however, measurement is more commonly in microfarads or picofarads.

CATV
Common Antenna Television – cable television.

CCIR
Comité Consultatif International des Radiocommunications.

CDMA
Code Division Multiple Access – spread spectrum technology for digital mobile communications.

Centre frequency
Mid-band frequency of a band-pass RF device, as e.g. quarter-wave protectors.

CEPT
European Conference of Postal and Telecommunications Administration.

Cloud-earth lightning
Lightning between cloud and earth (in the standard case from the negatively charged cloud to the positively charged earth).

CFR
Code of Federal Regulations (USA).

CIGRE
Conférence Internationale des Grands Réseaux Electriques à haute tension (International Conference on Large High Voltage).

Coaxial Cable (Line)
For transmission of RF/microwave signals in the TEM mode.

Combiner
RF circuit for the summation of several carriers within a defined frequency range.

Conductivity
A measure of the ability of a material to conduct electric current under a given electric field. Resistivity is the reciprocal of conductivity.

CT
Cordless Telephone.

Current-handling capability
Surge pulse current down-conducting capacity of a protector.

Cut-off Frequency
Upper frequency limit of a coaxial device.

CWG
Combination Wave Generator (surge pulse test generator 1.2/50; 8/20 µs according to IEC 61000-4-5).

CW
Continuous Wave.

CW power
Continuous RF power.

D

DAB
Digital Audio Broadcast.

DASR
Digital Airport Surveillance Radar.

dB – Decibel
Relative, dimensionless unit – 10 times the logarithm to the base ten of a power ratio or 20 times the logarithm to the base ten of a voltage ratio.

dBm
Absolute level of signal power with the reference 0 dBm being equal to 1 milliwatt.

dBc (Carrier)
Ratio of signal power to total carrier power.

DC
Direct current – a steady current in one direction.

DC Throughput
DC can be carried.

DC Injection
Component featuring an DC input/output.

DCS 1800
Digital Cellular System (1710 to 1880 MHz, GSM protocol).

DECT
Digital Enhanced Cordless Telecommunications (1880 to 1900 MHz, previously «Digital European Cordless Telephony»).Dielectric Withstanding Voltage
The maximum potential gradient that a dielectric material can withstand without failure.

DIN (Deutsche Industrienorm)
German Industry Standard.

DIN 1.6/5.6
Coaxial connector interface definition, standard size (outer diameter of inner conductor 1.6 mm, inner diameter of outer conductor 5.6 mm).

DIN 7/16
Coaxial connector interface definition, large size (outer diameter of inner conductor 7 mm, inner diameter of outer conductor 16 mm).

Diplexer
RF circuit for the combination of several carriers into one transmission line.

Direct Stroke
Direct lightning hit into a structure or equipment.

DLP
Data Line Protector.

DME
Distance Measuring System (DME, TACAN, SSR, MIDS, GNSS).

DQPSK
Differential Quadrature Phase Shift Keying.

Duplexer
RF circuit for simultaneous combination and splitting of several carriers for receive and transmit on one transmission line.

DUT
Device Under Test.

Dynamic Spark-over Voltage
Voltage which ignites the gas discharge tube in the case of a voltage rise of 2 kV/µs (U_{Zdyn}).

E

EAMPS
Extended Advanced Mobile Phone Service.

E-GSM
Enhanced Global System for Mobil Communications.

EMI – Electromagnetic Interference
Resistive, magnetic field and electric field cou pling effects caused by surge pulses in general.

EMC
Electromagnetic Compatibility.

EMP
Electromagnetic Pulse.

EM-Terrorism
Terrorism acted by EMI-producing devices.

EN
European Standard

ERC
European Radiocommunications Committee (of CEPT – European radio spectrum management).

ESD
Electrostatic Discharge.

ERMES
European Radio Messaging System.

ETACS
Extended Total Access Communications System.

ETSI
European Telecommunication Standards Institute.

Exo-NEMP
Exo-atmospheric Nuclear Electromagnetic Pulse.

Endo-NEMP
Endo-atmospheric Nuclear Electromagnetic Pulse.

F

F
Coaxial connector interface definition, miniature size.

Faraday Cage
Electric field screen for effective attenuation of electric and electromagnetic fields

FCC
Federal Communications Commission (USA).

FDD
Frequency Division Duplex.

FDMA
Frequency Division Multiple Access.

FDR
Frequency Domain Reflectometry.

Feed-through
Preferred HUBER+SUHNER® protector design enabling bulkhead installation and thus a consequent establishment of protection zones according to IEC 61312-1.

FPLMTS
Future Public Land Mobile Telecommunication System (1885–2025 MHz and 2110–2200 MHz, according to resolution 716 of WRC–95) removal term IMT-2000.

FSK
Frequency Shift Keying.
Basic digital signal modulation principle.

G

GDT
Gas Discharge Tube (gas capsule).

GFD Map
Ground Flash Density Map – showing no. of lightning hits per square mile or square km.

Gigahertz (GHz)
One billion cycles per second (10^9 cps).

GLC
Ground Loop Coupling.

Glonass
Global Orbiting Navigation Satellite System.
(Operator Russia – operation centre frequencies 1246 (1242–1252) MHz and 1602 (1598–1610) MHz).

Glow discharge voltage
Residual voltage across the gas discharge tube (GDT) when the discharge current operates the GDT in the glow state – typically at 10 mA (U_B).

GMSK
Gaussian Minimum Shift Keying.
Digital signal modulation principle.

GNSS
Global Navigation Satellite System (European system on scratch).

GPS
Global Positioning System (US military-operated positioning system – operation frequencies 1227.60 and 1575.42 MHz).

Grounding
All measures to lead a lightning current properly to earth (preferential system of earth termination for charge equalization).

GSM
Global System for Mobile Communications (previously «Groupe Spéciale Mobile»).

GSM-R
Global System for mobile communications for railway networks (GSM-F).

H

Hertz (Hz)
International standard unit for cycles per second.

HIPERLAN
Wireless LAN for mobile computing and multi-media applications.

I

IEC
International Electrotechnical Commission.

IEEE
Institute of Electrical and Electronics Engineers (USA).

IFF
Identify Friend or Foe.

IL Insertion Loss
The loss in load power due to the insertion of a device, connector or device at some point in a transmissions system. Generally expressed in decibels as the ratio of the power received at the load before insertion of the apparatus, to the power received at the load after insertion.

ILS
Instrument Landing System.

IM/PIM (Passive Intermodulation)
Nonlinear characteristics of RF devices cause undesirable signals by modulation effects in the case of several carriers being transmitted.

Impedance (characteristic, Z_0)
Nominal impedance of an RF device.

Impulse discharge current
Peak value of a defined current pulse which is allowed to be applied at least ten times at intervals of 30 seconds without causing any significant changes of the spark-over voltage specification. Values are given for a current pulse shape definition of 8/20 µs (rise time/half-value period) (I_S).

IMT-2000
International Mobile Telecommunication 2000 (1885–2025 MHz and 2110–2200 MHz according to resolution 716 of WRC-95) – also FPLMTS.

Inductance
The property of a circuit or circuit element that opposes a change in current flow, thus causing current changes to lag behind voltage changes. It is measured in Henrys.

Interface
The two surfaces on the contact side of both halves of a multiple-contact connector which face each other when the connector is assembled.

Intermodulation
Refer to IM/PIM.

ISM
Industrial, Scientific, Medical

ISO
International Standardisation Organisation.

Isokeraunic Level Map
Map showing lines of equal no. of thunderstorm days per year (isobronts), sometimes written «isoceraunic».

ITU
International Telecommunications Union (Headquarters Geneva/Switzerland).

J

JCT
Japanese Cordless Telephone.

Joule
Unit of energy (1 J = 1 Ws = 1 Nm)

JTACS
Japanese Total Access Communication System.

K

L

LAN
Local Area Network.

LEMP
Lightning Electromagnetic Pulse.

LPS
Lightning Protection System.

LPZ
Lightning Protection Zone.

LTE – Long Term Evolution
LTE is a set of enhancements to the Universal Mobile Telecommunications System (UMTS) which will be introduced in 3rd Generation Partnership Project (3GPP) Release 8. Much of 3GPP Release 8 will focus on adopting 4G mobile communications technology. Frequency band allocations are defined by 3GPP.

M

Maximum pulse current
Peak value of a defined single current pulse which can be conducted to ground without mechanical destruction or restriction of the protection function. For pulse shape refer to I_S (I_{SG}).

MCX (MICROAX)
Coaxial connector interface definition, subminiature size.

MIDS
Multi Functional Information Distribution System.

MIL-STD
Military standard (USA).

MLS
Microwave Landing System.

MSC
Mobile Switching Centre.

MSK
Minimum Shift Keying.
Basic digital signal modulation principle.

MSS
Mobile Satellite Service.

MTBF
Mean Time Between Failures.

N

N (Navy Connector)
Coaxial connector interface definition, standard size.

NEMP
Nuclear Electromagnetic Pulse (EMI caused by nuclear explosions).

NEMP Protectors
Protectors designed for the very fast NEMPs – a speciality of HUBER+SUHNER AG since 1975 – for coaxial and twin-axial transmission line applications.

NFPA
National Fire Protection Association.
(USA – general standards for lightning protection).

NMT
Nordic Mobile Phone (Europe).

NTIA
National Telecommunications and Information Administration (USA – radio spectrum management).

O

P

Passive Intermodulation
Refer to IM/PIM.

PCB
Printed Circuit Board.

PCN
Personal Communication Network (Europe).

PCS
Personal Communication Systems (North America).

PCS 1900
North American digital mobile communications standard.

PDC
Personal Digital Communications.

PEP
Peak Envelope RF Power

PHS
Personal Handyphone System (Japan).

Planar antenna
Special flat antenna design, suitable for wall integration, i.e. HUBER+SUHNER SPA series antennas.

Plating
Special metal surface layer of metal component parts, deposited galvanically or chemically – for improvement of electrical contact and environmental performance.

PMR
Professional/Private Mobile Radio.

POTS
Plain Old Telephone Service.

PSK
Phase Shift Keying.
Basic digital signal modulation principle.

PTFE (Polytetrafluorethylene)
High-grade isolation material of electronics, unaffected by sunlight, moisture (not wettable) and virtually all chemicals.

Q

QAM
Quadrature Amplitude Modulation.
Basic digital signal modulation principle.

QLA
Coaxial connector interface definition, subminiature size.

QPSK
Quadrature Phase Shift Keying.
Digital signal modulation principle.

R

Radio transceiver
Radio station for simultaneous transmit and receive operation, e.g. BTS

Reflection
See VSWR and RL – return loss.

Residual pulse (voltage and energy)
Output pulse of a protector in the case of any EMI, characterized by its voltage amplitude and energy.

RET
Remote Electrical Tilt unit (antenna drive unit).

RF
Radio Frequency.

RFI
Radio Frequency Interference.

R-GSM
Railway GSM.

Rise Time
Pulse front steepness specification, time period between 10% and 90% of amplitude.

RL – Return Loss
Part of signal which is lost due to reflection of power at a line discontinuity or mismatched RF device.

RLL
Radio in the Local Loop (also WLL).

rms (root mean square)
Characteristics of a sine-wave signal, effective value – important for power calculations.

Rx
Receive (path).

S

Screening Effectiveness
Ratio of the power fed into a coaxial cable to the power transmitted by the cable through the outer conductor.

SEMPER™
Self-extinguishing gas discharge tube protector

Shielding/Screening
Measures to reduce the effects of electromagnetic fields on electronic circuits (attenuation of the electric and magnetic field).

SMA (Subminiature A)
Coaxial connector interface definition, subminiature size.

SMS
Short Message Service.

SPD
Surge Protection Device.

Specific energy (action integral)
Characteristics of a surge current pulse, formula $W/R = \int i^2L * dt$ (unit MJ/W or kA^2s).

SSR
Secondary Surveillance Radar.

Static spark-over voltage
Voltage which ignites the gas discharge tube in the case of a voltage rise of less than 100 V/ms (U_{Zstat}).

SUCOPLATE®
HUBER+SUHNER® proprietary plating for optimum electrical and environmental performance of RF components, nonmagnetic copper, tin, zinc alloy.

Surge
Overvoltage in general.

Surge Arrestor
Alternative name for surge protector (occasionally also for lightning protector).

Surge suppressor
Alternative name for surge protector (occasionally also for lightning protector).

T

TACS
Total Access Communication System.

TACAN
Tactical Air Naviation.

TDD
Time Division Duplex.

TDMA
Time Division Multiple Access
Digital wireless communications modulation principle where every user channel is formed by a fixed time slot.

TDR
Time Domain Reflectometry.

TETRA
Terrestrial Trunked Radio.

TNC (Threaded Navy Connector)
Coaxial connector interface definition, miniature size.

Total Charge
Characteristics of a surge current pulse, formula $Q = \int iL * dt$ (unit As or C).

Tx
Transmit (path).

U

UHF (Ultra-High Frequency)
Coaxial connector interface definition, standard size.

UL
Underwriters Laboratory

UMTS
Universal Mobile Telecommunications System
Third generation mobile communication system being developed in Europe (European version of IMT-2000/ FPLMTS considered to be compatible)

V

Volt
Unit of electrical voltage.

VSWR
Voltage Standing Wave Ratio – ratio of U_{max} / U_{min} on an RF transmission line.

W

Wave Guide
Line for transmission of RF/microwave signals in the TM mode – hollow tube design.

W-CDMA
Wideband Code Division Multiple Access.

WiMAX
Worldwide interoperability for Microwave Access

WLAN
Wireless Local Area Network.

WLL
Wireless Local Loop (refer also to RLL).

WRC
World Radio Conference.

X

Y

Z

Special product enquiry form

In the case that you do not find a suitable lightning EMP protector within the presented product range you are invited to call our next available representative or to make use of our HUBER+SUHNER Internet home page www.hubersuhner.com for further information or contacts.
For the most effective discussion of your needs we would like you to fill in the following form. It can also be faxed to us. Once contacting us via Internet the home page will guide you in the products section to our "lightning EMP protector search page" for electronic processing and E-mailing as well.
Short term response guaranteed.

(NSI form – full page for direct copying, including customer's address data, technical specification needs and commercial aspects)

NSI – Lightning protectors for RF applications

Date

Name

Company

Address

Communication data (phone, fax, e-mail)

Application, equipment to be protected

Quantity (Qty) | Price limit

Samples Qty, date | First delivery Qty, date

Technical requirements

Electrical:

Line impedance (Ω) | Frequency | Frequency range

Special RF requirements (RL >20 dB, IL <0.2 dB)

RF power (Watts) | PIM requirement (dBc)

DC powering (DC on the coaxial line to supply e.g. outdoor equipment)

DC injection required – voltage | current

Protection – surge current handling requirements

- residual pulse requirements/voltage protection level

Environmental:

Operation temperature range

Waterproof IP (IEC 60529) IP

Special requirements

Design and Material:

Connector interface on both ends (series, connector, male/female) unprotected side | protected side

Mounting requirements – bulkhead (panel thickness), screw, bracket

DC injection/port connector QLA, MCX, other

Dimensions – any limitation?

Comments

Type index

Series 3400

Series 3401

Series 3402

Series 3403

Series 3404

Series 3406

Series 3407

Series 3409

Series 3410

Series 3414

High voltage DC blocks

Gas discharge tube

Accessories

Accessories (cont.)

Grounding kits

General, detailed selection flow chart for HUBER+SUHNER lightning protectors

Basic decision -

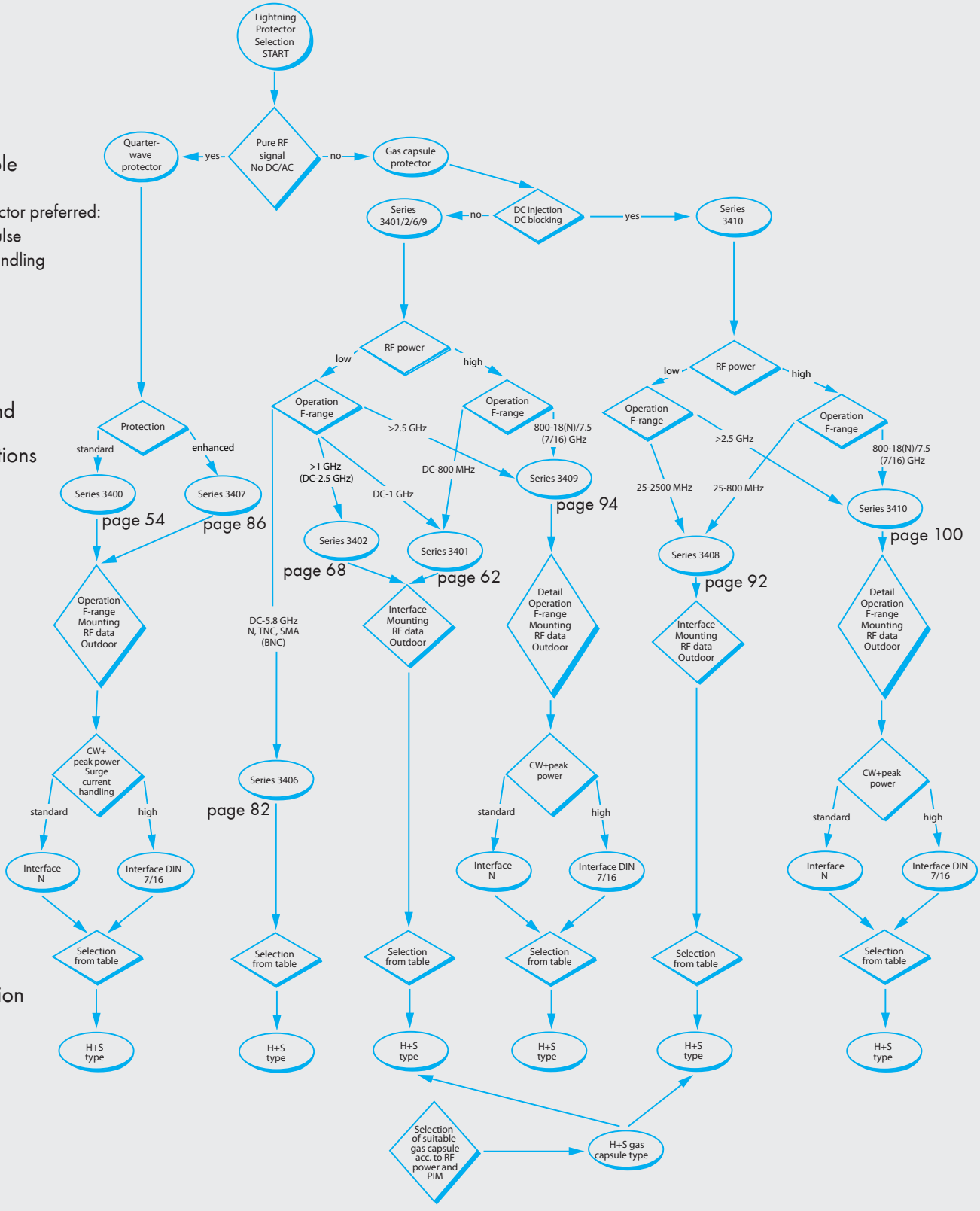
protector principle

Quarter-wave protector preferred:
- lowest residual pulse
- highest current handling
- lowest PIM
- maintenance-free

RF, protection and

further specifications

Final type selection



For uncertainties and difficult cases contact our web site www.hubersuhner.com or call.

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WAIVER

It is exclusively in written agreements that we provide our customers with warrants and representations as to the technical specifications and/or the fitness for any particular purpose. The facts and figures contained herein are carefully compiled to the best of our knowledge, but they are intended for general informational purposes only.

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